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VIA E-MAIL

Mr. Tony Hanna
City of Bethlehem Redevelopment Authority
10 East Church Street
Bethlehem, PA 18018-6005

October 14, 2014

Re: Preliminary Geotechnical Engineering Recommendations
Polk Street Garage
City of Bethlehem, Northampton County, PA
MC Project No. 14001490A

Dear Mr. Hanna:

Maser Consulting P.A. is pleased to provide this letter summarizing our preliminary geotechnical recommendations to assist you in the development the proposed Polk Street garage, located in the City of Bethlehem, Northampton County, Pennsylvania. These geotechnical recommendations are based on our recent field study, and will be summarized in more detail in the forthcoming geotechnical report to be issued on October 17th, 2014.

Existing and Proposed Development

The site currently consists of on grade asphalt paved parking lot, located at the northeast corner of the intersection of East Third Street and Polk Street. Site topography is generally flat, gently sloping downward from southeast to northeast from Elevation 234 to 231. Observed onsite utilities include overhead wires, as well as buried electric, stormwater, and water.

Currently, the proposed structure consists of a six-story parking garage and adjoining two-story commercial structure. Minor cuts and fills are anticipated throughout the site.

Subsurface Conditions

The site is located within the Great Valley Section of the Ridge and Valley Province. Locally, the site is underlain by the dolomite and impure limestone of the Allentown Formation. The subsurface evaluation revealed a weathered soil and rock profile typical of this formation, overlain by fill and alluvial deposits, as outlined below:

- Asphalt Pavement: Asphalt pavement was encountered throughout the parking lot, ranging from about 3 to 6 inches thick.

- Fill Material: Varying fill materials were encountered throughout the site, extending to depths of 4 to 8 feet below grade. Generally the fill material consists of either coarse-grained fill (slag, brick, and sand) or fine-grained fill (silt with varying amounts of sand or clay.
- Alluvial Soil: Alluvial deposits were encountered beneath the fill materials, extending to depths ranging from 25 to 36 feet. Generally two types of alluvial deposits were encountered, consisting of a silt and sand mixture with varying amounts of gravel; as well as a compact to very compact sand and gravel mixture with varying amounts of cobbles and suspected boulders.
- Decomposed Rock: Decomposed rock was encountered below the alluvial soil, extending to depths ranging from 42 to 46 feet. Decomposed rock consists of a soil material comprised of a mixture of sand and silt with occasional friable rock seams.
- Weathered Rock: Weathered rock was encountered below the decomposed rock, extending to auger refusal at depths ranging from 45 to 51 feet. Weathered rock generally resulted in split spoon refusal, but consisted of rock fragments where samples could be recovered.
- Fractured Rock: Fractured rock (poor quality rock) was encountered at depths ranging from 45 to 51 feet.
- Groundwater: Groundwater was encountered at depths ranging from 17 to 24 feet below grade.

Conclusions and Recommendations

Building Foundations

Maser Consulting considered several foundation options for the Polk Street site, including both shallow foundations with ground improvement, as well as deep foundation alternatives. Based on the anticipated loading and subsurface conditions, we recommend implementing an aggregate pier ground improvement program that will enable the garage structure and commercial building to be supported by conventional shallow foundations. A deep foundation alternate (micropiles) is also discussed below, as requested by Desman Associates.

Aggregate Pier Ground Improvement (Shallow Foundations)

Improve/stabilize fill materials and alluvial soils to enable to the use of shallow foundations. We believe this ground improvement technique could create a composite bearing surface capable of achieving an allowable bearing capacity of 7,500 pounds per square foot (psf), with a maximum of 1-inch total settlement.

Aggregate piers (a.k.a. GeoPiers, Stone Columns, Vibro-Columns, etc.) are a ground improvement technique used to stabilize relatively loose, granular soils. Typically, they consist of compacted, often vibrated aggregate material installed vertically through the

soil profile in 12 to 30-inch diameter columns. The installation method would also compact the surrounding soil materials, creating an improved soil-aggregate mass. When installed in a grid pattern beneath proposed foundations or other elements, the composite soil-aggregate bearing surface will have improved bearing capacity and settlement control properties.

In addition to being a relatively economical foundation system, we believe this approach would result in a more compatible foundation for the adjoining two-story structure, as the ground improvement program can be tailored to meet a specified composite bearing capacity and associated settlement criterion. Specifically, the interior and southern shallow foundations can be proportioned using a lesser bearing capacity, if desired.

