Appendix 5.5-2 Addendum – Expanded Recommendations for Earthwork and Foundations

Appendices

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UHS of Delaware, Inc.
C/O The Barrie Company
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April 16, 2020
NOVA Project No. 3019060

Attention: Mrs. Elizabeth Barrie

Subject: Addendum
Expanded Recommendations for Earthwork and Foundations
Multi-Story Tower and CUP Area, Inland Valley Regional Medical Center
36485 Inland Valley Drive, Wildomar, California
OSHPD Project No. G193289-33

References:

NOVA 2019. *Update Report, Geotechnical Investigation, Multi-Story Tower and CUP Area, Inland Valley Regional Medical Center, 36485 Inland Valley Drive, Wildomar, California,* NOVA Services, Inc., NOVA Project No. 3019060, December 12, 2020.

HOK 2019. *Site Plan, Phase 3 Plan with Survey, Inland Valley Regional Medical Center*, HOK, undated.

KH 2019. *Inland Valley Regional Medical Center – Rough Grading (South Option),* Kimley Horn and Associates, undated.

NV5*. As-Built Utility Plan, Inland Valley Regional Medical Center,* NV5, February 25, 2019.

Dear Mrs. Barrie:

The intent of this addendum is to the request by the Structural Engineer for expanded recommendations to NOVA 2019, addressing a variety of foundation design and earthwork-related matters.

This addendum was prepared by NOVA Services, Inc. (NOVA) for UHS of Delaware, Inc. NOVA is retained by UHS as Geotechnical Engineer-of-Record (GEOR) for this project.

BACKGROUND

Review of NOVA 2019
The referenced geotechnical report (NOVA 2019) recommends foundation preparation and foundation design as described below.

- Foundation Preparation. Foundation preparation should consist of removing the upper 5 feet Unit 1/Unit 2 soil or 3 feet below the deepest foundation element (whichever is greater), replacing these soils with Select Fill. This removal/replacement should be undertaken within the limits of the planned tower, extending at least 5 feet outward of the building footprint.

- Allowable Bearing. Foundations bearing in Unit 1 engineered fill should be designed for an allowable contact stress (q_a) of q_a = 3,000 psf and q_a = 2,500 psf for isolated and continuous foundations, respectively.

Based upon correspondence and discussions with the design team, NOVA has prepared this addendum to expand and amend recommendations provided in NOVA 2019, including additional foundation, earthwork and site development-related information. An abstract of the needed information is listed below.

- Foundations. Provide additional recommendations relevant to the design of foundations, as listed below.
  - *Bearing Factors of Safety.* The actual factor of safety (FS) and ultimate bearing values for both the formation and fill.
  - *Lateral Resistance.* Provide lateral resistance in formation.
  - *Subgrade Modulus*. Provide sub-grade modulus (k) values for fill and formation.
  - *Foundation Interaction*. In certain instances design may have existing and new footings adjacent to each other.

- Excavations. Provide recommendations for excavations.

- Temporary Shoring. Provide recommendations for design of temporary shoring.

- Retaining Walls. Recommendations for design.

- Miscellaneous Site Structures. Provide recommendations for miscellaneous site structures such as equipment pads, screen and canopies, and poles. Such structures may be located in fill or formation.

- Site Preparation and Earthwork. Revise recommendations for site preparation based upon new informantion on the conceptual design depths of foundations.

ADDENDUM RECOMMENDATIONS

Foundations

Review of Allowable Bearing

NOVA 2019 provides recommendations for allowable bearing for shallow foundations set in both the fill and the Pauba Formation. Table 1 (following page) reproduces those recommendations.

Bearing Factors of Safety
The ulimtate bearing capacity (q_u) for foundations designed as described on Table 1 is such that the FS (determined as FS = q_u /q_a) exceeds the maximum overstrength factor (Ω_0) of Ω_0 = 3. The FS for the above contact stresses is FS ≥ 5 for the fill and for the Pauba Formation.

