Geotechnical Engineering Report

DAP Foam Expansion – Location 2
Pacific, Missouri
October 22, 2020
Terracon Project No. 15205049 – Revision 1

Prepared for:
Civil & Environmental Consultants, Inc.
St. Charles, Missouri

Prepared by:
Terracon Consultants, Inc.
St. Louis, Missouri

Terracon GeoReport

October 22, 2020

Civil & Environmental Consultants, Inc.
3000 Little Hills Expressway, Suite 102
St. Charles, Missouri 63301

Attn: Mr. Patrick Bennett, P.E.
P: (314) 656-4578
E: pbennett@cecinc.com

Re: Geotechnical Engineering Report
DAP Foam Expansion – Location 2
307 Integram Drive
Pacific, Missouri
Terracon Project No. 15205049 – Revision 1

Dear Mr. Bennett:

We have completed the Geotechnical Engineering services for the above-referenced project. This study was performed in general accordance with Terracon Proposal No. P15205049.01, dated July 23, 2020 and authorized on September 28, 2020. This report addresses a proposed structure in another location on the site as compared to our previous study. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

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, please contact us.

Sincerely,

Terracon Consultants, Inc.

Jessica M. Cannon, E.I.
Staff Geotechnical Engineer

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REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	Four (4) borings were advanced to depths of 15 to 20 feet in order to obtain geotechnical engineering data for the proposed DAP Foam Expansion.
Geotechnical Characterization	Existing fill material was encountered in all of the borings to a depth of about 3 to 8 feet. Weathered dolomite bedrock was encountered in two of the borings beneath the fill. Groundwater was not encountered in the borings.
Earthwork	**Existing Fill Soils**: Foundations, floor slabs, and pavements should not bear on or above the existing fill soils unless the owner is willing to accept the risks associated with supporting the new structure on the existing fill, as discussed in the report. The existing fill could be removed and recompacted, or with some risk acceptance, portions of the existing fill could be left in place for support of foundations, floor slabs, and pavements. **Expansive Soils**: The fat clay soils encountered in the borings are very high in plasticity and prone to volume change with variations in moisture content. For this reason, we recommend that at least the upper 36, 24, and 12 inches of soil below the bottom of the floor slab level, foundations, and pavement base rock, respectively, consist of low plasticity (LP) material as defined in the **Earthwork** section. Existing lean clays can be used for engineered fill, fat clay should not be used without chemical treatment. Clays are sensitive to moisture variation
Shallow Foundations	Allowable bearing pressure = 2,500 psf Expected settlements: less than 1 inch total, less than ¾ inch differential
Seismic Considerations	International Building Code Site Class (IBC): C
Below-Grade Structures	Retaining Walls: None anticipated Basements: None anticipated
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report.

Geotechnical Engineering Report

DAP Foam Expansion – Location 2

307 Integram Drive

Pacific, Missouri

Terracon Project No. 15205049 – Revision 1

October 22, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed expansion to be located at 307 Integram Drive in Pacific, Missouri. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Site preparation and earthwork
- Excavation considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC

The geotechnical engineering scope of services for this project included the advancement of four (4) soil borings to depths ranging from approximately 15 to 20 feet below existing site grades.

Maps showing the site and boring locations are included in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section of this report.

The **General Comments** section provides an understanding of the report limitations.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 307 Integram Drive in Pacific, Missouri. Latitude: 38.48489ºN, Longitude: 90.7857ºW See **Site Location**
Existing Improvements	The expansion will be constructed to the northeast of the existing building and parking lot.

Item	Description
Current Ground Cover	Lightly vegetated
Existing Topography	Near the area of the proposed expansion, the ground slopes uphill towards the northwest, with 5.5 feet of relief between the borings.
Geology	Based on the Geological Map provided by the United States Geologic Survey (USGS), the subject site is located over the Smithville Dolomite Formation. The Smithville Dolomite Formation consists of dolomite bedrock with smaller amounts of shale, sandstone, and chert.
Solution Features	Solution features, including springs, caves, and sinkholes, are commonly present in the bedrock formations in this area. Based on our review of information available from MDNR, the subject site does not contain any previously identified sinkhole formations. However, there are field verified sinkholes approximately 0.5 miles to the east of the site. It is difficult to predict future sinkhole activity. Site grading and drainage may alter site conditions and could possibly cause sinkholes in areas that have no history of this activity.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Previous Exploration	Terracon previously performed a geotechnical investigation southwest of the southwest building corner.
Project Description	A 10,000 square-foot, free-standing building is proposed to the north of the northeast parking lot.
Finished Floor Elevation	A grading plan was not provided, assumed to be near existing grades
Maximum Loads (estimated by Terracon)	■ Columns: 100 kips ■ Walls: 3 kips per linear foot (klf) ■ Slabs: 150 pounds per square foot (psf)
Grading/Slopes	We assume up to 3 feet of cut and/or fill may be required to develop final grade. Final slope angles no steeper than 3H:1V (Horizontal: Vertical) are expected.
Below-Grade Structures	None anticipated.
Free-Standing Retaining Walls	None anticipated

Item	Description
Pavements	We assume both rigid (concrete) and flexible (asphalt) pavement sections should be considered. Anticipated traffic is as follows: ■ Autos/light trucks: 200 vehicles per day ■ Light delivery and trash collection vehicles: less than 5 vehicles per week ■ Tractor-trailer trucks: less than 1 vehicles per week The pavement design period is 20 years.

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, and geologic setting. This characterization, termed GeoModel, forms the basis of our geotechnical analyses and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs and GeoModel can be found in the **Exploration Results** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Surface**	Topsoil
2	**Fill and Possible Fill**	Lean with varying amounts of silt, sand, and gravel
	Clays	Fat clay (CH) with trace amounts of sand
3	**Bedrock**	Highly weathered dolomite bedrock

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**.

Groundwater was not encountered during or immediately after drilling operations. This does not necessarily mean the borings terminated above groundwater. Long-term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type. Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be different from the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Hydrocarbon odors were noted in the upper two samples from Boring B-3, which corresponds to the upper 5 feet of the boring.

GEOTECHNICAL OVERVIEW

Expansive Soils

The fat clay (CH) soils encountered in the borings are very high in plasticity (PI≥50) and prone to volume change with variations in moisture content. For this reason, we recommend that at least the upper 36, 24, and 12 inches of soil below the bottom of the floor slab level in the building footprint, foundations, and pavement base rock, respectively, consist of low plasticity (LP) material as defined in the **Earthwork** section.

