TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

September 10, 2023
Project No. T-8718

Mr. Jamie Buchan
William E. Buchan Homes
2630 – 116th Avenue NE, Suite 100
Bellevue, Washington 98004

Subject: Response to City of Mercer Island Comments
3036 – 67th Avenue SE
Mercer Island, Washington

References:
1. Geotechnical Report, 3036 – 67th Avenue SE, Mercer Island, Washington, Project No. T-8718, prepared by Terra Associates, Inc., dated August 22, 2022, revised April 21, 2023

3. Geotechnical Peer Review Comments, prepared by City of Mercer Island, dated August 2023

Dear Mr. Buchan:

As requested, we have reviewed the referenced comments from the City of Mercer Island regarding the project site. The following is our response to the geotechnical comments.

Page 1 – Comment #3

Because the results of the liquefaction analysis indicates the potential for liquefaction to occur, residual strength values in the liquefied zones should be included in the assessment of the site stability in a post-liquefaction condition.

Please provide the results of a post-liquefaction site stability assessment and provide supporting calculations for the residual strengths used in the analyses in a report addendum.

The liquefaction assessment also used truncated soil conditions in the boring logs from elevation 97.5. Please provide the liquefaction assessment for the entire soil column indicated in the boring logs. This will indicate whether the soils above elevation 97.5 might liquefy. If the analyses indicated as such, please include the residual strength values in the affected soil layers and resubmit the stability analyses in a report addendum. This analysis is not just for the building but for the entire site where the instability might affect the site development.

Response

The liquefaction analysis represents the post construction conditions at the two boring locations.

The post construction site stability using residual strengths has been completed and is included in the revised geotechnical report.

The liquefaction assessment of the entire soil column has been included in the revised geotechnical report.

Page 1 – Comment #4

> *In reviewing the revised slope stability analyses, it was noted that a minimum depth of 10 feet was required for the failure surfaces. The number of failure surfaces that did not meet that criteria was large (noted under error code 115) --meaning that lower factor of safety (FS) failure surfaces are probably associated with depths less than 10 feet.*
>
> *Please indicate why the failure surface depth was targeted at 10 feet when the standard of practice is to allow a search to find the failure surface with the lowest FS at the site. At a minimum, the failure surface associated with a FS=1 should be presented.*
>
> *Please provide revised slope stability analyses in a report addendum that do not require this minimum 10-foot depth.*

Response

The reviewer is correct, there are failure surfaces that are less than 10 feet associated with the slope stability analysis. They represent shallow surface failures that are typically associated with erosion. The erosion is managed onsite through vegetation or other means and methods. In order to determine meaningful slope stability results that represent the overall slope stability and not shallow erosion failures it is common for engineers to assign a minimum depth.

We have completed the requested analysis and included it in the revised report. The results of the analysis show shallow failure surfaces that would be consistent with erosion.

Page 1 – Comment #5

> *The recommendation to increase the density of the loose material under building foundations could involve thicknesses of 6 to 13 feet of soil improvement or replacement with compacted structural fill based on the bottom elevation of loose soils encountered in borings B-1 and B-2, respectively and on cross-sections A-A' and B-B' presented in the revised geotechnical report.*
>
> *Given the fines and moisture content of the soils described in the borings, the ability to improve the density of these soils with mechanical compaction will be limited. The excavations required to replace the loose soils could impact the site stability.*

Please revise the project plans (e.g. temporary grading plans, depth of interceptor trench, etc.) and revise stability analyses to include the potential overexcavation depths required to remove the loose soils below the foundations.

Response

The stability analysis has been updated to include the potential over excavation.

Page 1 – Comment #6

If the factor of safety against liquefaction calculation is less than one, please provide estimates and supporting calculations of the post- liquefaction ground settlement.

In addition, determine whether lateral spreading or flow failures may occur after liquefaction. Provide slope stability results or other documentation to support the conclusion of whether lateral spreading or flow failure may occur.

Please include associated post - liquefaction lateral displacement estimates and supporting calculations. Provide mitigation measures for these post-liquefaction impacts.

Please coordinate with the structural engineer and architect so that the project team can provide a coordinated design that addresses these deformations without the potential for building collapse.

