Geotechnical Recommendations for Proposed Additions to the Three Mile Creek Severe Weather Attenuation Tank Project

PREPARED FOR: Mobile Area Water and Sewer System (MAWSS)

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The existing site contains a 12-million-gallon (MG) Severe Weather Attenuation Tank (SWAT) and ancillary structures. The major components of the addition are as follows:

- Two 12-MG SWATs — 240-foot diameter pre-stressed concrete tank manufactured by CROM or Precon on 18-inch-thick foundation and 4" – 6" thick membrane concrete floor slab
- Generator facility — 30-foot-by-10-foot rigid heavily reinforced 18-inch-thick mat foundation
- Electrical building — 37-foot-by-14-foot reinforced slab-on-grade with thickened edges on 7-inch-thick foundation
- Lift station valve vault — 32-foot-by-14-foot rigid heavily reinforced 18-inch-thick mat foundation
- Pump station — 48-foot by-27-foot rigid heavily reinforced 30-inch-thick mat foundation
- Diversion box — 25-foot-by-24-foot rigid heavily reinforced 20-inch-thick mat foundation

Soil and groundwater conditions used in the foundation settlement evaluation were obtained from two geotechnical data reports provided by Southern Earth Sciences, dated May 11, 2016 and May 18, 2018.

Existing ground surface elevations, structure floor and foundation bottom elevations, and estimated foundation bearing loads were provided by the structural designer. Jacobs used the computer program Settle 3D to evaluate foundation settlement, and allowable bearing capacity was evaluated based on Terzaghi and Vesic Methods. The results are presented in Table 1.

Table 1. Soil Settlement at Estimated Bearing Load

Structure	Estimated Bearing Load	Modeled Bearing Capacity*	Total Settlement	Immediate Settlement	Long-term Settlement
SWAT Tank #2	2,750 psf	3000 psf	5.0 in.	2.5 in.	2.5 in.[a]
SWAT Tank #3	2,750 psf	3000 psf	1.0 in.	1.0 in.	N/A
Generator Facility	450 psf	500 psf	0.25 in.	0.25 in.	N/A
Electrical Building	750 psf	1000 psf	0.25 in.	0.25 in.	N/A
Lift Station Valve Vault	500 psf	500 psf	0.50 in.	0.25 in.	0.25 in.

Table 1. Soil Settlement at Estimated Bearing Load

Structure	Estimated Bearing Load	Modeled Bearing Capacity*	Total Settlement	Immediate Settlement	Long-term Settlement
Pump Station	2,350 psf	3000 psf	1.0 in.	0.25 in.	0.75 in.
Diversion Box	1,750 psf	2000 psf	0..75 in.	0.50 in.	0.25 in.

[a]SWAT Tank #2 is underlain by compressible clay soil on the approximate south half of the footprint. The immediate sand settlement will occur during construction. A long-term clay settlement of 2.5 in. is expected, resulting in a differential settlement of 2.5 in. The tank settlements were based on foundation loading conditions with tanks continuously filled with water.

*Modeled bearing capacity has a FS of at least 3 on bearing capacity failure.

in. = inches
N/A = not applicable
psf = pounds per square foot

For the Generator Facility, Electrical Building, Lift Station Valve Vault and Diversion Box slabs-on-grade (i.e., mat foundation) design a modulus of subgrade reaction for a 1-foot-square plate K_1 of 150 tcf (tons/ft^3) is recommended. For the Pump Station slab-on-grade design a modulus of subgrade reaction for a 1-foot-square plate K_1 of 25 tcf is recommended due to the presence of compressible silt below the foundation. The modulus of subgrade reaction should be adjusted as follows to account for the difference in size between the plate and the actual foundation:

$$K_S = K_1 \left[\frac{1 + \frac{B}{2L}}{1.5} \right]$$

Where:

- K_s = Adjusted modulus of subgrade reaction (tcf) for a square footing
- K_1 = Modulus of subgrade reaction for a 1-foot-square plate in tcf
- B = Width of mat/raft foundation (feet)
- L = Length of mat/raft foundation (feet)

Shallow compressible clay soils were encountered between 0 and 5 feet depth in the cone sounding performed for the Generator Facility and Electrical Building. Jacobs recommends over-excavating all soil to a 5-foot depth and to 5 feet beyond these structure's perimeter. Also, compressible clay soils are expected at the Lift Station Valve Vault foundation bearing level. Jacobs recommends over-excavating all soil to a 2-foot depth below bottom of foundation and to foundation perimeter. These over-excavations should be filled with Structural Backfill as defined in the specifications.

A factor of safety (FS) against uplift was evaluated for four structures that will have foundations below the 100-year flood elevation of +12 feet North American Vertical datum of 1988 (NAVD88). The results are summarized in Table 2.

Table 2. Factor of Safety Against Uplift Evaluation

Structure	Case 1: Fully Constructed, Backfilled Sides, and Filled with Water	Case 2: Fully Constructed, Backfilled Sides, and No Water Inside	Case 3: During Construction Phase, Open Excavation, No Water, and No Backfill
SWAT	FS = 8.07	FS = 0.87	FS = 0.81
Lift Station Valve Vault	FS = 2.28	N/A	FS = 1.90
Pump Station	FS = 1.77	FS = 1.29	FS = 0.86

Table 2. Factor of Safety Against Uplift Evaluation

Structure	Case 1: Fully Constructed, Backfilled Sides, and Filled with Water	Case 2: Fully Constructed, Backfilled Sides, and No Water Inside	Case 3: During Construction Phase, Open Excavation, No Water, and No Backfill
Diversion Box	FS = 1.83	FS = 1.24	FS = 1.24

The normal operation of the SWATs is to be empty; therefore, Case 2 would be the controlling condition. The structural engineer will specify hydrostatic pressure relief means.

Lateral earth pressures imposed by soil backfill for permanent walls of SWATs, Lift Station Valve Vault, Pump Station, and Diversion Box can be evaluated using soil with an equivalent fluid unit weight. These unit weights have been established for above (drained) and below (undrained) groundwater level conditions. Jacobs recommends that the backfill behind walls be Structural Fill placed and compacted in accordance with the specifications. An assumed soil unit weight of 115 pcf and phi of 35 degrees was used in the calculations. The results are presented in Table 3.

Table 3. Soil Equivalent Fluid Unit Weights

Earth Pressure Coefficient	Above Groundwater Level (Drained) (pcf)	Below Groundwater Level (Undrained) (pcf)
At-rest (Ko = 0.43)	58	89
Active (Ka = 0.24)	28	75
Passive (Kp = 3.70)	425	257

psf = pounds per cubic foot

Surcharge loads from temporary construction equipment or permanent structures should be added to the lateral earth pressure as an equivalent height of 2 feet of additional soil at 120 pcf unit weight.

For earthquake risk evaluation, this project would be classified as Site Class D. The estimated peak ground acceleration (PGA) is 0.049 g.