

DEVELOPMENT PERMIT

NO. DP-2017-18-AM2

TO: **The George Gibsons Development Ltd**
Attn: Klaus Fuerniss

ADDRESS: **P.O. Box 570**
Gibsons, B.C. V0N 1V0
(Permittee)

- 1) This Amended Development Permit (DP-2017-18-AM2) is issued subject to compliance with all of the Bylaws of the Town of Gibsons applicable thereto, except those specifically varied or supplemented by this Permit.
- 2) This Development Permit amends DP-2017-18, and DP-2017-18-AM1 previously issued on August 1, 2017 and May 1, 2019.
- 3) The Development Permit applies to those "lands" as well as the Winn Road area, east of Gower Point Road as described below:

Parcel Identifier	Legal Description	Civic Address
007-359-870	Lot 2, Block A, District Lot 686, Plan 14197	377 Gower Point Road
007-359-829	Lot 1, Block A, District Lot 686, Plan 14197	385 Gower Point Road
011-118-202	Lot 1, except the east 157 feet, Block A, District Lot 685, Plan 5579	397 Gower Point Road
011-117-524	Lot A (see 450146L) of Lot 1, Block A, District Lot 685, Plan 5579	689 Winn Road
011-118-211	Lot 2, Block A, District Lot 685, Plan 5579	407, 409 Gower Point Road

- 4) The "lands" are within Development Permit Area('s) of the Town of Gibsons Official Community Plan (Bylaw 985, 2005). This permit applies to Development Permit Area No. 9 for the purpose of protection of the Gibsons Aquifer. Specifically, this permit includes ground improvements necessary for the construction of the George Hotel and Residence buildings on the landward side only, including:
 - o Removal of contaminated materials
 - o Cone penetration tests
 - o Installations of piezometers
 - o Test trenching
 - o Field verification trial
 - o Deep mixing
 - o Replacement of existing sanitary sewer Construction of stormwater channel, north of the site
 - o Ancillary works associated with the above

- 5) The "lands" described herein shall be developed strictly in accordance with the terms and conditions and provisions of this Permit, and any plans and specifications attached to this Permit which shall form a part thereof; specifically:
 - a) Geosystems. L.P.: Summary of items required as permitting conditions (May 29, 2017)
 - b) Isherwood Geostructural Engineers: Technical Memorandum No. 3 Deep Mixing Design Basis Memorandum, including appendices (July 27, 2017)
 - c) Letter from Golder Associates Ltd: DPA9 Permit Review – George Gibsons Marine Report & Residences, dated May 1, 2019
 - d) Horizon Engineering Inc.: Proposed "The George" Mixed Use Development at Gower Point road and Winn Road, Gibsons, BC, Proposed Subsurface Investigation Program, dated May 1, 2019
 - e) Horizon Engineering Inc.: Proposed Drilling Program for The George Project, dated April 4, 2019
 - f) Horizon Engineering Inc.: map of test hole location plan, revised April 23, 2019
- 6) A minimum of 48-hours' notice prior to commencing excavation or drilling is to be provided to the Director of Infrastructure Services.
- 7) All requirements of the specifications are to be followed. On site monitoring by Horizon Engineering and Golder Engineers is required as set out in the attached documents.
- 8) Golder Associates Ltd are to perform all roles and responsibilities previously to be undertaken by Isherwood Geostructural Engineers, as set out in Isherwood Technical Memoranda dated June 9, 2017, June 22, 2017, and July 27, 2017 (attached).
- 9) On site monitoring by a qualified hydrogeologist is required.
- 10) Minor changes to the aforesaid specifications that do not affect the intent of this Development Permit are permitted only with the approval of the Town of Gibsons, Horizon Engineering, and Golder Engineers.
- 11) The Town reserves the right to engage its own hydrogeologist to review the drilling process and report to the Director of Infrastructure Services of any concerns or questions. The Director of Infrastructure Services will communicate directly with Horizon Engineering with any concerns.
- 12) All contractors and consultants to provide copies of their insurance naming the Town of Gibsons as additional insured prior to commencing work on site.
- 13) The approved Drilling Program is to be provided to all parties listed on the first page of the Program prior to mobilizing to site. All parties are to sign the final page of the Drilling Program with a copy provided to the Director of Infrastructure Services.
- 14) Soil remediation methodology used is to be the lowest risk option for any given subarea of the site. Option 1 (Conventional Deep Mixing Methods or DMM) as outlined in the Isherwood memorandum is not permitted.

- 15) A meeting is to be held for the purposes of reviewing geotechnical reports and investigations to date, roles and responsibilities, and to review the following items as outlined in the memorandum dated May 29, 2017 from Geosystems, L.P. and Isherwood Technical Memorandum No. 3 dated July 27, 2017:
- a. Design Basis Memorandum;
 - b. Calculation check on the uplift stability of the aquiclude during all construction phases;
 - c. Consolidated Geotechnical Data Report and Geotechnical Interpretive Report;
 - d. Audit of existing geotechnical instrumentation and data collected to date;
 - e. Timing of development of Field Verification Trial Proposal;
 - f. Review of procedures relating to excavation, foundation treatment, breach remediation plan, personnel safety, instrument monitoring and analysis.

Parties to be present at this meeting are the appropriate representatives from Horizon Engineering, Golder Associates, Geosystems L.P., George Gibsons Development Ltd, Waterline Resources, and the Town of Gibsons. The meeting is to be jointly chaired by Horizon and Golder. All above documentation is to be distributed to all parties a minimum of 60 days prior to the meeting date.

- 16) If the Permittee does not commence the development permitted by this Permit within twenty-four months of the date of this Permit, this Permit shall lapse.
- 17) All well logs are required upon completion of the works approved under this permit.
- 18) A letter from the qualified professional is required upon completion of the works approved under this permit.
- 19) This Permit is NOT a Building Permit.

ISSUED THIS 15th DAY OF MAY, 2019.



Lesley-Anne Staats, MCIP, RPP
Director of Planning

Copy of permit to

- Ernie Turner, Applicant
- Geotechnical Engineer, Karim Karimzadegan, M.A.Sc., P.Eng. Horizon Engineering Inc.
- Golder Associates Ltd.
- Qualified Environmental Professional, Michael Geraghty, M.Sc., P. Geo., PMP
Keystone Environmental

GEOSYSTEMS, L.P.

P.O. Box 237, Venetia, PA 15367, USA Phone: (724) 942-0570 Fax: (724) 942-1911
Email: dabruce@geosystemsbruce.com Website: www.geosystemsbruce.com

May 29, 2017

Town of Gibsons
Attn: Mr. Dave Newman
Director of Engineering
P.O. Box 340
474 South Fletcher Road
Gibsons, BC V0N 1V0

THE PROPOSED “THE GEORGE” MIXED USE DEVELOPMENT SUMMARY OF ITEMS REQUIRED AS PERMITTING CONDITIONS

Dear Sir:

As requested during our teleconference of Tuesday, May 23, 2017, I provide herein a list of actions and initiatives I regard as essential for the Proponent (and his Engineer-of-Record) to commit to undertake as conditions for permit approval. Kindly note there will be some overlap between this letter and my other letter of today's date (reviewing Horizon Engineering Inc.'s Draft Report of May 15, 2017), but there should be no inconsistencies. Further, it should be reiterated that many of these actions are required to be implemented just before or during construction, and so cannot be completed before the permitting process is undertaken: I believe what we seek is the *commitment* of the Proponent to assure that implementation will occur. Kindly note the following list applies solely to the engineering and construction aspects of the project, and does not address other spheres (e.g., environmental protection or well head protection) which are also integral to your permitting process.

In my opinion, the Proponent should commit to implementing the following items as conditions of being awarded the relevant permits.

- (i) Production of a Design Basis Memorandum, describing the choice of the foundation system and how the details are related to all relevant structural loading conditions. (Timing: prior to development of the Field Verification Trial Proposal.)
- (ii) Checking calculations on the uplift stability of the aquiclude, during all construction phases. (Timing: prior to development of the Field Verification Trial Proposal.)
- (iii) Production of a consolidated Geotechnical Data Report and a Geotechnical Interpretative Report. (Timing: prior to development of the Field Verification Trial Proposal.)
- (iv) Audit of existing geotechnical instrumentation (and especially of piezometer distribution in “high risk” areas), and installation of additional instruments as appropriate. (Timing: prior to development of the Field Verification Trial Proposal.)

- (v) Providing on site, throughout all phases of on site construction, the following supervisory/engineering staff, as a minimum:

- Project Manager
- Technical Manager

Each would, independently, have authority to suspend any or all construction activities in the event that there would be evidence of negative impact to the aquifer. These Professionals will be located in suitable office accommodation with communication facilities capable of real time monitoring of construction progress and geostructural instrumentation. (Timing: throughout all construction activities.)

- (vi) Production of a Field Verification Test Report detailing the design, installation, monitoring and analysis of the Field Verification Test Program. (Timing: minimum 30 days before Implementation.)
- (vii) Implementation and Analysis of aforementioned Test Program. (Timing (of final acceptance): minimum 7 days prior to commencement of Production Works.)
- (viii) Implementation of location-specific supplemental investigations to identify elevation and thickness of the aquiclude, including CPT, test pits and trenching. (Timing: prior to excavation and foundation treatment in any one area.)
- (ix) Provision of all equipment necessary to remediate any aquiclude breach occurring during construction. (Timing: throughout all excavation and foundation treatment activities.)
- (x) Development and acceptance of all submittals/work procedures relating (but not limited to):
- Excavation
 - Foundation treatment
 - Breach remediation plan
 - Personnel safety
 - Instrumentation monitoring and analysis (including threshold levels)

(Timing: prior to commencement of construction.)

Please advise if you require clarification on any of these proposed conditions.

Very truly yours,
GEOSYSTEMS, L.P.



Donald A. Bruce, Ph.D., D.GE, C.Eng., P.G. L.G., L.E.G.
President

Attention: Klaus Fuerniss

Klaus Fuerniss Enterprises Inc.
PO Box 570
Gibsons, BC
V0N 1V0

July 27, 2017
The George Development, Gibsons, BC
Job No.: 17.037
No. of Pages: 7

Technical Memorandum No 3: Deep Mixing Design Basis Memorandum

Dear Mr. Fuerniss,

This Deep Mixing (DM) Design Basis Memorandum has been prepared in support of the Development Permit Submission for Development Permit Application (DPA) 1, 2 and 9 for the proposed "The George" Mixed-Use Development, Gibsons, BC.

The objective of this DM Design Memorandum is to outline the design strategy adopted for DM, planned steps for detailed design and recommendations for DM construction. Deep Mixing "Issued for Construction" Drawings and supporting technical specifications and field trial specifications will be prepared as the project advances to Building Permit stage.

This technical memorandum has been sub-divided into the following categories:

1. Deep Mixing Scope
2. Isherwood's Role and Responsibilities
3. Reference Documents Review and DM Risk Assessment
4. Site Characterization
5. DM Design
6. DM Construction

1. Deep Mixing Scope

Isherwood Geostructural Engineers (Isherwood) has been retained by Klaus Fuerniss Enterprises Inc. on May 25, 2017 to provide Professional Engineering Services for DM ground improvement design for foundation support of the George Hotel and Residences structure only. It is understood that deep mixing is required for the main hotel and residences structure only, whilst all other proposed structures including the structures in the near-shore and off-shore areas are anticipated to be supported on deep foundations and not deep mixed areas.

The DM for foundation support will be designed to meet project-specific performance requirements under static and seismic load conditions. Refer to Horizon Engineering Inc. (Horizon)'s Geotechnical Investigation Report (Revised, July 27, 2017) for details pertaining to the proposed development. At this stage of design, the structural performance requirements for foundation support are as follows:

- **Static Conditions:**
 - Total settlement: in the order of 25 mm.

- o Differential settlement: between adjacent columns and between adjacent columns and walls, approximately 19 mm over 9.0 m.
- **Seismic Conditions** (in accordance with British Columbia Building Code 2012):
 - o Lateral displacement: between floors, 13 mm without damage to non-structural components, 50 mm without collapse of non-structural components.

Refinement of design requirements is anticipated to be carried out during detailed design, where an iterative process will be followed for structural foundations (raft, strip and pad foundations) and DM ground improvement design.

This DM Design Basis Memorandum has been prepared to provide an outline of the design approach and recommendations for DM construction including additional geotechnical and hydrogeological investigation and a DM field trial, to be carried out prior to the start of production DM. This technical memorandum provides confirmation that the DM design approach and technical recommendations for construction (including additional geotechnical and hydrogeological investigation and DM field trials) will be implemented as the project advances.

For all other geotechnical, hydrogeological and environmental aspects of this project including near-shore and off-shore areas, refer to Horizon's Geotechnical Report (Revised, July 27, 2017) and Keystone Environmental's Reports for details.

2. Isherwood's Role and Responsibilities

Isherwood has been retained as the DM ground improvement designer, responsible for DM design for foundation support of the George Hotel and Residences structure. Refer to Isherwood's Technical Memorandum No. 1 (June 9, 2017) appended to this technical memorandum for details. As part of the DM strategy, Isherwood has also provided technical input associated with contingency plans for aquifer protection. Details of the aquifer protection plans are outlined in Horizon's Geotechnical Investigation Report (Revised, July 27, 2017).

We understand that Horizon Engineering Inc. has been retained as the Project Geotechnical Engineer and is responsible for all geotechnical aspects of the project. The DM components are by Isherwood.

3. Reference Documents Review and DM Risk Assessment

Based on a review of the available reference documents prepared by the project design team and the Town of Gibsons's Peer Reviewers, a list of risk items pertaining to the DM components has been compiled. Refer to Appendix A to D as follows:

- **Appendix A:** List of available project reference documents received for DM review.
- **Appendix B:** List of risk items identified from project reference documents (Appendix A) review pertaining to DM. These risks were further grouped into three main categories for ease of assessment:
 - o General risks (GEN1 to GEN7)
 - o Design risks (DES1 to DES6)
 - o Construction risks (CON1 to CON4)

- **Appendix C:** List of general and design related risks with summary mitigation approach outlined.
- **Appendix D:** List of construction risks with an assessment considering the three main options for ground improvement for foundation support, previously discussed in “Evaluation of the viability of a DMM option as foundation support for “The George” development, Gibsons, BC (Geosystems L.P., April 18, 2017):
 - **Option 1:** Conventional Deep Mixing Methods (DMM) using hollow stem augers, after excavation, removal of peat/organic silt and backfilling with fill.
 - **Option 2:** Deep mixing using Cutter Soil Mixing (CSM) techniques.
 - **Option 3:** Excavation and replacement under Self-Hardening Slurry (SHS).

Based on a project-specific assessment of the construction related risks and considering the main goal, which is to provide ground improvement for foundation support for the hotel and residences whilst safeguarding the integrity and quality of the Gibsons Aquifer, the construction methodology to be adopted for DM requires careful assessment. All three construction methods, Options 1 to 3 require experienced specialist Contractors and operators and their success to achieve project-specific requirements are highly sensitive to the tools used.

