



June 11, 2015

Our File: 112-3155

TOWN OF GIBSONS

474 South Fletcher Road
Gibsons, BC V0N 1V0

Attn: Dave Newman

**Re: 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**

1.0 INTRODUCTION

Horizon Engineering published a Geotechnical Investigation Report (Revised) for the aforementioned development on April 7, 2015. Subsequently, this report was reviewed by Levelton Consultants Ltd. and Waterline Resources Inc. on behalf of the Town of Gibsons. The resulting review reports are referenced as follows:

- "Gibsons Aquifer Review of Geotechnical Investigation Report (Revised) for the Proposed "The George" Mixed Use Development at 377m 385 & 407 Gower Point Road, 397 & 689 Winn Road, and Winn Road Right-of-Way, Gibsons, BC", by Waterline Resources Inc., dated May 4, 2015
- "Geotechnical Review - Horizon Engineering Inc. Geotechnical Investigation Report - 07 April 2015 - Proposed "The George" Mixed Use Development, Gibsons, BC", by Levelton Consultants Ltd., dated May 7, 2015.

Our comments regarding the aforementioned Waterline review report have been prepared under separate cover. The following sections contain our comments and brief discussions in response to the aforementioned Levelton review report. It is recommended that our responses to the Levelton and Waterline reports be distributed to both companies because some discussions are relevant to both reviews. The referenced section numbers pertain to the aforementioned Horizon report dated April 7, 2015.

As discussed in Section 1.0 of Levelton's review report, it should be emphasized that the role of the reviewing parties was "to provide a level of professional due diligence" rather than endorse the technical recommendations provided in our report. As such, and under the existing contractual arrangements, we do not expect that Levelton (nor Waterline) are expected nor required to claim responsibility for the geotechnical and hydrogeological aspects of this project.

2.0 LEVELTON'S REVIEW REPORT

Section 2.0 - Discussion, Paragraph 1

The concepts provided in our report have been reviewed by the client and design team. It is understood that the proposed concepts are feasible for construction of the project with this magnitude and complexity.

Section 2.0 - Discussion, Paragraph 2

Levelton's concern regarding the lack of sufficient information for this stage of the project is understandable. As Horizon emphasized in the aforementioned report dated April 7, 2015, details of our recommended foundation concepts and other structural considerations will be more accurately determined at the detailed design stage of the project. The aforementioned report proposes a reasonable approach, which is consistent with the requirements of the project; specifically, protection of the aquifer.

It is our understanding that a design life of 50 to 75 years is typically assumed in building design and that the BC Building Code does not provide specific recommendations in this regard. If a design life of 75 years were to be assumed by the design team, we assume that sea level at the subject site could rise 0.74 metre (2 feet 5 inches) by 2090 (i.e., 90% of the expected 2 feet 8 inches / 0.82 metre sea level rise from 2000 to 2100) in accordance with the discussion provided in Section 9.2 of our report. Accordingly, we envisage that the Flood Construction Level at the end of a building's 75 year design life in 2090 would be approximately 5.54 metres (18 feet 2 inches). This elevation is 0.21 metre (8 inches) higher than the FCL recommended in our report when a 50 year design life is assumed (i.e., 5.33 metres / 17 feet 6 inches FCL). If the design team decides to assume a 75 year design life for the building, we recommend that the habitable space and sea dike elevations be revised accordingly.

The selection of a 50 year design life for the proposed structure is a common practice. In the 2012 BC Building Code, the seismic design requirements for a structure are based on a 50 year design life as well (i.e., 2% chance of exceedance in 50 years for a design seismic event). However, if the Town of Gibsons require a different criteria, our recommendations will be revised accordingly.

Section 2.0 - Discussion, Paragraph 5

Vertical hydraulic gradients were considered during the computer modelling work that is described in Section 8.0 of our report. Upward artesian water pressures within the Gibsons Aquifer were analyzed in order to estimate changes in subsurface stress conditions as excavation progresses and to determine the magnitudes of potential ground movements at each stage. This modelling work has been revisited since the April 7, 2015 report was issued, as discussed in our memorandum regarding the hydrogeological review report. For information, a print out of the calculated upward hydraulic gradient where the excavation for the P2 parking level is proposed is attached to this document.

As we show in our report, as supported by extensive computer modelling, the excavation for the proposed building will mainly be limited to removal of some of the fill materials that were placed relatively recently for the construction of Gower Point Road. If these fill materials were not present,

the proposed development would not excavate into the natural ground (except at limited areas that removal of minor thicknesses of peat, sand, and silty sand materials are also proposed) and there would be no significant / major stress change in the ground below (including within the Gibsons Aquifer). One of the reasons that the computer modelling carried out for this project is judged to be a conservative approach is that we did not simulate the previous natural, stable condition prior to the placement of fill materials. If that would have been carried out, the net stress change at depth would be near zero (comparing to the original / natural in-situ stresses) due to construction of the proposed building.

Section 2.0 - Discussion, Paragraph 6

It is noteworthy that the proposed excavation at the west portion of the site is expected to be less than approximately 5.0 to 5.8 metres (17 to 19 feet) deep, as discussed in Section 21.2 of our report. This is not considered to be a deep excavation, and we, as well as many local shoring contractors, have extensive experience with providing support to excavations much deeper than this. Off-site encroachment of anchors is expected to be required, as discussed in Section 21.2, but this is a common occurrence with excavation projects and is typically not problematic. Recommendations were provided in Section 14.2 of our report with regard to temporary excavation dewatering such that off-site settlement as a result of dewatering is avoided. Again, these are considered to be common construction practices that are not expected to be problematic.

