Report on Geotechnical Pavement Investigation

Larson Middle School
2222 East Long Lake Road
Troy, Michigan 48085

Latitude 42.591964˚ N
Longitude 83.104871˚ W

Prepared for:

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

G2 Project No. 220949
December 27, 2022

December 27, 2022

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

Re: Report of Geotechnical Pavement Investigation
Larson Middle School
2222 East Long Lake Road
Troy, Michigan 48085
G2 Project No. 220949

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Larson 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 leading from East Long Lake Road into Larson Middle School in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.1, dated January 1, 2022, the drives will be reconstructed with new heavy-duty bituminous pavements with Portland cement concrete curb and gutter along both sides of the drives. Traffic counts at the site were not available upon completion of this report. However, it is our understanding traffic generally consists of busses, cars, delivery trucks, and garbage trucks.

The existing pavements consist of bituminous concrete measuring 4-1/2 to 5 inches in thickness. Approximately 9-1/2 to 11 inches of crushed bituminous concrete base underlie the bituminous concrete surface. Stiff to very stiff silty clay and clayey silt with seams of sandy silt are present below the pavement section and extend to the explored depth of 5 feet. The silty clay at an approximate depth of 2-1/2 feet at boring B-3 has a liquid limit of 21 percent, a plastic limit of 16 percent, and a plasticity index of 5 percent. No measurable groundwater was observed during or upon completion of drilling operations at the soil boring locations.

The northbound drive (east drive) is in fair condition with moderately severity block and edge cracking. Toward the southern half of the drive, more extensive fatigue cracking is also present. The southbound drive (west drive) is in poor condition with high severity fatigue and edge cracking throughout. It appears patching was performed along both sides of the southbound drive between 2010 and 2015.

The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the condition of the existing pavements. Additionally, the crushed bituminous concrete is not optimal for support of pavements and drainage as pavements age. Therefore, we recommend completely reconstructing the bituminous pavements. New concrete curb and gutter will be constructed in conjunction with the new pavements. In addition, we recommend finger drains be installed at each catch basin location to collect surface runoff water that may pond atop of the silty clay subgrade.

We recommend completely removing the existing bituminous concrete and underlying crushed bituminous concrete. We do not recommend reusing the crushed bituminous concrete due to the poor drainage characteristics of the material and potential for breakdown of the asphaltic material. The subgrade soils will generally consist of stiff to very stiff silty clay and clayey silt which should be proof rolled using a heavily loaded, rubber-tired, tandem-axle dump truck and evaluated for stability before constructing the new pavement cross-section. Unsuitable soils or 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.

We recommend a significant budget be allocated for undercutting (assuming a majority of the west drive due to the assumed water infiltration through the extensive pavement distress) with the percentage increasing as the subgrade is exposed to precipitation. This potential is reflected in the higher moisture contents and lower consistency values of the upper cohesive soils within borings B-4 through B-8. 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 silty clay may become unstable under repeated loading of construction traffic; therefore, construction equipment should be limited on the exposed cohesive subgrade.

Based on the results of our analyses, we recommend a heavy-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 3 inches of MDOT 4EML bituminous concrete leveling course, supported on 10 inches of 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.

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 leading from East Long Lake Road into Larson Middle School in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.1, dated January 1, 2022, the drives will be reconstructed with new heavy-duty bituminous pavements with Portland cement concrete curb and gutter along both sides of the drives.

Traffic counts at the site were not available upon completion of this report. However, it is our understanding traffic generally consists of busses, cars, delivery trucks, and garbage trucks. The age of the existing pavements was not available upon completion of this report. However, after review of Google Earth Historical Aerial Photographs, it appears the pavements were constructed sometime prior to 2002. Between 2010 and 2015, some patching was performed along both sides of the drive.

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 access drives 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, 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 2-1/2 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, Atterberg limits, 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 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. 9 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 4-1/2 to 5 inches in thickness. Approximately 9-1/2 to 11 inches of crushed bituminous concrete base underlie the bituminous concrete surface.

The northbound drive (east drive) is in fair condition with moderately severity block and edge cracking (Photograph Nos. 1 through 4). Toward the southern half of the drive, more extensive fatigue cracking is also present (Photograph No. 5). The southbound drive (west drive) is in poor condition with high severity fatigue and edge cracking throughout (Photograph Nos. 6 through 12). It appears patching was performed along both sides of the southbound drive between 2010 and 2015 with more significant areas on the west side show with red arrows below.

No curb and gutter are present at the edge of the drives. Catch basins are present along the drives, on both sides of the drives, indicated by red ovals on the Soil Boring Location Plan. Portland cement concrete collars have been constructed around a few of the catch basins. The catch basins are both block and mortar and pre-cast concrete structures (Photograph Nos. 16, 17, 19, 22 and 23).

EXISTING SUBSURFACE CONDITIONS

Silty clay and clayey silt with seams of sandy silt underlie the pavement section and extend to the explored depth of 5 feet. The silty clay and clayey silt are stiff to very stiff in consistency with natural moisture contents ranging from 11 to 17 percent and unconfined compressive strengths ranging from 3,000 to 7,500 psf. The silty clay within boring B-3 has a liquid limit of 21 percent and a plastic limit of 16 percent.

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, Atterberg Limit Results, Figure No. 9, and Photographic Documentation, Figure Nos. 10 through 21, 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. 22.

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

General

The existing pavements are in poor conditions with more than half of the pavement exhibiting high severity block, edge, and fatigue cracking. The southbound lane is more extensive than the northbound lane.

The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the condition of the existing pavements. Additionally, the crushed bituminous concrete is not optimal for support of pavements and drainage as pavements age. Therefore, we recommend completely reconstructing the bituminous pavements. New concrete curb and gutter will be constructed in conjunction with the new pavements. In addition, we recommend finger drains be installed at each catch basin location to collect surface and subsurface runoff water that may pond atop of the silty clay subgrade.

Pavement Subgrade Preparation

We recommend completely removing the existing bituminous concrete and underlying crushed bituminous concrete. The subgrade soils will generally consist of stiff to very stiff silty clay and clayey silt with sandy silt seams. The exposed subgrade soils should be proof rolled using a heavily loaded, rubber-tired, tandem-axle dump truck and evaluated for stability before constructing the new pavement cross-section. Unsuitable soils or 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. The contractor should be prepared to utilize tri-axial geogrid to minimize extensive undercuts as directed by a G2 engineer or qualified personnel.

We recommend a significant budget be allocated for undercutting, assuming a majority of the west drive due to the assumed water infiltration through the extensive pavement distress, with the percentage increasing as the subgrade is exposed to precipitation. This potential is reflected in the higher moisture contents and lower consistency values of the upper silty clay within borings B-4 through B-8. Additionally, the sandy silt seams within the cohesive material can become unstable when exposed to moisture. 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.

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. Lift thicknesses should not exceed 9 inches. The use of a tri-axial geogrid may reduce undercut depths, if needed.

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 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 generally consist of silty clay 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 5,000 pounds per square inch (psi).

It is our understanding traffic at the site consists of cars, dump trucks, garbage trucks, and semi-trucks. If any actual traffic volume information becomes available, G2 should be notified so we can reevaluate our recommendations. We have designed the heavy-duty pavement section on an estimated of 150,000 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 0.49 for flexible pavements, and a reliability factor of 0.95.

Based on the results of our analyses, we recommend a heavy-duty flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 3 inches of MDOT 4EML bituminous concrete leveling course (placed in two 1-1/2 inch lifts), supported on 10 inches of 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. 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 edge drains be installed along curb lines between catch basins. In addition, 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.

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

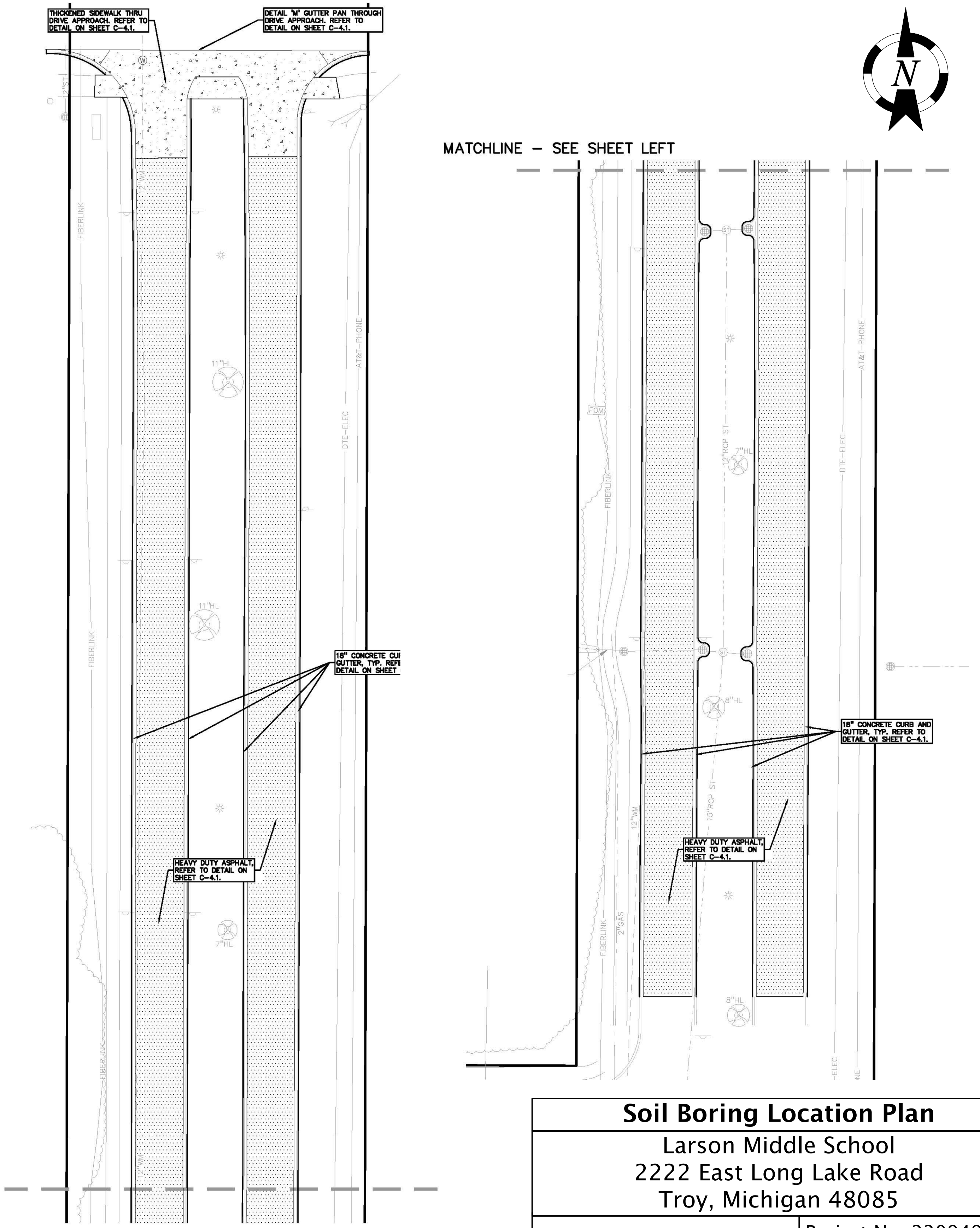
We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention 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 December 13, 2022
○	Drainage Structure

Soil Boring Location Plan

Larson Middle School
2222 East Long Lake Road
Troy, Michigan 48085

G2 CONSULTING GROUP

Project No. 220949
Drawn by: ALS
Date: 12/16/22
Scale: NTS

Plate No. 1

Project Name: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

Latitude: N/A Longitude: N/A

Soil Boring No. **B-1**

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		AS-1					
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (11 inches) 1.3							
	▥	Very Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt layers		AS-2			15.0		5000*
5		5.0	5	AS-3			15.3		5000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
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

Figure No. 1

Project Name: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

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		AS-1					
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (10 inches) 1.3							
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt layers		AS-2			11.3		7500*
5	▨	5.0	5	AS-3			14.4		6000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
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: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

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.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
	■	Bituminous Concrete (4-1/2 inches) 0.4		AS-1					
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (9-1/2 inches) 1.2							
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel		AS-2			16.5		4000*
5	▨	5.0	5	AS-3			15.4		5000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
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

Figure No. 3

Project Name: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

Latitude: N/A Longitude: N/A

Soil Boring No. **B-4**

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		AS-1					
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (10 inches) 1.3							
	▥	Very Stiff Brown and Gray Clayey Silt with trace sand and gravel 3.0		AS-2			13.2		6500*
5	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	AS-3			14.7		5000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
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 upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

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 (5 inches) 0.4		AS-1					
	▨	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (10 inches) 1.3							
	▥	Stiff to Very Stiff Brown Clayey Silt with trace sand and gravel		AS-2			17.4		3000*
5	▥	5.0	5	AS-3			16.2		4000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
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

Figure No. 5

Project Name: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

Latitude: N/A Longitude: N/A

Soil Boring No. **B-6**

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 (4-1/2 inches) 0.4		AS-1					
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (9-1/2 inches) 1.2		AS-2			17.0		3000*
5	▨	Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	AS-3			15.9		4000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
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

Figure No. 6

Project Name: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

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 (4-1/2 inches) 0.4		AS-1					
	▨	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (9-1/2 inches) 1.2							
	▥			AS-2			17.2		3000*
5	▥	Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt layers 5.0	5	AS-3			15.9		4000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
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: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No. 220949

Latitude: N/A Longitude: N/A

Soil Boring No. **B-8**

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	AS-1					
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (10 inches)	1.3						
	▨	Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt layers		AS-2			16.6		3500*
5			5.0	AS-3			15.1		4500*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 13, 2022
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

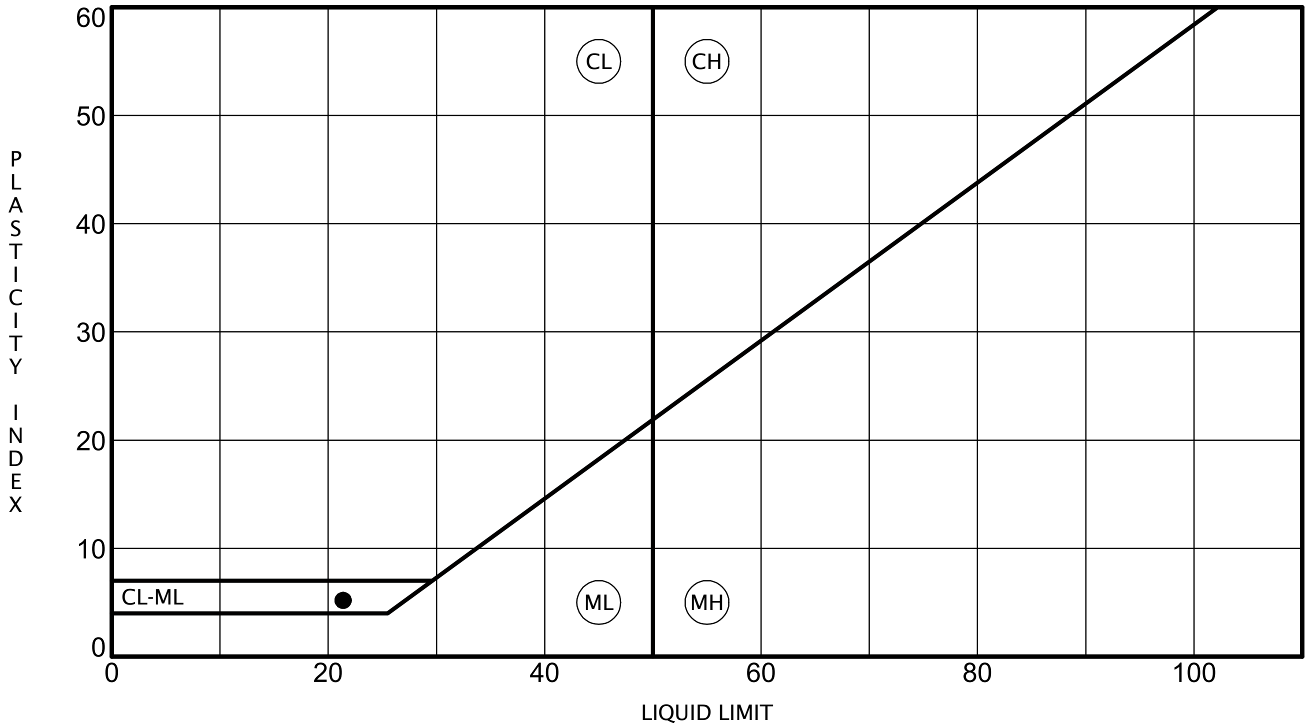
Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 8



Specimen Identification			LL	PL	PI	Fines	M %	Classification
●	B-3	AS-2	21	16	5		16	Brown and Gray Silty Clay

ATTERBERG LIMITS RESULTS

2 CONSULTING GROUP

Project Name: Larson Middle School

Project Location: 2222 East Long Lake Road
Troy, Michigan 48085

G2 Project No.: 220949

Figure No. 9

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 1: Moderate severity edge cracking at exit to E. Long Lake Road.