Based on our knowledge of the industry standard equipment, we are not aware that the monitoring equipment for Option 1 is sufficiently sensitive to allow auger/paddle mixing in the upper material to achieve a homogeneous product whilst ensuring that the tip of the auger does not penetrate more than 0.5 m into the aquitard and potentially breaching the underlying confined aquifer. Therefore, in order to minimize the risk of breaching the aquifer during DM, Option 1 is not recommended. For Option 3, excavation and replacement under self-hardening slurry is highly operator dependent (i.e. the risk of penetrating more than 0.5 m into the aquitard will heavily rely on the “feel” of the operator and the tool that is being used for excavation). Further, if the relative density of the aquitard is a gradual resistance change with depth, it would be difficult for the operator to confidently confirm that less than 0.5 m penetration into the aquitard is achieved. Of the three methods, Option 2 possesses more sensitive monitoring equipment that enables the operator to assess whether 0.5 m or less penetration into the aquitard is achieved during DM. Further, Option 2 enables peat/organic silt to be homogeneously mixed in situ to form foundation elements without the need for excavation and replacement. Therefore, based on the need to reduce the risk of breaching the underlying confined aquifer, Option 2 is recommended to be pursued for DM. It is anticipated that if Option 2 is pursued, the native peat/organic silt is expected to be left in situ and treated with the upper soils as part of the DM process.

A field trial and a cost-benefit assessment would need to be carried out to determine the most cost and schedule-efficient construction method, whilst managing project risks and meeting performance requirements. Option 2 was deemed to carry the least amount of risk concerning potential to breach the underlying aquifer compared with the other options.

The DM design approach, consistent with industry guidelines (Federal Highway Administration Design Manual: Deep Mixing for Embankment and Foundation Support, October 2013) and recommendations outlined for detailed design presented in this Technical Memorandum would be applicable to both Options 2 and 3. For the purposes of developing field trial and construction recommendations outlined in this Technical Memorandum, recommendations associated with

Option 2 have been outlined. For Option 3, some modifications would need to be made to the construction recommendations.

4. Site Characterization

Various geotechnical and hydrogeological investigations have been carried out at the project site and these have been summarized in Horizon's Geotechnical Investigation Report (Revised, July 27, 2017). The subsurface conditions within the "land-side" of the proposed development generally consist of the following variable conditions:

Soil conditions:

- Fill (granular and organic material); overlying
- Peat/Organic silt; overlying
- Sand to silty sand to sandy silt; overlying
- Silty sand to silt and sand till (where present); and
- Sand to sand and gravel to gravel.

Groundwater conditions:

- Non-artesian conditions within the upper fill and overburden (above silty sand to silt and sand till); and
- Artesian conditions within the Gibsons Aquifer (sand to sand and gravel to gravel).

Based on a review of the available geotechnical and hydrogeological data and considering the areas where ground improvement is required for foundation design, "data gaps" were identified in areas where additional soil and/or groundwater data would be beneficial to identify the elevation and thickness of the aquitard and artesian conditions to manage the risk of penetrating into the underlying confined aquifer or increasing the risk of basal instability during DM. The additional subsurface data is expected to be obtained during DM detailed design to enable refinement of the "ground and groundwater models" for DM design. For DM design, the following additional geotechnical and hydrological investigation was proposed:

- 32 No. in situ Cone Penetration Tests with pore pressure monitoring;
- 2 No. boreholes drilled for groundwater/pressure monitoring (2 No. nested vibrating wire piezometers per borehole); and
- 3 No. mechanically excavated trenches.

Refer to Isherwood's Technical Memorandum No. 2 for details pertaining to the scope of the additional investigation, including an exploratory holes location plan (Figure 1) showing existing and proposed exploratory hole locations, relative to the proposed development areas. In addition to the above additional geotechnical and hydrogeological investigation, Horizon also proposed additional groundwater monitoring at 7 No. locations, which we understood were intended for groundwater/pressure monitoring and groundwater sampling prior to, during and following completion of the DM work. Refer to Horizon's Geotechnical Investigation Report (Revised, July 27, 2017) for details pertaining to long-term groundwater monitoring strategy.

5. Deep Mixing Design

Design Philosophy

A performance-based design approach has been adopted by considering the estimated stress-deformation response of the DM areas under static and seismic conditions. The concept DM design, generally consistent with industry guidelines (FHWA, October 2013) is based on performing the following steps:

1. Establishing project performance requirements (including identifying areas where DM is required)
2. Assessing subsurface conditions (develop soil and groundwater model and characteristic parameters for analyses)
3. Preliminary analysis (stability, bearing capacity, crushing, shear and basal stability due to artesian conditions in the underlying confined aquifer) to estimate Area Replacement Ratio (ARR), treatment geometry and DM element design properties (strength, modulus and permeability).
4. Review of reference/published data to assess feasibility of DM design parameters, considering wet mixing using the CSM method of DM.

It is expected that during detailed design, and following a review of the additional subsurface data, the above steps will be revisited in order to refine the ground model and associated soil and groundwater parameters considered for analysis and progressing with the DM design. Currently, the concept DM design properties have been estimated considering raft foundations for heavily loaded areas, continuous strip foundations for moderately loaded areas and individual pad/perimeter strip foundations for lightly loaded areas (refer to Figure 1 of Isherwood's Technical Memorandum No. 2 (June, 2017) for details), as follows:

- Raft slab at P3 level (approx. EL. + 2.5 m to El. 3.0 m) – main parkade structure (west portion)
- Raft slab at P2 level (approx. EL. +3.0 m to EL+ 4.0 m) – fuel tank
- Continuous strip foundations at P3 level (EL. + 4 m) - main parkade structure (east portion)
- Raft slab at P2 level (approx. EL. +3.0 m to EL+ 4.0 m) – main parkade structure (north core)
- Pad and perimeter strip foundations at P2 level (approx. EL. +4.0 m to EL. + 5.0 m) – ancillary structures

Concept DM Design Properties

Based on the current proposed foundation layout, structural load and performance requirements and the subsurface soil and groundwater conditions, the following concept design has been estimated (subject to verification and refinement during detailed design):

- Area Replacement Ratio of approximately 0.35 to 0.40 (within proposed foundation footprint – P2 and P3 levels)
- Treatment depth of approximately 3.0 m to 5.5 m (maximum penetration of 0.5 m in aquitard)
- Treatment geometry – grid-like system with increased treatment within core, tank and other heavy load areas
- Target unconfined compressive strength, q_u of approx. 2.0 MPa

- Target Young's modulus of elasticity at 50% strain, E_{50} , is based on 300 q_u (FHWA, October 2013)

It should be noted that the above concept DM design properties are subject to verification during a full-scale field trial and further refinements are expected during detailed design.

Deep Mixing Design Information

Following completion of DM detailed design and a review of the additional geotechnical and hydrogeological data, "Issued for Construction" Drawings and Technical Specifications are anticipated to be prepared. Below is an outline of the information that is expected to be contained within the Technical Specifications (these will be developed during detailed design, prior to commencement of field trial and production DM):

- Description of the project;
- Project reference information (geotechnical report, architectural/structural/civil drawings including site plan and utility information);
- Project performance requirements (DM design properties) and acceptance criteria
- Remediation options
- List of pre-construction submittals required from Specialist DM Contractor:
 - Workplans for DM including managing obstructions and management of spoil, wet grab sampling, coring and testing;
 - Mix design;
 - Quality Assurance/Quality Control (QA/QC) plan;
 - Construction schedule;
 - Aquifer protection plan including list of equipment required; and
 - Breach of aquifer remediation plan including list of equipment required.
- List of field trial submittals:
 - Workplan and equipment required for field trials;
 - Mix designs;
 - QA/QC plan including sampling and testing requirements;
 - Data Acquisition System (including data to be submitted as part of QA/QC)
 - Aquifer protection plan including list of equipment required; and
 - Breach of aquifer remediation plan including list of equipment required.

Monitoring of groundwater conditions (quality and integrity) is anticipated to be carried out by the Project Geotechnical Engineer, Horizon. Refer to the aquifer protection plan including details pertaining to the monitoring plan and thresholds for action outlined in Horizon's Geotechnical Investigation Report (Revised, July 27, 2017).

6. Deep Mixing Construction

Full-Scale Field Trial

To verify that the construction methodology, proposed mix design(s) and aquifer protection plan meet project performance requirements and provides confirmation that a breach of the confined aquifer has

not taken place, a full-scale field trial is required. Subject to detailed design, the field trial is likely to consist of:

- 3 No. to 4 No. soil-cement elements to be constructed in various ground improvement areas (minimum 3 No. sets of design mixes with cement content of 350 kg/m³ to 450 kg/m³);
- Wet grab sampling and coring;
- Testing and reporting;
- Data acquisition system – review of select CSM parameters obtained during DM
- Monitoring of groundwater conditions (to be carried out by Project Geotechnical Engineer)

Where more than one method of ground improvement treatment is considered (e.g. Option 2 CSM and Option 3 SHS), additional soil-cement elements would need to be installed during the field trial.

Following sampling and testing (consistent with industry guidelines), all data including groundwater monitoring data is required to be provided to Isherwood for review and assessment. Isherwood is expected to provide full-time field support during the DM field trial and will prepare a field trial test report outlining the implementation of the field trial including method of installation, mixes considered and an evaluation of the performance of the soil-cement elements.

Subject to the outcome of the field trial, modifications could be required to the design and the construction method to be adopted for production DM.

During production DM, Isherwood is also expected to provide full-time technical field support, with full-time hydrogeological field support provided by Horizon.

We trust this memorandum provides sufficient information for your immediate requirements. If you have any queries, or require further input, please contact us.

Yours truly,

Isherwood Geostructural Engineers
A division of Brian Isherwood & Associates Ltd.



Marina S.W. Li, P.Eng.



Nadir Ansari, P.Eng.

Attachments:

- Technical Memorandum No. 1: Isherwood Role and Responsibilities for Deep Mixing
- Technical Memorandum No. 2: Deep Mixing – Additional Geotechnical Investigation Data

- Appendix A: Deep Mixing – List of Project Reference Documents Received for Review
- Appendix B: Deep Mixing – List of Risk Items Identified From Project Reference Documents Review
- Appendix C: Deep Mixing – General and Design Risks and Assessment
- Appendix D: Deep Mixing – Construction Risks and Assessment
- Appendix E: Additional References

Attention: Klaus Fuerniss

Klaus Fuerniss Enterprises Inc.
PO Box 570
Gibsons, BC
V0N 1V0

June 09, 2017
The George Development, Gibsons, BC
Job No.: 17.037
No. of Pages: 2

Technical Memorandum No 1: Isherwood Role and Responsibilities for Deep Mixing

Dear Mr. Fuerniss,

In response to the Town of Gibson's Peer Reviewer, Geosystems L.P. for "The George" Mixed Use Development, Gibsons, BC's request to clarify roles and responsibilities for engineering and field supervision, we write to confirm Isherwood Geostructural Engineers (Isherwood)'s role for this project is as follows:

- Deep Mixing (DM) Ground Improvement Designer, responsible for DM design for foundation support of the George Hotel and Residences Structure only.
- Responsibilities include:

Design Phase

1. Review of available reference information (geotechnical; hydrogeological; project information) for DM design;
2. Development of DM design strategy and production of a Design Basis Technical Memorandum;
3. DM detailed design and supporting analyses;
4. Production of an "Issued for Construction" set of drawings and supporting technical specifications for Deep Mixing;
5. Completion of Schedule B for DM ground improvement design and commitment to field reviews; and
6. Production of a Field Verification Trial Report outlining design, installation, monitoring and analysis of the DM field trial.

Construction Phase

1. Field review during DM field trial;
2. Production of a Technical Memorandum outlining findings from the DM field trial;
3. Field review during production deep mixing including review of monitoring data (collected by others); and
4. Completion of Schedule C-B for DM ground improvement field reviews during construction.

We anticipate the Project Geotechnical Engineer, Horizon Engineering Inc. be retained for all geotechnical aspects of the project, with the exception of the deep mixing components, which Isherwood will be responsible for.

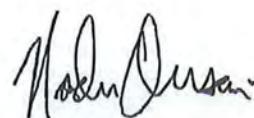
We trust this memorandum provides sufficient information for your immediate requirements. If you have any queries, or require further input, please contact us.

Yours truly,

Isherwood Geostructural Engineers
A division of Brian Isherwood & Associates Ltd.



Marina S.W. Li, P.Eng.



Nadir Ansari, P.Eng.

Attention: Klaus Fuerniss

Klaus Fuerniss Enterprises Inc.
 PO Box 570
 Gibsons, BC
 V0N 1V0

June 22, 2017
 The George Development, Gibsons, BC
 Job No.: 17.037
 No. of Pages: 3

Technical Memorandum No 2: Deep Mixing – Additional Geotechnical Investigation Data
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Dear Mr. Fuerniss,

This Technical Memorandum has been prepared to summarize the additional geotechnical investigation recommended for Deep Mixing (DM) design. The additional data required is supplementary to the existing geotechnical, hydrogeological and environmental data obtained through various stages of site investigations at “The George” Development site. A summary of the additional data recommended is presented in Table 1 and supporting Figure 1.

Table 1: Summary of Additional Geotechnical Data for Deep Mixing Design

Proposed Exploratory Hole Reference	Exploratory Hole Type	Location	Data
CPT 17-01 to CPT 17-21	In Situ Cone Penetration Tests (CPTs) with cone friction, tip resistance and pore pressure measurements to refusal (>200 bars)	P3 Raft and Strip Foundation Areas	<ul style="list-style-type: none"> • Thickness of peat/organic silt • Top of till (aquiclude) • Top of Aquifer
CPT 17-22 to CPT 17-24		P3 Fuel Tank Storage Area	
CPT 17-25 to CPT 17-32		P2 Pad and Strip Foundation Areas	
VW 17-1	2 No. Nested Vibrating Wire (VW) Piezometers per fully grouted auger hole installed between 4 and 8 m below existing ground	Western half of the main building	<ul style="list-style-type: none"> • Pore pressures in unconfined aquifer • Pore pressures in confined aquifer
VW 17-2		Eastern half of the main building	
TT17-01	Test trench (TT) mechanically excavated using 360 excavator up to approx. 5 m below ground (under stable conditions)	North portion of the main building	<ul style="list-style-type: none"> • Visual observation of soil conditions and groundwater inflow • Rising head test in test trench
TT17-02		East portion of the main building	
TT17-03		West portion of the main building	

Notes:

1. Method of in situ testing for the CPTs; drilling and installation of the nested vibrating wire piezometers; and trench excavation should be consistent with previous methods carried out during previous stages of site investigation. Contingency measures should be in place as part of

the site investigation field work. Prior to the commencement of fieldwork, work plans indicating method and procedures for drilling, installation, in situ testing and excavations should be provided to Isherwood for comment.

2. Exact location of exploratory holes as indicated in Figure 1 to be confirmed subject to suitable access on the site.
3. Maximum depth of CPTs is based on reaching refusal and is estimated to be between 5 m and 8 m below existing ground. Dissipation tests are anticipated to be carried out at 5 No. CPT locations, at typically three horizons.
4. Isherwood's proposed auger hole location for installation of VWs could be combined with nearby proposed piezometer installation locations proposed by Horizon for collection of hydrogeological data, provided the piezometers proposed are VWs installed within the upper unconfined aquifer and within the lower confined aquifer attached to data loggers to collect data at approximately 30 min. intervals for a duration of at least 2 months prior to commencement of the DM construction work.
5. Depth of auger holes for VW Piezometer installation will be dependent on the subsurface conditions encountered at the auger hole location.
6. Maximum depth of test trench will be based on stability of the side walls. On encountering groundwater inflow, a rising head test of up to 30 mins could be carried out at the location of each test trench.

It is anticipated that the Project Geotechnical Engineer, Horizon Engineering Inc. be retained for all aspects of the full-time field supervision of the geotechnical, hydrogeological and environmental site investigation including the additional investigation scope of work recommended in the above table. Isherwood is anticipated to visit the site periodically (a minimum period of 5 days) during the additional site investigation for periodic review and assessment of the data. Where additional field reviews are required due to extended field investigation and/or complications, these would be identified during the field works.