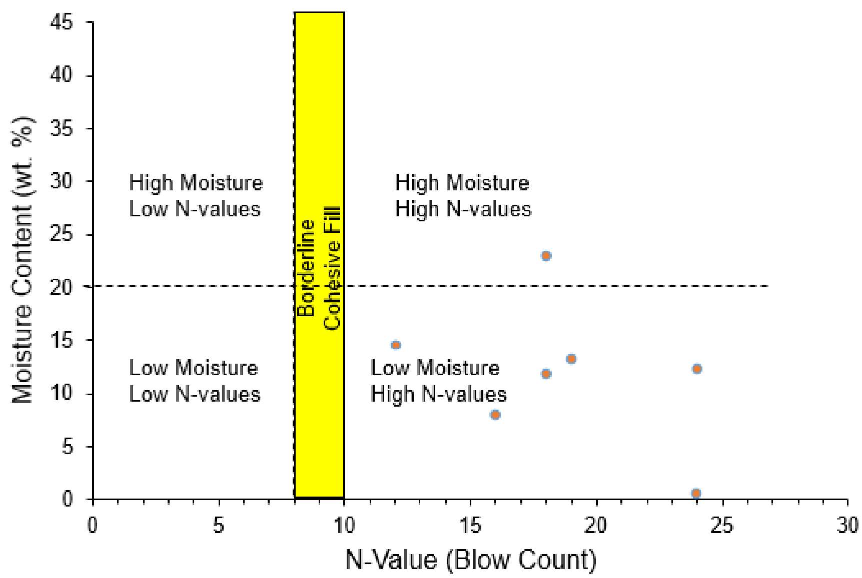
This LP layer should also be confirmed or placed below other flatwork abutting the structure. The procedures recommended in this report may not eliminate all future subgrade volume change and resultant movements. However, the procedures outlined should reduce the potential for subgrade volume change. Additional reductions in subgrade movements could be achieved by using a thicker LP zone. LP material could be imported or the high plasticity soils could be chemically modified to reduce their volume change susceptibility.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and at least minor cracking in the structure could still occur. The severity of cracking and other cosmetic damage, such as uneven floor slabs on grade, will likely increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and cosmetic distress may not be feasible, but it may be possible to further reduce the risk of movement if more extensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

Existing Fill

Existing fill was encountered to depths of about 3 to 8 feet in all of the borings performed for this current location. The fill could extend deeper in areas not explored. No documentation or records regarding the placement of this fill were provided for our review. If records are available, Terracon should be supplied with these documents to better assess the suitability of the existing fill. Further exploration and testing (e.g., borings, test pits, geophysical testing) of the existing fills could be performed, if requested.

Properly compacted cohesive fill will typically exhibit clear majorities of “borderline” (i.e., N=8 to 10 blows per foot (bpf)) or higher N-values and water contents in the mid-teens to low 20s. The N-values and water contents from the existing fill samples are illustrated below. One (1) of the seven (7) N-values in the clay fill soils is within the high moisture range. Overall, the seven (7) SPTs had an average N-value of about 18 bpf. Thus, the limited field and laboratory observations and testing of the existing fill materials suggest that the undocumented fill may be satisfactory for foundation support.



Provided the owner is willing to accept the risks associated with supporting foundations, floor slabs, and pavements over the existing fill materials in exchange for reduced construction costs, we recommend that the site be cut to grade, and before any new fill is placed, the exposed subgrade be proofrolled with a minimum of four passes with a minimum 15-ton vibratory roller. If any deflection is noted, then the subgrade should continue to be compacted until no deflection is observed.

If the owner is not willing to accept the risks associated with supporting the foundations on the existing fill, then the existing fill should be removed and replaced so that the foundations for the new building bear on suitable native soils or on properly placed and compacted engineered fill extending to suitable native soils. If the fill is completely removed and replaced, it should be removed within the proposed building footprint and extend at least 5 feet outside the building perimeter.

To reduce the risk of adverse performance from higher settlement and provide more consistent support for foundations, floor slabs, and pavements, the exposed existing fill materials should be observed and tested during construction. Where unsuitable conditions are observed, the materials should be improved by scarification and compaction or be removed and replaced with engineered fill. Unsuitable fill materials observed during construction may warrant further exploration at that time.

Support of foundations, floor slabs and pavements on or above existing fill materials is discussed in this report within the **Shallow Foundations**, **Floor Slabs**, and **Pavements** sections. However, even with the recommended construction procedures, there is an inherent risk for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by following the recommendations contained in this report. To take advantage of the cost benefit of not removing the entire amount of undocumented fill, the owner must be willing to accept the risks associated with building over the undocumented fills following the recommended reworking of the material.

Soft Subgrade

The near surface soils could become unstable with typical earthwork and construction traffic, especially after precipitation events. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the wetter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

EARTHWORK

Earthwork will include clearing and grubbing, excavations, and fill placement.

Existing Fill

As noted in **Geotechnical Characterization**, all borings encountered existing fill to depths of about 3 to 8 feet. Support of footings, floor slabs, and pavements, on or above existing fill soils, is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by following the recommendations contained in this report.

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed.

We recommend that the exposed subgrade be thoroughly evaluated by the Geotechnical Engineer prior to placement of new fill. The soils on the site are sensitive to disturbance from construction equipment traffic, particularly during wet periods. Excessively wet or dry material should either be removed or moisture conditioned and recompacted. The exposed subgrade, including areas of existing undocumented fill, should be proofrolled where possible to aid in locating loose or soft areas. Proofrolling can be performed with a loaded, tandem-axle dump truck. If unsuitable areas are observed during construction, subgrade improvement will then be necessary to establish a suitable subgrade support condition. Potential subgrade stabilization techniques are discussed below.

- **Scarification and Recompaction** – It may be feasible to scarify, dry, and recompact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades would likely not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.

- **Crushed Stone** – The use of crushed stone or gravel is the most common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 6 to 30 inches below finished subgrade elevation with this procedure. The use of high modulus geosynthetics (i.e., geotextile or geogrid) could also be considered after underground work, such as utility construction, is completed. Prior to placing the geosynthetic, we recommend that all below-grade construction, such as utility line installation, be completed to avoid damaging the geosynthetic. Equipment should not be operated above the geosynthetic until one full lift of crushed stone fill is placed above it. The maximum particle size of granular material placed over the geosynthetic should meet the manufacturer's specifications, and generally should not exceed 1½ inches.