Table 1. Recommendations for Foundation Bearing

Bearing Unit	Allowable Bearing (psf) for Footings[1]	
	Isolated[2]	Continuous[3]
Fill	3,000	2,500
Pauba Formation	5,000	4,500

Notes:
1. may be increased by one-third for transitory loads (e.g., wind and seismic)
2. minimum width of 30 inches, minimum embedment 24 inches
3. minimum width of 18 inches, minimum embedment 24 inches

As you are aware, the FS for bearing is comprised of two elements of foundation movement, as is abstracted below.

1. Ultimate Bearing (q_u): The load that will lead to failure of the ground due to insufficient soil strength.
2. Settlement-Limited Bearing (q_a). The load at which the foundation is at risk for unacceptable settlement, leading to unacceptable differential movement between adjacent, unevenly loaded footings.

Ultimate bearing capacity is calculated using the classical bearing capacity equation.[1]

$$q_u = cN_c + \gamma D_f N_q + 1/2\ \gamma B N_\gamma$$

where,

- q_u is the ultimate foundation bearing capacity
- N_c, N_q, N_γ are theoretical and empirical factors based on the geometry of the failing mass of soil beneath a footing and related to the soil strength (described by cohesion and friction, "*c*" and "ϕ", respectively)
- c is the soil cohesion (assumed c = 0 for sandy fill)
- D_f is the depth to which the footing is embedded below the soil grade surrounding it.
- γ is the unit weight (density) of the soil, and
- B is the width of the footing.

As may be seen by review of the above, q_u is not a constant for a constant soil type. The value varies with depth of embedment and footing width. As is discussed in detail in NOVA 2019, the Unit 1 fill at the foundation level is characteristically clayey. The soil strength parameters of this unit are characterized as c = 300 psf and ϕ = 10°. For a variety of footing sizes the q_u ~ 25,000 psf.

A safe bearing with respect to failure (i.e., with respect q_u) does not ensure adequate foundation performance. The allowable bearing is settlement limited in virtually all cases of foundation bearing analysis. NOVA completed analyses of the expected elastic settlement of foundations

[1] Terzaghi, K., Theoretical Soil Mechanics, John Wiley and Sons, Inc., New York, N.Y., 1943.

set in the fill using methods described by Schmertmann[2] and Eurocode DIN 4019/DIN 4017. These analyses estimate settlement (Δ) on the order of Δ ~ 0.6 inch over 40 feet at bearing of q ~ 3,000 psf, based upon which NOVA recommended q_a = 3,000 psf. This recommendation of allowable bearing was also tempered by NOVA's experience with engineered fills. These earthworks are much like any manufactured product, prone to some variability in quality and consistency. This consideration is particularly relevant to this site, which shows substantial heterogeneity in the Unit 1 fill. Soil gradations range sharply, from more compressible clays to sands.

It is NOVA's judgment that FS for footings set in the fill may be expressed as FS = q_u /q_a = 25,000 psf / 3,000 psf = 8.3.

A parallel evaluation was completed for footings supported on the Pauba Formation. The strength of this unit was characterized by c = 50 to 300 psf and ϕ = 30° to 34°, from which q_u ~ 50,000 psf may be determined. The elastic settlement of footings bearing at 5,000 psf on this unit will be on the order of Δ ~ 0.5 inch over 40 feet, based upon which NOVA recommended q_a = 5,000 psf. This recommendation was also tempered by NOVA's experience with the Pauba Formation.

It is NOVA's judgment that FS for footings set in the Pauba Fm is FS = q_u /q_a = 50,000 psf / 3,000 psf = 10.

Bearing Level

As is detailed in NOVA 2019, the relatively incompressible Pauba Formation was encountered at depths of 1 to 15 feet below existing grade within the area of the proposed tower and less than 1 foot depth at the CUP Area.

To allow for in increase in allowable contact stress, NOVA recommends that foundations be either (i) deepened and supported entirely in the Pauba Formation; or, (ii) over-excavated to contact with compotent Pauba Formation and backfilled with Controlled Low Strength Material (CLSM) to the foundation level.

Construction Quality Control

If employed, CLSM should consist of a minimum 2-sack sand-cement mixture, developing a compressive strength of at least 50 psi. A representative of NOVA should observe development of the bearing level for foundations.

