Geo-Advantec Inc.

G Geotechnical Engineering
A Earthquake Engineering
Inspection and Testing
I Engineering Geology

GEOTECHNICAL/PAVEMENT ENGINEERING REPORT

PROJECT:

PAVEMENT REHABILITATION ALONG FERGUSON DRIVE BETWEEN ATLANTIC BOULEVARD AND THE EAST CITY LIMIT COMMERCE, CA 90040

FOR:
THE CITY OF COMMERCE

PREPARED BY:
GEO-ADVANTEC INC.
457 W. ALLEN AVENUE, SUITE 113
SAN DIMAS, CALIFORNIA 91773
PROJECT NO. 17-1041-B
JUNE 21, 2017

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City of Commerce
Public Works & Development Services Department
2535 Commerce Way,
Commerce, CA 90040

June 21, 2017
Proposal No.: 17-1041

Subject: Geotechnical/Pavement Engineering Report,
Pavement Rehabilitation along Ferguson Drive
Between Atlantic Boulevard and the East City Limit
Commerce, CA 90040

1. INTRODUCTION

This report presents the results of a Limited Geotechnical Investigation performed by Geo-Advantec, Inc. (GAI) along Ferguson Drive, located within City of Commerce, California. This pavement evaluation is performed to provide information about the thickness of existing pavement layers, as well as our recommendations for construction and rehabilitation of the pavement for the subject project. The limit of the project along Ferguson Drive is between Atlantic Boulevard and the east city limit. This report includes our findings from the exploratory work and provides recommendations for the design and construction of the proposed future pavement rehabilitation from a geotechnical/pavement engineering standpoint.

The recommendations provided within this submittal are based on the results of our field exploration, laboratory testing, engineering analyses, and our experiences with similar projects. Our services were performed in general accordance with our Proposal No. 17-1041, dated June 21, 2017.

A vicinity map is presented as Figure A-1 within Appendix A. The vicinity map depicts the segment of Ferguson Drive this study pertains to. Aerial photo for the street have been used as the base map to depict the locations of the sampling performed for this investigation, and are presented as Figures A-2's within Appendix A.

Our professional services have been performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for The City of Commerce ("the City"), and their consultants for the subject project. The report has not been prepared for use by

other parties, and may not contain sufficient information for the purposes of other parties or other uses. The Geotechnical Engineer of Record should be allowed to review the plans for the proposed developments and perform such additional geotechnical analyses as may be required to confirm the applicability of the recommendations contained in this report to the final design.

2. SCOPE OF SERVICES

As we understand, the City intends to rehabilitate Ferguson Drive between Atlantic Boulevard and the east city limit. The length of this segment is about 9,500 feet and the rehabilitation consists mainly of milling/removing part of the existing asphalt concrete (AC) and overlaying the removed AC with new AC. In some areas with signs of relatively higher distress intensity and failure, milling/removing would be required for the full depth of existing AC and partial base; and in the higher traffic areas with signs of excessive distress intensity and failure, full depth removal (to the subgrade level) and reconstruction or full depth reclamation (to full/partial base layer) is recommended. Our scope of services for this project included the followings:

- Performing a site reconnaissance, evaluating the general condition of the existing pavement and mark the proposed coring and pothole locations for the purpose of underground utilities clearance and drilling;
- Conducting a total of 10 small diameter cores and 2 potholes using asphalt concrete coring machine and asphalt concrete saw-cutting machine;
- Measuring the existing asphalt concrete and base sections thicknesses, and determining the presence of pavement fabric at each location;
- Collecting disturbed/bulk samples of the encountered base and subgrade materials;
- Performing laboratory testing on the selected soils samples obtained from the field exploration and;
- Reviewing the field data and the laboratory test results, and preparing a final geotechnical report which includes our findings and recommendation for pavement reconstruction and/or rehabilitation for different streets from the geotechnical point of view.

3. FIELD EXPLORATORY WORKS AND EXISTING PAVEMENT

The field exploration program consisted of performing 10 small diameter cores and 2 potholes, and was performed on May 25, 26, and 30, 2017. The asphalt concrete was cored/saw-cut and

the base materials were cored/dug through at each location; and the asphalt concrete thickness and underlying base layer thickness were measured. Bulk samples of base materials and subgrade soils were collected for each location. The following table presents the results of our measurements on the existing pavement sections along with classification of subgrade material.

Table 1– Asphalt Concrete and Base Layer Thicknesses

SAMPLE LOCATION[1]	LANE[1]	DEPTH TO PAVEMENT FABRIC[2] (IN)	LAYER THICKNESSES (IN)		MATERIAL CLASSIFICATION	
			ASPHALT CONCRETE	BASE	BASE[3]	SUBGRADE[4]
C-1	SL - West	--	10	4	Well-graded Sand[5]	Sandy Lean Clay
TP-1	TL - West	--	10.5	6	Well-graded Sand with Silt and Gravel	Sandy Silt
C-2	TL - West	--	8.5	0	--	Sandy Silt
C-3	TL - East	--	12+[6]	--	--	--
TP-2[7]	SL- West	--	4.5	9.5	Crushed Miscellaneous Base	Sandy Lean Clay
C-4	TL - West	--	5	14	Silty Sand with Gravel	Clayey Sand
C-5	TL - East	--	4	13	Silty Sand with Gravel	Sandy Silty Clay
TP-3[7]	SL- East	--	4	11.5	Crushed Miscellaneous Base	Sandy Silt
C-6	TL - West	--	4	15	Well-graded Gravel with Silt and Sand	Lean Clay over Poorly graded Sand with Silt
C-7	SL- West	--	5.5	10+[8]	Crushed Miscellaneous Base	--
TP-4	SL- East	--	5	15	Poorly graded Sand with Gravel	Sandy Lean Clay
C-8	SL - East	--	4	10	Silty Sand with Gravel	Sandy Lean Clay

Notes:

(1) C- prefix indicates cored location. TP- prefix indicates potholed location. SL and TL indicate slow lane and traffic lane, respectively.

(2) -- indicates no observed presence of pavement fabric.

(3) Base classification was based on visual observation with the aids of laboratory lab tests, and was not tested for its conformity to specification defined the Standard Specifications for Public Works Construction ("Greenbook").

(4) Subgrade classification was based on visual classification method with the aids of laboratory lab tests.

(5) Wet base material.

(6) Unable to remove asphalt concrete core. Thickness of asphalt concrete is 12 inches or greater.

(7) Sawcut for pothole was terminated and resumed with asphalt coring instead.

(8) Unable to break through very hard compacted base layer to expose the subgrade. Thickness of base layer is 10 inches or greater.

Ferguson Drive between Atlantic Boulevard and Gerhart Avenue is a commercial and industrial neighborhood and the road within this limit serves traffic of heavy trucks. The pavement condition within the addressed commercial limit of Ferguson Drive is severely damaged and deteriorated.

The rest of the Ferguson Drive from Gerhart Avenue on the west to the end of the project, i.e. east city limit, passes residential areas and is subject to lighter traffic loads and vehicles. The severity of damage within this part of the project is less, and in some areas localized full depth repair will be warranted.

4. SUBSURFACE CONDITIONS

Based on the sampling conducted along the project, the subgrade material consists of predominantly of sandy silt and sandy lean clay. Subgrade materials in sample locations C-3 and C-7 could not be determined due to equipment and/or physical limitation. The soil conditions described in this report are based on the soils observed in the sampling conducted for this investigation and the laboratory test results. It is possible that soil conditions could vary in areas other than the explored locations.

5. LABORATORY TESTING

Gradation tests and plasticity index (Atterberg limits) tests were performed on selected base and subgrade samples obtained from the cores and potholes to aid in the classification of the encountered material and to evaluate their general properties. Also, expansion index test and R-value test were performed on selected bulk sample collected from potholed locations. The results of performed laboratory tests are provided in Appendix C.

6. PAVEMENT DESIGN AND CONSTRUCTION

6.1. General

Choosing the best rehabilitation alternative for each project depends on several technical factors; and one of the most decisive factor contributing the final decision is the economy of the project and available financial resources. Selecting the most cost-effective strategy for pavement rehabilitation continues to be a significant challenge to the transportation professionals.

A systematic approach should be employed as the most effective way to evaluate and select pavement rehabilitation techniques and must account for all applicable parameters and their impacts on the choice between alternatives. These parameters may be both pavement and non-pavement related. Initial cost of rehabilitation, expected pavement life span, anticipated maintenance, and future rehabilitation requirements also influence strategy selection.

6.2. Recommended Pavement Alternatives

Based on our conversation with the City officials, it is our understanding that due to the financial/budget consideration, in addition to full replacement and reconstruction, pavement rehabilitation alternatives needs to be studied. Our team of engineers have visually observed the existing pavement condition to identify the type, severity, and extent of distress. The following table provides our recommendations for different portions/segments along the length of the project taking account the existing pavement condition.

Table 2 – Pavement Alternatives for Different Portions/Segments of the Project

PORTIONS/SEGMENTS	RECOMMENDED ALTERNATIVES	APPLICABLE RECOMMENDATION SECTION
Between Atlantic Boulevard and Gerhart Avenue (See Figure A-3 – Note ①)	Full Depth Removal and Replacement (FDR&R) or Full Depth Reclamation (FDR)	6.2.1. or 6.2.2
Various (See Figure A-3 – Note ②)	AC Removal and Replacement (ACR&R)	6.2.3
All other areas	Mill and Overlay	6.2.4.

The recommendation options provided above are believed to be the most appropriate solution for each of the segment. However, and due to various parameters contributing to the projects, other alternatives may be considered and selected by the City. It should be noted that different alternatives addressed in the forthcoming sections of this report will result in different end products with different life-spans.

Samples of the subgrade soils were obtained within the project limits and two selected samples were tested for their R-Values. The new pavement section recommendations provided in the following Section 6.2.2 are based on the on-site subgrade soils having a design R-Value of 15. The new pavement section recommendations are also for assumed Traffic Index (TI) values of 6, 7, 8, and 9. We would be pleased to provide additional pavement section recommendations for different TI values upon request.

