Addendum 1

Project: **BRFP NUMBER 2324-03 – TROY SCHOOL DISTRICT 2024 SITE IMPROVEMENTS PAVING PROJECTS**

Bid Due date: 11:30 AM Local Time, Tuesday, November 21, 2023 (UNCHANGED)

This Addendum is issued as modifications to the RFP previously issued to provide clarifications to the scope of work. This Addendum supersedes the original RFP. This along with the RFP becomes the bid documents.

I. General Information

1. For questions e-mail purchasingoffice@troy.k12.mi.us or through Buildingconnected.com.
2. Report on Geotechnical Pavement Investigation for Baker Middle School dated September 27, 2023. (Attached)
3. Report on Geotechnical Pavement Investigation for Morse Elementary School dated September 28, 2023. (Attached)
4. Report on Geotechnical Pavement Investigation for Service and Administration Access Drive dated September 26, 2023. (Attached)
5. Report on Geotechnical Pavement Investigation for Troy School District Transportation dated October 3, 2023. (Attached)
6. Report on Geotechnical Pavement Investigation for Troy Learning Center dated October 10, 2023. (Attached)
7. Report on Geotechnical Pavement Investigation for Baker Middle School dated September 27, 2023. (Attached)

END

Report on Geotechnical
Pavement Investigation

Baker Middle School
1359 Torpey Road
Troy, Michigan 48083

Latitude 42.569022˚ N
Longitude 83.121776˚ W

Prepared for:

Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

G2 Project No. 230715
September 27, 2023

September 27, 2023

Ms. Michelle Kerns
Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

Re: Report of Geotechnical Pavement Investigation
Baker Middle School
1359 Torpey Road
Troy, Michigan 48083
G2 Project No. 230715

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Bake Middle School in the City of Troy, Michigan. This report presents the results of our observations and analyses and our recommendations for pavement design and construction considerations as they relate to the geotechnical conditions along the alignment of the proposed pavement rehabilitation/reconstruction.

As always, we appreciate the opportunity to be of service to Lecole Planners, LLC and Troy School District and look forward to discussing the recommendations presented. In the meantime, if you have any questions regarding this report or any other matter pertaining to the project, please let us know.

Sincerely,

G2 Consulting Group, LLC

Amy L. Schneider, P.E
Project Manager

Noel J. Hargrave-Thomas, P.E.
Principal

ALS/NJHT/ljv

Enclosures

EXECUTIVE SUMMARY

We understand the project consists of rehabilitation/reconstruction of the access drives and parking lots on the north side of Baker Middle School in Troy, Michigan. Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic generally consists of cars with occasional buses for special events.

Approximately 2-1/2 to 4-1/2 inches of bituminous concrete underlain by 6 to 10 inches of limestone aggregate base are present at the soil borings.in thickness. Approximately 6 to 8 inches of crushed concrete are present below the limestone aggregate base at borings B-1, B-5, and B-9. Fill soils, consisting of loose to medium compact clayey sand, sand, and gravelly sand, underlie the crushed concrete and aggregate base at borings B-2, B-4, and B-8 and extend to approximate depths ranging from 2 feet to the explored depth of 5 feet. Native stiff to very stiff silty clay and sandy clay are present below the fill and pavement section and extend to the explored depth of 5 feet. No measurable groundwater was observed during or upon completion of drilling operations at the soil boring locations.

The existing pavements at the ***east lot and east entrance to the west lot*** are in poor condition with more than half of the pavement exhibiting high severity block, joint, and fatigue cracking. Based on historical aerial imagery, the pavements in these areas were exhibiting extensive distress by the time they were less than 10 years old. Considering the poor historical performance of the areas, we recommend the existing bituminous concrete be completely removed, undercuts performed, and a new pavement section constructed. Additionally, we recommend additional drainage be constructed through the center of the lot to improve pavement performance.

The ***access drive and west lot*** are in relatively good condition, exhibiting low to moderate severity block, fatigue, and edge cracking. The existing pavements at these areas are generally not suitable to be rehabilitated by mill and overlay due to the thin existing pavement section (as thin as 2-1/2 inches at boring B-5). However, in consideration of the relatively good performance of the pavements and suitable aggregate base thickness, we recommend the existing bituminous concrete be completely removed and a new pavement section be constructed atop the existing aggregate base.

We recommend a significant budget be allocated for undercutting at the east lot and east access drive to the west lot on the order of 50 to 60 percent of the total area based on the poor historical performance of the pavement and the assumed water infiltration through the extensive pavement distress, with the percentage increasing as the subgrade is exposed to precipitation. At the west lot and access drive, we recommend a budget for undercutting on the order of 15 to 20 percent. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts.

Based on the results of our analyses, we recommend a standard-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course supported on the existing aggregate base or a minimum of 8 inches of imported MDOT 21AA dense graded aggregate base course where undercuts are required. We further recommend all bituminous concrete materials have a binder from RAP less than 17 percent of the total binder and using a binder of PG 64-22.

This summary is not to be considered separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

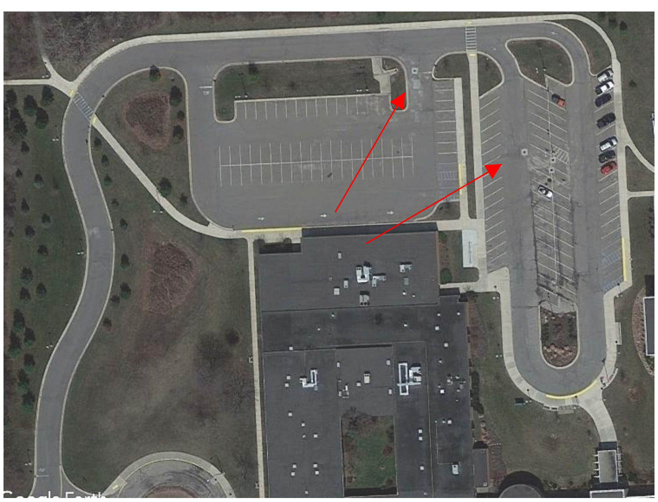
PROJECT DESCRIPTION

We understand the project consists of rehabilitation/reconstruction of the access drive and parking lots on the north side of Baker Middle School in Troy, Michigan. Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic generally consists of cars with occasional buses for special events.

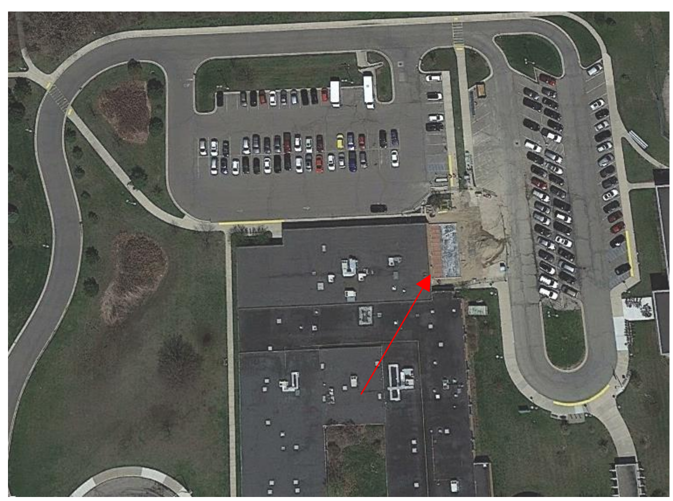
Google Earth Historical Aerial Photographs indicates construction of the access drive, parking lots, and east wing of the school began between 2005 and 2006 and was completed by 2010. Between 2010 and 2015, concrete collars were added around the catch basins at the north side of both lots, and two bituminous patches were performed at the east entrance to the west lot. An addition was constructed at the northeast side of the building in 2019 at which time the east parking lot appeared to already be exhibiting high severity block and joint cracking. See aerial images below:

2005 Google Earth Image

2007 Google Earth Image



2015 Google Earth Image



2019 Google Earth Image

The purpose of our investigation is to determine and evaluate the general pavement and subsurface conditions within existing pavements and develop general recommendations for the proposed pavement rehabilitation/reconstruction and pavement design.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of geotechnical engineering in this area. Our scope of services for this project is as follows:

1. We drilled a total of ten pavement core/hand auger soil borings within the parking lots and access drive extending to a depth of 4 feet each below existing grade. We measured the existing pavement section materials (bituminous concrete) and identified the type and condition of subgrade soils.

2. We performed laboratory testing on samples obtained from the soil borings. Laboratory testing included visual engineering classification, moisture content, Atterberg Limits, grain size distribution, and unconfined compressive strength determinations.

3. We prepared this engineering report which includes our evaluation of the subsurface conditions at the site and our recommendations for pavement rehabilitation/reconstruction.

FIELD OPERATIONS

G2 Consulting Group, LLC (G2), selected the number depth and location of the soil borings. The soil borings were located in the field by a G2 representative by use of GPS assisted mobile technology in conjunction with conventional taping methods. The approximate soil boring locations are presented on the Soil Boring Location Plan, Plate No. 1. No ground surface elevations were available at the time of this investigation.

We used a gas-powered core rig equipped with a 4-inch diameter diamond-tipped core barrel to core the pavement locations. Pavement cores were drilled through the full depth of the existing pavement structure to obtain an accurate determination of the pavement thickness.

Hand auger borings were performed using a 3-inch diameter hand auger. Within each hand-auger boring, soil samples were obtained at depths of 2 and 4 feet and at transitions in soil types. The soil samples were placed in sealed containers in the field and brought to the laboratory for testing and classification. A Dynamic Cone Penetrometer (DCP) test was performed within each hand auger boring at depths of 2 feet and 4 feet to evaluate the consistency of the in-situ soil. DCP testing involves driving a 1-1/2-inch diameter cone with a 45˚ vertex angle into the ground using a 15-pound weight dropped 20 inches after the cone is seated into the bottom of the hand auger borehole. The Dynamic Cone Penetrometer is driven successive 1-3/4 increments. The blow counts for each 1-3/4 inch increment are presented on the individual hand-auger soil boring logs.

During drilling operations, a G2 engineer maintained logs of the encountered subsurface conditions, including changes in stratigraphy and observed groundwater levels to be used in conjunction with our analysis of the subsurface conditions. The final hand-auger boring logs are based on the field logs and laboratory soil classification and testing. After completion of boring operations, the boreholes were backfilled with excavated soil and capped with cold patch.

LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine soil parameters pertinent to pavement design and site preparation. An experienced geotechnical engineer classified the samples in general conformance with the Unified Soil Classification System.

Laboratory testing included natural moisture content, Atterberg limits, grain size distribution, and unconfined compressive strength determinations. The Atterberg Limits testing was performed as per ASTM D4318 Standard Test Methods for liquid limit, plastic limit, and plasticity index of soils. The grain-size distributions were determined in general accordance with ASTM D422, "Standard Test Method for Particle-Size Analysis of Soils". The unconfined compressive strengths were determined by using a spring-loaded hand penetrometer. The hand penetrometer estimates the unconfined compressive strength to a maximum of 4-1/2 tons per square foot (tsf) by measuring the resistance of the soil sample to the penetration of a calibrated spring-loaded cylinder.

The results of the moisture content and unconfined compressive strength laboratory tests are indicated on the soil boring logs at the depths the samples were obtained. Atterberg Limits are presented on Figure No. 11 within the Appendix. Grain size distribution results are also presented graphically on Figure No. 12 in the Appendix. We will hold the soil samples for 60 days from the date of this report. If you would like the samples, please let us know.

EXISTING PAVEMENT CONDITIONS

The existing pavements consist of bituminous concrete measuring 2-1/2 to 4-1/2 inches in thickness. Approximately 6 to 10 inches of limestone aggregate base underlie the bituminous concrete surface. At borings B-1, B-5, and B-9, approximately 8 inches of crushed concrete fill are present below the aggregate base.

Grain size distribution was performed on a representative sample of aggregate base from boring B-3. Test results indicated the material is slightly of specification for gradation requirements of MDOT 21AA dense-graded aggregate base as presented on Figure No. 12 in the Appendix and in the table below. The values in bold indicate where the material is *out* of specification. Based on the results, we recommend the material remain in place for support of the new pavement section or within undercuts.

Sieve Size	MDOT 21AA Percent Passing Specification	B-1 Aggregate Base Percent Passing
1-1/2"	100	100
1"	85 to 100	**80**
1/2"	50 to 75	52
No. 8	20 to 45	24
Loss by Wash	4 to 8	8
Meets 21AA Gradation		**No**

The east parking lot (borings B-1 through B-4) is exhibiting high severity joint, block, and fatigue cracking throughout (Photograph Nos. 1 through 7) in the Appendix. The observed distresses appears to be a result of poorly constructed joints (potentially during cold weather). The cracking along the joints allows infiltration of water into the aggregate base and subgrade and subsequent fatigue cracking develops and propagating outward.

Concrete sidewalk lines the east and west sides of the lot and concrete curb and gutter surround the landscape islands at the north and south ends of the lot and the exit drives from the lot (Photograph Nos. 3 and 7). Catch basins are present toward the north side of the lot. Based on visual observations, the lot appears to grade to the center (Photograph No. 5).

The west parking lot (borings B-6 through B-8) is in relatively good condition with low to moderate severity block and secondary fatigue cracking (Photograph Nos. 12 through 14). However, at the east entrance to the lot, high severity fatigue and joint cracking is present and previous pavement patches were noted (Photograph Nos. 10 and 11). Concrete sidewalk extends along the south side of the lot, adjacent to the school. The remaining perimeter of the lot is surrounded by concrete curb and gutter. Except for the one catch basin at the east entrance to the lot, no other drainage structures are present.

The access drive from Torpey Road to both of the parking lots (borings B-5, B-9, and B-10) is in relatively good condition, exhibiting low to moderate severity fatigue and edge cracking (Photograph No. 9 and 15 through 18). Concrete curb and gutter line the drive and two drainage structures are present along the east curb line (Photograph No. 15).

EXISTING SUBSURFACE CONDITIONS

Fill soils, consisting of clayey sand, sand, and gravelly sand, underlie the crushed concrete and aggregate base at borings B-2, B-4, and B-8 and extend to approximate depths ranging from 2 feet to the explored depth of 5 feet. Native silty clay and sandy clay are present below the fill and pavement section and extend to the explored depth of 5 feet.

The granular fill soils are loose to medium compact with Dynamic Cone Penetrometer (DCP) Test N-values ranging from 6 to 21 blows per 1-3/4 inch drive. The native sandy clay and silty clay are stiff to very stiff in consistency with natural moisture contents ranging from 12 to 16 percent and unconfined compressive strengths ranging from 2,000 to 7,000 psf. The silty clay at boring B-7 has a liquid limit of 25, a plastic limit of 14, and a plasticity index of 11.

The stratification depths shown on the soil boring logs represent the soil conditions at the boring locations. Variations may occur between borings. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transition may be more gradual than what is shown. We have prepared the boring logs on the basis of laboratory classification and testing as well as field logs of the soils encountered.

The Soil Boring Location Plan, Plate No. 1, Soil Boring Logs Figure Nos. 1 through 10, Atterberg Limit Results, Figure No. 11, and Grain Size Distribution, Figure No. 12, are presented in the Appendix. The soil profiles described above are generalized descriptions of the soil conditions at the boring locations. General Notes Terminology defining the nomenclature used on the boring logs and elsewhere in this report is presented on Figure No. 13.

GROUNDWATER CONDITIONS

No measurable groundwater was observed during or upon completion of drilling operations. Fluctuations in perched and long-term groundwater levels should be anticipated due to seasonal variations and following periods of prolonged precipitation. It should also be noted that groundwater observations made during drilling operations in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the low permeability of such soils and the tendency of drilling operations to seal off the natural paths of groundwater flow.

PAVEMENT EVALUATION AND RECOMMENDATIONS

The existing pavements at the ***east lot and east entrance to the west lot*** are in poor condition with more than half of the pavement exhibiting high severity block, joint, and fatigue cracking. We recommend the existing bituminous concrete be completely removed, and a new pavement section constructed atop the existing aggregate base.

The ***access drive and west lot*** are in relatively good condition, exhibiting low to moderate severity block, fatigue, and edge cracking. The existing pavements at these areas are generally not suitable to be rehabilitated by mill and overlay due to the thin existing pavement section (as thin as 2-1/2 inches at boring B-5). However, in consideration of the performance of the pavements and suitable aggregate base thickness, we recommend the existing bituminous concrete be completely removed and a new pavement section be constructed atop the existing aggregate base.

We recommend completely removing the existing bituminous concrete across all the areas. The exposed aggregate base should be fine-graded to allow placement of the design pavement section (4 inches) and promote effective drainage and then compacted with a large vibratory roller making a minimum of 10 passes in 2 perpendicular directions across the subgrade to densify the granular soils for support of the new pavement section and evaluated for instability. Any soils exhibiting excessive instability, such as severe rutting or pumping, should be removed by undercutting to expose stable soils. Any remaining unstable or unsuitable areas noted should be improved by additional compaction or removed and replaced with engineered fill.

Based on the existing pavement conditions, we recommend a budget for undercutting the east lot and east entrance to the west lot on the order of 40 to 50 percent and the west lot and access drive on the order of 15 to 20 percent of the total area. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts. We anticipate most of the undercuts will occur in the heavily distressed pavement areas.

Subgrade undercuts, if required, should be evaluated by a qualified engineering technician to determine if subgrade stabilization is necessary. We recommend undercut excavations, where required, be backfilled with MDOT 21AA limestone aggregate base placed in an engineered manner. Lift thicknesses should not exceed 9 inches. All engineered fill should be compacted to a density of at least 95 percent of the maximum density determined by the Modified Proctor (ASTM D 1557) method of testing. All engineered fill material should be placed and compacted at approximately the optimum moisture content. Frozen material should not be used as fill, nor should fill be placed on a frozen subgrade.

To minimize subgrade instability and undercuts, we recommend the exposed subgrade not be left exposed to precipitation and construction operations be performed during the summer months to ensure dry, warm, weather. Additionally, the subgrade may become unstable under repeated loading of construction traffic; therefore, construction equipment should be limited on the exposed subgrade. We recommend a drain tile be placed within any undercut area and connected to the closest catch basin to prevent groundwater from pooling within the granular soils in undercuts and creating “bathtubs” in the cohesive soils.

Pavement Design

We performed pavement design analyses in accordance with the “AASHTO Guide for Design of Pavement Structures”. The subgrade soils will generally consist of silty clay, sandy clay, and clayey sand which are considered fair for support of pavements. Based on the existing subgrade soils and the historically poor pavement performance, we have provided a design pavement section based on an effective subgrade resilient modulus of 6,000 pounds per square inch (psi).

It is our understanding traffic at the site consists primarily of cars with occasional buses for special events. If any actual traffic volume information becomes available, G2 should be notified so we can reevaluate our recommendations. We have designed the standard-duty pavement section on an estimated of 75,000 18-kip equivalent single-axle loads (ESALs) over a 20-year design life in consideration of the occasional buses. For evaluation purposes, we have utilized a serviceability loss of 2.0, a standard deviation of 0.49 for flexible pavements, and a reliability factor of 0.90.

We recommend a standard-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course, supported on the existing aggregate base or a minimum of 8 inches of imported MDOT 21AA dense graded aggregate base course. We recommend all bituminous concrete materials have a binder from RAP less than 17 percent of the total binder and using a binder of PG 64-22.

All pavement materials are specified within the 2012 Standard Specifications for Construction from the Michigan Department of Transportation. The aggregate materials for the subbase are described in Section 902. The bituminous pavement materials are described in Section 501 and can be assigned a structural coefficient number of 0.42. Imported MDOT 21AA dense graded aggregate base material can be assigned a structural coefficient number of 0.14.

Pavement Drainage

Proper pavement drainage is essential for cohesive subgrade soils due to their relatively impermeable nature and given the historically poor performance of the existing pavements. The pavement and subgrade should be properly sloped to promote effective surface and subsurface drainage and prevent water from ponding. We also recommend pavement subbase materials consist of non-frost-susceptible aggregates where possible.

We recommend additional drainage structures be installed, particularly at the east side of the west lot and the center of the east lot. In addition, we recommend installing finger drains at each catch basin to remove groundwater from the aggregate base layer, particularly down the center of the east lot. Since the east lot is sloped to the center of the pavement and then to the catch basin in the north third, an underdrain is recommended along the pavement valley going from south to north connecting to the catch basins. Such drains should extend to minimum depths of 4 inches below the bottom of the proposed aggregate base course or granular fill placed within undercut areas and connect to the nearest catch basin. We also recommend edge drains be installed around the pavement perimeter and islands to prevent seepage into the pavement base.

Pavement Maintenance

Regular timely maintenance should be performed on the pavement to reduce the potential deterioration associated with moisture infiltration through surface cracks. The owner should be prepared to seal the cracks with a hot-applied elastic crack filler as soon as possible after cracking develops and as often as necessary to block the passage of water to the subgrade soils.

GENERAL COMMENTS

We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention for review and evaluation with respect to the prevailing subsurface conditions.

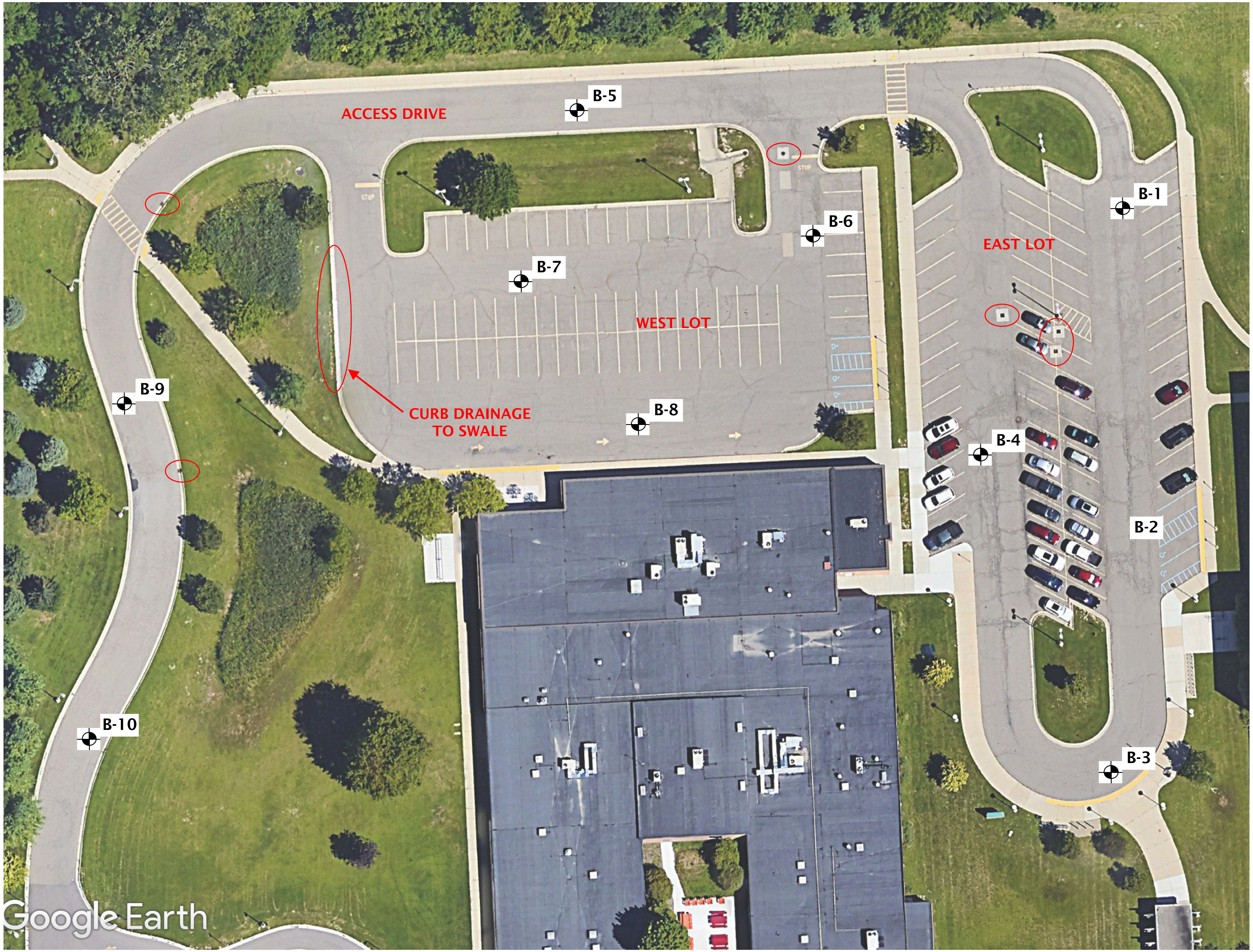
The scope of the present investigation was limited to evaluation of subsurface conditions for the construction of the proposed pavement reconstruction and other related aspects of the proposed project. No chemical, environmental, or hydrogeological testing or analysis were included in the scope of this investigation. If changes occur in the design, location, or concept of the project, the conclusions and recommendations contained in this report are not valid unless G2 Consulting Group, LLC reviews the changes. G2 Consulting Group, LLC will then confirm the recommendations presented herein or make changes in writing.

