Amendment No. 2 to

Invitation for Bid

Port KC

Grading and Paving Project Phase 2 Services

Date of Issuance: April 30th, 2026

General:

1. A pre-bid meeting was held on-site April 20th, 2026, at 1 PM. A copy of attendees list is included as part of this addendum.
2. Port KC owns the property where the existing overhead electric lines are located, which is currently in an existing easement. The proposed relocated underground electric line will be on Port KC property; however a new easement will be required for the proposed facilities/location.
3. The Second Addendum includes the following support documents for reference:
    a. Pre-bid meeting attendees list
    b. GFT Memo – Structural Pad for Magnesium Tanks Geotech Memo "Geotech Memo"
    c. 2019-07-15 Deed to Port KC (1724 Market) Woodswether – evidencing Port KC ownership
    d. Copy of the existing overhead power easement

Project Questions and Answer:

1. Prebid Question:
   Question: *Where is the Prebid today for the grading and paving project phase 2 services*

   Answer: Please refer to Invitation for Bid (IFB) for address

2. Mandatory Pre-Bid Meeting:
   Question: I am reaching out to see if there is any flexibility regarding the requirement to attend the mandatory pre-bid meeting in order to submit a proposal for this project. Due to the IFB being received by a team member who was out of the office, we were not aware of the scheduled pre-bid meeting until after it had taken place. We have extensive experience delivering similar scopes of work and believe we can bring strong value and competitive pricing to this project. We would appreciate the opportunity to still be considered and are happy to review any meeting notes, site information, or requirements to ensure we are fully aligned.

   Answer: Please see section label "Site Visit" Per IFB and Addendum 1. "Failure to attend for the duration of the meeting will result in a Bidder's disqualification."

3. Bid Bond:
   Question: The Invitation for Bid states a bid bond will need to be submitted alongside bid submission. I do not see any mention of which Bid Bond form to use, as well as I didn't see it attached in the plan rooms. Would you be able to inform me of which bid bond form we need to use?

   Answer: Port KC does not have standard bid bond form. Industry recognized forms, such as those from the Engineers Joint Contract Documents Committee (EJCDC) or the American Institute of Architects (AIA) are acceptable.

4. Pre-Bid Attendee List:
   Question: Will a listing of the contractors who attended the mandatory pre-bid be included in the next upcoming addendum?

   Answer: Please see attachment

5. General Question:
   Question: Is there anything not mentioned that may impede or stop the contractor from starting the work as soon as the contractor is ready?

   Answer: Port KC is not aware of any factors that would impede the contractor from commencing work once ready. However, this is subject to unforeseen conditions or circumstances beyond Port KC's control.

6. Wage Order:
   Question: Is the Wage Order #32 Heavy or Building?

   Answer: The project falls under the Heavy wage, since the project is a civil site.

7. General Question:
   Question: Payment Terms. Please provide clarification on the project's payment terms, including schedule of values, progress payment frequency, retainage, and any specific invoicing requirement.

   Answer: Details will be provided in the contract if bidder is awarded the project.

8. Tax-Exempt:
   Question: Will a tax-exempt certificate be issued?

   Answer: Yes. A 5060 Form will be issued.

9. Permits:
   Question: What Permits are required?

   Answer: Please refer to IFB and the First Addendum for details regarding permit responsibilities.

10. Traffic Control:
    Question: Please confirm if traffic control is required?

    Answer: Please refer to the First Addendum

11. SWPP:
    Question: Is the contractor responsible for creating the SWPP?

    Answer: Yes, contractor is responsible for creating the SWPP.

12. Agg Rock:
    Question: Can all of the ¾ Agg Rock be recycled concrete, but needs to be washed?

    Answer: No. Please refer to the IFB and plans set for details

13. Demo Foundation:
    Question: Demo Foundation to 1' below grade. Should we backfill the resulting void with on-site crushed aggregate and, if necessary, import material? Please confirm the required final grade following demolition.

    Answer: Yes. Final grading should be compacted and match surrounding area and graded to drain.

14. GeoTech and Boring Log:
    Question: Can you provide any Geotech Reports for the project and the boring log for the hole drilled at the tank base location.

    Answer: Please see attachment

15. Testing:
    Question: What Testing is required? Is it just what is on SP002?

    Answer: Testing is only required for the structural pad and completed by others (Port KC's Engineers)

16. Tank Foundation:
    Question: What is the existing tank foundation depth?

    Answer: Exact limits are unknown. See geotech memo attachment for additional information

17. Railroad:
    Question: Will there be any requirements from the Railroad?

    Answer: No. Please refer to the First Addendum

18. Railroad Insurance:
    Question: Will we need Railroad Insurance since the railroad is owned by Port KC?

    Answer: Please refer to the First Addendum

19. Railroad Flagging:
    Question: Will we need railroad flagging since the railroad is owned by Port KC?

    Answer: No

20. Electrical Utility Question:
    Question: Has the demo of the existing poles and installation of the new transformer been discussed with Evergy?

    Answer: Yes. See contact on cover sheets of plans

21. Evergy Lead Time:
    Question: What is the lead time and duration for Evergy to complete their work?

    Answer: At this time, Evergy has not provided that information.

22. Electrical Surveying & Legal:
    Question: Please confirm the contractor will only be responsible for the surveying and legal fees for the easement of the electrical lines

    Answer: Yes contractor is responsible for surveying and legal fees for the easement of the electrical lines. Please refer to IFB and the First Addendum for additional details regarding this section of the project.

23. Electrical Easement:
    Question: Does the electrical easement item include any recording fees

    Answer: No. Recording will be completed by Port KC or by others.

ACKNOWLEDGE RECEIPT

CONTRACTOR (COMPANY): _____

CONTRACTOR'S AUTHORIZED REPRESENTATIVE: _____

DATE: _____

portkc Parson Port Phase II Paving IFB
Monday 4/20/2026 1pm

Contractor Attendance

Contractor	Representative	Phone	email
Triple Check	Eric Cairo	913-426-2588	eCairo.TripleCheck@gmail..
Triple Check	JJ Wolters	913-293-9781	JJwolters2405@gmail.com
GFT	Chad Banka	913-636-5701	CBanka@gftinc.com
Gunter Construction	Garrett Meyer	620-755-3484	Bids@gunterkc.com
MEGAKC	Austin Pfannenstiel	816-762-9393	Megabids@megaKC.com
CLARKSON CONST.	Scott Gorsuch	913.269.7268	sgorsuch@clarksonconstructio
Kissick Construction	Siman Williams	816-810-1917	SimanW@kissick.co
Transport 360	Aaron Khouri		
Transport 360	Terry Kelley		
Port KC	Mait Mehlhaff		

MEMORANDUM

TO: Chad Banka, P.E.
GFT Infrastructure, Inc.

FROM: Jason Gardner, P.E., and Ben Harlacher, E.I.T.
GFT Infrastructure, Inc.

DATE: March 6, 2026

RE: Port of Kansas City – Structural Pad for Magnesium Tanks
Geotechnical Memorandum
GFT Project No. AO003043.000
For Design Purposes Only

INTRODUCTION

A structural pad is proposed to support fourteen 30,000-gallon magnesium storage tanks at the Port of Kansas City located in Kansas City, Missouri. Information provided by GFT Structural Engineers indicates the proposed pad has dimensions of 36 feet wide by 120 feet long by 3.5 feet thick. Additionally, the structural pad loading is not expected to exceed 2,000 psf, including the weight of the pad itself. Based on review of existing borings provided by the Owner that were performed at the site of the proposed pad, unconsolidated fill is present below the proposed pad. Accordingly, when the unconsolidated fill experiences the applied loads from the pad, the unconsolidated fill is expected to settle; however, the extent of the settlement is difficult to predict given the highly variable nature of the fill materials. A deep foundation system, such as auger cast piles, would minimize the risk of settlement and any potential negative impacts to the structural slab and/or the magnesium tanks. It is understood that the 14 magnesium storage tanks will not be attached to the structural slab; therefore, the Owner is willing to install a more economical foundation system and accept higher than normal settlement of the pad. Therefore, over-excavation of a few feet of unconsolidated fill below the proposed pad and replacement with an engineered fill was evaluated to support the proposed pad in lieu of deep foundations. This memorandum presents a review of available geotechnical data for the project site, the results of geotechnical analyses, and provides recommendations related to subgrade preparation for the proposed pad construction at the Port of Kansas City.

SUBSURFACE INVESTIGATION

Subsurface investigations have previously been performed at the project location. An investigation was performed in 2016 by Geotechnology, Inc. for the proposed Union Pacific Railroad track relocation at Port of Kansas City. As part of this investigation, Boring B-6 was completed in the vicinity of the proposed pad location. The boring was sampled a total depth of 10 feet and encountered approximately 7.5 feet of fill underlain by 2.5 feet of what is believed to be alluvium material. The fill was typically medium dense, laboratory classified as

clayey sand with gravel (SC), and was noted to contain glass and red brick fragments. The alluvium was identified as medium dense poorly graded sand (sp). More recently, an investigation was performed in 2024 by Alpha-Omega Geotech, Inc. to evaluate existing subsurface conditions at the site. As part of this investigation, Boring B2B was completed in the vicinity of the proposed pad location. The boring was sampled a total depth of 98.9 feet and encountered 28.5 feet of fill underlain by what is believed to be 60 feet of alluvium and 10.4 feet of residuum. The fill typically consisted of soft to stiff clay (cl) and medium dense poorly graded sand (sp). The alluvium typically consisted of loose silt and sandy silt (ml), medium dense to very dense poorly graded sand (sp) and clayey sand with gravel (sc), and stiff lean/fat clay (cl/ch). Residuum consisted of weathered shale. Applicable pages from the referenced subsurface investigation reports, including boring plans, logs, and laboratory testing, are included in Appendix A for reference. Due to the existing geotechnical data that was provided for the proposed pad site, no additional subsurface exploration was required for the proposed structural pad.