6.2.1 Full Depth Reclamation (FDR)

Full depth reclamation (FDR) alternative commonly includes grinding and mixing the full or partial depth of the existing asphalt concrete (AC) and predetermined portion (full or partial) of base material together with cement to create cement stabilized pulverized base (CSPB). The pulverized mix for CSPB will be placed back, moisture-conditioned, compacted, and will be overlaid by compacted layers of new hot mixed asphalt (HMA). Compared to full reconstruction of the pavement (6.2.2), this alternative will result in more economic construction and is recommended as an alternative for the areas between Atlantic Boulevard and Gerhart Avenue as shown in Figure A-3, within Appendix A.

Taking into account the variation in the thicknesses of existing AC and base layers, availability of AC and base to be reclaimed, type of base materials, and variations in subgrade conditions, we have provided our recommendations for Traffic Index of 8 and 9 in the following Table 3. The intent of our analysis was to determine optimum thickness for the CSPB layer and eliminate/decrease any need for supplemental base materials. It is our recommendation to grind and haul out the top 3 to 4 inches of the existing AC layer. Then, grind, pulverize and mix the remaining asphalt section with full thickness of existing base layer and 5 percent of cement to create a 10-inch thick layer of cement stabilized pulverized base (CSPB). After placement and compacting the CSPB layer, a 1.5-inch dense graded leveling asphalt course shall be placed, followed by placing the upper course(s) of AC, as recommended in the following Table 3. The following table provides the recommendation for FDR pavement sections.

Table 3 – Recommended Full Depth Reclamation

TRAFFIC INDEX	HOT MIXED ASPHALT CAP COURSES (INCHES)	HOT MIXED ASPHALT LEVELING COURSE (INCHES)	CSPB (INCHES)
8	5.0	1.5	10.0
9	6.0	1.5	10.0

It is recommended that the HMA be placed and compacted in layers of not exceeding 4 inches in thickness.

Specifications for CSPB: Portland cement Type II shall be 5 percent, based on in-place dry unit weight of the mixed pulverized AC and base materials. In-place dry unit weight of 130 pcf should be used for estimating purposes. The cement content shall vary no more than 0.5 percent under and not more than 1.0 percent over the specified cement content. Cement shall not be spread upon the

prepared material more than 2 hours prior to the mixing operation. The CSPB shall be comprised of pulverized existing AC and base materials. The subgrade may be disturbed during the construction activities to get down to the desired over-excavation level. However, subgrade soils shall not be mixed with and/or included in CSPB.

The CSPB layer shall be compacted to a minimum of 97% relative compaction in accordance with the ASTM D558. Then, prior to placement of asphalt layers, fine grading to the required grades should be done, and micro-cracking the completed cement stabilized surface within 24 to 48 hours after completion of placement and compaction of CSPB shall be performed. The ground asphalt concrete surfacing and underlying base/soil materials shall be pulverized such that 100 percent of the material will pass a 1.5-inch sieve and a minimum of 90-percent will pass a 3/4-inch sieve. The pulverized materials shall be free of roots, sod, weeds, wood, and construction debris.

The newly constructed CSPB should be kept moist, by lightly watering or misting, for a 7-day period, or a moisture retaining curing compound may be placed over the surface of the completed CSPB soon after completion to retain the moisture and allow the cement to hydrate.

The mixed cement stabilized pulverized base shall not have compressive strength less than 500 psi at 7 days, when sampled by using the molds specified in ASTM D698 and cured per ASTM D559-15. The contractor should collect samples of AC and Base from the site, and prepare trial samples to assure the required strength is obtainable, otherwise, the contractor should provide their own submittal/mix design for our review and approval.

6.2.2 Full Depth Removal and Replacement (FDR&R)

Full depth removal and replacement (FDR&R) option includes removal of the entire asphalt concrete (AC) and base layer, reworking and compacting of the subgrade soils, and placing back well-compacted layers of base and asphalt concrete. This alternative is considerably costly, with longer life span, and is recommended as an alternative for the areas between Atlantic Boulevard and Gerhart Avenue as shown in Figure A-3, within Appendix A.

The tests performed on the on-site subgrade material has resulted in low R-values (indicating presence of weak subgrade) and very low to medium expansion potential (based on ASTM D4829) in the specified areas. Due to the existing weak clayey and/or silty subgrade soils with some area of high moisture content, pumping may occur while performing compaction on the subgrade soils.

The recommendations provided hereafter include pavement sections for different traffic conditions to occur within the project area and schematic sections depicting the grading requirements are presented as Figures A-4, within Appendix A of this report.

For the hot mixed asphalt (HMA) pavement sections, the depth of excavation/removal of the on-site shallow soils shall be determined based on the thicknesses provided in Table 4 below, plus the recommended thickness for over-excavation and backfilling with reworked/compacted soils. Two different options for HMA pavement are recommended:

Option I: is to construct the pavement section by placing layer(s) of HMA over the compacted base materials. The base layer should be underlain by reworked/compacted fill. It is recommended that the upper 12 inches of the subgrade soils below the base layer be over-excavated, reworked, and compacted in layers. The backfilled areas shall be moisture-conditioned to moisture content between 2 and 4 percent above the optimum moisture content, and compacted to at least 90 percent of the maximum dry density obtained per ASTM D1557. The backfill materials shall comply with the specifications outlined in Section 6.3 of this report. It should be noticed that pumping is expected for silty clayey subgrades when the moisture content is higher than the optimum moisture content.

Option II: involves enhancement of the subgrade by using a layer of Subgrade Enhancement Geotextile (SEG). We recommend the HMA layer be underlain by the specified layer of base materials, underlain by a layer of geotextile which will be placed over reworked subgrade. It is recommended that the upper 12 inches of the subgrade soils below the base layer be scarified, moisture-conditioned to a moisture content between 2 and 4 percent above the optimum moisture content, and compacted to at least 90 percent of the maximum dry density obtained per ASTM D1557.

The geotextile layer should be Mirafi RS380i or equivalent, and shall be placed over the entire reworked/compacted subgrade area prior to placing base material. Following placing and spreading the geotextile layer, base material shall be placed and compacted in layers. The base shall be placed and compacted to at least 95 percent of the maximum dry density obtained per ASTM D1557. Lastly, new HMA of specified thickness, as indicated in Table 4 below, shall be placed on top of the base layer and compacted. It is recommended that the HMA be placed in 1.5-inches dense/leveling layers, followed by final layers of not exceeding 4 inches in thickness.

After over-excavation and for both alternatives, the upper layer of exposed subgrade shall be scarified to a minimum depth of 8 inches, moisture-conditioned to between the optimum

moisture content and 2 percent above the optimum moisture content, and compacted to at least 90 percent of the maximum dry density obtained per ASTM D1557.

The following table provides the recommendation for hot mixed asphalt (HMA) pavement sections.

Table 4 – Recommended Full Depth Removal and Replacement

OPTIONS	TRAFFIC INDEX	MINIMUM COURSE THICKNESS (IN)		
		HOT MIXED ASPHALT, T_{AC}	AGGREGATE BASE, T_B	REWORKED/COMPACTED BACKFILL/SCARIFIED SUBGRADE
I – HMA over Base over Reworked/Compacted Subgrade	6	5.0	7.5	12.0/8.0
	7	6.0	9.5	
	8	7.0	11.0	
	9	8.0	12.0	
II – HMA over Base over SEG over Reworked/Compacted Subgrade	6	5.0	6.0	8.0
	7	6.0	8.0	
	8	7.0	9.0	
	9	8.0	10.0	

Base course material should consist of Crushed Aggregate Base (CAB) as defined by Section 200-2.2 of the Standard Specifications for Public Works Construction ("Greenbook"). In lieu of CAB materials, Crushed Miscellaneous Base (CMB) materials as defined by Section 200-2.4 of the Standard Specifications for Public Works Construction ("Greenbook") may be used. Base course should be compacted to at least 95 percent of the maximum dry density of that material. The assumed R-value in design of the above provided preliminary sections for CAB material is 78.

Base course material should be purchased from a supplier who will certify the base course will meet or exceed the specifications in the Greenbook as indicated. We could, at your request, perform sieve analysis and sand equivalency tests on material delivered to the site which appears suspect. Additional tests could be performed, upon request, to determine if the material is in compliance with the specifications.

In order to increase pavement performance and extend the pavement life, concrete curbs should be deepened to extend at least 6 inches into the base course material. The intent of deepening the curbs and gutters is to form a "cut-off" wall to reduce the amount of water flow through the base from adjacent landscaped areas. Subgrade soils which become saturated as a result of water flowing through base material can reduce the life of the pavement. Also after completion of the work, all the joints between curb/gutter segments and between curbs and adjoining flatwork shall be sealed and

waterproofed. Any abandoned footing and/or underground concrete structure within the work limit shall be removed entirely and backfilled to the grade.

6.2.3 Asphalt Concrete Removal and Replacement (ACR&R)

Asphalt concrete removal and replacement (ACR&R) includes removal of the entire asphalt concrete (AC) layer and partial base layer, rolling and compacting the existing in-place base layer, and placing well compacted layers of asphalt concrete. This alternative is recommended for various areas as shown in Figure A-3, within Appendix A.

It is our recommendation that the entire asphalt concrete layer and partial base layer be milled/removed such that the bottom of the removal is about 7.0 inches below the finished AC surface. Care shall be taken when removing the AC and partial base layer to ensure that the top of the exposed base layer is as undisturbed as possible.

After milling and removing the entire thickness of the existing asphalt layer and partial base layer down to about 7 inches below the finished AC surface, the base shall be rolled/compacted to at least 95 percent of the maximum dry density of the material obtained per ASTM D1557.

After compacting the base layer in-place, new HMA shall be placed on top and compacted. The new HMA thickness shall be equal or greater than the removed AC plus base thickness. It is recommended that the HMA be placed in a 2 to 3 inches thick dense/leveling layers, followed by final layers of not exceeding 4 inches in thickness.