It is expected that the additional data obtained from the additional investigation be provided to Isherwood within a 24 hrs to 48 hrs period to allow for timely review and recommendations to be made.

It should be noted that the above data requested has been designed for detailed DM design for foundation support of the George Hotel and Residences Structure only. Refer to Horizon Engineering Inc. (Horizon) recommendations for additional geotechnical and hydrogeological data required for areas outside of the main structure, e.g., nearshore and offshore areas, as well as establishing control monitoring points for assessment and monitoring of groundwater pressures and groundwater quality of the confined aquifer prior to, during and following completion of the DM construction work.

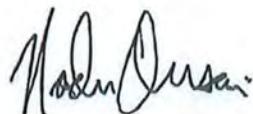
We trust this memorandum provides sufficient information for your immediate requirements. If you have any queries, or require further input, please contact us.

Yours truly,

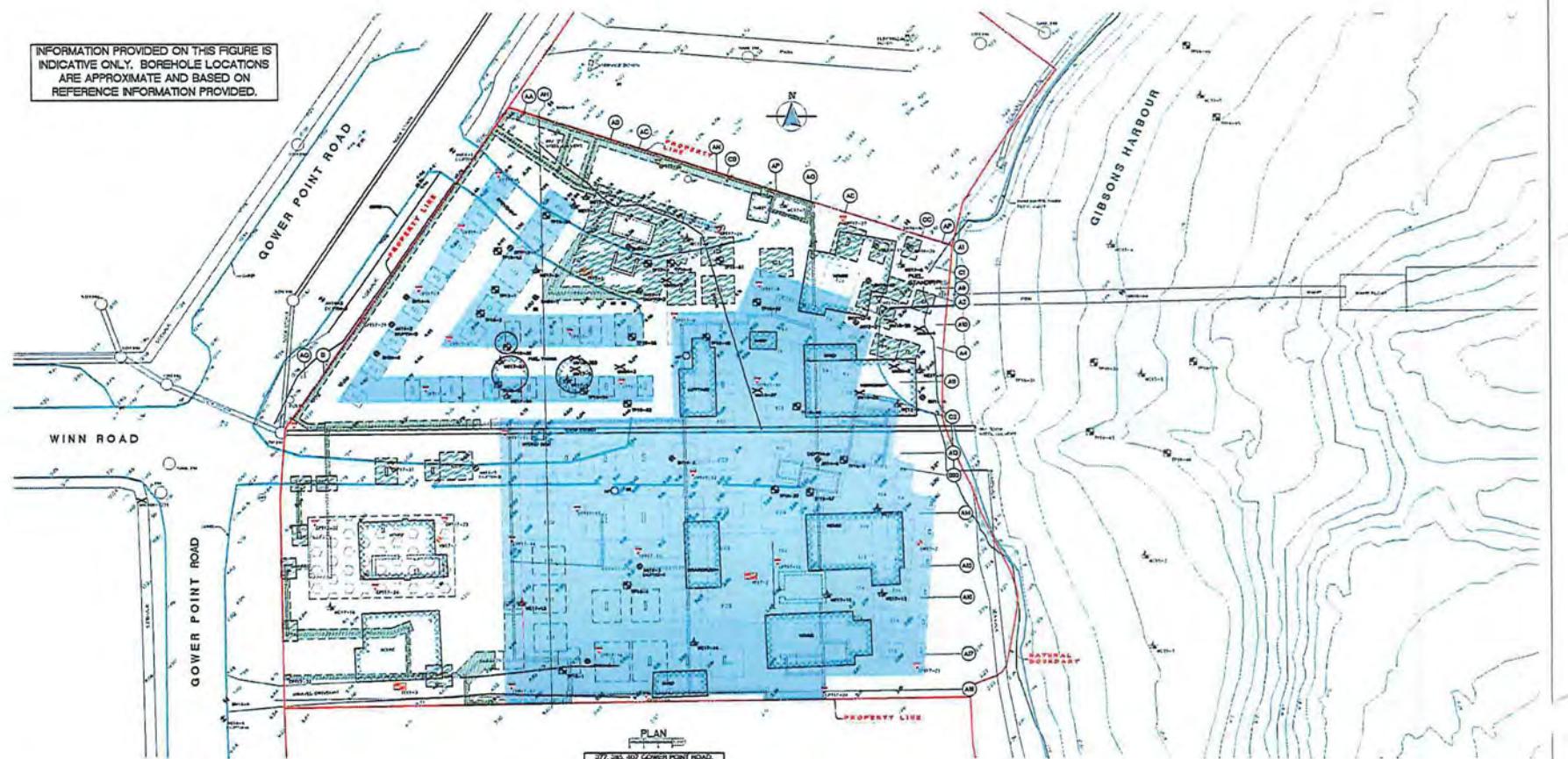
Isherwood Geostructural Engineers
A division of Brian Isherwood & Associates Ltd.



Marina S.W. Li, P.Eng.



Nadir Ansari, P.Eng.



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4. Refer to International Technical Note # 2 (IATN-2) for details.

5. Temperature sensors are not recommended for use in pressurized containers because they can cause pressure fluctuations. Refer to References for details.

REFERENCES

 1. International Electrotechnical Commission (IEC) standard IEC 60075-2, 1992 and IEC 60075-2, 1992, by Metrel, Paris, Christoffersen Ltd., 1992.
 2. International Electrotechnical Commission (IEC) standard IEC 60075-3, 1992 and IEC 60075-3, 1992, by Metrel, Paris, Christoffersen Ltd., 1992.
 3. National Institute of Standards and Technology (NIST) Special Publication 200, "Temperature Measurement," by National Bureau of Standards, Washington, DC, 1975.
 4. Temperature Sensors, "Temperature Sensors," by John D. West, AIA, U.S. Patent, No. 4,995,165, issued Dec. 25, 1991.
 5. Thermometers, "Thermometers," by John D. West, AIA, U.S. Patent, No. 5,001,597, issued Mar. 26, 1991.
 6. Thermometers, "Survey of Modern Thermometers," provided by National Bureau of Standards, NBS Special Publication 200, May 20, 1957.

PROJECT: THE GEORGE MIXED-USE DEVELOPMENT, GIBSONS, BC

PREPARED BY: ISHERWOOD

APPENDIX A: DEEP MIXING - LIST OF PROJECT REFERENCE DOCUMENTS RECEIVED FOR REVIEW

DOC. NO.	DATE	AUTHOR	TITLE OF DOCUMENT
1	12.11.26	Horizon Engineering Inc.	Proposed Commercial Development - "The George" 377 & 385 Gower Point Road, 397 & 689 Winn Road, and Winn Road Right-of-Way, Gibsons, BC - Geotechnical Investigation Report
2	13.05.13	Waterline Resources Inc.	Aquifer Mapping Study
3	13.05.16	Town of Gibsons	Agenda
4	14.02.12	Horizon Engineering Inc.	Revised Geotechnical Investigation Report
5	14.03.20	Levelton Consultants Ltd.	Geotechnical Review of Horizon's Report 2014
6	14.06.23	Levelton Consultants Ltd.	Geotechnical Review of Horizon's Report of June 5, 2014
7	14.06.25	Waterline Resources Inc.	Hydrogeological Review of Horizon's Report of June 5, 2014
8	15.04.07	Horizon Engineering Inc.	Geotechnical Investigation Report (Revised)
9	15.04.07	Horizon Engineering Inc.	Summary of Geotechnical Investigation Report (Revised)
10	15.05.04	Waterline Resources Inc.	Gibsons Aquifer Review of Geotechnical Investigation Report (Revised) for the Proposed "The George" Mixed-Use Development 377, 385& 407 Gower Point Road, 397 & 689 Winn Road and Winn Road Right-of-Way, Gibsons BC
11	15.05.07	Levelton Consultants Ltd.	Geotechnical Review, Horizon Engineering Inc. Geotechnical Investigation Report – 07 April 2015 Proposed "The George" Mixed-Use Development, Gibsons, BC
12	15.06.11	Horizon Engineering Inc.	Proposed "The George" Mixed-Use Development 377, 385 & 407 Gower Point Road, 397 & 689 Winn Road, and Winn Road Right-of-Way, Gibsons, BC, Memorandum Regarding Geotechnical Review Report.
13	15.06.12	Horizon Engineering Inc.	Memorandum Regarding the Hydrogeological Redevelopment
14	16.07.06	Keystone Environmental	Detailed Investigation - 377 and 385 Gower Point Road, Gibsons BC Project No. P2924
15	16.07.07	Keystone Environmental	Detailed Investigation - 377 and 385 Gower Point Road, Gibsons BC Project No. P2924
16	16.10.31	Keystone Environmental	Report of Findings - Detailed Site Investigation
17	16.11.01	Horizon Engineering Inc.	Proposed "The George" Mixed-Use Development 377, 385 & 407 Gower Point Road, 397 & 689 Winn Road, and Winn Road Right-of-Way, Gibsons, BC, Supplementary Memorandum Regarding Geotechnical Review Report.
18	16.12.01	Waterline Resources Inc.	DRAFT – Hydrogeological Review Update for the Proposed "The George" Mixed Use Development 377, 385 & 407 Gower Point Road, 397 & 689 Winn Road, and Winn Road Right-of-Way, Gibsons, BC.
19	16.12.19	Town of Gibsons	Geotechnical Peer Review
20	17.01.17	Town of Gibsons	Geotechnical Review
21	17.02.10	MRC Total Build	The George – Site Preparation Utilizing DSM
22	17.02.07	Horizon Engineering Inc.	Proposed "The George" Mixed-Use Development 377, 385 & 407 Gower Point Road, 397 & 689 Winn Road, and Winn Road Right-of-Way, Gibsons, BC, Memorandum Regarding December 1, 2016 Hydrogeological Review Report
23	17.03.14	WSP	Geotechnical Review
24	17.03.23	Waterline Resources Inc.	Hydrogeological Review
25	17.03.24	Town of Gibsons	Geotechnical Peer Review Next Steps
26	17.04.28	Geosystems L.P	Evaluation of the Viability of DMM Option as Foundation Support for "The George" Development, Gibsons, BC
27	17.05.15	Horizon Engineering Inc.	Response to Memorandum Regarding Geosystems Peer Review Report dated 17.04.18
28	17.05.18	Keystone Environmental	Remedial Plan and Certificate of Compliance Application 377, 385, and 407 Gower Point Road, 689 Winn Rd and Winn Road Right-of-Way, Gibsons BC
29	17.05.08	Town of Gibsons	Meeting Notes
30	17.04.26	Horizon Engineering Inc.	Memorandum Regarding Protection of Aquifer During Construction and Proposed DSM Construction Methodology
31	17.05.15	Horizon Engineering Inc.	Memorandum Regarding Protection of Aquifer During Construction and Proposed DSM Construction Methodology
32	17.05.29	Geosystems L.P	The Proposed "The George" Mixed-Use Development - Summary of Items Required as Permitting Conditions
33	17.05.29	Geosystems L.P	The Proposed "The George" Mixed-Use Development - Review of Draft Report from Horizon Engineering Inc. May 15, 2017

PROJECT: THE GEORGE MIXED-USE DEVELOPMENT, GIBSONS, BC

PREPARED BY: ISHERWOOD

APPENDIX B: DEEP MIXING - LIST OF RISK ITEMS IDENTIFIED FROM PROJECT REFERENCE DOCUMENTS REVIEW

RISK REF	RISK/REQUESTED ITEM	REFERENCE (APPENDIX A)	REFERENCE (APPENDIX C & D)
1	Risk of unknown structural loads for foundation design.	Doc nos. 1, 4, 23 and 25	GEN1
2	To ensure protection of the Gibsons Aquifer, it was recommended that the geotechnical and hydrogeological aspects of the Vashon Till confining unit be fully evaluated prior to, and during construction.	Doc nos. 2 and 6	GEN2
3	Risk that the geotechnical data is based on extrapolation due to no access to 407 Gower Road for supplementary site investigation.	Doc nos. 4 and 7	GEN2
4	Requirement that the deep foundations and site investigation do not penetrate the underlying confined aquifer.	Doc no. 4	GEN3
5	Risk that there is insufficient piezometric pressures and subsoil stratigraphy information to confirm that the excavation will not breach the aquitard or create global instability or heave.	Doc nos. 5, 6, 24, 25, 32 and 33	GEN2
6	Request for Horizon to revisit the seismic classification of the entire development as part of their review.	Doc no. 5	DES1
7	Request for Horizon to revisit the subgrade preparation and verification during construction.	Doc no. 5	DES6
8	Issue of lateral load resistance needs to be clarified by the Proponent's design team.	Doc no. 5	GEN1
9	Requirement for the Proponent's design team to describe the approach that will be implemented to address the potential issue of differential settlement relative to grade and pier supported structures (in particular, the proposed service line that enters/exits the building, the fuel line running from the building to the marina).	Doc no. 5	DES2
10	Requirement to develop a mitigation strategy to control and avoid accumulation beneath the suspended floor slab or within portions of the building, for the risk of methane generation associated with the peat deposits that are to be left beneath the building.	Doc no. 5	GEN4
11	Requirement to develop recommendations for the design water level for waterproof design of the parkade structure.	Doc no. 6	DESS
12	Requirement to perform a sensitivity analysis of the soil parameters used in models to improve the understanding of variations and risks associated with the proposed excavation.	Doc no. 6	DES1
13	Requirement to develop a monitoring program/approach to check on variations in pore pressures in the aquifer.	Doc no. 6	GEN5
14	Requirement to undertake a slope stability assessment of the proposed temporary excavation slopes along the west side of the site.	Doc no. 6	GEN6
15	Requirement to assess adequate performance of the soil-cement columns subject to lateral loads during a seismic event. This would include consideration of soil loading on the columns as well as building inertial load transfer to the columns.	Doc no. 6	DES1
16	Requirement that the current elevation survey ties in with the existing aquifer mapping data and site data (with geo-reference) to a common reference.	Doc No. 7	GEN6
17	Risk of uncertainty in a steady state seepage model and requirement to complete a sensitivity analysis of key parameters controlling groundwater pressure and flow, as well as a sensitivity analysis for a deformation model.	Doc Nos. 7 and 10	DES1
18	Requirement that the proposed excavation does not cut into the till-like silty sand materials, nor penetrate the confining layers over the Gibsons Aquifer.	Doc No. 7	GEN8
19	Requirement to include a table and figure in the report that lists/shows all of the subgrade development features that are being proposed (excavation, all individual piles, foundation, etc.) and identify the data used to design that feature. The distance offset to the nearest known data point should also be included. A comment should be provided regarding the relative risk to the aquifer system and the risk mitigation strategy that would be applied during construction.	Doc No. 7	GEN1
20	Requirement to provide estimates of expected groundwater inflow into the proposed excavation to support the statement "we envisage that the volume of water expected to be encountered at the subject site should be managed with conventional drainage measures" and comment on whether the Seep/W model was used to assess groundwater flux into the excavation.	Doc No. 7	DES1
21	Requirement that preliminary architectural drawings are needed to integrate subsurface structural features with the underlying Gibsons aquifer/aquitard system. Final drawings should include warning/notes regarding the aquifer protection design features that are in place and references to detailed documents which provides instructions to contractors for construction monitoring.	Doc No. 7	GEN1
22	Request for long-term monitoring of the water levels (pressure) using a data logger is recommended, as well as the collection of water chemistry data (routine metals, nutrients, and isotopes) to assist with determining source of the groundwater.	Doc No. 7	GEN5
23	Requirement for Professional Engineer(s) who is responsible for foundation and excavation design to be on site during construction work.	Doc Nos. 7, 10, 32 and 33.	DES6