- **Chemical Stabilization** – Improvement of subgrades with portland cement, lime, lime kiln dust (Code L), or Class C fly ash could be considered for improving unstable soils. Chemical modification should be performed by a prequalified contractor having experience with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions. Results of chemical analysis of the additive materials should be provided to the geotechnical engineer prior to use. The hazards of chemicals blowing across the site or onto adjacent property should also be considered. Additional testing would be needed to develop specific recommendations to improve subgrade stability by blending chemicals with the site soils. Additional testing could include, but not be limited to, evaluating various stabilizing agents, the optimum amounts required, the presence of sulfates in the soil, and freeze-thaw durability of the subgrade. For estimating purposes, typical incorporation rates for chemical treatment (on a dry soil unit rate basis) are:
    - 2 to 3 percent for hydrated lime, by weight;

- 5 to 7 percent for lime kiln dust (Code L), by weight; or
- 4 to 6 percent for portland cement, by weight.

Fill Material Types

Compacted structural fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
High Plasticity Material	CH (LL≥70 or PI≥40)	Below upper 3 feet of floors and other lightly-loaded structures; 2 feet of foundations; and 1 foot of pavement base rock
Moderate to High Plasticity Material [2]	CH or CL, with 70>LL≥45 or 40>PI≥25	Below upper 2 feet of floor slabs and any other lightly-loaded structures, below upper 1 foot of pavement base rock
Granular Material [3]	GM, GC, SM, or SC	All locations and elevations
Low Plasticity (LP) Material [4]	CL (LL<45 & PI<25) or Granular Material [3]	

1. Compacted structural fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to Terracon for evaluation. On-site soils generally appear suitable for use as fill outside of the LP zone.
2. Delineation of moderate to high plasticity clays should be performed in the field by a qualified geotechnical engineer or their representative, and could require additional laboratory testing.
3. Crushed limestone aggregate, limestone screenings or granular material such as sand, gravel or crushed stone containing at least 15 percent low plasticity fines.
4. Low plasticity cohesive soil or granular soil having low plasticity fines. Material should be approved by the geotechnical engineer.

Fill Compaction Requirements

Item	Description
Fill Lift Thickness	9 inches or less in loose thickness for heavy compaction equipment 4 to 6 inches or less in loose thickness for light, hand-operated compaction equipment
Compaction Requirements [1]	At least 95 percent of the material’s standard Proctor maximum dry density
Moisture Content – Cohesive Soil	-1 to +3 percent of the optimum moisture content value as determined by the standard Proctor test
Moisture Content – Granular Material	Workable moisture levels [2]

Item	Description
1.	We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested, as required, until the specified moisture and compaction requirements are achieved.
2.	Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proofrolled.

All trench excavations should be made with sufficient working space to permit construction, including backfill placement and compaction. If utility trenches in cohesive soils are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill.

Utility trenches are a common source of water infiltration and migration. All utility trenches in cohesive soils that penetrate beneath buildings should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the structure. We recommend constructing an effective clay “trench plug” that extends at least 5 feet out from the face of the structure exterior. The plug material should consist of lean clay compacted at a water content at or above the soil’s optimum water content. The lean clay fill should be placed to completely surround the utility line and be compacted in accordance with the recommendations in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. These greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5 percent away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping, final grades should be checked to document that effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure’s maintenance program. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints to resist surface water infiltration.

Earthwork Construction Considerations

Upon completion of filling and grading, care should be taken to maintain the subgrade water content. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Any water that collects over, or adjacent to, construction areas should be promptly removed. If the subgrade freezes, or becomes excessively wet or dry, or is disturbed, the affected material should be removed, or these materials should be scarified, moisture conditioned, and recompacted, prior to further construction. All of these processes should be observed by Terracon.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming any responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The Geotechnical Engineer should be retained during the construction phase of the project to observe earthwork and to perform tests and observations during subgrade preparation, proofrolling, placement and compaction of controlled compacted fills, backfilling of excavations into the completed subgrade, and just prior to construction of slabs.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations. At least 2 feet of LP material should be placed directly beneath the foundation bottom. Foundations should not bear on or above the existing fill materials unless the Owner is willing to accept the associated risks.

Design Parameters – Compressive Loads

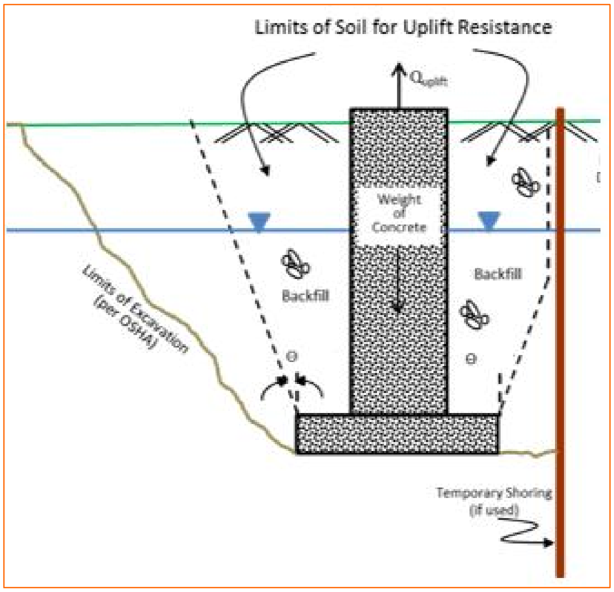
Item	Description
Maximum net allowable bearing pressure [1, 2]	2,500 psf
Required bearing stratum [3]	24 inches of LP material over native soils, newly placed compacted structural fill extending down to native soils, or existing fill if the owner is willing to accept the risks of building over the existing fill
Minimum foundation dimensions	Columns: 30 inches Continuous: 18 inches

Item	Description
Ultimate passive resistance [4] (equivalent fluid pressures)	250 pcf (LP clay)
Ultimate coefficient of sliding friction [5]	0.30 (LP clay)
Minimum embedment below finished grade [6]	30 inches
Estimated total settlement from structural loads [2]	Less than about 1 inch
Estimated differential settlement [2, 7]	About ¾ of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. A factor of safety of 3 has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Values assume that exterior grades are no steeper than 20 percent within 10 feet of the structure.
2. Values provided are for the maximum loads noted in **Project Description**. Greater settlement could occur for foundations over undocumented fill.
3. Unsuitable or soft soils, including existing fill, should be overexcavated and replaced according to the recommendations presented in **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions. Should be neglected if passive pressure is used to resist lateral loads.
6. Embedment necessary to resist the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of up to 50 feet.

Design Parameters - Uplift Loads

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, q, of 20 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 120 pcf should be used for the backfill. This unit weight should be reduced to 60 pcf for portions of the backfill or natural soils below the groundwater elevation.