6.2.4 Mill and Overlay (MO)

The thickness of the hot mix asphalt (HMA) overlay for each project depends on several factors. The most appropriate approach for design of a pavement rehabilitation projects is to conduct deflection study. As mentioned, determining an accurate estimate for milling and overlay is difficult without a deflection study because valid data on existing conditions is needed to know how much structural strength is lost hence how much needs to be removed and replaced with new material to produce a structurally adequate pavement. Such a study usually is not justified for smaller projects such as local and low traffic streets within cities. In absence of a deflection study, we have used guidelines provided in Caltrans Design Manual (Reference 2), Flexible Pavement Rehabilitation Manual (Reference 3), our engineering judgment, as well as our experience from similar projects.

However, based on the guidelines provided in References 2 and 3, our experience with similar projects and the results of our evaluation, specially thickness of existing AC layer, we recommend a

3.0-inch thickness MO for the entire studied area east of Gerhart Avenue (unless otherwise noted for areas to be repaired per FDR, FDR&R, and ACR&R). The new HMA thickness shall be the same or greater than the removed AC thickness. It is recommended that the asphalt be placed in a 1.0-inch dense/leveling layers, followed by a 2.0-inch capping/final layer.

The MO alternative consists of grinding the recommended thickness of the existing AC pavement and placing the same thickness of new AC overlay on the ground surface. This alternative is applicable for the entire studied area since the sampled locations shows that the existing AC thickness is ranges between 4.0 and 5.5 inches. A minimum AC thickness of 4.0 inches is required so that after grinding the recommended 3 inches, there shall be at least 1.0 inches of AC remains in place, which is the minimum required thickness to carry the weight of the grinding machine during construction.

Before adding the new HMA overlay, the damaged areas and cracks shall be repaired, sealed and patched properly. Cracks wider than 1/6 inch should be sealed, loose pavement removed and patched, spalls repaired, and broken slabs or punch outs replaced. If any localized deep failure area is observed after grinding, the existing asphalt pavement section within the localized areas of pavement failures should be completely removed and replaced with a full depth asphalt concrete section, per the recommendations provided in section 6.2.2.

The existing cracks in areas to be overlaid with HMA may eventually reflect through, and less likely when overlaid with Rubberized Hot Mix Asphalt (RHMA). However, reflective cracking cannot be eliminated unless the pavement is completely removed and replaced.

6.3. Fill Materials and Import

In general, the on-site clayey silty soils have been determined to have a very low to medium expansion potential. On-site materials or imported materials can be used for backfilling purpose, considering that some of the on-site materials are prone to pumping. Import materials, if needed, should have an expansion index (EI) of less than 35 and should contain sufficient fines (binder material) so as to be relatively impermeable and result in a stable subgrade when compacted. The imported materials being used for backfilling purpose should be free of organic materials, debris, and cobbles larger than 3 inches, with no more than 25 percent of the materials being larger than 2 inches in size and no more than 40 percent passing #200 sieve. A bulk sample of potential backfill/import material, weighing at least 30 pounds, should be submitted to the Geotechnical Consultant at least 72 hours before fill operations. Upon approval of the potential backfill earth

materials, contractor will be allowed to start importing/hauling process. All backfill materials should be approved by the Geotechnical Consultant prior to being placed at the site.

7. SOIL EXPANSIVITY

We have performed expansivity tests on selected soil samples obtained from different cored/potholed locations to determine the expansion characteristics of the on-site shallow soils. The sample was obtained from on-site soils in the upper 5 feet bgs, which is susceptible to expansion when facing seasonal cycles of saturation/desiccation. The test result is presented in the following table.

Table 5 – Expansion Test Results

SAMPLE LOCATION	SAMPLE DEPTH	SOIL CLASSIFICATION	EXPANSION INDEX (EI)	EXPANSION POTENTIAL (ASTM D4829 – 11)
C-1	Subgrade	Sandy Lean Clay	57	Medium
C-4	Subgrade	Clayey Sand	30	Low
TP-1	Subgrade	Sandy Silt	2	Very Low

The above tabulated test results on the on-site shallow soils within the pavement areas indicate very low to medium expansion potential (based on ASTM D4829-11).

8. OBSERVATION AND TESTING

This final report has been prepared assuming that GEO-ADVANTEC, INC. will perform all geotechnical-related field observations and testing. If the recommendations presented in this report are utilized, and observation of the geotechnical work is performed by others, the party performing the observations must review this report and assume responsibility for recommendations contained herein. That party would then assume the title "Geotechnical Consultant of Record".

A representative of the Geotechnical Consultant should be present to observe all grading operations as well as all footing excavations. Upon the client's request, a report or final verification letter presenting the results of these observations and related testing should be issued upon completion of the grading operations.

9. CLOSURE

The findings and recommendations presented in this final report were based on the results of our field and laboratory investigations, combined with professional engineering experience and judgment. The report was prepared in accordance with generally accepted engineering principles and practice. We make no other warranty, either expressed or implied.

The soils encountered in the sampled locations are believed to be representative of the total under consideration area for the subject proposed development; however, soil characteristics can vary throughout the site. GAI should be notified if subsurface conditions are encountered which differ from those described in this report.

Samples secured for this investigation will be retained in our laboratory for a period of 45 days from the date of this report and will be disposed after this period unless other arrangements are made.

Should you have any questions concerning this submittal, or the recommendations contained herewith, please do not hesitate to call our office.

Respectfully submitted,
GEO-ADVANTEC, INC.

Jack Lee
Senior Project Engineer

Shawn Ariannia, Ph.D., P.E., G.E.
Principal Geotechnical Engineer

Distribution:

1. Addressee (3 wet stamped copy + pdf copy via e-mail)
2. File

APPENDICES

Appendix A: Maps and Plans and Figures

Figure A-1: Vicinity Map
Figure A-2: Coring and Pothole Locations Plan
Figure A-3: Rehabilitation Plan
Figure A-4: Asphalt Concrete Pavement Sections

Appendix C: Laboratory Test Results

Sieve Analysis
Percent Finer than No. 200
Plasticity Chart
R-Value Test

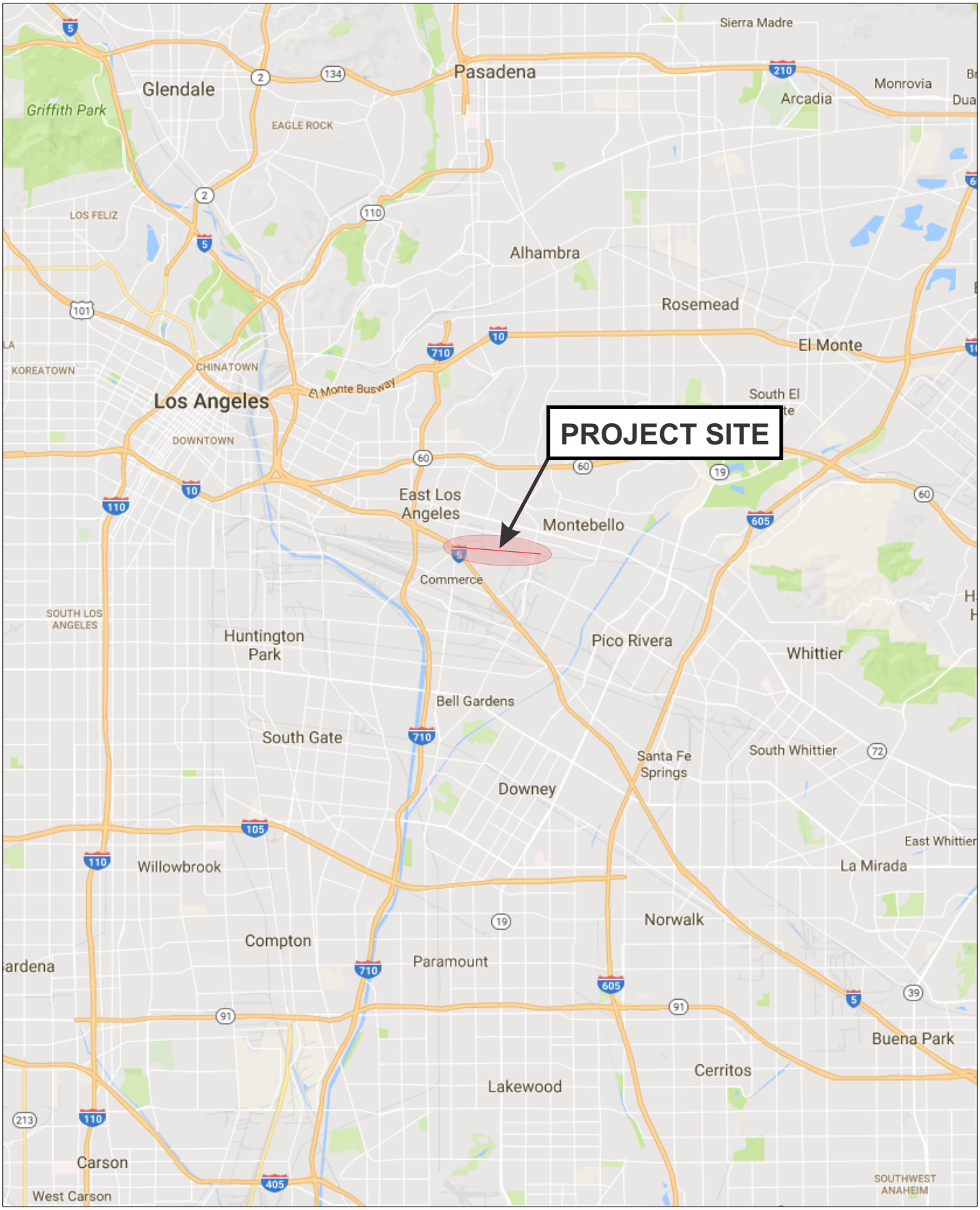
REFERENCES

1. Thickness Design for Concrete Highway and Street Pavements – Portland Cement Association (1995)
2. Highway Design Manual – Caltrans (2012)
3. Flexible Pavement Rehabilitation Manual – Caltrans (2001)
4. Full Depth Reclamation Using Cement-Caltrans (2013)