24	Risk of artesian groundwater pressures affecting geotechnical foundation design.	Doc No. 9	DESS
25	Risk of high, non artesian groundwater levels affecting the geotechnical foundation design.	Doc No. 9	DESS
26	Risk of sea level rise affecting the geotechnical foundation design.	Doc No. 9	DESS
27	Risk of tsunami hazard affecting the geotechnical foundation design.	Doc No. 9	DESS
28	Risk of loose and compressible soil affecting the geotechnical foundation design.	Doc No. 9	GEN2
29	Risk of liquefaction affecting the geotechnical foundation design.	Doc No. 9	DES3
30	Risk of dredging on foreshore area affecting the geotechnical foundation design.	Doc No. 9	DES4
31	Requirement to confirm monitoring efforts during the ground improvement process to detect failures and how they will be mitigated to ensure the protection of the Gibsons aquifer/aquitard system.	Doc no. 10	GEN5
32	Requirement that the clarification and summarization of the subsurface data is required in order for the developer to provide assurance that the Gibsons aquifer/aquitard system will be fully protected by the proposed development.	Doc no. 10	DES4
33	Risk of "dam effect" affecting stability of ground improvement and the foundation scheme.	Doc no. 11	DES2
34	Requirement that the assumptions or the assumed design conditions presented in the April 2015 Geotechnical Report have been provided by and/or are endorsed by the Proponent and Architect. Confirmation from the Proponent that this report has been accepted and endorsed by their design group is required.	Doc no. 11	GEN2
35	Risk that the financial feasibility assessment has not been completed, particularly in relation to the proposed ground improvement, waterproofing and foundation concepts that have been advanced.	Doc no. 11	GEN7
36	Risk that the vertical hydraulic gradients in the westerly proximity of the parkade that might result in an upward seepage and the potential for soil piping, uncontrollable sinkhole, aquifer depressurization, or ground settlement has not been considered. An uncontrollable loss of ground or piping could be catastrophic, the request that this mode of failure is considered in the deformation modelling is completed and reported.	Doc nos. 11 & 23	DES4
37	Request to confirm in regards to the proposed use of areas like Parkade P3 and whether or not such portions of the building are actually considered "habitable".	Doc no. 11	GEN1
38	Request for the foundation design to address seismically induced uplift and lateral loads. The need for base shear resistance could impact ground improvement needs, associated costs, and therefore economical viability. Liquefaction will not be mitigated and therefore the foundation system will need to consider lateral spread of loose soils as well as lateral load transfer from the structure.	Doc no. 11	DES4/DES3/GEN7
39	Request that waterproofing and methane control requirements should be factored into the selection of the foundation design and associated potential costs.	Doc no. 11	GEN7/GEN4
40	Request to confirm whether the stated ultimate bearing values given in the geotechnical reports are factored.	Doc no. 11	GEN1
41	Risk of a seismic hazard in non-improved areas between the zones of primary foundation support.	Doc no. 11	DES3
42	Risk that ground improvement areas will create a series of hard points/lines within an otherwise soft soil setting. There is a potential for long-term settlement in areas away from improved ground both within and beyond the building footprint. The potential for differential settlement and "sag" should be considered in the design and layout of buried utilities, grade supported structures and roadways.	Doc no. 11	DES2
43	Risk that the untreated soils might displace significantly during a seismic event.	Doc no. 17	DES3
44	Risk of penetrating the aquitard and the risk of the breach of the underlying aquifer during DM.	Doc nos. 18, 19, and 25	GEN3
45	Risk of development of preferential flow pathways through the aquitard at the margin between the improved soils and the unimproved soils.	Doc no. 18	DES4
46	Request to submit a single updated document that collates the work to date and that is focussed to the needs of the pertinent application.	Doc nos. 23 and 24	CON4
47	Requirement to confirm a design life adopted for the design of the structure.	Doc no. 23	GEN1
48	Request to confirm a foundation system for underground pipe work (i.e. the fuel line).	Doc no. 23	GEN1
49	Requirement for ground improvement works to provide adequate lateral support and to safely transfer lateral loads onto the adjacent soils. These soils are expected to liquefy during a design event and/or to consist of peat.	Doc no. 23	DES3
50	Risk of insufficient geotechnical data for the foundation design and managing risks associated with an uncontrollable breach of the aquifer.	Doc nos. 23 and 25	GEN2
51	Risk of insufficient lateral support along the eastern portion of the southern area of the site.	Doc no. 23	GEN1

52	Request for a mitigation plan to control artesian flow in the event of a breach of the aquifer.	Doc nos. 24, 25 and 29	DES6
53	Risk that an aquitard breach is not easily repaired using grout or other sealing strategies to control artesian flow.	Doc no. 24	DES6
54	Risk that quality control challenges in the DSM column installation process exists with the auger/paddle mixing method.	Doc no. 24	CON1
55	Risk that the selection of an "assumed" hydraulic conductivity value for the piping analysis may not be conservative. No supporting data was provided to support the bulk hydraulic conductivity selected in analysis.	Doc no. 24	DES4
56	Risk of penetration into the aquifer during probing, ahead of bulk excavation/construction work.	Doc no. 25	GEN3
57	Risk of penetration into the aquifer during bulk excavation.	Doc no. 25	GEN3
58	Risk of penetration into the aquifer during localized excavation for peat removal.	Doc no. 25	GEN3
59	Risk of penetration into the aquifer during DM.	Doc no. 25	GEN3
60	Risk that additional fill is required to create a working platform for excavators and DM equipment to be supported during construction activities.	Doc no. 25	CON2
61	Risk that the construction method currently proposed relative to the depth of DM, as well as the site preparation work requirements might not be efficient or economical.	Doc no. 25	CON4
62	Risk that the DM equipment is not "sensitive" enough to halt penetration at 0.5 m or less into the aquitard.	Doc no. 25	CON3/CON4
63	Risk that during DM, an "uncontrollable" breach into the aquifer develops and that there is insufficient time to respond appropriately (i.e. maintaining temporary stability of the DM column during construction).	Doc no. 25	DES6
64	Risk that the DM equipment penetrates into the aquifer and impacts on the quality of the aquifer.	Doc no. 25	GEN8
65	Risk that the depth to the top of the peat and the thickness of the peat is variable and may impact on depth of excavation; stability of temporary trench; and construction schedule.	Doc no. 25	GEN2
66	Risk that the method of DM does not render relatively large, massive blocks of soilcrete, given the geometry of the soilcrete column.	Doc no. 25	CON1
67	Request to submit comprehensive geotechnical data and interpretive reports.	Doc no. 25 and 33	GEN2/GEN6
68	Request that an instrumented test section is required to assess the impact of DM on the aquifer.	Doc no. 25	GEN8
69	Risk of the peat layer being a potential "deal breaker" for the conventional DMM.	Doc no. 25	CON1
70	Risk that it would not be deemed economically viable to mobilize DMM operation for the purpose of treating only a few metres of soil under the peat. Furthermore the exact depth of the peat and organic silt would vary from element to element and would therefore be difficult to judge.	Doc no. 25	GEN7
71	Risk that the type of equipment needed (and hence the surface preparation and maintenance), the presence of organics, the limited depth of treatment, and the shape of the treatment (i.e. large blocks) is incompatible with the use of conventional DMM on this project.	Doc no. 25	CON4
72	Request to obtain long-term groundwater monitoring data to confirm response of the aquifer under the building footprint during prolonged pumping from Town Well 1 (24 hrs and/or longer).	Doc no. 25	GEN5
73	Request for evidence of static and seismic analysis carried out for the foundation design and DM design.	Doc no. 25	DES1
74	Risk of liquefaction of the underlying loose soils and peat affecting structural bearing.	Doc no. 25	DES3
75	Risk that the area replacement ratio of over 65% has no engineering back-up or justification and could render the scheme uneconomical.	Doc no. 25	GEN7
76	Request to confirm how hydrogeological control of the site will be maintained at all times during DM.	Doc no. 29	GEN5
77	Risk of variable artesian pressures that may be encountered affecting the foundation design.	Doc no. 29	DESS
78	Request to confirm how the impact on the confining layers will be minimized during DM.	Doc no. 29	GEN2
79	Request to consider the logistics of required materials and equipment to and from the site as part of the construction management plan.	Doc no. 29	CON4
80	Request to confirm when a complete response to peer review comments can be expected to advance permitting process.	Doc no. 33	GEN2
81	Request to consider supplementary local pits or trenches and CPTs to be located adjacent to the existing site investigation holes to allow for close correlation and calibrations.	Doc nos. 32 and 33	GEN2
82	Request to provide more detailed information for a construction procedure and a contingency plan to protect the aquifer, required prior to construction.	Doc nos. 32 and 33	CON4
83	Request to review basal stability calculations for excavation and DM.	Doc nos. 32 and 33	DES4

84	Request to provide a Design Basis Memorandum explaining the selection and details of the foundation system in relation to all the valid structural loading conditions. It is essential that the properties of the DMM material and the treatment pattern are consistent with the structural demands.	Doc nos. 32 and 33	GEN1
85	Request to confirm the addition of certain fields of expertise (e.g. in DMM) to the design team, as well as formally acknowledging the roles and responsibilities as a point of due diligence.	Doc no. 33	DES6
86	Request to provide a field verification test report.	Doc no. 32	CON3
87	Request for the development of work procedures relating to excavation; foundation treatment; breach remediation plan; personnel safety; instrumentation monitoring and analysis.	Doc no. 32	CON4
88	Risk of increased traffic affecting local area during bulk excavation.	Discussed during May 8, 2017 meeting	CON4
89	Risk of increased traffic affecting local area during peat excavation and backfilling.	Discussed during May 8, 2017 meeting	CON4
90	Risk of increased traffic affecting local area during DM.	Discussed during May 8, 2017 meeting	CON4
91	Lack of space on site for stockpiling during bulk excavation.	Discussed during May 8, 2017 meeting	CON4
92	Lack of space on site for stockpiling during bulk peat removal and backfilling.	Discussed during May 8, 2017 meeting	CON4
93	Lack of space on site for stockpiling/spoil management during DM.	Discussed during May 8, 2017 meeting	CON4

PROJECT: THE GEORGE MIXED-USE DEVELOPMENT, GIBSONS, BC
PREPARED BY: ISHERWOOD
APPENDIX C: DEEP MIXING - GENERAL AND DESIGN RISKS AND ASSESSMENT

RISK AREA	RISK/REQUESTED ITEM	MITIGATION APPROACH	REFERENCE
GEN1	Risk that DM and foundation design have not taken into consideration the proposed development requirements (i.e. unknown structural loads, architectural information and proposed development information including design life of main structure).	Proposed project information consisting of architectural drawings (Nov 2016), structural drawings (Nov 2016), civil drawings (Nov 2016) and geotechnical design recommendations (Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017) were reviewed to assess feasibility for DM ground improvement. Refer to Deep Mixing Design Basis Memorandum outlining information considered for concept design, feasibility assessment and recommendations for detailed design and construction.	Deep Mixing Design Basis Memorandum and Section 4 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
GEN2	Risk that there is insufficient geotechnical and hydrogeological information commensurate with the level of risk at this site for DM and foundation design (i.e. additional geotechnical and hydrogeological information required for detailed design and construction risk management).	Refer to Deep Mixing Design Basis Memorandum for additional geotechnical and hydrogeological investigation recommended for DM design and risk management. The additional investigation is anticipated to be carried out during DM detailed design, prior to commencement of DM production construction. For additional geotechnical and hydrogeological investigation including long-term monitoring as part of the "risk of penetration into the underlying aquifer", refer to Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, for details.	Deep Mixing Design Basis Memorandum and Section 23 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
GEN3	Risk of penetration into underlying aquifer causing uncontrolled breach of the aquifer: - A: during geotechnical/hydrogeological investigation probing; - B: during excavation and removal of peat/organic silt; and - C: during DM.	Design strategy is based on maximum 0.5 m penetration into the aquitard during geotechnical investigation (boreholes/test pits/cone penetration tests) and bulk excavation, with the exception groundwater monitoring instrumentation where vibrating wire piezometers/piezometers will be installed in the unconfined and confined aquifers. Refer to Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, for details. For DM, design strategy is also based on maximum 0.5 m penetration into the aquitard, with no excavation for peat/organic silt removal required. Refer to Deep Mixing Design Basis Memorandum for details. Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, outlines the contingencies proposed for protection of the aquifer.	Deep Mixing Design Basis Memorandum and Sections 15, 22, 23 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
GEN4	Risk of methane build-up for areas where peat/organic silt is left in situ (untreated areas of DM within the building foundation footprint).	Methane venting system developed by Horizon to manage risk of methane build-up. Refer to Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, for details.	Section 16 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
GEN5	Risk of insufficient hydrogeological data for monitoring during construction and long-term monitoring of aquifer conditions at the site.	Additional groundwater monitoring instrumentation (vibrating wire piezometers/piezometers) proposed the unconfined and confined aquifer prior to and during DM, refer to Deep Mixing Design Basis Memorandum for details. For long-term monitoring, additional groundwater monitoring instrumentation (piezometers and/or standpipes) proposed to be installed prior to the start of DM, refer to Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, for details.	Deep Mixing Design Basis Memorandum and Section 23 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
GEN6	Risk of uncoordinated information, request for an updated summary geotechnical investigation and interpretative report to be provided, as well as a Deep Mixing Design Basis Memorandum outlining DM design and construction approach.	Horizon has prepared an updated Geotechnical Investigation Report (Revised) dated July 27, 2017. A Deep Mixing Design Basis Memorandum has also been prepared to provide details on design approach, construction, DM field trials, reporting of field trial results, quality assurance and quality control during construction.	Deep Mixing Design Basis Memorandum and Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
GEN7	Risk that a feasibility assessment for the current proposed development, including excavation and DM ground improvement, has not been undertaken.	A feasibility assessment has been carried out by the Proponent and his design team consisting of the Project Manager, Architect, Structural Engineer, Civil Engineer, Geotechnical Engineer and General Contractor. As the concept of DM ground improvement was generally accepted by the Town of Gibsons (Geosystems LP's "Evaluation of the Viability of a DMM Option as Foundation Support for "The George" development, Gibsons, BC"), the Proponent's design team has refined the DM design to further improve the technical and commercial viability of the scheme. Refer to Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, and Deep Mixing Design Basis Memorandum for details.	Deep Mixing Design Basis Memorandum and Sections 11 and 13 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
GEN8	Risk of deep mixing construction adversely impacting on the underlying confined aquifer, requirement for deep field trial to be carried out and construction method of DM assessed prior to production DM.	The method of DM proposed has been determined based on a risk-assessment approach considering the project risks against the three methods of DM (Option A: conventional soil auger mixing; Option B: DM using cutter soil mixing; and Option C: excavation under soil hardened slurry). Refer to the DM design and construction risk assessment for details. As part of the DM strategy, a field trial program based on installing trial DM elements in three areas of the proposed development site to verify and assess that the proposed method of DM and associated controls meet project performance requirements, whilst not adversely impacting the underlying confined aquifer. Refer to Deep Mixing Design Basis Memorandum for details of risk assessment, proposed method of DM selected and proposed DM field trial for details. Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, outlines the contingencies proposed for the protection of the aquifer.	Deep Mixing Design Basis Memorandum and Section 15 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
DES1	Risk of geotechnical parameters (static and seismic) and design water levels not representative of varying site conditions. Request that a sensitivity analysis is carried out to determine the impact of these parameters on design, construction and protection against uncontrolled breach into the underlying confined aquifer.	The geotechnical parameters (static and seismic) and hydrogeological parameters have been updated by the design team, with further assessment to be carried out after completion of the additional geotechnical and hydrogeological investigation proposed by the design team (June 2017), refer to Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, for details. The DM ground improvement design is proposed to be carried out in accordance with Industry Guidelines, refer to Deep Mixing Design Basis Memorandum for details.	Deep Mixing Design Basis Memorandum and Sections 9, 13 and 23 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
DES2	Risk that the DM design has not taken into consideration static load requirements for the foundation design and consideration for settlement/differential settlement including "dam effect" of DM affecting hydrogeological conditions within the proposed foundation footprint.	The Deep Mixing Design Basis Memorandum outlines the approach to be adopted for detailed design, which consists of static analysis of proposed DM elements for ground improvement and foundation support of project-specific loads including an evaluation of settlement and stability for temporary (during construction) and permanent (post-construction) conditions, in accordance with Industry Guidelines.	Deep Mixing Design Basis Memorandum.
DES3	Risk that the DM design has not taken into consideration seismic load requirements including liquefaction and impact of potential loss of material due to a seismic event.	The Deep Mixing Design Basis Memorandum outlines the approach to be adopted for detailed design, which also consists of seismic analysis of proposed DM elements for ground improvement and foundation support of project-specific seismic loads including an evaluation of settlement and stability for temporary (during construction) and permanent (post-construction) conditions, in accordance with Industry Guidelines. Refer to Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017, for details of seismic parameters recommended for analysis and liquefaction assessment, which will be considered for DM detailed design.	Deep Mixing Design Basis Memorandum and Section 9 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
DES4	Risk that the DM design has not taken into consideration impact of temporary conditions that could cause uncontrolled breach of the underlying confined aquifer (e.g. penetration into aquifer; basal stability and piping; and preferential flow path at interface between DM element and native soils).	The Deep Mixing Design Basis Memorandum outlines the approach to be adopted for detailed design, which includes an assessment of temporary conditions during DM and following installation of DM elements to evaluate basal stability and piping. The DM design approach is in conjunction with the method of DM proposed (selection based on a project-specific risk assessment) which is based on minimizing risk of penetration into the underlying confined aquifer (e.g. maximum 0.5 m penetration into the aquitard); proposing DM equipment with suitable controls to limit penetration into the aquitard; DM fill and native soils in situ without the need for excavation and remove existing material, hence reducing the likelihood of basal instability, piping and creating preferential flow paths for an uncontrolled breach of the confined aquifer; and suitable equipment to mix fill and native soils including peat and organic silt with cement slurry to achieve project-specific requirements for ground improvement, foundation support and mitigation against liquefaction.	Deep Mixing Design Basis Memorandum and Section 12 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
DES5	Risk of perched water, artesian conditions, rise in sea level and tsunami events affecting DM.	The DM detailed design will take into consideration the updated groundwater recommendations (groundwater level in the upper unconfined aquifer, groundwater pressures in the lower confined aquifer, design life of the proposed structure including design sea level for foundation and structural design and waterproofing, and impact of tsunami events on the proposed structure) outlined in Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.	Deep Mixing Design Basis Memorandum and Sections 7, 10 and 15 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.
DES6	Requirement for Professional Engineers to provide technical support throughout the DM and excavation construction activities.	Isherwood is responsible for the DM components of this project and will have part-time representation during the additional geotechnical and hydrogeological investigation field work, and full-time representation during the DM field trial and production DM work, refer to Isherwood Technical Memorandum No. 1 outlining Isherwood's role and responsibilities for DM (June, 2017). With the exception of the DM components, Horizon is responsible for all geotechnical aspects of the project including excavation.	Deep Mixing Design Basis Memorandum, Isherwood's Role and Responsibilities for Deep Mixing [Technical Memorandum No. 1 dated June 9, 2017] and Section 12 of Horizon's Geotechnical Investigation Report (Revised) dated July 27, 2017.