Response

The liquefaction calculations are included in the revised geotechnical report. Should the soil liquefy, the estimated settlement is between one half inch and one inch post construction. These settlements are considered acceptable under structures and are not expected to severally impact the building.

The post construction seismic analysis for both cross sections have factors of safety greater than 1.1. Based on the analysis completed, the construction of an interceptor trench, and the proposed building placement, it is our opinion that there is no risk of lateral spreading or flow failure to occur at the site.

Comment #5

The response to the SUB 1 comment included the following from Terra Associates:

"While the loose soil conditions are not dense soil conditions, it does not mean the layers were not glacially overridden. The upper layers of the loose and medium dense material are interpreted as a glacial drift or weather (sic) zone of the underlying older deposits. Although a layer is "loose", it does not mean that it is unable to support a building load. Alluvial sands and silts with SPT blow counts of 1 and 2 are used to support buildings in the areas where they are present in the Puget Sound Region. In addition, the recommendations within the geotechnical report are to increase the density of the loose material, where exposed, under building foundations. ..."

The reviewer disagrees with the interpretation provided in the response. If the soil was overridden by the last glaciation involving 4000 feet of ice, then the soil subjected to that pressure would be dense. The variability of the recorded SPT values is not supportive of the applicant's interpretation of a weathered zone (i.e. considering that weathering occurs from the exposed surface downward, resulting in lower SPT values at the surface, not at depth.)

It is agreed that development occurs in alluvial areas, but this site is not an alluvial site, so the loose soil conditions encountered are not consistent with the geologic environment.

Because these soil conditions are contrary to the expected geologic environment, it is the reviewer's interpretaion that the deposit should be viewed as being disturbed (e.g. a non-engineered fill, landslide debris, etc.). Accordingly, the use of shallow foundations would not be appropriate because the erratic, variable nature of a disturbed deposit precludes the ability to assign representative soil properties. From a design aspect, the soil bearing capacity gives way to a design governed by settlement, which requires reliable soil properties to accurately estimate settlements.

As previously noted, the applicant has the option to have an applicant-paid, outside 3rd party geotechnical engineering review if the differing subsurface characterizations and related foundation design approach cannot be resolved between the geotechnical engineer or record and the City geotechnical reviewer. Please feel free to contact the building official about this process at don.cole@mercergov.org.

Response

Since the reviewer continues to state that shallow foundations are not appropriate in this area due to the potentially loose soil conditions under the building foundations, we are proposing to remove the loose soils under the building foundations so that the shallow foundations will bear on suitable structural fill. As the assumptions are being made on the two borings completed for the project, we are recommending the need for over excavation and replacement be made in the field during construction. The foundation areas will be potholed down the estimated one to four feet to the top of loose soil layers from the proposed finished floor foundation of the building. If the layers are observed, the foundations will be over excavated six to ten feet to the medium dense to dense formation underlying the loose soil layer. If the loose soil is not observed, the potholes will be backfilled in accordance with the recommendations for structural fill in the referenced report.

Page 1 – Comment #7

Please refer to the comment requiring the use of residual strengths in the post-liquefaction site stability analyses and the requested re-analysis. When liquefaction is anticipated the stability analyses should incorporate a residual shear strength in the impacted soil layers to reflect the strength loss due to the effects of liquefaction.

The installation of the interceptor trench will require an excavation of 14-1/2 to 17 feet depending on the bottom elevation of the trench which is shown as 99.6 ft in the plan set, but as elevation 97 in the geotechnical report.

The current location shown in the plan set (Civil sheet 6 of 7, or plan sheet 9 of 28) is 14 feet from the property line. The excavation would require a steeper than 1H:1V open cut excavation to remain on the project site. The current recommendation for temporary open cuts is 1.5H:1V or flatter (p.10 of geotechnical report).

Given that the interceptor trench is a key project component that impacts the design and construction of several other project components (loose soil removal and replacement, floor slab drainage, etc.), please provide a description of how this trench will be installed and the anticipated lateral and vertical extent of the excavation. With the 14 to 17-foot excavation depth, sloping ground conditions to the east of the trench location and proximity to the property line, stability analyses of the trench installation is requested for review.