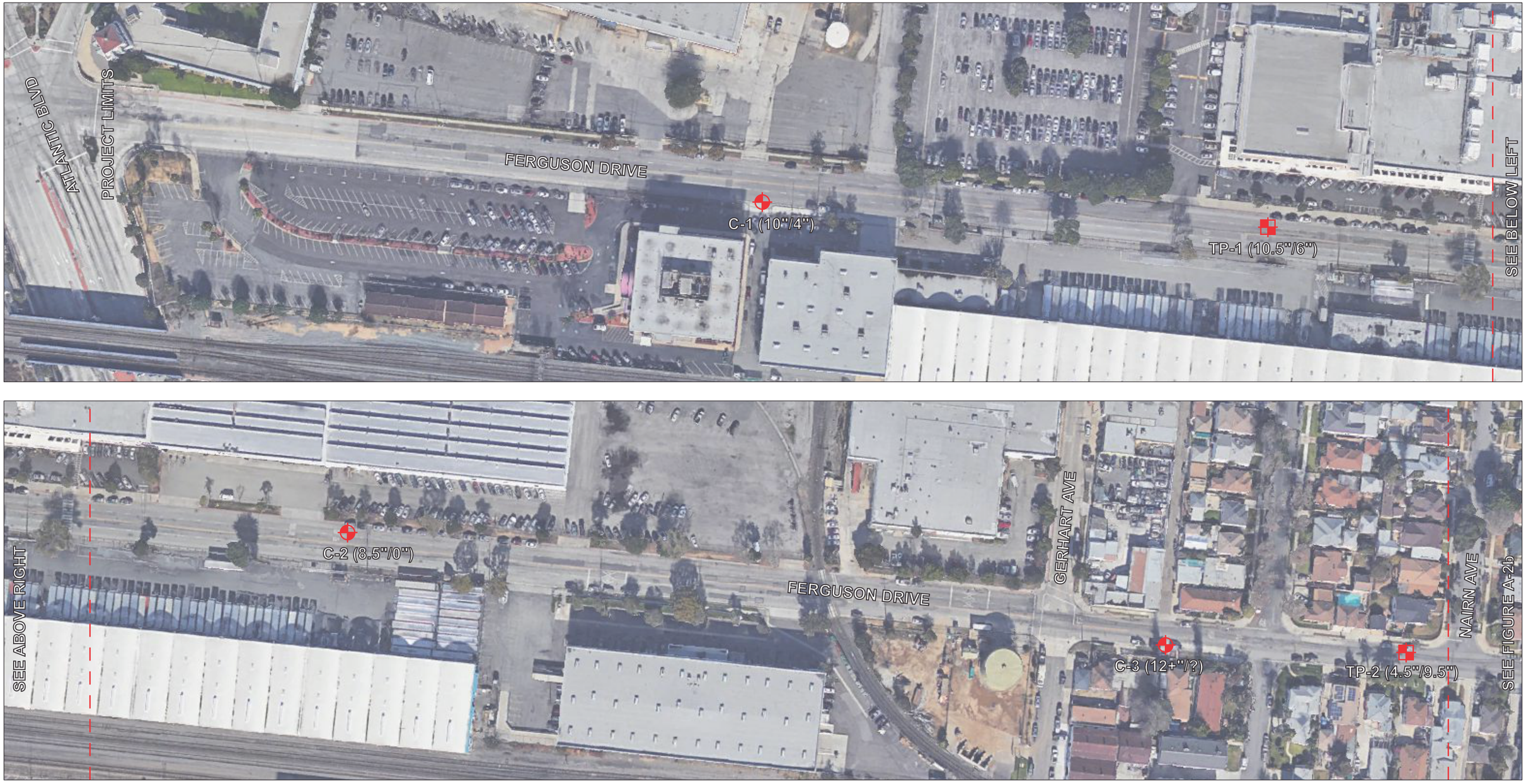
APPENDICES

APPENDIX A

MAPS, PLANS AND FIGURES



Geo-Advantec Inc.		VICINITY MAP	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-1
DATE	06-19-2017		



Geo-Advantec Inc.		CORING AND POTHOLE LOCATIONS PLAN	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-2a
DATE	06-19-2017		

LEGEND

CORING LOCATION

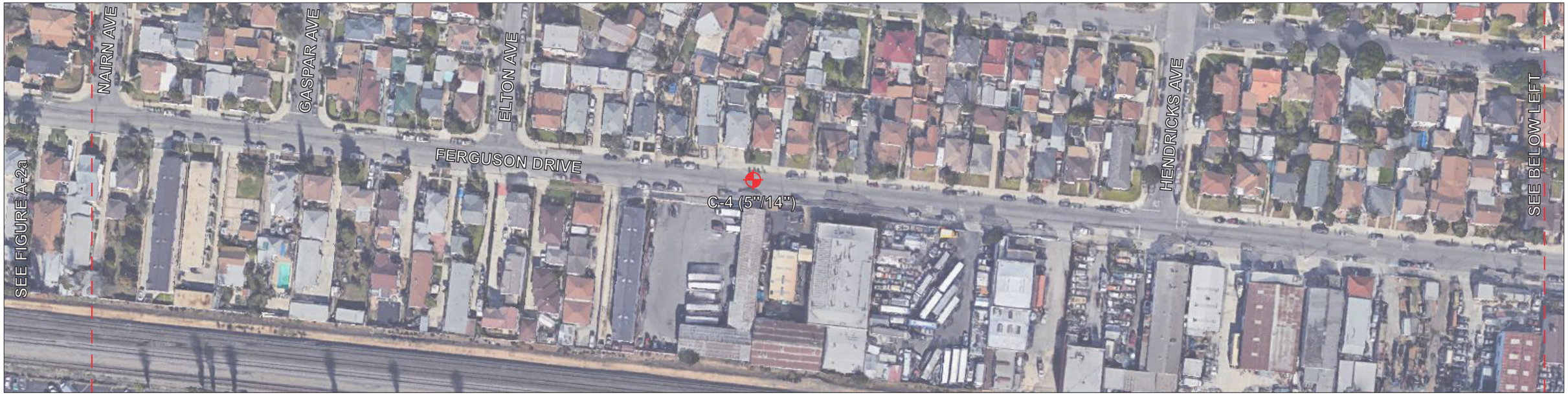
POTHOLE LOCATION

TP-2 (4.5"/9.5") NAME (AC/Base Thickness)

N

SCALE (FT)

0 50 100 200



Geo-Advantec Inc.		CORING AND POTHOLE LOCATIONS PLAN	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-2b
DATE	06-19-2017		

LEGEND

CORING LOCATION

POTHOLE LOCATION

C-6 (4"/15") NAME (AC/Base Thickness)

N

SCALE (FT)

0 50 100 200

Geo-Advantec Inc.		CORING AND POTHOLE LOCATIONS PLAN	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-2c
DATE	06-19-2017		

LEGEND

CORING LOCATION

POTHOLE LOCATION

C-8 (4"/10") NAME (AC/Base Thickness)

N

SCALE (FT)

0 50 100 200

LEGEND

① FULL DEPTH R&R OR FULL DEPTH RECLAMATION

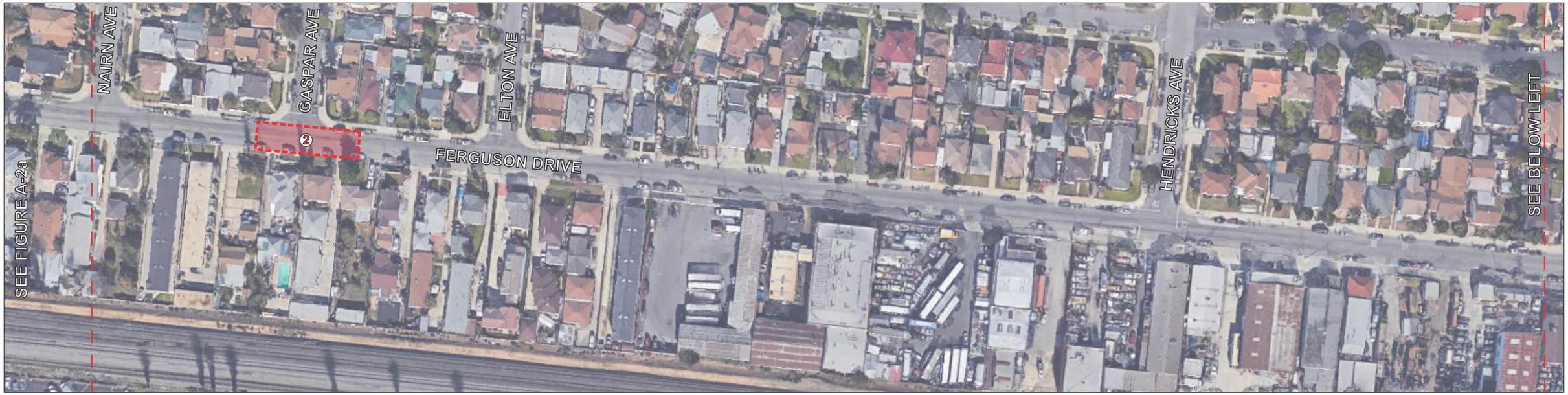
② FULL DEPTH ACR&R TO ~7.0 INCHES BELOW AC SURFACE

M&O ALL OTHERS

Geo-Advantec Inc.		REHABILITATION PLAN	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-3a
DATE	06-19-2017		

N

SCALE (FT)
0 50 100 200



LEGEND

① FULL DEPTH R&R OR FULL DEPTH RECLAMATION

② FULL DEPTH ACR&R TO ~7.0 INCHES BELOW AC SURFACE

M&O ALL OTHERS

Geo-Advantec Inc.		REHABILITATION PLAN	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-3b
DATE	06-19-2017		

N

SCALE (FT)