Based on the above, as well as on the discussion above regarding Paragraph 5, we do not envisage that truncation of the P2 parkade level is required, as was suggested in Levelton's report.

Section 2.0 - Discussion, Paragraph 7, Bullet 2

Pile design would be carried out at the detailed design stage of the project. These analyses would consider hydrodynamic loading and impact from tsunami waves and associated debris, as required. To clarify, the main development west of the shoreline is not subjected to a tsunami hazard, as discussed in Section 9.3, provided that the requirements for Flood Construction Level are met.

Section 2.0 - Discussion, Paragraph 7, Bullet 3

As described in Sections 9.2 and 16.0 in our report, the sea dike is proposed to comprise a gravity structure, constructed above existing grades in conjunction with a waterproofed building envelope to provide protection to the proposed habitable spaces from flood hazards. Accordingly, the presence of a high natural water table and artesian groundwater pressures are not expected to have an impact on the design or functionality of the sea dike. Therefore, there is no need to install a below-grade groundwater cut-off wall. We recommend that the proposed sea dike structure should be reasonably impermeable.

As described in Section 14.3, waterproofing systems would be designed by a qualified building envelope engineer. It is typical for geotechnical engineers to seek indemnification when buildings are constructed as waterproofed structures below the water table. Please note that the indemnification is required to ensure that if the structure is not maintained or operated as per the design requirements, the designer is not responsible for the consequences. Horizon Engineering is not seeking indemnity for their responsibility for the design and construction supervision and performance of the structure if it is constructed in accordance with the design requirements.

Section 2.0 - Discussion, Paragraph 7, Bullet 4

As discussed above with regard to Paragraph 6, off-site encroachment of anchors is expected to be required for shoring at the northwest portion of the site, but this is a common occurrence with excavation projects and is typically not problematic. Encroachment onto public property is expected to be required (i.e., Gower Point Road and Winegarden Park). We understand that the Town of Gibsons has established the permit requirements for temporary encroachment into public property. These requirements will be met at the time of Building Permit submission.

Section 2.0 - Discussion, Paragraph 7, Bullet 5

As described in Section 14.3 of our report, an in-ground infiltration system would be designed to disperse groundwater that is intercepted by the waterproofed building. Natural groundwater from the west side of the building would be directed into a dispersion field on the east side of the building to naturally drain into near-surface, permeable soil. This concept is common for situations where the building is designed as a waterproofed structure and located on a sloping site. No additional water would be added to this system beyond the natural intercepted groundwater. The proposed infiltration system would not extract nor direct groundwater from the subject property into the Town of Gibsons' stormwater disposal system. This system would be constructed above existing grades, possibly beneath the eastern portion of the proposed building.

Construction of the proposed sea dike (an above-grade, gravity type structure) is not expected to have any impact on the natural groundwater regime, nor the functionality of the proposed upstream infiltration system.

Section 2.0 - Discussion, Paragraph 7, Bullet 7

It is our understanding that the developer is flexible with regard to the dredging depth at the west portion of the proposed marina area. Therefore, the depth of dredging would be limited to the loose seabed sediments, as recommended in our report.

Section 2.0 - Discussion, Paragraph 7, Bullet 9

Based on the results of the site assessments and subsequent engineering analyses, it is concluded that the subject site is considered to be "safe for the intended use" from a geotechnical perspective, provided that the recommendations described in our report dated April 7, 2015 are incorporated into the design and construction of the development at the subject site.

Section 2.0 - Discussion, Paragraph 8

The list of points listed by Levelton are among the items that would be addressed at the detailed design stage of the project.

3.0 CLOSURE

At this stage of the project and in order to provide geotechnical engineering recommendations for the proposed development, specifically addressing protection of the aquifer, Horizon Engineering demonstrated a high level of professional due diligence by conducting subsurface investigations, in-situ and laboratory testing, and engineering analyses. The engineers involved in this project were qualified for the type and complexity of the project, and we are confident that the recommendations provided are valid and can safely be implemented for the design and construction of the project. We also acknowledge that more rigorous engineering analysis will be required at the detailed design stage of the project and that revisions to our recommendations may be required depending on the outcome of the detailed design stage.



Therefore, we confidently confirm that if our recommendations are implemented into the detailed design and construction phases of the project, there will be no adverse impact on the performance of the Gibsons Aquifer and the project will be safe for the intended use from a geotechnical point of view.

I, Karim Karimzadegan, P.Eng., as the geotechnical engineer of record for this project, also emphasize that I am confident with the recommendations provided in our report. I have more than 25 years of experience in the field of geotechnical engineering and have been involved in the design and construction stage of more than one hundred projects with complexities comparable to the proposed development.

We trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or require clarification of the above, please do not hesitate to contact us.

For

HORIZON ENGINEERING INC



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

For

HORIZON ENGINEERING INC

Pamela Bayntun, P.Eng.
Project Engineer

Attachment: Hydraulic Gradient Results for P2 Parking Level Excavation

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