SUMMARY OF GEOTECHNICAL RECOMMENDATIONS

It is recommended to over-excavate a minimum of 3-feet below the proposed bottom of pad and replace with compacted Engineered Fill to reduce potential settlement. The Engineered Fill is recommended to consist of compacted Type 5 Aggregate meeting the MoDOT Standard Specification 1007.3, with a minimum of 3 layers of geogrid meeting the requirements of MoDOT Standard Specification 1052.20.2. It is recommended the excavation be lined with a separation geotextile meeting the requirements of MoDOT Standard Specification 1011.3.4 prior to placing the Engineered Fill. A Typical Detail for the subgrade undercut is included in Appendix D with the following construction notes:

1) Over-excavate a minimum of 3-feet below the bottom of structural pad. Extend the excavation a minimum of 18-inches beyond the edges of the pad.

2) Compact the subgrade and perform a proof roll in the presence of a qualified third-party inspector. Do not perform the proof roll when the subgrade is saturated. Remove any soft or unsuitable material observed during the proof roll and replace with compacted Type 5 Aggregate, meeting the requirements of MoDOT Standard Specification 1007.3, to the bottom of subgrade.

3) Once the subgrade has been approved, line the excavation with separation geotextile meeting the requirements of MoDOT Standard Specification 1011.3.4. Overlap strips of geotextile a minimum of 12 inches.

4) Place the bottom layer of geogrid, meeting the requirements of MoDOT Standard Specification 1052.20.2, on top of the separation geotextile. Overlap strips of geogrid a minimum of 12 inches. Remove slack from the geogrid and pin as necessary. Place 12-inches of compacted Type 5 Aggregate over the geogrid and wrap the ends of geogrid around the aggregate a minimum of 18 inches. A minimum of 6 inches of Type 5 Aggregate

is to be placed on the geogrid before permitting compaction. Loose lifts of Type 5 Aggregate shall not exceed 8 inches before compaction.

5) Place additional layers of geogrid and Type 5 Aggregate as previously described in Note 4 up to the bottom of the structural pad. Geogrid layers are to be spaced 1-foot vertically with the top layer located 1-foot below the bottom of structural pad. A minimum of 3 layers of geogrid is recommended.

SUBSURFACE PARAMETER DEVELOPMENT

Soil parameters were developed for the site based on the available historical boring data. Boring B2B from the 2024 Alpha-Omega report was utilized to model subsurface conditions for the site due to being the most recently available subsurface data, and having a greater boring depth as compared to Boring B-6 from the 2014 Geotechnology Report. The subsurface stratum was broken into 6 distinct layers for parameter development. Parameters were developed for each layer by correlating classifications and densities (i.e., SPT N_{60}-values) to published values. No laboratory testing was performed for the fine-grained layers (i.e., in-situ layers 1 and 3), therefore conservative drained parameters were selected for these strata.

Soil parameters were also developed for the engineered fill. The engineered fill was assumed to consist of Type 5 Aggregate meeting the requirements of MoDOT Section 1007.3 with layers of geogrid meeting the requirements of MoDOT Section 1052.20.2. It was assumed the geogrid has no effect on the soil's effective friction angle but does increase the soil's Modulus of Elasticity (E_s) by providing confinement and additional tensile strength when loaded. Parameters for this layer were developed by correlating the Type 5 Aggregate to published recommended values. A summary of all developed soil parameters is included in Appendix B and backup for their development is included in Appendix C.

BEARING RESISTANCE

A bearing resistance calculation was performed for the proposed structural pad in accordance with AASHTO guidelines. Due to the loading conditions being relatively unknown at the time of analysis, the maximum allowable eccentricity of 1/3B was assumed for the base width, resulting in an effective base width of 12 feet for analysis. The top of pad was assumed to be level with finished ground; therefore, the bottom of pad was assumed to be 3.5-feet deep. A 3-foot over-excavation and replacement with engineered fill was assumed beneath the bottom of pad. Multiple strata are located below the bottom of pad, including the engineered fill. Therefore, an equivalent friction angle and unit weight was utilized for the calculation. It was assumed the critical depth for bearing extended to the bottom of in-situ Layer 3 due to this layer having the weakest soil parameters. An equivalent friction angle of 28 degrees and moist unit weight of 114 pcf was calculated for the soil within the assumed critical depth and was utilized for the analysis. A factored (i.e., Strength Limit State) bearing resistance of 3,000 psf is recommended for the pad based on

the calculation. The factored resistance is greater than the assumed load of 2,000 psf and is therefore acceptable. The full calculation may be referenced in Appendix C.

SETTLEMENT ANALYSIS

A settlement analysis was performed for the proposed structural pad using Rocscience Inc.'s Settle3 computer program. The subsurface was modeled using Boring B2B and developed parameters were input into the program. The analysis utilized 4 stages for estimating total settlement and consisted of the following:

Stage 1 – Existing condition modeled after Boring B2B.

Stage 2 – Pad excavation 36-feet-wide x 120-feet-long x 3.5-feet-deep.

Stage 3 – Excavate and replace 3-feet below bottom of pad with Engineered Fill.

Stage 4 – Foundation load of 2,000 psf applied at bottom of pad (includes weight of pad).

The program estimated a maximum elastic settlement of 3.3-inches for the proposed structural pad placed on 3-feet of engineered fill. It should be noted that actual settlement is expected to be less than estimated due to the following considerations:

1) Unconsolidated fill is located below the proposed pad location and will likely vary in composition and density from the assumed worst-case condition.
2) Fine-grained cohesive soils were identified in the subsurface. Due to no available laboratory data or pocket penetrometer readings for these soils, consolidation parameters are unable to be accurately estimated. Therefore, all settlement was assumed to be elastic (i.e., immediate) using conservative parameters.
3) Analysis assumes no previous loads have been placed on the area and no elastic settlement has taken place to date. However, based on the proposed location it is likely that some form of load, such as machinery, portable storage tank, or stockpile, has temporarily been on the area and induced some elastic settlement of the soils.
4) The geogrid provided in the engineered fill has the ability to distribute loads and bridge softer soils that are subject to settlement, and the geogrid's ability to distribute loads is difficult to accurately model in the Settle3 computer program.

The full settlement calculation is provided in Appendix C.

REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), *LRFD Bridge Design Specifications*, 8th Edition, 2020.

Alpha-Omega Geotech, Inc., *Geotechnical Data Report for the Port of KC*, November 19, 2024.

Geotechnology, Inc., *Subsurface Exploration Report for Union Pacific Railroad Track Relocation at Port Kansas City*, July 15, 2016.

Missouri Department of Transportation (MoDOT), *Standard Specifications for Highway Construction*, Third Edition, January 2026.

APPENDIX A

Relevant Historical Geotechnical Data

SUBSURFACE EXPLORATION
UNION PACIFIC RAILROAD TRACK RELOCATION
PORT KANSAS CITY
KANSAS CITY, MISSOURI

Prepared for:

BURNS & MCDONNELL ENGINEERING COMPANY, INC.
Kansas City, Missouri

Prepared by:

GEOTECHNOLOGY, INC.
Overland Park, Kansas

Geotechnology, Inc. Project No. J027153.01

July 15, 2016

NOTES

1. Plan adapted from a March 27, 2016 aerial photograph courtesy of Google Earth.
2. Borings were located in the field with a GPS device and are shown approximate only.

LEGEND

Boring Location

0 80 160 320

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: MTI	App'vd By: SDG
Date: 6-12-16	Date: 6-13-16	Date: 7-13-16

GEOTECHNOLOGY INC
FROM THE GROUND UP

Union Pacific Railroad Track Relocation
Port Kansas City
Kansas City, Missouri

AERIAL PHOTOGRAPH OF SITE AND BORING LOCATIONS

Project Number J027153.01

PLATE 2

Surface Elevation 754 | Completion Date: 6/8/16

Datum NAVD83

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - dark brown, silt, clayey sand, gravel, glass, red brick			
			4-6-3	SS1
			2-5-7	SS2
5				
			3-3-5	SS3
	SAND - tan, fine to coarse, medium dense, poorly graded - SP			
			5-7-6	SS4
10	Boring terminated at 10 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4 " HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER BBP LOGGER

CME 550 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: ADC	Check by: MTI	App'vd by: SDG
Date: 6/13/16	Date: 6/21/16	Date: 6/22/16