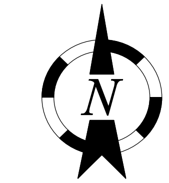
We have based the analyses and recommendations submitted in this report upon the data from soil borings performed at the approximate locations shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring locations. The nature and extent of any such variations may not become clear until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate our report recommendations.

Soil conditions at the site could vary from those generalized on the basis of soil borings made at specific locations. It is, therefore, recommended that G2 Consulting Group, LLC be retained to provide soil engineering services during the water main and roadway construction phases of the proposed project.

This is to observe compliance with the design concepts, specifications, and recommendations. Also, this allows design changes to be made in the event that subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX





Legend

- Pavement Core/Hand Auger Soil Borings performed by G2 Consulting Group, LLC on September 9, 2022
- Drainage Structure

Soil Boring Location Plan		
Baker Middle School 1359 Torpey Road Troy, Michigan 48083		
G2 CONSULTING GROUP	Project No. 230715	
	Drawn by: ALS	
	Date: 9/21/23	Plate No. 1
	Scale: NTS	

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-1**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/2 inches) 0.3		AS-1				
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (8 inches) 1.0						
		Fill: Crushed Concrete Sandy Gravel 1.5						
		End of Boring @ 1.5 ft, Auger Refusal						
5			5					

Total Depth: 1.5 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4 inches)	0.3	AS-1				
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (8 inches)	1.0					
		Fill: Loose Dark Brown Clayey Sand with trace silt, gravel, and organic matter	2.5	AS-2	7			
		Very Stiff Mottled Dark Brown and Gray Sandy Clay with trace silt and gravel	4.0	AS-3	17	16.3		5000*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 2

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-3**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4 inches) — 0.3		AS-1				
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (10 inches) — 1.2						
		Stiff Brown Sandy Clay with trace silt and gravel		AS-2	7	14.9		2000*
		— 4.0		AS-3	7	11.5		2000*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-4**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4 inches)	0.3	AS-1				
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (9 inches)	1.1					
		Fill: Loose Dark Brown Clayey Sand with trace silt and gravel	2.0	AS-2	6			
		Very Stiff Mottled Dark Brown and Gray Sandy Clay	4.0	AS-3	13	14.6		4000*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 4

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-5**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE / DESCRIPTION	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
0.2	Bituminous Concrete (2-1/2 inches)					
0.7	Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (6 inches)	AS-1				
1.4	Fill: Crushed Concrete Sandy Gravel (8 inches)					
4.0	Very Stiff Mottled Brown and Gray Silty Clay with trace sand and gravel	AS-2	13	15.5		4000*
		AS-3	24	13.4		7000*
5	End of Boring @ 4 ft					

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-6**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4-1/2 inches) 0.4		AS-1				
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (7 inches) 1.0						
		Stiff to Very Stiff Mottled Brown and Gray Silty Clay with trace sand and gravel		AS-2	10	13.7		3000*
		4.0		AS-3	24	13.0		7000*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 6

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-7**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/2 inches) 0.3		AS-1				
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (8 inches) 1.0						
		Stiff to Very Stiff Mottled Brown and Gray Silty Clay with trace sand and gravel 4.0		AS-2	10	15.7		3000*
				AS-3	25	13.8		7500*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-8**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-3/4 inches)	0.3					
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (8 inches)	1.0	AS-1				
		Fill: Medium Compact Brown Sand with trace silt and gravel	2.5	AS-2	12			
		Fill: Medium Compact Gray Gravelly Sand with trace silt	4.0	AS-3	21			
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-9**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)		Sample Type/No.	DCP Blows/ 1.75-Inches	Moisture Content (%)	Dry Density (PCF)	Uncof. Comp. St. (PSF)
0.2	Bituminous Concrete (2-3/4 inches)					
1.0	Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (9 inches)	AS-1				
1.6	Fill: Crushed Concrete Sandy Gravel (8 inches)					
4.0	Very Stiff Brown Silty Clay with trace sand and gravel	AS-2	13	12.3		4000*
		AS-3	13	13.9		4000*
	End of Boring @ 4 ft					

Depth scale: 5

Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No. 230715

Latitude: N/A Longitude: N/A

Soil Boring No. **B-10**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/2 inches)	0.3	AS-1				
		Crushed Limestone Aggregate Base: Gray Sandy Gravel with trace silt (8 inches)	1.0					
		Very Stiff Brown Silty Clay with trace sand and gravel		AS-2	13	12.3		4000*
			4.0	AS-3	17	13.8		5000*
5		End of Boring @ 4 ft	5					

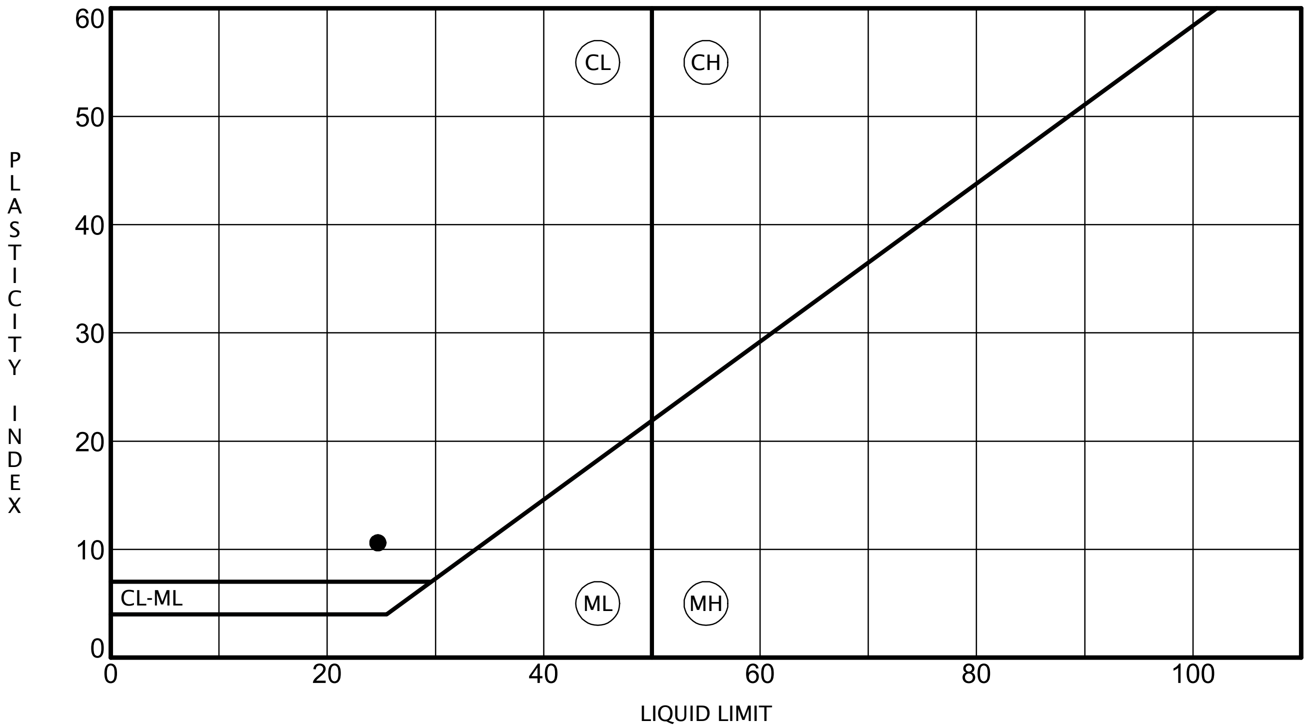
Total Depth: 4 ft
Drilling Date: September 9, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond-tipped core barrel and hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch



	Specimen Identification		LL	PL	PI	Fines	M %	Classification
●	B-5	AS-2	25	14	11		15	Brown and Gray Silty Clay

CONSULTING GROUP

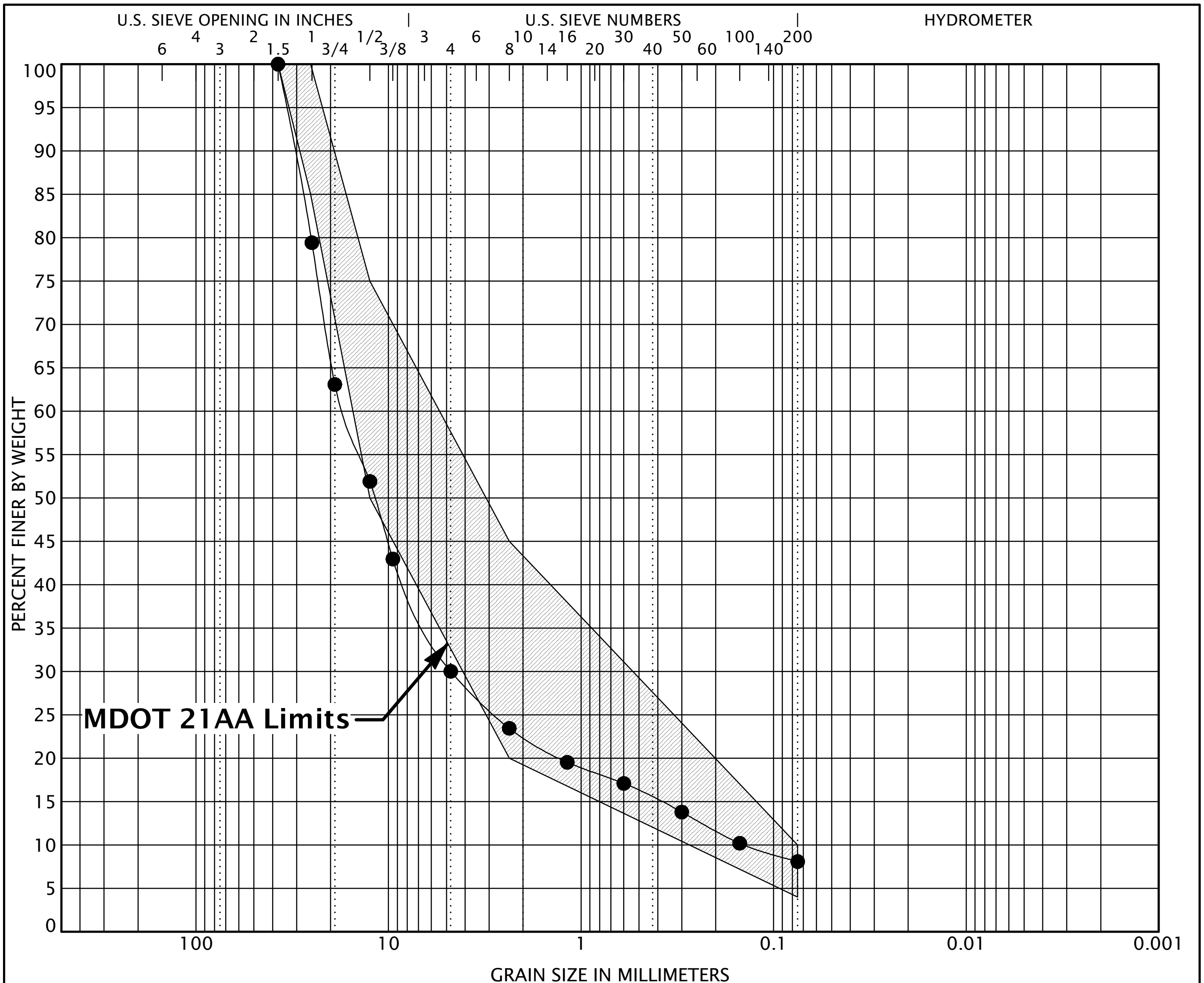
ATTERBERG LIMITS RESULTS

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No.: 230715

Figure No. 11



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Description	LL	PL	PI	Cc	Cu
●	B-3 AS-1	Gray Sandy Gravel with trace silt				9.45	120.28

	Specimen ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-3 AS-1	37.5	16.93	4.745	0.141	70.0	21.9	8.1	

CONSULTING GROUP

GRAIN SIZE DISTRIBUTION

Project Name: Baker Middle School

Project Location: 1359 Torpey Road
Troy, Michigan 48083

G2 Project No.: 230715

Figure No. 12

US_GRAIN_SIZE_MDOT_21AA 230715.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 9/27/23

GENERAL NOTES TERMINOLOGY

Unless otherwise noted, all terms herein refer to the Standard Definitions presented in ASTM 653.

PARTICLE SIZE

Boulders		- greater than 12 inches
Cobbles		- 3 inches to 12 inches
Gravel	- Coarse	- 3/4 inches to 3 inches
	- Fine	- No. 4 to 3/4 inches
Sand	- Coarse	- No. 10 to No. 4
	- Medium	- No. 40 to No. 10
	- Fine	- No. 200 to No. 40
Silt		- 0.005mm to 0.074mm
Clay		- Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e. clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituent (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35%	Little - 12 to 23%
And - over 35%	Some - 23 to 33%

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier, i.e. sandy clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils, i.e. silty clay, trace sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Approximate Range of (N)
Very Soft	Below 500	0 - 2
Soft	500 - 1,000	3 - 4
Medium	1,000 - 2,000	5 - 8
Stiff	2,000 - 4,000	9 - 15
Very Stiff	4,000 - 8,000	16 - 30
Hard	8,000 - 16,000	31 - 50
Very Hard	Over 16,000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 - 50
Very Compact	86 - 100	Over 50

Relative Density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

AS - Auger Sample – Cuttings directly from auger flight
BS - Bottle or Bag Samples
S - Split Spoon Sample - ASTM D 1586
LS - Liner Sample with liner insert 3 inches in length
ST - Shelby Tube sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted

STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0 inch outside-diameter, 1-3/8 inch inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

Figure No.13

Photographic Documentation
Baker Middle School
Troy, Michigan
G2 Project No. 230715

Photograph No. 1: Looking south toward B-1. High severity fatigue and joint cracking.

Photograph No. 2: Looking west at B-1. High severity fatigue and joint cracking.

Photographic Documentation
Baker Middle School
Troy, Michigan
G2 Project No. 230715

Photograph No. 3: Looking south at B-2. High severity fatigue and joint cracking.

Photograph No. 4: Looking west at B-3. Low severity fatigue
Cracking at access loop.

Photographic Documentation
Baker Middle School
Troy, Michigan
G2 Project No. 230715

Photograph No. 5: Looking north toward B-3. Low to moderate severity fatigue and cracking.

Photograph No. 6: Look south at B-4. High severity joint and fatigue cracking.

Photographic Documentation
Baker Middle School
Troy, Michigan
G2 Project No. 230715

Photograph No. 7: Moderate to high severity fatigue cracking looking north toward B-4. Note concrete collar around catch basin.

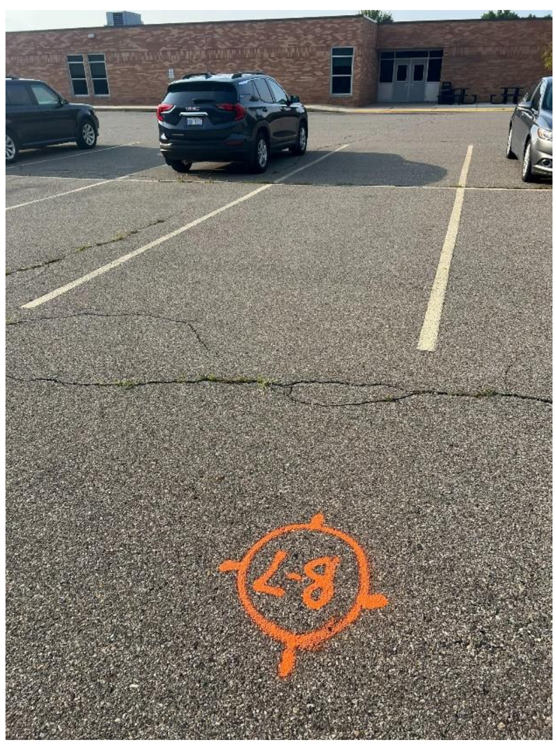
Photograph No. 8: Moderate severity fatigue and edge cracking, looking east toward B-5.

Photograph No. 9: Low to moderate severity edge fatigue cracking looking west toward B-5.

Photograph No. 10: High severity fatigue and joint cracking looking north toward B-6. Note concrete collar around basin and patch south of basin.

Photographic Documentation
Baker Middle School
Troy, Michigan
G2 Project No. 230715

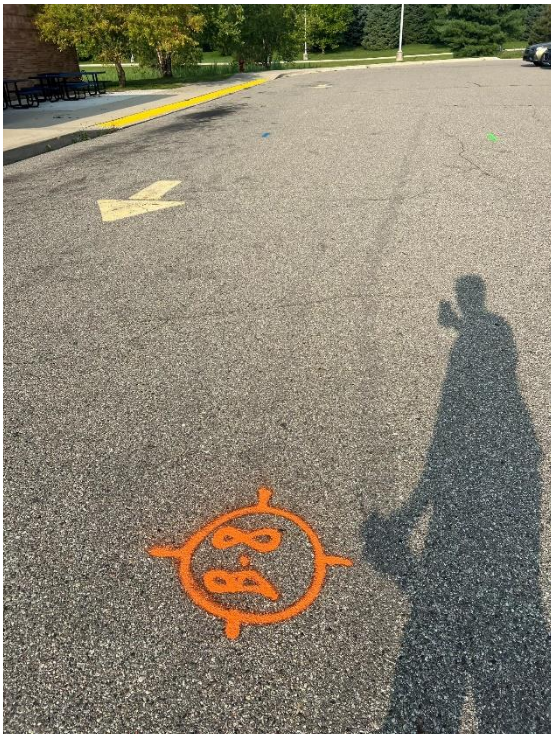
Photograph No. 11: Moderate to high severity fatigue and block cracking looking west toward B-6. Note previous concrete patch.



Photograph No. 12: Low to moderate severity block cracking in west lot.

Photographic Documentation
Baker Middle School
Troy, Michigan
G2 Project No. 230715

Photograph No. 13: Low to moderate severity block and fatigue cracking.
Note drainage path in curb on west side of lot to drainage swale.



Photograph No. 14: Low severity block cracking.

Photograph No. 15: Low to moderate severity edge cracking propagating outward. Note transverse cracking and previous patch along west side of drive. Drainage structure in gutter on east side of drive. Looking south.

Photograph No. 16: Low to moderate severity edge cracking propagating outward. Looking north.

Photographic Documentation
Baker Middle School
Troy, Michigan
G2 Project No. 230715

Photograph No. 17: Low to moderate severity edge cracking propagating outward. Looking south.

Photograph No. 18: Moderate severity transverse, fatigue, and edge cracking looking east toward B-10.

Report on Geotechnical
Pavement Investigation

Morse Elementary School
475 Cherry Avenue
Troy, Michigan 48083

Latitude 42.555771˚ N
Longitude 83.136898˚ W

Prepared for:

Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

G2 Project No. 230716
September 28, 2023

September 28, 2023

Ms. Michelle Kerns
Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

Re: Report of Geotechnical Pavement Investigation
Morse Elementary School
475 Cherry Avenue
Troy, Michigan 48083
G2 Project No. 230716

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Morse Elementary School in the City of Troy, Michigan. This report presents the results of our observations and analyses and our recommendations for pavement design and construction considerations as they relate to the geotechnical conditions along the alignment of the proposed pavement rehabilitation/reconstruction.

As always, we appreciate the opportunity to be of service to Lecole Planners, LLC and Troy School District and look forward to discussing the recommendations presented. In the meantime, if you have any questions regarding this report or any other matter pertaining to the project, please let us know.

Sincerely,

G2 Consulting Group, LLC

Amy L. Schneider, P.E
Project Manager

Noel J. Hargrave-Thomas, P.E.
Principal

ALS/NJHT/ljv

Enclosures

EXECUTIVE SUMMARY

We understand the project consists of rehabilitation/reconstruction of the access drives, parking lots, and play surface west and north of the school. We anticipate traffic for the lots and access drives will generally consists of cars, delivery trucks, and garbage trucks and the play surface will be predominantly pedestrian traffic and light snow plowing equipment. We anticipate a standard-duty pavement section will be required. However, considering the dumpster at the north side of the lot, we have also provided a heavy-duty section if required by the civil engineer.

Approximately 3 to 5 inches of bituminous concrete are present at the soil boring locations. The bituminous concrete is underlain by 3-3/4 to 21 inches of gravelly sand natural aggregate base at borings B-1 through B-5 and B-7. Loose to medium compact silty sand fill is present below the aggregate base at boring B-3 and bituminous concrete at borings B-6 and B-8 and extends to approximate depths ranging from 1-1/2 to 2-1/2 feet. Buried silty sand topsoil with between 5 and 10 percent organic matter underlies the aggregate base and fill at borings B-1, B-3, and B-4 and extends to approximate depths ranging from 2 to 3-1/2 feet. The deep aggregate deposits are at the areas of the topsoil deposits and may be associated with previous undercuts or subgrade stabilization. Native loose to medium compact granular soils, consisting of sand, silty sand, sandy gravel, underlie the fill, pavement section, and buried topsoil and extend to the explored depth of 4 feet. No measurable groundwater was observed during or upon completion of drilling operations at the soil boring locations.

The existing pavements are in fair condition with areas of moderate severity distress. The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the thin existing pavement section at borings B-1 through B-5 and B-7, thin aggregate at borings B-2, B-5, and B-7, and lack of aggregate base at borings B-6 and B-8. Therefore, we recommend completely removing the existing bituminous concrete and a sufficient amount of aggregate base, fill, or native soils to accommodate the design pavement section and constructing a new pavement section.

Following removal of the bituminous concrete and required aggregate base/fill/native soil, we anticipate the exposed subgrade soils (remaining aggregate base or loose to medium compact granular native and fill soils) will generally be suitable for support of the proposed pavement section. The exposed subgrade soils should be thoroughly proof compacted with a large vibratory roller making a minimum of 10 passes in 2 perpendicular directions across the subgrade to densify the granular soils for support of the new pavement section. Unsuitable soils or soils exhibiting excessive instability should be removed by undercutting to expose stable soils. Any remaining unstable or unsuitable areas noted should be improved by additional compaction or removed and replaced with engineered fill.

We recommend a budget be allocated for undercutting on the order of 20 to 25 percent, with the percentage increasing as the subgrade is exposed to precipitation. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts. To further minimize the potential for subgrade instability and undercuts, we recommend the exposed subgrade not be left exposed to precipitation, and construction operations be performed during the summer months to ensure dry, warm, weather.