Photograph No. 2: Looking south from B-1, moderate severity transverse cracking.

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 3: Moderate severity transverse and edge cracking near B-2. Bituminous curb along drive.

Photograph No. 4: Looking south from B-2, moderate severity block cracking along entire alignment.

Figure No. 11

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 5: Moderate to high severity block cracking near B-3. Patch noted on west side of drive.

Photograph No. 6: High severity block and edge cracking. Patch noted on west side of drive.

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 7: High severity block and edge cracking. Note previous site work.

Photograph No. 8: High severity fatigue cracking near B-5. Patching throughout drive.

Figure No. 13

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 9: High severity block and edge cracking and patching throughout.

Photograph No. 10: High severity fatigue cracking and previous patching near B-6.

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 11: High severity block and edge cracking. Previous patching.

Photograph No. 12: High severity block and fatigue cracking looking south from B-7.

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 13: Concrete entrance apron along East Long Lake Road, transverse cracking.

Photograph No. 14: Overall view of entrance drive. Note high severity edge cracking throughout and previous patching.

Photograph No. 15: Drains along east side of drive leading into wooded area.

Photograph No. 16: Catch basin adjacent to drain.

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 17: Interior of catch basin adjacent to drain.

Photograph No. 18: Catch basins along interior of boulevard. Note newer concrete collars.

Photograph No. 19: Interior of boulevard catch basin.

Photograph No. 20: Catch basin along interior of boulevard at south end of drives.

Photograph No. 21: Catch basin along interior of boulevard at south end of drives.

Photograph No. 22: Interior of boulevard catch basin.

Photographic Documentation
Larson Middle School
Troy, Michigan
G2 Project No. 220949

Photograph No. 23: Interior of boulevard catch basin.

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).

Report on Geotechnical
Pavement Investigation

Schroeder Elementary School
3514 Jack Drive
Troy, Michigan 48084

Latitude 42.568214° N
Longitude 83.193669° W

Prepared for:

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

G2 Project No. 220976
January 4, 2023

January 4, 2023

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

Re: Report of Geotechnical Pavement Investigation
Schroeder Elementary School
3514 Jack Drive
Troy, Michigan 48084
G2 Project No. 220976

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Schroeder 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 north access drive, northwest parking lot, and west play surface at Schroeder Elementary in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.2, dated January 1, 2022, the access drive and a portion of the parking lots are designed to be reconstructed with a heavy-duty bituminous pavement section and the remainder of the parking lots are designed to be reconstructed with a standard-duty bituminous pavement section, as depicted on the Soil Boring Location Plan, Plate No. 1. Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic will generally consist of cars, delivery trucks, and garbage trucks.

The existing pavements consist of bituminous concrete measuring 2-1/2 to 4-1/2 inches in thickness. Approximately 6-1/2 to 8 inches of crushed concrete base underlie the bituminous concrete surface at borings B-1 through B-6 and approximately 8-1/2 inches of limestone aggregate base underlie the bituminous concrete surface at borings B-7 and B-8. Loose to medium compact silty sand fill is present below the pavement section at borings B-1, B-2, and B-5 and extends to approximate depths ranging from 4-1/2 feet to the explored depth of 5 feet. Stiff silty clay fill and sandy clay fill with trace organic matter underlies the pavement section at borings B-3, B-4, B-6, and B-7 and extends to approximate depths ranging from 2 to 3-1/2 feet. Native stiff to very stiff silty clay is present below the fill and extends to the explored depth of 5 feet. Groundwater was measured within borings B-1, B-2, B-6, and B-7 during drilling operations at approximate depths ranging from 9 inches to 4-1/2 feet. No measurable groundwater was observed during or upon completion of drilling operations at the remaining soil boring locations.

The existing pavements are generally overall in fair condition with less than half of the pavement exhibiting moderate severity block and fatigue cracking. The distress is most significant within the north drive and south side of the north lot. The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the thin nature of the existing bituminous concrete and areas of heavy fatigue. Therefore, we recommend completely reconstructing the bituminous pavements supported on the existing aggregate base. This will provide a more cost effective alternative and reduce the amount of exported/imported material required.

We recommend a budget be allocated for undercutting (on the order of 25 to 30 percent) due to the assumed water infiltration through the pavement distress and presence of organic matter, 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 flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 2-1/2 inches of MDOT 4EML bituminous concrete leveling course, supported on the existing aggregate base or a minimum of 8 inches of MDOT 21AA dense graded aggregate base course where undercuts are required. The existing aggregate base should be fine graded to allow for placement of the design section on the maximum thickness of aggregate base. The pavement section can be decreased to 4 inches adjacent to the building and sidewalk to match existing grades and facilitate drainage, as shown on Plate No. 1.

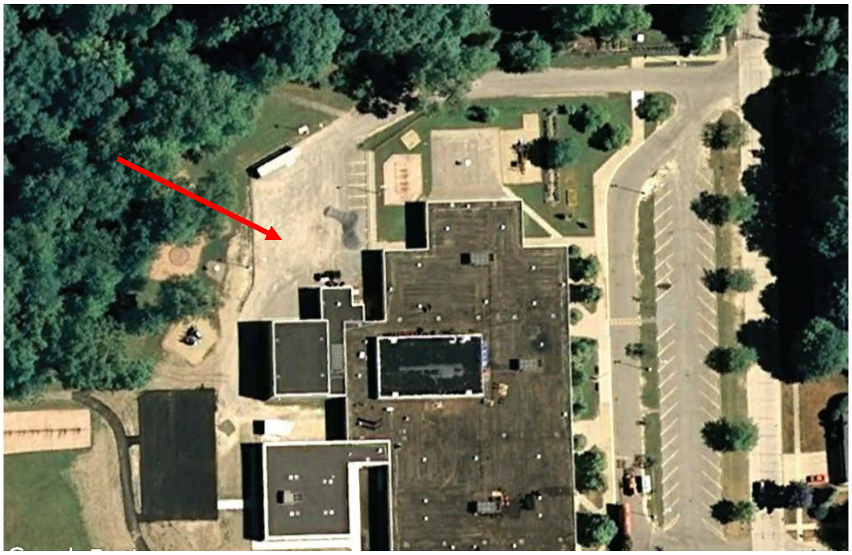
This summary is not to be considered separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

PROJECT DESCRIPTION

We understand the project consists of rehabilitation/reconstruction of the north access drive, north parking lot, and west play surface at Schroeder Elementary in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.2, dated January 1, 2022, the access drive and a portion of the parking lots are designed to be reconstructed with a heavy-duty bituminous pavement section and the remainder of the parking lots are designed to be reconstructed with a standard-duty bituminous pavement section, as depicted on the Soil Boring Location Plan, Plate No. 1. No existing curb and gutter are present around the pavement area currently and are not planned for the reconstruction project.

We anticipate traffic for the pavement associated with this investigation will consists primarily of passenger cars with occasional delivery trucks and garbage trucks within the heavy-duty designed areas, as well as dump trucks and semi-trucks during construction.

The age of the existing pavements was not available upon completion of this report. However, after review of Google Earth Historical imagery, it appears the pavements are upwards of 20 years old, with the exception of the play surface which was constructed between 2006 and 2007 in conjunction with an addition. The parking lot and access drive appear to have been subjected to construction traffic during this time as shown in image 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 pavement areas 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, organic matter content (loss-on-ignition), 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 2-1/2 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, organic matter content, 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 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 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, 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 results are presented on Figure No. 9 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 2-1/2 to 4-1/2 inches in thickness. Approximately 6-1/2 to 8 inches of crushed concrete base underlie the bituminous concrete surface at borings B-1 through B-6, and approximately 8-1/2 inches of limestone aggregate base underlie the bituminous concrete surface at borings B-7 and B-8. The limestone aggregate base sample from boring B-7 meets the gradation requirements of MDOT 21AA dense graded aggregate as presented graphically on Figure No. 9 in the Appendix. The crushed concrete sample from boring B-1 is out of specification for the ½-inch sieve requirements as well as containing recycled material.

The pavements at the school are bituminous concrete with no curb and gutter present around the perimeter. The existing pavement within the north drive is in fair condition with areas of high severity fatigue cracking (Photograph Nos. 2 and 3). Based on visual observations, grades slope downward to the south which is evident with the lack of vegetation and greater distress on the south side of the drive (Photograph No. 1). A precast concrete catch basin with a concrete collar is present within the drive (Photographs 3, 17, and 18) and appears to be in good condition.

The north lot is in fair to good condition with the northwest side of the lot showing little to no distress (Photograph Nos. 4 and 5). The pavement distress increases toward the south side of the lot with areas moderate to high severity block and fatigue cracking (Photograph Nos. 6 through 8). The pavement appears to slope to the south toward one precast concrete catch basin with a concrete collar which appears to be in good condition (Photograph Nos. 7, 15, and 16).

The west drive is in good condition with low severity transverse cracking toward the south side of the drive which appears to be the low spot. Based on visual observations, the grade slopes downward to the west and south, evidenced with the lack of vegetation (Photograph Nos. 9 and 10).

The west lot appears to be used as a play surface for basketball. The lot is in relatively good condition around the perimeter of the lot and has low to moderate severity longitudinal and fatigue cracking through the center of the lot in a north/south direction (Photograph Nos. 11 through 13). Grades appear to slope toward the center of the lot, with one precast concrete catch basin the center of the pavement and an additional structure off the southeast side of the pavement (Photograph Nos. 12 and 14).

EXISTING SUBSURFACE CONDITIONS

Silty sand fill is present below the pavement section at borings B-1, B-2, and B-5 and extends to approximate depths ranging from 4-1/2 feet to the explored depth of 5 feet. Silty clay fill and sandy clay fill underlies the pavement section at borings B-3, B-4, B-6, and B-7 and extends to approximate depths ranging from 2 to 3-1/2 feet. Native silty clay is present below the fill and extends to the explored depth of 5 feet.

The silty sand fill is loose to medium compact with Standard Penetration Test N-values ranging from 8 to 12 blows per foot. The silty clay fill and sandy clay fill are stiff in consistency with moisture contents ranging from 18 to 21 percent, unconfined compressive strengths ranging from 3,000 to 4,000 psf, and organic matter contents of 2.3 and 3.3 percent. The native silty clay is stiff to very stiff in consistency with natural moisture contents ranging from 12 to 23 percent and unconfined compressive strengths ranging from 2,000 to 6,000 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 8, Grain Size Distribution, Figure No. 9, and Photographic Documentation, Figure Nos. 10 through 19, 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. 20.

GROUNDWATER CONDITIONS

Groundwater was measured within borings B-1 and B-2 during and upon completion of drilling operations at approximate depths of 3 to 4-1/2 feet in borings B-1 and B-2. We anticipate the encountered water at these borings is perched within the granular fill, potentially backfill from the adjacent storm drain. At borings B-6 and B-7, groundwater was encountered at an approximate depth of 9 inches during drilling operations. Upon completion of drilling at these borings, no measurable groundwater was noted within the boreholes, indicating it may be perched within the aggregate base. No measurable groundwater was observed during or upon completion of drilling operations at the remaining soil 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

General

The existing pavements are overall in fair conditions with less than half of the pavement exhibiting moderate severity block and fatigue cracking. The distress is most significant within the north drive and south side of the north lot.

The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the thin nature of the existing bituminous concrete and areas of heavy fatigue. Therefore, we recommend completely reconstructing the bituminous pavements, supported on the existing aggregate base.

Pavement Subgrade Preparation

We recommend completely removing the existing bituminous concrete. The subgrade soils will generally consist of existing aggregate base over granular and cohesive fill soils. The exposed aggregate base should be fine graded allow placement of the design pavement section while maintaining the maximum thickness of aggregate base.

The exposed subgrade should be proof rolled using a heavily loaded, rubber-tired, tandem-axle dump truck and evaluated for stability before constructing the new pavement cross-section. Unsuitable soils or 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. The contractor should be prepared to utilize tri-axial geogrid to minimize extensive undercuts as directed by a G2 engineer or qualified personnel.

We recommend a budget be allocated for undercutting (on the order of 25 to 30 percent) due to the assumed water infiltration through the existing pavement distress and presence of organic matter, 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.

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. Lift thicknesses should not exceed 9 inches. The use of a tri-axial geogrid may reduce undercut depths, if needed, and should be directed by qualified personnel.

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 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 typically consist of predominantly granular and cohesive fill soils (with organic matter at borings B-6 and B-7) 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 5,000 pounds per square inch (psi).

We anticipate traffic for the pavement associated with this investigation will consists primarily of passenger cars with occasional delivery trucks and garbage trucks within the heavy-duty designed areas, as well as dump trucks and semi-trucks during construction. If any actual traffic volume information becomes available, G2 should be notified so we can reevaluate our recommendations. We have designed the pavement section on an estimated of 100,000 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 0.49 for flexible pavements, and a reliability factor of 0.95.