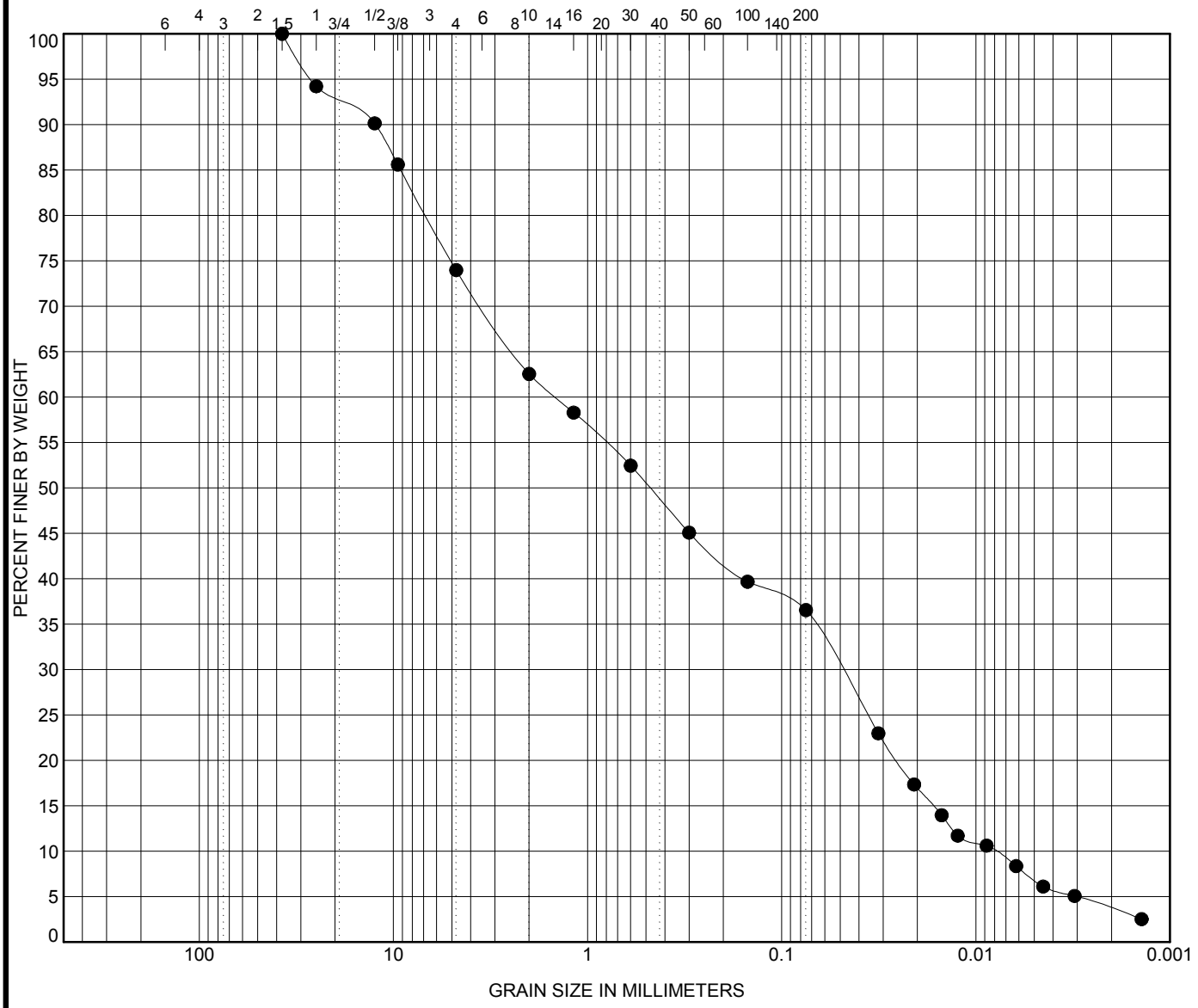
GEOTECHNOLOGY INC
FROM THE GROUND UP

UP Railroad Track Relocation
Port Kansas City, Missouri

LOG OF BORING: B-6

Project No. J027153.01

LOG OF BORING 2002 WL GINT.GPJ GTINC 0638301.GPJ 7/15/16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**B-6 at 1.0'**	**FILL: CLAYEY SAND with GRAVEL (SC)**				**0.21**	**182.31**

	Specimen Identification	2.00mm	0.425mm	0.075mm	0.02mm	0.002mm	0.001mm	%Silt	%Clay
●	**B-6 at 1.0'**	**62.5**	**48.8**	**36.5**	**16.9**	**3.7**		**29.7**	**6.8**

GEOTECHNOLOGY INC
FROM THE GROUND UP

GRAIN SIZE DISTRIBUTION

UP Railroad Track Relocation
Port Kansas City, Missouri
J027153.01

AMRL GRAIN SIZE GINT.GPJ US LAB.GDT 7/15/16

ALPHA-OMEGA GEOTECH

1701 State Avenue
Kansas City, KS 66102

t 913-371-0000
f 913-371-6710

AOGeotech.com

GEOTECHNICAL DATA REPORT

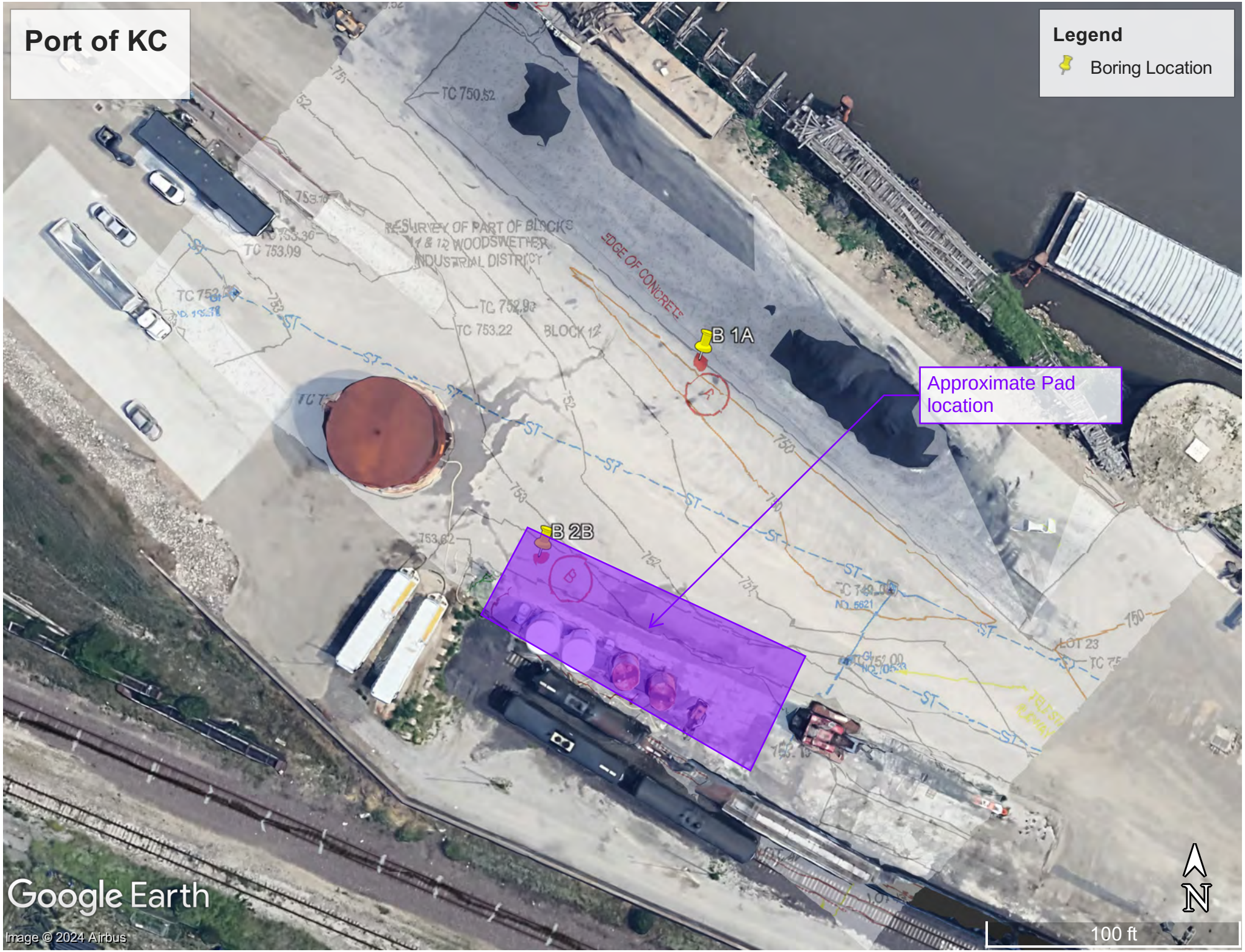
PORT OF KC

1769 MARKET STREET
KANSAS CITY, MISSOURI
(AOG 240684 E)

Date: November 19, 2024

Submitted to: Massman Construction Co.
Brian N. Koelling, P.E.
12412 Rott Road
St. Louis, MO 63127

Submitted by: ALPHA-OMEGA GEOTECH, INC.


Port of KC
Legend
Boring Location
B 1A
B 2B
Approximate Pad location
Google Earth
Image © 2024 Airbus
N
100 ft

ALPHA-OMEGA GEOTECH

LOG OF BORING
No. B2B

PROJECT: PORT OF KC **PROJECT NO.:**
CLIENT: MASSMAN CONSTRUCTION CO.
PROJECT LOCATION: 1769 MARKET ST., KCMO
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: KK **LOGGED BY:** CW/NN
DRILLING METHOD: POWER AUGER **DATE:** 11/5/24
DEPTH TO - WATER> INITIAL: ▽ 28.5' **AFTER 24 HOURS:** ▼ **CAVING>** ℄ NONE

Elevation / Depth (ft.)	Soil Symbols, Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
0		Gravel with ASPHALT								
		1.0								
		Gray FAT/LEAN CLAY (Possible FILL)								CH-CL
		2.5								
		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)								CL
	3 4 4	3.5								CL
5		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)								CL
		5.0								
		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)								
	3 4 4	8.5								SP
		Poorly graded sand (Possible FILL)								
10		10.0								
		Poorly graded sand (Possible FILL)								SP
		13.5								
	2 7 7	Poorly graded sand (Possible FILL)								SP
15		15.0								
		Poorly graded sand (Possible FILL)								SP
		18.5								
	2 1 2	Dark brown, mottled dark gray LEAN CLAY (Possible FILL)								CL
20		20.0								
		Dark brown, mottled dark gray LEAN CLAY (Possible FILL)								CL
		23.5								
	1 2 1	Dark brown, mottled dark gray silty LEAN CLAY (Possible FILL)								CL
25		25.0								
		Dark brown, mottled dark gray silty LEAN CLAY (Possible FILL)								CL
	▽	28.5								
	1 3 3	Brown, mottled gray silt								ML
30		30.0								
		Brown, mottled gray silt								ML
		33.5								
	1 3 3	Brown, mottled gray sandy silt								ML
35		35.0								
		Brown, mottled gray sandy silt								ML