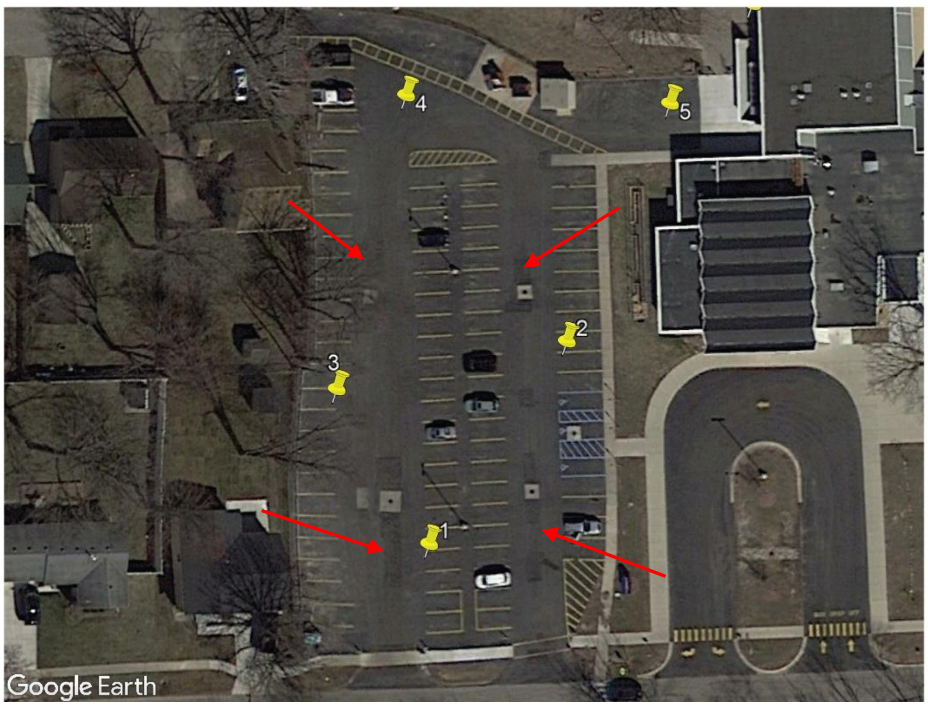
Based on the results of our analyses, we recommend a standard-duty flexible pavement consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of 4EML, supported on 8 inches of existing MDOT 22A natural aggregate base of imported MDOT 21AA dense graded aggregate base. We recommend a heavy-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 3 inches of MDOT 3EML bituminous concrete leveling course, supported on 10 inches of existing MDOT 22A natural aggregate base of imported MDOT 21AA dense graded aggregate base. We recommend all bituminous concrete materials have a binder from RAP less than 17 percent of the total binder and using a binder of PG 64-22.

This summary is not to be considered separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

PROJECT DESCRIPTION

We understand the project consists of rehabilitation/reconstruction of the access drives, parking lots, and play surface west and north of the school. We anticipate traffic for the lots and access drives will generally consists of cars, delivery trucks, and garbage trucks and the play surface will be predominantly pedestrian traffic and light snow plowing equipment. We anticipate a standard-duty pavement section will be required. However, considering the dumpster at the north side of the lot, we have also provided a heavy-duty section if required by the civil engineer.

The age of the existing pavements was not available upon completion of this report. However, after reviewing Google Earth Historical Aerial Photographs, it appears the pavements were constructed sometime prior to 1999. Concrete collars were constructed around the catch basins between 2007 and 2010 and between 2011 and 2015. Concrete patches were constructed throughout the parking lot between 2020 and 2021, indicated with red arrows below.



The purpose of our investigation is to determine and evaluate the general pavement and subsurface conditions within existing pavements and develop general recommendations for the proposed pavement rehabilitation/reconstruction and pavement design.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of geotechnical engineering in this area. Our scope of services for this project is as follows:

1. We drilled a total of eight pavement core/hand auger soil borings within the parking lots and access drives extending to a depth of 4 feet each below existing grade. We measured the existing pavement section materials (bituminous concrete) and identified the type and condition of subgrade soils.

2. We performed laboratory testing on samples obtained from the soil borings. Laboratory testing included visual engineering classification, moisture content, organic matter content (loss-on-ignition), and grain size distribution.

3. We prepared this engineering report which includes our evaluation of the subsurface conditions at the site and our recommendations for pavement rehabilitation/reconstruction.

FIELD OPERATIONS

G2 Consulting Group, LLC (G2), selected the number depth and location of the soil borings. The soil borings were located in the field by a G2 representative by use of GPS assisted mobile technology in conjunction with conventional taping methods. The approximate soil boring locations are presented on the Soil Boring Location Plan, Plate No. 1. No ground surface elevations were available at the time of this investigation.

We used a gas powered core rig equipped with a 4-inch diameter diamond-tipped core barrel to core the pavement locations. Pavement cores were drilled through the full depth of the existing pavement structure to obtain an accurate determination of the pavement thickness.

Hand auger borings were performed using a 3-inch diameter hand auger. Within each hand-auger boring, soil samples were obtained at depths of 2 and 4 feet and at transitions in soil types. The soil samples were placed in sealed containers in the field and brought to the laboratory for testing and classification. A Dynamic Cone Penetrometer (DCP) test was performed within each hand auger boring at depths of 2 feet and 4 feet to evaluate the consistency of the in-situ soil. DCP testing involves driving a 1-1/2 inch diameter cone with a 45° vertex angle into the ground using a 15-pound weight dropped 20 inches after the cone is seated into the bottom of the hand auger borehole. The Dynamic Cone Penetrometer is driven successive 1-3/4 increments. The blow counts for each 1-3/4 inch increment are presented on the individual hand-auger soil boring logs.

During drilling operations, a G2 engineer maintained logs of the encountered subsurface conditions, including changes in stratigraphy and observed groundwater levels to be used in conjunction with our analysis of the subsurface conditions. The final hand-auger boring logs are based on the field logs and laboratory soil classification and testing. After completion of boring operations, the boreholes were backfilled with excavated soil and capped with cold patch.

LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine soil parameters pertinent to pavement design and site preparation. An experienced geotechnical engineer classified the samples in general conformance with the Unified Soil Classification System.

Laboratory testing included natural moisture content, grain-size distribution, and organic matter content. The grain-size distributions were determined in general accordance with ASTM D422, "Standard Test Method for Particle-Size Analysis of Soils". The organic matter content of representative samples was determined in accordance with ASTM Test Method D 2974, "Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils."

The results of the moisture content, organic matter content, and unconfined compressive strength laboratory tests are indicated on the soil boring logs at the depths the samples were obtained. Grain size distribution results are also presented graphically on Figure No. 9 in the Appendix. We will hold the soil samples for 60 days from the date of this report. If you would like the samples, please let us know.

EXISTING PAVEMENT CONDITIONS

Approximately 3 to 5 inches of bituminous concrete are present at the soil boring locations. The bituminous concrete is underlain by 3-3/4 to 21 inches of gravelly sand natural aggregate base at borings B-1 through B-5 and B-7. A grain size test was performed on a representative sample of the natural aggregate base from boring B-2. Test results indicated the material is out of specification for gradation requirements of MDOT 22A dense-graded aggregate base based on the percent passing the No. 200 sieve as presented on Figure No. 9. The existing aggregate base can be reused for the new pavement section or within undercut areas.

The parking lot and play surface are in fair condition with low to moderate severity block, joint, and fatigue cracking (Photograph Nos. 3,4, 9, and 10). Areas of high severity fatigue cracking are present throughout the lot (Photograph Nos. 1, 2, 5, 7, and 8). Crack sealing is visible at the play surface (Photograph Nos. 12 through 15). It appears patching was performed within both the lot and the play surface (Photograph Nos. 2, 6, and 12). The pavement is flush against the building at the north side of the school (Photograph No. 12) and the concrete sidewalk (Photograph Nos. 7, 9, and 10).

No curb or gutter are present around the perimeter of the lot or play surface. Catch basins are present through the center of the lot. Portland cement concrete collars have been constructed around a few of the catch basins (Photograph Nos. 1, 3, and 6).

EXISTING SUBSURFACE CONDITIONS

Silty sand fill is present below the aggregate base at boring B-3 and bituminous concrete at borings B-6 and B-8 and extends to approximate depths ranging from 1-1/2 to 2-1/2 feet. Buried silty sand topsoil underlies the aggregate base and fill at borings B-1, B-3, and B-4 and extends to approximate depths ranging from 2 to 3-1/2 feet. Native loose sand, silty sand, and sandy gravel underlie the fill, pavement section, and buried topsoil and extend to the explored depth of 4 feet.

The buried topsoil is loose to medium compact with Dynamic Cone Penetrometer (DCP) Test N-values ranging from 7 to 12 blows per 1-3/4 inch drive and organic matter contents ranging from 5.2 to 10.0 percent. The silty sand fill at borings B-3, B-6, and B-8 is loose to medium compact with DCP Test N-values ranging from 10 and 11 blows per 1-3/4 inch drive. The underlying native granular soils are medium compact with DCP Test N-values ranging from 11 to 27 blows per 1-3/4 inch.

The stratification depths shown on the soil boring logs represent the soil conditions at the boring locations. Variations may occur between borings. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transition may be more gradual than what is shown. We have prepared the boring logs on the basis of laboratory classification and testing as well as field logs of the soils encountered.

The Soil Boring Location Plan, Plate No. 1, Soil Boring Logs Figure Nos. 1 through 8, and Grain Size Distribution, Figure No. 9, are presented in the Appendix. The soil profiles described above are generalized descriptions of the soil conditions at the boring locations. General Notes Terminology defining the nomenclature used on the boring logs and elsewhere in this report is presented on Figure No. 10.

GROUNDWATER CONDITIONS

No measurable groundwater was observed during or upon completion of drilling operations. Fluctuations in perched and long-term groundwater levels should be anticipated due to seasonal variations and following periods of prolonged precipitation.

PAVEMENT EVALUATION AND RECOMMENDATIONS

General

The existing pavements are in fair condition with areas of moderate severity distress. The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the thin existing pavement section at borings B-1 through B-5 and B-7, thin aggregate at borings B-2, B-5, and B-7, and lack of aggregate base at borings B-6 and B-8. Therefore, we recommend completely removing the existing bituminous concrete and underlying aggregate base, fill, and native soils to accommodate the design pavement section and constructing a new pavement section.

Pavement Subgrade Preparation

Once the existing bituminous concrete and underlying aggregate base, fill, and native soils have been removed to accommodate the design pavement section, we anticipate the exposed subgrade soils (remaining aggregate base and loose to medium compact granular native and fill soils) will generally be suitable for support of the proposed pavement section. The exposed subgrade soils should be thoroughly proof compacted with a large vibratory roller making a minimum of 10 passes in 2 perpendicular directions across the subgrade to densify the granular soils for support of the new pavement section. Unsuitable soils or soils exhibiting excessive instability should be removed by undercutting to expose stable soils. Any remaining unstable or unsuitable areas noted should be improved by additional compaction or removed and replaced with engineered fill.

Subgrade undercuts, if required, should be evaluated by a qualified engineering technician to determine if subgrade stabilization is necessary. We recommend undercut excavations, where required, be backfilled with MDOT 21AA dense graded aggregate placed in an engineered manner. We recommend a budget be allocated for undercutting on the order of 20 to 25 percent, with the percentage increasing as the subgrade is exposed to precipitation. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts.

To minimize subgrade instability and undercuts, we recommend the exposed subgrade not be left exposed to precipitation and construction operations be performed during the summer months to ensure dry, warm, weather. Additionally, the subgrade may become unstable under repeated loading of construction traffic; therefore, construction equipment should be limited on the exposed subgrade.

All engineered fill should be compacted to a density of at least 95 percent of the maximum density determined by the Modified Proctor (ASTM D1557) method of testing. Lift thicknesses should not exceed 9 inches. All engineered fill material should be placed and compacted at approximately the optimum moisture content. Frozen material should not be used as fill, nor should fill be placed on a frozen subgrade.

Pavement Design

We performed pavement design analyses in accordance with the “AASHTO Guide for Design of Pavement Structures”. The subgrade soils will generally consist of aggregate base and granular native and fill soils which are considered good for support of pavements. Based on the existing granular subgrade soils, we have provided design pavement sections based on an effective subgrade resilient modulus of 8,000 pounds per square inch (psi).

We anticipate traffic for the lots and access drives will generally consists of cars, delivery trucks, and garbage trucks and the play surface will be predominantly pedestrian traffic and light snow plowing equipment. If any actual traffic volume information becomes available, G2 should be notified so we can reevaluate our recommendations. We have designed the standard-duty pavement section on an estimated 50,000 equivalent single-axle loads (ESALs) over a 20-year design life and the heavy-duty pavement section on an estimated 150,000 ESALs. For evaluation purposes, we have utilized a serviceability loss of 2.0, a standard deviation of 0.49 for flexible pavements, and a reliability factor of 0.90. If additional traffic volume information becomes available, G2 should be notified so we can re-evaluate our recommendations. Based on the results of our analysis, we recommend the following pavement design cross sections:

Standard-Duty Flexible Pavement Section		
Material	**Thickness**	**Structural Coefficient**
Bituminous Wearing Course (MDOT 5EML)	2 inches	0.42
Bituminous Leveling Course (MDOT 4EML)	2 inches	0.42
Existing 22A Natural Aggregate or MDOT 21AA Dense Graded Aggregate	8 inches	0.14

Heavy-Duty Flexible Pavement Section		
Material	**Thickness**	**Structural Coefficient**
Bituminous Wearing Course (MDOT 5EML)	2 inches	0.42
Bituminous Leveling Course (MDOT 3EML)	3 inches	0.42
Existing 22A Natural Aggregate or MDOT 21AA Dense Graded Aggregate	10 inches	0.14

Large front-loading refuse trucks can impose significant concentrated wheel loads at trash dumpster pick-up areas. This type of loading can result in rutting of asphalt pavements and ultimately in failure. Therefore, we recommend 8 inches of Portland cement concrete pavement be used in this area and be large enough to accommodate the entire truck during pick-up operations.

All pavement materials are specified within the 2012 Standard Specifications for Construction from the Michigan Department of Transportation. The aggregate materials for the subbase are described in Section 902. The bituminous pavement materials are described in Section 501 and can be assigned a structural coefficient number of 0.42. The existing 22A natural aggregate base can be assigned a structural coefficient number of 0.12, and any imported MDOT 21AA dense graded aggregate base material can be assigned a structural coefficient number of 0.14. We recommend all bituminous concrete materials have a binder from RAP less than 17 percent of the total binder and using a binder of PG 64-22.

Pavement Drainage

Proper pavement drainage is essential for long-term pavement performance. The pavement should be properly sloped to promote effective surface drainage and prevent water from ponding. We also recommend pavement subbase materials consist of non-frost-susceptible aggregates where possible.

Pavement Maintenance

Regular timely maintenance should be performed on the pavement to reduce the potential deterioration associated with moisture infiltration through surface cracks. The owner should be prepared to seal the cracks with a hot-applied elastic crack filler as soon as possible after cracking develops and as often as necessary to block the passage of water to the subgrade soils.

GENERAL COMMENTS

We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention for review and evaluation with respect to the prevailing subsurface conditions.

The scope of the present investigation was limited to evaluation of subsurface conditions for the construction of the proposed pavement reconstruction and other related aspects of the proposed project. No chemical, environmental, or hydrogeological testing or analysis were included in the scope of this investigation. If changes occur in the design, location, or concept of the project, the conclusions and recommendations contained in this report are not valid unless G2 Consulting Group, LLC reviews the changes. G2 Consulting Group, LLC will then confirm the recommendations presented herein or make changes in writing.

We have based the analyses and recommendations submitted in this report upon the data from soil borings performed at the approximate locations shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring locations. The nature and extent of any such variations may not become clear until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate our report recommendations.

Soil conditions at the site could vary from those generalized on the basis of soil borings made at specific locations. It is, therefore, recommended that G2 Consulting Group, LLC be retained to provide soil engineering services during the water main and roadway construction phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations. Also, this allows design changes to be made in the event that subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-1**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/2 inches) 0.3		AS-1				
		Natural Aggregate Base: Brown Sand and Gravel with trace silt (16 1/2 inches) 1.7						
		Buried Topsoil: Medium Compact Dark Brown Silty Sand (Organic Matter Content = 5.2%) 2.5		AS-2	12			
		Medium Compact Brown Sandy Gravel with trace silt 4.0		AS-3	27			
5		End of Boring @ 4 ft, Auger Refusal	5					

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion

Notes:
Auger Refusal Encountered at 2-1/2 feet

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 1

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	DESCRIPTION	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
0.3	Bituminous Concrete (3 inches)					
0.6	Natural Aggregate Base Brown Sand and Gravel with trace silt (4 inches)	AS-1				
1.5	Brown Sand with trace silt and gravel					
3.0	Medium Compact Brown Sandy Gravel with trace silt	AS-2	23			
4.0	Medium Compact Brown Sand with trace silt and gravel	AS-3	12			
	End of Boring @ 4 ft, Auger Refusal					
5						

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion

Notes:
Auger Refusal Encountered at 2 feet

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-3**

CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3 inches)	0.3	AS-1				
		Natural Aggregate Base Brown Sand and Gravel with trace silt (21 inches)	2.0	AS-2	11			
		Fill: Medium Compact Brown Silty Sand with trace gravel, occasional clay clods	2.7					
		Buried Topsoil: Loose Dark Brown Silty Sand (Organic Matter Content = 5.8%)	3.5					
		Medium Compact Gray Silty Sand with trace gravel	4.0	AS-3	15			
		End of Boring @ 4 ft						
5			5					

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Figure No. 3

PAVEMENT CORE DCP 230716.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 9/28/23

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-4**

G2 CONSULTING GROUP

DEPTH (ft)	PRO-FILE	SUBSURFACE PROFILE — GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/2 inches)	0.3	AS-1				
		Natural Aggregate Base Brown Sand and Gravel with trace silt (16-1/2 inches)	1.7					
		Buried Topsoil: Loose Dark Brown Silty Sand (Organic Matter Content = 10.0%)	2.0	AS-2	7			
		Medium Compact Brown and Gray Silty Sand with trace gravel	4.0	AS-3	16			
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Figure No. 4

PAVEMENT CORE DCP 230716.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 9/28/23

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-5**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/4 inches) 0.3						
		Natural Aggregate Base Brown Sand and Gravel with trace silt (3-3/4 inches) 0.6		AS-1				
		Medium Compact Brown and Gray Sand with trace silt and gravel		AS-2	14			
		4.0		AS-3	11			
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-6**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (5 inches)	0.4					
		Fill: Loose Brown Silty Sand with trace gravel, occasional clay clods	2.0	AS-1	10	15.9		
		Medium Compact Brown and Gray Sand with trace silt and gravel	4.0	AS-2	16			
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-7**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/4 inches)	0.3					
		Natural Aggregate Base Brown Sand and Gravel with trace silt (5-3/4 inches)	0.8	AS-1				
		Medium Compact Brown Silty Sand with trace gravel	1.5	AS-2	16			
		Medium Compact Brown and Gray Silty Sand with trace gravel	4.0	AS-3	15			
		End of Boring @ 4 ft						
5			5					

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No. 230716

Latitude: N/A Longitude: N/A

Soil Boring No. **B-8**

G2 CONSULTING GROUP

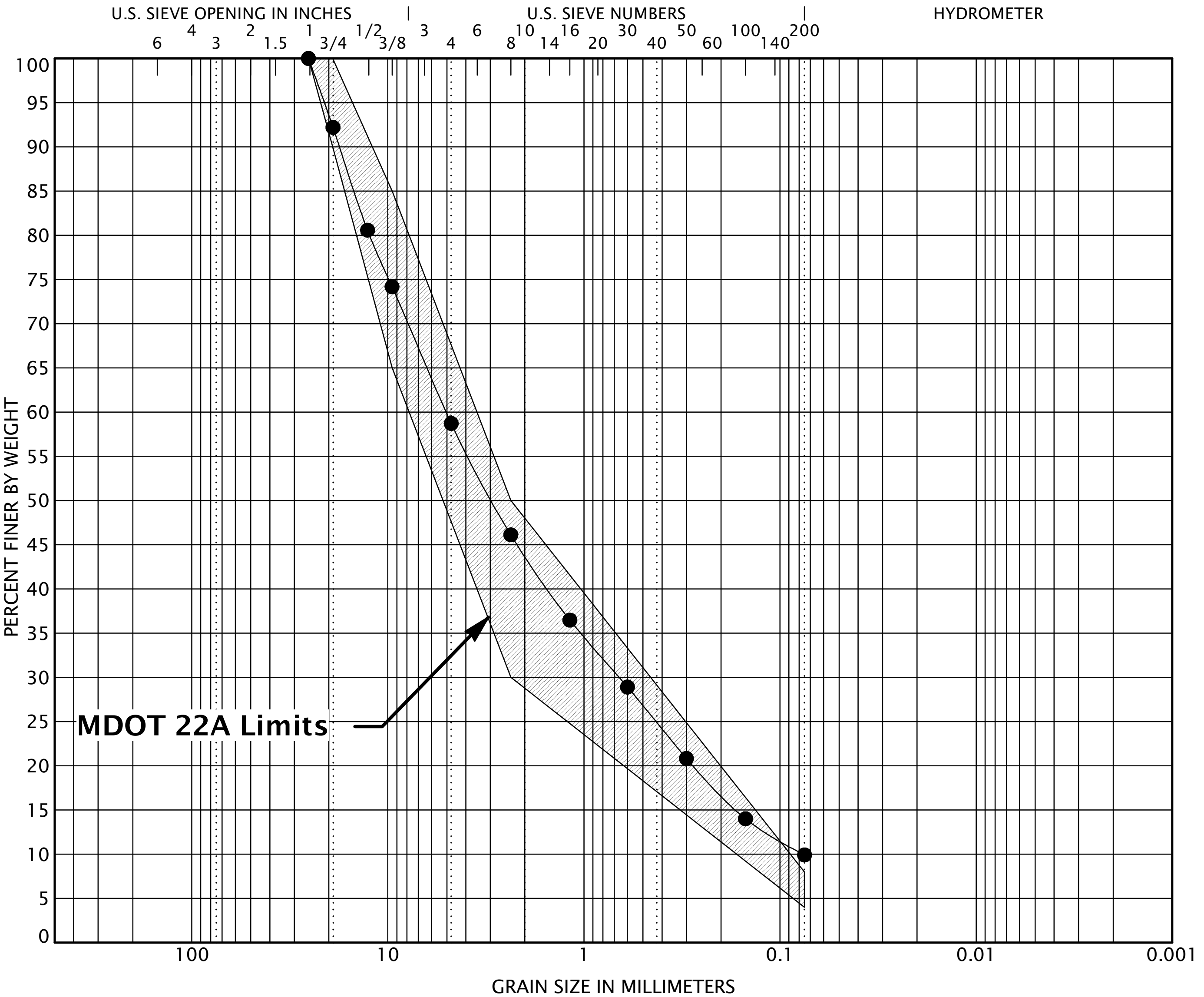
SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4-1/4 inches) — 0.4						
		Fill: Medium Compact Brown and Dark Brown Silty Sand with trace gravel — 1.5						
		Medium Compact Brown and Gray Silty Sand with trace gravel — 4.0		AS-1	13			
				AS-2	18			
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: August 26, 2023
Inspector:
Contractor: G2 Consulting Group LLC
Driller: A. Nolan

Water Level Observation:
Dry during and upon completion

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen ID	Description	LL	PL	PI	Cc	Cu
● B-2 AS-1	Brown Sand and Gravel with trace silt				1.14	66.09

Specimen ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-2 AS-1	25.4	5.033	0.662	0.076	41.3	48.8	9.9	

G2 CONSULTING GROUP

GRAIN SIZE DISTRIBUTION

Project Name: Morse Elementary School

Project Location: 475 Cherry Avenue
Troy, Michigan 48083

G2 Project No.: 230716

Figure No. 9

US_GRAIN_SIZE_MDOT_22A 230716.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 9/28/23

GENERAL NOTES TERMINOLOGY

Unless otherwise noted, all terms herein refer to the Standard Definitions presented in ASTM 653.