Based on the results of our analyses, we recommend a flexible pavement section consisting of 2 inches of 5EML bituminous concrete wearing course over 2-1/2 inches of MDOT 4EML bituminous concrete leveling course, supported on the existing aggregate base or a minimum of 8 inches of MDOT 21AA dense graded aggregate base course where undercuts are required. The pavement section can be decreased to 4 inches adjacent to the building and sidewalk to match existing grades and facilitate drainage, as shown on Plate No. 1.

Large front-loading refuse trucks can impose significant concentrated wheel loads within trash dumpster pick-up areas. This type of loading can result in rutting of asphalt pavements and ultimately in failure. Therefore, we recommend reinforced 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. 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 cohesive subgrade soils due to their relatively impermeable nature. The pavement and subgrade below the aggregate base should be properly sloped to promote effective surface and subsurface 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.

Based on the lack of vegetation around the perimeter of the pavements, especially on the south side of the north drive and west side of west drive, the pavement should be graded to better facilitate drainage to existing structures. Consideration should be given to installing edge drains around the perimeter of pavements in areas of poor drainage such as the south side of the north drive and west side of west drive. We also recommend installing finger drains at each catch basin to remove groundwater from the aggregate base layer, particularly as pavements age. 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.

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

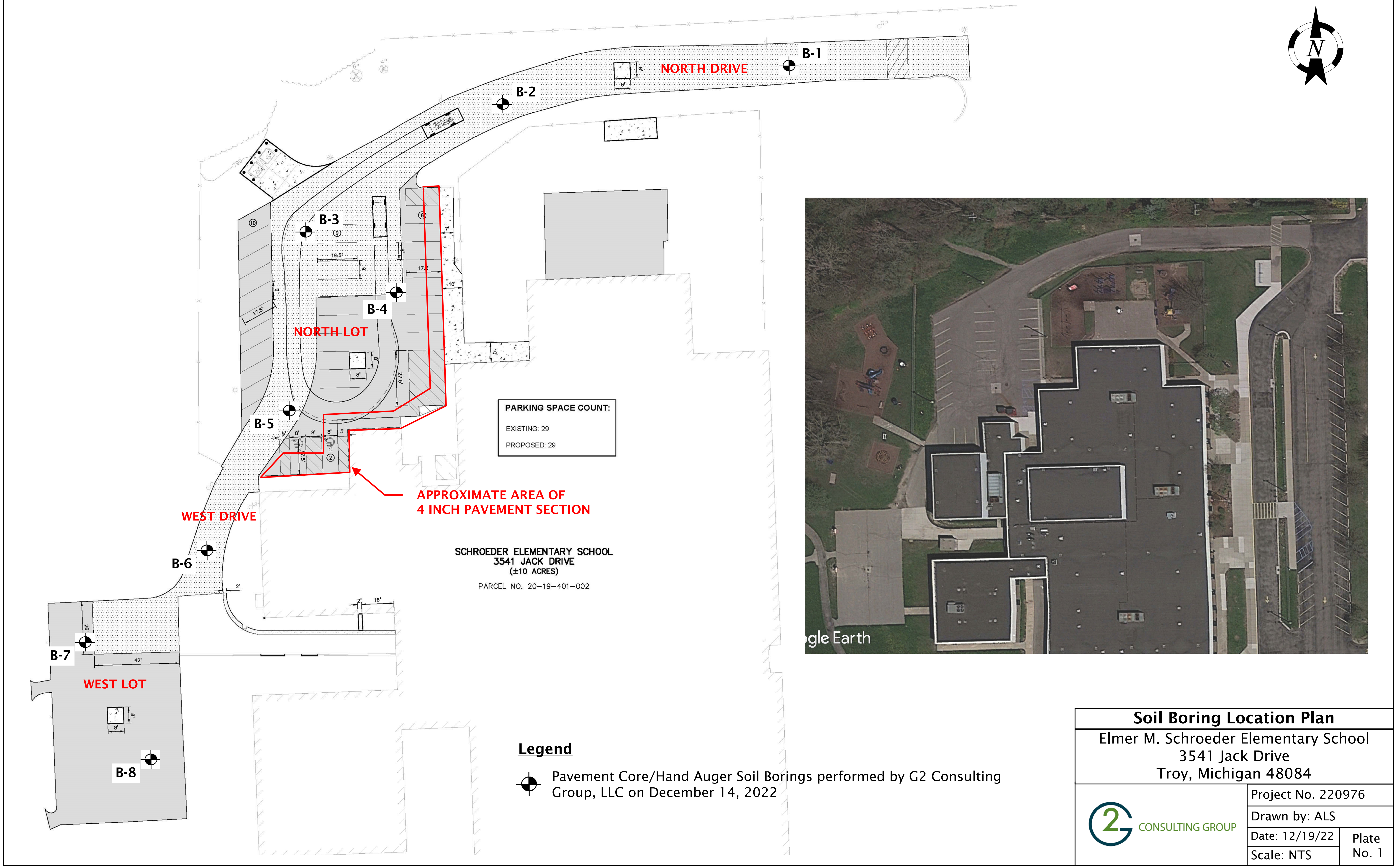
We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention 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 December 14, 2022

Soil Boring Location Plan

Elmer M. Schroeder Elementary School
3541 Jack Drive
Troy, Michigan 48084

G2 CONSULTING GROUP

Project No. 220976	
Drawn by: ALS	
Date: 12/19/22	Plate No. 1
Scale: NTS	

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976
Latitude: N/A Longitude: N/A

Soil Boring No. **B-1**

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 Sand and Gravel with trace silt (8 inches) 0.9		AS-1				
	▨	Fill: Loose to Medium Compact Brown Silty Sand with trace gravel ▼		AS-2	12			
5	▨	5.0	5	AS-3	8			
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

Water Level Observation:
4-1/2 feet 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. 1

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976

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 Concrete Aggregate Base: Gray Sand and Gravel with trace silt (7 inches) 0.9						
	▨	▼ Fill: Medium Compact Brown Silty Sand with trace gravel 4.5		AS-2	11			
5	▥	Very Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	AS-3	17	13.2		5000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 2

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976

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 Concrete Aggregate Base: Gray Sand and Gravel with trace silt (6-1/2 inches) 0.9						
	▨	Fill: Very Stiff Brown Silty Clay with trace sand and gravel, occasional sand seams and layers 3.5		AS-2	13	17.8		4000*
5	▥	Very Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	AS-3	20	12.1		6000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
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

Figure No. 3

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976
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 (4-1/2 inches) 0.4						
	▨	Crushed Concrete Aggregate Base: Gray Sand and Gravel with trace silt (8 inches) 1.0		AS-1				
	▨	Fill: Stiff Brown Sandy Clay with trace silt and gravel, occasional sand seams and layers 3.5		AS-2	10	21.0		3000*
5	▥	Very Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	AS-3	15	16.4		4500*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 4

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976
Latitude: N/A Longitude: N/A

Soil Boring No. **B-5**

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						
	▨	Crushed Concrete Aggregate Base: Gray Sand and Gravel with trace silt (7-1/2 inches) 0.9		AS-1				
5	▨	Fill: Loose to Medium Compact Brown Silty Sand with trace gravel, occasional clay seams 5.0	5	AS-2 AS-3	12 10			
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

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. 5

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976

Latitude: N/A Longitude: N/A

Soil Boring No. **B-6**

G2 CONSULTING GROUP

SUBSURFACE PROFILE

DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)
	■	Bituminous Concrete (3 inches) 0.3	
	▨ ∇	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (8 inches) 0.9	
	▨	Fill: Dark Brown Sandy Clay with trace organic matter (Organic Matter Content = 2.3%) 2.0	
5	▥	Very Stiff Brown Silty Clay with trace sand and gravel 5.0	5
		End of Boring @ 5 ft	

SOIL SAMPLE DATA

SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
AS-1				
AS-2	15	14.6		4500*
AS-3	20	12.0		6000*

Total Depth: 5 ft
Drilling Date: December 14, 2022
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:
9 inches during; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 6

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976
Latitude: N/A Longitude: N/A

Soil Boring No. **B-7**

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 (2-1/2 inches)	0.2						
	▩ ▽	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (8-1/2 inches)	0.9		AS-1				
	▩	Fill: Dark Brown Sandy Clay with trace organic matter (Organic Matter Content = 3.3%)	2.0		AS-2	7	22.8		2000*
5	▥	Stiff to Very Stiff Brown Silty Clay with trace sand and gravel	5.0	5	AS-3	15	16.7		4500*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 14, 2022
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:
9 inches during; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 7

Project Name: Schroeder Elementary School

Project Location: 3514 Jack Drive
Troy, Michigan 48084

G2 Project No. 220976
Latitude: N/A Longitude: N/A

Soil Boring No. **B-8**

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 (2-1/2 inches)	0.2						
	▩	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (8-1/2 inches)	1.0		AS-1				
	▨	Stiff to Very Stiff Brown Silty Clay with trace sand and gravel			AS-2	12	18.6		3500*
5			5.0	5	AS-3	15	16.1		4500*
		End of Boring @ 5 ft							

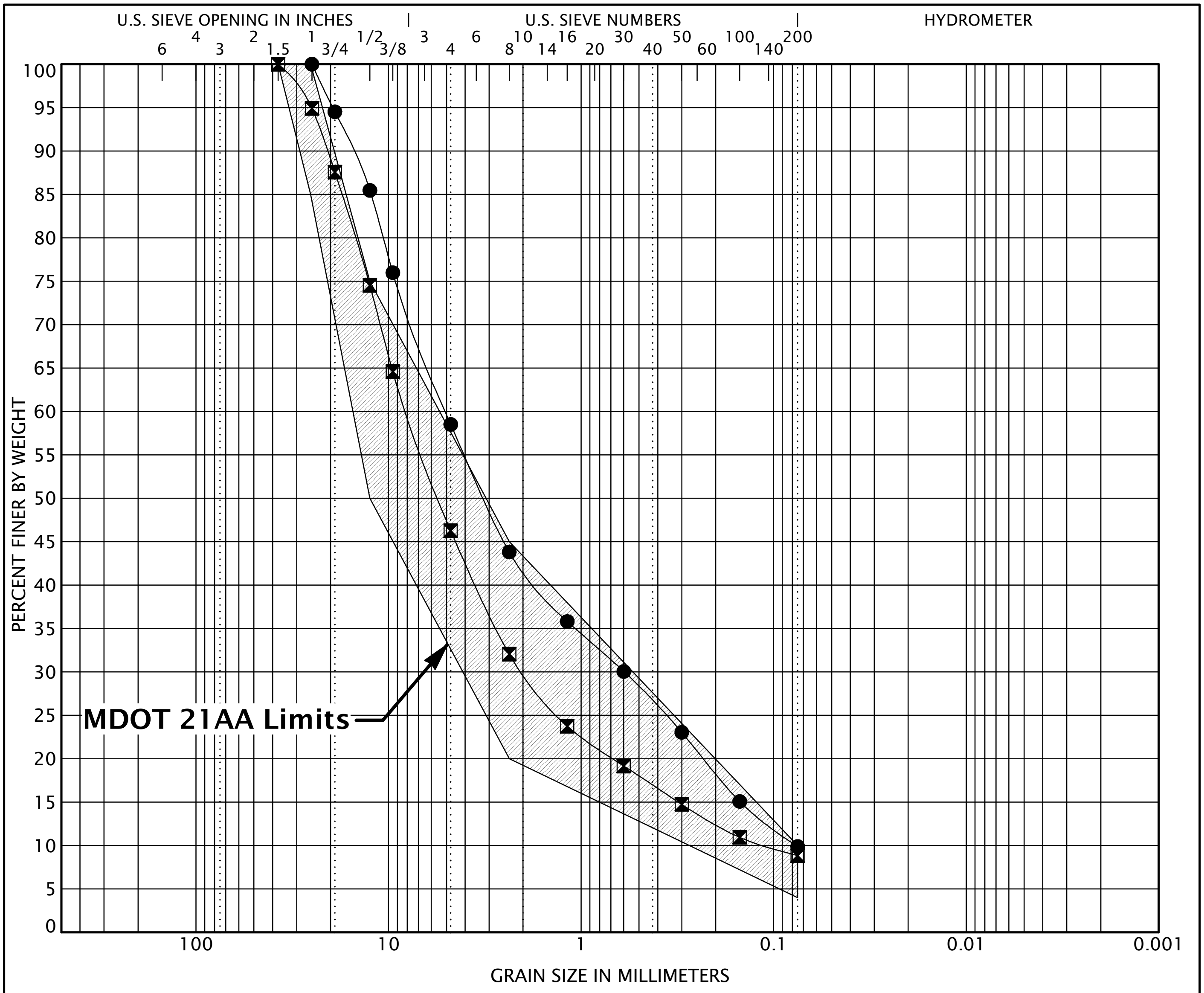
Total Depth: 5 ft
Drilling Date: December 14, 2022
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

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



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen ID			Description	LL	PL	PI	Cc	Cu
●	B-1	AS-1	Gray Sand and Gravel with trace silt				0.93	66.10
☒	B-7	AS-1	Gray Gravel and Sand with trace silt				4.52	72.72

Specimen ID			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	AS-1	25	5.041	0.597	0.076	41.5	48.6	9.9	
☒	B-7	AS-1	37.5	7.988	1.99	0.11	53.8	37.4	8.8	

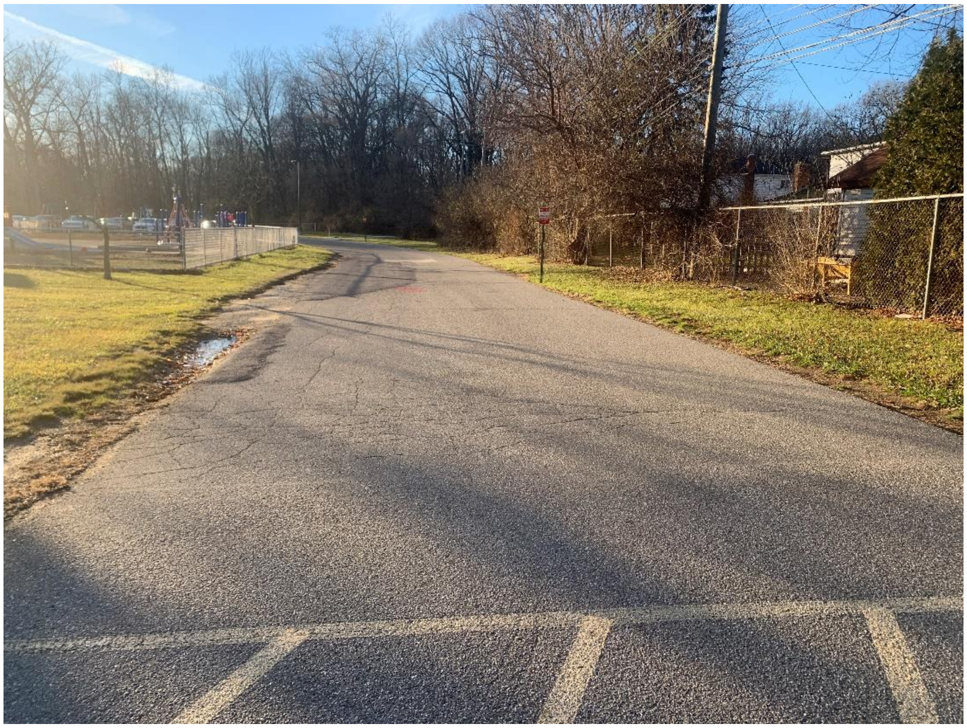
GRAIN SIZE DISTRIBUTION

Project Name:	Schroeder Elementary School
Project Location:	3514 Jack Drive Troy, Michigan 48084
G2 Project No.:	220976

Figure No. 9

US_GRAIN_SIZE_MDOT_21AA 220976.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 1/4/23

Photographic Documentation
Schroeder Elementary School
Troy, Michigan
G2 Project No. 220976



Photograph No. 1: Low to moderate severity edge and fatigue cracking east of B-1.