In addition, please resolve conflict of location and bottom of trench elevation on project plans.

Response

The location and depth of the interceptor trench has been corrected on the civil plans.

In order to install the interceptor trench a trench box will likely be used to minimize the impact to the project site and adjacent properties. Properly installed trench boxes are often used when installing utilities or drains.

Page 20 – Comment #1

The reviewer continues to disagree with the use of shallow foundations at this site.

The allowable bearing pressure calculation provided in the response indicated a factor of safety (FS) of 2.35 for 6 blow count soil (phi angle of 25 degrees). The standard of practice is to provide a FS of 3 for foundation design. Using the calculated ultimate bearing pressure of 4705 psf and a FS=3, that would result in an allowable soil bearing pressure less than the current design pressure of 2000 psf. However, the calculation did not include the presence of groundwater in the 6 blowcount soil. Correcting for the presence of groundwater, the allowable bearing pressure would be reduced to less than 1500 psf.

The allowable bearing pressure was also calculated for building foundations (the reviewer presumes this takes into account subgrade improvement) using a phi angle of 32. This calculation accounted for the presence of groundwater and had a sufficient FS to provide an allowable soil bearing pressure design value of 2000 psf. The difference in these calculations shows the importance of providing the foundation subgrade improvement recommended by the geotechnical engineer of record. However, as discussed in a comment on plan sheet 1, this may require significant overexcavations below the footings.

It is agreed that it may not be practical to provide dewatered subgrade conditions at all sites, particularly alluvial valley locations, therefore accounting for the presence of groundwater in the bearing capacity calculation becomes an important design consideration. To verify that the presence of groundwater is taken into account, these design calculations are requested as part of the permit review process.

Again, the applicant has the option to have an applicant-paid, outside 3rd party geotechnical engineering review if the differing opinions related to the foundation design approach cannot be resolved between the geotechnical engineer or record and the City geotechnical reviewer. Please feel free to contact the building official about this process at don.cole@mercergov.org.

Response

As noted above, we are proposing to over excavate the foundations where loose soil is observed. The foundations will be potholed to determine if loose soils are present and if found they will be removed, and grade restored with structural fill. This will eliminate the reviewers' concern about the loose material under the building foundations and allow for the installation of shallow foundations.

Page 21 – Comment #1

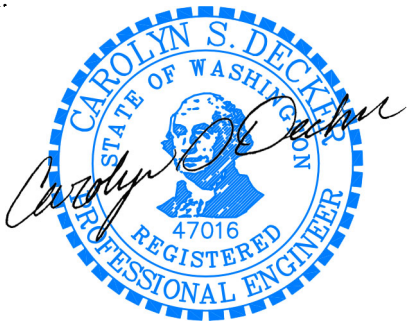
Please provide settlement calculations to support the SUB 1 response.

Response

The differential settlement will be eliminated when the foundations are all founded on structural fill which is possible based on the proposed over excavation. However, in the event the loose soils are not observed, and the building foundations bear directly on native soils, we have completed the requested calculation. The results are attached to this letter.

We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.



9-10-2023

Carolyn S. Decker, P.E.
President

Enclosed: Differential Settlement Calculations

Differential Settlement

Loose Soils: $S = q_o B \left(\frac{1-\mu^2}{E_s}\right)$

$E_s = 500(N+15)$

$= 500(6+15)$

$= 10500 \text{ Kpa} / 50 = 210 \text{ Ksf}$

$S = (2)(2)\left(\frac{1-0.3^2}{210}\right)$

$= 0.017 \text{ ft} = 0.21 \text{ in}$

$q_o = 2 \qquad \mu = 0.3$

$B = 2$ (assumed)

Medium Dense Soils: $E_s = 500(20+15)$

$= 17500 \text{ KPa} / 50 = 350 \text{ Ksf}$

$S = (2)(2)\left(\frac{1-0.3^2}{350}\right)$

$= 0.0104 \text{ ft} = 0.125 \text{ in}$

Difference: $0.21 - 0.125 =$ **0.085 inches**

TERRA ASSOCIATES Geotechnical Consultants	PROJECT 3036 67TH	BY	SHEET 1 / 1
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