Geotechnical Engineering Report

New Water Tower
Hedrick, Iowa
TEAM Project No. 1-5107
March 11, 2022

Prepared for:
City of Hedrick

Prepared by:
TEAM Services, Inc.
Des Moines, Iowa

TEAM Services

March 11, 2022

City of Hedrick
109 Main Street, P.O. Box No. 167
Hedrick, IA 52563

Attn: Ashley Olinger

Re: Subsurface Exploration
New Water Tower
Hedrick, IA
TEAM Project No. 1-5107

Dear Ms. Olinger:

We have completed the subsurface exploration for the proposed elevated water storage tank in Hedrick, Iowa. The accompanying geotechnical report presents the findings of the subsurface exploration and our geotechnical recommendations concerning design and construction for the proposed water tower.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service to you in any way, please do not hesitate to contact us.

Sincerely yours,
TEAM Services

Clinton Halverson, P.E.
Principal Engineer

Cc: Matt Walker, P.E., Garden & Associates, Ltd.

LICENSED PROFESSIONAL ENGINEER Clinton Halverson 19928 IOWA	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.
	Clinton Halverson, P.E. License Number 19928 Date: 03/11/2022 My license renewal date is December 31, 2023. Pages covered by this seal: All Pages .

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PROJECT INFORMATION

Project information has been provided by Mr. Matt Walker, P.E. of Garden & Associates through email. A new legged water tower is planned in Hedrick, Iowa. Documents provided include an RFP letter stating project details with a map showing the proposed tower location and desired boring locations. The new tower is proposed to hold 75,000 gallons and have a high-water level of about 120 feet. For the purposes of this report, TEAM Services assumes the structure weight will be less than or equal to the weight of the contained water.

SITE CONDITIONS

The project site is located north of W 1st Street and about half-way between Main Street and West Street in Hedrick, Iowa. The site is currently open grass space. The area where our borings were conducted was relatively flat with less than a foot of elevation difference recorded between our borings. Our truck-mounted auger drill rig was supported by the existing surfaces without difficulty.

FIELD EXPLORATION

A total of 3 borings were drilled at the site between depths of approximately 40 and 60 feet below existing grades on February 17 and 18, 2022. Boring locations were staked with elevations provided by Garden and Associates. The approximate locations of the borings are shown on the attached Boring Plan in the Appendix. Boring surface elevations are noted on their respective Boring Logs.

Representative samples were obtained using thin-walled tube and split-barrel sampling procedures in general accordance with ASTM Specifications D 1587 and D 1586, respectively. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the ground to obtain relatively undisturbed samples of cohesive or moderately cohesive soils. In the split-barrel sampling procedure, a standard 2-inch O.D. split-barrel sampling spoon is driven into the ground with a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the standard penetration resistance value. These values are indicated on the Boring Logs at the depths of occurrence. The samples were tagged for identification, sealed and returned to the laboratory for testing and classification.

An automatic hammer was used to perform the Standard Penetration Tests. In the automatic hammer system, the cathead and rope used traditionally in the manual test procedure is replaced with an automatic lifting mechanism for the 140 pound driving weight. The reduction in system friction with the automatic hammer system results in significant increase in the driving energies. This results in significantly greater driving efficiencies and a corresponding decrease in the number of blows in the Standard Penetration Test results. We have taken the driving efficiency of the automatic hammer into account when analyzing this data.

Field logs of each boring were prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling, as well as the driller's interpretation of the subsurface conditions between samples. Final Boring Logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

LABORATORY TESTING

Based on the driller's field records and examination of the samples in the laboratory, a soil testing program was developed to collect more information about the soil conditions at the site. The following is a brief description of the specific tests completed for this project.

Natural Moisture Content -- The natural moisture content of selected samples was determined in accordance with ASTM D 2216. The moisture content of the soil is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the soil particles. The results are presented on the Boring Logs at the depths from which the samples were obtained.

Unit Weight -- In the laboratory, selected undisturbed samples of the site soils were measured and weighed to determine gross weight and volume of the samples. Where possible, the samples are placed in a template and trimmed at each end to fit the template. The moisture content of each specimen was then determined, and the dry unit weight was calculated. The results of these tests are presented on the Boring Logs at the appropriate sample depths.

Unconfined Compressive Strength -- A calibrated hand penetrometer was used to estimate the approximate unconfined compressive strength of selected cohesive soil samples. The calibrated hand penetrometer has been correlated with unconfined compression tests and provides a better estimate of soil consistency than visual examination alone.

Torvane Shear Tests -- The Torvane test was performed on a precut flat soil sample surface with a calibrated, hand-held spring loaded dial device with thin flanges in a radial array which can be pressed into the soil sample. The vanes are pressed into the soil sample, and the dial face is twisted slowly until the vanes begin to shear the soil. This test gives a direct dial reading of soil shear strength when the sample fails. The test is especially useful for estimating the shear strength of soft cohesive soils. Torvane shear test results are noted on the Boring Logs at the depth of the samples tested.