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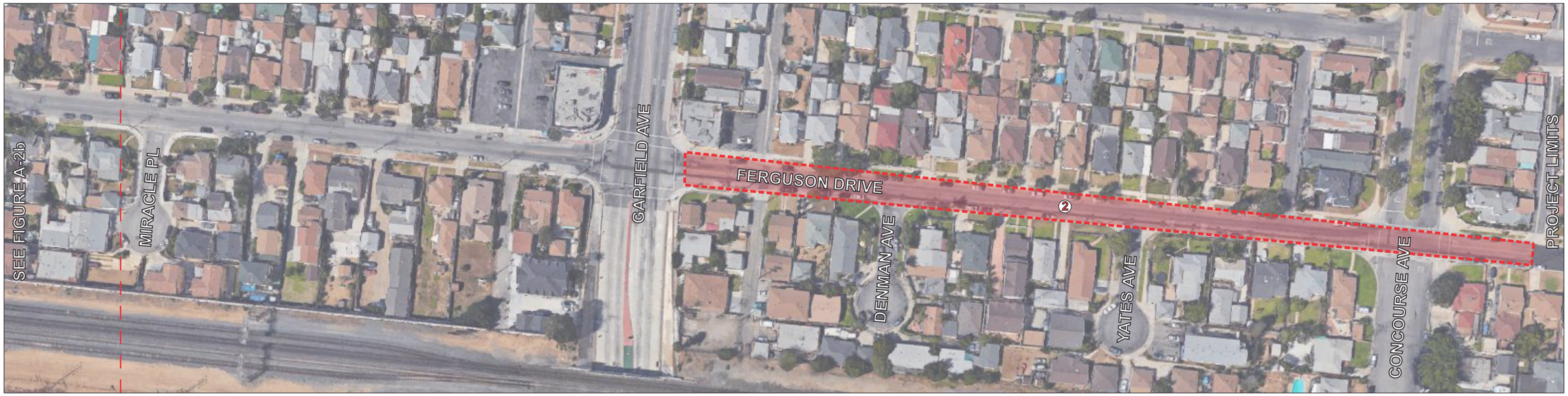


LEGEND

① FULL DEPTH R&R OR FULL DEPTH RECLAMATION

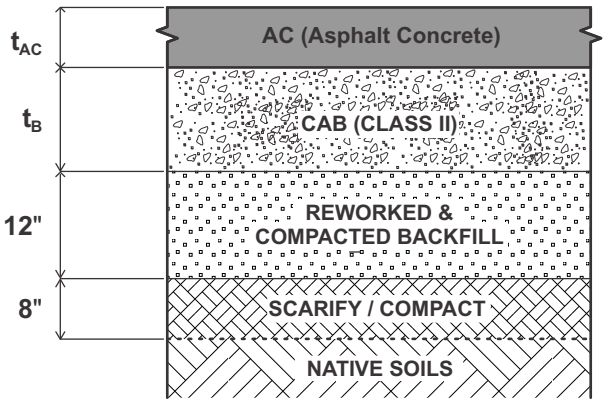
② FULL DEPTH ACR&R TO ~7.0 INCHES BELOW AC SURFACE

M&O ALL OTHERS

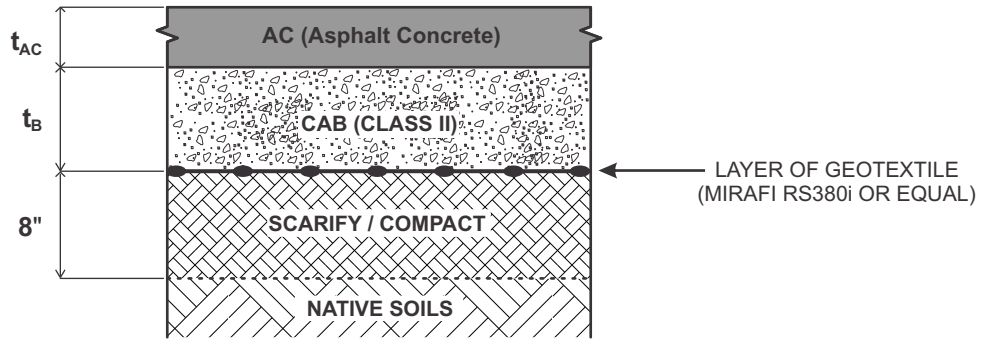
Geo-Advantec Inc.		REHABILITATION PLAN	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-3c
DATE	06-19-2017		

N

SCALE (FT)
0 50 100 200



ASPHALT CONCRETE PAVEMENT (OPTION I)



ASPHALT CONCRETE PAVEMENT (OPTION II)

Geo-Advantec Inc.		ASPHALT CONCRETE PAVEMENT SECTIONS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	A-4
DATE	06-19-2017		

APPENDIX C

LABORATORY TEST RESULTS

PARTICLE SIZE DISTRIBUTION REPORT

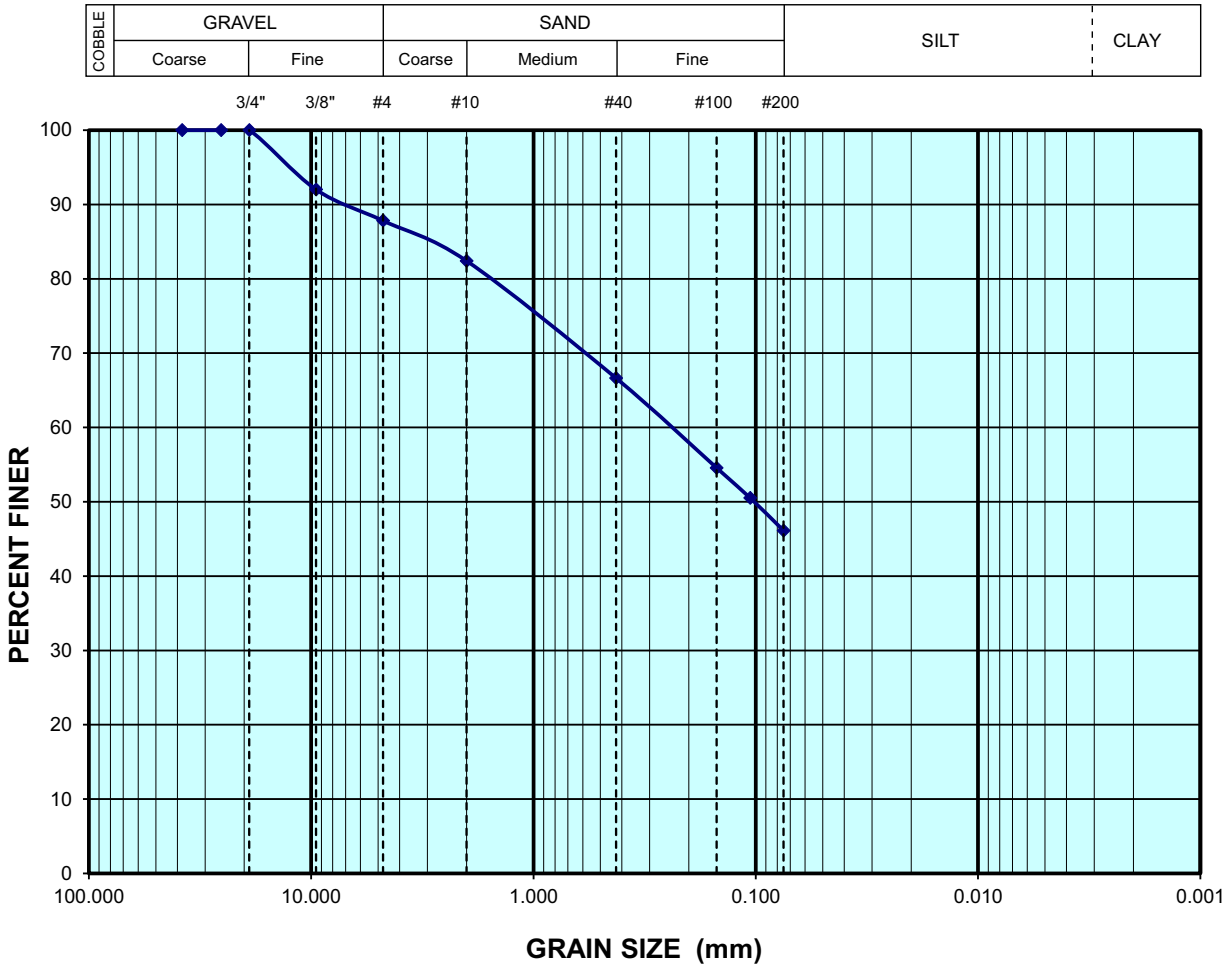
Project: Ferguson Drive Pavement Rehabilitation
Site: Commerce, CA
Tech: MN

Project No. 17-1041-B
Date: 6/6/2017

Sample C-4@SG
Material Clayey SAND (SC)

Test Specification: ASTM D422

Sieve	Mesh Opening (mm)	Percent Passing (%)
1 1/2 in	38.1	100.0 %
1 in	25.4	100.0 %
3/4 in	19.0	100.0 %
3/8 in	9.51	92.0 %
No. 4	4.75	87.8 %
No. 10	2.00	82.4 %
No. 40	0.425	66.6 %
No. 100	0.150	54.6 %
No. 140	0.106	50.5 %
No. 200	0.075	46.1 %



Geo-Advantec Inc.		SIEVE ANALYSIS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