PROJECT: THE GEORGE MIXED-USE DEVELOPMENT, GIBSONS, BC		DEEP MIXING OPTIONS					
PREPARED BY: ISHERWOOD		1 CONVENTIONAL AUGER SOIL MIXING AFTER BACKFILLING WITH FILL AREAS WHERE PEAT/ORGANIC SILT WAS EXCAVATED AND REMOVED.					
APPENDIX D: DEEP MIXING CONSTRUCTION RISKS AND ASSESSMENT		2 DEEP MIXING USING CUTTER SOIL MIXING					
3 EXCAVATION AND REPLACEMENT UNDER SELF-HARDENING SLURRY		3 EXCAVATION AND REPLACEMENT UNDER SELF-HARDENING SLURRY					
RISK REF	RISK/REQUESTED ITEM	1 RISK CATEGORY	1 SUPPORTING COMMENTS	2 RISK CATEGORY	2 SUPPORTING COMMENTS	3 RISK CATEGORY	3 SUPPORTING COMMENTS
CON1	Risk of quality issues affecting DM product (e.g. insufficient mixing of peat/organic silts with cement slurry to achieve design requirements; artesian conditions impacting on the quality of the DM elements. Risk of breaching aquifer during DM.	Medium/High Risk	<p>Auger mixes in horizontal axis has difficulty with mixing vertically within a soil-cement element and has difficulty with binding organic material (particularly fibrous peat and roots) with cement slurry to give a homogeneous product (may contain soft, unmixed native soil pockets). Although the peat/organic silt could be removed prior to soil auger mixing, it would introduce additional risks such as identifying the depth to the underside of the peat/organic silt and removal of the peat/organic silt whilst maintaining basal stability, as well as additional costs and schedule impact due to the need to excavate and replace, followed by soil mixing, which requires different equipment and the need to import fill. At any time, the soil-cement element is supported either with native soils, cement slurry or a combination of native soil blended with cement slurry and therefore basal stability is maintained during soil-cement element installation. Equipment is not sufficiently sensitive to allow auger/paddle mixing in the upper material to achieve a homogeneous product whilst ensuring that the tip of the auger does not penetrate more than 0.5 m into the aquitard and potentially breaching the <i>underlying confined aquifer</i>.</p> <p>Fill is required to form a working platform for auger mixing equipment, as well as additional fill required to replace peat/organic silt removed.</p>	Low Risk	<p>Twin cutter wheels blend vertically and enables fill, peat, organic silt and native soils to be mixed with cement-slurry to form a homogeneous soil-cement element to meet design and project-specific performance requirements. At any time, the soil-cement element is supported either with native soils, cement slurry or a combination of native soil blended with cement slurry, and therefore basal stability is maintained during soil-cement element installation. Equipment is sufficiently sensitive to enable operator to assess whether 0.5 m or less penetration into the aquitard is achieved during DM.</p>	Low Risk	<p>Removal of the peat/organic silt would eliminate the risk of "unmixed" zones of soil-cement. Excavation would be supported at all times (i.e. as native material is excavated, cement-slurry is introduced into the excavation area), therefore basal stability is maintained. Although cost of the equipment is low, additional costs to consider include disposal of native soils and increased volume of cement slurry (compared with Option 2). Excavation and replacement is highly operator dependent (i.e. the risk of penetrating more than 0.5 m into the aquitard will heavily rely on the "feel" of the operator and the tools used for excavation). If the relative density of the aquitard is a gradual resistance change with depth, it would be difficult for the operator to confidently confirm that less than 0.5 m of penetration into the aquitard is achieved.</p>
CON2	Risk of additional fill/material required to be imported to the site for the construction of a working platform and removal and backfilling of excavated peat/organic silt areas.	High Risk		Low Risk	Fill is required to form a working platform for cutter soil mixing rig.	Low/Medium Risk	Whilst the fill required to form a working platform is substantially less compared with Options 1 and 2, a significant amount of cement slurry is required to fill the excavated native soils.
CON3	Risk that the method of DM proposed is not compatible with the proposed development and design requirements. Request for a DM field trial to be completed to assess the performance of DM method proposed and compatibility of proposed DM method with achieving design requirements.	High Risk	Circular soil-cement elements would need to be designed as overlapping elements to create a treatment plan compatible with the foundation requirements. Auger mixing may produce localized "un-mixed" zones if peat/organic silt is not removed prior to auger mixing.	Low Risk	Rectangular soil-cement elements with nominal overlap can be designed to obtain a treatment plan compatible with foundation requirements. Vertical mixing generally will produce fewer localized "un-mixed" zones of peat/organic silt compared with Option 1. The removal of peat/organic silt prior to DM is not required.	Low Risk	Rectangular shaped excavation zones can be created to obtain a treatment plan compatible with foundation requirements. As this method requires complete removal of native soils, "un-mixed" zones of peat/organic silt will not be present in the completed treatment areas.
CON4	Risk of significant logistics required (i.e. materials, equipment and transportation to and from site) during construction. Request for a construction management plan to be developed.	High Risk	Auger mixing units are required to be mounted on large cranes. Due to the need to excavate the peat/organic silt and replace with fill, careful logistical planning is required to transport, remove, stockpile and replace material. As peat/organic silt cannot be re-used on the site, disposal is required. Additional transportation of material on and off site will impact other environmental conditions (e.g. traffic and noise).	Low Risk	Cutter soil mixing is carried out using small base equipment (compared with Option 1). The spoil generated from the "wet mixing" can be mixed and stockpiled on the site, transportation for removal of untreated native soil is not required. Transportation of raw material is significantly less than transportation requirements for Option 1.	Low/Medium Risk	Due to the need to excavate the peat/organic silt and replace with fill, careful logistical planning is required to transport, remove, stockpile and replace material. As peat/organic silt cannot be re-used on the site, disposal is required. Additional transportation of material on and off site will impact other environmental conditions (e.g. traffic and noise).

PROJECT: THE GEORGE MIXED-USE DEVELOPMENT, GIBSONS, BC

PREPARED BY: ISHERWOOD

APPENDIX E: DEEP MIXING - ADDITIONAL REFERENCES

Bruce, M.E.C., Berg, R.R., Collin, J.G., Filz, G.M., Terashi, M. and Yang, D.S., 2013. Federal Highway Administration Design Manual; Deep Mixing for Embankment and Foundation Support. Report No. FHWA-HRT-13-046. Contract/Grant No. DTFH61-06-C-00039.

Horizon Engineering Inc., July 26, 2017. Geotechnical Investigation Report (Revised).

Reed Jones Christoffersen Ltd., The George Hotel and Residences, Gibsons, BC, Drawing Nos. S1.01 to S1.08, S2.A01 to S2.A04, S2.B01 to S2.B07 and S2.C01 to S2.C05 Rev. 3 Re-Issued for Geotechnical Coordination, 28.10.2016.

British Columbia Building Code (2012) British Columbia Office of Building and Construction Standards, National Research Council Canada, Ottawa.



May 1, 2019

18103851

Ernie Turner, Project Manager

Klaus Fuerniss Enterprises Inc.
 PO Box 570
 Gibsons, BC
 B0N 1B0

DPA9 PERMIT REVIEW – GEORGE GIBSONS MARINE RESORT & RESIDENCES

Dear Mr. Turner,

The purpose of this letter is to confirm that Golder Associates Ltd. (Golder) has reviewed The Town of Gibson's Development Permit No. DP-2017-18 (The Permit), dated August 1, 2017, and we can confirm that we are in general agreement with statements and process details made by Isherwood Geostructural Engineers (Isherwood) within this document.

Following our review of The Permit we wish to make the following clarifications:

- The scope of work for the drilling program has been updated as outlined in the "Proposed Drilling Program for "The George" Project", dated April 4, 2019, previously submitted to The Town;
- While it is understood that site monitoring is being undertaken by a qualified hydrogeologist, this service is not being provided by Golder; and,
- At this time, Golder has not provided technical input associated with contingency plans for aquifer protection. This is logical at this stage as the drilling program is owned by Horizon Engineering Inc. (Horizon).

Should you have any questions or concerns regarding this letter please do not hesitate to contact the undersigned.

Golder Associates Ltd.

Dave Siddle, MEng
Operations Manager - Civil Construction

DJS/RO/djs



Roberto Olivera, Ph.D, P.Eng
Geotechnical Engineer



May 1, 2019
Our File: 112-3155

KLAUS FUERNISS ENTERPRISES

P. O. Box 570
Gibsons, BC, V0N 1V0

Attention: Klaus Fuerniss

Re: **Proposed “The George” Mixed Use Development at
Gower Point road and Winn Road, Gibsons, BC
Proposed Subsurface Investigation Program**

1.0 INTRODUCTION

As per the request of the Town of Gibsons, this letter presents the changes in the proposed subsurface investigation program in comparison to the investigation program proposed in 2017, as indicated in our Geotechnical Investigation Report, dated July 27, 2017.

It must be noted that the intent of the investigation program is similar to the investigation program proposed in 2017. The changes to the proposed investigation program will provide more information that would be beneficial for detail design of the ground improvement system and the environmental remediation.

2.0 PROPOSED INVESTIGATION PROGRAM (2019)

Table 1 summarizes the proposed investigation, including the type of the tests to be conducted, and expected depths of investigation.

Table 1: Proposed Additional Subsurface Investigation

Note	Type of Test	ID	Expected Depth	Stand Pipe
1	Cone Penetration Test (CPT)	CPT19-1 to CPT19-34 and SCPT19-1 to SCPT19-6	3.0 to 8.0 m	N/A
2	Sonic Drilling	BH19-1 to BH19-9	10.0 m	N/A
3	Sonic Drilling and Installation of Piezometer	PZ19-1 to PZ-19-6	6.0 to 10.0 m	In the aquifer
4	MASW	2 Profiles	At ground level	N/A
5	Excavation of Test Pits for Environmental purposes (Keystone)	TP19-1 to TP19-8	Up to 1.5 m	N/A

(1) Insitu CPTs with cone friction, tip resistance, pore pressure, shear wave velocity, and resistivity measurements will be carried out to refusal depth with tip resistance of greater than 200 bars.



CPTs will be carried out to find the thickness of peat and organic silt, the top of till-like material, and top of aquifer, if possible. Dissipation tests are anticipated to be carried out at five of the CPTs.

(2) After the CPTs are advanced and depths to aquifer are determined across the site, bore holes BH19-1 to BH19-9 will be drilled to determine the thickness of the soil layers on top of the till-like materials, if presents or the aquifer. Soil samples would be collected for laboratory testing and also to be provided to Golder Associates for design of the ground improvement system.

(3) PZ19-1 to PZ-19-6 will be drilled to find the thickness of the till-like material, if presents, depth to the aquifer, and will be penetrated into the aquifer. A stand pipe piezometer with inner diameter of 4 inches will be installed with the screen portion in the aquifer to measure pore pressures in the aquifer. These stand pipe piezometers may be used for depressurizing the aquifer in case of breach, as part of the contingency plan provided in draft of Horizon Engineering's geotechnical report.

(4) Multichannel Analyses of Surface Waves (MASW) is a geophysical method that measures the shear wave velocity of the subsurface soil layers without drilling bore holes. Two MASW profiles would be carried out at the site. The results would be used by Golder Associates for design of the ground improvement system.

(5) Excavation of test pits will be carried out to a depth of up to 1.5 metres. Test pits will be carried out to provide samples for environmental contamination testing.

3.0 CHANGES IN THE INVESTIGATION PROGRAM (2019 VS. 2017)

Based on the Client's decision with the approval of the Town of Gibsons, Golder Associates was selected for the design and construction of the soil improvement system. Based on the coordinations between Horizon Engineering, Golder Associates, and Keystone Environmental, some changes were proposed into the subsurface investigation program. Table 2 summarizes the changes between the proposed subsurface investigation programs in 2017 and 2019.