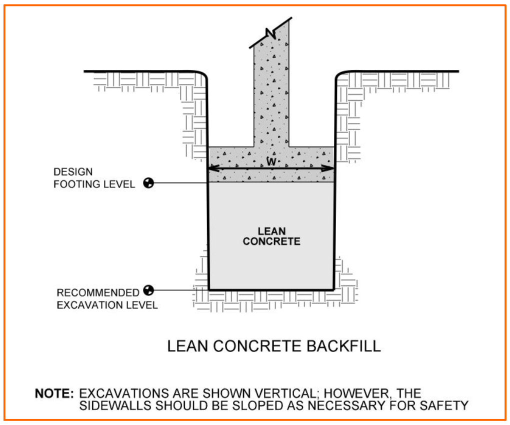


Foundation Construction Considerations

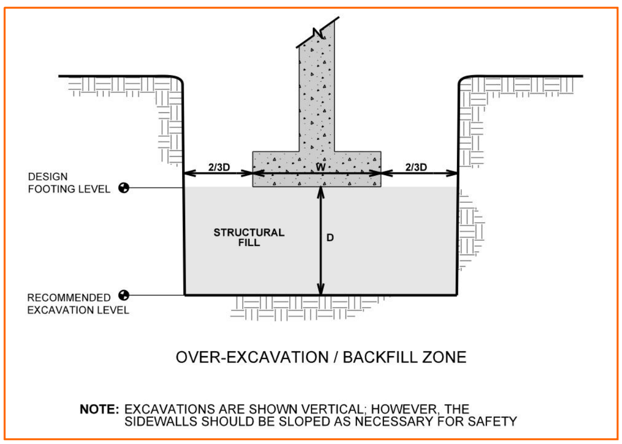
As noted in **Earthwork**, the footing excavations should be evaluated by the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil and rock, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed. Placement of a lean concrete mud-mat over the bearing soils should be considered if the excavations must remain open for an extended period of time.

Although groundwater was not encountered in the borings at depths expected to affect foundation excavations, it could still be encountered during foundation excavations or in other excavation activities. In addition, some surface and/or perched groundwater may enter foundation excavations during construction. It is anticipated that any water entering foundation excavations from these sources can be removed using sump pumps or gravity drainage. Additional dewatering efforts may be required if greater inflow occurs.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils. The footings could then bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



As an alternative, the footings could also bear on properly compacted structural backfill extending down to suitable soils. Overexcavation for compacted structural fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation. Overexcavation for structural fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation as recommended in the **Earthwork** section.



SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Class is required to determine the Seismic Design Category for a structure. The Site Class is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7-10. Based on the soil/bedrock properties encountered at the site and as described on the boring logs, the **Seismic Site Class is C**. Borings at this site were extended to a maximum depth of 20 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

FLOOR SLABS

The subgrade soils include moderate to very high plasticity clays, and these soils exhibit the potential to swell with increased water content. Construction of the floor slab and revising site drainage creates the potential for gradual increased water contents within the clays. Increases in water content could cause the clays to swell and damage the floor slab. To reduce the swell potential, we recommend that at least the upper 36 inches of materials below the floor slab be an approved Low Plasticity (LP) material.

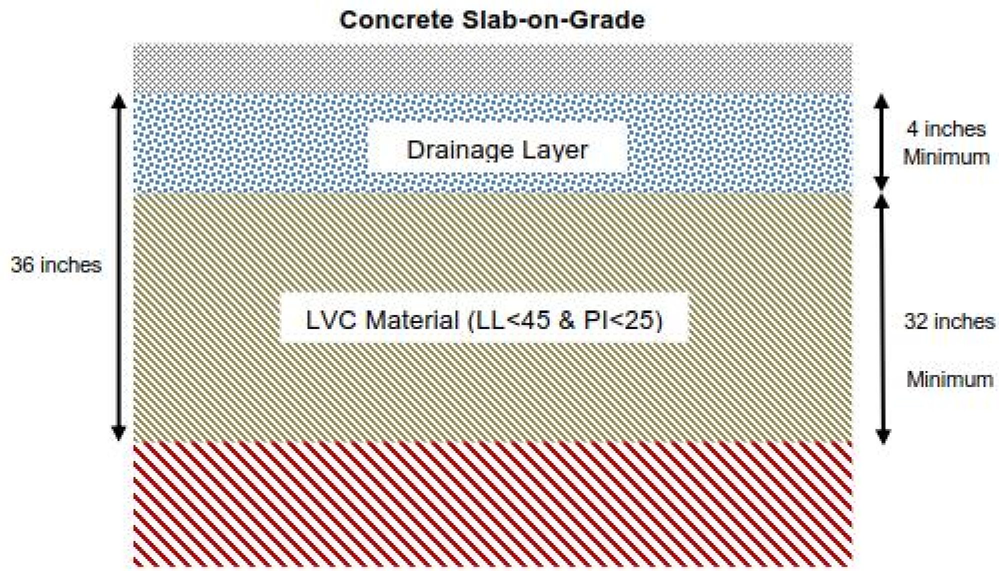


Image not to scale

As previously discussed, If the owner is not willing to accept the risks of supporting floor slabs over existing undocumented fill materials, then the existing fill should be removed and replaced to support floor slabs.

Design parameters for floor slabs assume that the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure. This also includes positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor slab support [1]	Minimum 4 inches of free-draining (less than 5 percent passing the U.S. No. 200 sieve) crushed aggregate compacted to at least 95 percent of ASTM D 698 [2, 3] over at least 32 inches of low plasticity cohesive or granular soils with at least 15 percent passing the U.S. No. 200 sieve
Estimated modulus of subgrade reaction [2]	150 pounds per square inch per inch (psi/in) for point loads.

1. Floor slabs should be structurally independent of any building footings or walls to reduce the potential of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table including the 36-inch thick LP layer. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.
3. Other design considerations, such as cold temperatures and condensation development, could warrant more extensive design provisions.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or any cracks that develop should be sealed with a waterproof, nonextruding compressible compound specifically recommended for heavy-duty concrete and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted, but could be larger than normal and result in some cracking. Mitigation measures as noted in **Existing Fill** within **Earthwork** are critical to the performance of floor slabs. In addition to those mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade within and for at least 10 feet beyond the floor slab should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become excessively wet or dry, or damaged prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs, noted in this section, are applicable if the site has been prepared as recommended in the **Site Preparation** section.

Pavements are typically more tolerant of non-uniform subgrade conditions than foundations and floor slabs. As discussed in **Expansive Soils**, we recommend at least 12 inches of LP material beneath the pavement base rock to reduce the shrink/swell potential of the subgrade. Support characteristics of subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as the soils encountered on this site. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

As discussed in **Existing Fill**, portions of existing undocumented fill may remain in the pavement areas if the owner is willing to accept the potential for higher than normal settlement, distress, and/or maintenance in exchange for reduced construction costs. If the owner is not willing to accept the risks of supporting pavements over existing undocumented fill materials, then the existing fill should be removed and replaced to support pavements.