PARTICLE SIZE DISTRIBUTION REPORT

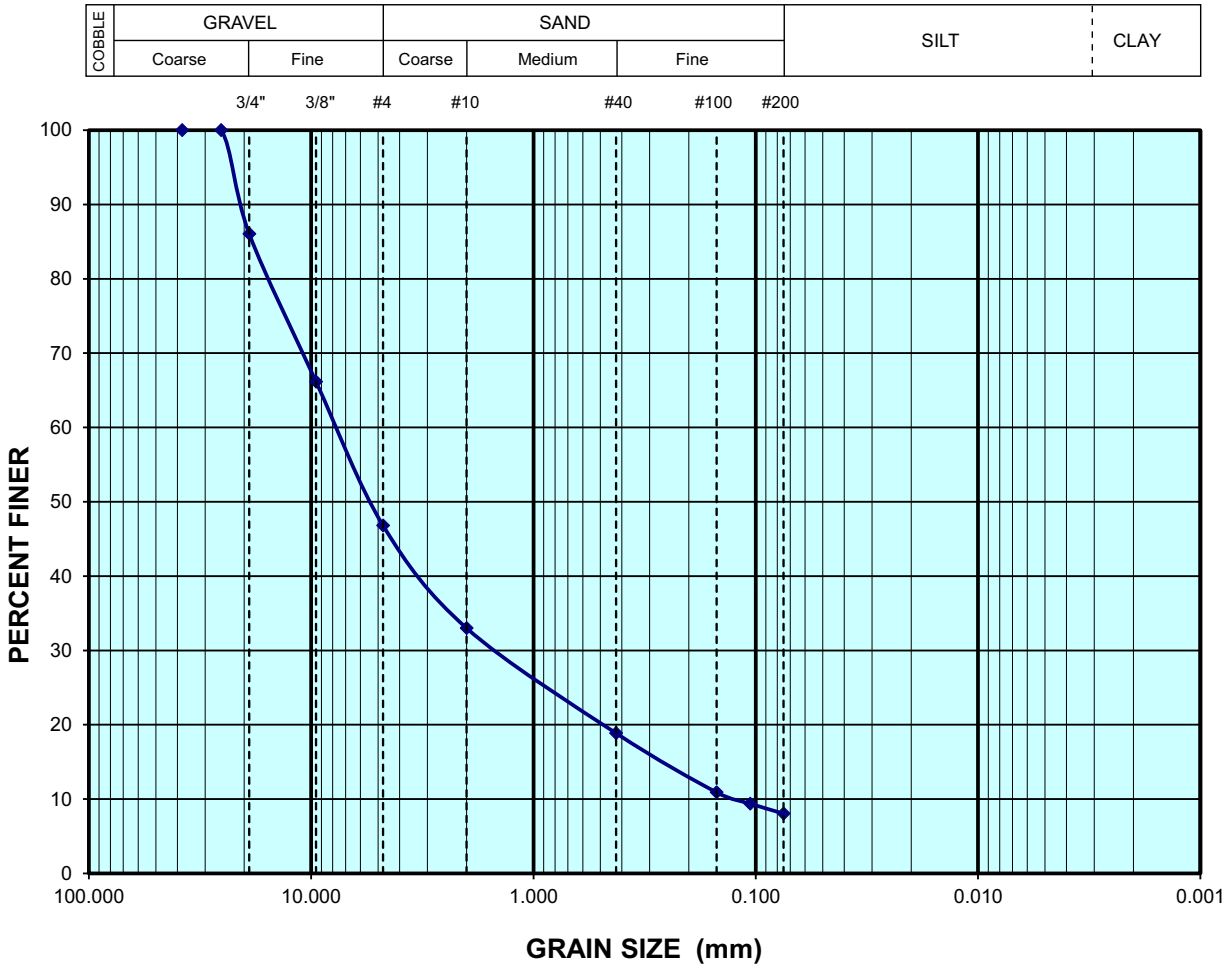
Project: Ferguson Drive Pavement Rehabilitation
Site: Commerce, CA
Tech: MN

Project No. 17-1041-B
Date: 6/6/2017

Sample C-6@Base
Material Well-graded GRAVEL with Silt and Sand (GW-GM)

Test Specification: ASTM D422

Sieve	Mesh Opening (mm)	Percent Passing (%)
1 1/2 in	38.1	100.0 %
1 in	25.4	100.0 %
3/4 in	19.0	86.1 %
3/8 in	9.51	66.2 %
No. 4	4.75	46.8 %
No. 10	2.00	33.0 %
No. 40	0.425	18.9 %
No. 100	0.150	10.9 %
No. 140	0.106	9.4 %
No. 200	0.075	8.1 %



Geo-Advantec Inc.		SIEVE ANALYSIS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

PARTICLE SIZE DISTRIBUTION REPORT

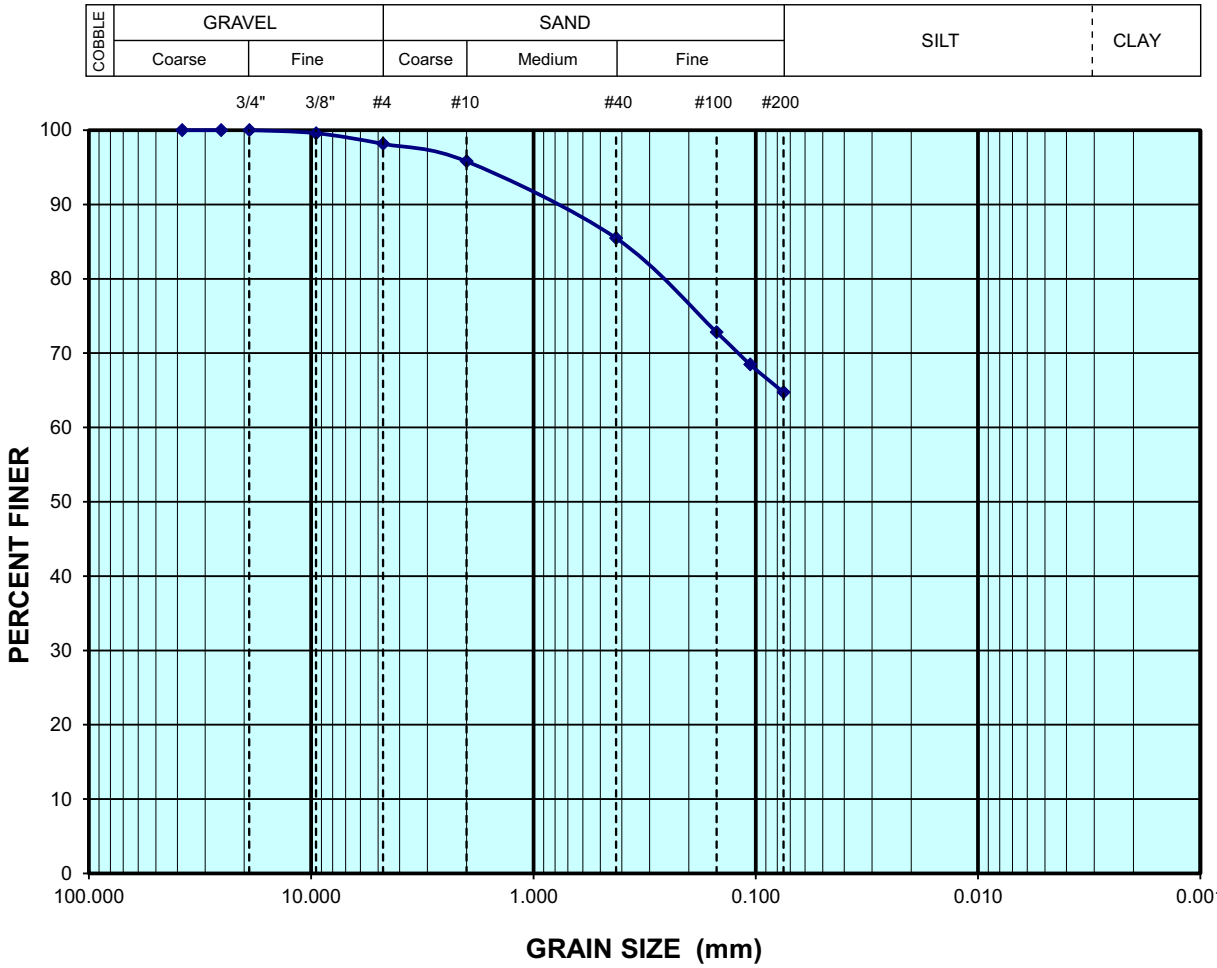
Project: Ferguson Drive Pavement Rehabilitation
Site: Commerce, CA
Tech: MN

Project No. 17-1041-B
Date: 6/6/2017

Sample C-8@SG
Material Sandy Lean CLAY (CL)

Test Specification: ASTM D422

Sieve	Mesh Opening (mm)	Percent Passing (%)
1 1/2 in	38.1	100.0 %
1 in	25.4	100.0 %
3/4 in	19.0	100.0 %
3/8 in	9.51	99.6 %
No. 4	4.75	98.2 %
No. 10	2.00	95.8 %
No. 40	0.425	85.5 %
No. 100	0.150	72.8 %
No. 140	0.106	68.5 %
No. 200	0.075	64.7 %



Geo-Advantec Inc.		SIEVE ANALYSIS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