PARTICLE SIZE

Boulders		- greater than 12 inches
Cobbles		- 3 inches to 12 inches
Gravel	- Coarse	- 3/4 inches to 3 inches
	- Fine	- No. 4 to 3/4 inches
Sand	- Coarse	- No. 10 to No. 4
	- Medium	- No. 40 to No. 10
	- Fine	- No. 200 to No. 40
Silt		- 0.005mm to 0.074mm
Clay		- Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e. clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituent (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35%	Little - 12 to 23%
And - over 35%	Some - 23 to 33%

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier, i.e. sandy clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils, i.e. silty clay, trace sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Approximate Range of (N)
Very Soft	Below 500	0 - 2
Soft	500 - 1,000	3 - 4
Medium	1,000 - 2,000	5 - 8
Stiff	2,000 - 4,000	9 - 15
Very Stiff	4,000 - 8,000	16 - 30
Hard	8,000 - 16,000	31 - 50
Very Hard	Over 16,000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 - 50
Very Compact	86 - 100	Over 50

Relative Density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

AS - Auger Sample – Cuttings directly from auger flight
BS - Bottle or Bag Samples
S - Split Spoon Sample - ASTM D 1586
LS - Liner Sample with liner insert 3 inches in length
ST - Shelby Tube sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted

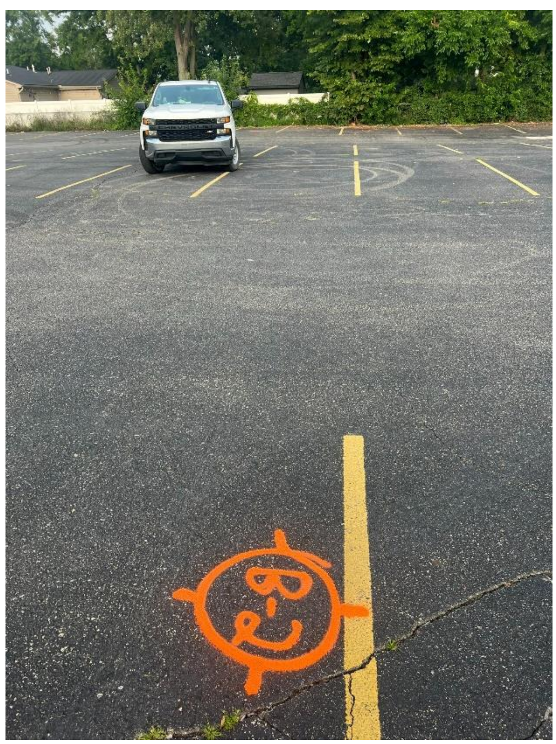
STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0 inch outside-diameter, 1-3/8 inch inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

Photographic Documentation
Morse Elementary School
Troy, Michigan
G2 Project No. 230716

Photograph No. 1: Looking north, low to moderate severity block, joint, and fatigue cracking. Concrete collar around basin.

Photograph No. 2: Low to moderate severity fatigue cracking. Note previous patch.

Photograph No. 3: Looking south, low to moderate severity block and fatigue cracking.



Photograph No. 4: Low to moderate severity block and fatigue cracking.

Photographic Documentation
Morse Elementary School
Troy, Michigan
G2 Project No. 230716

Photograph No. 5: Moderate to high severity fatigue cracking through center of drive lane, looking east.

Photograph No. 6: Looking south toward entrance, erosion from west edge of pavement indicating sheet draining to lot.

Photograph No. 7: Moderate severity fatigue cracking looking east.

Photograph No. 8: Moderate to high severity fatigue cracking looking south.

Photographic Documentation
Morse Elementary School
Troy, Michigan
G2 Project No. 230716

Photograph No. 9: Low to moderate severity fatigue cracking looking west.

Photograph No. 10: Low severity fatigue cracking looking north playground. New concrete to the east adjacent to the school.

Photographic Documentation
Morse Elementary School
Troy, Michigan
G2 Project No. 230716

Photograph No. 11: Moderate to high severity fatigue cracking and settlement evident.

Photograph No. 12: Looking south. Pavement is flush to building.
Previous patch and crack sealing visible.

Photographic Documentation
Morse Elementary School
Troy, Michigan
G2 Project No. 230716

Photograph No. 13: Moderate severity cracking with previous crack sealing.

Photograph No. 14: Pavement flush to grass looking east.

Photographic Documentation
Morse Elementary School
Troy, Michigan
G2 Project No. 230716

Photograph No. 15: Pavement flush to building. Moderate to high severity cracking.

Report on Geotechnical
Pavement Investigation

Service and Administration Access Drive 4400 Livernois Road Troy, Michigan 48098

Latitude 42.584159° N
Longitude 83.145632° W

Prepared for:

Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

G2 Project No. 220979
September 26, 2023

g2consultinggroup.com

Headquarters	1866 Woodslee St	Troy, MI 48083	P 248.680.0400	F 248.680.9745
Ann Arbor	1350 Eisenhower Pl	Ann Arbor, MI 48108	P 734.390.9330	F 734.390.9331
Chicagoland	1186 Heather Dr	Lake Zurich, IL 60047	P 847.353.8740	F 847.353.8742

September 26, 2023

Ms. Michelle Kerns
Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

Re: Report of Geotechnical Pavement Investigation
Service and Administration Access Drive
4400 Livernois Road
Troy, Michigan 48098
G2 Project No. 220979

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the access drive at the Troy Schools Service and Administration property in the City of Troy, Michigan. This report presents the results of our observations and analyses and our recommendations for pavement design and construction considerations as they relate to the geotechnical conditions along the alignment of the proposed pavement rehabilitation/reconstruction.

As always, we appreciate the opportunity to be of service to Lecole Planners, LLC and Troy School District and look forward to discussing the recommendations presented. In the meantime, if you have any questions regarding this report or any other matter pertaining to the project, please let us know.

Sincerely,

G2 Consulting Group, LLC

Amy L. Schneider, P.E
Project Manager

Noel J. Hargrave-Thomas, P.E.
Principal

ALS/NJHT/ljv

Enclosures

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EXECUTIVE SUMMARY,

We understand the project consists of rehabilitation/reconstruction of the access drive at the Troy Schools Service and Administration property in Troy, Michigan. Bituminous curb currently surrounds the existing pavements, which we anticipate will be removed. We anticipate a 2-foot-wide gravel shoulder will be constructed along both sides of the drive, to match the adjacent new drive to the east (based on plans prepared by PEA Group, Drawing No. C-2.8, dated January 1, 2022).

We anticipate traffic will consist primarily of passenger cars with occasional delivery trucks and garbage trucks. The age of the existing pavements was not available upon completion of this report. However, after reviewing Google Earth Historical imagery, it appears the pavements are upwards of 15 years old.

The existing pavements consist of bituminous concrete measuring 3 to 3-1/4 inches in thickness. Approximately 8-3/4 to 10 inches of crushed concrete aggregate base underlie the bituminous concrete surface. Stiff silty clay is present below the aggregate at borings B-1 and B-2 and extends to approximate depths of 1-1/2 and 1-3/4 feet. Loose silty sand underlies the silty clay and extends to approximate depths ranging from 3 to 4 feet. Stiff silty clay is present below the silty sand and pavement section within boring B-2 and extends to the explored depth of 5 feet. Groundwater was encountered at an approximate depth of 2 to 3 feet during drilling operations at borings B-1 and B-3. Upon completion of drilling at these borings, groundwater was measured at an approximate depth of 3 to 4 feet. No measurable groundwater was observed during or upon completion of drilling operations within boring B-2.

The existing pavements are overall in relatively good condition with less than half of the pavement exhibiting low to moderate severity fatigue cracking. The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the thin nature of the existing bituminous concrete. The crushed concrete aggregate base is slightly out of specification of MDOT 21AA; however, considering the historically good performance of the pavement, we recommend the crushed concrete remain in place for support of the design bituminous concrete section. Therefore, we recommend completely removing the bituminous surface, fine grading the existing crushed concrete aggregate base to accommodate the design pavement section, evaluating the exposed subgrade for stability, performing any undercuts, if necessary, then constructing the new bituminous concrete section atop the existing crushed concrete aggregate base.

The exposed aggregate base should be proof compacted using a heavy vibratory roller. Unsuitable soils or soils exhibiting excessive instability should be removed by undercutting to expose stable soils. We recommend a budget be allocated for undercutting (on the order of 10 to 15 percent of the pavement area), with the percentage increasing as the subgrade is exposed to precipitation. To minimize subgrade instability and undercuts, we recommend the exposed subgrade not be left exposed to precipitation and construction operations be performed during the summer months to ensure dry, warm, weather. Additionally, the subgrade may become unstable under repeated loading of construction traffic; therefore, construction equipment should be limited on the exposed subgrade.

Based on the results of our analyses, we recommend a standard-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course, supported on the existing aggregate base or a minimum of 8 inches of imported MDOT 21AA dense graded aggregate base with undercut areas. We further recommend all bituminous concrete materials have a binder from Recycled Aggregate Product (RAP) less than 17 percent of the total binder and using a binder of PG 64-22.

This summary is not to be considered separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

PROJECT DESCRIPTION

We understand the project consists of rehabilitation/reconstruction of the access drive at the Troy Schools Service and Administration property in Troy, Michigan. Bituminous curb currently surrounds the existing pavements, which we anticipate will be removed. We anticipate a 2-foot-wide gravel shoulder will be constructed along both sides of the drive, to match the adjacent new drive to the east (based on plans prepared by PEA Group, Drawing No. C-2.8, dated January 1, 2022).

We anticipate traffic for the pavement associated with this investigation will consist primarily of passenger cars with occasional delivery trucks and garbage trucks. The age of the existing pavements was not available upon completion of this report. However, after reviewing Google Earth Historical imagery, it appears the pavements are upwards of 15 years old.

The purpose of our investigation is to determine and evaluate the general pavement and subsurface conditions within existing pavements and develop general recommendations for the proposed pavement rehabilitation/reconstruction and pavement design.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of geotechnical engineering in this area. Our scope of services for this project is as follows:

1. We drilled three pavement core/hand auger soil borings within the access drive extending to a depth of 4 feet each below existing grade. We measured the existing pavement section materials (bituminous concrete) and identified the type and condition of subgrade soils.

2. We performed laboratory testing on samples obtained from the soil borings. Laboratory testing included visual engineering classification, moisture content, grain size distribution, and unconfined compressive strength determination.

3. We prepared this engineering report which includes our evaluation of the subsurface conditions at the site and our recommendations for pavement rehabilitation/reconstruction.

FIELD OPERATIONS

G2 Consulting Group, LLC (G2), selected the number, depth, and location of the soil borings. The soil borings were located in the field by a G2 representative by use of GPS assisted mobile technology in conjunction with conventional taping methods. The approximate soil boring locations are presented on the Soil Boring Location Plan, Plate No. 1. No ground surface elevations were available at the time of this investigation.

We used a gas-powered core rig equipped with a 4-inch diameter diamond-tipped core barrel to core the pavement locations. Pavement cores were drilled through the full depth of the existing pavement structure to obtain an accurate determination of the pavement thickness.

Hand auger borings were performed using a 3-inch diameter hand auger. Within each hand-auger boring, soil samples were obtained at depths of 2-1/2 and 5 feet and at transitions in soil types. The soil samples were placed in sealed containers in the field and brought to the laboratory for testing and classification. A Dynamic Cone Penetrometer (DCP) test was performed within each hand auger boring at depths of 2-1/2 feet and 5 feet to evaluate the consistency of the in-situ soil. DCP testing involves driving a 1-1/2 inch diameter cone with a 45˚ vertex angle into the ground using a 15-pound weight dropped 20 inches after the cone is seated into the bottom of the hand auger borehole. The Dynamic Cone Penetrometer is driven successive 1-3/4 increments. The blow counts for each 1-3/4 inch increment are presented on the individual hand-auger soil boring logs.

During drilling operations, a G2 engineer maintained logs of the encountered subsurface conditions, including changes in stratigraphy and observed groundwater levels to be used in conjunction with our analysis of the subsurface conditions. The final hand-auger boring logs are based on the field logs and laboratory soil classification and testing. After completion of boring operations, the boreholes were backfilled with excavated soil and capped with cold patch.

LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine soil parameters pertinent to pavement design and site preparation. An experienced geotechnical engineer classified the samples in general conformance with the Unified Soil Classification System.

Laboratory testing included natural moisture content, grain-size distribution, and unconfined compressive strength determinations. The grain-size distributions were determined in general accordance with ASTM D422, "Standard Test Method for Particle-Size Analysis of Soils". The unconfined compressive strengths were determined by using a spring-loaded hand penetrometer. The hand penetrometer estimates the unconfined compressive strength to a maximum of 4-1/2 tons per square foot (tsf) by measuring the resistance of the soil sample to the penetration of a calibrated spring-loaded cylinder.

The results of the moisture content and unconfined compressive strength laboratory tests are indicated on the soil boring logs at the depths the samples were obtained. Grain size results are presented graphically on Figure No. 4 within the Appendix. We will hold the soil samples for 60 days from the date of this report. If you would like the samples, please let us know.

EXISTING PAVEMENT CONDITIONS

The existing pavements consist of bituminous concrete measuring 3 to 3-1/4 inches in thickness. Approximately 8-3/4 to 10 inches of crushed concrete aggregate base underlie the bituminous concrete surface. A grain size analysis was performed on a representative sample of the limestone aggregate base obtained from boring B-1. Test results indicate the aggregate base does *not* meet the graduation requirements of MDOT 21AA as graphically presented on Figure No. 4 in the Appendix. The MDOT 21AA gradation specifications and sieve analysis results are also presented below. The values in bold indicate the material is out of specification.

Sieve Size	MDOT21AA Percent Passing Specification	B-1 Aggregate Base Percent Passing
1-1/2"	100	100
1"	85 to 100	100
1/2"	50 to 75	**90**
No. 8	20 to 45	**47**
Loss by Wash	4 to 8	**10**
Meets 21AA Gradation		**No**

The crushed concrete is only slightly out of specification and appears to have provided relatively good support for the existing pavement based on the current condition. Therefore, the existing crushed concrete can be reused for the new pavement section or within any undercuts.

The pavements are bituminous concrete with a bituminous concrete curb present along the north and south alignment. The pavement surface is in relatively good condition with less than half the pavement exhibiting low severity cracking (Photograph Nos. 1 and 3). Areas of moderate severity cracking and previous patching are present near boring B-2 going west (Photograph Nos. 4 through 6). The curb is also in fair condition with cracking and distress (Photograph No. 1). The pavement appears to be designed to drain to the south side of the drive and then along the curb to the west and east.

Additionally, an open area of the curb is present east of B-2 which allows water to drain to a nearby swale (Photograph No. 4).

EXISTING SUBSURFACE CONDITIONS

Silty clay is present below the aggregate base at borings B-1 and B-2 and extends to approximate depths of 1-1/2 and 1-3/4 feet. Silty sand underlies the silty clay and pavement section within B-3 and extends to approximate depths ranging from 3 to 4 feet. Silty clay is present below the silty sand and extends to the explored depth of 5 feet. The silty sand is loose in compactness with Dynamic Cone Penetrometer (DCP) Test N-values ranging from 8 to 10 blows per 1-3/4 inch drive. The upper and lower silty clay is stiff in consistency with natural moisture contents ranging from 19 to 20 percent and unconfined compressive strengths ranging from 3,000 to 3,500 psf.

The stratification depths shown on the soil boring logs represent the soil conditions at the boring locations. Variations may occur between borings. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transition may be more gradual than what is shown. We have prepared the boring logs on the basis of laboratory classification and testing as well as field logs of the soils encountered.

The Soil Boring Location Plan, Plate No. 1, Soil Boring Logs, Figure Nos. 1 through 3, and Grain Size Distribution, Figure No. 4, are presented in the Appendix. The soil profiles described above are generalized descriptions of the soil conditions at the boring locations. General Notes Terminology defining the nomenclature used on the boring logs and elsewhere in this report is presented on Figure No. 5.

GROUNDWATER CONDITIONS

Groundwater was encountered at an approximate depth of 3 feet during drilling operations at borings B-1 and B-3. Upon completion of drilling at these borings, groundwater was measured at an approximate depth of 4 feet. No measurable groundwater was observed during or upon completion of drilling operations within boring B-2.

Fluctuations in perched and long-term groundwater levels should be anticipated due to seasonal variations and following periods of prolonged precipitation. It should also be noted that groundwater observations made during drilling operations in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the low permeability of such soils and the tendency of drilling operations to seal off the natural paths of groundwater flow.

PAVEMENT EVALUATION AND RECOMMENDATIONS

General

The existing pavements are overall in relatively good condition with less than half of the pavement exhibiting low to moderate severity fatigue cracking. The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the thin nature of the existing bituminous concrete. Therefore, we recommend completely removing the bituminous surface, fine grading the existing crushed concrete aggregate base to accommodate the design pavement section, evaluating the exposed subgrade for stability, performing any undercuts, if necessary, then constructing the new bituminous concrete section atop the existing crushed concrete aggregate base.

Pavement Subgrade Preparation

The existing bituminous concrete must be completely removed. The crushed concrete aggregate base should be graded to accommodate the design bituminous concrete section. Following grading, the exposed crushed concrete should be proof compacted using a heavy vibratory roller. During proof roll operations, the crushed concrete underlain by predominantly stiff silty clay fill should be evaluated for stability. Unsuitable soils or soils exhibiting excessive instability should be undercut to expose stable soils.

We recommend a budget be allocated for undercutting (on the order of 10 to 15 percent of the drive alignment), with the percentage increasing as the subgrade is exposed to precipitation. To minimize subgrade instability and undercuts, we recommend the exposed subgrade not be left exposed to precipitation and construction operations be performed during the summer months to ensure dry, warm, weather. Additionally, the subgrade may become unstable under repeated loading of construction traffic; therefore, construction equipment should be limited on the exposed aggregate base / subgrade.

Subgrade undercuts, if required, should be evaluated by a qualified engineering technician to determine if subgrade stabilization is necessary. We recommend undercut excavations, where required, be backfilled with MDOT 21AA dense graded aggregate or stockpiled crushed concrete aggregate base placed in an engineered manner. Lift thicknesses should not exceed 9 inches. The contractor should be prepared to use tri-axial geogrid to minimize undercut depths, if needed. Undercuts and use of geogrid should be evaluated by a G2 engineer or qualified personnel.

All engineered fill should be compacted to a density of at least 95 percent of the maximum density determined by the Modified Proctor (ASTM D1557) method of testing. All engineered fill material should be placed and compacted at approximately the optimum moisture content. Frozen material should not be used as fill, nor should fill be placed on a frozen subgrade.

Pavement Design

We performed pavement design analyses in accordance with the "AASHTO Guide for Design of Pavement Structures". The subgrade soils will consist of stiff silty clay fill and loose silty sand which are considered fair for support of pavements. Based on the existing subgrade soils, we have provided design pavement sections based on an effective subgrade resilient modulus of 7,000 pounds per square inch (psi).

We anticipate traffic for the access drive associated with this investigation will consist primarily of passenger cars with occasional delivery trucks and garbage trucks. If any actual traffic volume information becomes available, G2 should be notified so we can reevaluate our recommendations. We have designed the standard-duty pavement section on an estimated of 75,000 18-kip equivalent single-axle loads (ESALs) over a 20-year design life, in consideration of assumed garbage trucks and delivery trucks. For evaluation purposes, we have utilized a serviceability loss of 2.0, a standard deviation of 0.49 for flexible pavements, and a reliability factor of 0.90.

Based on the results of our analyses, we recommend a standard-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course, supported on the existing crushed concrete aggregate base or a minimum of 8 inches of imported MDOT 21AA dense graded aggregate base.

All pavement materials are specified within the 2012 Standard Specifications for Construction from the Michigan Department of Transportation. The aggregate materials for the subbase are described in Section 902. The bituminous pavement materials are described in Section 501 and can be assigned a structural coefficient number of 0.42. Imported MDOT 21AA dense graded aggregate base material can be assigned a structural coefficient number of 0.14 and the crushed concrete can be assigned a structural coefficient number of 0.12. We recommend all bituminous concrete materials have a binder from RAP less than 17 percent of the total binder and using a binder of PG 64-22.

Pavement Drainage

Proper pavement drainage is essential for cohesive subgrade soils due to their relatively impermeable nature. The pavement and crushed concrete aggregate base should be properly sloped to promote effective surface drainage and prevent water from ponding, especially as pavements age and water infiltrates the surface. We also recommend pavement subbase materials consist of non-frost-susceptible aggregates where possible. The aggregate shoulder should also be sloped away from the pavement to allow surface run off to drain beyond the shoulder and pavement edge.

Pavement Maintenance

Regular timely maintenance should be performed on the pavement to reduce the potential deterioration associated with moisture infiltration through surface cracks. The owner should be prepared to seal the cracks with a hot-applied elastic crack filler as soon as possible after cracking develops and as often as necessary to block the passage of water to the subgrade soils.

GENERAL COMMENTS

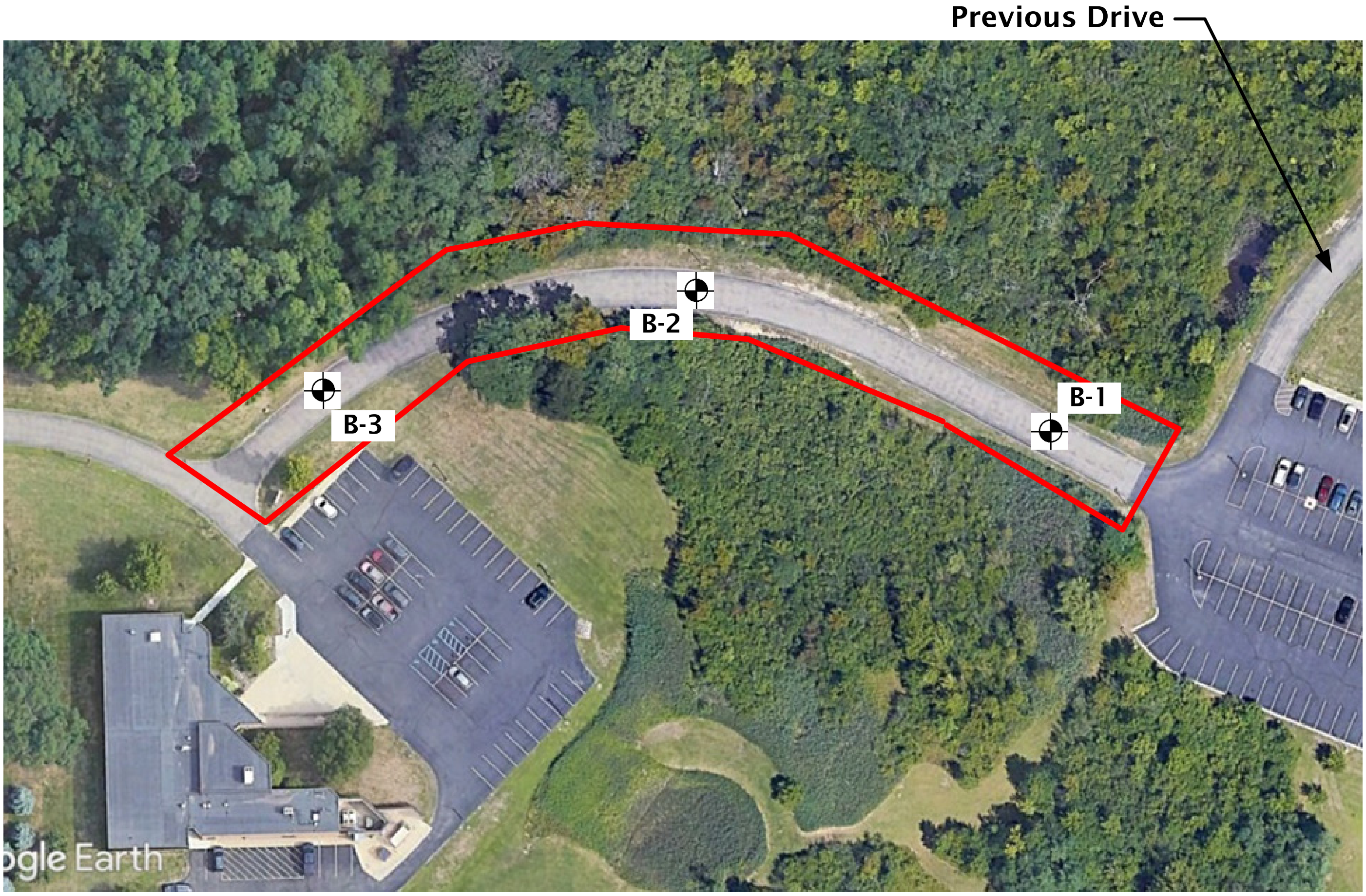
We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention for review and evaluation with respect to the prevailing subsurface conditions.