Soil cylinders should be collected in the field periodically during placement of CLSM for strength testing to verify the mix recommended by NOVA is being achieved. A set of five molded CLSM cylinders should be created for compressive strength testing for every 150 cubic yards or fraction thereof of CLSM placed. All cylinders will be moist cured, then one cylinder break from each of the three test mixes will be performed at one cylinder at 7 days, three cylinders at 28 days, and one stored for holding.

Cylinder molding, moist curing, and strength testing will be performed in accordance with ASTM D1633 ('Compressive Strength of Molded Soil-Cement Cylinders').

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[2] Schmertmann, J.H., Hartman, J.P., and Brown, P.R.; *Improved Strain Influence Factor Diagrams,* Journal of Soil Mechanics and Foundations Division, ASCE, Vol. 104, No.GT8, August, 1978, pp.1131-1135.

Lateral Resistance
NOVA 2019 provides for lateral resistance of footings set in fill as resistance by an equivalent fluid pressure of 200 psf per foot of depth against the face of the footing, neglecting the upper 1 foot of soil below surrounding grade.

The lateral resistance of footings cast neat against the Pauba Formation will develop lateral resistance by an fluid pressure of 350 psf per foot of depth against the face of the footing.

In both of the above cases, a coefficient of friction of 0.30 between soil and the concrete base of the footing may be used with dead loads.

Subgrade Modulus
NOVA 2019 provides a a modulus of subgrade reaction (k) for the fill of k = 150 pci. A value of k = 250 pci may be used with the Pauba Formation.

Foundation Interaction
Construction may involve placement of new foundations near existing foundations. New foundations should be evaluated for the potential that loads from these foundations may affect existing foundations. Where new footings are located adjacent to existing footings not located within the zone-of-influence, new footings should be separated by a horizontal distance of at least one foot.

The zone of influence of a footing- the zone distribution of ground bearing stresses- is commonly approximated as being between two lines subtended at 45° from each bottom corner of the footing. Figure 1 (following page) depicts this concept.

New footings should be considered for the potential that loads may affect nearby, existing footings, adding load to the subsurface beneath those footings. The distribution of footing influence depicted on Figure 1 may be used in initial assessments of this potential.

In the event that it is determined that this potential exists, NOVA should be contacted to provide more rigorous evaluation. Such evaluation would address the magnitude of new loads below existing footings and the potential that such loads could effect new movement in the existing structure.

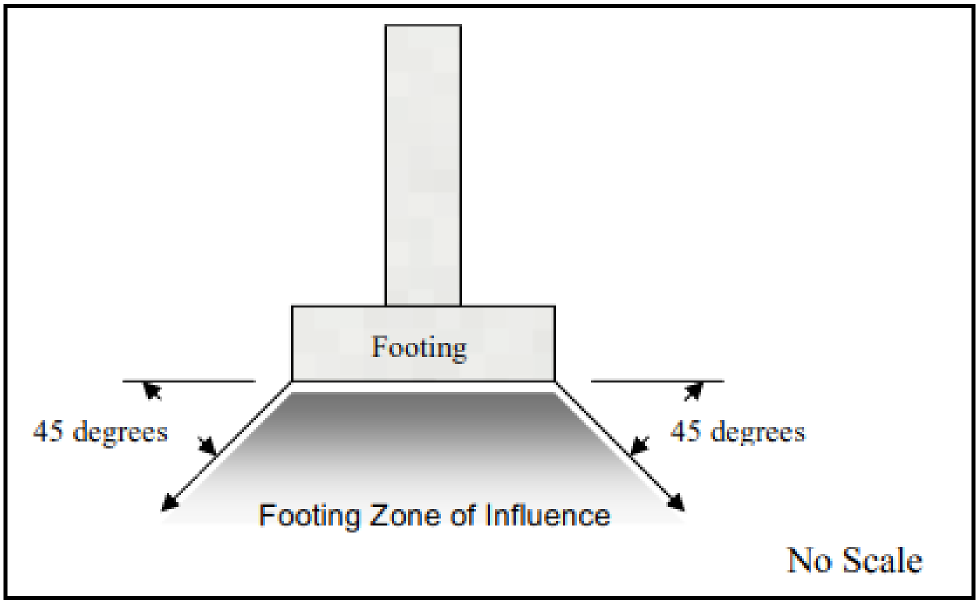

Figure 1. Fooring Zone of Influence

Temporary Slopes and Excavations

General
The safety and stability of temporary slopes and excavations is the sole responsibility of the Contractor.

