GEO Group Northwest, Inc. Geotechnical Engineers, Geologists & Environmental Scientists

July 30, 2015

G-3837

Mr. William C. Summers
MI Treehouse, LLC
P.O. Box 261
Medina, Washington 98039

Subject: Response to Geotechnical Third Party Review Comments
Proposed Residence
5637 East Mercer Way
Mercer Island, Washington

Dear Mr. Summers:

Per your request, GEO Group Northwest, Inc. has prepared this letter which presents our responses to comments in the June 12, 2015, geotechnical third party review letter by Perrone Consulting, Inc., regarding the proposed residence at 5637 East Mercer Way in Mercer Island, Washington.

Landslide Hazard

In our opinion, the project site meets the criteria for classification as a geologic hazard area per Chapter 19.16 of the Mercer Island Municipal Code (MIMC). MIMC-identified geologic hazards at the site consist of erosion hazard, landslide hazard, and seismic hazard.

Published geologic mapping of the site vicinity identifies a landslide scarp running along the steep slope area from the southern part of the project site toward the southwest and then northwest along an arc-shaped path on adjacent properties. We have no information that indicates landsliding has occurred at this location in the recent past (i.e., since construction of the surrounding residences or archiving of municipal records). The mapped scarp is associated with, older, pre-historical, landsliding of unknown age, possibly starting with the most recent recession of the Puget Lobe approximately 13,000 years ago.

Known landslides, based on mapping retrieved from the City of Mercer Island Information and Geographic Services internet portal, are located along East Mercer Way next to parcels at the addresses of 5645/5655 and 5638. A landslide also is noted at parcels 5425 and 5432 Parkwood Lane located approximately 275 feet north-northwest from the project site. A copy of an excerpt of the mapping is enclosed as Attachment 1.

Slope Stability Evaluation

In our opinion, the steep slope on the southern portion of the site has some susceptibility to shallow raveling or sloughing, particularly if it is disturbed by earthwork or significant clearing. It is our opinion that construction of the proposed residence will not adversely affect the overall stability of the slope, provided that the area is not disturbed or significantly cleared during this period except as recommended below for purposes of enhancing stability and drainage.

In our opinion, mitigation of potential soil movement during earthwork, which should only take a few weeks to complete, can be achieved by placing rip rap rock against exposed cut slopes as needed to contain active raveling and prevent subsequent additional raveling, in lieu of installing excavation shoring for the project. We recommend that the excavation work be performed during the dry weather season while water seepage at the site is at a reduced level.

Ground Improvement to Improve Long-Term Slope Stability

We recommend that improvement of the long-term stability of the steep slope on the southern part of the site be achieved by placing a layer of rip rap rock along the base of the slope (in the area where seepage is present) to provide lateral support to the saturated sandy soils while preventing the accumulation of water within the soils. The rip rap rock can be placed behind the proposed rockery to achieve this purpose. A layer of geotextile filter fabric should be laid behind the rip rap to aid in the retention of the sandy soils in the slope.

Catchment Wall

Out of an abundance of caution, we recommend that the bottom 4 feet of the above-grade portion of the exterior southeast wall of the residence be designed as a catchment wall to retain potential debris in the unlikely event of significant slope movement.

Seismic Hazard

In our March 13, 2015, report, we concluded that the near-surface, loose, sandy soils at the site are susceptible to liquefaction based on the conditions found in the two soil borings that were completed for our investigation. These soils consist of the upper approximately 10 feet of soils encountered at the location of boring B-1 and the upper approximately 15 to 20 feet of soils encountered at the location of boring B-2. The deeper, relatively siltier soils are less susceptible to liquefaction, in our opinion.

In our opinion, mitigation of potential adverse impacts to the proposed development due to potential, limited soil liquefaction can be achieved through two types of measures: Use of a pile supported foundation system to fully support the proposed residence, and improvement and stabilization of the proposed driveway subgrade. These measures are recommended in our March 13, 2015 report.

Earthquake induced ground shaking, slope failure, or settlement also are items which are noted in the MIMC seismic hazard area definition. In our opinion, potential adverse effects to the proposed residence structure due to these items also can be mitigated by fully supporting the structure on a pile foundation system such as a pipe pile and grade beam system, as recommended in our March 13, 2015 report, and by incorporating a structural catchment wall into the design of the southeast exterior wall of the residence, as described above in this letter.