The scope of the present investigation was limited to evaluation of subsurface conditions for the construction of the proposed pavement reconstruction and other related aspects of the proposed project. No chemical, environmental, or hydrogeological testing or analysis were included in the scope of this investigation. If changes occur in the design, location, or concept of the project, the conclusions and recommendations contained in this report are not valid unless G2 Consulting Group, LLC reviews the changes. G2 Consulting Group, LLC will then confirm the recommendations presented herein or make changes in writing.

We have based the analyses and recommendations submitted in this report upon the data from soil borings performed at the approximate locations shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring locations. The nature and extent of any such variations may not become clear until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate our report recommendations.

Soil conditions at the site could vary from those generalized on the basis of soil borings made at specific locations. It is, therefore, recommended that G2 Consulting Group, LLC be retained to provide soil engineering services during the water main and roadway construction phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations. Also, this allows design changes to be made in the event that subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX



Legend

Soil Borings Drilled by G2 Consulting Group, LLC on August 29, 2023

Soil Boring Location Plan

Service and Administration Access Drive
4400 Livernois Road
Troy, Michigan 48098

G2 CONSULTING GROUP

Project No. 220979	
Drawn by: ALS	
Date: 9/25/23	Plate No. 1
Scale: NTS	

Project Name: Service and Administration Access Drive

Project Location: 4400 Livernois Road
Troy, Michigan 48098

G2 Project No. 220979

Latitude: N/A   Longitude: N/A

Soil Boring No. **B-1**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3 inches) — 0.3						
		Crushed Concrete Aggregate Base: Gray Gravelly Sand with trace silt (9 inches) — 1.0		AS-1				
		Fill: Stiff Brown Clay with trace sand and gravel — 1.5						
		Loose Brown Silty Sand with trace clay and gravel — 3.0		AS-2	10			
5		Stiff Brown and Gray Clay with trace sand and gravel — 5.0	5	AS-3	10	20.2		3000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: August 29, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Water Level Observation:
3 feet during drilling; 4 feet upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 1

Project Name: Service and Administration Access Drive

Project Location: 4400 Livernois Road
Troy, Michigan 48098

G2 Project No. 220979

Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3 inches) 0.3						
		Crushed Concrete Aggregate Base: Gray Gravelly Sand with trace silt (8-3/4 inches) 1.0		AS-1				
		Fill: Stiff Brown Clay with trace sand and gravel 1.8						
		Loose Brown Silty Sand with trace clay and gravel 4.0		AS-2	8			
5		Stiff Brown and Gray Clay with trace sand and gravel 5.0	5	AS-3	10	19.3		3000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: August 29, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Service and Administration Access Drive

Project Location: 4400 Livernois Road
Troy, Michigan 48098

G2 Project No. 220979

Latitude: N/A Longitude: N/A

Soil Boring No. **B-3**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (3-1/4 inches) 0.3						
		Crushed Concrete Aggregate Base: Gray Gravelly Sand with trace silt (10 inches) 1.1		AS-1				
		Loose Brown Silty Sand with trace clay gravel 3.5		AS-2	9			
5		Stiff Brown and Gray Clay with trace sand and gravel 5.0	5	AS-3	12	19.8		3500*
		End of Boring @ 5 ft						

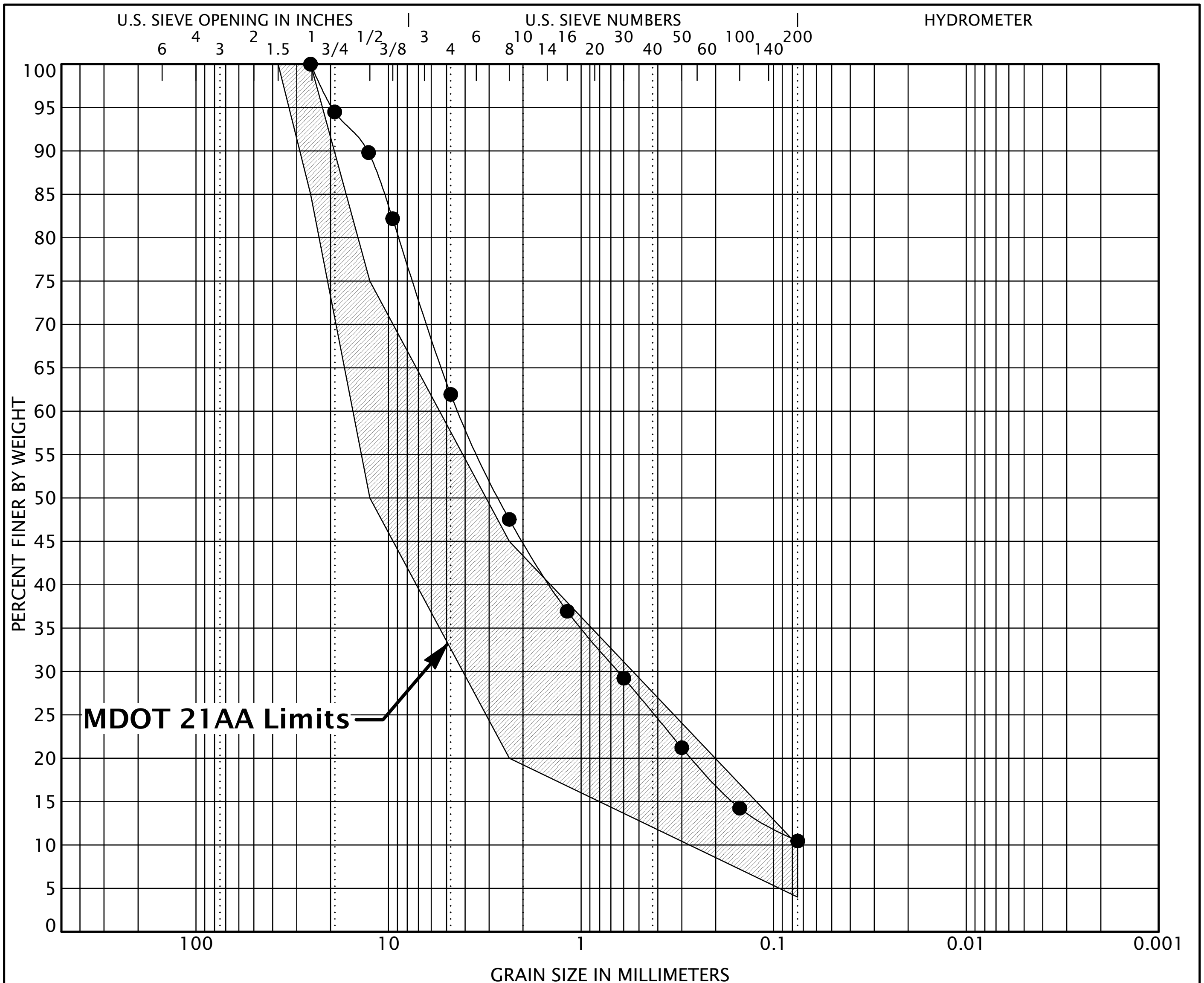
Total Depth: 5 ft
Drilling Date: August 29, 2023
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Water Level Observation:
2 feet during drilling; 3 feet upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID		Description	LL	PL	PI	Cc	Cu
●	B-1	AS-1	Gray Gravelly Sand with trace silt				1.38	62.68

	Specimen ID		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	AS-1	25.4	4.323	0.642		38.1	51.5	10.5	

GRAIN SIZE DISTRIBUTION

CONSULTING GROUP

Project Name: Service and Administration Access Drive

Project Location: 4400 Livernois Road
Troy, Michigan 48098

G2 Project No.: 220979

Figure No. 4

US_GRAIN_SIZE_MDOT_21AA 220979.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 9/27/23

GENERAL NOTES TERMINOLOGY

Unless otherwise noted, all terms herein refer to the Standard Definitions presented in ASTM 653.

PARTICLE SIZE

Boulders		- greater than 12 inches
Cobbles		- 3 inches to 12 inches
Gravel	- Coarse	- 3/4 inches to 3 inches
	- Fine	- No. 4 to 3/4 inches
Sand	- Coarse	- No. 10 to No. 4
	- Medium	- No. 40 to No. 10
	- Fine	- No. 200 to No. 40
Silt		- 0.005mm to 0.074mm
Clay		- Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e. clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituent (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35%	Little - 12 to 23%
And - over 35%	Some - 23 to 33%

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier, i.e. sandy clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils, i.e. silty clay, trace sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Approximate Range of (N)
Very Soft	Below 500	0 - 2
Soft	500 - 1,000	3 - 4
Medium	1,000 - 2,000	5 - 8
Stiff	2,000 - 4,000	9 - 15
Very Stiff	4,000 - 8,000	16 - 30
Hard	8,000 - 16,000	31 - 50
Very Hard	Over 16,000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 - 50
Very Compact	86 - 100	Over 50

Relative Density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

AS - Auger Sample – Cuttings directly from auger flight
BS - Bottle or Bag Samples
S - Split Spoon Sample - ASTM D 1586
LS - Liner Sample with liner insert 3 inches in length
ST - Shelby Tube sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted

STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0 inch outside-diameter, 1-3/8 inch inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

Photographic Documentation
Service and Administration Access Drive
Troy, Michigan
G2 Project No. 220979

Photograph No. 1: Looking west. Low to moderate severity fatigue and edge cracking. Broken curb line.

Photograph No. 2: Moderate severity edge cracking and previous patching along bituminous curb. Looking east.

Figure No. 6

Photographic Documentation
Service and Administration Access Drive
Troy, Michigan
G2 Project No. 220979

Photograph No. 3: Looking west. Low to moderate severity fatigue and edge cracking. Evidence of ponding along south curb line.

Photograph No. 4: Moderate severity fatigue cracking looking east toward B-2. Previous patching along curb line and center.

Photographic Documentation
Service and Administration Access Drive
Troy, Michigan
G2 Project No. 220979

Photograph No. 5: Moderate severity fatigue cracking and patch along north curb line, looking east toward B-3.

Photograph No. 6: Moderate severity block, joint, and fatigue cracking looking west toward drive entrance.

Report on Geotechnical
Pavement Investigation

Troy School District Transportation
120 Hart Avenue
Troy, Michigan 48083

Latitude 42.583871˚ N
Longitude 83.151547˚ W

Prepared for:

Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

G2 Project No. 230465
October 3, 2023

October 3, 2023

Ms. Michelle Kerns
Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

Re: Report of Geotechnical Pavement Investigation
Troy School District Transportation
120 Hart Avenue
Troy, Michigan 48083
G2 Project No. 230465

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Troy School District Transportation property in Troy, Michigan. This report presents the results of our observations and analyses and our recommendations for pavement design and construction considerations as they relate to the geotechnical conditions for the proposed pavement rehabilitation/reconstruction.

As always, we appreciate the opportunity to be of service to Lecole Planners, LLC and Troy School District and look forward to discussing the recommendations presented. In the meantime, if you have any questions regarding this report or any other matter pertaining to the project, please let us know.

Sincerely,

G2 Consulting Group, LLC

Amy L. Schneider, P.E
Project Manager

Noel J. Hargrave-Thomas, P.E.
Principal

ALS/NJHT/ljv

Enclosures

EXECUTIVE SUMMARY

We understand the project consists of rehabilitation/reconstruction of the access drives and pavements at the Transportation property in Troy, Michigan. Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic generally consists of buses in the main lot and cars in the west lot. Existing and proposed grades were not available at the time of this investigation. However, we estimate grades will be similar to existing.

The existing pavements consist of bituminous concrete measuring 5 to 7 inches in thickness. Approximately 6 to 7 inches of aggregate base underlie the bituminous concrete surface. Stiff sandy clay fill with 3-1/2 percent organic matter underlies the pavement section at boring B-1 and extends to an approximate depth of 3 feet. Loose silty sand fill with 1-1/2 percent organic matter is present below the pavement section at boring B-3 and extends to an approximate depth of 3 feet. Medium compact sand fill underlies the pavement section at boring B-7 and extends to the explored depth of 5 feet. Native very stiff to hard silty clay is present below the fill at borings B-1, B-3, and B-7 and pavement section at the remaining borings and extends to the explored depth of 5 feet. Groundwater was encountered during drilling operations at approximate depths of 3 and 4 feet at borings B-1 and B-7, respectively. No measurable groundwater was observed during or upon completion of drilling operations at the remaining boring locations.

The pavement in the main lot (borings B-1 through B-7) is in relatively good condition, exhibiting generally low severity block and fatigue with less frequent areas of moderate severity distress. In consideration of the historical performance of the pavements and suitable aggregate base thickness, we recommend milling the existing pavement 2 inches, performing full depth patching of heavily distressed areas, and placing a 2-inch overlay of MDOT 5E1 bituminous concrete wearing course across the entire area. We anticipate this option will provide little maintenance over the next 7 to 10 years. However, the district should understand some reflective cracking may appear within several years after construction. We recommend the bituminous concrete section within full depth patch areas match the removed pavement thickness and consist of MDOT 3E1 or 4E1 bituminous concrete leveling course.

The pavement in the west lot (borings B-8 and B-9) is in poor condition, exhibiting moderate to high severity fatigue cracking. In consideration of the anticipated car traffic, we recommend the existing bituminous concrete be completely removed, additional MDOT 21AA limestone aggregate base placed, and a new pavement section constructed atop the aggregate base. Based on the results of our analyses, we recommend a standard-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course supported on the existing aggregate base or a minimum of 8 inches of imported MDOT 21AA limestone dense graded aggregate base where undercuts are required. We further recommend all bituminous concrete materials have a binder from RAP less than 17 percent of the total binder and using a binder of PG 64-22.

We recommend a significant budget be allocated for undercutting in the main lot of 20 to 25 percent and in the west lot on the order of 25 to 30 percent of the total area, with the percentage increasing as the subgrade is exposed to precipitation. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts.

This summary is not to be considered separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

PROJECT DESCRIPTION

We understand the project consists of rehabilitation/reconstruction of the access drives and pavements at the Transportation property in Troy, Michigan. Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic generally consists of buses in the main lot and cars in the west lot. Existing and proposed grades were not available at the time of this investigation. However, we estimate grades will be similar to existing.

Google Earth Historical Aerial Photographs indicate construction of the main parking lot was completed prior to 1999, and it was expanded to the west between 1999 and 2002. In 2007, the lot was expanded to the west, a landscape island infilled, and a detention basin constructed, which was complete by 2010.

1999 Google Earth Image

2002 Google Earth Image

2007 Google Earth Image

2010 Google Earth Image

Between 2015 and 2017, concrete collars were constructed around a majority of the catch basins. In 2022, a patch at the west entrance was constructed which appears to be associated with the existing detention basin and the lot may have been seal coated.

The purpose of our investigation is to determine and evaluate the general pavement and subsurface conditions within existing pavements and develop general recommendations for the proposed pavement rehabilitation/reconstruction and pavement design.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of geotechnical engineering in this area. Our scope of services for this project is as follows:

1. We drilled a total of nine soil borings within the pavements extending to a depth of 5 feet each below existing grade. We measured the existing pavement section materials (bituminous concrete) and identified the type and condition of subgrade soils.

2. We performed laboratory testing on samples obtained from the soil borings. Laboratory testing included visual engineering classification, moisture content, grain size distribution, and unconfined compressive strength determinations.

3. We prepared this engineering report which includes our evaluation of the subsurface conditions at the site and our recommendations for pavement rehabilitation/reconstruction.

FIELD OPERATIONS

G2 Consulting Group, LLC (G2), selected the number depth and location of the soil borings. The soil borings were located in the field by a G2 representative by use of GPS assisted mobile technology in conjunction with conventional taping methods. The approximate soil boring locations are presented on the Soil Boring Location Plan, Plate No. 1. No ground surface elevations were available at the time of this investigation.

The soil borings were drilled using a truck-mounted rotary drilling rig. Continuous flight, 2-1/4-inch, inside diameter, hollow-stem augers were used to advance borings to the explored depth. Soil samples were obtained at intervals of 2-1/2 feet. These samples were obtained by the Standard Penetration Test method (ASTM D 1586), which involves driving a 2-inch diameter split-spoon sampler into the soil with a 140-pound weight falling 30 inches. The sampler is generally driven three successive 6-inch increments with the number of blows for each increment recorded. The number of blows required to advance the sampler the last 12 inches is termed the Standard Penetration Resistance (N). Blow counts for each 6-inch increment and the resulting N-values are presented on the individual soil boring logs.

During drilling operations, a G2 engineer maintained logs of the encountered subsurface conditions, including changes in stratigraphy and observed groundwater levels to be used in conjunction with our analysis of the subsurface conditions. The final hand-auger boring logs are based on the field logs and laboratory soil classification and testing. After completion of boring operations, the boreholes were backfilled with excavated soil and capped with cold patch.

LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine soil parameters pertinent to pavement design and site preparation. An experienced geotechnical engineer classified the samples in general conformance with the Unified Soil Classification System.

Laboratory testing included natural moisture content, grain size distribution, and unconfined compressive strength determinations. The grain-size distributions were determined in general accordance with ASTM D422, "Standard Test Method for Particle-Size Analysis of Soils". The unconfined compressive strengths were determined by using a spring-loaded hand penetrometer. The hand penetrometer estimates the unconfined compressive strength to a maximum of 4-1/2 tons per square foot (tsf) by measuring the resistance of the soil sample to the penetration of a calibrated spring-loaded cylinder.

The results of the moisture content and unconfined compressive strength laboratory tests are indicated on the soil boring logs at the depths the samples were obtained. Grain size distribution results are also presented graphically on Figure Nos. 10 and 11 in the Appendix. We will hold the soil samples for 60 days from the date of this report. If you would like the samples, please let us know.

EXISTING PAVEMENT CONDITIONS

The existing pavements consist of bituminous concrete measuring 5 to 7 inches in thickness. Approximately 6 to 7 inches of aggregate base underlie the bituminous concrete surface. Grain size analyses were performed on a representative sample of aggregate base from borings B-4, B-5, and B-7. Test results indicated the material out of specification for gradation requirements of MDOT22A and MDOT 21AA dense-graded aggregate base as presented on Figure Nos. 10 and 11 in the Appendix and in the table below. The values in bold indicate where the material is *out* of specification.

Sieve Size	MDOT 22A Percent Passing Specification	B-4 Aggregate Base Percent Passing	B-7 Aggregate Base Percent Passing
1”	100	100	100
3/4”	90 to 100	100	100
3/8”	65 to 85	**92**	**93**
No. 8	30 to 50	**60**	**60**
Loss by Wash	4 to 8	**10**	**5**
Meets 22A Gradation		No	No

Sieve Size	MDOT 21AA Percent Passing Specification	B-5 Aggregate Base Percent Passing
1-1/2”	100	100
1”	85 to 100	100
1/2”	50 to 75	**98**
No. 8	20 to 45	**61**
Loss by Wash	4 to 8	**26**
Meets 21AA Gradation		No

The main parking lot (borings B-1 through B-7) is in relatively good condition (Photograph Nos. 1 through 14). However, areas of low to moderate severity block and fatigue cracking (Photograph Nos. 2, 4, 8, and 13). The west lot is in poor condition exhibiting moderate to high severity fatigue cracking (Photograph Nos. 15 through 18). Photograph No. 18 shows a recently constructed concrete collar and a bituminous patch which may be associated with a drainage structure extending down the center of the lot and tying into the catch basin.

No curb or gutter are present around the perimeter of the pavements. Several catch basins are present throughout the lots. Most of the basins have concrete collars surrounding them.

EXISTING SUBSURFACE CONDITIONS

Sandy clay fill with organic matter underlies the pavement section at boring B-1 and extends to an approximate depth of 3 feet. Silty sand fill with organic matter is present below the pavement section at boring B-3 and extends to an approximate depth of 3 feet. Sand fill underlies the pavement section at boring B-7 and extends to the explored depth of 5 feet. Native silty clay underlies the fill at borings B-1 and B-3 and pavement section at the remaining borings and extends to the explored depth of 5 feet.

The sandy clay fill at boring B-1 is stiff in consistency with a moisture content of 22 percent, an unconfined compressive strength of 2,500 psf, and an organic matter content of 3.6 percent. The silty sand fill at boring B-3 is loose in compactness with a Standard Penetration Test N-value of 5 blows per foot and an organic matter content of 1.3 percent. The sand fill at boring B-7 is medium compact with N-values ranging from 14 to 19 blows per foot. The native silty clay is very stiff to hard in consistency with natural moisture contents ranging from 12 to 20 percent and unconfined compressive strengths ranging from 4,500 to 9,000 psf.

The stratification depths shown on the soil boring logs represent the soil conditions at the boring locations. Variations may occur between borings. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transition may be more gradual than what is shown. We have prepared the boring logs on the basis of laboratory classification and testing as well as field logs of the soils encountered.

The Soil Boring Location Plan, Plate No. 1, Soil Boring Logs Figure Nos. 1 through 9, and Grain Size Distribution, Figure Nos. 10 and 11, are presented in the Appendix. The soil profiles described above are generalized descriptions of the soil conditions at the boring locations. General Notes Terminology defining the nomenclature used on the boring logs and elsewhere in this report is presented on Figure No. 12.

GROUNDWATER CONDITIONS

Groundwater was encountered during drilling operations at approximate depths of 3 and 4 feet at borings B-1 and B-7, respectively. No measurable groundwater was observed during or upon completion of drilling operations at the remaining boring locations.

Fluctuations in perched and long-term groundwater levels should be anticipated due to seasonal variations and following periods of prolonged precipitation. It should also be noted that groundwater observations made during drilling operations in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the low permeability of such soils and the tendency of drilling operations to seal off the natural paths of groundwater flow.

PAVEMENT EVALUATION AND RECOMMENDATIONS

Main Lot

The pavement in the main lot (borings B-1 through B-7) is in relatively good condition, exhibiting generally low severity block and fatigue with less frequent areas of moderate severity distress. In consideration of the historical performance of the pavements and suitable aggregate base thickness, we recommend the existing bituminous concrete be milled, full depth patching performed where required, and an overlay constructed atop the milled surface.

For evaluation purposes of the bituminous mill/overlay, we estimated the remaining life of the pavement at 50 percent, a condition factor of 0.89, and an existing pavement structural number 2.8. Based on the results of our analyses, we recommend milling the existing pavement 2 inches, performing full depth patching of heavily distressed areas, and placing a 2-inch overlay across the entire area. We anticipate this option will provide little maintenance over the next 7 to 10 years. However, the district should understand some reflective cracking may appear within several years after construction.