Table 2: Changes in the proposed investigation program

Test	Total	
	2017	2019
CPT	35	40
Borehole into the Aquifer	6	7
Borehole into the Aquitard	2	8
MASW	0	2
Excavation of Test Pits (Geotechnical)	3	0
Excavation of Test Pits (Environmental)	?	8



HORIZON
ENGINEERING INC

Proposed "The George" Development at
Gower Point Road at Winn Road, Gibsons, BC
Proposed Subsurface Investigation Program

Attachment D
Page 3 of 4

Our File: 112-3155
May 1, 2019
Page 3

It must be noted that the proposed 2019 investigation program is similar in nature to the investigation program proposed in 2017. The changes to the proposed investigation program is intended to provide additional information that would be beneficial for detail design of the ground improvement system and the environmental remediation.

4.0 CLOSURE

We trust that the above is sufficient for the noted concerns. If you would like further details or require clarification of the above, please do not hesitate to contact us.

For
HORIZON ENGINEERING INC.



May 1, 2019

Nima Tafazzoli, Ph.D., P.Eng.
Geotechnical Engineer

For
HORIZON ENGINEERING INC.



KARIM KARIMZADEGAN
May 1, 2019



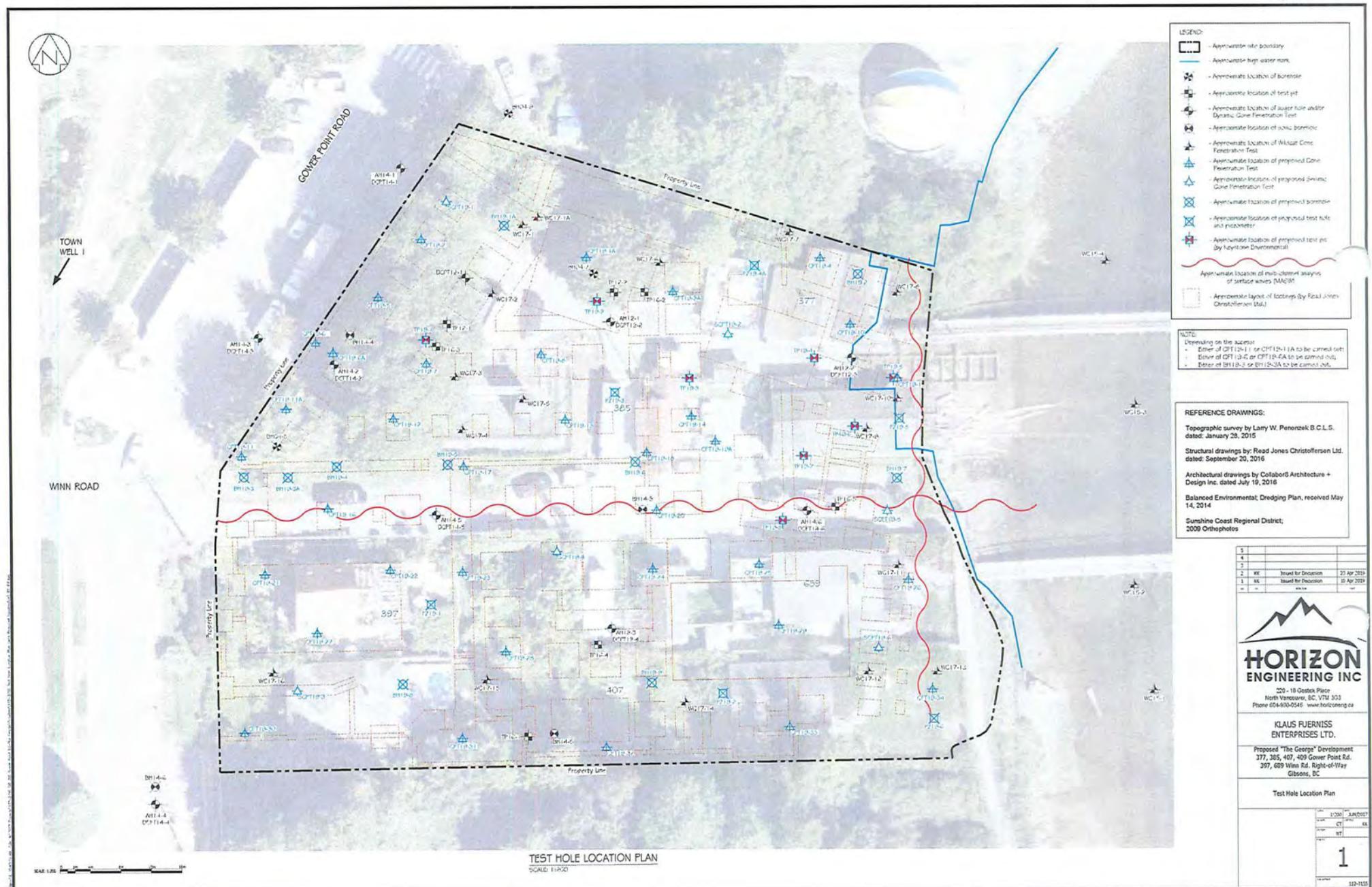
PROFESSIONAL
ENGINEERS
ONTARIO
KARIM KARIMZADEGAN
#27165
P. BRITISH
COLUMBIA
ENGINEER

Karim Karimzadegan, M.A.Sc., P.Eng.
Principal

Attachments:

Figure 1: Test Hole Location Plan

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Proposed Drilling Program for “The George” Project

Submitted to: The Town of Gibsons

Date Issued: April 4, 2019

Prepared by: Horizon Engineering Inc.
cc: Town of Gibsons Representative: Director of Engineering - Dave Newman
Town's Peer Reviewer: Geosystems – Donald Bruce
Drilling Contractor: Mud Bay Drilling Co. Ltd.
Barge Contractor: N/A
Other personnel on site: Ernie Turner

Contact List:

EMERGENCY NUMBERS

Town of Gibsons Representative: Dave Newman (Work 604-886-2274 ext 212, Cell 604-741-8370)
Horizon Engineering: Karim Karimzadegan (Work 604-990-0583 ext 103, Cell 604-809-0942)
Keystone Environmental: Michael Geraghty (Work 604-430-0671, Cell 778-233-0655)

Mud Bay Drilling Representative: Shawn Ashley (Work 604-888-2206)
Ambulance/Hospital: 911

PRIME CONSULTANT IN CHARGE (HORIZON ENGINEERING)

Principal Consultant: Karim Karimzadegan (work 604-990-0546 ext 103, cell 604-809-0942)
Field Consultant: Nima Tafazzoli (work 604-990-0546 ext 105, cell 604-970-6462)

GROUND IMPROVEMENT CONSULTANT (GOLDER ASSOCIATES)

Project Manager: David Siddle (Work 604-296-2893, Cell 778-837-3507)
Roberto Olivera (Work 604-296-2893)

HYDROGEOLOGIST AND ENVIRONMENTAL CONSULTANT (KEYSTONE ENVIRONMENTAL)

Field Hydrogeologist Christopher Homes (Work 604-430-0671, Cell 778-233-0655)

SERVICE COMPANIES

Drilling Contractor: Mud Bay Drilling, Driller: Ian Taylor (Work 604-888-2206)
Grouting/Cement Contractor: Mud Bay Drilling
Excavation Contractor: NB Contracting (work 604-885-8405)
Utility Locate Search Contractor: Quadra Utility Locating or Western Locate
Vacuum Truck: N/A
Waste Removal Contractor: N/A
Barge Operator: N/A

1. OVERVIEW

1.1 Purpose

As per comments of Geosystems L.P., the Town of Gibson's peer reviewer, and the requirements of the project, Horizon Engineering, Golder Associates, and Keystone Environmental are proposing additional supplementary subsurface investigation to be carried out as part of detailed design for the ground improvement for the areas that there are limited hydrogeological and geotechnical subsurface information available.

1.2 Aquifer

The proposed drilling area is underlain by a known artesian aquifer (the Gibsons Aquifer) and therefore, an increased standard of care is needed to protect the aquifer when conducting operations at surface.

Based on the Town of Gibsons Aquifer Mapping study (2013) prepared by Waterline Resources, and previous subsurface investigations carried out by Horizon Engineering, piezometric heads of over 15 m above sea level are understood to be possible if the aquifer is penetrated at the proposed borehole locations. In addition, at Town Well 1, artesian flow in excess of 100 lpm was noted at the time of drilling.

Horizon Engineering carried out subsurface investigations at the subject site and is aware of presence of the aquifer. Our observations of the aquifer during subsurface investigations are presented in Horizon Engineering's Geotechnical Investigation Report (Revised), dated July 27, 2017.

1.3 Risks

We envisage that the following risks would be involved in the proposed drilling program:

1. Uncontrolled artesian flow if the aquitard is breached and control of the well is lost.
2. Development of a sinkhole if artesian flow is left unattended or site personnel are unprepared to mitigate the flow.
3. Impact on the Town of Gibsons' water wells if the aquifer is breached and left unsealed.
4. Potential loss of aquifer pressure if the aquifer is breached and not sealed properly.

1.4 Proposed Drilling Program

Table 1 summarizes the proposed investigation, including the type of the tests to be conducted, and expected depths of investigation. The locations of the proposed tests are shown on Figure 1. All the tests, as proposed, would be contained within the subject site.

Utility locate search will be conducted, under the supervision of Horizon Engineering, prior to subsurface investigation to assess the proposed test locations with respect to potential conflict with existing traceable underground utilities.

It must be noted that Horizon Engineering carried out subsurface investigations at the subject site, the marina, and Gower Point Road, on September 19 and 24, 2012, April 11, 15, and 16, 2014, December 9 and 10, 2014, January 12, 2015, August 3, 2016, and January 25 and 26, 2017. The

subsurface investigations consisted of drilling auger holes within the aquitard, sonic holes in the aquifer, installation of piezometers, excavation of test pits, and WildCat penetration testing.

Table 1: Proposed Additional Subsurface Investigation

Note	Type of Test	ID	Expected Depth	Stand Pipe
1	Cone Penetration Test (CPT)	CPT19-1 to CPT19-34 and SCPT19-1 to SCPT19-6	3.0 to 8.0 m	N/A
2	Sonic Drilling	BH19-1 to BH19-9	10.0 m	N/A
3	Sonic Drilling and Installation of Piezometer	PZ19-1 to PZ-19-6	6.0 to 10.0 m	In the aquifer
4	MASW	2 Profiles	At ground level	N/A
5	Excavation of Test Pits for Environmental purposes (Keystone)	TP19-1 to TP19-8	Up to 1.5 m	N/A

(1) Insitu CPTs with cone friction, tip resistance, pore pressure, shear wave velocity, and resistivity measurements will be carried out to refusal depth with tip resistance of greater than 200 bars. CPTs will be carried out to find the thickness of peat and organic silt, the top of till-like material, or top of the aquifer, if till-like material does not present). Dissipation tests are anticipated to be carried out at the locations of five of the CPTs.

(2) After the CPTs are advanced and depths to aquifer are determined across the site, bore holes BH19-1 to BH19-9 will be drilled to find the thickness of the soil layers on top of the till-like materials, if presents or the aquifer. Soil samples would be collected for laboratory testing and also to be provided to Golder Associates for design of the ground improvement system.

(3) PZ19-1 to PZ-19-6 will be drilled to find the thickness of the till-like material, if presents, depth to the aquifer, and will be penetrated into the aquifer. A stand pipe piezometer with inner diameter of 4 inches will be installed with the screen portion in the aquifer to measure pore pressures in the aquifer. These stand pipe piezometers may be used for depressurizing the aquifer in case of breach, as part of the contingency plan provided in draft of Horizon Engineering's geotechnical report.

(4) Multichannel Analyses of Surface Waves (MASW) is a geophysical method that measures the shear wave velocity of the subsurface soil layers without drilling bore holes. Two MASW profiles would be carried out at the site. The results would be used by Golder Associates for design of the ground improvement system.

(5) Excavation of test pits will be carried out to a depth of up to 1.5 metres. Test pits will be carried out to provide samples for environmental contamination testing.

All stand pipe piezometers will be equipped with transducers for continuous readings for a period of time at least 2 months prior to commencement of the ground improvement construction work.

We recommend that the transducers installed within the existing and proposed piezometers at the site monitor the water levels when the town's well #1 is not in operation and when it is in operation. This would provide better understanding of the effect of the pumping at the town's well #1 on the aquifer pore pressures across the site.

It is our understanding that the existing buildings are demolished and trees are removed. Therefore, access for the proposed investigation program is provided. We recommend that the locations of the proposed test holes be identified / surveyed for location and elevation at the site by surveyors.

2. PRE- DRILLING REQUIREMENTS

The following have been established:

1. Knowledge and understanding of BC's Water Sustainability and Groundwater Protection Regulations.
2. WorkSafe BC program (site specific H&S requirements including traffic control, special considerations).
3. Permit Requirements: We understand that the only permit requirements are from the Town of Gibsons.
4. Driller certification: Training courses for the drillers that will be conducting the subject drilling program.
5. All rig lifting equipment, and overhead equipment will be certified to the Original Equipment Manufacturers Specifications (OEM).
6. Casing running procedures: 6" Core Barrel and 7" casing to be presented to the drill head by way of "rod/casing handler". This mechanical device allows for the safe connection of the drill string without the added risk of crew members physically holding rods or casing while they turn into the drill head.
7. Certificate of Insurance and WorkSafe BC letter are attached.
8. Drill rig specifications (Sonic DB320) are attached.

3. RIG MOVE, RIG SETUP, AND SITE SAFETY

The following procedures and site safety provisions will be followed during mobilizing, set up, and operation of the drill rig:

1. Mud Bay to confirm that the site and drill are ready.
2. Move in and rig setup drilling rig and auxiliary equipment on site. Prior to initiating drilling, carry out detailed rig inspection and report any unsafe conditions to Horizon.
3. Hold a pre-drilling safety meeting with the rig crew and site personnel and discuss the Site Specific Health and safety Plan Hazardous Operations and drilling program.
4. Certified driller from Mud Bay to be on site at all times during drilling.

4. GENERAL SUBSURFACE INVESTIGATION PROCEDURES

4.1 Roles and Responsibilities.

1. Mud Bay will operate all drilling and auxiliary equipment, retrieve soil samples, install standpipes, and seal boreholes.

2. Horizon will oversee utility locate search, indicate possible drilling locations, and log stratigraphy. The on-site hydrogeologist will direct standpipe installation.
3. Horizon's field geotechnical engineer and Keystone's hydrogeologist will be on site to supervise the subsurface investigation, as required, to ensure that there is no adverse impact on the aquifer.
4. The Town of Gibsons reserves the right to have a representative during the subsurface investigation to review drilling operations, standpipe installation, and hole sealing procedures to ensure that the integrity of the aquifer is maintained.

4.2 Methodology of Data and Sample Collection

1. Field engineer from Horizon will be on site to collect select soil samples at particular zones of interest. Keystone's field hydrogeologist will be on site to supervise piezometer installation, sealing of test holes, and excavation of test pits, as required, and to verify that all measures are taken to maintain the integrity of the aquifer.
2. Soil samples will be transported to the Horizon offices for further review and examination.
3. Cone Penetration Tests will be carried out to refusal depth with tip resistance of greater than 200 bars to determine soil density / consistency, the soil behavior, and depth to the till-like or aquifer.
4. Electrical conductivity (EC) measurements may be carried out based on the on-site hydrogeologist recommendations.
5. Artesian flow rates and static head elevations will be estimated if artesian groundwater is encountered.