Temporary slopes and excavations should be built in conformance with all local, state and federal requirements and ordinances. The CalOSHA requirements for temporary excavations may be found at may be found at http://www.dir.ca.gov/title8/sb4a6.html.

Excavations
Both the fill and the Pauba Formation may be excavated to depths of 4 feet vertically without shoring except in surcharge conditions. Excavations in the Pauba Formation will likely stand at slopes as steep as 0.5H:1V (horizontal: vertical) for several days. Unretained excavations in the fill may be cut as steep as 1H:1V beyond a depth of 4 feet.

Temporary excavations adjacent to existing foundations and for other surcharged scenarios, should be sloped at a 1H:1V or flatter gradient.

Temporary Shoring

Responsibilities
The recommendations provided herein are intended to provide guidance for design of temporary shoring for creation of stable temporary excavations. NOVA expects that temporary excavations may be extended to as deep as about 15 feet below surrounding ground.

It is the responsibility of the Contractor to provide an excavation that is safe, with deflections that do not damage nearby structures or utilities. Design of temporary shoring should be performed by a qualified Shoring Engineer. The Shoring Engineer should be solely responsible for the design, utilizing the indications of subsurface conditions provided in NOVA 2019.

Wall Pressures
Active wall pressures should be applied by equivalent fluid pressure of 35 lb/ft^3.

It is assumed that soldier beams will be set in pre-drilled holes and backfilled with lean concrete or a sand cement slurry with a compressive strength of at least 700 psf. Passive resistance to embedment of soldier piles for a temporary wall may be calculated using an 'equivalent fluid wall pressure' distribution, where the maximum equivalent fluid pressure (P) may be calculated as:

P (psf) = (K_p) (γ) (D) where,

$K_p = (1 + \sin \phi) / (1 - \sin \phi)$ $\phi = 33°$, $K_p = 3.4$

$\gamma = 125$ lb/ft^3 (buoyant unit weight)

D = depth of wall embedment

$P = 3.4 \times 125 \times D = 425 D$ (ultimate)

The passive resistance can be assumed to act over a width of 2.5 pile diameters. The means and methods of placement of this slurry mix will be the responsibility of the Shoring Contractor.

Method of Temporary Shoring
Anticipating a single level of permanent below grade construction, excavations may extend to about up to 15 feet below existing ground surface, requiring temporary shoring for stability. Support of the excavation face can be provided by a variety of means.

NOVA expects that a cantilevered system of 'soldier piles and wood lagging' will provide a most cost-effective system. The remainder of this section addresses this design concept, though much of this discussion is applicable to other cantilevred wall concepts.

Design for cantilevered retaining walls should endeavor to limit deflection at the top of the wall to on the order of 1-inch. Actual wall movement and related ground settlement are related to a variety of factors, most significantly (i) the stiffness and spacing of the soldier piles; and, (ii) workmanship in wall construction.

NOVA does not provide shoring design services. However, to check the feasibility of constructing the planned cantilevered wall, NOVA has determined that W24 x 84 soldier beams embedded 15 feet below the excavation bottom and spaced 7 feet on center would minimize top deflection to about 0.8 inches or less.

Permanent Walls

Lateral Pressures
Lateral earth pressures to permanent below-grade walls are related to the type of backfill, drainage conditions, slope of the backfill surface, and the allowable rotation of the wall. For one level below-grade, the groundwater level will be at least 25 feet below existing grade.

Table 2 (following page) provides recommendations for soil wall loading to below-grade walls with level backfill for varying conditions of wall yield.

Table 2. Lateral Earth Pressures to Below Grade Walls

Condition	Equivalent Fluid Pressure (psf/foot) for Approved Backfill Notes A, B
Active	35
At Rest	55
Passive	350

Note A: site-sourced Select Fill or similar imported soil.
Note B: assumes wall includes appropriate drainage and no hydrostatic pressure.