PARTICLE SIZE DISTRIBUTION REPORT

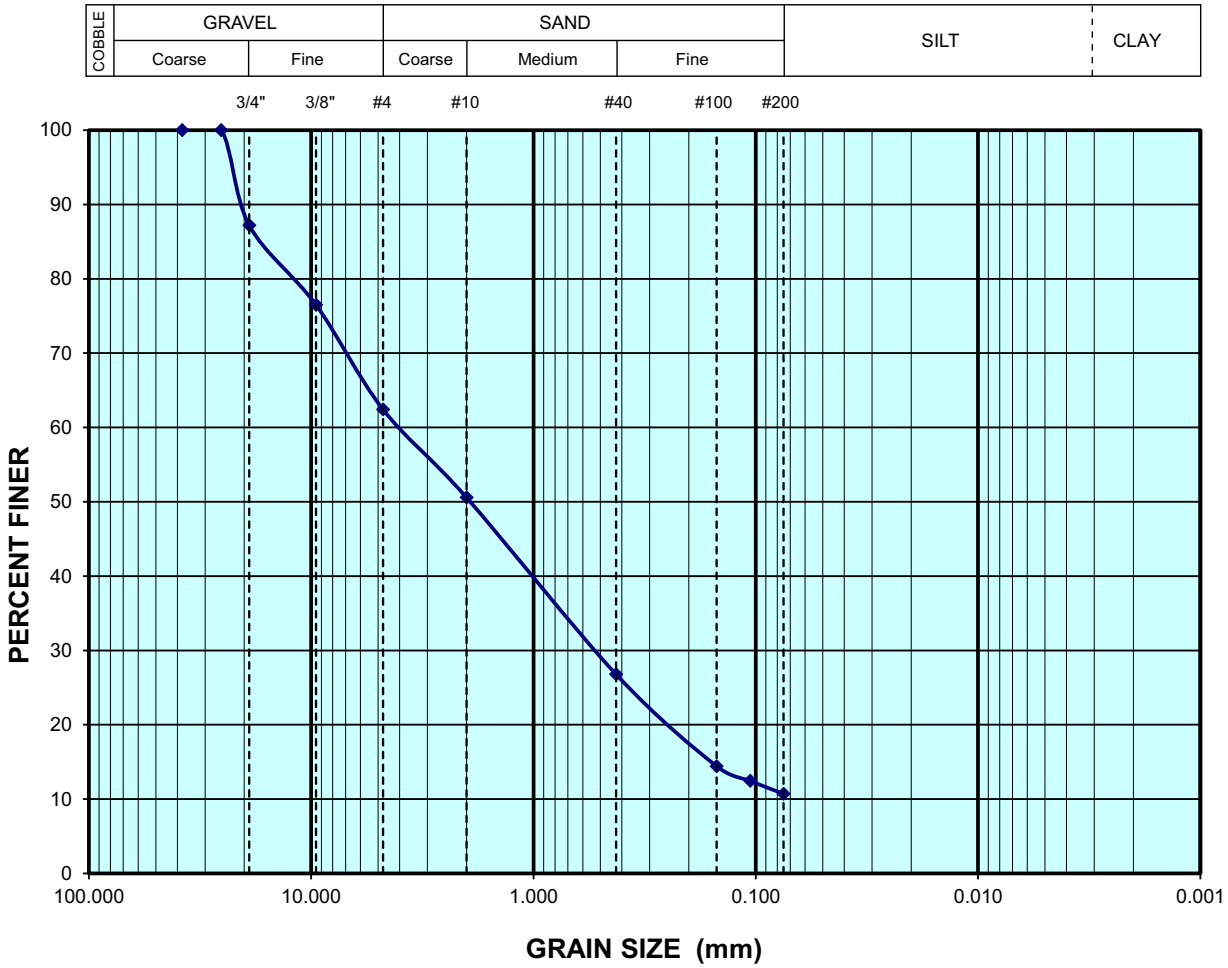
Project: Ferguson Drive Pavement Rehabilitation
Site: Commerce, CA
Tech: MN

Project No. 17-1041-B
Date: 6/6/2017

Sample TP-1@Base
Material Well-graded SAND with Silt and Gravel (SW-SM)

Test Specification: ASTM D422

Sieve	Mesh Opening (mm)	Percent Passing (%)
1 1/2 in	38.1	100.0 %
1 in	25.4	100.0 %
3/4 in	19.0	87.2 %
3/8 in	9.51	76.5 %
No. 4	4.75	62.4 %
No. 10	2.00	50.6 %
No. 40	0.425	26.8 %
No. 100	0.150	14.4 %
No. 140	0.106	12.5 %
No. 200	0.075	10.7 %



Geo-Advantec Inc.		SIEVE ANALYSIS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

PARTICLE SIZE DISTRIBUTION REPORT

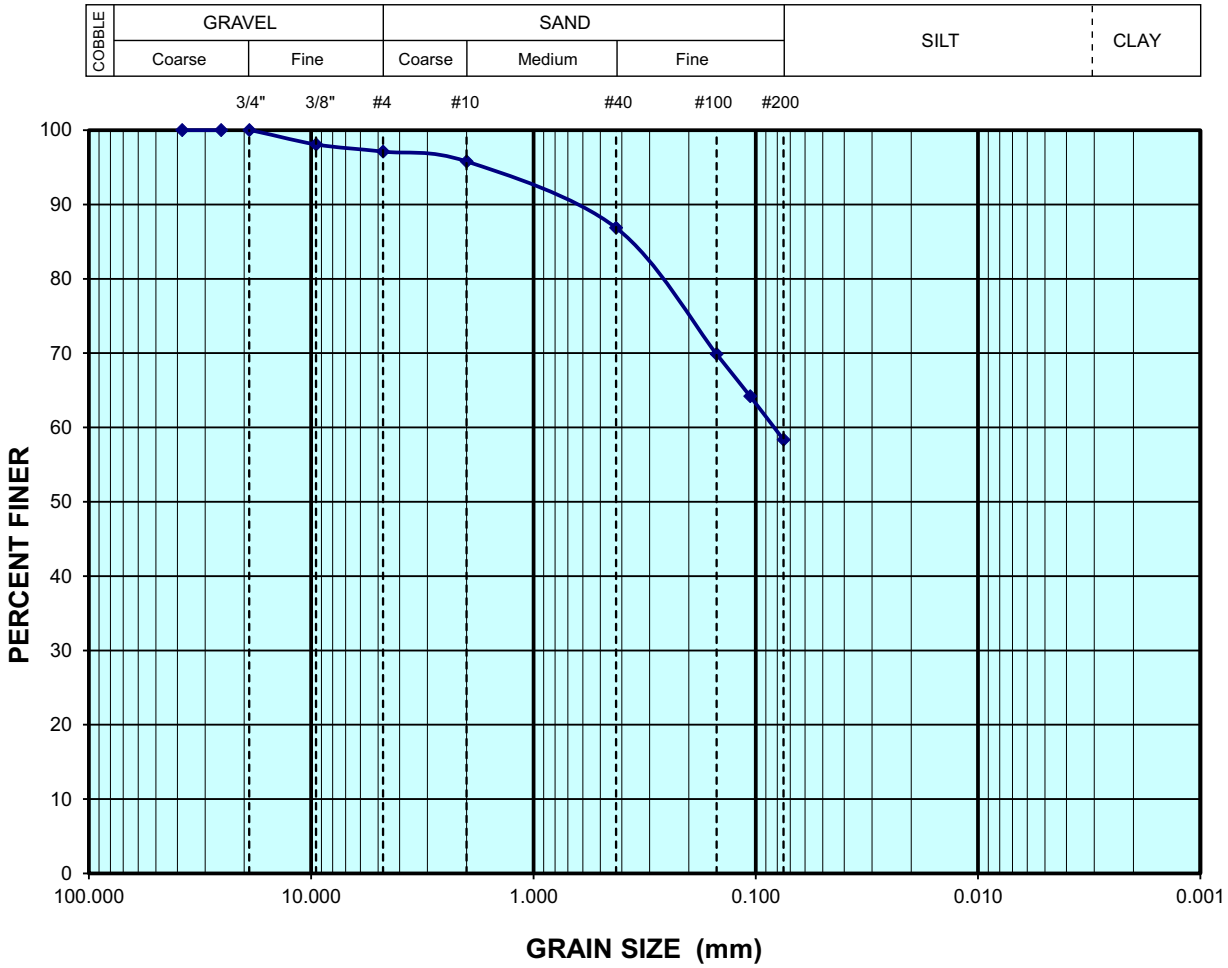
Project: Ferguson Drive Pavement Rehabilitation
Site: Commerce, CA
Tech: MN

Project No. 17-1041-B
Date: 6/6/2017

Sample TP-4@SG
Material Sandy Lean CLAY (CL)

Test Specification: ASTM D422

Sieve	Mesh Opening (mm)	Percent Passing (%)
1 1/2 in	38.1	100.0 %
1 in	25.4	100.0 %
3/4 in	19.0	100.0 %
3/8 in	9.51	98.1 %
No. 4	4.75	97.1 %
No. 10	2.00	95.8 %
No. 40	0.425	86.9 %
No. 100	0.150	69.9 %
No. 140	0.106	64.2 %
No. 200	0.075	58.4 %



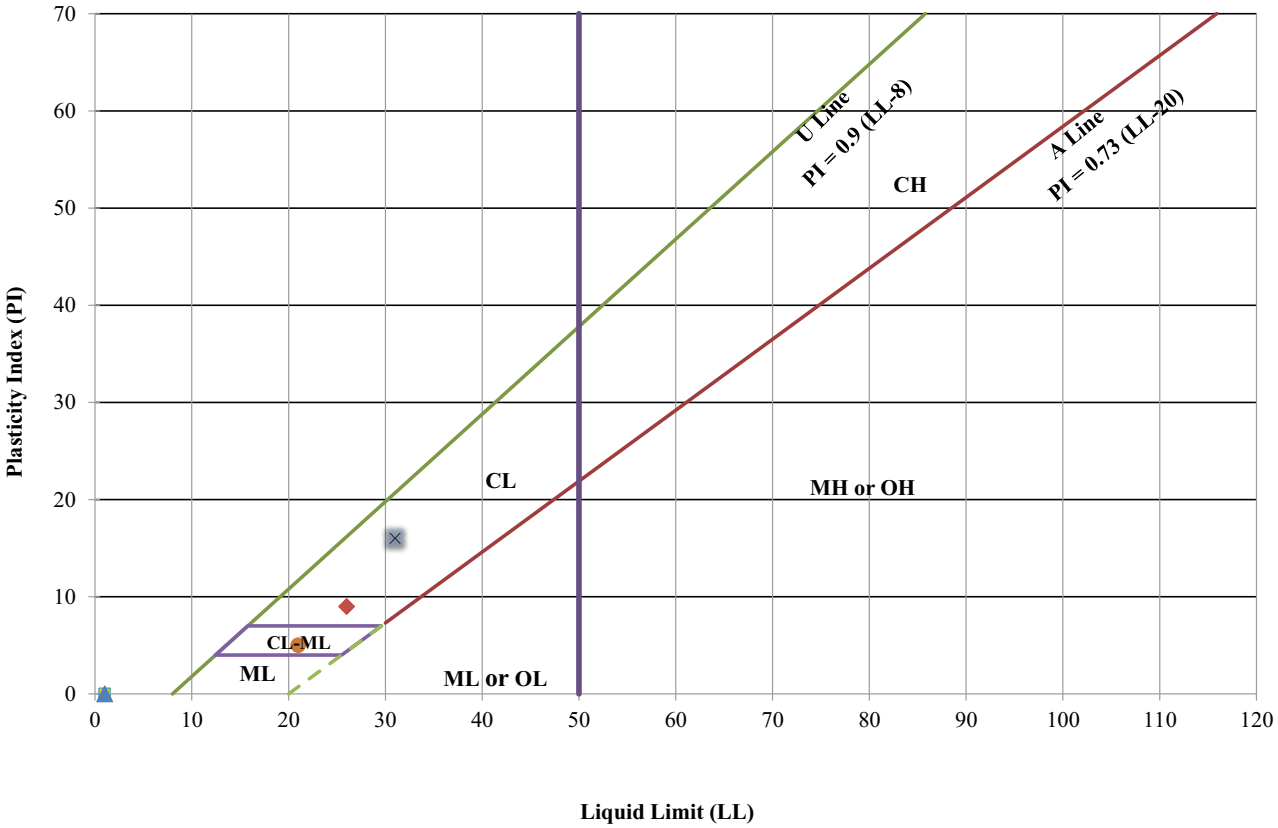
Geo-Advantec Inc.		SIEVE ANALYSIS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