Pavement Subgrade Preparation

On most projects, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturate some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to improve stability temporarily. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the upper 9 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the material with compacted structural fill.

After proofrolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in the **Earthwork** section to provide a more consistent subgrade for pavement construction. Areas that appear desiccated (dry) following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

Pavement Design Considerations

We anticipate that the new parking areas (i.e., light-duty) will be primarily used by personal vehicles (cars and pick-up trucks). Delivery trucks and refuse disposal vehicles are expected in the drive lanes (i.e., medium-duty). We have estimated up to 10 trucks per week.

Pavement thickness can be calculated using AASHTO, Asphalt Institute, and/or other methods if specific wheel loads, axle configurations, frequencies, and desired pavement life are provided. Pavement design methods are intended to provide structural pavement sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. Terracon can provide thickness recommendations for pavements subjected to loads other than personal vehicle and occasional delivery and trash removal truck traffic, if this information is provided.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Grades adjacent to pavements should slope down from the edges at a minimum 2 percent;
- The pavement subgrade and surface should have a minimum 2 percent slope to promote proper drainage;

- Pavement drainage should be installed in areas anticipated for frequent wetting;
- Joint sealant should be installed and cracks sealed immediately; and
- Compacted, low permeability backfill should be placed against the exterior sides of curbs and gutters, and landscaped areas in, or adjacent to pavements to reduce moisture migration into pavement subgrade soils.

Estimates of Minimum Pavement Thickness

Asphaltic concrete pavements can be used for pavements such as drive lanes and parking areas. We recommend Portland cement concrete (PCC) pavements for entrance aprons, trash container pads, loading docks, drive-through lanes, and in any other areas subjected to heavy wheel loads and/or channelized or turning traffic.

Recommended thicknesses for light- and medium-duty areas are provided in the table below.

Pavement Section Thickness (inches)							
Traffic Area	Alternative	Asphalt Concrete		Portland Cement Concrete [1]	Aggregate Base Course [2]	Total Thickness
		Surface Course	Base Course			
Light-Duty (car parking)	PCC	--	--	5	4	9
	ACC	3	--	--	8	11
Medium-Duty (drives and loading areas)	PCC	--	--	6	4	10
	ACC	2	3	--	8	13
Trash Container Pad [3]	PCC	--	--	7	4	11

1. 4,000 psi at 28 days, 4-inch maximum slump and 5 to 7 percent air entrained pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic.
2. Crushed stone (MoDOT Type 5 aggregate)
3. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

Although not required for structural support, a minimum 4-inch thick aggregate base course layer is recommended for the PCC pavements to help reduce the potential for slab curl, shrinkage cracking, and subgrade "pumping" through joints. Proper joint spacing will also be required for PCC pavements to resist excessive slab curling and shrinkage cracking. All joints should be sealed to resist entry of foreign material and dowelled where necessary for load transfer.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrades should be graded to provide positive drainage within the granular base section. We recommend the subgrades beneath the pavement sections be graded to slope toward the storm water catch basins. A drainage collection and removal system (e.g., finger drains) could be used to allow water in the granular base to enter the storm sewers, or otherwise be removed from the granular base.

Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a pavement maintenance program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required. Geosynthetic reinforcement could be considered to extend the length of time before maintenance is required.

GENERAL COMMENTS

Our services are conducted with the understanding of the project as described in the proposal, and incorporate collaboration with the design team as we complete our services. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Support of foundations, floor slabs, and pavements over existing fill are discussed in this report. However, even with the recommended construction testing, there is a risk that unsuitable materials within or buried by the fill will not be discovered. This risk cannot be eliminated without removing the fill but can be reduced by thorough exploration and testing.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations may occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during construction. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation costs. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation costs. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, cost estimating, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
4	15 to 20	Building addition corners

Boring Layout and Elevations: Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±20 feet). Approximate elevations (rounded to the nearest ½-foot) were obtained with a surveyor's level and grade rod. The finished floor of the northeast loading dock entrance was used as a temporary benchmark with an assigned elevation of 100.0 feet. If more precise elevations and boring locations are desired, we recommend the borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with an ATV-mounted rotary drill rig using continuous flight, hollow-stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling was performed using thin-walled tube and split-barrel sampling procedures.

In the thin-walled tube sampling procedure, a seamless thin-walled steel tube with a sharpened beveled edge is pushed hydraulically into the cohesive or moderately cohesive soil at a selected depth at the base of the borehole. A relatively undisturbed sample of the soil is retained in the tube, and extracted in the laboratory for further testing.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance (SPT N-value). This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency (86 percent for Drill Rig 721) is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

Based on the material's texture and plasticity, we describe and classify soil samples in accordance with the Unified Soil Classification System. The project engineer reviewed the field data and assigned various laboratory tests to better understand the engineering properties of the soil and rock strata. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- Water content
- Dry unit weight
- Atterberg limits
- Unconfined compressive strength

Rock classification was conducted using the Description of Rock Properties and locally accepted practices for engineering purposes. Petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