It is expected that the below walls within the structure will be fixed, designed to resist ‘at rest’ soil loads. If footings or other surcharge loads are located a short distance outside the wall, these influences should be added to the lateral stress considered in the design of the wall. Surcharged loading can be assumed as 40 percent as an equivalent fluid pressure. Surcharge loading should consider wall loads that may develop from adjacent streets and sidewalks.

Seismic Increment to Non-Yielding Walls
The lateral seismic thrust acting on a non-yielding retaining walls should be estimated by the dynamic (seismic) thrust, ΔP_E. Dynamic thrust is approximated as:

$$\Delta P_E = k_h H^2 \gamma$$ where,

k_h is the pseudostatic horizontal earthquake coefficient, equal to $S_{DS}/2.5$
H is the height of the wall in feet from the footing to the point of fixity
γ is equal to the unit weight of the backfill material, in pcf (about 120 pcf)

The resultant dynamic thrust may be distributed as an inverted triangle acting at a distance of 0.6H above the base of the wall.

Seismic Increment to Cantilevered Walls
The lateral seismic thrust acting on a cantilevered retaining walls taller than 6 feet should be estimated by the dynamic (seismic) thrust, ΔP_E. Dynamic thrust is approximated as:

$$\Delta P_E = 0.4\, k_h H^2 \gamma$$ where,

k_h , pseudostatic horizontal earthquake coefficient, equal to $S_{DS}/2.5$
H is the height of the wall in feet from the footing to the point of fixity
γ is equal to the unit weight of the backfill material, in pcf (about 120 pcf)

The resultant dynamic thrust may be distributed as a triangle acting at a distance of 0.3H above the base of the wall.

Drainage
Design for permanent walls should include drainage to limit accumulation of water behind the wall. Figure 2 (following page) provides guidance for such design.

The guidance provided on Figure 2 is conceptual. A variety of options are available to drain permanent below-grade walls.