Plasticity (Atterberg Limits) Tests -- Selected soil samples were tested for Plastic Index. The soils' Plastic Index (PI) is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The LL is the moisture content at which the soil will flow as a heavy viscous fluid. The PL is the moisture content at which the soil begins to crumble when rolled into a small thread. These tests are conducted in general accordance with ASTM D 4318. The results are indicated on the Boring Log at the depth where the sample was obtained.

As part of the testing program, the samples were classified in the laboratory based on visual observation, texture and plasticity. The descriptions of the soils indicated on the Boring Logs are in accordance with the enclosed *General Notes* and the *Unified Soil Classification System*. Estimated group symbols according to the *Unified Soil Classification System* are given on the Boring Logs. A brief description of this classification system is attached to this report.

SUBSURFACE CONDITIONS

Subsurface conditions encountered during this exploration are indicated on the individual Boring Logs. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows.

We encountered existing fill at the ground surface in all borings. Fill consisted primarily of sandy lean clays and extended to depths of about 1 to 2 feet below existing grades.

Topsoil was encountered beneath the existing fill. The topsoil generally consisted of medium stiff or stiff lean to fat clay with trace amounts of organics. The topsoil extended to a depth of about 3 feet below existing grades.

Loess (wind-blown soil) was encountered below the topsoil. The loess soils are typically fat clay nearest to the ground surface but transition to lean to fat clay and lean clay soils with depth. The loess ranged from stiff to very stiff in consistency. The loess extended to a depth of about 13 feet below existing grades.

Paleosol was encountered beneath the loess. Paleosol is a weathered zone of glacially derived soils that is commonly found at the top of glacial strata. These materials were deposited during the advance or retreat of continental glacial ice sheets which previously covered this area. Paleosol is usually underlain by less weathered glacial till soils. The paleosol at the site consisted of stiff to very stiff fat clay and extended to a depth of about 27 feet.

Glacial till was encountered beneath the paleosol. The glacial till soils are more or less unsorted soil deposits consisting of a mixture of sand, silt, and clay, with the engineering properties of the soil being controlled by the clay fraction. The glacial till soils at the site consisted of sandy lean clay which were generally stiff to very stiff in the upper zones and transitioning to being hard to very hard below a depth of about 37 feet.

Glacial outwash seams and layers were fairly common amongst the till. Outwash seams and layers are glacial deposits which have been sorted by moving water. The glacial outwash consisted of medium dense to very dense clayey sand. Borings terminated in the glacial soils at depths of up to 60 feet below existing grades.

Cobbles and boulders were not noted in our borings. However, glacial soils often contain cobbles and boulders. The possibility of their presence should be considered where excavations or grading operations at the site advance into the glacial soils.

The above descriptions provide a general summary of the subsurface conditions encountered. The attached Boring Logs contain detailed information recorded at each boring location. These Boring Logs represent our interpretation of the field logs based on engineering examination of the field samples. The lines designating the interfaces between various strata represent approximate boundaries and the transition between strata may be gradual. Where strata changes occur between sample depths, the strata change elevation is typically estimated based on interpolation, and is approximate. Soil conditions will vary between each boring location.

GROUNDWATER CONDITIONS

The borings were monitored while drilling and after the completion of drilling operations for the presence and level of groundwater accumulation. Groundwater levels observed in the borings are noted on the Boring Logs.

Groundwater seepage was encountered during drilling between the depths of about 13½ and 34½ feet below existing grades between the three borings. Soon after drilling, the water level in Boring 3 was checked at which time the water level had risen to a depth of about 20 feet. The water level in Boring 2 was recorded at a depth of about 8 feet after stabilizing overnight. Boring 1 was left open for weeks after which time the water level, read on March 10th, resided at a depth of about 5 feet.

Longer term monitoring in cased holes or piezometers would be required for a more accurate evaluation of the groundwater conditions at the site.

These groundwater level observations provide an approximate indication of the groundwater conditions existing on this site at the time of drilling operations. Fluctuation of groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, surface drainage, subsurface drainage, site topography, irrigation practices, ground cover (pavement or vegetation), and other factors not evident at the time the borings were conducted. Normally, the highest groundwater levels occur in late winter and spring time while the lowest levels occur in late summer and fall time. The fluctuation of the groundwater levels should be considered when developing the design and construction plans for this project.

CONCLUSIONS AND RECOMMENDATIONS

General Water Tank Suitability and Mitigation Options

The proposed water tank loads are substantial and will compress soils to a deep depth beneath the ground surface. Different allowable bearing pressures are provided in the **Shallow Foundation Design** section of this report to accommodate 2 or 3-inch settlement tolerances for the tower. If less settlement and/or higher bearing pressures are desired, then an intermediate foundation option could be employed or TEAM Services could provide recommendations for overexcavation and replacement to meet those