DAP Foam Expansion – Location 2 ■ Pacific, MO

October 23, 2020 ■ Terracon Project No. 15205049

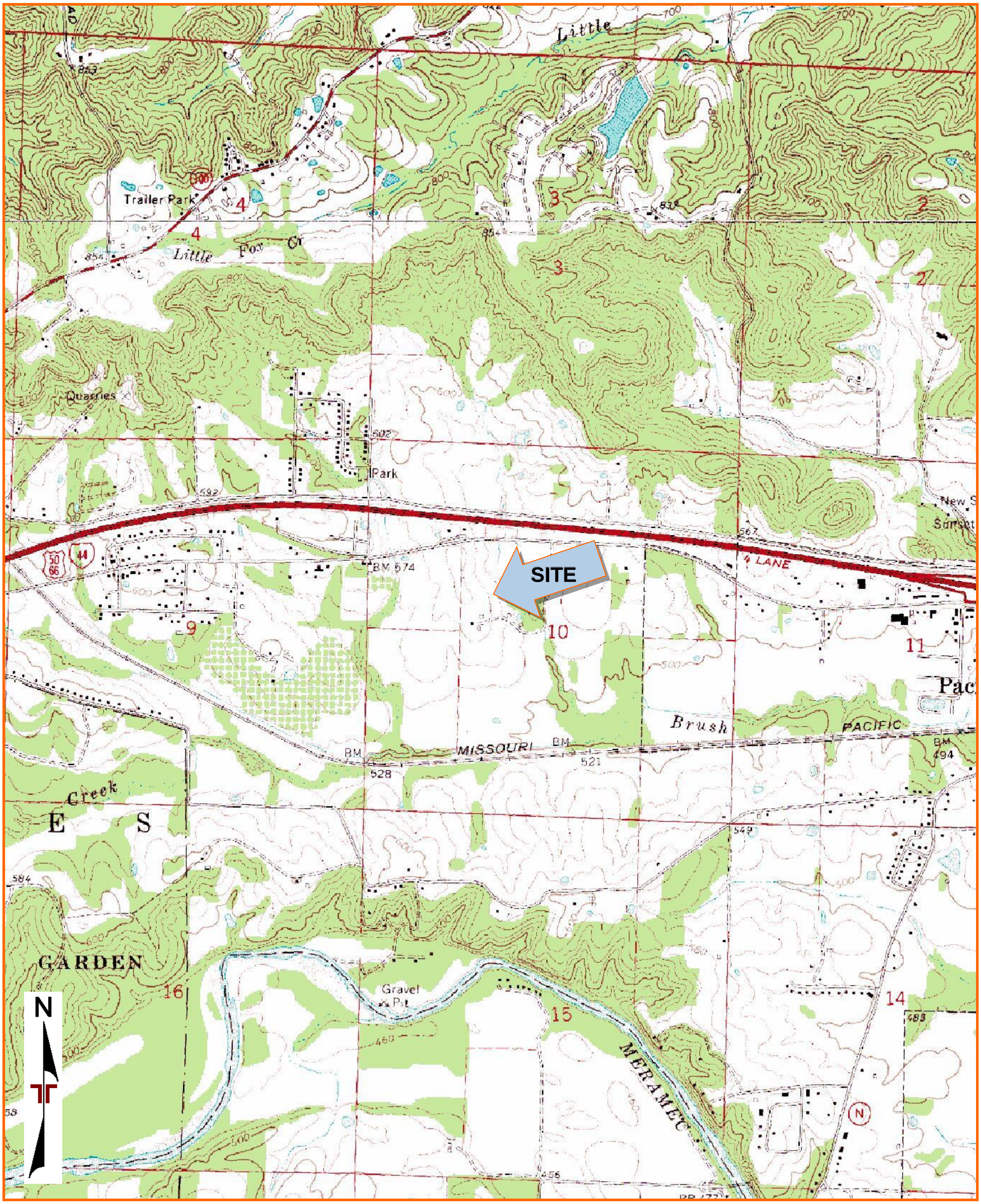


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: LABADIE, MO (1/1/1980) and GRAY SUMMIT, MO (1/1/1969).

EXPLORATION PLAN

DAP Foam Expansion – Location 2 ■ Pacific, MO
October 23, 2020 ■ Terracon Project No. 15205049

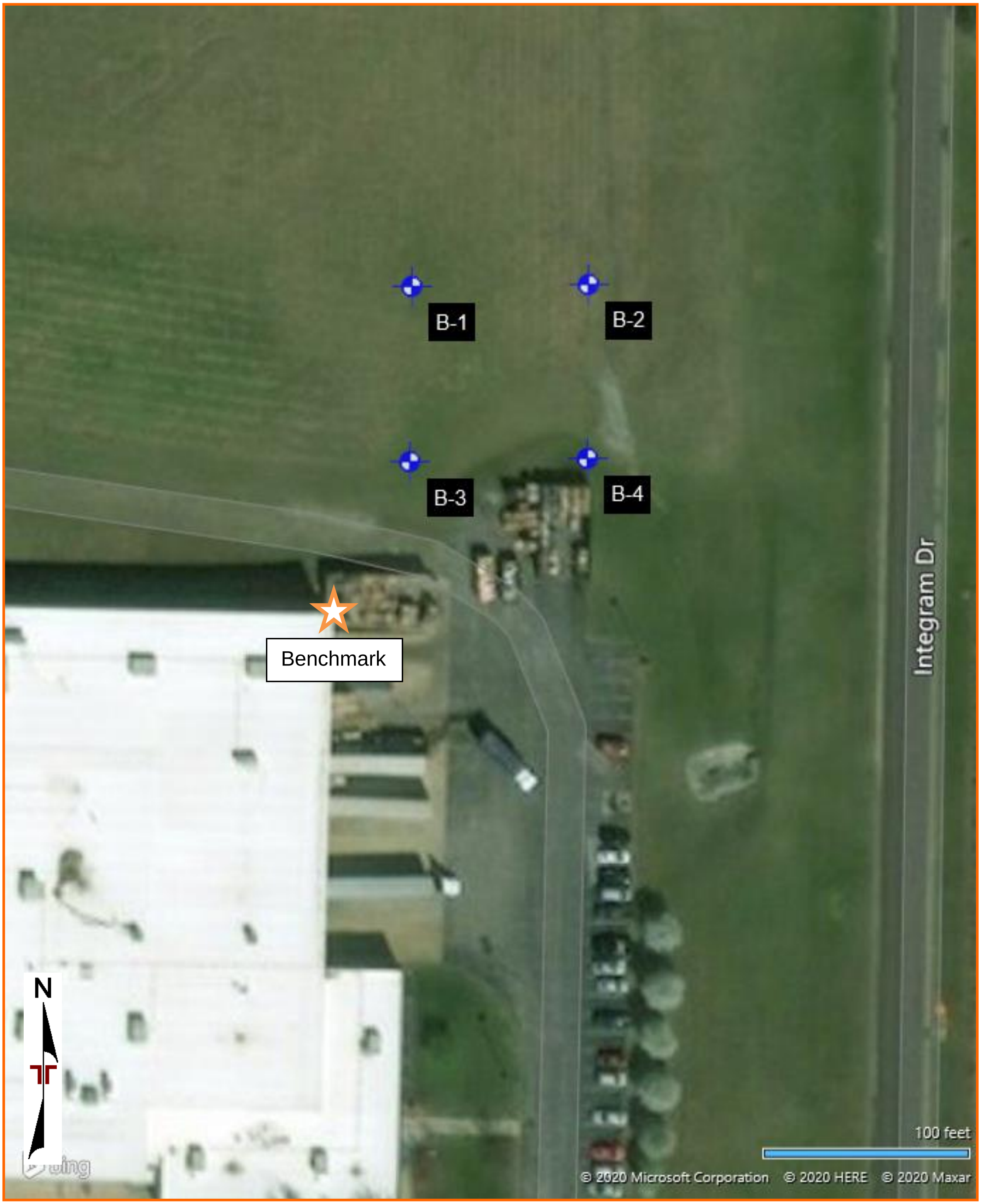


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Logs (B-1 through B-4)
GeoModel