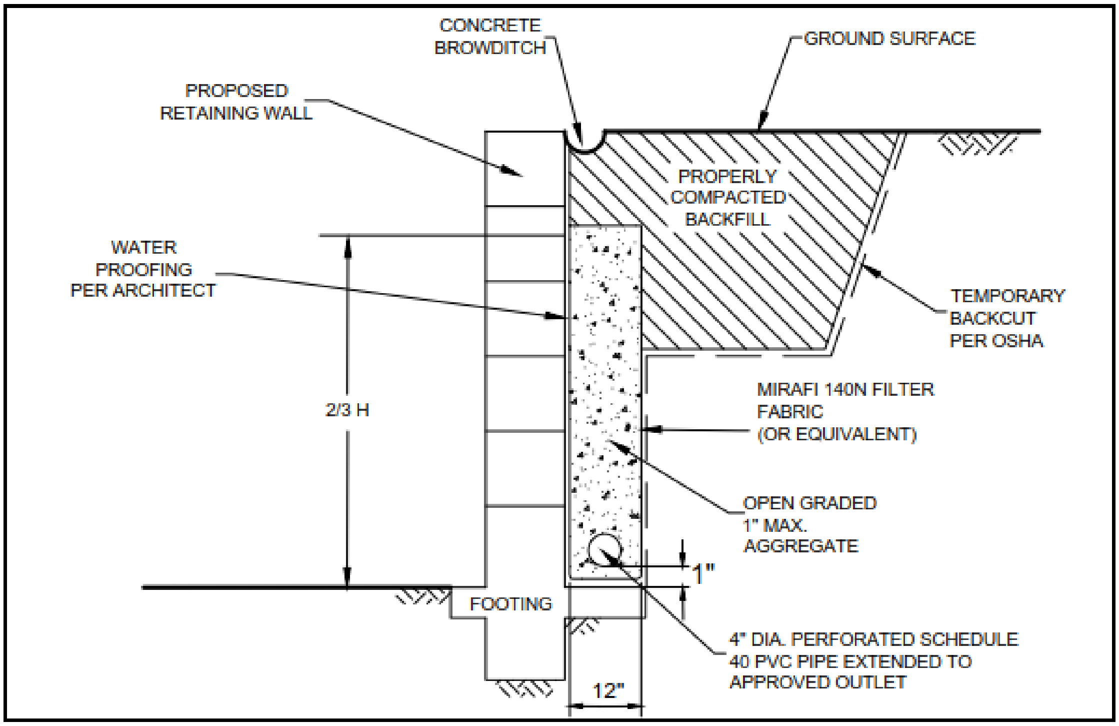

Figure 2. Conceptual Design for Wall Drainage

Miscellaneous Site Structures

Canopies, Screen Walls, Signs and Light Poles

Canopies, screen walls, sign structures and light standard foundations as columns directly embedded in the ground or socketed in ground-embedded footings should be designed in general accordance with Section 1807 of the California Building Code (CBC). With the expectation that most of poles for signs and light standards will be embedded in fill, the structures will accumulate support as described below:

- lateral resistance will accumulate at a rate of 150 pounds per square foot per foot of depth below natural grade;
- the allowable lateral soil bearing pressure may be increased by a factor of two for short-term lateral loads, as allowed by Section 1806A.3.4 of the CBC; and,
- an allowable soil bearing pressure of 1,500 psf may be used to support vertical compressive loads in areas not improved with remedial grading. Where supported into Pauba Formation, a bearing capacity of $q_a = 5{,}000$ psf may be utilized.
- Skin friction may be taken as 200 psf for fill and 300 psf for Pauba Formation.

Flatwork

Flat work and exterior concrete should be supported on at least 12 inches of compacted, low expansive engineered fill or undisturbed formational soils moisture conditioned to at least 3% over optimum and then densified to at least 90% relative compaction after ASTM D 1557.

Concrete slabs should be designed by the Structural Engineer, but minimally should be reinforced with welded wire mesh placed at mid depth.

Equipment Pads
Pads to support a variety of special equipment (for example, air conditioning equipment, transformers, etc.) may be supported on ground bearing slabs embedded at least 6 inches below surrounding grade..

These miscellaneous slabs should be supported on at least 12 inches of compacted, low expansive engineered fill or undisturbed formational soils moisture conditioned to at least 3% over optimum and then densified to at least 90% relative compaction after ASTM D1557.

Founded as described above, ground supported equipment and related slabs will have a bearing capacity of q_a = 1,500 psf. Where supported on Pauba Formation, a bearing capacity of q_a = 5,000 psf may be utilized.

Site Preparation and Remedial Grading

General
As recommendatoins for the development and design design of foundations have been provided above, the following text provides addendum site preparation and grading recommendations within the footprint of the tower.

Site Preparation
Any abandoned utilities should be removed and properly disposed off-site before the start of excavation operations. The area planned for structures and pavements should be cleared of vegetative material, including the root zone.

Remedial Grading
Remedial grading for the proposed tower to improve and proof the quality of the Unit 1 fill for support of ground bearing slabs should be undertaken in the step-wise manner described below.

1. Step 1, Excavation/Densification. For the proposed tower structure, the upper 2 feet of the Unit 1 fill within the limits of structure should be excavated and staged for later replacement. Removal should extend outward at least 5 feet beyond the structure footprint.

2. Step 2, Proof-Roll. The ground exposed by the Step 1 excavation should be redensified. After densification of the excavated surface, the area should be proof-rolled. A loaded dump truck or similar should be used to aid in identifying localized soft or unsuitable material. Any soft or unsuitable materials encountered during this proof-rolling should be removed, replaced with an approved backfill, and compacted.

3. Step 3, Replacement. The soil excavated by Step 1 should be replaced in conformance with the criteria identified in Section 6.4 of NOVA 2019.

Previous recommendations within NOVA 2019 for the CUP area and other associated improvements remain applicable.

CLOSURE

NOVA appreciates the opportunity to be of continued service to UHS of Delaware on this most interesting project.

Should you have any questions regarding this addendum or other matters, please do not hesitate to contact the undersigned at (949) 388-7710.

Sincerely,
NOVA Services, Inc.

Jesse D. Bearfield, RCE 84335

John F. O’Brien, GE 651