4.3 Drilling Details

4.3.1 *Sonic Drilling*

The proposed boreholes will be drilled vertically to the depths noted in Table 1. The actual termination depth of these boreholes will be finalized in the field based on observations of cutting samples and the presence of artesian groundwater. We plan to terminate the hole as soon as artesian groundwater is observed. The borehole will generally be advanced as follows, as illustrated in the attached "Sonic Drilling System" brochure:

1. Sonically advance core barrel into the undisturbed soil, typically 1.5 metres per run (i.e., before retrieving the soil sample), with exception of soils above the glacial till, which may be drilled in 3 metre runs. Water may be used to advance the core barrel.
2. Sonically override a larger diameter casing over the core barrel.
3. Return the core barrel to the surface for sample extraction and logging by the Field Engineer(s).

4. Complete coring and overriding casing to desired depth.
5. Field Engineer to complete geotechnical logging and collect EC data, if required, as previously described.
6. Keystone's field Hydrogeologist to observe the process and assist wherever possible, as previously described.
7. Between runs, measure water level and collect salinity reading, if required, to confirm seawater or fresh water inside casing.
8. If the aquifer soil (which is understood to comprise coarse grained sand and/or gravel) and/or artesian pressures are encountered, the hole would be terminated immediately and completed / sealed as described below. The pressure data will be collected to assess design consideration of the proposed development.

4.3.2 *Piezometer Installation Details*

Standpipe piezometers are planned to be installed in holes as follows:

1. When the aquifer is penetrated and artesian flow is detected, the hydraulic head pressure can be measured at the surface by placing a cap with a pressure gauge onto the top of the casing. Once the hydraulic pressure is recorded, the cap is removed.
2. Lower the PVC screen and riser pipe (PVC in lower portion, iron in upper portion) to the bottom of the borehole.
3. Attach a suction hose from a contractor's pump onto the top of the PVC standpipe and adjust the flow rate so that the water level in the annulus of the casing (space between the OD of the PVC and ID of the casing) is maintained at a steady level below ground surface.
4. With the pump maintaining a steady level, place silica filter sand adjacent to the screened section of the piezometer. (Use tremie pipe to place silica if needed).
5. Design suitable backfill materials to correlate with the removal of the drill casings, i.e. install 10 feet of suitable backfill materials, and then remove 10 feet of casing.
6. Place bentonite seal above silica sand filter pack in same manner as installation of silica sand. Use tremie to place bentonite pellets/chips if necessary. This operation will continue with weighted cement grout mix to ensure that the grout sealed the hole.
7. When placing grout (Cementitious / bentonite mixture) in the annular space, the weight and volume of grout should be calculated to balance the formation artesian pressure at a depth below the bottom of the steel drill casing, so that the casing can subsequently be removed.
8. The grout (calculated weight and volume) is placed by tremie into the annular space above the bentonite seal to a depth estimated to be below the bottom of the steel drill casing. This drill casing is then retracted to a depth estimated to be above the level of the grout column. Pressure grouting may be required if the above is found to be inadequate.
9. A tremie line is lowered to the bottom of the drill casing and the annular space is flushed with fresh water to eliminate the possibility that any grout will set up inside the steel drill casing.

10. A cap is placed on top of the standpipe and also on top of the casing so that no artesian flow occurs. This will be done to ensure that the grout sets and performs under artesian pressure.
11. The grout is allowed to setup until no artesian flow is observed at the surface when the standpipe is capped.
12. After the grout is allowed to set up, the caps are removed from the piezometer and drill casing.
13. Upon completion, groundwater flow should be present in the piezometer and no flow should be present in the annular space at the ground surface.
14. If the above is confirmed, then the annular space can be grouted to the surface and steel drill casing can be removed.
15. Surface casing can be installed with relevant surface completion. We plan to install valves near the surface of each standpipe to allow the piezometer to be "turned on/off" for installation and removal of groundwater monitoring equipment. The piezometer cap would be threaded onto the riser pipe and water tight.
16. Data loggers will be installed in each standpipe to collect groundwater pressure data for a period of at least several months until the pressures in the aquifer are collected for further analysis.
17. The completed hole will be visually monitored by site personnel (Horizon or the owner's representative) throughout the rest of the day and for subsequent days. Any sign of flow from the hole would be reported to Horizon immediately, and remedial action would be taken as soon as possible (which may require re-mobilization of drilling equipment to the site).

4.3.3 Borehole Abandonment Program (Flowing Artesian Hole, if Piezometer Not Installed)

1. If artesian water is flowing out the top of the casing, short pieces of casing could be added until the water stops flowing or is reduced to a small flow that will allow the placement of bentonite chips and pellets by gravity. A cap would be placed with a pressure gauge onto the top of the casing to determine the artesian pressure before adding supplementary casing lengths. The location of each borehole will be surveyed based on a common datum.
2. Backfill with bentonite chips from the bottom of the borehole to the bottom of the glacial till layer. Confirm that artesian flow has stopped prior to proceeding prior to completely pulling the casing.
3. Once artesian flow has stopped, backfill on top of the bentonite chips with a layer of coated bentonite pellets.
4. Mix a recipe of Portland cement and barite as heavy as possible and still be able to pump into the casing from the top of the bentonite pellets to the surface. Take the 'Mud Balance' to measure the weight of the 'heavy cementitious grout' so that we know the pressure of the grout column that is placed to balance any artesian water pressure that may be encountered. We want to place the bentonite to act as a 'plug' into the aquifer. If we did not place this bentonite plug, the cementitious grout may 'disappear' into the aquifer.
5. No casing would be removed prior to confirming control of any artesian flow.

6. Allow cement/bentonite to set and confirm seal before moving off the location.
7. Sufficient volume of fresh water would be on site for the mixing of the cementitious grout.
8. Storage capacity would be available on site for the collection of any drill fluid returned to the surface.

4.3.4 *Borehole Abandonment Program (Non-Flowing / Non-Artesian Hole, if Piezometer Not Installed)*

The bore holes will be backfilled with soil cuttings, filter sand, bentonite chips.

4.4 Excavation of Test Pits

Excavation of test pits will be carried out to a depth of up to 1.5 metres. Keystone Environmental's representative would collect samples for environmental remediation purposes. Excavation must be carried out in lifts of no more than 0.3 metre. After removal of each lift, the excavated area would be reviewed by the on-site hydrogeologist for any potential heaving and/or upward groundwater seepage. The contractor, prior to beginning of excavation of test pits, must mobilize to the site with suitable equipment (e.g. hoe pack) and well-graded granular backfill with minimum 10% of fines content to restore grades of areas with signs of potential heave. Backfill material must be compacted using a hoe pack. Backfill material should be stockpiles on site during the excavation of test pits.

Soil sampling will be carried out in the presence of the General Contractor for bench scale testing by ground improvement tenderers.

5. FIELD PACKAGE

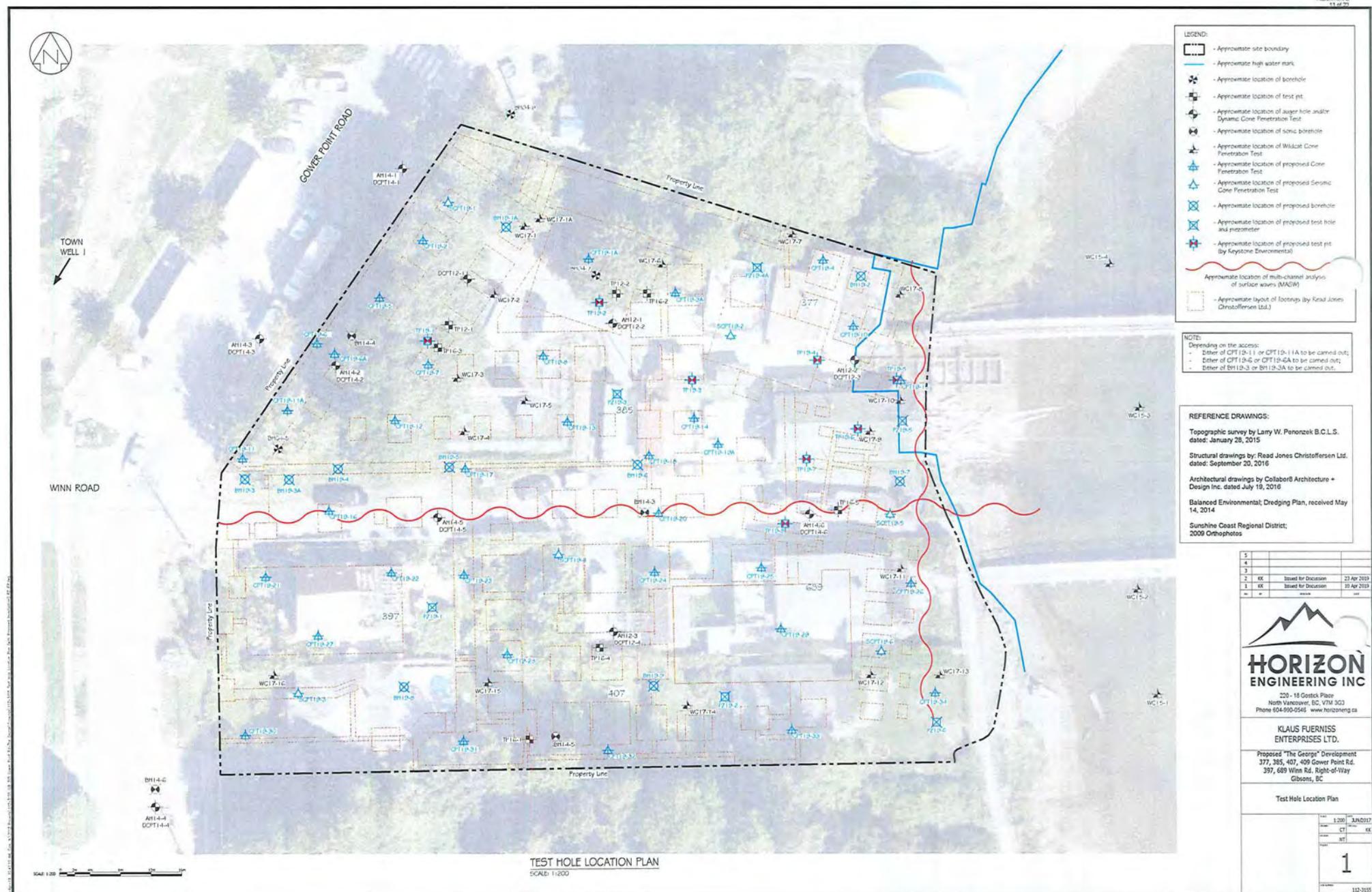
The following documents are attached:

1. Figure 1: Proposed test hole location plan
2. Sonic Drilling System brochure
3. Mud Bay's sonic drill rig specifications sheet
4. Horizon Engineering Certificate of Insurance
5. Keystone Environmental Certificate of Insurance
6. Mud Bay Drilling Certificate of Insurance
7. Horizon Engineering WorkSafe BC letter
8. Keystone Environmental WorkSafe BC letter
9. Mud Bay Drilling WorkSafe BC letter
10. Mud Bay drillers' safety training records

The following signees read this document and understand their responsibilities and agree to implement the requirements of this document.

The following signees read this document and understand their responsibilities and agree to implement the requirements of this document.

Name	Company	Position	Signature
CHRIS HOMES	KEYSTONE ENV.	HYDROGEOLOGIST	<u>Christopher D. Homes</u>
Jason Tom	Horizon Engineering	Geotechnical Engineer (EI)	<u>Jason Tom</u>
Nima Tahazzoli	Horizon Eng.	Geotechnical Eng.	<u>N. Tahazzoli</u>
Devon White	MBD	Driller	<u>Devon White</u>
SAR CARON	MBD	Driller helper	<u>SAR CARON</u>
Elom DOBZ	MBD	Driller helper	<u>Elom DOBZ</u>
Lauralynn Golder		Junior Geotech Eng	<u>Lauralynn Golder</u>



CERTIFICATE OF INSURANCE					DATE (YY/MM/DD) April 11, 2019									
BROKER		<p>envision INSURANCE</p> <p>This certificate is issued as a matter of information only and confers no rights upon the certificate holder. This certificate does not amend, extend or alter the coverage afforded by the policies below.</p>												
		<p align="center">COMPANIES AFFORDING COVERAGE</p> <table border="0"> <tr> <td>COMPANY A</td> <td>Certain Lloyds Underwriters as arranged by I3 Underwriting Managers Inc.</td> </tr> <tr> <td>COMPANY B</td> <td>Chubb Insurance Company</td> </tr> <tr> <td>COMPANY C</td> <td></td> </tr> <tr> <td>COMPANY D</td> <td></td> </tr> </table>					COMPANY A	Certain Lloyds Underwriters as arranged by I3 Underwriting Managers Inc.	COMPANY B	Chubb Insurance Company	COMPANY C		COMPANY D	
COMPANY A	Certain Lloyds Underwriters as arranged by I3 Underwriting Managers Inc.													
COMPANY B	Chubb Insurance Company													
COMPANY C														
COMPANY D														
INSURED														
Mud Bay Drilling (2015) Ltd. 19545 Telegraph Trail Surrey, British Columbia V4N 4G9														
COVERAGES														
<p>This is to certify that the policies of insurance listed below have been issued to the insured named above for the policy period indicated, notwithstanding any requirement, term or condition of any contract or other document with respect to which this certificate may be issued or may pertain, the insurance afforded by the policies described herein is subject to all the terms, exclusions and conditions of such policies.</p>														
LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.														
CO LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (YY/MM/DD)	POLICY EXPIRY DATE (YY/MM/DD)	LIMITS									
A	GENERAL LIABILITY <input checked="" type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS MADE <input checked="" type="checkbox"/> OCCURRENCE <input checked="" type="checkbox"/> TENANT'S LEGAL LIABILITY CROSS LIABILITY INCLUDED EMPLOYERS LIABILITY INCLUDED PRIMARY/NONCONTRIBUTORY COVERAGE XCU COVERAGE INCLUDED <input checked="" type="checkbox"/> NON-OWNED <input type="checkbox"/> HIRED	I3-3974	2018/12/04	2019/12/04	EACH OCCURRENCE \$10,000,000. GENERAL AGGREGATE \$10,000,000. PRODUCTS – COMPLETED/OP AGG \$10,000,000. PERSONAL INJURY \$10,000,000. TENANT'S LEGAL LIABILITY \$2,000,000. MEDICAL PAYMENTS ANY ONE PERSON \$2,500. NON-OWNED AUTOMOBILE \$10,000,000.									
A	CONTRACTORS EQUIPMENT	I3-3974	2018/12/04	2019/12/04	BROAD FORM	\$3,000,000.								
B	ENVIRONMENTAL LIABILITY	EIL355731 001	2018/12/04	2019/12/04	POLLUTION LIABILITY	\$5,000,000.								
A	FOREST FIRE FIGHTING EXPENSES	I3-3974	2018/12/04	2019/12/04	BROAD FORM	\$5,000,000.								
A	EXCESS LIABILITY	I3-5563	2018/12/04	2019/12/04	EXCESS LIABILITY	\$6,000,000.								
ADDITIONAL INSURED Town of Gibsons			DESCRIPTION OF OPERATIONS/LOCATIONS/AUTOMOBILES/SPECIAL ITEMS Drilling Investigation											
CERTIFICATE HOLDER			CANCELLATION											
Town of Gibsons 474 South Fletcher Road, Box 340 Gibsons, BC V0N 1V0			Should any of the above described policies be cancelled before the expiration date thereof, the issuing company will endeavor to mail 30 days written notice to the certificate holder named to the left, but failure to mail such notice shall impose no obligation or liability of any kind upon the company, its agents or representatives.											
			AUTHORIZED REPRESENTATIVE – Elaine Stewart, CIP 											
Per Envision Insurance Services a division of First West Insurance Services Ltd.														