<u>Resistance to Lateral Loads</u>

We have evaluated lateral load resistance for pipe pile supported foundations and for basement walls. With regard to basement walls, a rectangular lateral pressure of 8H pounds per square foot (psf), where H is the height of the wall measured in feet, can be used for short-term seismic loads. If the basement walls are not fully drained, then the lateral pressures provided in our March 13, 2015 report should be modified to the following:

<u>Active Earth Pressure</u>
60 pcf, equivalent fluid pressure, for level ground behind the walls;
75 pcf, equivalent fluid pressure, for wall backslope of 2H:1V

At-Rest Earth Pressure
75 pcf, equivalent fluid pressure, for level ground behind the walls;
90 pcf, equivalent fluid pressure, for wall backslope of 2H:1V

Passive Earth Pressure
275 pcf, equivalent fluid pressure, for undisturbed, medium dense to dense native soil or structural fill

For pipe pile supported foundations, lateral loads can be resisted either by using battered piles or helical anchors that are embedded into the native competent soils. Helical anchors typically provide much higher load resistance capacities than battered pipe piles and provide resistance to both compressive and tension loads (battered pipe piles are not recommended for providing resistance to tension loads).

Based on the soil conditions encountered in the borings previously drilled on the site, we anticipate that the anchors will need to extend a minimum distance of approximately 10 feet into the competent native soils in order to achieve acceptable embedment. The minimum anchor lengths, subject to testing during installation, should be determined during the design stage of the project and inspected during construction.

The ultimate capacity for helical anchors should be determined and verified in the field by a geotechnical engineer based on the maximum torque that is successfully achieved during installation. For Chance helical anchors, the ultimate capacity can be determined by the following empirical relationship:

$$Q_{ULT} = K_t * T$$

where K_t is the empirical factor (= 10 ft^{-1} for square shaft anchors); and T is the installation torque.

The allowable capacity of the helical anchor is developed when sufficient torque is recorded during installation. For example, based on the above empirical correlation developed by the A. B. Chance Company, an installation torque of 4,000 ft-lbs roughly correlates to an ultimate capacity of 20 tons. Thus, the allowable capacity for an installed anchor with a factor of safety of 2 with respect to its ultimate capacity is approximately 10 tons.

The performance of helical anchors is dependent on the method and to what bearing stratum the anchors are installed. Since an anchor cannot be directly observed when in the ground, it is critical that judgment and experience be used as a basis for determining the acceptability of an anchor. Therefore, we recommend that GEO Group Northwest be retained to monitor the anchor installation operations, collect and interpret installation data, and verify acceptable loading capacity for the anchor has been attained.

Down-drag Effects on Piles

In our opinion, the sandy character of the near-surface loose soils has a minimal potential to exert significant down-drag on piles installed on the project site. The recommended allowable pile capacities presented in our March 13, 205 report are adequate to accommodate the expected conditions.

Erosion Hazard

We recommend that long-term, post-construction measures be implemented to mitigate potential soil erosion associated with the proposed development. Stormwater from impervious areas (such as building roofs and driveways) should be collected, handled as appropriate per code (i.e., for polluting and non-polluting cases), and discharged to an approved stormwater handling facility (such as the municipal stormwater utility). Subsurface drainage associated with basement walls or other retaining walls should be collected and tightlined (separately from surface stormwater) to an approved discharge location.

Areas of the site that had been disturbed as a result of construction of the proposed development should be restored and re-vegetated to a condition that mitigates potential soil erosion. Temporary stabilization of soils that had been exposed can include amending and/covering the soils with mulching or topsoil, and then covering these areas with bio-degradable netting and adding plantings of non-invasive plants that will develop to provide suitable soil cover or stabilization (rooting).

Closing

Please feel welcome to contact us if you have any questions.

GEO Group Northwest, Inc.