We recommend the proposed overlay consist of 2 inches of MDOT 5E1 bituminous concrete wearing course. To facilitate construction of the proposed overlay, the existing pavement should be milled 2 inches. Prior to constructing the overlay, any existing cracks or joints in the pavement surface wider than 1/8 inch should be cleaned, covered with emulsified tack, then fill with a hand patching bituminous concrete mix. Any areas of the pavement that exhibit excessive fatigue cracking or deterioration should be completely removed to expose the existing subgrade soils and replaced with a full depth patch. For full depth patches, the bituminous concrete should be saw-cut a minimum 2 feet laterally from the distressed area to be removed. The underlying aggregate should be proof compacted with a vibratory roller and areas that remain unstable should be undercut and replaced with MDOT 21AA limestone aggregate. We recommend the bituminous concrete section within full depth patch areas match the removed pavement thickness and consist of MDOT 3E1 or 4E1 bituminous concrete leveling course. Prior to placing the full-depth patch, a tack coat should be applied to the sides of the saw-cut pavement. Additionally, after milling and full depth patching, as required, a bituminous tack coat must be placed prior to placement of the overlay.

Based on the existing pavement conditions, we recommend a budget for undercutting the main lot on the order of 20 to 25 percent of the total area. We anticipate most of the undercuts will occur in the heavily distressed pavement areas, such as in the vicinity of borings B-1 and B-3. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts.

West Lot

The pavement in the west lot (borings B-8 and B-9) is in poor condition, exhibiting moderate to high severity fatigue cracking. In consideration of the anticipated car traffic, we recommend the existing bituminous concrete be completely removed, additional MDOT 21AA limestone aggregate base placed, and a new pavement section constructed atop the existing aggregate base.

We recommend completely removing the existing bituminous concrete. The exposed aggregate base should be fine-graded, additional MDOT 21AA limestone dense graded aggregate placed as required and to promote effective drainage, and then compacted with a large vibratory roller making a minimum of 10 passes in 2 perpendicular directions across the aggregate base for support of the new pavement section and evaluated for instability. Any remaining unstable or unsuitable areas noted should be improved by additional compaction or removed and replaced with engineered fill.

Based on the existing pavement conditions, we recommend a budget for undercutting the west lot on the order of 25 to 30 percent of the total area. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts.

We performed pavement design analyses in accordance with the "AASHTO Guide for Design of Pavement Structures". The subgrade soils consist primarily of very stiff to hard silty clay. Cohesive soils are considered fair for support of pavements, predominantly due to their poor drainage characteristics. Based on the existing subgrade soils and historically good pavement performance, we have evaluated the presented design pavement sections based on a conservative effective subgrade resilient modulus of 7,000 pounds per square inch (psi).

We anticipate traffic for the west lot will consist predominantly of cars. We have evaluated the pavement section on an estimated of 50,000 18-kip equivalent single-axle loads (ESALs) over a 20-year design life. For evaluation purposes, we have utilized a serviceability loss of 2.0, a standard deviation of 0.45 for flexible pavements, and a reliability factor of 0.90. If additional traffic volume information becomes available, G2 should be notified so we can re-evaluate our recommendations. Based on the results of our analysis, we recommend the following pavement design cross section for the west log:

Flexible Standard-Duty Pavement Section		
Material	**Thickness**	**Structural Coefficient**
Bituminous Wearing Course (MDOT 5EML)	2 inches	0.42
Bituminous Leveling Course (MDOT 4EML)	2 inches	0.42
Existing Aggregate Base / MDOT 21AA Limestone Aggregate Base		

General

Subgrade undercuts should be evaluated by a qualified engineering technician to determine if subgrade stabilization is necessary. We recommend undercut excavations, where required, be backfilled with MDOT 21AA limestone aggregate base placed in an engineered manner. Lift thicknesses should not exceed 9 inches. All engineered fill should be compacted to a density of at least 95 percent of the maximum density determined by the Modified Proctor (ASTM D 1557) method of testing. All engineered fill material should be placed and compacted at approximately the optimum moisture content. Frozen material should not be used as fill, nor should fill be placed on a frozen subgrade.

To minimize subgrade instability and undercuts, we recommend the exposed subgrade not be left exposed to precipitation, and construction operations be performed during the summer months to ensure dry, warm, weather. Additionally, the aggregate base and subgrade may become unstable under repeated loading of construction traffic; therefore, construction equipment should be limited on the exposed subgrade. We recommend a drain tile be placed within any undercut area and connected to the closest catch basin to prevent groundwater from pooling within the granular soils in undercuts and creating “bathtubs” in the cohesive soils.

All pavement materials are specified within the 2012 Standard Specifications for Construction from the Michigan Department of Transportation. The aggregate materials for the subbase are described in Section 902. The bituminous pavement materials are described in Section 501 and can be assigned a structural coefficient number of 0.42. The existing 22A natural aggregate base can be assigned a structural coefficient number of 0.12 and imported MDOT 21AA limestone aggregate base material can be assigned a structural coefficient number of 0.14. We recommend all bituminous concrete materials have a binder from RAP less than 17 percent of the total binder and using a binder of PG 64-22.

Pavement Drainage

Proper pavement drainage is essential for cohesive subgrade soils due to their relatively impermeable nature. The pavement and subgrade should be properly sloped to promote effective surface and subsurface drainage and prevent water from ponding. We also recommend pavement subbase materials consist of non-frost-susceptible aggregates where possible.

We recommend installing finger drains at each catch basin to remove groundwater from the aggregate base layer. Such drains should extend to minimum depths of 4 inches below the bottom of the proposed aggregate base course or granular fill placed within undercut areas and connect to the nearest catch basin. We also recommend edge drains be installed around the pavement perimeter to prevent seepage into the pavement base.

Pavement Maintenance

Regular timely maintenance should be performed on the pavement to reduce the potential deterioration associated with moisture infiltration through surface cracks. The owner should be prepared to seal the cracks with a hot-applied elastic crack filler as soon as possible after cracking develops and as often as necessary to block the passage of water to the subgrade soils.

GENERAL COMMENTS

We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention for review and evaluation with respect to the prevailing subsurface conditions.

The scope of the present investigation was limited to evaluation of subsurface conditions for the construction of the proposed pavement reconstruction and other related aspects of the proposed project. No chemical, environmental, or hydrogeological testing or analysis were included in the scope of this investigation. If changes occur in the design, location, or concept of the project, the conclusions and recommendations contained in this report are not valid unless G2 Consulting Group, LLC reviews the changes. G2 Consulting Group, LLC will then confirm the recommendations presented herein or make changes in writing.

We have based the analyses and recommendations submitted in this report upon the data from soil borings performed at the approximate locations shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring locations. The nature and extent of any such variations may not become clear until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate our report recommendations.

Soil conditions at the site could vary from those generalized on the basis of soil borings made at specific locations. It is, therefore, recommended that G2 Consulting Group, LLC be retained to provide soil engineering services during the water main and roadway construction phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations. Also, this allows design changes to be made in the event that subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX

Legend

⊕ Soil Borings Drilled by 2G Drilling, Inc. on September 25, 2023

Soil Boring Location Plan		
Troy School District Transportation 120 Hart Avenue Troy, Michigan 48098		
2G CONSULTING GROUP	Project No. 230465	
	Drawn by: ALS	
	Date: 10/2/23	Plate No. 1
	Scale: NTS	

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A Longitude: N/A

Soil Boring No. **B-1**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.6	Bituminous Concrete (7 inches)							
1.2	Natural Aggregate Base: Gravelly Sand with trace silt (7 inches)							
3.0	Fill: Stiff Dark Gray and Black Sandy Clay with trace silt, gravel and organic matter, hydrocarbon odor noted (Organic Matter Content = 3.6%)		S-1	1 2 2	4	21.7		2500*
5.0	Very Stiff Brown and Gray Silty Clay with trace sand and gravel, hydrocarbon odor noted	5	S-2	3 4 3	7	20.1		5000*
	End of Boring @ 5 ft	10						

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
3 feet during drilling operations; wet cave measured at 3 feet upon removal of augers

Notes:
Borehole collapsed at 3 ft after auger removal
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 1

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A   Longitude: N/A

Soil Boring No. **B-2**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (6 inches) 0.5							
		Natural Aggregate Base: Gravelly Sand with trace silt (6 inches) 1.0							
		Hard Mottled Brown Silty Clay with trace sand and gravel		S-1	2 3 5	8	12.6		9000*
5		5.0	5	S-2	6 6 8	14	13.4		9000*
		End of Boring @ 5 ft							
10			10						

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 2

SOIL / PAVEMENT BORING 230465.GPJ 20150116 G2 CONSULTING DATA TEMPLATE.GDT 10/10/23

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A Longitude: N/A

Soil Boring No. B-3

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE DESCRIPTION	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.6	Bituminous Concrete (7 inches)						
1.2	Natural Aggregate Base: Gravelly Sand with trace silt (7 inches)						
3.0	Fill: Loose Dark Brown and Gray Silty Sand with trace clay, gravel, and organic matter (Organic Matter Content = 1.3%)	S-1	4 3 2	5			
5.0	Very Stiff Brown and Gray Silty Clay with trace sand and gravel	S-2	4 4 6	10	15.1		6000*
	End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 3

SOIL / PAVEMENT BORING 230465.GPJ 20150116 G2 CONSULTING DATA TEMPLATE.GDT 10/10/23

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A Longitude: N/A

Soil Boring No. **B-4**

G2 CONSULTING GROUP

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	DESCRIPTION	DEPTH (ft)
0.5	Bituminous Concrete (6-1/2 inches)	
1.0	Natural Aggregate Base: Gravelly Sand with trace silt (6 inches)	
3.0	Very Stiff Bluish Gray and Brown Silty Clay with trace sand and gravel, occasional sand seams	
5.0	Hard Mottled Brown and Gray Silty Clay with trace sand and gravel	5
	End of Boring @ 5 ft	10

SOIL SAMPLE DATA

SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
S-1	3 2 3	5	15.8		4500*
S-2	5 4 5	9	14.9		9000*

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 4

SOIL / PAVEMENT BORING 230465.GPJ 20150116 G2 CONSULTING DATA TEMPLATE.GDT 10/10/23

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A Longitude: N/A

Soil Boring No. **B-5**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (7 inches) 0.6							
		Limestone Aggregate Base: Silty Sand with little gravel (7 inches) 1.2							
		Very Stiff to Hard Mottled Brown Silty Clay with trace sand and gravel		S-1	3 2 3	5	18.3		6000*
5		5.0	5	S-2	4 4 5	9	14.7		9000*
		End of Boring @ 5 ft							
10			10						

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A Longitude: N/A

Soil Boring No. **B-6**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE DESCRIPTION	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.4	Bituminous Concrete (5 inches)							
0.9	Natural Aggregate Base: Gravelly Sand with trace silt (6 inches)							
	Hard Brown Silty Clay with trace sand and gravel		S-1	3 3 4	7	14.5		9000*
5.0		5	S-2	3 4 4	8	15.0		9000*
	End of Boring @ 5 ft							
10		10						

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A   Longitude: N/A

Soil Boring No. **B-7**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (6 inches) — 0.5							
		Natural Aggregate Base: Gravelly Sand with trace silt (6 inches) — 1.0							
		Fill: Medium Compact Brown Sand with trace gravel		S-1	8 9 10	19			
5		— 5.0	5	S-2	7 7 7	14			
		End of Boring @ 5 ft							
10			10						

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
4 feet during drilling operations; wet cave measured at 4 feet upon removal of augers

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A Longitude: N/A

Soil Boring No. **B-8**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (5 inches)	0.4						
		Natural Aggregate Base: Gravelly Sand with trace silt (6 inches)	0.9						
		Very Stiff to Hard Brown Silty Clay with little sand and trace gravel		S-1	3 2 3	5	15.0		7000*
5			5.0	S-2	4 6 5	11	11.7		9000*
		End of Boring @ 5 ft							
10			10						

Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 8

SOIL / PAVEMENT BORING 230465.GPJ 20150116 G2 CONSULTING DATA TEMPLATE.GDT 10/10/23

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No. 230465

Latitude: N/A Longitude: N/A

Soil Boring No. **B-9**

2G CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	Description	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (5 inches)	0.4						
		Natural Aggregate Base: Gravelly Sand with trace silt (6 inches)	0.9						
		Hard Mottled Brown and Gray Silty Clay with trace sand and gravel	3.0	S-1	1 2 3	5	15.7		8500*
5		Hard Brown Silty Clay with little sand and trace gravel	5.0	S-2	5 5 5	10	14.3		9000*
10		End of Boring @ 5 ft	10						

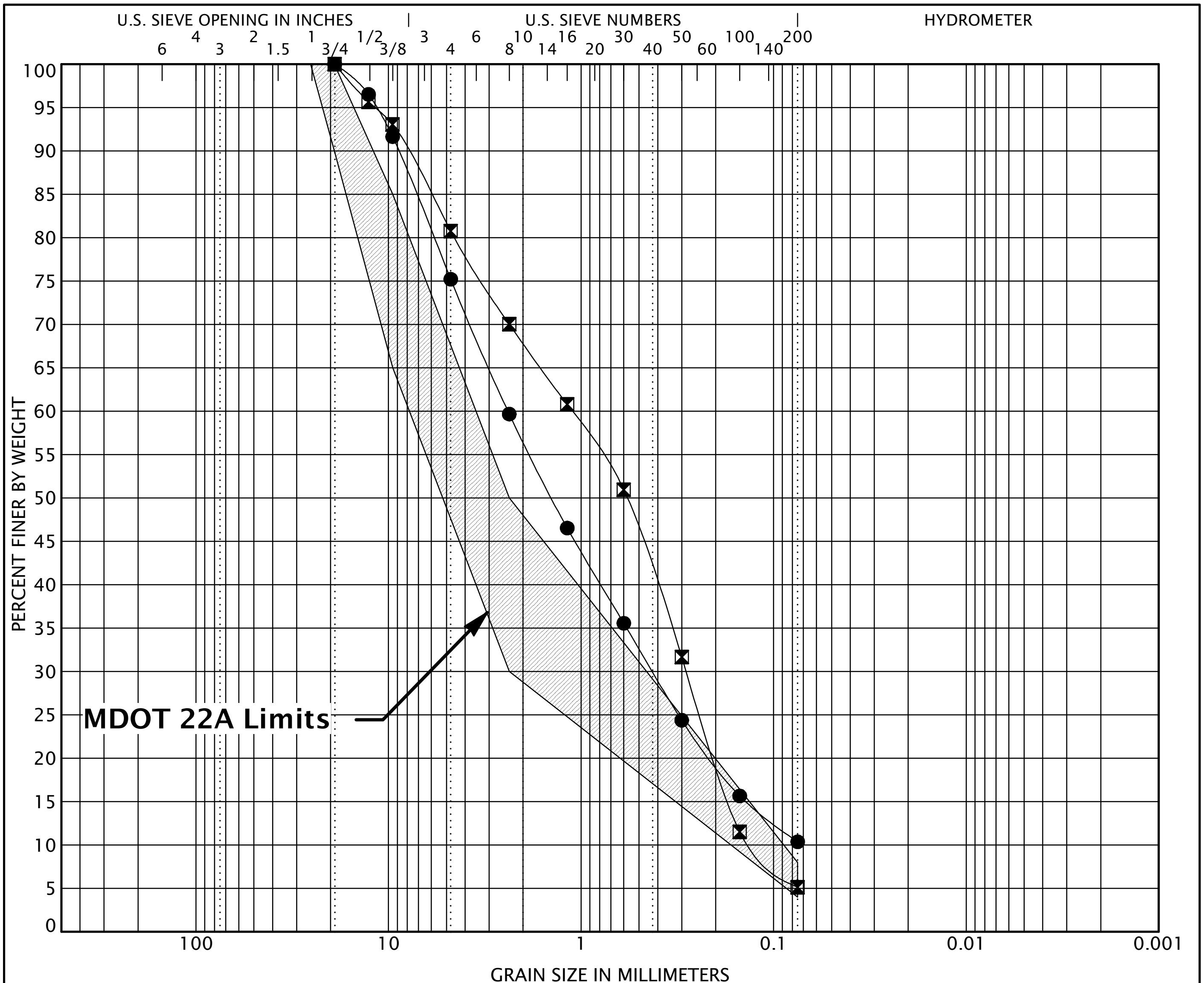
Total Depth: 5 ft
Drilling Date: September 25, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Description	LL	PL	PI	Cc	Cu
●	B-4	Gravelly Sand with trace silt				1.06	33.52
⊠	B-7	Gravelly Sand with trace silt				0.56	8.78

	Specimen ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-4	19.05	2.396	0.425		24.8	64.8	10.4	
⊠	B-7	19.05	1.117	0.283	0.127	19.2	75.6	5.1	

GRAIN SIZE DISTRIBUTION

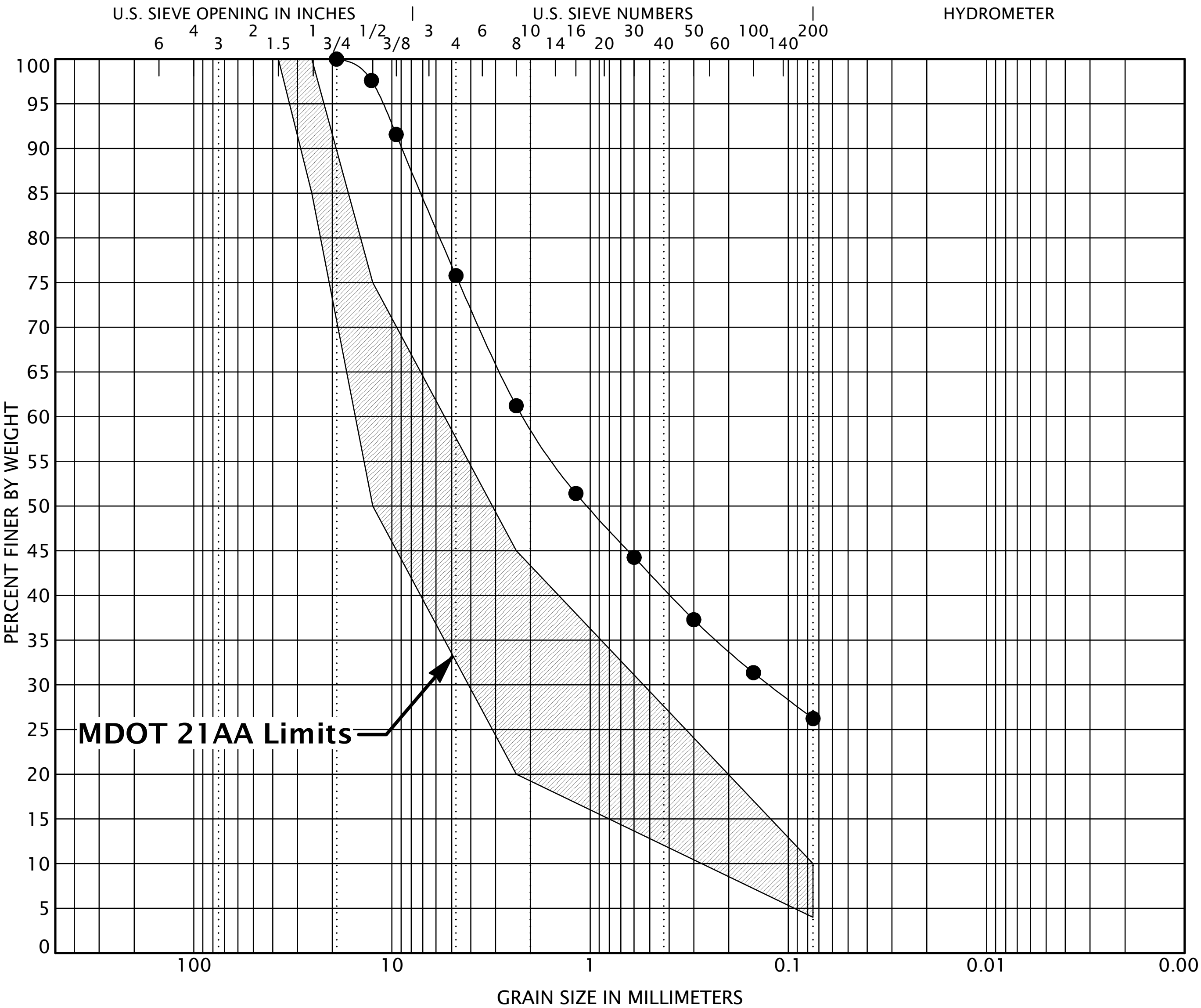
CONSULTING GROUP

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No.: 230465

Figure No. 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Description	LL	PL	PI	Cc	Cu
●	B-5	Silty Sand with little gravel					

	Specimen ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-5	19.05	2.165	0.125		24.2	49.5	26.2	

2 CONSULTING GROUP

GRAIN SIZE DISTRIBUTION

Project Name: Troy School District Transportation

Project Location: 120 Hart Avenue
Troy, Michigan 48083

G2 Project No.: 230465

Figure No. 11

GENERAL NOTES TERMINOLOGY

Unless otherwise noted, all terms herein refer to the Standard Definitions presented in ASTM 653.

PARTICLE SIZE

Boulders		- greater than 12 inches
Cobbles		- 3 inches to 12 inches
Gravel	- Coarse	- 3/4 inches to 3 inches
	- Fine	- No. 4 to 3/4 inches
Sand	- Coarse	- No. 10 to No. 4
	- Medium	- No. 40 to No. 10
	- Fine	- No. 200 to No. 40
Silt		- 0.005mm to 0.074mm
Clay		- Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e. clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituent (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35%	Little - 12 to 23%
And - over 35%	Some - 23 to 33%

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier, i.e. sandy clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils, i.e. silty clay, trace sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Approximate Range of (N)
Very Soft	Below 500	0 - 2
Soft	500 - 1,000	3 - 4
Medium	1,000 - 2,000	5 - 8
Stiff	2,000 - 4,000	9 - 15
Very Stiff	4,000 - 8,000	16 - 30
Hard	8,000 - 16,000	31 - 50
Very Hard	Over 16,000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 - 50
Very Compact	86 - 100	Over 50

Relative Density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

AS - Auger Sample – Cuttings directly from auger flight
BS - Bottle or Bag Samples
S - Split Spoon Sample - ASTM D 1586
LS - Liner Sample with liner insert 3 inches in length
ST - Shelby Tube sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted

STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0 inch outside-diameter, 1-3/8 inch inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

Photographic Documentation
Troy School District Transportation
Troy, Michigan
G2 Project No. 230465

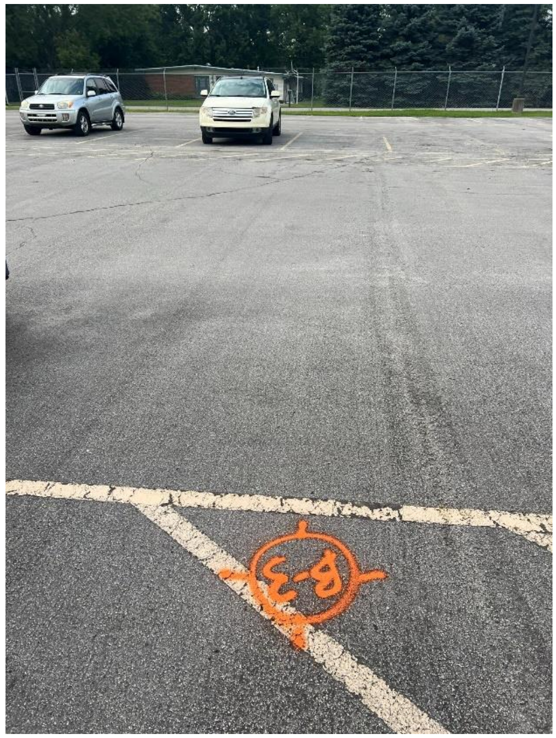
Photograph No. 1: Moderate severity fatigue and block cracking looking east.