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: DAP Foam Expansion - Location 2

CLIENT: Civil & Environmental Consultants, Inc.
Hazelwood, MO

SITE: 307 Integram Drive
Pacific, MO

LOCATION See Exploration Plan

Latitude: 38.485° Longitude: -90.7858°

Approximate Surface Elev.: 100.0 (Ft.) +/-

Model Layer	Depth	Material Description	Elevation (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Sample Number	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
1	0.3	**TOPSOIL**, (approximately 3 inches)	99.5+/-											
2	3.0	**FILL - LEAN CLAY**, trace silt and sand, brown and grayish brown	97+/-				10	8-12-12 N=24	1	1.0		12.2		
3	13.0	**FAT CLAY (CH)**, trace sand, brown and grayish brown, stiff to very stiff		5			17	6-6-8 N=14	2	1.0		25.8		91-19-72
							11		3	4.5	5590	16.5	110	
		reddish brown	87+/-	10			18	4-5-10 N=15	4	1.5		37.8		
4	15.0	**DOLOMITE**, light gray, highly weathered	85+/-	15			1	50/1"	5			6.6		

Auger Refusal at 15 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow-stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using a surveyor's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
11600 Lilburn Park Rd
Saint Louis, MO

Boring Started: 10-06-2020	Boring Completed: 10-06-2020
Drill Rig: DR721	Driller: JM
Project No.: 15205049	

BORING LOG NO. B-2

PROJECT: DAP Foam Expansion - Location 2

CLIENT: Civil & Environmental Consultants, Inc.
Hazelwood, MO

SITE: 307 Integram Drive
Pacific, MO

LOCATION See Exploration Plan

Latitude: 38.485° Longitude: -90.7855°

Approximate Surface Elev.: 96.0 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	POCKET PENETROMETER (tsf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**TOPSOIL**, (approximately 3 inches)	95.5+/-											
2		**FILL - LEAN CLAY**, trace sand and gravel, brown				Split spoon	3	10-16-8 N=24	1	1.0		0.5		
	5.0		91+/-	5		Split spoon	3	7-8-4 N=12	2			14.5		
3		**FAT CLAY (CH)**, trace sand, brown and gray, medium stiff to stiff				Shelby tube	12		3	1.5	2360	24.9	94	
				10		Split spoon	16	1-3-4 N=7	4	1.0		22.4		
		reddish brown, very stiff		15		Split spoon	17	5-7-9 N=16	5	1.0		31.4		
	20.0		76+/-	20		Split spoon	18	6-6-8 N=14	6	1.0		28.3		

Boring Terminated at 20 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow-stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using a surveyor's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
11600 Lilburn Park Rd
Saint Louis, MO

Boring Started: 10-06-2020	Boring Completed: 10-06-2020
Drill Rig: DR721	Driller: JM
Project No.: 15205049	

BORING LOG NO. B-3

PROJECT: DAP Foam Expansion - Location 2

CLIENT: Civil & Environmental Consultants, Inc. Hazelwood, MO

SITE: 307 Integram Drive Pacific, MO

LOCATION See Exploration Plan

Latitude: 38.4848° Longitude: -90.7858°

Approximate Surface Elev.: 100.0 (Ft.) +/-

MODEL LAYER	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	POCKET PENETROMETER (tsf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.2	**TOPSOIL**, (approximately 2 inches)	100+/-											
2	3.0	**FILL - LEAN CLAY**, trace silt and sand, brown and grayish brown, hydrocarbon odor noted in Sample No. 1	97+/-			Split spoon	11	6-8-11 N=19	1	1.0		13.2		
2	8.0	**POSSIBLE FILL - LEAN CLAY**, trace silt and sand, brown and grayish brown hydrocarbon odor noted in Sample No. 2	92+/-	5		Split spoon	15	6-8-10 N=18	2	1.0		23.0		
						Shelby tube	9		3	4.5	5790	17.9	106	
3		**FAT CLAY (CH)**, trace sand, brown, stiff to very stiff		10		Split spoon	16	5-7-10 N=17	4	1.0		22.1		
				15		Split spoon	18	3-4-5 N=9	5	1.0		36.7		
	20.0	reddish brown	80+/-	20		Split spoon	18	4-5-10 N=15	6	1.5		36.7		

Boring Terminated at 20 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow-stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using a surveyor's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
11600 Lilburn Park Rd
Saint Louis, MO

Boring Started: 10-06-2020	Boring Completed: 10-06-2020
Drill Rig: DR721	Driller: JM
Project No.: 15205049	

BORING LOG NO. B-4

PROJECT: DAP Foam Expansion - Location 2

CLIENT: Civil & Environmental Consultants, Inc.
Hazelwood, MO

SITE: 307 Integram Drive
Pacific, MO

LOCATION See Exploration Plan

Latitude: 38.4848° Longitude: -90.7855°

Approximate Surface Elev.: 94.5 (Ft.) +/-

MODEL LAYER	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	POCKET PENETROMETER (tsf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.2	**TOPSOIL**, (approximately 2 inches)	94.5+/-											
2		**FILL - LEAN CLAY**, trace silt and sand, brown					7	7-8-10 N=18	1	1.0		11.7		
				5			16	6-7-9 N=16	2	1.0		7.9		
	6.0		88.5+/-											
3		**FAT CLAY (CH)**, trace sand, brown, stiff to very stiff					14		3	4.0	6550	18.6	109	70-17-53
				10			18	4-6-7 N=13	4	1.0		21.2		
				15			18	8-9-8 N=17	5	1.5		42.9		
	16.0		78.5+/-											
4	16.6	**DOLOMITE**, light gray, highly weathered	78+/-				1	50/1"	6			23.1		
		Auger Refusal at 16.6 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow-stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using a surveyor's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