Sincerely,

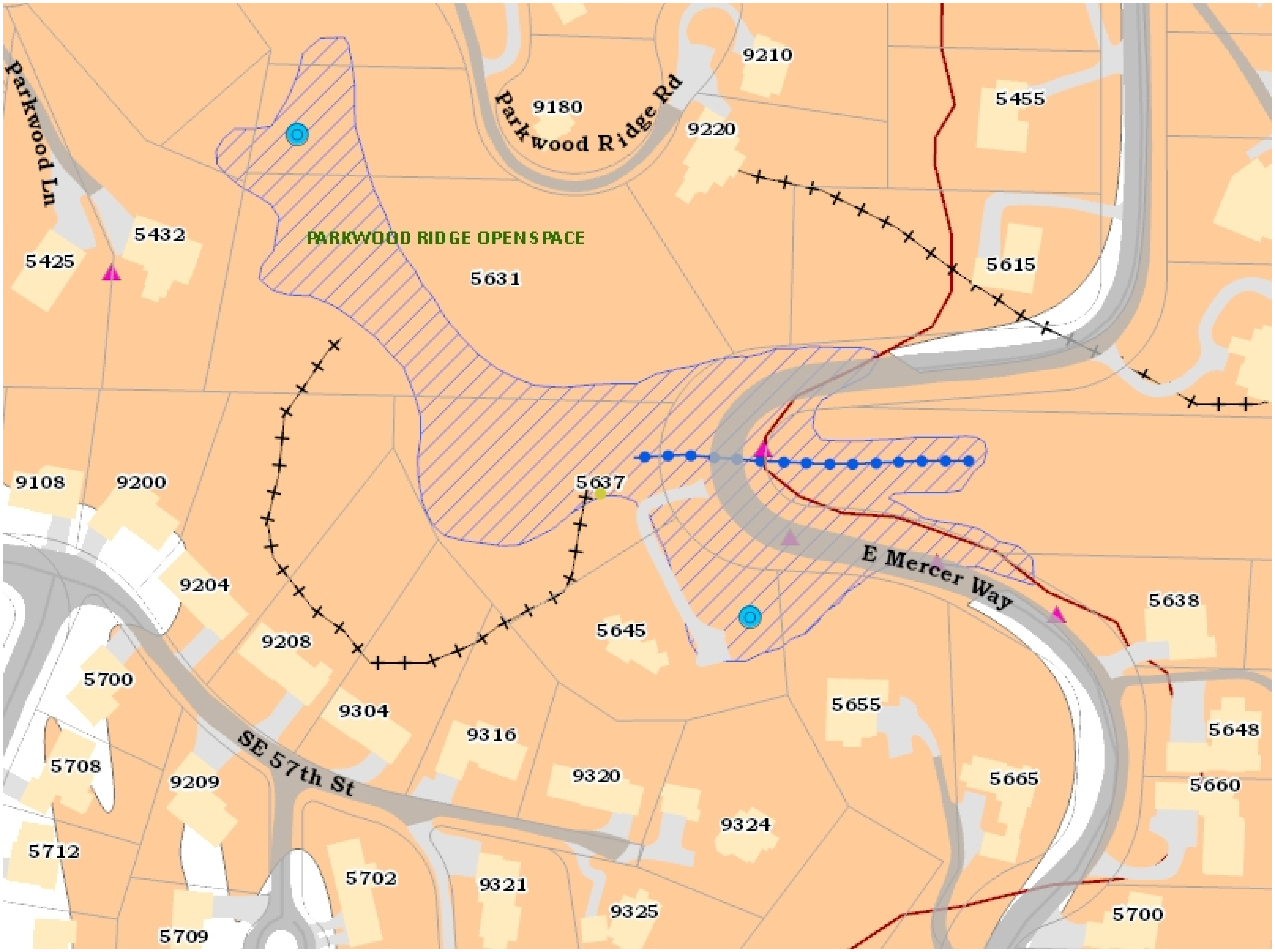
GEO GROUP NORTHWEST, INC.

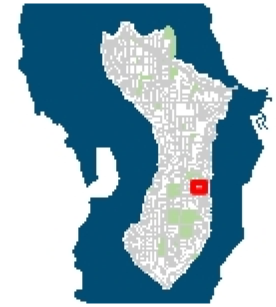
Keith Johnson
Project Geologist

William Chang, P.E.
Principal

Enclosure: City of Mercer Island GIS Mapping Excerpt

IGS
Information & Geographic Services





Legend

- Parcels
- Buildings
- Docks
- Bridge
- SideWalk
- Paved Road
- Paved Driveway
- Paved Parking Area
- Identified Landslide Location
- Scarp
- Geologic Contacts
- Spring Locations
- Springs Mapped
- Water < 10 ft below ground sui
- Landslide Area
- Address
- Street Centerline
- Lake Washington
- Parks

1: 1,660

276.6 0 138.30 276.6 Feet

Map Printed: July 8, 2015

Disclaimer: These maps were developed by the City of Mercer Island and are intended to be a general purpose digital reference tool. These maps are not an accepted legal instrument for describing, establishing, recording or maintaining descriptions for property concerns or boundaries. The City makes no representation or warranty with respect to the accuracy or currency of these data sets, especially in regard to labeling of surveyed dimensions, or agreement with official sources such as records of survey, or mapped locations of features.

Notes