Photograph No. 2: High severity fatigue cracking near B-1, previous patching and lack of vegetation on south side of drive.

Photographic Documentation
Schroeder Elementary School
Troy, Michigan
G2 Project No. 220976

Photograph No. 3: High severity fatigue cracking near B-2. Concrete collar around catch basin east of B-2.

Photograph No. 4: Looking south toward B-3, pavement is relatively good condition.

Photographic Documentation
Schroeder Elementary School
Troy, Michigan
G2 Project No. 220976

Photograph No. 5: Pavement in relatively good condition near B-3.

Photograph No. 6: High severity fatigue cracking looking north at B-4 and beyond.

Photograph No. 7: Moderate to high severity fatigue and block cracking, looking north toward B-4.

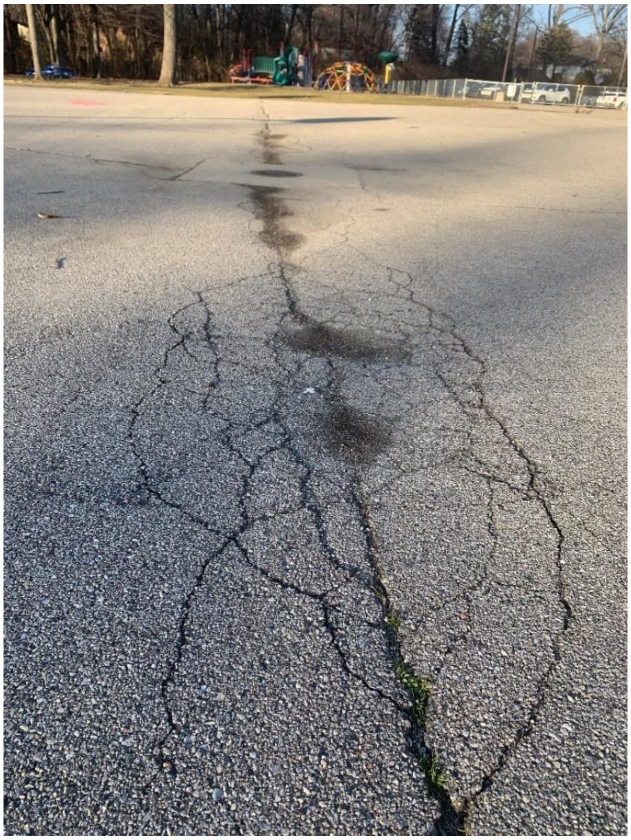
Photograph No. 8: Moderate severity block and fatigue cracking near B-5. Settlement noted in areas of heavy fatigue.

Photograph No. 9: Note lack of vegetation along west drive near B-6, indicative of poor drainage.

Photograph No. 10: West drive in relatively good condition.

Photographic Documentation
Schroeder Elementary School
Troy, Michigan
G2 Project No. 220976

Photograph No. 11: Low to moderate severity block cracking near B-7.



Photograph No. 12: Moderate severity longitudinal and fatigue cracking along center of play surface, in line with drainage lines.

Figure No. 15

Photograph No. 13: Low to moderate severity longitudinal and fatigue cracking along center of play surface.

Photograph No. 14: Drainage structure southwest of pavement surface.

Photograph No. 15: Interior of precast storm structure with standing water.

Photograph No. 16: Catch basin with concrete collar southwest of B-4, high severity fatigue cracking around collar.

Photographic Documentation
Schroeder Elementary School
Troy, Michigan
G2 Project No. 220976

Photograph No. 17: Interior of precast structure near B-4, holding water.

Photograph No. 18: Drainage structure east of B-2.

Photographic Documentation
Schroeder Elementary School
Troy, Michigan
G2 Project No. 220976

Photograph No. 19: Interior of precast drainage structure near B-2, holding water.

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).

Report on Geotechnical
Pavement Investigation

Leonard Elementary School
4401 Tallman Drive
Troy, Michigan 48085

Latitude 42.583987˚ N
Longitude 83.140418˚ W

Prepared for:

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

G2 Project No. 220977
January 4, 2023

January 4, 2023

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

Re: Report of Geotechnical Pavement Investigation
Leonard Elementary School
4401 Tallman Drive
Troy, Michigan 48085
G2 Project No. 220977

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Leonard 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

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

EXECUTIVE SUMMARY

We understand the project consists of rehabilitation/reconstruction of the north drive, northwest lot, and two paved playground surfaces (middle and south lots) at Leonard Elementary in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.3, dated January 1, 2022, the north drive and perimeter of the northwest lot will be reconstructed with a heavy-duty bituminous pavement section and the interior of the parking lot, middle lot, and south lot will be reconstructed with a standard-duty bituminous pavement section. Portland cement concrete curb and gutter are present around the perimeter of the north drive and northwest lot. Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic for the north drive and northwest lot will generally consist of busses (as this is the main drop off loop), cars, delivery trucks, and garbage trucks, and the middle and south lots will generally see pedestrian traffic.

The existing pavements consist of bituminous concrete measuring 1-1/2 to 3 inches in thickness. Approximately 6-1/2 to 10-1/2 inches of limestone aggregate base underlie the bituminous concrete surface. Stiff to very stiff silty clay is present below the pavement section and extends to the explored depth of 5 feet. The silty clay at an approximate depth of 2-1/2 feet at boring B-4 has a liquid limit of 29 percent, a plastic limit of 16 percent, and a plasticity index of 13 percent. No measurable groundwater was observed during or upon completion of drilling operations at the soil boring locations.

The existing pavements appear to be between 15 and great than 20 years old. The pavements at the north drive and northwest lot are in poor condition with more than half of the pavement exhibiting moderate to high severity block and fatigue cracking. These existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the condition of the existing pavements, early distress noted in the pavements, and thin bituminous and aggregate sections. Therefore, we recommend completely reconstructing the bituminous pavements at the north drive and northwest lot. At the middle and south lots, the pavements are in fair to good condition with less than half the pavement exhibiting low to moderate severity block and fatigue cracking. We recommend the existing bituminous pavement at these lots be removed and a new bituminous pavement surface constructed on the existing aggregate base after completion of pavement subgrade preparation.

We recommend a budget be allocated for undercutting (on the order of 25 percent of the pavement area) due to the assumed water infiltration through the extensive pavement distress, 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 at the northwest lot consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course, supported on 9 inches of MDOT 21AA dense graded aggregate base course and a heavy-duty flexible pavement section for the north drive and northwest lot consisting of 2 inches of 5EML bituminous concrete wearing course over 3 inches of MDOT 4EML bituminous concrete leveling course (placed in 2 lifts), supported on 8 inches of MDOT 21AA dense graded aggregate base course. At the middle and south lots, we recommend the standard-duty pavement section consist of 2 inches of MDOT 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course placed over the existing aggregate base or a minimum of 6 inches of MDOT 21AA dense graded aggregate where subgrade undercuts are required.

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 north drive, northwest lot, and two paved playground surfaces (middle and south lots) at Leonard Elementary in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.3, dated January 1, 2022, the north drive and perimeter of the northwest lot will be reconstructed with a heavy-duty bituminous pavement section and the interior of the northwest lot, middle lot, and south lot will be reconstructed with a standard-duty bituminous pavement section. Portland cement concrete curb and gutter will be reconstructed around the perimeter of the north drive and northwest lot. However, it should be noted the existing curb and gutter is generally in good condition.

Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic for the north drive and northwest lot will generally consist of busses (as this is the main drop off loop), cars, delivery trucks, and garbage trucks, and the middle and south lots will generally see pedestrian traffic. Based on Google Earth Historical imagery, the pavement for the north drive, northwest lot, and middle lot were constructed between 2006 and 2007. The south lot was constructed prior to 1999.

The purpose of our investigation is to determine and evaluate the general pavement and subsurface conditions of 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 access drive, northwest lot, middle lot, and south lot 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, Atterberg Limits, grain size, 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), in conjunction with Lecole Planners, 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, 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. 9 within the Appendix. Grain size results are presented on Figure No. 10 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 1-1/2 to 3 inches in thickness. Approximately 6-1/2 to 10-1/2 inches of limestone aggregate base underlie the bituminous concrete surface. The limestone aggregate base samples from borings B-2 and B-7 are only slightly out of specification for gradation requirements of MDOT 21AA dense graded aggregate as presented graphically on Figure No. 10 in the Appendix. This material is suitable for reuse as aggregate base within the new pavement sections.

The existing pavements at the northwest lot and north drive are in poor conditions with more than half of the pavement exhibiting moderate to high severity block and fatigue cracking (Photograph Nos. 2, 6, 8, and 10). The two playground surface areas (middle and south lots) are in relatively good condition with low to moderate severity fatigue and block cracking (Photograph Nos. 11, 13, and 14).

Concrete curb and gutter surround the existing parking lot and appear to be in relatively good condition as shown throughout the Photographic Documentation in the Appendix. Drainage appears to be designed toward catch basin; however, based on visual observations, it appears surface water may be draining to low areas instead as well as where significant distress is occurring. Four catch basins are present within the parking lot (Photograph Nos. 12, 15, 16, 17, and 18). Additionally, a structure is located along the gutter on the south side of the access drive (Photograph No. 19). Concrete collars were added to the basins between 2010 and 2015 (Photograph Nos. 15 through 17) and the collar around the basin adjacent to the sidewalk was reconstructed between 2016 and 2017 (Photograph No. 18). A catch basin is present within the center of the middle lot (Photograph No. 12).

EXISTING SUBSURFACE CONDITIONS

Silty clay underlies the pavement section at the boring locations and extends to the explored depth of 5 feet. The silty clay is stiff to very stiff in consistency with natural moisture contents ranging from 11 to 18 percent and unconfined compressive strengths ranging from 3,000 to 7,000 psf. The silty clay within boring B-2 has a liquid limit of 29 percent, a plastic limit of 15 percent, and a plasticity index of 13 percent.

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, Atterberg Limit Results, Figure No. 9, Grain Size Distribution, Figure No. 10, and Photographic Documentation, Figure Nos. 11 through 20, 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. 21.

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

General

The existing pavements at the north drive and northwest lot are in poor condition with more than half of the pavement exhibiting moderate to high severity block and fatigue cracking. The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the condition of the existing pavements, early distress noted in the pavements, and thin bituminous and aggregate sections. Based on historical aerial imagery, the pavements were exhibiting severe distress as early as 2015 at less than 10 years old. Therefore, we recommend completely reconstructing the bituminous pavement and aggregate base at the north drive and northwest lot.

At the middle and south lots, the pavements are in fair to good condition with less than half the pavement exhibiting low to moderate severity block and fatigue cracking. We recommend the existing bituminous pavement at these lots be removed and a new bituminous pavement surface be constructed, supported on the existing aggregate base after completion of pavement subgrade preparation.

Pavement Subgrade Preparation

At the north drive and northwest lot, we recommend completely removing the existing bituminous concrete and removing and stockpiling the underlying limestone aggregate base for reuse in the new pavement section. The subgrade soils will generally consist of stiff to very stiff silty clay which should be proof rolled using a heavily loaded, rubber-tired, tandem-axle dump truck and evaluated for stability before constructing the new pavement cross-section. Unsuitable soils or 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. The contractor should be prepared to utilize tri-axial geogrid to minimize extensive undercuts as directed by a G2 engineer or qualified personnel.

At the middle and south lots, we recommend completely removing the existing bituminous concrete to the underlying aggregate base. The aggregate should be graded to account for the new designed pavement section (consisting of cutting approximately 1-1/2 inches of existing aggregate base or raising grades approximately 1-1/2 inches if able). Once grades are achieved, the exposed aggregate base should be proof compacted with a vibratory roller making a minimum of 10 passes in two perpendicular directions to densify the existing aggregate base, and the subgrade should be evaluated for stability. Any 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 25 percent of the pavement area) due to the assumed water infiltration through the extensive pavement distress, 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.

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. Lift thicknesses should not exceed 9 inches. The use of a tri-axial geogrid may reduce undercut depths, if needed, and should be utilized under directive of G2 personnel or qualified parties.

We recommend a drain tile be placed within the deepest portion of an 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 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 generally consist of silty clay which are considered fair for support of pavements. Based on the existing subgrade soils, we have provided a design pavement section based on an effective subgrade resilient modulus of 7,000 pounds per square inch (psi).

We anticipate traffic for the north drive and northwest lot will generally consist of busses (as this is the main drop off loop), cars, delivery trucks, and garbage trucks and the middle and south lots will generally see pedestrian traffic. 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 50,000 18-kip equivalent single-axle loads (ESALs) and an estimated 200,000 ESALs for the heavy-duty section, both over a 20-year design life. 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 0.95.

Based on the results of our analyses, we recommend a standard-duty flexible pavement section at the northwest lot consisting of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course, supported on 9 inches of MDOT 21AA dense graded aggregate base course and a heavy-duty flexible pavement section for the north drive and northwest lot consisting of 2 inches of 5EML bituminous concrete wearing course over 3 inches of MDOT 4EML bituminous concrete leveling course (placed in 2 lifts), supported on 8 inches of MDOT 21AA dense graded aggregate base course. Both sections have a total thickness of 13 inches for ease of construction and to maintain a consistent subgrade elevation to ensure property subgrade drainage to finger drains.

At the middle and south lots, we recommend the standard-duty pavement section consist of 2 inches of MDOT 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course placed over the existing aggregate base or a minimum of 6 inches of MDOT 21AA dense graded aggregate where subgrade undercuts are required.

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. We recommend all bituminous concrete materials have a binder from recycled asphalt pavement (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 below the aggregate base should be properly sloped to promote effective surface and subsurface drainage and prevent water from ponding, especially as pavements age and water infiltrates the surface. The subgrade within the standard-duty section areas must also be sloped to drain to the heavy-duty section areas and then to drainage structures to ensure water is not trapped in the aggregate base and ponding. We also recommend pavement subbase materials consist of non-frost-susceptible aggregates where possible.