The minimum width of all wall footings should be 24 inches, and the minimum horizontal dimension of all spread footings should be 36 inches, regardless of the bearing pressure developed.

Exterior footings subject to frost action should be based at least 36 inches below the adjacent exterior grade. Interior footings should be based at least 24 inches below the finished floor elevation. In addition, we recommend that the shallow foundations bear below a zone bounded by a plane that extends outward and upward on a 1:1 slope from any proposed or existing underground utility excavation, below-grade walls, or other underground features.

Deep Foundation Alternate (Micropiles)

Several deep foundation systems were considered to support the proposed garage structure, including driven (H-piles, pipe piles) and drilled (auger cast, etc.) piles. Based on the anticipated loading and the coarse-grained alluvial deposit (which may result in premature shallow refusal and/or penetration difficulties for the pile types listed above), we believe micropiles are a viable option to support the garage structure in lieu of the aggregate pier ground improvement program.

We believe the following allowable individual pile capacities can be achieved for a typical micropile:

Competent, Intact Bedrock (>60 feet, bgs)
- 6-inch diameter:
  - 5-ft bond zone - 40 tons (compression and tension)
  - 10-ft bond zone - 80 tons (compression and tension)
- 8-inch diameter:
  - 5-ft bond zone - 50 tons (compression and tension)
  - 10-ft bond zone - 100 tons (compression and tension)

Micropile bond zone depths will be dependent on the encountered conditions, but are anticipated to begin at depths greater than 60 feet below grade.

Micropiles may also be used to support the proposed two-story structure, however, we believe a less costly hybrid approach can be utilized, including deep foundations along the northern building line and shallow foundations within the building interior and southern building lines. This hybrid approach would include a limited removal and replacement program to stabilize the remaining fill materials, extending to depths on the order of 5-feet below bearing surface. Assuming the existing fill material or loose alluvial deposits are removed or stabilized, shallow foundations for the two-story structure may proportioned using an allowable bearing capacity of 3,000 psf and the general requirements listed above, while maintaining total post construction settlements within 1-inch.

Seismic Site Class

In accordance with the 2009 International Building Code, this site may be designed assuming a Site Class "C". This classification was determined by utilizing the Standard Penetration Test (SPT) blow count data through the upper 100 feet of the subsurface profile. A value of 100 blows per foot was used for intact rock, as permitted by IBC.

Floor Slabs-on-Grade

The floor slabs for the proposed buildings may be supported on-grade in accordance with the following criteria. The subgrade should be re-compacted with a smooth-drum roller just prior to installation of the aggregate base to re-compact any materials disturbed by previous construction activities or adverse weather conditions. Any unstable zones detected that cannot be stabilized by additional compaction should be removed, and the excavated area backfilled with load-bearing fill. We anticipate some limited selective undercutting may be required.

Immediately prior to slab construction, we recommend that a minimum 6-inch layer of dense-graded aggregate (crushed stone or recycled concrete) conforming to PADOT 2A be placed and compacted over the prepared subgrade. For those areas to receive floor coatings such as carpeting, floor tile, or epoxy-based finishes, we recommend that a minimum 10-mil vapor retarder be placed over the subgrade, followed by the minimum 6-inch layer of dense-graded aggregate. The aggregate should be dampened just prior to concrete placement. These procedures are intended to provide more uniform concrete curing conditions.

Reinforced concrete floor slabs should be simply supported at wall and column junctures to allow unrestricted rotation of the slab edges. Alternatively, the slabs should be free to undergo vertical deflections at the edges. We anticipate that, following proper site

preparation, the subgrade soils can achieve a Modulus of Subgrade Reaction on the order of 200 pounds per cubic inch (pci). Based on the anticipated soil conditions, a coefficient of sliding friction of 0.20 may be used for design of a floor slab with a polyethylene vapor retarder over soil. A coefficient of sliding friction of 0.40 may be used for design of a floor slab without a vapor retarder.

Existing Utilities

We recommend that the existing underground utilities (water, storm-water, etc.) within the proposed building footprints be relocated or removed, as appropriate. Utilities to remain in service should be relocated outside a zone bounded by a plane that extends outward and downward on a 1:1 slope from the perimeter of any proposed footing or pile cap. Trench excavations necessary to remove such utilities should be backfilled in compacted lifts with load-bearing fill.

Should you have any questions or require any additional information, please contact Ryan at 610-868-4201.

Very truly yours,

MASER CONSULTING P.A.

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