ALPHA-OMEGA GEOTECH

LOG OF BORING
No. B2B

PROJECT: PORT OF KC **PROJECT NO.:**
CLIENT: MASSMAN CONSTRUCTION CO.
PROJECT LOCATION: 1769 MARKET ST., KCMO
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: KK **LOGGED BY:** CW/NN
DRILLING METHOD: POWER AUGER **DATE:** 11/5/24
DEPTH TO - WATER> INITIAL: ▽ 28.5' **AFTER 24 HOURS:** ▽ **CAVING>** C NONE

Elevation / Depth (ft.)	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
		38.5								
	3 5 4	Brown, mottled gray silty sand								SM
40		40.0								
		Brown, mottled gray silty sand								SM
		43.5								
	5 8 10	Olive brown poorly graded sand								SP
45		45.0								
		Olive brown poorly graded sand								SP
		48.5								
	8 10 20	Brown, mottled gray silty sand (Very hard, very slow drilling)								SM
50		50.0								
		Brown, mottled gray silty sand (Very hard, very slow drilling)								SM
		53.5								
	12 14 12	Brown, poorly graded sand (Very hard, very slow drilling)								SP
55		55.0								
		Brown, poorly graded sand (Very hard, very slow drilling)								SP
		58.5								
	5 6 6	Gray poorly graded sand								SP
60		60.0								
		Gray poorly graded sand								SP
		63.5								
	20 25 34	Olive brown and gray silty sand (Very hard, very slow drilling)								SM
65		65.0								
		Olive brown and gray silty sand (Very hard, very slow drilling)								SM
		68.5								
	13 8 8	Dark brown silty sand (Very hard, very slow drilling)								SM
70		70.0								
		Dark brown silty sand (Very hard, very slow drilling)								SM
		73.5								
	10 16 12	Brown poorly graded sand (Very hard, very slow drilling)								SP
75		75.0								
		Brown poorly graded sand (Very hard, very slow drilling)								SP

ALPHA-OMEGA GEOTECH

LOG OF BORING
No. B2B

PROJECT: PORT OF KC **PROJECT NO.:**
CLIENT: MASSMAN CONSTRUCTION CO.
PROJECT LOCATION: 1769 MARKET ST., KCMO
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: KK **LOGGED BY:** CW/NN
DRILLING METHOD: POWER AUGER **DATE:** 11/5/24
DEPTH TO - WATER> INITIAL: ▽ 28.5' **AFTER 24 HOURS:** ▽ **CAVING>** C NONE

Elevation / Depth (ft.)	Soil Symbols, Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
80	14 4 4	78.5 Brown, mottled gray LEAN/FAT CLAY								CL-CH
		80.0 Brown, mottled gray LEAN/FAT CLAY								CL-CH
85	7 7 7	83.5 Gray and brown clayey sand with gravel								SC
		84.8 Gray and brown clayey sand with gravel								SC
90	41 31 50/3	88.5 Brown, mottled gray LEAN/FAT CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
		88.7 Brown, mottled gray LEAN/FAT CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
95	50/3	93.5 Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
		93.8 Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
100	50/4	98.5 Brown, mottled gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
		98.9 End of boring at about 98.9 feet								
105										
110										
115										

APPENDIX B

Summary of Developed Soil Parameters

Summary of In-Situ Design Soil Parameters									
Layer Number	Depth[(1)] (ft)	N_{60} Avg (bpf)	USCS Classification	γ_m (pcf)	γ_{sat} (pcf)	Φ' (°)	c' (psf)	E_s (ksi)	v
1	0-8.5	11	CL	115	120	28	0	3.00	0.40
2	8.5-18.5	15	SP	120	125	30	0	4.17	0.30
3	18.5-28.5	4	CL	105	110	24	0	0.347	0.40
4	28.5-38.5	8	ML	115	120	28	0	1.67	0.30
5	38.5-88.5	29	SP/SM/SC/CL/CH	125	130	34	0	6.94	0.30
6	88.5-98.9	Refusal	Weathered Shale	140	145	38	0	13.89	0.30

(1) Depth measured from existing ground surface of Boring B2B at the time of sampling. No elevation provided on the log.

Summary of Engineered Fill Design Soil Parameters							
Material Description	USCS Classification	γ_m (pcf)	γ_{sat} (pcf)	Φ' (°)	c' (psf)	E_s (ksi)	v
Compacted MoDOT Type 5 Aggregate with Geogrid	GW/GP/SW/SP	120	125	38	0	20	0.20

APPENDIX C

Geotechnical Analyses

GFT

Appendix C – Table of Contents

Objective: Summarize applicable boring data for use in engineering calculations for the Port of Kansas Structural Slab project.

References:
1) Alpha-Omega Geotech, Inc., Geotechnical Data Report for Port of KC, November 2024.
2) Geotechnology, Inc., Subsurface Exploration Report for Union Pacific Railroad Track Relocation at Port Kansas City, July 2016.
3) AASHTO, LRFD Bridge Design Specifications, 9th Ed., 2020.

Methodology:
1) Per Ref. 1 and Ref. 2, Borings B2B and B-6 were drilled in the vicinity of the proposed structural pad. Boring B2B was performed more recently and provides greater depth of subsurface information. Therefore, use Boring B2B for analysis.
2) Per Ref. 1 report, an automatic hammer was utilized for sampling. Correct SPT N-values to N_{60}-values (i.e., corrected for automatic hammer efficiency).
3) Interpret layers based on similar material descriptions, classifications, and depositions.

Calculation:

Boring B2B					
N-value (bpf)	N_{60}-value[1] (bpf)	USCS Classification	Deposition[2]	Layer Number	N_{60} Avg (bpf)
8	11	CL	Fill	1	11
8	11	SP	Fill	2	15
14	19	SP	Fill		
3	4	CL	Fill	3	4
3	4	CL	Fill		
6	8	ML	Alluvium	4	8
6	8	ML	Alluvium		
9	12	SM	Alluvium	5	29
18	24	SP	Alluvium		
30	40	SM	Alluvium		
26	35	SP	Alluvium		
12	16	SP	Alluvium		
59	79	SM	Alluvium		
16	21	SM	Alluvium		
28	37	SP	Alluvium		
8	11	CL/CH	Alluvium		
14	19	SC	Alluvium		
REF	REF	-	Weathered Shale	6	Ref.
REF	REF	-	Weathered Shale		
REF	REF	-	Weathered Shale		

(1) N_{60} calculated per Ref. 3, Eq. 10.4.6.2.4-2 for Automatic Hammer.

(2) Material under fill assumed to be alluvium based on boring proximity to the Missouri River.

REFERENCE 1

BY: BEH 02/26
CHECKED BY: GSB 03/26

ALPHA-OMEGA GEOTECH

1701 State Avenue
Kansas City, KS 66102

t 913-371-0000
f 913-371-6710

AOGeotech.com

GEOTECHNICAL DATA REPORT

PORT OF KC

1769 MARKET STREET
KANSAS CITY, MISSOURI
(AOG 240684 E)

Date: November 19, 2024

Submitted to: Massman Construction Co.
Brian N. Koelling, P.E.
12412 Rott Road
St. Louis, MO 63127

Submitted by: ALPHA-OMEGA GEOTECH, INC.

The N-values obtained from each of the SPT's completed in these borings using a CME automatic hammer are included on the boring logs and summarized in the Summary of Laboratory Testing sheet found in Appendix B. Samples retrieved during drilling efforts were returned to AOG's laboratory for testing and evaluation.

3.0 LABORATORY TESTING PROGRAM

Laboratory testing on materials collected during drilling was performed on samples selected by AOG. Results from these tests can be found in Appendix B and on the boring logs in Appendix C. The following laboratory tests were performed by qualified AOG personnel in accordance with ASTM specifications to determine pertinent engineering properties of the soils:

- Visual classification (ASTM D2488)

All of the soil classifications given throughout the laboratory test data, as well as, the boring logs, were made using the visual and tactile techniques described in ASTM D2488. As a result, additional analyses could reveal other soil types of different classification and potentially higher plasticity and swelling potential both onsite and within the nearby vicinity.

4.0 GROUNDWATER

Free water was encountered at about 3.5 fbeg in boring B1A, and at about 28.5 fbeg in boring B2B during the time of drilling. The remaining boring did not encounter water. However, a twenty-four-hour water level was not established in these borings due to time restrictions, as well as potential safety hazards associated with open bore holes.

Although the ground water levels given on the boring logs reflect the conditions observed at the time the borings were made, they should not be construed to represent an accurate or permanent condition. There is uncertainty involved with short-term water level observations in bore holes especially in clay soils of relatively low permeability. The groundwater level should be expected to fluctuate with variations in precipitation, site grading and drainage conditions. In addition, it is also possible that seasonal perched ground water may be encountered within these soil deposits and bedrock formations at different depths during other times of the year based on drainage conditions, seasonal snowmelt and rainwater infiltration.