Photograph No. 2: Moderate severity fatigue cracking looking west.
Pavement surface showing weathering.

Photographic Documentation
Troy School District Transportation
Troy, Michigan
G2 Project No. 230465

Photograph No. 3: Low severity fatigue along east extent of lot looking south.

Photograph No. 4: Moderate severity fatigue cracking looking west toward B-2.



Photograph No. 5: Moderate severity cracking.

Photograph No. 6: Low severity fatigue cracking. Evidence of ponding near wheel load indicating potential settlement.

Photograph No. 7: Low severity block cracking near building.

Photograph No. 8: Moderate severity fatigue cracking near bus garage.

Photographic Documentation
Troy School District Transportation
Troy, Michigan
G2 Project No. 230465

Photograph No. 9: Catch basin adjacent to the car wash building.

Photograph No. 10: Low severity transverse cracking.

Photographic Documentation
Troy School District Transportation
Troy, Michigan
G2 Project No. 230465

Photograph No. 11: Moderate severity block and fatigue cracking looking west toward west entrance.

Photograph No. 12: Looking north toward parking stalls, no significant distress.

Photographic Documentation
Troy School District Transportation
Troy, Michigan
G2 Project No. 230465

Photograph No. 13: Moderate severity block and fatigue cracking looking south at east entrance.

Photograph No. 14: Low to moderate severity joint and fatigue cracking looking west along south side of lot.

Photographic Documentation
Troy School District Transportation
Troy, Michigan
G2 Project No. 230465

Photograph No. 15: Previous patch near B-8.

Photograph No. 16: High severity fatigue cracking In parking stalls.

Photographic Documentation
Troy School District Transportation
Troy, Michigan
G2 Project No. 230465

Photograph No. 17: Low severity fatigue cracking looking east along south side of the property. Previous patch crossing west entrance drive.

Photograph No. 18: Previous bituminous patch and new concrete collar around basin looking west.

Report on Geotechnical
Pavement Investigation

Troy Learning Center
1522 East Big Beaver Road
Troy, Michigan 48083

Latitude 42.583871˚ N
Longitude 83.151547˚ W

Prepared for:

Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

G2 Project No. 230681
October 10, 2023

October 10, 2023

Ms. Michelle Kerns
Lecole Planners, LLC
145 North Center Street B
Northville, Michigan 48167

Re: Report of Geotechnical Pavement Investigation
Troy Learning Center
1522 East Big Beaver Road
Troy, Michigan 48083
G2 Project No. 230681

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Troy Learning Center in the City of Troy, Michigan. This report presents the results of our observations and analyses and our recommendations for pavement design and construction considerations as they relate to the geotechnical conditions along the alignment of the proposed pavement rehabilitation/reconstruction.

As always, we appreciate the opportunity to be of service to Lecole Planners, LLC and Troy School District and look forward to discussing the recommendations presented. In the meantime, if you have any questions regarding this report or any other matter pertaining to the project, please let us know.

Sincerely,

G2 Consulting Group, LLC

Amy L. Schneider, P.E
Project Manager

Noel J. Hargrave-Thomas, P.E.
Principal

ALS/NJHT/ljv

Enclosures

EXECUTIVE SUMMARY

We understand the project consists of rehabilitation/reconstruction of the pavement on the east side of the Learning Center property (borings B-5 through B-7) in Troy, Michigan. Soil borings were performed in the west lot and south concrete pavement; however, no work is currently proposed in these areas. Traffic counts at the site were not available upon completion of this report. We anticipate traffic will generally consist of cars with occasional delivery trucks.

Approximately 5 to 6 inches of bituminous concrete underlain by generally 4 to 6 inches of gravelly sand aggregate base (with the exception of 10 inches at boring B-1) are present at soil borings B-1 through B-7. Approximately 4 inches of Portland cement concrete underlain by 4 to 6 inches of silty sand aggregate base are present at borings B-8 and B-9. Compact gravelly sand fill with 2.4 percent organic matter and hydrocarbon odors underlies the aggregate base at boring B-1 and extends to an approximate depth of 3 feet. Very loose to loose sand fill is present below the aggregate base at boring B-4 and extends to the explored depth of 5 feet. Very stiff to hard silty clay fill with 3.6 percent organic matter underlies the aggregate base at borings B-5 and B-6 and extends to an approximate depth of 3 feet. Native stiff to hard silty clay is present below the fill at borings B-1 and B-4 through B-6 and the pavement section at the remaining borings and extends to the explored depth of 5 feet. Groundwater was encountered at an approximate depth of 1 foot during drilling operations at borings B-1 and B-4. No measurable groundwater was observed during or upon completion of drilling operations at the remaining boring locations.

The east parking lot (borings B-4 through B-7) is in fair condition with more than half the pavement exhibiting moderate severity block cracking throughout and previous crack sealing is visible. Areas of secondary moderate severity fatigue cracking are also present, such as near boring B-6 where the subgrade consists of silty clay fill with organic matter. In consideration of the condition of the existing bituminous concrete and thickness of the existing bituminous concrete and aggregate base, we recommend the existing bituminous concrete be milled 2 inches, full depth patching performed where required, and an MDOT 5EML bituminous concrete wearing course overlay constructed atop the milled surface. We anticipate this option will provide little maintenance over the next 7 to 10 years. However, the district should understand some reflective cracking may appear within several years after construction.

To facilitate construction of the proposed overlay, the existing pavement should be milled 2 inches. Prior to constructing the overlay, any existing cracks or joints in the pavement surface wider than 1/8 inch should be cleaned, covered with emulsified tack, then fill with a hand patching bituminous concrete mix. Any areas of the pavement that exhibit excessive fatigue cracking or deterioration should be completely removed to expose the existing subgrade soils and replaced with a full depth patch. For full depth patches, the bituminous concrete should be saw-cut a minimum 2 feet laterally from the distressed area to be removed. The underlying aggregate should be proof compacted with a vibratory roller and areas that remain unstable should be undercut and replaced with MDOT 21AA limestone aggregate. We recommend the bituminous concrete section within full depth patch areas match the removed pavement thickness and consist of MDOT 3EML or 4EML bituminous concrete leveling course. Prior to placing the full-depth patch, a tack coat should be applied to the sides of the saw-cut pavement. Additionally, after milling and full depth patching, as required, a bituminous tack coat must be placed prior to placement of the overlay.

Based on the existing pavement conditions, we recommend a budget for undercutting the east lot on the order of 20 to 25 percent of the total area. We anticipate most of the undercuts will occur in the heavily distressed pavement areas, such as in the vicinity of boring B-6. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts.

This summary is not to be considered separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

PROJECT DESCRIPTION

We understand the project consists of rehabilitation/reconstruction of the pavement on the east side of the Learning Center property (borings B-5 through B-7) in Troy, Michigan. Soil borings were performed in the west lot and south concrete pavement; however, no work is currently proposed in these areas. Traffic counts at the site were not available upon completion of this report. We anticipate traffic will generally consist of cars with occasional delivery trucks.

Google Earth Historical Aerial Photographs indicates the parking lot was constructed prior to 1999. No evidence of patching or pavement maintenance is visible in the historical imagery through May 2023. However, visual observations currently indicate a slurry coat appears to have been applied sometime between May and the time of our field work in late August 2023.

The purpose of our investigation is to determine and evaluate the general pavement and subsurface conditions within east lot and develop general recommendations for the proposed pavement rehabilitation/reconstruction and pavement design.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of geotechnical engineering in this area. Our scope of services for this project is as follows:

1. We drilled a total of nine soil borings within the pavements extending to a depth of 5 feet each below existing grade. We measured the existing pavement section materials (bituminous concrete) and identified the type and condition of subgrade soils.

2. We performed laboratory testing on samples obtained from the soil borings. Laboratory testing included visual engineering classification, moisture content, grain size distribution, and unconfined compressive strength determinations.

3. We prepared this engineering report which includes our evaluation of the subsurface conditions at the site and our recommendations for pavement rehabilitation/reconstruction.

FIELD OPERATIONS

G2 Consulting Group, LLC (G2), selected the number depth and location of the soil borings. The soil borings were located in the field by a G2 representative by use of GPS assisted mobile technology in conjunction with conventional taping methods. The approximate soil boring locations are presented on the Soil Boring Location Plan, Plate No. 1. No ground surface elevations were available at the time of this investigation.

The soil borings were drilled using a truck-mounted rotary drilling rig. Continuous flight, 2-1/4-inch, inside diameter, hollow-stem augers were used to advance borings to the explored depth. Soil samples were obtained at intervals of 2-1/2 feet. These samples were obtained by the Standard Penetration Test method (ASTM D 1586), which involves driving a 2-inch diameter split-spoon sampler into the soil with a 140-pound weight falling 30 inches. The sampler is generally driven three successive 6-inch increments with the number of blows for each increment recorded. The number of blows required to advance the sampler the last 12 inches is termed the Standard Penetration Resistance (N). Blow counts for each 6-inch increment and the resulting N-values are presented on the individual soil boring logs.

During drilling operations, the drillers maintained logs of the encountered subsurface conditions, including changes in stratigraphy and observed groundwater levels to be used in conjunction with our analysis of the subsurface conditions. The final hand-auger boring logs are based on the field logs and laboratory soil classification and testing. After completion of boring operations, the boreholes were backfilled with excavated soil and capped with cold patch.

LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine soil parameters pertinent to pavement design and site preparation. An experienced geotechnical engineer classified the samples in general conformance with the Unified Soil Classification System.

Laboratory testing included natural moisture content, grain size distribution, and unconfined compressive strength determinations. The grain-size distributions were determined in general accordance with ASTM D422, "Standard Test Method for Particle-Size Analysis of Soils". The unconfined compressive strengths were determined by using a spring-loaded hand penetrometer. The hand penetrometer estimates the unconfined compressive strength to a maximum of 4-1/2 tons per square foot (tsf) by measuring the resistance of the soil sample to the penetration of a calibrated spring-loaded cylinder.

The results of the moisture content and unconfined compressive strength laboratory tests are indicated on the soil boring logs at the depths the samples were obtained. Grain size distribution results are also presented graphically on Figure Nos. 10 and 11 in the Appendix. We will hold the soil samples for 60 days from the date of this report. If you would like the samples, please let us know.

EXISTING PAVEMENT CONDITIONS

Approximately 5 to 6 inches of bituminous concrete underlain by generally 4 to 6 inches of gravelly sand aggregate base (with the exception of 10 inches at boring B-1) are present at soil borings B-1 through B-7. Approximately 4 inches of Portland cement concrete underlain by 4 to 6 inches of silty sand aggregate base are present at borings B-8 and B-9.

Test results indicated the material out of specification for gradation requirements of MDOT 22A or MDOT 21AA dense-graded aggregate base as presented on Figure Nos. 10 and 11 in the Appendix and in the table below. The values in bold indicate where the material is *out* of specification.

Sieve Size	MDOT 22A Percent Passing Specification	B-3 Aggregate Base Percent Passing	B-6 Aggregate Base Percent Passing
1"	100	100	100
3/4"	90 to 100	100	98
3/8"	65 to 85	**88**	**88**
No. 8	30 to 50	46	**56**
Loss by Wash	4 to 8	4	**10**
Meets 22A Gradation		No	No

Sieve Size	MDOT 21AA Percent Passing Specification	B-8 Aggregate Base Percent Passing
1-1/2"	100	100
1"	85 to 100	100
1/2"	50 to 75	**97**
No. 8	20 to 45	**76**
Loss by Wash	4 to 8	**16**
Meets 21AA Gradation		No

The east parking lot (borings B-4 through B-7) is in fair condition with more than half the pavement exhibiting moderate severity block cracking throughout and previous crack sealing is visible (Photograph Nos. 8 and 9). Areas of secondary moderate severity fatigue cracking are present, most notably near boring B-6 where the subgrade consists of silty clay fill with organic matter (Photograph Nos. 13, 14, and 16).

The south Portland cement concrete is in poor condition with extensive cracking throughout (Photograph Nos. 10 and 17 through 20). The west lot appears to have been slurry coated (Photograph Nos. 1 through 7) which is covering the fatigue and block cracking visible in historical aerial photographs. The interface of the three pavement surfaces is shown in Photograph No. 8.

Concrete sidewalks line the perimeter of the building, and the bituminous pavement abuts the sidewalk (Photograph Nos. 11 and 13). Low asphalt curbs line the east entrance drive (Photograph Nos. 15 and 16). Catch basins with concrete collars are present at the center of the west and east lots and the pavement surface appears to grade to the center of the lot.

EXISTING SUBSURFACE CONDITIONS

Gravelly sand fill with organic matter and hydrocarbon odors underlies the aggregate base at boring B-1 and extends to an approximate depth of 3 feet. Sand fill is present below the aggregate base at boring B-4 and extends to the explored depth of 5 feet. Silty clay fill with organic matter underlies the aggregate base at borings B-5 and B-6 and extends to an approximate depth of 3 feet. Native silty clay is present below the fill at borings B-1 and B-4 through B-6 and the pavement section at the remaining borings and extends to the explored depth of 5 feet.

The gravelly sand fill is compact with a Standard Penetration Test N-value of 31 blows per foot and an organic matter content of 2.4 percent. The sand fill is very loose to loose in compactness with N-values of 3 and 7 blows per foot. The silty clay fill is very stiff to hard in consistency with moisture contents of 20 percent, unconfined compressive strengths of 6,000 and 8,500 psf, and organic matter contents of 3.6 percent. The native silty clay is typically stiff to very stiff in consistency with natural moisture contents ranging from 13 to 22 percent and unconfined compressive strengths ranging from 2,000 to 6,000 psf. Layers of hard silty clay are present at borings B-2, B-5, and B-7 with natural moisture contents ranging from 11 to 20 percent and unconfined compressive strengths ranging from 8,500 to 9,000 psf.

The stratification depths shown on the soil boring logs represent the soil conditions at the boring locations. Variations may occur between borings. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transition may be more gradual than what is shown. We have prepared the boring logs on the basis of laboratory classification and testing as well as field logs of the soils encountered.

The Soil Boring Location Plan, Plate No. 1, Soil Boring Logs Figure Nos. 1 through 9, and Grain Size Distribution, Figure Nos. 10 and 11, are presented in the Appendix. The soil profiles described above are generalized descriptions of the soil conditions at the boring locations. General Notes Terminology defining the nomenclature used on the boring logs and elsewhere in this report is presented on Figure No. 12.

GROUNDWATER CONDITIONS

Groundwater was encountered at an approximate depth of 1 foot during drilling operations at borings B-1 and B-4. No measurable groundwater was observed during or upon completion of drilling operations at the remaining boring locations.

Fluctuations in perched and long-term groundwater levels should be anticipated due to seasonal variations and following periods of prolonged precipitation. It should also be noted that groundwater observations made during drilling operations in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the low permeability of such soils and the tendency of drilling operations to seal off the natural paths of groundwater flow.

PAVEMENT EVALUATION AND RECOMMENDATIONS

East Lot

The existing bituminous concrete in the east lot (borings B-4 through B-7) is in fair condition, exhibiting generally moderate severity block and fatigue cracking. In consideration of the condition and thickness of the existing bituminous concrete and aggregate base, we recommend the existing bituminous concrete be milled, full depth patching performed where required, and an overlay constructed atop the milled surface.

For evaluation purposes of the bituminous mill/overlay, we estimated the remaining life of the pavement at 50 percent, a condition factor of 0.89, and an existing pavement structural number 3.2. Based on the results of our analyses, we recommend milling the existing pavement 2 inches, performing full depth patching of heavily distressed areas, and placing a 2-inch overlay across the entire area. We anticipate this option will provide little maintenance over the next 7 to 10 years. However, the district should understand some reflective cracking may appear within several years after construction.

We recommend the proposed overlay consist of 2 inches of MDOT 5EML bituminous concrete wearing course. To facilitate construction of the proposed overlay, the existing pavement should be milled 2 inches. Prior to constructing the overlay, any existing cracks or joints in the pavement surface wider than 1/8 inch should be cleaned, covered with emulsified tack, then fill with a hand patching bituminous concrete mix. Any areas of the pavement that exhibit excessive fatigue cracking or deterioration should be completely removed to expose the existing subgrade soils and replaced with a full depth patch.

For full depth patches, the bituminous concrete should be saw-cut a minimum 2 feet laterally from the distressed area to be removed. The underlying aggregate should be proof compacted with a vibratory roller and areas that remain unstable should be undercut and replaced with MDOT 21AA limestone aggregate. We recommend the bituminous concrete section within full depth patch areas match the removed pavement thickness and consist of MDOT 3EML or 4EML bituminous concrete leveling course. Prior to placing the full-depth patch, a tack coat should be applied to the sides of the saw-cut pavement. Additionally, after milling and full depth patching, as required, a bituminous tack coat must be placed prior to placement of the overlay.

Based on the existing pavement conditions, we recommend a budget for undercutting the east lot on the order of 20 to 25 percent of the total area. We anticipate most of the undercuts will occur in the heavily distressed pavement areas, such as in the vicinity of boring B-6. The contractor should be prepared to utilize tri-axial geogrid, as necessary, to minimize extensive undercuts.

All pavement materials are specified within the 2020 Standard Specifications for Construction from the Michigan Department of Transportation. The aggregate materials for the subbase are described in Section 902. The bituminous pavement materials are described in Section 501 and can be assigned a structural coefficient number of 0.42. MDOT 22A natural aggregate can be assigned a structural coefficient number of 0.12, and imported MDOT 21AA dense graded aggregate base material can be assigned a structural coefficient number of 0.14.

West Lot and Concrete Pavement

We understand no work is currently proposed for the west lot and the concrete pavement on the south side of the property. Based on the condition of the existing bituminous pavement at the west lot in Google Aerial photographs and existing pavement thickness, we anticipate a mill and overlay may be a viable option for rehabilitation. However, once the area is to be rehabilitated / reconstructed, we recommend pavement condition survey be performed to reevaluate the current pavement condition.

We understand no work is currently proposed for the south concrete pavement either at the time of this investigation. The concrete is in poor condition as previously discussed, and we anticipate the concrete will need to be completely removed, the subgrade evaluated, and a new Portland cement concrete section constructed. This pavement should also be reevaluated at the time rehabilitation / reconstruction is proposed.

Pavement Drainage

Proper pavement drainage is essential for cohesive subgrade soils due to their relatively impermeable nature. The pavement should be properly sloped to promote effective surface drainage and prevent water from ponding.

We recommend installing finger drains at each catch basin to remove groundwater from the aggregate base layer, particularly down the center of the east lot. Such drains should extend to minimum depths of 4 inches below the bottom of the proposed aggregate base course or granular fill placed within undercut areas and connect to the nearest catch basin. We also recommend edge drains be installed around the pavement perimeter to prevent seepage into the pavement base.

Pavement Maintenance

Regular timely maintenance should be performed on the pavement to reduce the potential deterioration associated with moisture infiltration through surface cracks. The owner should be prepared to seal the cracks with a hot-applied elastic crack filler as soon as possible after cracking develops and as often as necessary to block the passage of water to the subgrade soils.

GENERAL COMMENTS

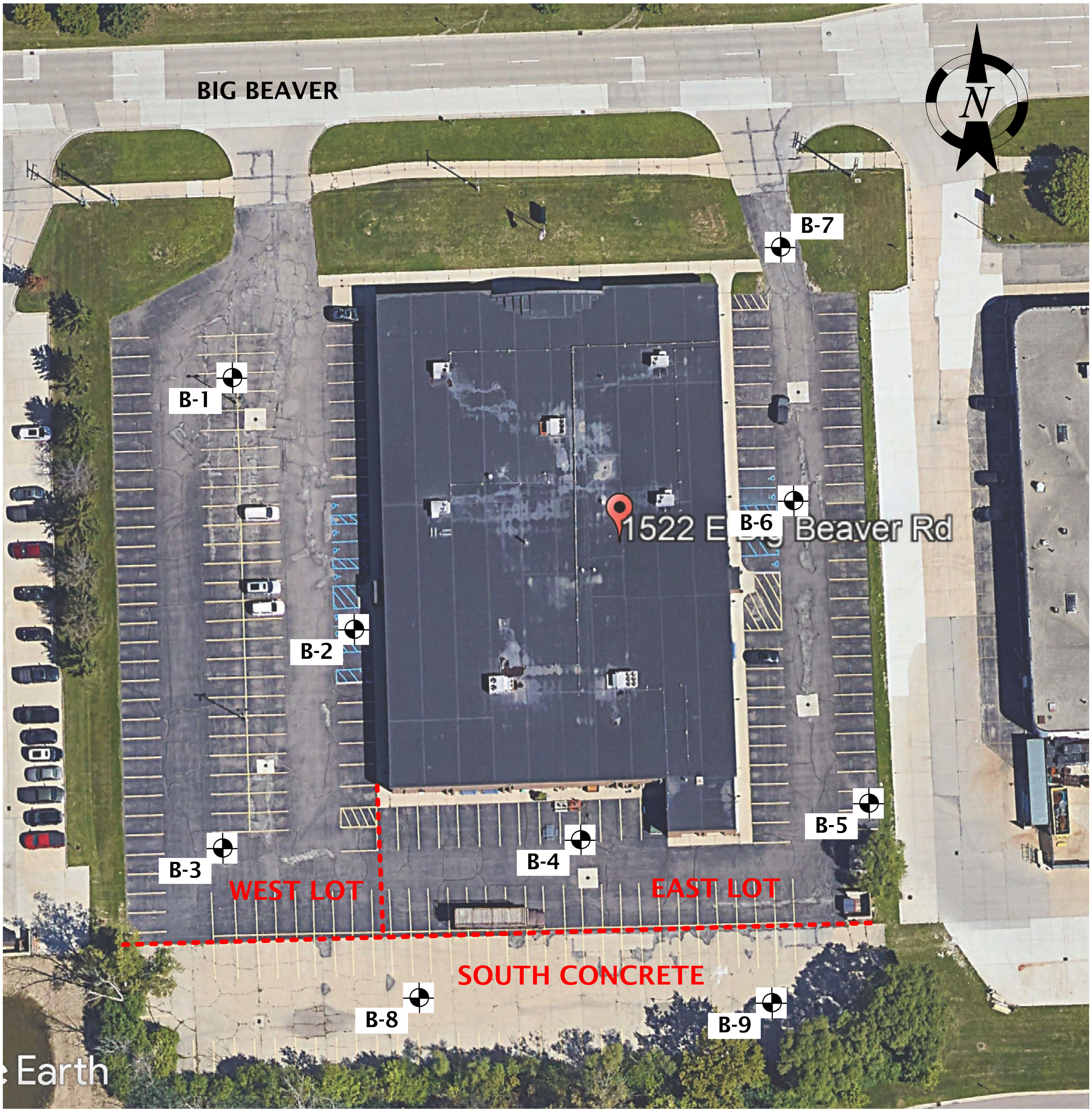
We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention for review and evaluation with respect to the prevailing subsurface conditions.

The scope of the present investigation was limited to evaluation of subsurface conditions for the construction of the proposed pavement reconstruction and other related aspects of the proposed project. No chemical, environmental, or hydrogeological testing or analysis were included in the scope of this investigation. If changes occur in the design, location, or concept of the project, the conclusions and recommendations contained in this report are not valid unless G2 Consulting Group, LLC reviews the changes. G2 Consulting Group, LLC will then confirm the recommendations presented herein or make changes in writing.

We have based the analyses and recommendations submitted in this report upon the data from soil borings performed at the approximate locations shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring locations. The nature and extent of any such variations may not become clear until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate our report recommendations.