This policy contains a clause that may limit the amount payable.



WORKING TO MAKE A DIFFERENCE

Assessment Department	Location
Mailing Address	6951 Westminster Highway
PO Box 5350	Richmond BC
Station Terminal	V7C 1C6
Vancouver BC V6B 5L5	www.worksafebc.com

Attachment E
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Clearance Section
Telephone 604 244 6380
Toll Free within Canada
1 888 922 2768
Fax 604 244 6390

Town of Gibsons
474 South Fletcher Road, Box 340
GIBSONS, BC V0N 1V0

April 11, 2019

Person/Business : MUD BAY DRILLING (2015) LTD.
MUD BAY DRILLING
Account number : 957885

We confirm that the above-mentioned account is currently active and in good standing.

This firm has had continuous coverage with us since October 01, 2015 and has satisfied assessment remittance requirements to April 01, 2019.

The next payment that will affect this firm's clearance status is due on April 20, 2019.

This information is only provided for the purposes of Section 51 of the *Workers Compensation Act*, which indicates that a person using a contractor or subcontractor to perform work may be responsible for unpaid assessments of the contractor or subcontractor.

Employer Service Centre
Assessment Department

Clearance Reference # : C130869601
CLRA1A

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Please refer to your account number in your correspondence or when contacting the Assessment Department.
To alter this document constitutes fraud.



CERTIFICATE OF LIABILITY INSURANCE

This certificate is issued as a matter of information only and confers no rights upon the certificate holder and imposes no liability on the insurer.
This certificate does not amend, extend or alter the coverage afforded by the policies below.

1. CERTIFICATE HOLDER - NAME AND MAILING ADDRESS				2. INSURED'S FULL NAME AND MAILING ADDRESS		
Town of Gibsons 474 South Fletcher Road, Box 340 Gibsons BC POSTAL CODE V0N 1V0				Keystone Environmental Ltd. #320 - 4400 Dominion Street Burnaby British Columbia POSTAL CODE V5G 4G3		
3. DESCRIPTION OF OPERATIONS/LOCATIONS/AUTOMOBILES/SPECIAL ITEMS TO WHICH THIS CERTIFICATE APPLIES (but only with respect to the operations of the Named Insured) Environmental Consulting Engineers						
4. COVERAGES This is to certify that the policies of insurance listed below have been issued to the insured named above for the policy period indicated notwithstanding any requirements, terms or conditions of any contract or other document with respect to which this certificate may be issued or may pertain. The insurance afforded by the policies described herein is subject to all terms, exclusions and conditions of such policies.						
LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS						
TYPE OF INSURANCE	INSURANCE COMPANY AND POLICY NUMBER	EFFECTIVE DATE YYYY/MM/DD	EXPIRY DATE YYYY/MM/DD	LIMITS OF LIABILITY (Canadian dollars unless indicated otherwise)		
				COVERAGE	DED.	AMOUNT OF INSURANCE
COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS MADE OR <input checked="" type="checkbox"/> OCCURRENCE <input checked="" type="checkbox"/> PRODUCTS AND / OR COMPLETED OPERATIONS <input type="checkbox"/> EMPLOYER'S LIABILITY <input checked="" type="checkbox"/> CROSS LIABILITY <input checked="" type="checkbox"/> TENANTS LEGAL LIABILITY <input type="checkbox"/> POLLUTION LIABILITY EXTENSION <input checked="" type="checkbox"/> NON-OWNED AUTOMOBILES <input checked="" type="checkbox"/> HIRED AUTOMOBILES	Certain Underwriters at Lloyd's - MPL00037	2018/06/11	2019/06/11	COMMERCIAL GENERAL LIABILITY BODILY INJURY AND PROPERTY DAMAGE LIABILITY - GENERAL AGGREGATE - EACH OCCURRENCE	\$5,000	
				PRODUCTS AND COMPLETED OPERATIONS AGGREGATE		\$2,000,000
				<input type="checkbox"/> PERSONAL INJURY LIABILITY OR <input checked="" type="checkbox"/> PERSONAL AND ADVERTISING INJURY LIABILITY		\$2,000,000
				MEDICAL PAYMENTS		\$5,000
				TENANTS LEGAL LIABILITY	\$5,000	\$700,000
				POLLUTION LIABILITY EXTENSION		
				NON OWNED AUTOMOBILE		\$2,000,000
				BODILY INJURY AND PROPERTY DAMAGE COMBINED		
				BODILY INJURY (PER PERSON)		
				BODILY INJURY (PER ACCIDENT)		
AUTOMOBILE LIABILITY <input type="checkbox"/> DESCRIBED AUTOMOBILES <input type="checkbox"/> ALL OWNED AUTOMOBILES <input type="checkbox"/> LEASED AUTOMOBILES ** <small>** ALL AUTOMOBILES LEASED IN EXCESS OF 30 DAYS WHERE THE INSURED IS REQUIRED TO PROVIDE INSURANCE</small>				PROPERTY DAMAGE		
EXCESS LIABILITY <input type="checkbox"/> UMBRELLA FORM <input type="checkbox"/>				EACH OCCURRENCE		
				AGGREGATE		
OTHER LIABILITY (SPECIFY)						
<input type="checkbox"/>						
<input type="checkbox"/>						
<input type="checkbox"/>						
5. CANCELLATION						
6. BROKERAGE/AGENCY FULL NAME AND MAILING ADDRESS				7. ADDITIONAL INSURED NAME AND MAILING ADDRESS (but only with respect to the operations of the Named Insured)		
Metrix Professional Insurance Brokers Inc. 400 - 555 Burrard Street, Box 275				Town of Gibsons 474 South Fletcher Road, Box 340		
Vancouver BC POSTAL CODE V7X 1M8						
BROKER CLIENT ID: KEYST-1				Gibsons BC POSTAL CODE V0N 1V0		
8. CERTIFICATE AUTHORIZATION						
ISSUER Metrix Professional Insurance Brokers Inc.				CONTACT NUMBER(S) TYPE Main NO. (604) 629-2668 TYPE Fax NO. (604) 683-8032		
AUTHORIZED REPRESENTATIVE Mike Russell, C.I.P.				TYPE NO. TYPE NO.		
SIGNATURE OF AUTHORIZED REPRESENTATIVE <i>Mike Russell</i>				DATE April 11, 2019 EMAIL ADDRESS mrussell@mpib.com		



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Attachment E
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Assessment Department	Location	Clearance Section
Mailing Address PO Box 5350 Station Terminal Vancouver BC V6B 5L5	6951 Westminster Hwy Richmond BC V7C 1C6 www.worksafebc.com	Telephone 604 244 6380 Toll Free within Canada 1 888 922 2768 Fax 604 244 6390

KEYSTONE ENVIRONMENTAL LTD
UNIT 320 4400 DOMINION ST
BURNABY BC V5G 4G3

April 03, 2019

Person/Business: KEYSTONE ENVIRONMENTAL LTD
488241

We confirm that the above-mentioned account is currently **active** and **in good standing**.

This firm has had continuous coverage with us since July 19, 1993 and has satisfied assessment remittance requirements to **July 01, 2019**.

This information is provided for the purposes of Section 51 of the *Workers Compensation Act*, which indicates that a person using a contractor or subcontractor to perform work may be responsible for unpaid assessments of the contractor or subcontractor.

Employer Service Centre
Assessment Department

Clearance Reference #: 531961
CLRA1A-7

1981663

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**SOUTH
WESTERN
GROUP**

401 The West Mall, Suite #700
Toronto, ON M9C 5J5,
WATTS: (866) 794-5463
FAX: 1-877-329-2794

Please visit our website @www.swgins.com

CERTIFICATE OF INSURANCE

THIS IS TO CERTIFY TO: Town of Gibsons, 474 South Fletcher Road, Box 340, Gibsons, BC V0N 1V0

that policies of insurance, as herein described, have been issued to the
INSURED named below and are in force as of this date.

INSURER(S): Effectuated with Certain Lloyd's Underwriters as evidenced by Contract No. B1921
KC000010R

NAME OF INSURED: Horizon Engineering Inc.

ADDRESS OF INSURED: 18 Gostick Place,
North Vancouver, BC V7M 3G3

KIND OF POLICY: Professional Liability

POLICY NUMBER: SWG1025817

	Month	Day	Year		Month	Day	Year
POLICY PERIOD:	From		04/29/18	to		04/29/19	

LIMITS OF LIABILITY:	E&O	\$2,000,000	(Cdn) Per Claim
		\$2,000,000	(Cdn) Aggregate Amount Payable

NOTE: The insurance afforded is subject to the terms, conditions and exclusions of the applicable policy.
This Certificate is issued as a matter of information only and confers no rights on the holder and
imposes no liability on the Insurer

July 5, 2018

Date

A handwritten signature in black ink, appearing to read 'John A. Barclay'.

John A. Barclay, President & CEO



WORKING TO MAKE A DIFFERENCE

Assessment Department	Location
Mailing Address	6951 Westminster Highway
PO Box 5350	Richmond BC
Station Terminal	V7C 1C6
Vancouver BC V6B 5L5	www.worksafebc.com

Attachment E
17 of 23
Clearance Section
Telephone 604 244 6380
Toll Free within Canada
1 888 922 2768
Fax 604 244 6390

Town of Gibsons
474 South Fletcher Road, Box 340
GIBSONS, BC V0N 1V0

April 10, 2019

Person/Business : HORIZON ENGINEERING INC
Account number : 614606

This letter provides clearance information for the purposes of Section 51 of the Workers Compensation Act.

We confirm that the above-referenced firm is active, in good standing, and has met WorkSafeBC's criteria for advance clearance. Accordingly, if the addressee on this letter is the prime contractor, the addressee will not be held liable for the amount of any assessment payable for work undertaken by the above-referenced firm to July 01, 2019.

This firm has had continuous coverage with us since March 01, 1997.

Employer Service Centre
Assessment Department

Clearance Reference # : C130865561
CLRAAA

For more information about Section 51 and clearance letters visit WorkSafeBC.com

Please refer to your account number in your correspondence or when contacting the Assessment Department.
To alter this document constitutes fraud.

› Sonic DB1



Sonic DB1

Rubber tracked Sonic DB320 drill rig with rubber tracked support unit

Drill Features

Max tooling diameter: 8"
Typical maximum drilling depth: 150'
Pull back: 15,000 lbs
Pull down: 7,900 lbs
Max core barrel length: 10'

Capabilities

Continuous sonic soil sampling
Angle drilling
Iso-Flow sampling
All geotechnical testing
• SPT, DCPT, Shelby, Vane Testing
• Deploying CPT
Diamond drilling

Equipment and Features

Automatic SPT hammer
Rod/casing handler
Rotation safety guards
Skid steer for support

Drill Travel Dimensions

Length: 24'
Width: 8'
Height: 9' 8"
Weight: 24,200 lbs

Drill Setup Dimensions

Length: 20' (34' including rod handler)
Width: 8'
Height: 25'



www.mudbaydrilling.com

Surrey: 19545 Telegraph Trail / Surrey BC, Canada V4N 4G9 / p. [604] 888.2206 / f. [604] 888.4206
Kelowna: 3334 Sexsmith Road / Kelowna BC, Canada V1X 7S5 / p. [250] 765.2210 / f. [250] 769.4206





Competency Form

Form Completed By: kvandenbossche@mudbaydrilling.com

Driller_C05-020_8/14/2018

Safety Procedure			
Wears correct PPE and mentor to assistants	Yes	Understands regulatory requirements	Yes
Conducts site and equipment inspections	Yes	Recognizes potential issues	Yes
Addresses hazards and informs personnel	Yes		

Site Operation			
Set up site and equipment safely	Yes	Understands hoist and winch limits	Yes
Operates controls within equipment capacities	Yes	Metric and imperial measurements understood	Yes
Work performed within equipment capacities	Yes	Feed rate appropriate for site conditions	Yes
Correct combination of rotation, feed pressures	Yes	Operation is smooth	Yes
Understands calculations and depth checks	Yes	Safe working conditions maintained	Yes
Uses correct fluids and concentrations	Yes	Hole alignment and anticipated deflections	Yes
Correct fluid and air pressures used	Yes	Depth and direction accurate	Yes
Able to communicate well with client	Yes	Corrective action correct with hole deviation	Yes
Gauges monitored and interpreted	Yes	General surface knowledge and formation	Yes

Cement and Grouting			
Correct volume of slurry required	Yes	Uses appropriate methods	Yes
Well versed with cement, water, and additives	Yes	Understands pump components	Yes

Leadership

Strong coordination of crew	No	Keeps crew engaged and focused	Yes
Understands limitation of crew members	Yes	Punctual and ready to start next task	Yes
Shows ability to train new assistants	No	Communication with office, supervisor	Yes
Professionalism with clients	Yes	Self sufficient on independent tasks	Yes
Able to handle conflict resolution	Yes	Maintains tools and equipment	Yes
Instruct assistants with respect	Yes	Organized support units and load secured	Yes
Seeks assistance when necessary	Yes	Organized, neat notes	Yes

Experience

Monitoring well installation	Yes	Loss point well installation	No
Multi stage or nested well installs	No	Porous pipe well installation	No
Slope indicator installation	Yes	Drilled with various diameter casing	Yes
Sparge injection well	Yes	Shelby tube sampling	No
Dry drilling	No	Standard penetration testing	Yes
Drilled various depths	Yes	Stainless or PVC wells	No

Critical Thinking and Multi task

Can communicate while controlling drill	Yes	Exhibits learning from errors	Yes
Safely operates more than one lever at a time	Yes	Can adapt to changing conditions	Yes
Able to make quick decisions	Yes	Follows client specs	Yes
Creative, while maintaining procedure	Yes	Reports logs correctly and timely	Yes

Maintenance

Basic understanding of hydraulics and hoses	Yes	Winch and hoist inspections	Yes
Basic understanding of engine components	Yes	Oil levels, filters, fluids maintained	Yes
Basic understanding of vehicle components	Yes	General cleanliness	Yes
Proactive reporting of issues	Yes		

Competency BreakdownAttachment 1E
21 of 23

Ground disturbance course	Yes
---------------------------	-----

Overall Ability

Stage 1: Green. Requires supervisor or mentor at all times.	No
Stage 2: Intermediate. See restrictions section.	Yes
Stage 3: Experienced. No routine mentoring required	No

Restrictions, If Any

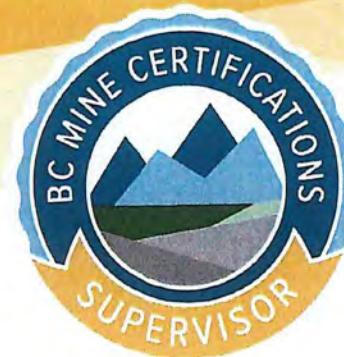
Kevin Vandenbossche
Verification Signature

kvandenbossche@mudbaydrilling.com
New Operator Signature

*KV**DW*

8/14/2018

837303



DEVON ANDREW WHITE

has successfully completed the

Mine Supervisor Certification

of the BC Mine Certifications Program

Valid until: January 8, 2024

Issued by:



Ministry of
Energy, Mines and
Petroleum Resources



No. 00001-GN-16

CERTIFICATE OF QUALIFICATION

This is to certify that

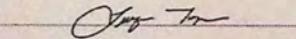
Nicholas Daniel Fairney

has met the certification requirements in the occupation of

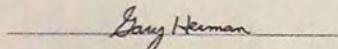
Geotechnical/Environmental Driller

In accordance with the Statutes of the province of British Columbia.

Given at Victoria, British Columbia, this 27th day of January, 2016



BOARD CHAIR



CHIEF EXECUTIVE OFFICER