We recommend edge drains be installed along curb lines to minimize water infiltration from surrounding grades into the aggregate base below the pavements. In addition, 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.

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

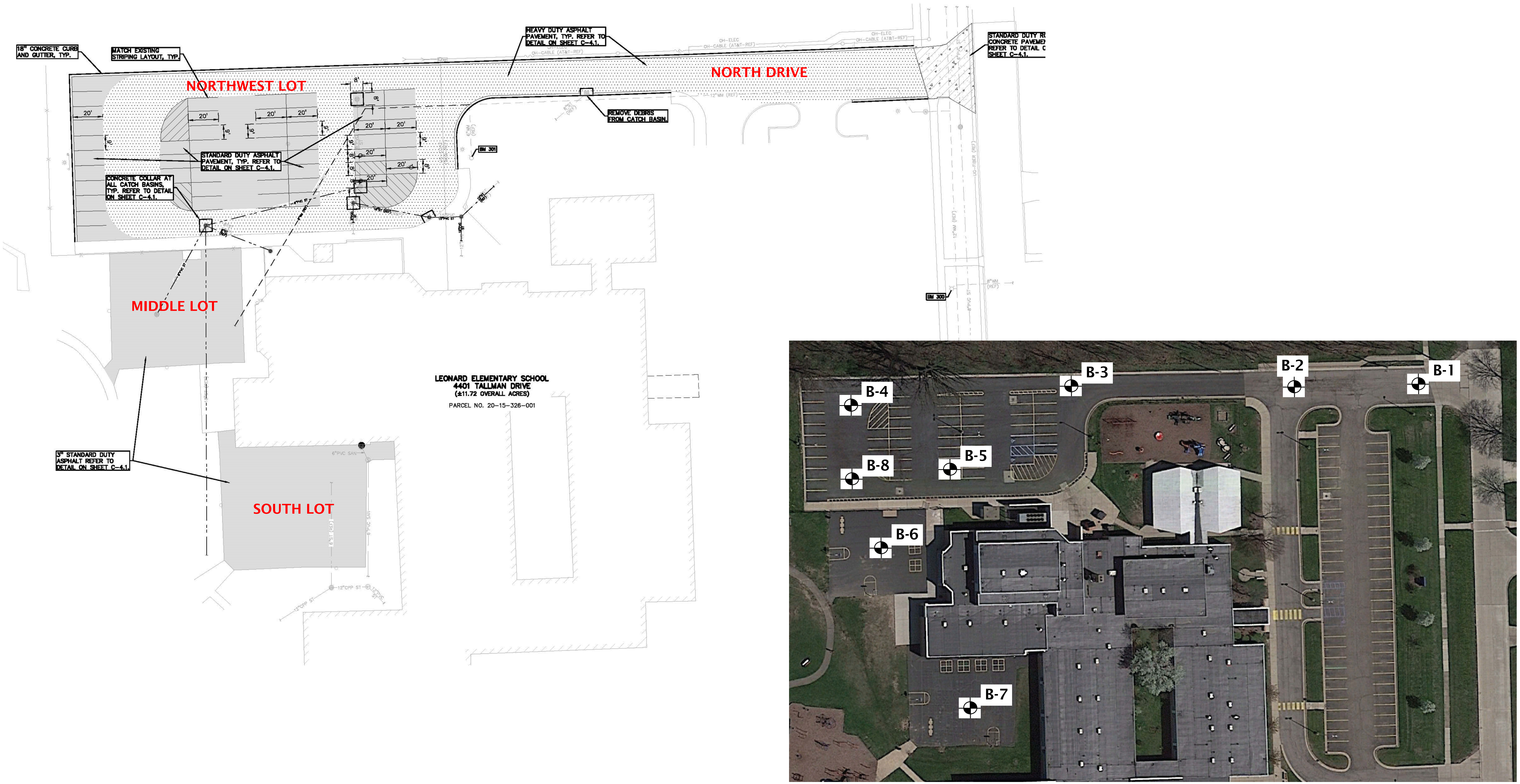
We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention 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 December 14, 2022

Soil Boring Location Plan

Leonard Elementary School
4401 Tallman Drive
Troy, Michigan 48085

G2 CONSULTING GROUP

Project No. 220977
Drawn by: ALS
Date: 1/3/23
Scale: NTS
Plate No. 1

Project Name: Leonard Elementary School

Soil Boring No. **B-1**

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977

Latitude: N/A Longitude: N/A

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 (2-1/2 inches)	0.2						
	▩	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (6-1/2 inches)	0.8		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel			AS-2	20	14.2		6000*
5			5.0	5	AS-3	13	16.0		4000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 1

PAVEMENT CORE DCP 220977.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 1/6/23

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977
Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

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 (2-1/2 inches) 0.2						
	▩	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (8-1/2 inches) 0.9		AS-1				
	▨	Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel		AS-2	20	13.8		6000*
5	▨	5.0	5	AS-3	10	17.9		3000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 2

Soil Boring No. **B-3**

CONSULTING GROUP

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977
Latitude: N/A Longitude: N/A

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 Limestone Aggregate Base: Gray Gravel and Sand with trace silt (8 inches) 0.9		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel		AS-2	15	14.9		4500*
5	▨	5.0	5	AS-3	13	16.4		4000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 3

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977

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 (2-1/2 inches)	0.2						
	▩	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (9-1/2 inches)	1.0		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel			AS-2	17	14.3		5000*
5	▨		5.0	5	AS-3	23	11.3		7000*
		End of Boring @ 5 ft							

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977
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 inches) 0.3						
	▩	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (9 inches) 1.0		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel		AS-2	15	15.5		4500*
5	▨	5.0	5	AS-3	22	13.4		6500*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 5

PAVEMENT CORE DCP 220977.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 1/6/23

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977

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 (1-1/2 inches) 0.1						
	▩	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (8-1/2 inches) 0.8		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel		AS-2	13	15.8		4000*
5	▨	5.0	5	AS-3	17	14.3		5000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977
Latitude: N/A Longitude: N/A

Soil Boring No. **B-7**

G2 CONSULTING GROUP

SUBSURFACE PROFILE

DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)
	■	Bituminous Concrete (1-1/2 inches) 0.1	
	▨	Crushed Concrete Aggregate Base: Gray Sand and Gravel with trace silt (10-1/2 inches) 1.0	
5	▨	Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5
		End of Boring @ 5 ft	

SOIL SAMPLE DATA

SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
AS-1				
AS-2	15	15.4		4500*
AS-3	12	17.0		3500*

Total Depth: 5 ft
Drilling Date: December 14, 2022
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 of drilling operations

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 7

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No. 220977

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 (1-1/2 inches) 0.1						
	▨	Crushed Limestone Aggregate Base: Gray Gravel and Sand with trace silt (10-1/2 inches) 1.0		AS-1				
	▨			AS-2	13	16.5		4000*
5	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	AS-3	20	12.9		6000*
		End of Boring @ 5 ft						

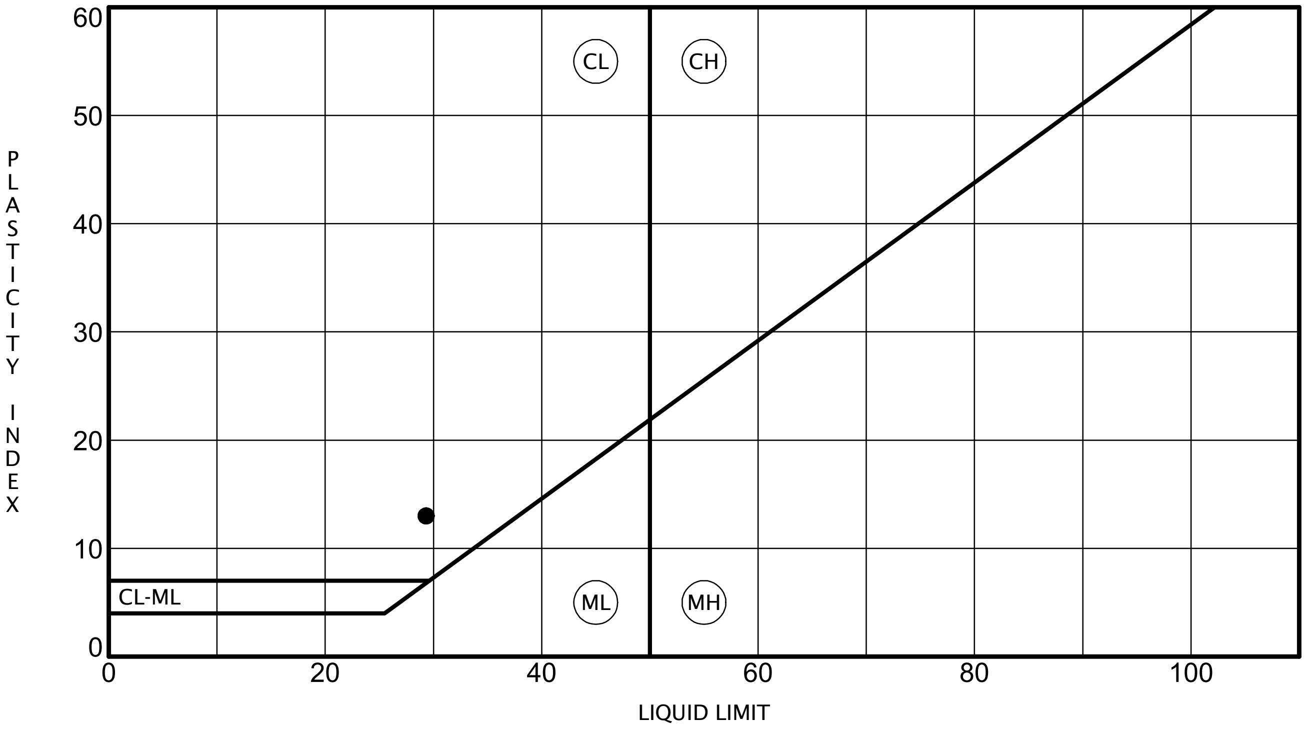
Total Depth: 5 ft
Drilling Date: December 14, 2022
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

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

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

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch



	Specimen Identification	LL	PL	PI	Fines	M %	Classification
●	B-4 AS-2	29	16	13		14	Brown and Gray Silty Clay

CONSULTING GROUP

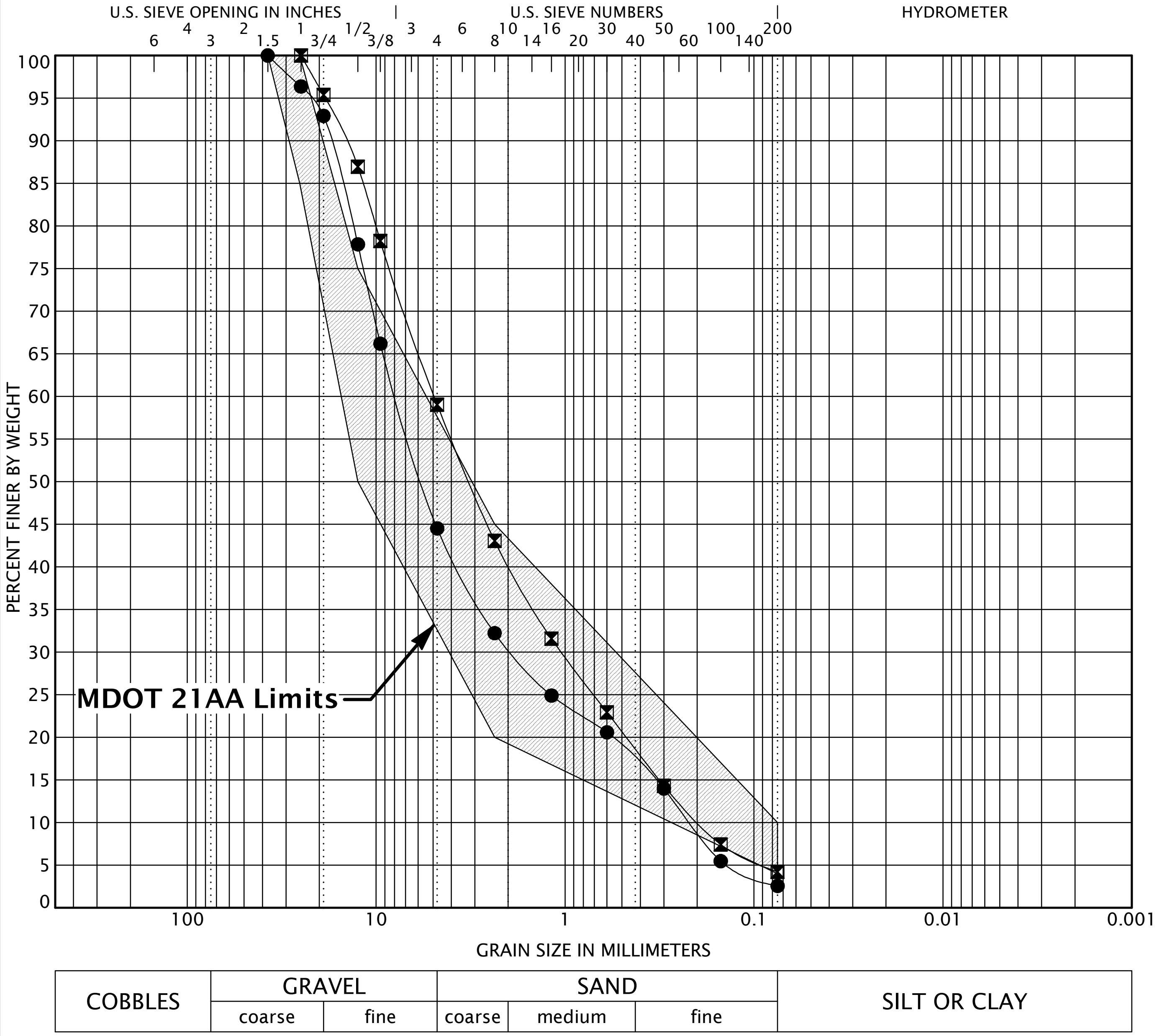
ATTERBERG LIMITS RESULTS

Project Name: Leonard Elementary School

Project Location: 4401 Tallman Drive
Troy, Michigan 48085

G2 Project No.: 220977

Figure No. 9



Specimen ID	Description	LL	PL	PI	Cc	Cu
● B-2 AS-1	Gray Gravel and Sand with trace silt				2.16	35.95
☒ B-7 AS-1	Gray Sand and Gravel with trace silt				1.14	25.33

Specimen ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-2 AS-1	37.5	7.795	1.912	0.217	55.5	41.9	2.6	
☒ B-7 AS-1	25	4.919	1.044	0.194	41.0	54.8	4.2	

CONSULTING GROUP

GRAIN SIZE DISTRIBUTION

Project Name:	Leonard Elementary School
Project Location:	4401 Tallman Drive Troy, Michigan 48085
G2 Project No.:	220977

Figure No. 10

Photographic Documentation
Leonard Elementary School
Troy, Michigan
G2 Project No. 220977

Photograph No. 1: Low to moderate severity edge and fatigue cracking east of B-1.