5.0 LIMITATIONS

This report is presented in broad terms to provide a comprehensive assessment of the interpreted subsurface conditions and their potential effect on the adequate design of the Port of KC project located in Kansas City, MO, as discussed herein. This report has been prepared for the exclusive use of our client for specific application to the project discussed herein and has been prepared within our client's directive and budgetary constraints and in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

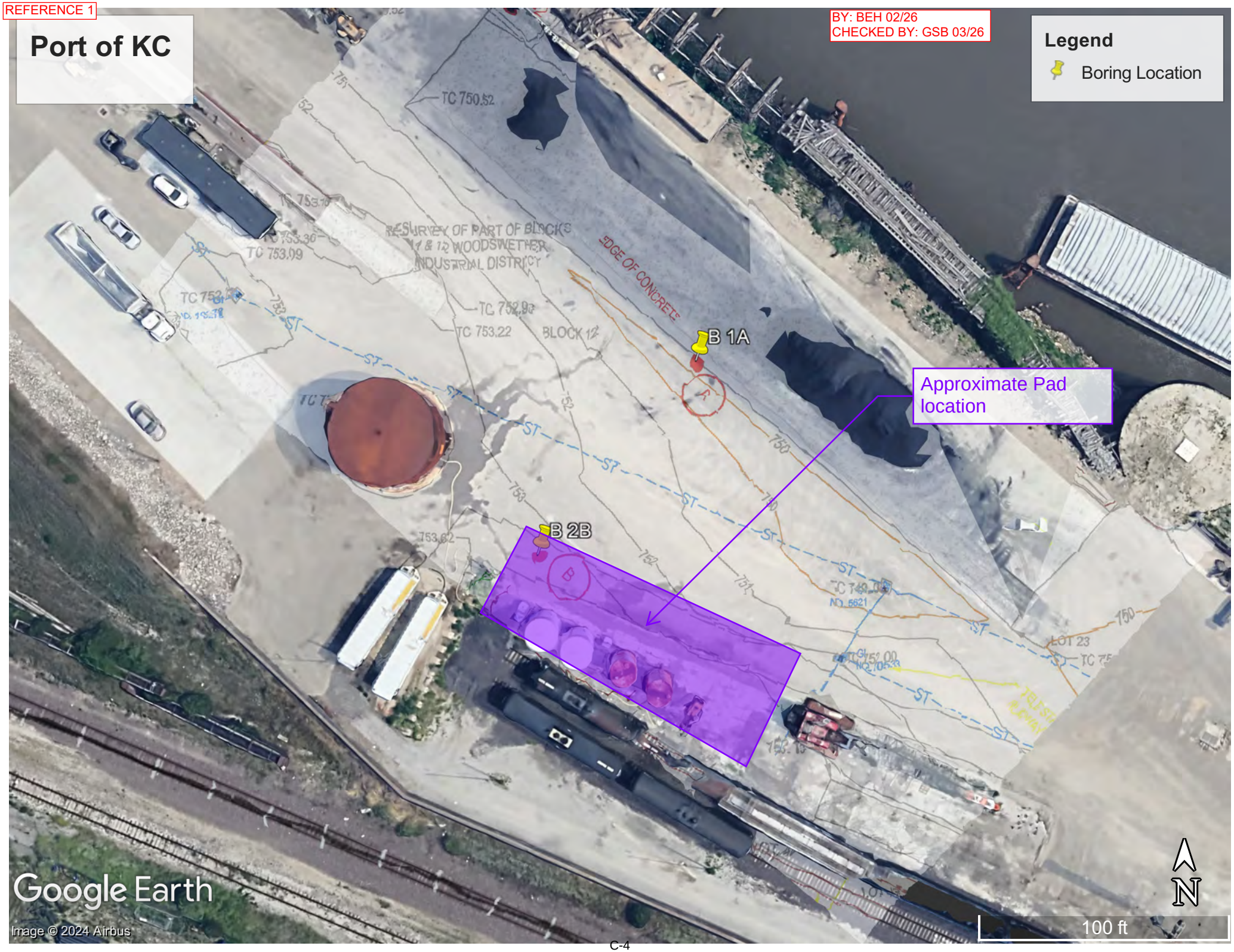
REFERENCE 1

Port of KC

BY: BEH 02/26
CHECKED BY: GSB 03/26

Legend

Boring Location



REFERENCE 1

BY: BEH 02/26
CHECKED BY: GSB 03/26

ALPHA-OMEGA GEOTECH

LOG OF BORING
No. B2B

PROJECT: PORT OF KC **PROJECT NO.:**
CLIENT: MASSMAN CONSTRUCTION CO.
PROJECT LOCATION: 1769 MARKET ST., KCMO
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: KK **LOGGED BY:** CW/NN
DRILLING METHOD: POWER AUGER **DATE:** 11/5/24
DEPTH TO - WATER> INITIAL: ▽ 28.5' **AFTER 24 HOURS:** ▽ **CAVING>** ℄ NONE

Elevation / Depth (ft.)	Soil Symbols, Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
0		Gravel with ASPHALT								
		1.0								
		Gray FAT/LEAN CLAY (Possible FILL)								CH-CL
		2.5								
		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)								CL
	3 4 4	3.5								CL
5		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)								CL
		5.0								
		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)								
	3 4 4	8.5								SP
		Poorly graded sand (Possible FILL)								
10		10.0								SP
		Poorly graded sand (Possible FILL)								
		13.5								SP
	2 7 7	Poorly graded sand (Possible FILL)								
15		15.0								SP
		Poorly graded sand (Possible FILL)								
		18.5								CL
	2 1 2	Dark brown, mottled dark gray LEAN CLAY (Possible FILL)								
20		20.0								CL
		Dark brown, mottled dark gray LEAN CLAY (Possible FILL)								
		23.5								CL
	1 2 1	Dark brown, mottled dark gray silty LEAN CLAY (Possible FILL)								
25		25.0								CL
		Dark brown, mottled dark gray silty LEAN CLAY (Possible FILL)								
	▽	28.5								ML
	1 3 3	Brown, mottled gray silt								
30		30.0								ML
		Brown, mottled gray silt								
		33.5								ML
	1 3 3	Brown, mottled gray sandy silt								
35		35.0								ML
		Brown, mottled gray sandy silt								

REFERENCE 1

BY: BEH 02/26
CHECKED BY: GSB 03/26

ALPHA-OMEGA GEOTECH

LOG OF BORING
No. B2B

PROJECT: PORT OF KC **PROJECT NO.:**
CLIENT: MASSMAN CONSTRUCTION CO.
PROJECT LOCATION: 1769 MARKET ST., KCMO
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: KK **LOGGED BY:** CW/NN
DRILLING METHOD: POWER AUGER **DATE:** 11/5/24
DEPTH TO - WATER> INITIAL: ▽ 28.5' **AFTER 24 HOURS:** ▽ **CAVING>** NONE

Elevation / Depth (ft.)	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
	3 5 4	38.5 Brown, mottled gray silty sand								SM
40		40.0 Brown, mottled gray silty sand								SM
	5 8 10	43.5 Olive brown poorly graded sand								SP
45		45.0 Olive brown poorly graded sand								SP
	8 10 20	48.5 Brown, mottled gray silty sand (Very hard, very slow drilling)								SM
50		50.0 Brown, mottled gray silty sand (Very hard, very slow drilling)								SM
	12 14 12	53.5 Brown, poorly graded sand (Very hard, very slow drilling)								SP
55		55.0 Brown, poorly graded sand (Very hard, very slow drilling)								SP
	5 6 6	58.5 Gray poorly graded sand								SP
60		60.0 Gray poorly graded sand								SP
	20 25 34	63.5 Olive brown and gray silty sand (Very hard, very slow drilling)								SM
65		65.0 Olive brown and gray silty sand (Very hard, very slow drilling)								SM
	13 8 8	68.5 Dark brown silty sand (Very hard, very slow drilling)								SM
70		70.0 Dark brown silty sand (Very hard, very slow drilling)								SM
	10 16 12	73.5 Brown poorly graded sand (Very hard, very slow drilling)								SP
75		75.0 Brown poorly graded sand (Very hard, very slow drilling)								SP

REFERENCE 1

BY: BEH 02/26
CHECKED BY: GSB 03/26

ALPHA-OMEGA GEOTECH

LOG OF BORING
No. B2B

PROJECT: PORT OF KC **PROJECT NO.:**
CLIENT: MASSMAN CONSTRUCTION CO.
PROJECT LOCATION: 1769 MARKET ST., KCMO
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: KK **LOGGED BY:** CW/NN
DRILLING METHOD: POWER AUGER **DATE:** 11/5/24
DEPTH TO - WATER> INITIAL: ▽ 28.5' **AFTER 24 HOURS:** ▽ **CAVING>** ℄ NONE

Elevation / Depth (ft.)	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
80	14 4 4	78.5 Brown, mottled gray LEAN/FAT CLAY								CL-CH
		80.0 Brown, mottled gray LEAN/FAT CLAY								CL-CH
85	7 7 7	83.5 Gray and brown clayey sand with gravel								SC
		84.8 Gray and brown clayey sand with gravel								SC
90	41 31 50/3	88.5 Brown, mottled gray LEAN/FAT CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
		88.7 Brown, mottled gray LEAN/FAT CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
95	50/3	93.5 Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
		93.8 Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
100	50/4	98.5 Brown, mottled gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								SH
		98.9 End of boring at about 98.9 feet								
105										
110										
115										

GEOTECHNOLOGY INC
FROM THE GROUND UP

SUBSURFACE EXPLORATION
UNION PACIFIC RAILROAD TRACK RELOCATION
PORT KANSAS CITY
KANSAS CITY, MISSOURI

Prepared for:

BURNS & MCDONNELL ENGINEERING COMPANY, INC.
Kansas City, Missouri

Prepared by:

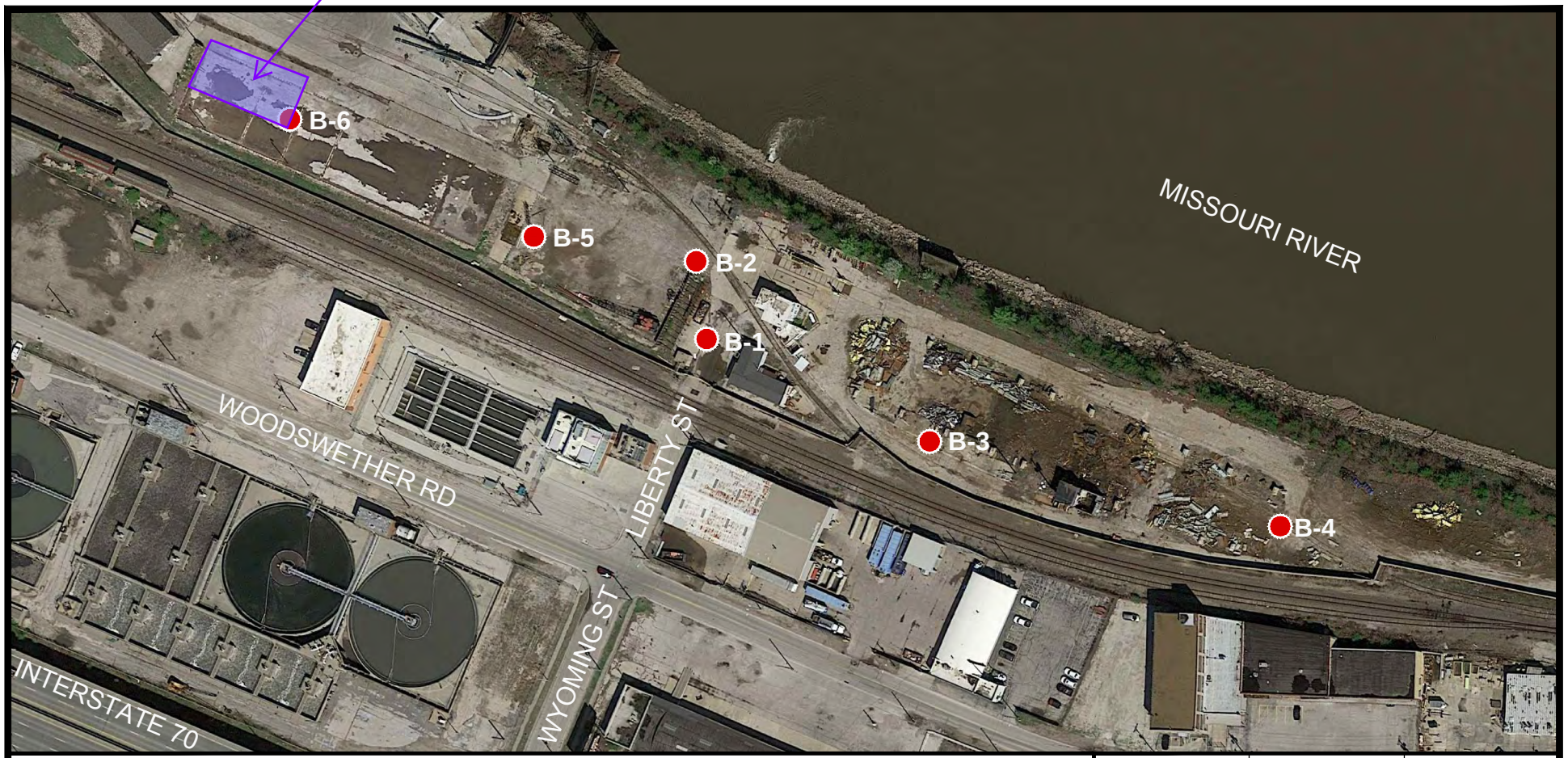
GEOTECHNOLOGY, INC.
Overland Park, Kansas

Geotechnology, Inc. Project No. J027153.01

July 15, 2016

REFERENCE 2

BY: BEH 02/26
CHECKED BY: GSB 03/26



NOTES

1. Plan adapted from a March 27, 2016 aerial photograph courtesy of Google Earth.
2. Borings were located in the field with a GPS device and are shown approximate only.

LEGEND

● Boring Location

N

0 80 160 320

SCALE IN FEET

Drawn By: WAH	Ck'd By: MTI	App'vd By: SDG
Date: 6-12-16	Date: 6-13-16	Date: 7-13-16

GEOTECHNOLOGY INC
FROM THE GROUND UP

Union Pacific Railroad Track Relocation
Port Kansas City
Kansas City, Missouri

AERIAL PHOTOGRAPH OF SITE AND BORING LOCATIONS

Project Number J027153.01

PLATE 2

REFERENCE 2

BY: BEH 02/26
CHECKED BY: GSB 03/26

Surface Elevation 754 Completion Date: 6/8/16

Datum NAVD83

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - dark brown, silt, clayey sand, gravel, glass, red brick			
			4-6-3	SS1
			2-5-7	SS2
5				
			3-3-5	SS3
	SAND - tan, fine to coarse, medium dense, poorly graded - SP			
			5-7-6	SS4
10	Boring terminated at 10 feet.			

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4 " HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER BBP LOGGER

CME 550 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: ADC	Check by: MTI	App'vd by: SDG
Date: 6/13/16	Date: 6/21/16	Date: 6/22/16

GEOTECHNOLOGY INC
FROM THE GROUND UP

UP Railroad Track Relocation
Port Kansas City, Missouri

LOG OF BORING: B-6

Project No. J027153.01

LOG OF BORING 2002 WL GINT.GPJ GTINC 0638301.GPJ 7/15/16

$$N_{60} = \left(\frac{ER}{60\%}\right)N \qquad (10.4.6.2.4\text{-}2)$$

where:

N_{60} = *SPT* blow count corrected for hammer efficiency (blows/ft)
ER = hammer efficiency expressed as percent of theoretical free fall energy delivered by the hammer system actually used (dim)
N = uncorrected *SPT* blow count (blows/ft)

When *SPT* blow counts have been corrected for both overburden effects and hammer efficiency effects, the resulting corrected blow count shall be denoted as $N1_{60}$, determined as:

$$N1_{60} = C_N N_{60} \qquad (10.4.6.2.4\text{-}3)$$

The drained friction angle of granular deposits should be determined based on the following correlation.

Table 10.4.6.2.4-1—Correlation of *SPT* $N1_{60}$ Values to Drained Friction Angle of Granular Soils (modified after Bowles, 1977)

$N1_{60}$	ϕ_f
<4	25–30
4	27–32
10	30–35
30	35–40
50	38–43

For gravels and rock fill materials where *SPT* testing is not reliable, Figure 10.4.6.2.4-1 should be used to estimate the drained friction angle.

Rock Fill Grade	Particle Unconfined Compressive Strength (ksf)
A	>4,610
B	3,460–4,610
C	2,590– 3,460
D	1,730– 2,590
E	≤1,730

reflect the greater energy delivered to the sampler by these systems.

Hammer efficiency (*ER*) for specific hammer systems used in local practice may be used in lieu of the values provided. If used, specific hammer system efficiencies shall be developed in general accordance with ASTM D4945 for dynamic analysis of driven piles or other accepted procedure.

The following values for *ER* may be assumed if hammer specific data are not available, e.g., from older boring logs:

ER = 60 percent for conventional drop hammer using rope and cathead

ER = 80 percent for automatic trip hammer

Corrections for rod length, hole size, and use of a liner may also be made if appropriate. In general, these are only significant in unusual cases or where there is significant variation from standard procedures. These corrections may be significant for evaluation of liquefaction. Information on these additional corrections may be found in Youd and Idriss (1997).

The $N1_{60}$-ϕ_f correlation used is modified after Bowles (1977). The correlation of Peck, Hanson, and Thornburn (1974) falls within the ranges specified. Experience should be used to select specific values within the ranges. In general, finer materials or materials with significant silt-sized material will fall in the lower portion of the range. Coarser materials with less than five percent fines will fall in the upper portion of the ranges. The geologic history and angularity of the particles may also need to be considered when selecting a value for ϕ_f.

Care should be exercised when using other correlations of *SPT* results to soil parameters. Some published correlations are based on corrected values ($N1_{60}$) and some are based on uncorrected values (N).

The designer should ascertain the basis of the correlation and use either $N1_{60}$ or N as appropriate.

Care should also be exercised when using *SPT* blow counts to estimate soil shear strength if in soils with coarse gravel, cobbles, or boulders. Large gravels, cobbles, or boulders could cause the *SPT* blow counts to be unrealistically high.

The secant friction angle derived from the procedure to estimate the drained friction angle of gravels and rock fill materials depicted in Figure 10.4.6.2.4-1 is based on a straight line from the origin of a Mohr diagram to the intersection with the strength envelope at the effective normal stress. Thus, the angle derived is applicable only to analysis of field conditions subject to similar normal stresses. See Terzaghi, Peck, and Mesri (1996) for additional details regarding this procedure.

Objective:

Develop soil parameters for use in geotechnical design calculations for the Port of Kansas proposed Structural Pad for Magnesium Tanks.

References:

1) GFT, Port of Kansas Structural Pad Boring Summary Calculation, February 2026.
2) Missouri Department of Transportation (MoDOT), Standard Specifications for Highway Construction, Third Edition, January 2026.
3) AASHTO, LRFD Bridge Design Specifications, 9th Edition, 2020.
4) Bowles, Joseph E., Foundation Analysis and Design, Fifth Edition, 1997.
5) UFC, Soil Mechanics (DM 7.1), January 2026.

Assumptions:

1. Overexcavation and replacement will be performed for the proposed structural pad in order to improve the bearing material. The overexcavated material will be replaced with MoDOT Type 5 Aggregate per Section 1007.3 (Ref. 2). Additionally, geogrid will be placed within the aggregate to further improve bearing and reduce settlement. Develop parameters for this Engineered Fill Layer.
2. In-situ soil layers based on Reference 1 calculation.
3. Due to 5-foot interval sampling, select conservative parameters due to the uncertainty of intermediate materials between samples.
4. Saturated unit weights are assumed to be moist unit weight + 5 pcf.