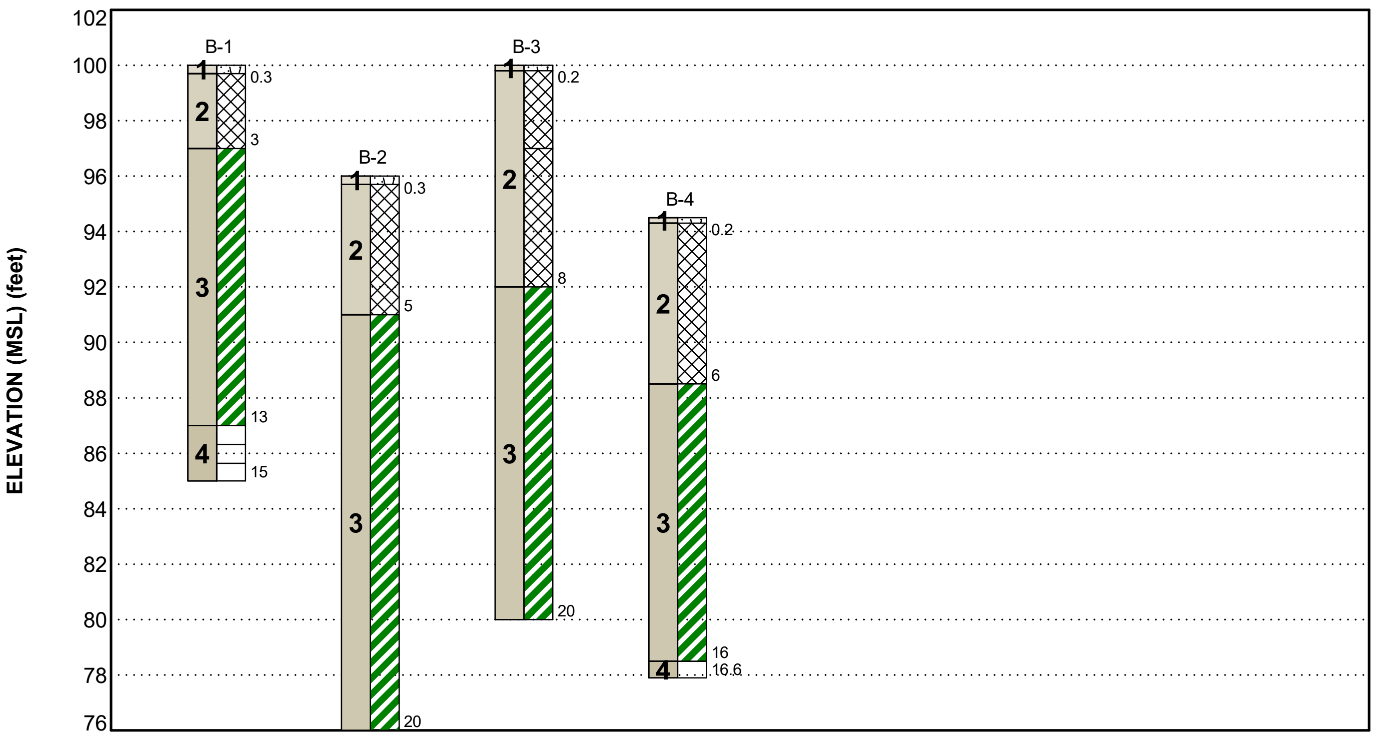
Groundwater not encountered

Terracon
11600 Lilburn Park Rd
Saint Louis, MO

Boring Started: 10-06-2020	Boring Completed: 10-06-2020
Drill Rig: DR721	Driller: JM
Project No.: 15205049	

GEOMODEL

DAP Foam Expansion - Location 2 ■ Pacific, MO
Terracon Project No. 15205049



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Surface	Topsoil
2	Fill and Possible Fill	Lean clay with varying amounts of silt, sand, and gravel
3	Fat Clay	Fat clay (CH) with trace amounts of sand
4	Bedrock	Highly weathered dolomite bedrock

LEGEND

Topsoil
Dolomite
Fill
Fat Clay

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

SUPPORTING INFORMATION

Contents:

General Notes
Unified Soil Classification System
Description of Rock Properties

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

DAP Foam Expansion - Location 2 ■ Pacific, MO

Terracon Project No. 15205049

Terracon GeoReport

SAMPLING

Shelby Tube

Split Spoon

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
UC	**Unconfined Compressive Strength**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

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Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:**	Cu ³ 4 and 1 £ Cc £ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines:	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:**	Cu ³ 6 and 1 £ Cc £ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [E]		SP	Poorly graded sand [I]
		Sands with Fines:	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"		CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K, L, M]
			PI plots below "A" line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ³ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ³ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

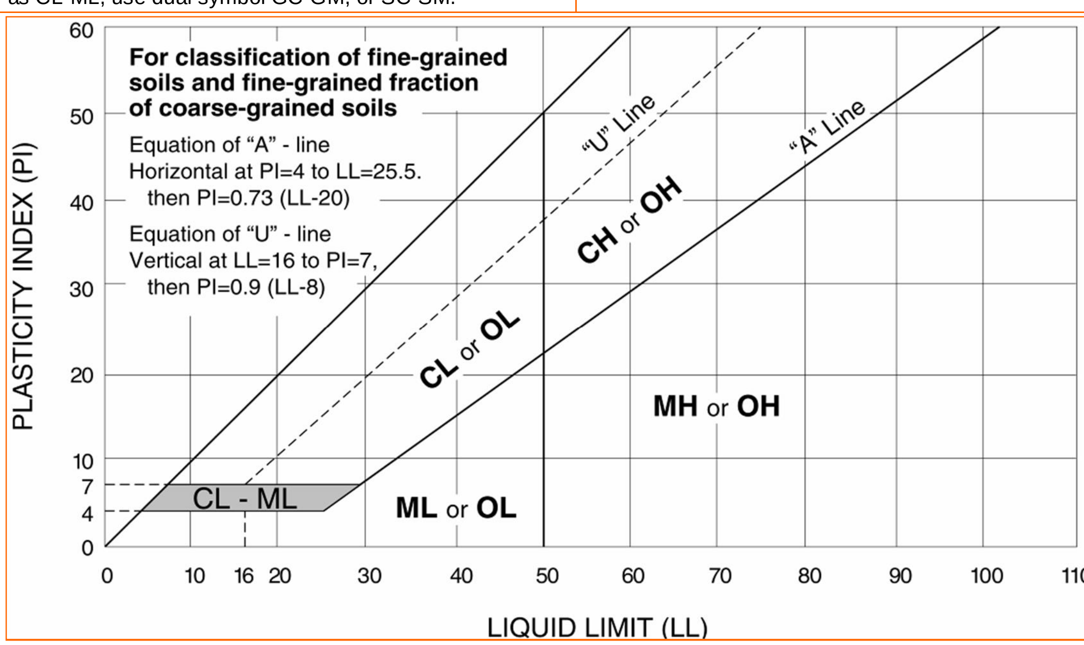
[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

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WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft. (50 – 300 mm)
Moderate	8 in – 2 ft. (200 – 600 mm)	**Medium**	1 ft. – 3 ft. (300 – 900 mm)
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	**Thick**	3 ft. – 10 ft. (900 mm – 3 m)
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	**Massive**	> 10 ft. (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 Technical Manual for Design and Construction of Road Tunnels – Civil Elements