Photograph No. 2: High severity fatigue cracking near B-2, water infiltration through distress evident.

Figure No. 11

Photographic Documentation
Leonard Elementary School
Troy, Michigan
G2 Project No. 220977

Photograph No. 3: Moderate severity fatigue cracking near B-3.

Photograph No. 4: Looking east toward B-3, moderate severity fatigue and block cracking.

Photograph No. 5: Low to moderate severity fatigue cracking looking west toward B-3.

Photograph No. 6: High severity fatigue cracking looking south at B-4 and beyond.

Photographic Documentation
Leonard Elementary School
Troy, Michigan
G2 Project No. 220977

Photograph No. 7: Moderate severity fatigue east of B-4.

Photograph No. 8: High severity fatigue cracking and pavement raveling, looking east toward B-8.

Photograph No. 9: Low to moderate severity fatigue cracking near B-5. Settlement noted in areas of heavy fatigue.

Photograph No. 10: Moderate severity fatigue cracking near B-5.

Photographic Documentation
Leonard Elementary School
Troy, Michigan
G2 Project No. 220977

Photograph No. 11: Low severity block cracking near B-6. Evidence of sediment from ponding.

Photograph No. 12: Catch basin with sediment around structure. Note previous sawcut patch south of B-6, in east/west direction.

Figure No. 16

Photograph No. 13: Looking northeast across Lot B. Lot is in relatively good condition.

Photograph No. 14: Low severity block cracking throughout Lot C.

Photographic Documentation
Leonard Elementary School
Troy, Michigan
G2 Project No. 220977

Photograph No. 15: Precast concrete catch basin with block around top and concrete collar at surface.

Photograph No. 16: Concrete collar around catch basin in fair condition. Precast basin structure.

Photographic Documentation
Leonard Elementary School
Troy, Michigan
G2 Project No. 220977

Photograph No. 17: Interior of precast structure with standing water.

Photograph No. 18: Catch basin with newer concrete collar.

Figure No. 19

Photograph No. 19: Drainage structure in gutter along south side of drive.

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).

Report on Geotechnical Pavement Investigation

Barnard Elementary School
3601 Forge Drive
Troy, Michigan 48083

Latitude 42.573614˚ N
Longitude 83.104685˚ W

Prepared for:

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

G2 Project No. 220978
December 28, 2022

December 28, 2022

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

Re: Report of Geotechnical Pavement Investigation
Barnard Elementary School
3601 Forge Drive
Troy, Michigan 48083
G2 Project No. 220978

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical pavement investigation for the proposed rehabilitation/reconstruction of the pavements at Barnard 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 northeast portion of the existing parking lot at Barnard Elementary in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.7, dated January 1, 2022, the parking lot will be reconstructed with a standard-duty bituminous pavement section with Portland cement concrete curb and gutter around the perimeter. Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic will generally consist of cars, delivery trucks, and garbage trucks.

The existing pavements consist of bituminous concrete measuring 3 to 4 inches in thickness. Approximately 6 to 8 inches of crushed bituminous concrete base underlie the bituminous concrete surface. Stiff to very stiff silty clay with seams of sandy silt is present below the pavement section and extends to the explored depth of 5 feet. The silty clay at an approximate depth of 2-1/2 feet at boring B-3 has a liquid limit of 29 percent, a plastic limit of 17 percent, and a plasticity index of 12 percent. No measurable groundwater was observed during or upon completion of drilling operations at the soil boring locations.

The existing bituminous pavement is in poor to fair condition with moderate to high severity block and fatigue cracking throughout. The severity of the distress increases toward the drive lanes. The existing lot within the scope of this report appears to be upwards of 20 years old.

The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the condition of the existing pavements. Additionally, the crushed bituminous concrete aggregate base is not optimal for support of pavements and drainage as pavements age. Therefore, we recommend completely reconstructing the bituminous pavements. New concrete curb and gutter will be constructed in conjunction with the new pavements. In addition, we recommend finger drains be installed at each catch basin location to collect surface runoff water that may pond atop of the silty clay subgrade.

We recommend completely removing the existing bituminous concrete and underlying crushed bituminous concrete. We do not recommend reusing the crushed bituminous concrete due to the poor drainage characteristics of the material and potential for breakdown of the asphaltic material. The subgrade soils will generally consist of stiff to very stiff silty clay which should be proof rolled using a heavily loaded, rubber-tired, tandem-axle dump truck and evaluated for stability before constructing the new pavement cross-section. Unsuitable soils or 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.

We recommend a significant budget (on the order of 30 to 40 percent) be allocated for undercutting due to the assumed water infiltration through the extensive pavement distress, with the percentage increasing as the subgrade is exposed to precipitation. This potential is reflected in the higher moisture contents, particularly toward borings B-3 and B-4. Additionally, the sandy silt seams within the cohesive material can become unstable when exposed to moisture. 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 8 inches of MDOT 21AA dense graded aggregate base course. We recommend all bituminous concrete materials have a binder from Recycled Asphalt Pavement (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 northeast parking lot at Barnard Elementary in Troy, Michigan. Per the Engineering Plan prepared by PEA Group, Drawing No. C-2.7, dated January 1, 2022, the parking lot will be reconstructed with new standard-duty bituminous pavements with Portland cement concrete curb and gutter around the perimeter.

Traffic counts at the site were not available upon completion of this report. However, we anticipate traffic will generally consist of cars, delivery trucks, and garbage trucks. The age of the existing pavements was not available upon completion of this report. However, after review of Google Earth Historical imagery, it appears the pavements are upwards of 20 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 a total of four pavement core/hand auger soil borings within the access drives 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, Atterberg Limits, 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), in conjunction with Lecole Planners, 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, Atterberg limits, 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 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. 5 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 4 inches in thickness. Approximately 6 to 8 inches of crushed bituminous concrete base underlie the bituminous concrete surface.

The existing pavements are in poor conditions with more than half of the pavement exhibiting high severity block and fatigue cracking (Photograph Nos. 2, 5, 8). The distress is most significant toward the drive lanes (Photograph Nos. 3 and 4). The pavement appears to be upwards of 20 years old with some areas of patching as shown in Photograph Nos. 1 and 3.

Concrete curb and gutter surround the existing parking lot and appear to be in relatively good condition. Drainage appears to be toward low spots within the parking lot rather than catch basins. The concrete collar around the basin south of B-3 appears to have been recently reconstructed (Photograph No. 9). Settlement and distress were noted around the basin south of B-1 (Photograph No. 11). Interior of catch basins indicate they are block and mortar construction.

EXISTING SUBSURFACE CONDITIONS

Silty clay with sandy silt seams underlies the pavement section and extends to the explored depth of 5 feet. The silty clay is stiff to very stiff in consistency with natural moisture contents ranging from 15 to 23 percent and unconfined compressive strengths ranging from 2,500 to 6,000 psf. The silty clay within boring B-2 has a liquid limit of 29 percent, a plastic limit of 17 percent, and a plasticity index of 12 percent.

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 4, Atterberg Limit Results, Figure No. 5, and Photographic Documentation, Figure Nos. 6 through 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

General

The existing pavements are in poor conditions with more than half of the pavement exhibiting high severity block and fatigue cracking. The distress is most significant toward the drive lanes.

The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the condition of the existing pavements. Additionally, the crushed bituminous concrete aggregate base is not optimal for support of pavements and drainage as pavements age. Therefore, we recommend completely reconstructing the bituminous pavements. New concrete curb and gutter will be constructed in conjunction with the new pavements. In addition, we recommend finger drains be installed at each catch basin location to collect surface and subsurface runoff water that may pond atop of the silty clay subgrade.

Pavement Subgrade Preparation

We recommend completely removing the existing bituminous concrete and underlying crushed bituminous concrete. The subgrade soils will generally consist of stiff to very stiff silty clay with sandy silt seams. The exposed subgrade soils should be proof rolled using a heavily loaded, rubber-tired, tandem-axle dump truck and evaluated for stability before constructing the new pavement cross-section. Unsuitable soils or 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. The contractor should be prepared to utilize tri-axial geogrid to minimize extensive undercuts as directed by a G2 engineer or qualified personnel.

We recommend a significant budget (on the order of 30 to 40 percent) be allocated for undercutting due to the assumed water infiltration through the extensive pavement distress, with the percentage increasing as the subgrade is exposed to precipitation. This potential is reflected in the higher moisture contents, particularly toward borings B-3 and B-4. Additionally, the sandy silt seams within the cohesive material can become unstable when exposed to moisture. 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.

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. Lift thicknesses should not exceed 9 inches. The use of a tri-axial geogrid may reduce undercut depths, if needed.

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 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 generally consist of silty clay which are considered fair for support of pavements. Based on the existing subgrade soils and assumed infiltration through pavement distress, we have provided a design pavement section based on an effective subgrade resilient modulus of 5,000 pounds per square inch (psi).

We anticipate traffic at the site will consists of cars and garbage trucks as well as dump trucks and semi-trucks during construction. 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 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 0.49 for flexible pavements, and a reliability factor of 0.95.

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 8 inches of MDOT 21AA dense graded aggregate base course. We recommend all bituminous concrete materials have a binder from recycled asphalt pavement (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. The pavement and subgrade below the aggregate base should be properly sloped to promote effective surface and subsurface 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.

We recommend edge drains be installed along curb lines between catch basins. In addition, 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.

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

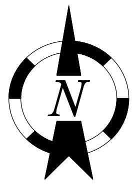
We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention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

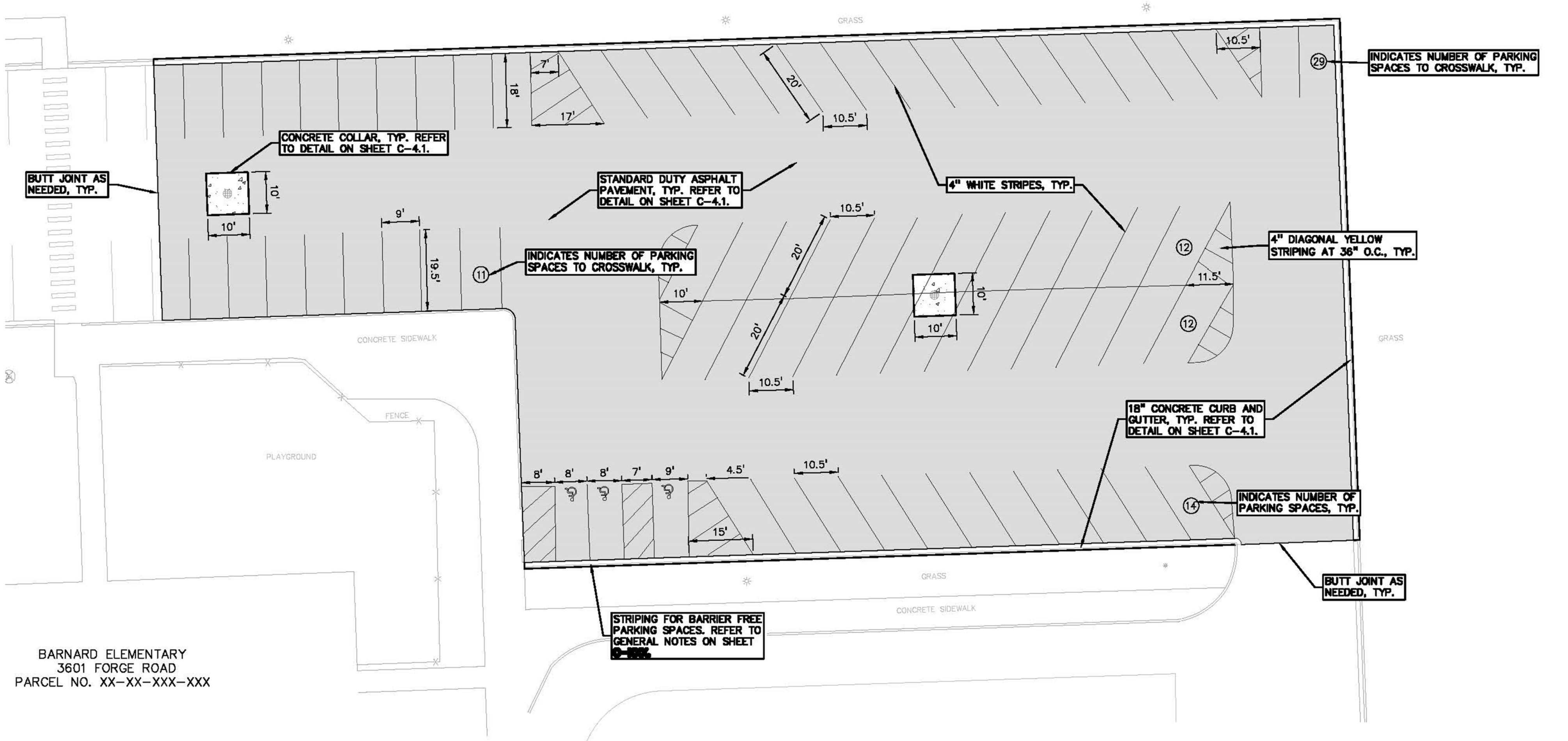
The scope of the present investigation was limited to evaluation of subsurface conditions for the construction of the proposed pavement reconstruction and other related aspects of the proposed project. No chemical, environmental, or hydrogeological testing or analysis were included in the scope of this 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.