Calculation: (see attached for summary of developed parameters)

In-Situ Layer 1 (0.0' – 8.5'):

- Fine-grained soil (CL) with average N_{60} = 11 bpf. Dut to being a stiff clay, analyze using drained parameters.
- Ref. 4 Table 3-4 for Medium Density and Fine-Grained, Φ' = 30-34° and γ_m = 110-130 pcf.
- Ref. 3 Table C10.4.6.3-1 for Stiff Clay, E_s = 2.08-6.94 ksi and v = 0.4 - 0.5
- Recommended Parameters:

γ_m = 115 pcf, γ_{sat} = 120 pcf, Φ' = 28°, c' = 0 psf, E_s = 3.00 ksi, v = 0.40

In-Situ Layer 2 (8.5' – 18.5'):

- Coarse-grained soil (SP) with average N_{60} = 15 bpf.
- Ref. 4 Table 3-4 for Medium Density and Medium-Grained, Φ' = 32-36° and γ_m = 110-130 pcf
- Ref. 3 Table C10.4.6.3-1 for Medium Dense Sand, E_s = 4.17-6.94 ksi and v = 0.20-0.40
- Recommended Parameters:

γ_m = 120 pcf, γ_{sat} = 125 pcf, Φ' = 30°, c' = 0 psf, E_s = 4.17 ksi, v = 0.30

In-Situ Layer 3 (18.5' – 28.5'):

- Fine-grained soil (CL) with average N_{60} = 4 bpf. No consolidation, pocket penetrometer, or Atterberg Limits testing was completed for this material. Therefore, analyze layer using very conservative drained parameters.
- Ref. 4 Table 3-4 for Loose and Fine-Grained, Φ' = 28-30° and γ_m = 90-115 pcf
- No consolidation, pocket penetrometer, or Atterberg Limits testing was completed for this material. Therefore, analyze using very conservative elastic settlement parameters (E_s and v). Ref. 3 Table C10.4.6.3-1 for Medium Stiff Clay, E_s = 0.347-2.08 ksi and v = 0.4-0.5
- Recommended Parameters:

γ_m = 105 pcf, γ_{sat} = 110 pcf, Φ' = 24°, c' = 0 psf, E_s = 0.347 ksi, v = 0.40

In-Situ Layer 4 (28.5' – 38.5'):

- Fine-grained non-cohesive soil (ML) with average N_{60} = 8 bpf.
- Ref. 4 Table 3-4 for Medium Density and Fine-Grained, Φ' = 30-34° and γ_m = 110-130 pcf.
- Ref. 3 Table C10.4.6.3-1 for Silt, E_s = 0.278-2.78 ksi and v = 0.30-0.35
- Recommended Parameters:

γ_m = 115 pcf, γ_{sat} = 120 pcf, Φ' = 28°, c' = 0 psf, E_s = 1.67 ksi, v = 0.30

In-Situ Layer 5 (38.5' – 88.5'):

- Predominantly coarse-grained soil (SP/SM/SC/CL/CH) with average N_{60} = 29 bpf.
- Ref. 4 Table 3-4 for Medium Density and Medium-Grained, Φ' = 32-36° and γ_m = 110-130 pcf
- Ref. 3 Table C10.4.6.3-1 for Medium Dense Sand, E_s = 4.17-6.94 ksi and v = 0.20-0.40
- Recommended Parameters:

γ_m = 125 pcf, γ_{sat} = 130 pcf, Φ' = 34°, c' = 0 psf, E_s = 6.94 ksi, v = 0.30

In-Situ Layer 6 (88.5' – 98.9'):

- Weathered Shale with Refusal blow counts. Analyze as very dense gravel.
- Ref. 4 Table 3-4 for Very Dense and Medium Grained, $\Phi' < 50°$ and γ_m = 130-150 pcf
- Ref. 3 Table C10.4.6.3-1 for Dense Gravel, E_s = 13.89-27.78 ksi and v = 0.30-0.40
- Recommended Parameters:

γ_m = 140 pcf, γ_{sat} = 145 pcf, Φ' = 38°, c' = 0 psf, E_s = 13.89 ksi, v = 0.30

Engineering Fill (Compacted MoDOT Type 5 Aggregate with Geogrid Reinforcement):

- Based on gradation of MoDOT Type 5 aggregate provided in Ref. 2, Section 1007.3.2, material likely classifies as either GP, GW, SP, or SW soils depending on actual gradation.
- Ref. 5, Table 8-2 for Φ', GW > 38°, GP > 37°, SW = 38°, and SP = 37°.
- Ref. 4 Table 3-4 for Dense and Medium to Coarse Grained, Φ' = 36-50° and γ_m = 110-140 pcf
- Ref. 3 Table C10.4.6.3-1 for Dense Sand, E_s = 6.94-11.11 ksi and v = 0.20-0.40, and for Dense Gravel, E_s = 13.89-27.78 ksi and v = 0.30-0.40
- Due to the addition of geogrids within the engineered fill, assume it has no effect on the soil friction angle (Φ'), but it does increase in the soil's apparent Modulus of Elasticity (E_s) due to the geogrid providing additional tension reinforcement and confinement when load is applied. Due to this, utilize an Es value that is on the higher end of recommended values, and a v value that is on the lower end of recommended values.
- Recommended Parameters:

γ_m = 120 pcf, γ_{sat} = 125 pcf, Φ' = 38°, c' = 0 psf, E_s = 20.00 ksi, v = 0.20

Summary of In-Situ Design Soil Parameters									
Layer Number	Depth[(1)] (ft)	N_{60} Avg (bpf)	USCS Classification	γ_m (pcf)	γ_{sat} (pcf)	Φ' (°)	c' (psf)	E_s (ksi)	v
1	0-8.5	11	CL	115	120	28	0	3.00	0.40
2	8.5-18.5	15	SP	120	125	30	0	4.17	0.30
3	18.5-28.5	4	CL	105	110	24	0	0.347	0.40
4	28.5-38.5	8	ML	115	120	28	0	1.67	0.30
5	38.5-88.5	29	SP/SM/SC/CL/CH	125	130	34	0	6.94	0.30
6	88.5-98.9	Refusal	Weathered Shale	140	145	38	0	13.89	0.30

(1) Depth measured from existing ground surface of Boring B2B at the time of sampling. No elevation provided on the log.

Summary of Engineered Fill Design Soil Parameters							
Material Description	USCS Classification	γ_m (pcf)	γ_{sat} (pcf)	Φ' (°)	c' (psf)	E_s (ksi)	v
Compacted MoDOT Type 5 Aggregate with Geogrid	GW/GP/SW/SP	120	125	38	0	20	0.20

SECTION 1007
AGGREGATE FOR BASE

1007.1 Scope. This specification covers aggregate to be used for base.

1007.2 Type 1 Aggregate.

1007.2.1 Type 1 aggregate for base shall consist of crushed stone, sand and gravel or reclaimed asphalt or concrete. The aggregate shall not contain more than 15 percent deleterious rock and shale. The fraction passing No. 40 sieve shall have a maximum plasticity index of six. Any sand, silt and clay and any deleterious rock and shale shall be uniformly distributed throughout the material.

1007.2.2 The aggregate shall be in accordance with the following gradation requirements:

Sieve	Percent by Weight
Passing 1-inch	100
Passing 1/2-inch	60-90
Passing No. 4	35-60
Passing No. 30	10-35

1007.3 Type 5 Aggregate.

1007.3.1 Type 5 aggregate for base shall consist of crushed stone, sand and gravel or reclaimed asphalt or concrete. The aggregate shall not contain more than 15 percent deleterious rock and shale. The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six. Any sand, silt and clay, and any deleterious rock and shale shall be uniformly distributed throughout the material.

1007.3.2 Type 5 aggregate shall be in accordance with the following gradation requirements:

Sieve	Percent by Weight
Passing 1-inch	100
Passing 1/2-inch	60-90
Passing No. 4	35-60
Passing No. 30	10-35
Passing No. 200	0-15

1007.4 Type 7 Aggregate.

1007.4.1 Type 7 aggregate for base shall consist of crushed stone, sand and gravel, or reclaimed asphalt or concrete. The aggregate shall not contain more than 15 percent deleterious rock and shale. The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six. Any sand, silt and clay, and any deleterious rock and shale shall be uniformly distributed throughout the material.

1007.4.2 Type 7 aggregate shall be in accordance with the following gradation requirements:

Sieve	Percent by Weight
Passing 1 1/2-inch	100
Passing 1-inch	70-100
Passing No. 8	15-50
Passing No. 200	0-12

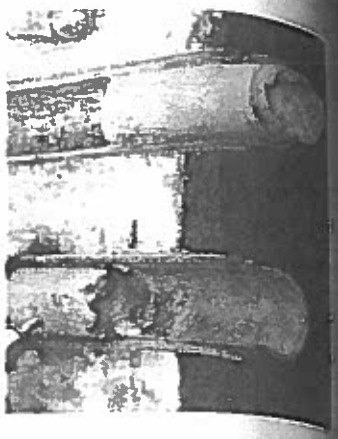
Table C10.4.6.3-1—Elastic Constants of Various Soils (modified after U.S. Department of the Navy, 1982; Bowles, 1988)

Soil Type	Typical Range of Young's Modulus Values, E_s (ksi)	Poisson's Ratio, ν (dim)
Clay:		
Soft sensitive		0.4–0.5 (undrained)
Medium stiff	0.347–2.08	
to stiff	2.08–6.94	
Very stiff	6.94–13.89	
Loess	2.08–8.33	0.1–0.3
Silt	0.278–2.78	0.3–0.35
Fine Sand:		
Loose	1.11–1.67	0.25
Medium dense	1.67–2.78	
Dense	2.78–4.17	
Sand:		
Loose	1.39–4.17	0.20–0.36
Medium dense	4.17–6.94	
Dense	6.94–11.11	0.30–0.40
Gravel:		
Loose	4.17–11.11	0.20–0.35
Medium dense	11.11–13.89	
Dense	13.89–27.78	0.30–0.40