SIEVE ANALYSIS (SOIL PASSING #200) ASTM D1140

Boring	Depth (ft)	PRE-WASH DRY WEIGHT (gm)	AFTER WASH DRY WEIGHT (gm)	% - # 200	SOIL TYPE
C-1	SG	357.8	127.3	64.4	CL
C-2	SG	273.6	108.3	60.4	ML
C-5	SG	324.9	143.6	55.8	CL-ML
TP-1	SG	364.8	131.0	64.1	ML
TP-3	SG	192.6	92.5	52.0	ML

Geo-Advantec Inc.		PERCENT FINER THAN NO. 200 SIEVE	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

PLASTICITY CHART (ASTM D4318)



Symbol	Source	Depth (ft)	Classification	Natural M.C. (%)	Liquid Limit (LL)	Plasticity Index (PI)	%Passing #200 Sieve
×	C-1	SG	Sandy Lean CLAY (CL)		31	16	64.4
■	C-2	SG	Sandy SILT (ML)		NP	NP	60.4
●	C-5	SG	Sandy SILTY CLAY (CL-ML)		21	5	55.8
▲	TP-1	SG	Sandy SILT (ML)		NP	NP	64.1
◆	TP-2	SG	Sandy Lean CLAY (CL)		26	9	
■	TP-3	SG	Sandy SILT (ML)		NP	NP	52

Geo-Advantec Inc.		PLASTICITY CHART	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

R-VALUE TEST DATA

Project Ferguson Drive Pavement Rehabilitation | Project No. 17-1041-B | Date Tested 6/6/2017

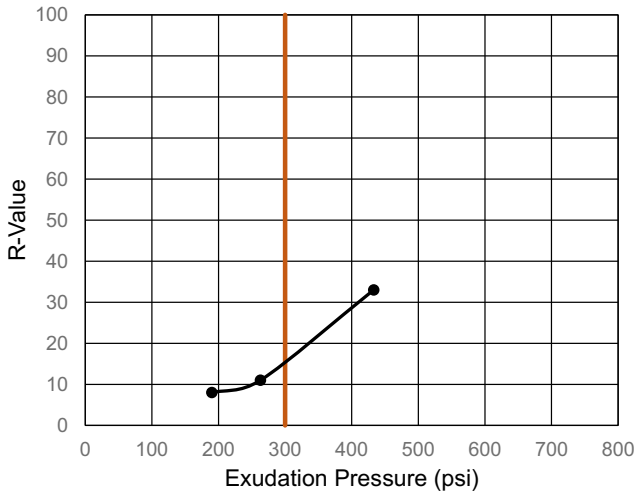
Site Location Commerce, CA | Test Specification ASTM D 2844

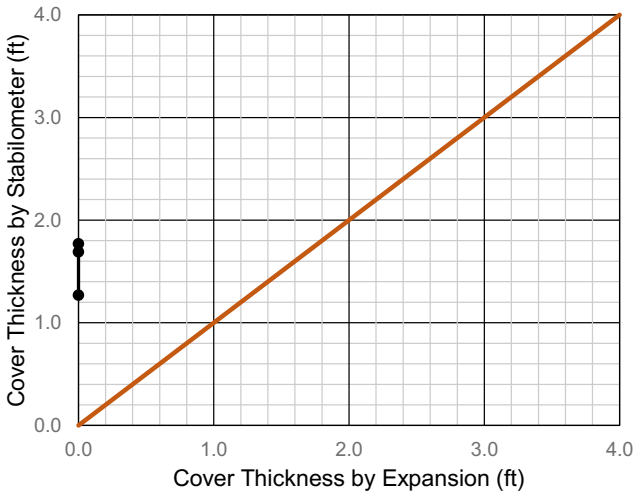
Boring No. TP-1 | Sample Depth Subgrade | Test Performed by AP

Soil Description Sandy Silt

Mold Number	G	I	H	
Water Added, g	0	-15	-30	
Compact Moisture, %	13.9	12.3	10.8	
Compaction Gage Pressure, psi	50	50	110	
Exudation Pressure, psi	190	263	433	
Sample Height, Inches	2.4	2.4	2.4	
Gross Weight Mold, g	2923	2903	2905	
Tare Weight Mold, g	1827	1819	1837	
Net Sample Weight, g	1096	1084	1067	
Expansion, $x10^{-4}$ inches	0	0	0	
Stability 2,000 (160 psi)	66/134	60/126	42/82	
Turns Displacement	5.65	4.75	4.28	
R-Value Uncorrected	8	12	36	
R-Value Corrected	8	11	33	
Dry Density, pcf	121.5	121.8	121.6	
Traffic Index	8	8	8	
G.E. by Stability	1.77	1.69	1.27	
G.E. by Expansion	0.00	0.00	0.00	

R-VALUE	By Exudation	16
	By Expansion	*N/A
	At Equilibrium (by Exudation)	16
Remarks	Gf = 1.34, and 1.9% Retained on the 3/4" *Not Applicable	





Geo-Advantec Inc.		R-VALUE TEST RESULTS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		

R-VALUE TEST DATA

Project Ferguson Drive Pavement Rehabilitation | Project No. 17-1041-B | Date Tested 6/5/2017

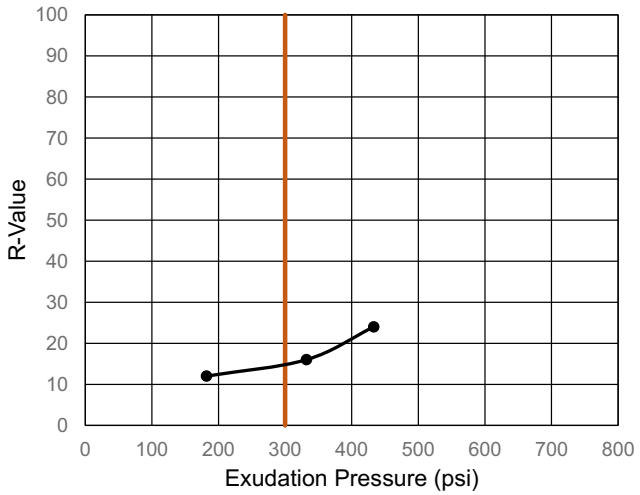
Site Location Commerce, CA | Test Specification ASTM D 2844

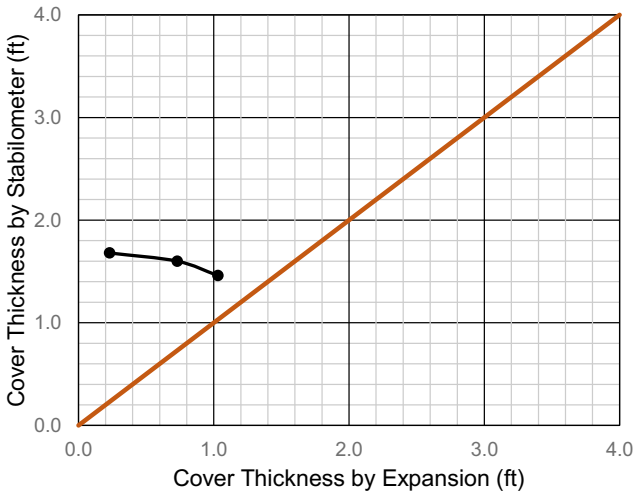
Boring No. TP-4 | Sample Depth Subgrade | Test Performed by AP

Soil Description Sandy Lean Clay

Mold Number	A	B	C	
Water Added, g	0	-8	-16	
Compact Moisture, %	16.0	15.1	14.2	
Compaction Gage Pressure, psi	90	130	150	
Exudation Pressure, psi	182	332	433	
Sample Height, Inches	2.4	2.4	2.3	
Gross Weight Mold, g	3013	2998	2994	
Tare Weight Mold, g	1968	1967	1965	
Net Sample Weight, g	1046	1032	1029	
Expansion, $x10^{-4}$ inches	7	22	31	
Stability 2,000 (160 psi)	62/131	56/123	48/110	
Turns Displacement	3.76	3.55	3.12	
R-Value Uncorrected	13	17	27	
R-Value Corrected	12	16	24	
Dry Density, pcf	113.8	113.2	118.8	
Traffic Index	8	8	8	
G.E. by Stability	1.68	1.6	1.46	
G.E. by Expansion	0.23	0.73	1.03	

R-VALUE	By Exudation	15
	By Expansion	*N/A
	At Equilibrium (by Exudation)	15
Remarks	Gf = 1.34, and 1.9% Retained on the 3/4" *Not Applicable	





Geo-Advantec Inc.		R-VALUE TEST RESULTS	FIGURE
PROJECT NO.	17-1041-B	Ferguson Drive Pavement Rehabilitation - Commerce, CA	
DATE	06-19-2017		