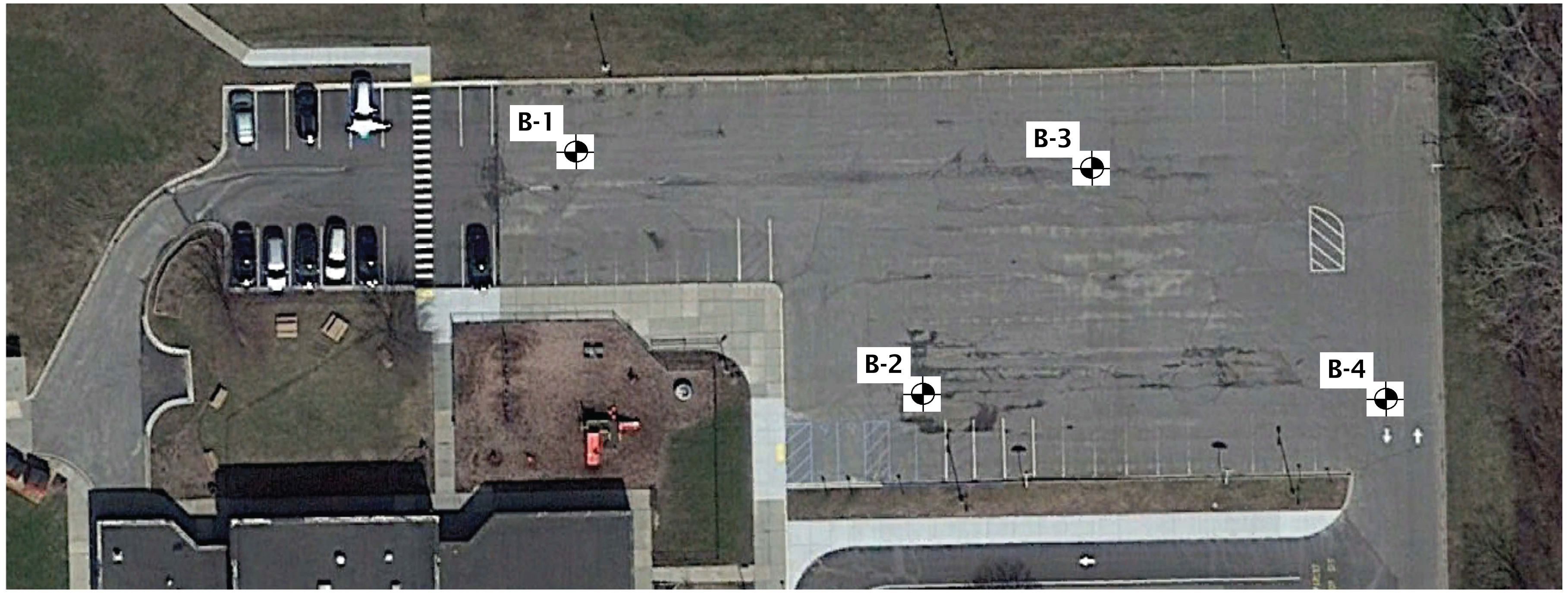
We have based the analyses and recommendations submitted in this report upon the data from soil borings performed at the approximate locations shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring locations. The nature and 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 December 13, 2022

Soil Boring Location Plan

Barnard Elementary School
3601 Forge Drive
Troy, Michigan 48083

CONSULTING GROUP

Project No. 220978
Drawn by: ALS
Date: 12/26/22
Scale: NTS
Plate No. 1

Project Name: Barnard Elementary School

Project Location: 3601 Forge Drive
Troy, Michigan 48083

G2 Project No. 220978

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 (4 inches) 0.3						
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (6 inches) 0.8		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt seams		AS-2	20	15.4		6000*
5	▨	5.0	5	AS-3	18	16.2		5500*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 13, 2022
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: Barnard Elementary School

Project Location: 3601 Forge Drive
Troy, Michigan 48083

G2 Project No. 220978

Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

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 Bituminous Concrete Aggregate Base: Black Sand and Gravel (8 inches) 0.9		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt seams		AS-2	20	15.5		6000*
5	▨	5.0	5	AS-3	13	18.4		4000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 13, 2022
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

Figure No. 2

Project Name: Barnard Elementary School

Project Location: 3601 Forge Drive
Troy, Michigan 48083

G2 Project No. 220978

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 (3-1/2 inches) 0.3						
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (7 inches) 0.9		AS-1				
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt seams		AS-2	13	18.3		4000*
5	▨	5.0	5	AS-3	13	17.9		4000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 13, 2022
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

Figure No. 3

Project Name: Barnard Elementary School

Project Location: 3601 Forge Drive
Troy, Michigan 48083

G2 Project No. 220978

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						
	▩	Crushed Bituminous Concrete Aggregate Base: Black Sand and Gravel (8 inches) 1.0		AS-1				
	▨	Stiff Brown and Gray Silty Clay with trace sand and gravel, occasional sandy silt seams		AS-2	7	22.7		2500*
5	▨	5.0	5	AS-3	10	20.7		3000*
		End of Boring @ 5 ft						

Total Depth: 5 ft
Drilling Date: December 13, 2022
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Bowles

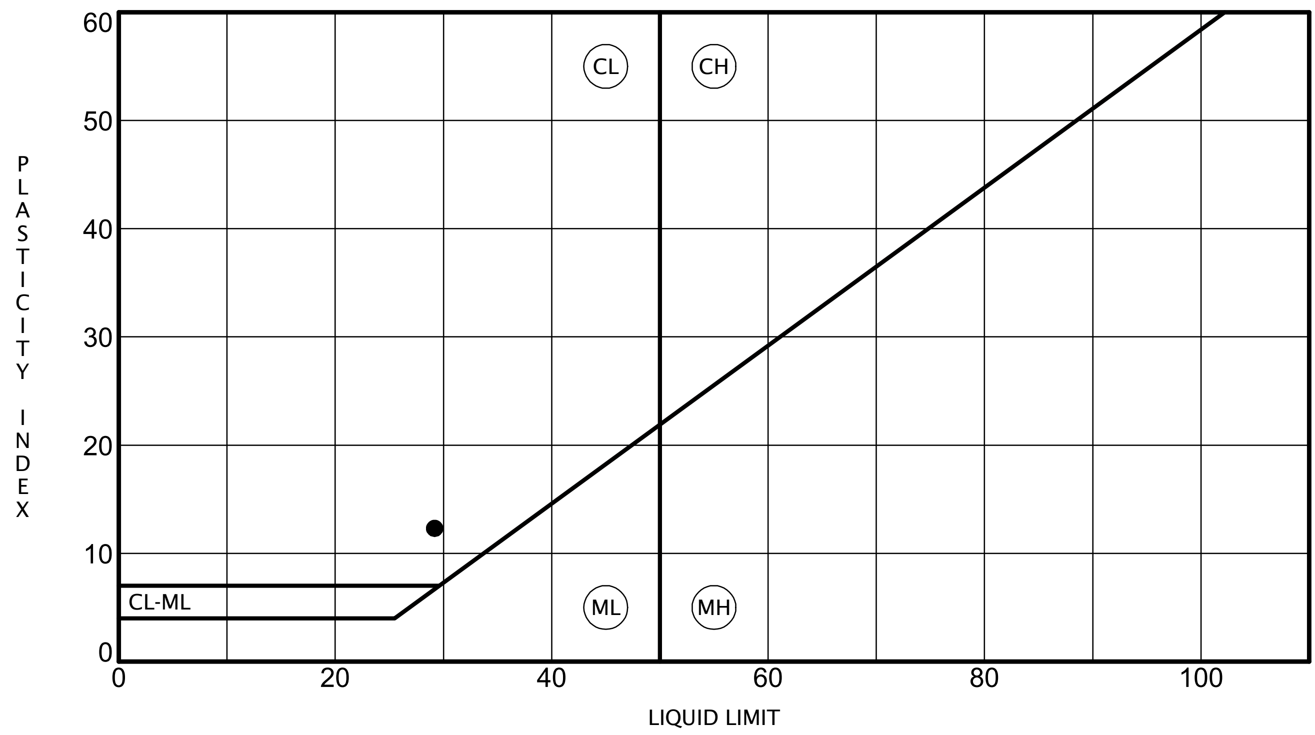
Drilling Method:
4-inch diameter diamond tipped core barrel;
3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 4



	Specimen Identification		LL	PL	PI	Fines	M %	Classification
●	B-2	AS-2	29	17	12		15	Brown and Gray Silty Clay

ATTERBERG LIMITS RESULTS

CONSULTING GROUP

Project Name: Barnard Elementary School

Project Location: 3601 Forge Drive
Troy, Michigan 48083

G2 Project No.: 220978

Figure No. 5

Photographic Documentation
Barnard Elementary
Troy, Michigan
G2 Project No. 220978

Photograph No. 1: Moderate to high severity block and fatigue cracking looking west toward B-1 and beyond.

Photograph No. 2: Looking north toward B-2, high severity fatigue cracking.

Photographic Documentation
Barnard Elementary
Troy, Michigan
G2 Project No. 220978

Photograph No. 3: High severity fatigue cracking near B-2 looking west.
Note patch in pavement.

Photograph No. 4: Looking south from B-3, high severity fatigue cracking.
Note new concrete collar around catch basin.

Photographic Documentation
Barnard Elementary
Troy, Michigan
G2 Project No. 220978

Photograph No. 5: High severity fatigue cracking near B-3, looking west across lot.

Photograph No. 6: Low to moderate severity block and fatigue cracking. Looking north at B-4 and beyond.

Photographic Documentation
Barnard Elementary
Troy, Michigan
G2 Project No. 220978

Photograph No. 7: Moderate severity block and fatigue cracking looking at B-4 and beyond.

Photograph No. 8: Moderate severity fatigue cracking looking at B-4 and beyond. Moderate to high severity distress visible across entire lot.

Photograph No. 9: High severity fatigue cracking propagating from catch basin near B-3.

Photograph No. 10: Interior of catch basin.

Photographic Documentation
Barnard Elementary
Troy, Michigan
G2 Project No. 220978

Photograph No. 11: Catch basin near B-1. Settlement and distress around basin.

Photograph No. 12: Interior of basin, holding water.

Photographic Documentation
Barnard Elementary
Troy, Michigan
G2 Project No. 220978

Photograph No. 13: Pavement west of areas to be reconstructed. Note settlement around drainage structure.

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

Report on Geotechnical
Pavement Investigation

Wass Elementary School
2340 Willard Drive
Troy, Michigan 48085

Latitude 42.555326° N
Longitude 82.100033° W

Prepared for:

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

G2 Project No. 210872
December 19, 2021

G2
CONSULTING
GROUP

December 19, 2021

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

Re: Report of Geotechnical Pavement Investigation
Wass Elementary School
2340 Willard Drive
Troy, Michigan 48085
G2 Project No. 210872

Dear Ms. Kerns,

In accordance with your request, we have completed the geotechnical investigation for the proposed pavement rehabilitation/reconstruction at Wass Elementary School in the City of Troy, Michigan. This report presents the results of our observations and analyses and our recommendations for pavement rehabilitation or reconstruction, 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 Troy School District and Lecole Planners, LLC on this project 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

Jeffrey M. Hayball

Jeffrey M. Hayball, P.E.
Project Engineer

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

Amy L. Schneider, P.E.
Project Manager/Associate

JMH/NJHT/ljv

Enclosures

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EXECUTIVE SUMMARY

We understand the project consists of rehabilitation/reconstruction of the pavements within the parking lot west of the school and separate bus/drop off loop north of the school at Wass Elementary School located within the City of Troy, Michigan. The existing pavements are bituminous concrete. It is our understanding bus traffic at the school consist of 2 busses twice per day during the school year, as well as car traffic and occasional garbage and delivery trucks. The age of the existing pavements was not available upon completion of this report. However, after review of Google Earth Historical Aerial Photographs, it appears the pavements were constructed sometime prior to 1999.

The existing pavements consist of bituminous concrete ranging from 2-1/2 to 4-1/2 inches in thickness. Medium compact sand underlies the bituminous concrete within the borings and extends to an approximate depth of 3 feet below existing grade. Stiff to very stiff silty clay is present below the sand and extends to the explored depth of 4 feet below existing grade. Groundwater was observed within the borings at an approximate depth of 3 feet during drilling operations. No measurable groundwater was observed within the borings upon completion of drilling operations.

The existing pavements are in poor condition with most of the pavements within the west parking lot and more than half of the pavements within the bus/drop off loop exhibiting moderate to high severity block and fatigue cracking. No aggregate base material is present beneath the bituminous concrete at the soil boring locations. Concrete curb and gutter surround the pavements for both the parking lot and drop off loop. Where sidewalk is present around the existing school, the pavement butts into the sidewalk.

The existing pavements are generally not suitable to be rehabilitated by mill and overlay based on the condition of the pavement and lack of aggregate base. Therefore, we recommend completely reconstructed the existing bituminous concrete pavements. Per the Dimension and Paving Plans prepared by Professional Engineering Associates (Sheets 3.1 through 3.3), standard-duty pavements are to be constructed within both areas. In addition, the existing curb and gutter is to be replaced in conjunction with the pavement reconstruction.

Based on the results of our analyses, we recommend the proposed new pavement section consist of 2 inches of 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course, supported on a minimum of 8 inches of 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.

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 pavements within the parking lot west of the school and separate bus/drop off loop north of the school at Wass Elementary School located within the City of Troy, Michigan. The existing pavements are bituminous concrete. It is our understanding bus traffic at the school consist of 2 busses twice per day during the school year, as well as car traffic and occasional garbage and delivery trucks. The age of the existing pavements was not available upon completion of this report. However, after review of Google Earth Historical Aerial Photographs, it appears the pavements were constructed sometime prior to 1999.

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 existing pavement areas, each extending to a depth of 4 feet below existing grades. Pavement core/hand auger borings B-1 through B-5 were drilled within the west parking lot. Pavement core/hand auger borings B-6 through B-8 were performed within the bus/drop off loop. 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, natural moisture content, 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. Ground surface elevations were not available upon completion of this report.

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 feet, 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 professional 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 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 and unconfined compressive strength determinations. 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. 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. Moderate to high severity block and fatigue cracking are present along most of the pavements within the west parking lot and more than half of the bus/drop off loop.

The pavements are sloped to drain into catch basins generally located within the middle of the parking lot or into Portland cement curbs present along the pavement edge of the bus/drop off loop, which further drain into catch basins built into the curb line. The catch basins generally consist of brick and mortar construction atop of pre-cast concrete structures. Cracking of the mortar joints within the catch basins was observed during our site visit. A Portland cement concrete collar has been constructed around one of the catch basins.

EXISTING SUBSURFACE CONDITIONS

Sand underlies the bituminous concrete within the borings and extends to an approximate depth of 3 feet below existing grade. Silty clay is present below the sand and extends to the explored depth of 4 feet below existing grade.

The sand is medium compact with Dynamic Cone Penetrometer (DCP) Test N-values ranging from 12 to 18 blows per 1-3/4 inch drive. The silty clay is stiff to very stiff in consistency with natural moisture contents ranging from 18 to 25 percent and unconfined compressive strengths ranging from 3,000 to 6,500 pounds per square foot (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 8, and Photographic Documentation, Figure Nos. 9 through 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 are presented on Figure No. 13.

GROUNDWATER CONDITIONS

Groundwater observations were made during and upon completion of the drilling operations. Groundwater was observed within the borings at an approximate depth of 3 feet during drilling operations. No measurable groundwater was observed within the borings upon completion of drilling operations. We anticipate the encountered groundwater is perched within the granular soils on the underlying relatively impermeable silty clay. We further anticipate surface water infiltrating through the existing pavement distress may influence the amount of water present within the granular soils. 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 poor conditions with most of the pavements within the parking lot (such as within Photograph Nos. 1 and 2) and more than half of the pavements within the bus/drop off loop (such as within Photograph No. 8) exhibiting moderate to high severity block and fatigue cracking. No aggregate base material is present beneath the bituminous concrete within the soil borings. The existing pavements are generally not suitable to be rehabilitated by mill and overlay due to the condition of the existing pavement and lack of aggregate base. Therefore, we recommend completely reconstructed the existing bituminous concrete pavements. Per the Dimension and Paving Plans prepared by Professional Engineering Associates (Sheets 3.1 through 3.3), standard-duty pavements are to be constructed within both areas. In addition, the existing curb and gutter is to be replaced in conjunction with the pavement reconstruction.