Soil conditions at the site could vary from those generalized on the basis of soil borings made at specific locations. It is, therefore, recommended that G2 Consulting Group, LLC be retained to provide soil engineering services during the water main and roadway construction phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations. Also, this allows design changes to be made in the event subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX



Legend

⊕ Soil Borings Drilled by 2G Drilling on September 26, 2023

Soil Boring Location Plan

Troy Learning Center
1522 East Big Beaver Road
Troy, Michigan 48083

2G CONSULTING GROUP

Project No. 230681	
Drawn by: ALS	
Date: 9/29/23	Plate No. 1
Scale: NTS	

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. **B-1**

G2 CONSULTING GROUP

SUBSURFACE PROFILE					SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A		DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (5 inches)	0.4							
		Aggregate Base: Gravelly Sand with trace silt (10 inches)	1.3							
		Fill: Compact Brown and Gray Gravelly Sand with trace clay silt, wood, organic matter, and debris, hydrocarbon odor noted (Organic Matter Content = 2.4%)	3.0		S-1	9 14 17	31			
5		Stiff Brown and Gray Silty Clay with trace sand and gravel	5.0	5	S-2	2 2 2	4	22.3		3000*
10		End of Boring @ 5 ft		10						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
1 foot during drilling operations; 3 feet upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	DESCRIPTION	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.5		Bituminous Concrete (6 inches)						
1.0		Aggregate Base: Gravelly Sand with trace silt (6 inches)						
			S-1	2 2 4	6	18.0		6000*
5.0		Very Stiff to Hard Brown and Gray Silty Clay with trace sand and gravel	S-2	5 6 6	12	14.4		9000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. **B-3**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	Description	Layer bottom (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
	Bituminous Concrete (5 inches)	0.4						
	Aggregate Base: Gravelly Sand with trace silt (4 inches)	0.8						
	Stiff Greenish Gray and Brown Silty Clay with trace sand and gravel	1.5						
	Stiff Brown and Gray Silty Clay with trace sand and gravel		S-1	3 3 4	7	18.2		4000*
5		5.0	S-2	3 3 4	7	18.7		2500*
	End of Boring @ 5 ft							
10								

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. B-4

2G CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (6 inches) 0.5							
		Aggregate Base: Gravelly Sand with trace silt (6 inches) 1.0							
		Fill: Very Loose to Loose Brown Sand with trace gravel		S-1	3 4 3	7			
5		5.0	5	S-2	1 1 2	3			
		End of Boring @ 5 ft							
10			10						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
1 foot during and upon completion of drilling operations

Notes:
Borehole collapsed at 3 ft after auger removal

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. B-5

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (6 inches) 0.5							
		Aggregate Base: Gravelly Sand with trace silt, crushed concrete, brick (6 inches) 1.0							
		Fill: Hard Black Silty Clay with trace sand, gravel, and organic matter (Organic Matter Content = 3.6%) 3.0		S-1	3 3 5	8	20.1		8500*
5		Stiff Bluish Gray and Brown Silty Clay with trace sand and gravel 5.0	5	S-2	2 2 3	5	20.2		3500*
10		End of Boring @ 5 ft	10						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. B-6

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (6 inches) 0.5							
		Aggregate Base: Gravelly Sand with trace silt, crushed concrete, brick (6 inches) 1.0							
		Fill: Very Stiff Black Silty Clay with trace sand, gravel, and organic matter (Organic Matter Content = 3.6%) 3.0		S-1	5 4 4	8	20.3		6000*
5		Stiff Bluish Gray and Brown Silty Clay with trace sand and gravel 5.0	5	S-2	4 5 7	12	19.0		3000*
10		End of Boring @ 5 ft	10						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 6

SOIL / PAVEMENT BORING 230681.GPJ 20150116 G2 CONSULTING DATA TEMPLATE.GDT 10/11/23

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. **B-7**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (6 inches) 0.5							
		Aggregate Base: Gravelly Sand with trace silt, crushed concrete, brick (6 inches) 1.0							
		Hard Brown and Gray Silty Clay with trace sand and gravel 3.0		S-1	5 4 4	8	11.3		9000*
5		Stiff Bluish Gray and Brown Silty Clay with trace sand and gravel, occasional sand seams 5.0	5	S-2	3 4 4	8	18.7		2000*
10		End of Boring @ 5 ft	10						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. **B-8**

G2 CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Portland Cement Concrete (4 inches) 0.3							
		Limestone Aggregate Base: Silty Sand with little gravel (6 inches) 0.8							
		Stiff Bluish Gray and Brown Silty Sand with trace sand and gravel 3.0		S-1	2 2 2	4	17.8		2500*
5		Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	S-2	3 5 7	12	15.2		3000*
10		End of Boring @ 5 ft	10						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No. 230681

Latitude: N/A Longitude: N/A

Soil Boring No. **B-9**

G2 CONSULTING GROUP

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Portland Cement Concrete (4 inches) 0.3							
		Limestone Aggregate Base: Silty Sand with little gravel (4 inches) 0.7							
		Stiff Bluish Gray and Brown Silty Clay with trace sand and gravel 3.0		S-1	3 4 4	8	16.3		3000*
5		Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	S-2	2 2 2	4	13.4		3500*
		End of Boring @ 5 ft							
10			10						

Total Depth: 5 ft
Drilling Date: September 26, 2023
Inspector:
Contractor: 2G Drilling
Driller: H. Pace

Drilling Method:
2-1/4 inch inside diameter hollow stem auger

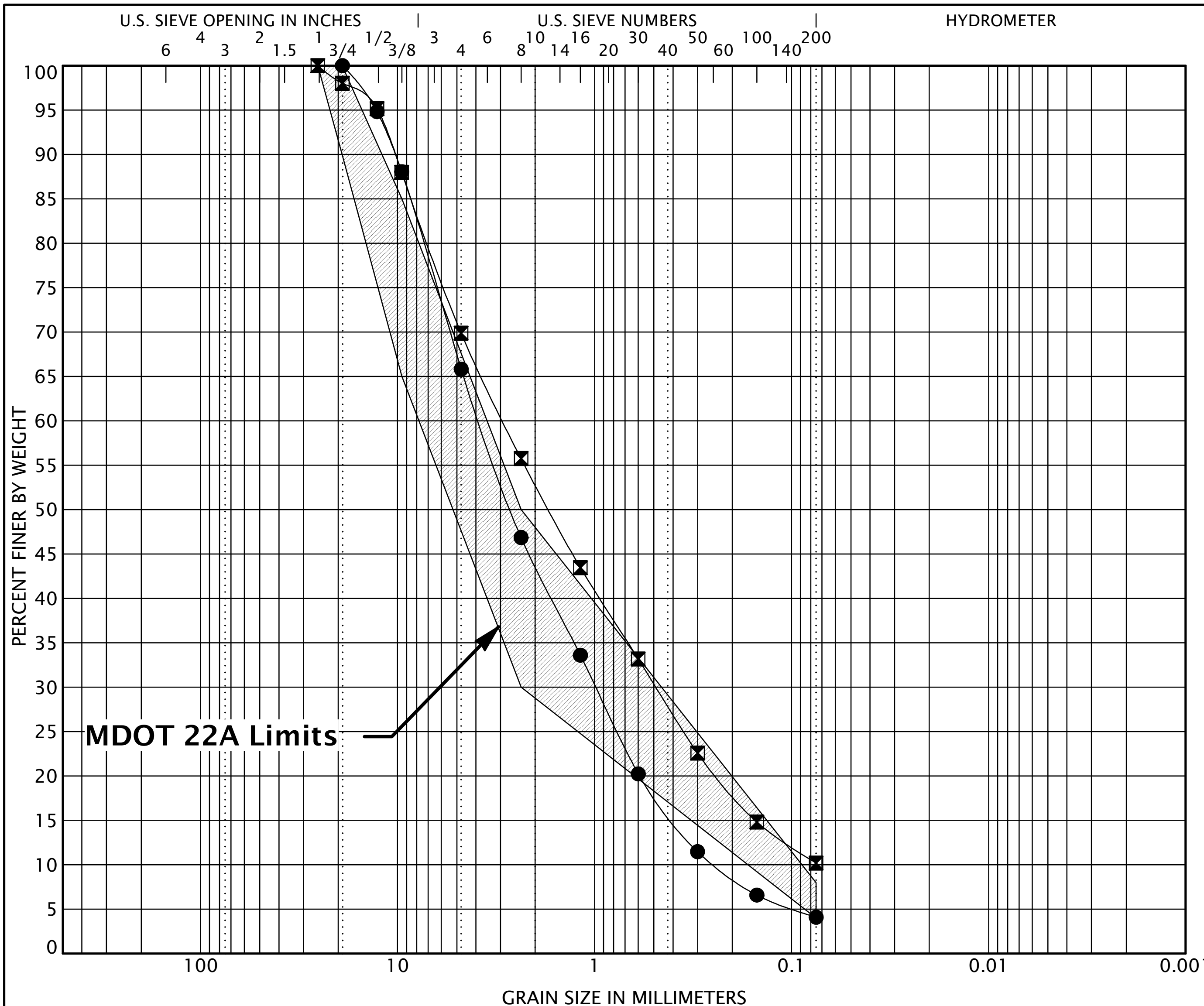
Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 9

SOIL / PAVEMENT BORING 230681.GPJ 20150116 G2 CONSULTING DATA TEMPLATE.GDT 10/11/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Description	LL	PL	PI	Cc	Cu
●	B-3	Gravelly Sand with trace silt				1.04	15.74
⊠	B-6	Gravelly Sand with trace silt				1.12	40.02

	Specimen ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-3	19.05	3.832	0.983	0.243	34.2	61.7	4.1	
⊠	B-6	25.4	2.914	0.487		30.1	59.7	10.2	

G2 CONSULTING GROUP

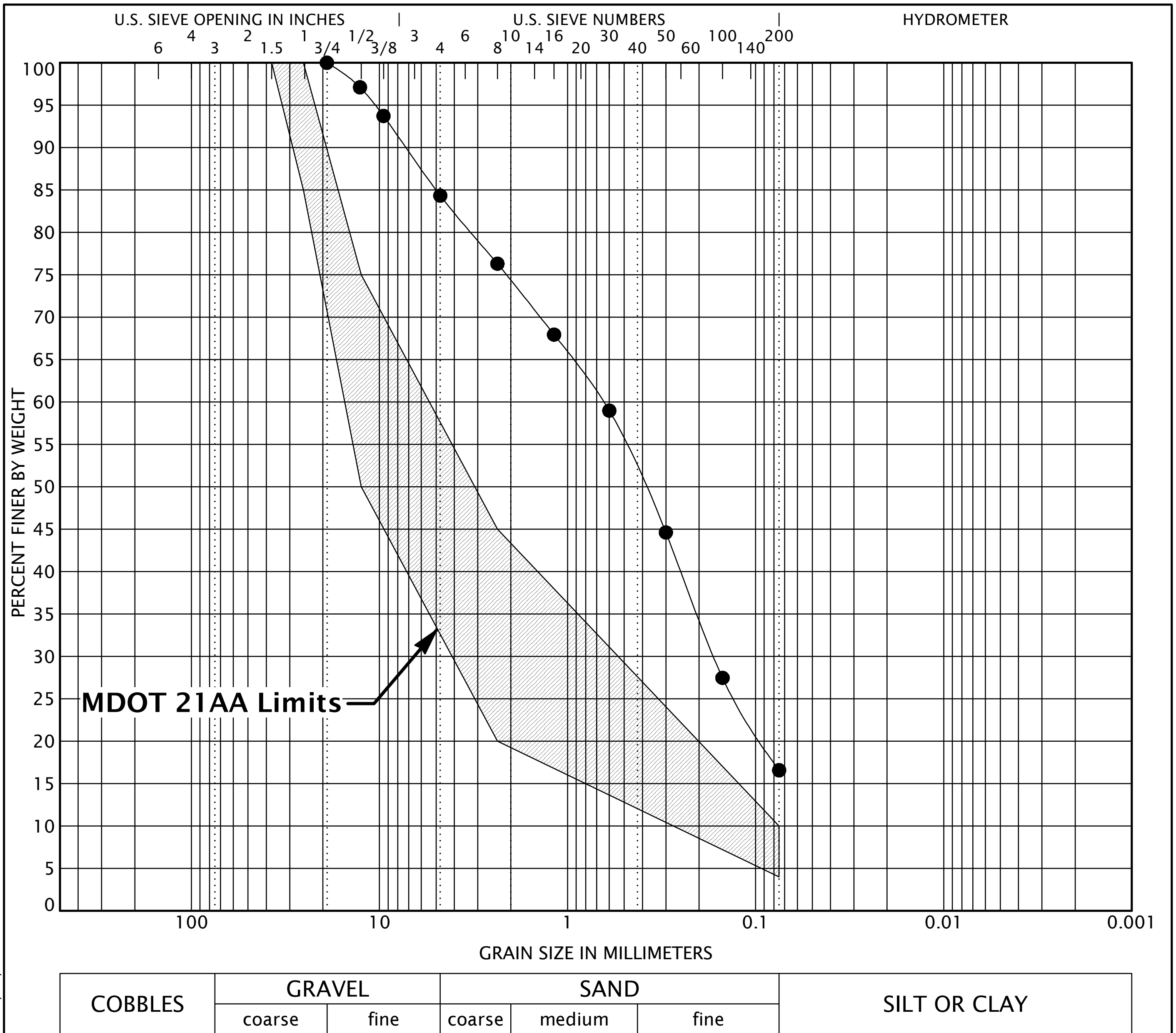
GRAIN SIZE DISTRIBUTION

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No.: 230681

Figure No. 10



	Specimen ID	Description	LL	PL	PI	Cc	Cu
●	B-8	Limestone: Silty Sand with little gravel					

	Specimen ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-8	19.05	0.648	0.166		15.7	67.8	16.6	

G2 CONSULTING GROUP

GRAIN SIZE DISTRIBUTION

Project Name: Troy Learning Center

Project Location: 1522 East Big Beaver Road
Troy, Michigan 48083

G2 Project No.: 230681

Figure No. 11

C2G CONSULTING GROUP

GENERAL NOTES TERMINOLOGY

Unless otherwise noted, all terms herein refer to the Standard Definitions presented in ASTM 653.

PARTICLE SIZE

Boulders		- greater than 12 inches
Cobbles		- 3 inches to 12 inches
Gravel	- Coarse	- 3/4 inches to 3 inches
	- Fine	- No. 4 to 3/4 inches
Sand	- Coarse	- No. 10 to No. 4
	- Medium	- No. 40 to No. 10
	- Fine	- No. 200 to No. 40
Silt		- 0.005mm to 0.074mm
Clay		- Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e. clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituent (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35%	Little - 12 to 23%
And - over 35%	Some - 23 to 33%

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier, i.e. sandy clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils, i.e. silty clay, trace sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Approximate Range of (N)
Very Soft	Below 500	0 - 2
Soft	500 - 1,000	3 - 4
Medium	1,000 - 2,000	5 - 8
Stiff	2,000 - 4,000	9 - 15
Very Stiff	4,000 - 8,000	16 - 30
Hard	8,000 - 16,000	31 - 50
Very Hard	Over 16,000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 - 50
Very Compact	86 - 100	Over 50

Relative Density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

AS - Auger Sample – Cuttings directly from auger flight
BS - Bottle or Bag Samples
S - Split Spoon Sample - ASTM D 1586
LS - Liner Sample with liner insert 3 inches in length
ST - Shelby Tube sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted

STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0 inch outside-diameter, 1-3/8 inch inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

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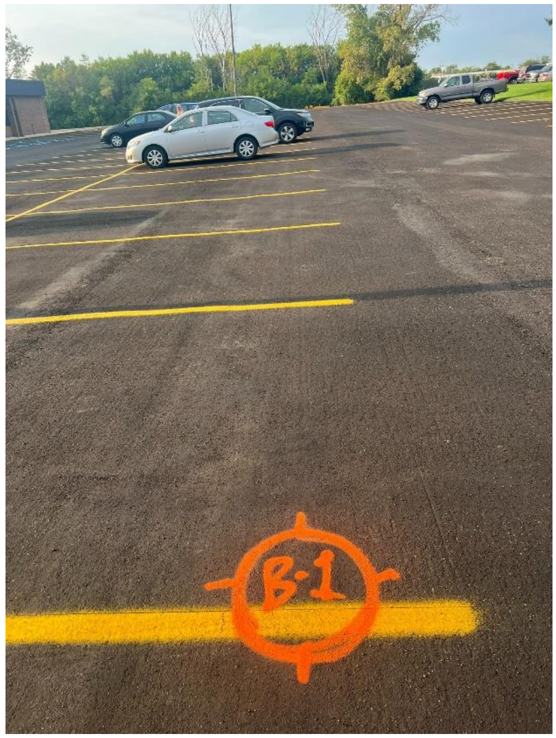
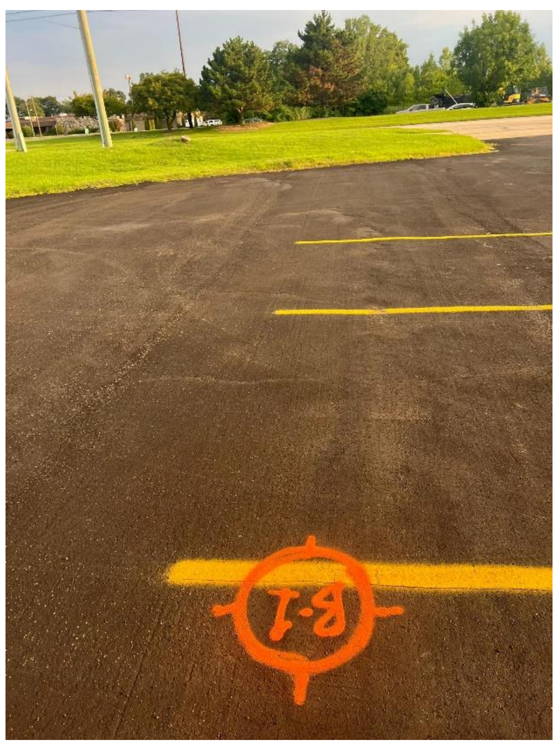


Photograph No. 1: Looking south across west lot.



Photograph No. 2: Looking north across west lot.

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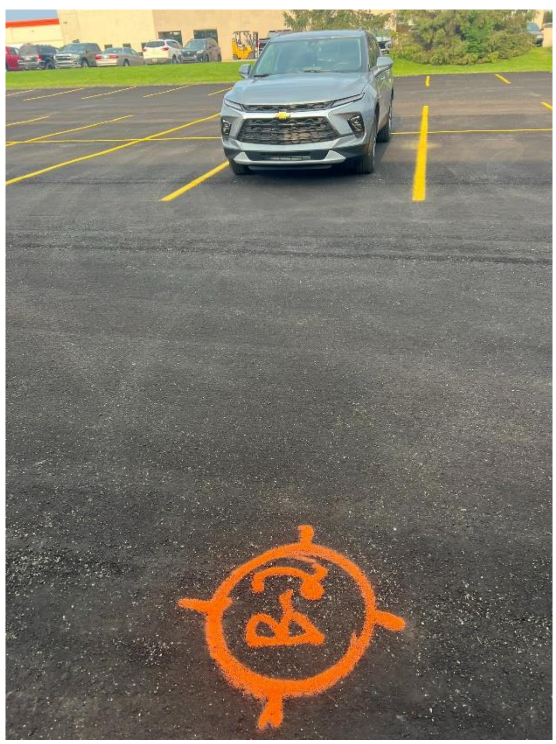
Photograph No. 3: Looking south.



Photograph No. 4: Looking west.

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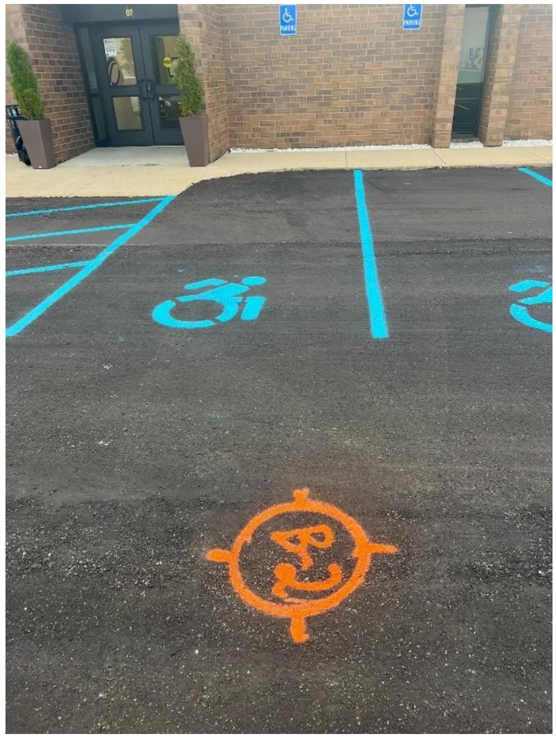

Photograph No. 5: Looking east, pavement flush with sidewalk about building.

Photograph No. 6: Looking south toward concrete pavement at south end of the lot.

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Photograph No. 7: Looking north across west lot.

Photograph No. 8: Looking west, note the concrete pavement on the south side of the lot and newer pavement on west lot. Moderate to high severity block cracking.

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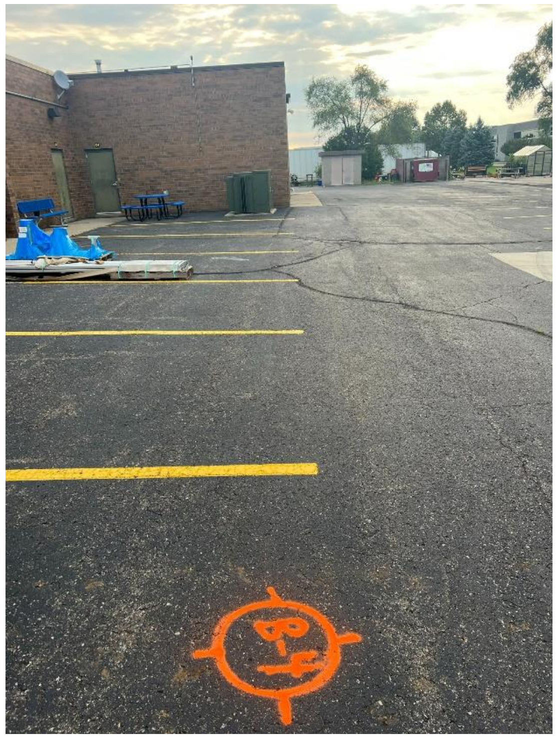

Photograph No. 9: Moderate severity block and fatigue cracking looking east.
Concrete color around catch basin. Pavement flush with building.

Photograph No. 10: Concrete pavement at south side of lot.
Moderate severity fatigue cracking.

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Troy, Michigan
G2 Project No. 230681

Photograph No. 11: Moderate severity block cracking with moderate to high severity fatigue cracking propagating outward, looking north along east lot.

Photograph No. 12: Moderate severity block and fatigue cracking looking south.

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Troy, Michigan
G2 Project No. 230681

Photograph No. 13: Moderate to high severity block and joint cracking with secondary fatigue cracking looking north toward drive entrance.

Photograph No. 14: High severity fatigue cracking and settlement evident. Previous patch constructed.

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Photograph No. 15: Moderate fatigue cracking at east entrance. Note asphalt curb.

Photograph No. 16: High severity fatigue cracking at center of lot
looking south from access drive.

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Photograph No. 17: Moderate to high severity longitudinal and transverse cracking, looking west along concrete lot.

Photograph No. 18: Moderate to high severity longitudinal and transverse cracking, looking east along concrete lot.

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Troy, Michigan
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Photograph No. 19: Moderate to high severity longitudinal and transverse cracking, looking north along concrete lot.

Photograph No. 20: Moderate to high severity longitudinal and transverse cracking, looking west along concrete lot.