Pavement Subgrade Preparation

We recommend completely removing the existing bituminous concrete. Additional undercutting of the exposed subgrade will be required to account for the new underlying aggregate base course. Once the subgrade has been cut to the proposed subgrade elevation, we recommend these soils be evaluated for stability.

We anticipate the subgrade soils will generally consist of medium compact sand. All exposed subgrade soils should be evaluated for stability before constructing the new pavement cross-section. We recommend the subgrade soils be proof compacted with a vibratory roller. The vibratory roller should make a minimum of 10 passes across the granular subgrade in two perpendicular directions, where applicable. We recommend the vibratory setting of the roller be turned off within 20 feet of the existing school and the subgrade be static rolled. Soils exhibiting excessive instability, such as severe rutting or pumping, should be removed by undercutting to expose stable soils or installing subdrains to removed perched water within the granular 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. In consideration of the existing granular soils extending to a depth of approximately 3 feet and areas of low severity pavement distress, we anticipate 30 to 40 percent of the site may require undercuts. We recommend undercut excavations, where required, be backfilled with MDOT 21AA dense graded aggregate 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 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 generally consist of medium compact sand. Based on the existing subgrade soils, we have provided design pavement sections based on an effective subgrade resilient modulus of 9,000 pounds per square inch (psi).

It is our understanding bus traffic consists of 2 busses, twice per day during the school year, along with car traffic and the occasional garbage and delivery truck. If any additional traffic volume information becomes available, G2 should be notified so we can reevaluate our recommendations. For evaluation purposes, we have designed the standard-duty pavement section based on 75,000 18-kip equivalent single-axle loads (ESALs) over a 20-year design life. The design utilized a serviceability loss of 2.0, a standard deviation of 0.49 for flexible pavements, and a reliability factor of 0.95.

Based on the results of our analyses, we recommend the proposed standard-duty pavement section consist of 2 inches 5EML bituminous concrete wearing course over 2 inches of MDOT 4EML bituminous concrete leveling course, supported on a minimum of 8 inches of the 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 and Maintenance

The pavement and subgrade should be properly sloped to promote effective surface and subsurface drainage and prevent water from ponding. Finger drains extending from the catch basins should be considered due to the presence of perched groundwater and the underlying impermeable cohesive soils with higher than optimum moisture contents. We also recommend pavement subbase materials consist of non-frost-susceptible aggregates where possible.

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

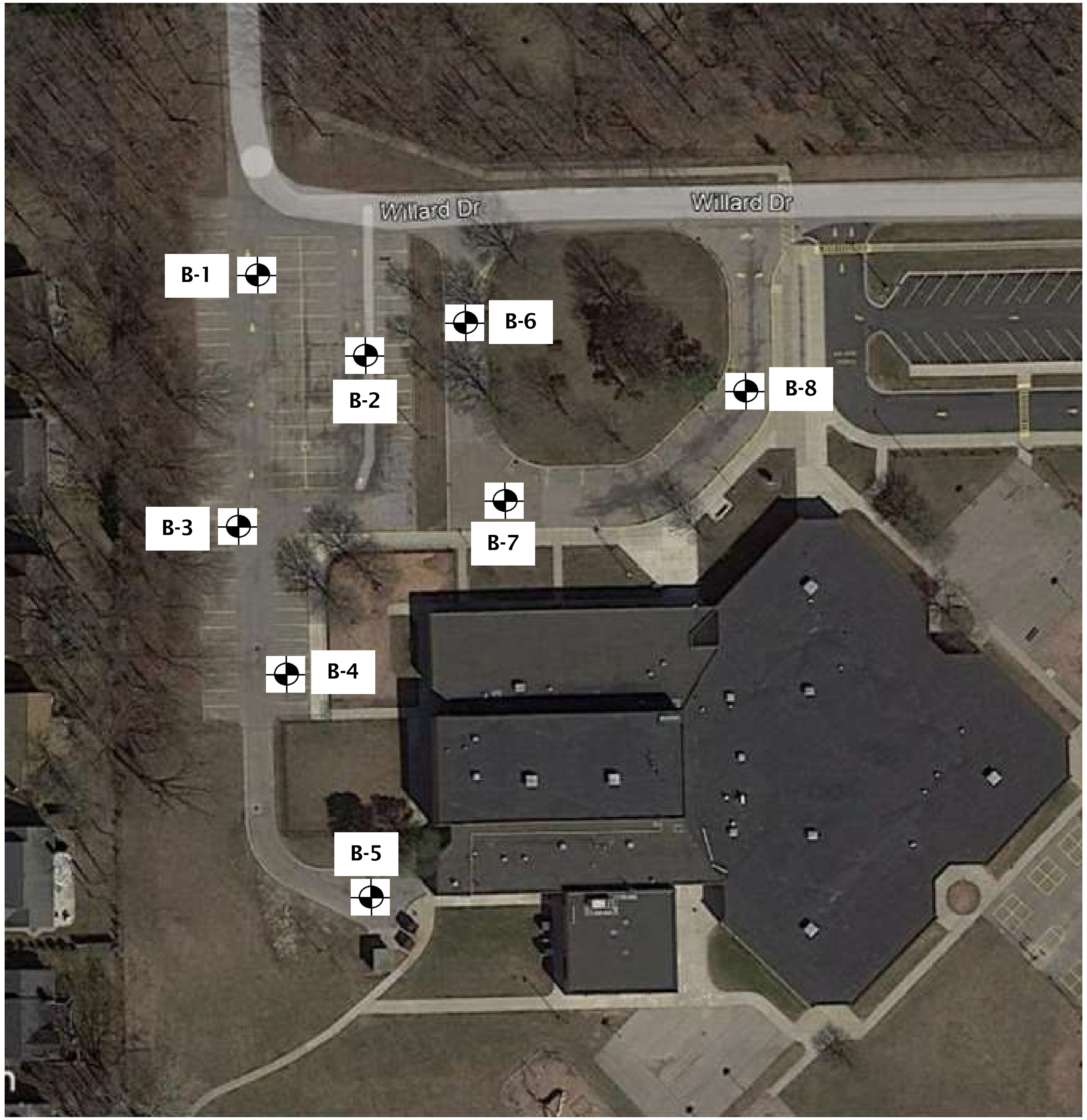
We have formulated the evaluations and recommendations presented in this report relative to site preparation and pavement construction on the basis of data provided to us relating to the location, type, and grade for the proposed site. Any significant change in this data should be brought to our attention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

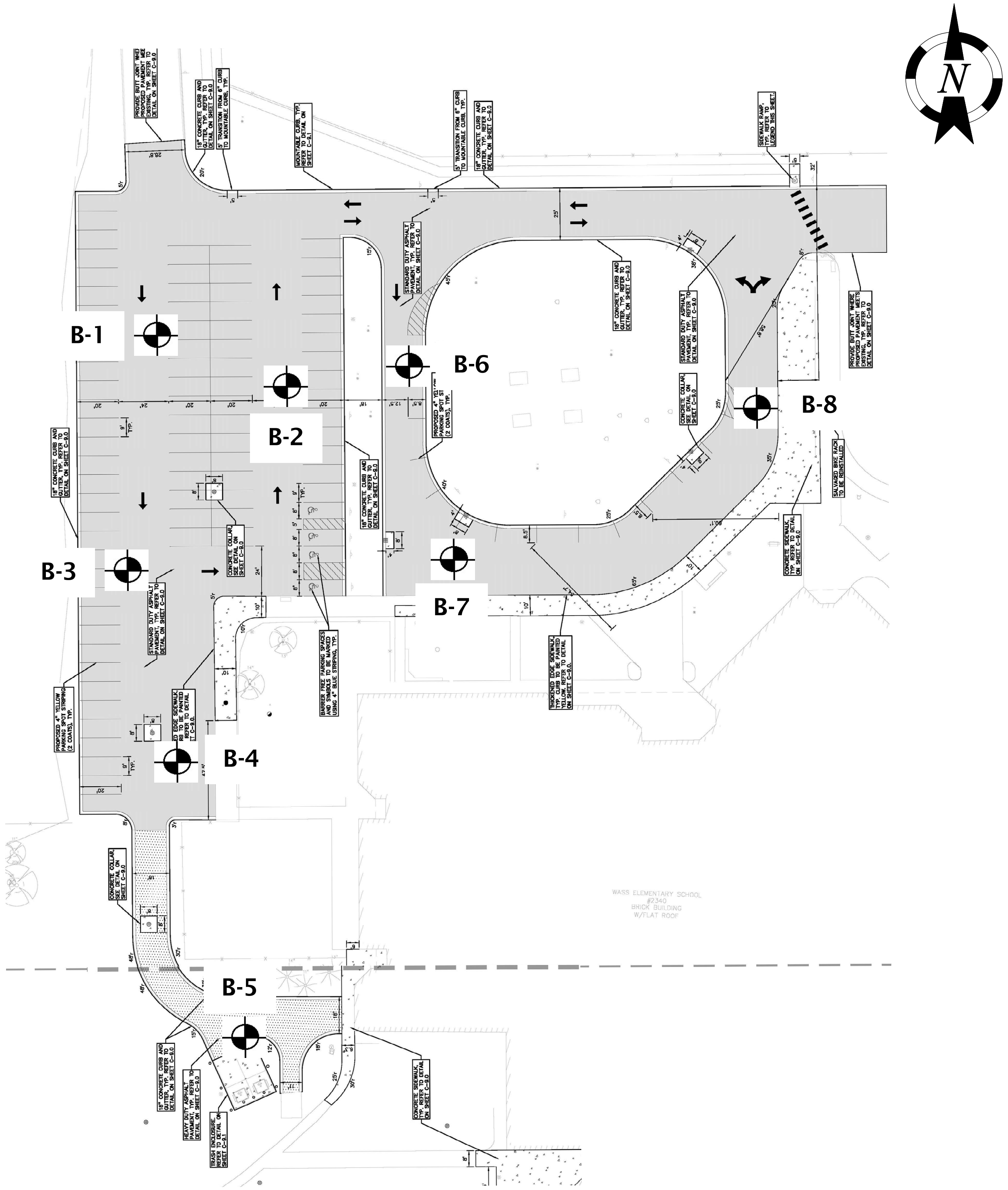
The scope of the present investigation was limited to evaluation of subsurface conditions for the proposed pavement reconstruction and other related aspects of the proposed project. No chemical, environmental, or hydrogeological testing or analysis were included in the scope of this investigation. If 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 December 6, 2021

Soil Boring Location Plan

Wass Elementary School
2340 Willard Drive
Troy, Michigan 48085

CONSULTING GROUP

Project No. 210872
Drawn by: JMH
Date: 12/16/21
Scale: NTS
Plate No. 1

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872

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 (4 inches)	0.3					
	░	Medium Compact Brown Sand with trace silt and gravel		AS-1	15			
		▽	3.0					
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel	4.0	AS-2	22	17.5		6500*
		End of Boring @ 4 ft						
5			5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 1

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872

Latitude: N/A Longitude: N/A

Soil Boring No. **B-2**

CONSULTING GROUP

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PRO-FILE	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
	■	Bituminous Concrete (2-1/2 inches)	0.2					
	░	Medium Compact Brown Sand with trace silt and gravel	3.0 ▽	AS-1	16			
	▨	Stiff Brown and Gray Silty Clay with trace sand and gravel	4.0	AS-2	10	24.8		3000*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 2

PAVEMENT CORE DCP 210872.GPJ 20140820 G2 CONSULTING DATA TEMPLATE.GDT 12/16/21

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872

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 (3-1/2 inches)	0.3					
	⁚	Medium Compact Brown Sand with trace silt and gravel		AS-1	15			
	⁚ ▽		3.0					
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel	4.0	AS-2	20	18.8		6000*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 3

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872

Latitude: N/A Longitude: N/A

Soil Boring No. **B-4**

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					
	░	Medium Compact Brown Sand with trace silt and gravel		AS-1	12			
	░ ▽		3.0					
	▨	Very Stiff Brown and Gray Silty Clay with trace sand and gravel	4.0	AS-2	22	18.6		6500*
		End of Boring @ 4 ft						
5			5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 4

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872
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 (4 inches)	0.3					
	░	Medium Compact Brown Sand with trace silt and gravel		AS-1	14			
	▽		3.0					
	▨	Stiff Brown and Gray Silty Clay with trace sand and gravel	4.0	AS-2	10	24.3		3000*
		End of Boring @ 4 ft						
5			5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 5

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872
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 (4-1/4 inches) 0.4						
	▒	Medium Compact Brown Sand with trace silt and gravel		AS-1	15			
		▽ 3.0						
	▨	Stiff Brown and Gray Silty Clay with trace sand and gravel 4.0		AS-2	12	23.6		3500*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 6

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872

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 (4-1/2 inches)						
		0.4						
	░	Medium Compact Brown Sand with trace silt and gravel		AS-1	18			
	▽	3.0						
	▨	Stiff Brown and Gray Silty Clay with trace sand and gravel		AS-2	12	22.8		3500*
		4.0						
		End of Boring @ 4 ft						
5			5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Project Name: Wass Elementary School

Project Location: 2340 Willard Drive
Troy, Michigan 48085

G2 Project No. 210872
Latitude: N/A Longitude: N/A

Soil Boring No. **B-8**

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						
	▒	Medium Compact Brown Sand with trace silt and gravel ▽ 3.0		AS-1	16			
	▨	Stiff Brown and Gray Silty Clay with trace sand and gravel 4.0		AS-2	10	23.9		3000*
5		End of Boring @ 4 ft	5					

Total Depth: 4 ft
Drilling Date: December 6, 2021
Inspector: DJ Radich, P.E.
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; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings and capped with cold patch

Figure No. 8

Photographic Documentation
Wass Elementary School
Troy, Michigan
G2 Project No. 210872

Photograph No. 1: High severity block and fatigue cracking near boring B-1. View to the north.

Photograph No. 2: High severity block and fatigue cracking near boring B-2. View to the northwest.

Figure No. 9

Photographic Documentation
Wass Elementary School
Troy, Michigan
G2 Project No. 210872

Photograph No. 3: Moderate to high severity block and fatigue cracking near boring B-3. View to the north.

Photograph No. 4: Moderate to high severity block and fatigue cracking near boring B-4. View to the south.

Photographic Documentation
Wass Elementary School
Troy, Michigan
G2 Project No. 210872

Photograph No. 5: Moderate to high severity block and fatigue cracking near boring B-5. View to the northwest.

Photograph No. 6: Low severity edge cracking near boring B-6 View to the south.

Photographic Documentation
Wass Elementary School
Troy, Michigan
G2 Project No. 210872

Photograph No. 7: Low severity transverse cracking near boring B-7. View to the east.

Photograph No. 8: Moderate to high severity block and fatigue cracking near boring B-8. View to the north.

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).