Estimating E_s from *SPT N* Value	
Soil Type	E_s (ksi)
Silts, sandy silts, slightly cohesive mixtures	$0.056\ N1_{60}$
Clean fine to medium sands and slightly silty sands	$0.097\ N1_{60}$
Coarse sands and sands with little gravel	$0.139\ N1_{60}$
Sandy gravel and gravels	$0.167\ N1_{60}$
Estimating E_s from q_c (static cone resistance)	
Sandy soils	$0.028q_c$

The modulus of elasticity for normally consolidated granular soils tends to increase with depth. An alternative method of defining the soil modulus for granular soils is to assume that it increases linearly with depth starting at zero at the ground surface in accordance with the following equation:

$$E_s = nh \times z \qquad \text{(C10.4.6.3-1)}$$



$$N'_{60} = 0.68 \times 20 \times 1.00 \times 1.0 \times 0.80 \times 1.05 = \underline{11}$$

$$N'_{70} = \frac{60}{70} \times 11 = \underline{9}$$

////

Example 3-4

Same as Example 3-2 but $E_r = 55$; $p'_a = 100$ kPa; 205 mm hollow stem auger; hole depth = 6 m

$$C_N = \left(\frac{95.76}{100}\right)^{1.2} = 0.98$$

$$\eta_1 = \frac{55}{70} = 0.79 \qquad \eta_2 = 0.95 \quad 6 < 10\text{ m}$$

$$\eta_3 = 1.0 \quad \text{no liner} \qquad \eta_4 = 1 \quad \text{using hollow stem auger}$$

$$N'_{70} = 0.98 \times 20 \times 0.79 \times 0.95 \times 1.0 \times 1.0 = \underline{15}$$

$$N'_{60} = \frac{70}{60} \times 15 = \underline{17}$$

////

3-8 SPT CORRELATIONS

The SPT has been used in correlations for unit weight, relative density D_r, angle o internal friction ϕ, and undrained compressive strength q_u. For reasons in the preceding section these will be of questionable value—particularly since many were suggested prior to extensive study of the large number of variables affecting the N values. The data shown in Table 3-4 for D_r and ϕ relate roughly to N'_{70} and fo borehole depths on the order of 4 to 6 m as for spread foundations.

TABLE 3-4 **Empirical values for ϕ, D_r, and unit weight of granular soils based on the SPT a about 6 m depth and normally consolidated**

Description	Very loose	Loose	Medium	Dense	Very den
Relative density D_r	0 0.15	0.35	0.65	0.85	
SPT N'_{60}: fine	1–2	3–6	7–15	16–30	?
medium	2–3	4–7	8–20	21–40	>40
coarse	3–6	5–9	10–25	26–45	>45
ϕ: fine	26–28	28–30	30–34	33–38	
medium	27–28	30–32	32–36	36–42	<50
coarse	28–30	30–34	33–40	40–50	
γ_{wet}, pcf	70–100†	90–115	110–130	110–140	130–150
(kN m^3)	(11–16)	(14–18)	(17–20)	(17–22)	(20–23)

† Excavated soil or material dumped from a truck will weigh 11 to 14 kN m^3 and must be quite dense to weigh mu over 21 kN m^3. No existing soil has a $D_r = 0.00$ nor a value of 1.00—common ranges are from 0.3 to 0.7

correlated parameter is greater than the actual value, which undesirable in many cases (e.g., shear strength, Young's modulus, etc.). In a few cases, the opposite might be the case (e.g., compression index).

8-2 EFFECTIVE STRESS (DRAINED) SHEAR STRENGTH.

8-2.1 Coarse-Grained Soils.

Most of the correlations presented for coarse-grained soils have been developed for relatively clean sands unless otherwise noted. These correlations should not be used in micaceous sands. The presence of mica tends to reduce some index properties (e.g. the SPT N value) significantly but might not affect the drained friction angle when compared to clean sands (Sabatini et al. 2002). These correlations should not be used for gravelly soils unless specified.

8-2.1.1 Correlations with Soil Type.

Carter and Bentley (2016) summarized typical values for the effective stress friction angles of coarse-grained soils as presented in Table 8-1 and Table 8-2. Table 8-1 presents values for the drained friction angle of different types of coarse-grained soils in loose and dense conditions and Table 8-2 presents the values of effective stress friction angle for coarse-grained soils compacted to the maximum dry density based on ASTM D698.

Table 8-1 Typical Values of the Effective Stress Friction Angle for Coarse-grained Soils (Carter and Bentley 2016)

Soil Description	ϕ' (in degrees)	
	Loose	Dense
Uniform sand, round grains	27	34
Well-graded sand, angular grains	33	45
Sandy gravel	35	50
Silty sand	27-33	30-34
Inorganic silt	27-30	30-35

Table 8-2 Typical Values of the Effective Stress Friction Angle for Compacted Coarse-grained Soils (Carter and Bentley 2016)

Soil Description	USCS	ϕ' (in degrees)
Well-graded sand-gravel mixtures	GW	>38
Poorly-graded sand-gravel mixtures	GP	>37
Silty gravels, poorly-graded gravel-sand-silt	GM	>34
Clayey gravels, poorly-graded gravel-sand-clay	GC	>31
Well-graded clean sand, gravelly sand	SW	38
Poorly-graded clean sand, gravelly sand	SP	37

Objective:

Estimate the bearing resistance for the proposed Structural Slab for the Port of Kansas.

References:

1) AASHTO, LRFD Bridge Design Specifications, 9th Ed., 2020.
2) GFT, Port of Kansas – Structural Pad Soil Parameters, February 2026.
3) GFT, Port of Kansas – Structural Pad Boring Summary, February 2026.

Slab Dimensions: Provided by Matt Thekkekara – Structural Engineer (attached)

- Area: 36’ x 120’
- Pad Thickness: 3.5’

Assumptions:

- All loads are assumed vertical (i_c=1.0, i_q=1.0, i_γ=1.0).
- Foundation is not located on a slope based on location plan provided in Ref. 3 (i.e., Ref. 1, Section 10.6.3.1.2c not applicable).
- Conservatively assume soil above the bearing elevation is less competent than soils below bearing elevation (d_q = 1.0). Assume In-Situ Layer 1 above bottom of pad.
- Assume top of pad is located at existing ground surface. Utilize Boring B2b (Ref. 3) for subsurface conditions.
- Eccentricty is unknown. Due to the pad holding portable magnesium storage tanks, conservatively assume max eccentricity of 1/3B (Ref. 1, Section 11.6.3.3. Assume eccentricity only acts in the B direction.
- Assume a 3’ overexcavation and replacement with engineered fill (Type 5 Aggregate with Geotextile) directly below the pad.
- Soil Parameters per Ref. 2.
- Soil profile below the pad consists of a multi-layered profile. Assume critical depth for bearing occurs within Layers 1-3 (Ref. 3) due to Layer 3 having the lowest friction angle. Utilize an equivalent friction angle and unit weight in order to estimate the bearing capacity:
  - Friction Angle: $\varphi_{eq} = \frac{(38°*3') + (28°*2') + (30°*10') + (24°*10')}{25'} = 28.4° \; (Use \; 28°)$
  - Unit Weight: $\gamma_{eq} = \frac{(120*3') + (115*2') + (120*10') + (105*10')}{25'} = 113.6 \, pcf \; (Use \; 114 \, pcf)$

Bearing Resistance Calculation (LRFD – STR):

36' x 120' Wide Pad Foundation:

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

$$q_n = cN_{cm} + \gamma_q D_f N_{qm} C_{wq} + 0.5\gamma_f B N_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

Notes: (1) Eccentricity is unknown at the time of this calculation. Conservatively assume the maximum eccentricity where B'=B-2e (Ref. 1, Eq. 10.6.1.3-1) where e_{max} = 1/3*B. Utilize B' in the above equation.

(2) Soils assumed cohesionless, therefore $cN_{cm} = 0$

Where:

γ_1 = 115 pcf (Ref. 2, In-Situ Layer 1)

D_f = 3.5 ft

N_q = 14.7 (Ref. 1 – Table 10.6.3.1.2a-1 for 28°)

N_γ = 16.7 (Ref. 1 – Table 10.6.3.1.2a-1 for 28°)

$\gamma_2 = \gamma_{eq}$ = 114 pcf

B' = B-2e = 36' – 2* (1/3*36') = 12 ft. L = 120'

Shape Factors: (Ref 1 – Table 10.6.3.1.2a-3 for Φ_f = 28°)

$$s_q = 1 + \left(\frac{B\prime}{L}\right) tan\emptyset = 1 + \left(\frac{12\prime}{120\prime}\right) \tan(28) = 1.05$$

$$s_\gamma = 1 - 0.4\left(\frac{B'}{L}\right) = 1 - 0.4\left(\frac{12'}{120'}\right) \approx 0.96$$

Depth Factor: (Ref 1 – Equation 10.6.3.1.2a-10)

Note: Conservatively assume soil above footing is less competent than bearing soil.

$$d_q = 1.0$$

Inclination Factor: (Ref. 1, Equations 10.6.3.1.2a-7 and -8)

Note: Load assumed to be vertical.

$$i_q = i_\gamma = 1.0$$

36’ x 120’ Wide Pad Foundation (Continued):

Groundwater Factors: (Ref. 1, Table 10.6.3.1.2a-2)

Note: Df = 3.5’ and B = B’ = 12’. Groundwater at 28.5’ BGS per Boring B2B

$C_{wq} = 1.0$

$C_{w\gamma} = 1.0$

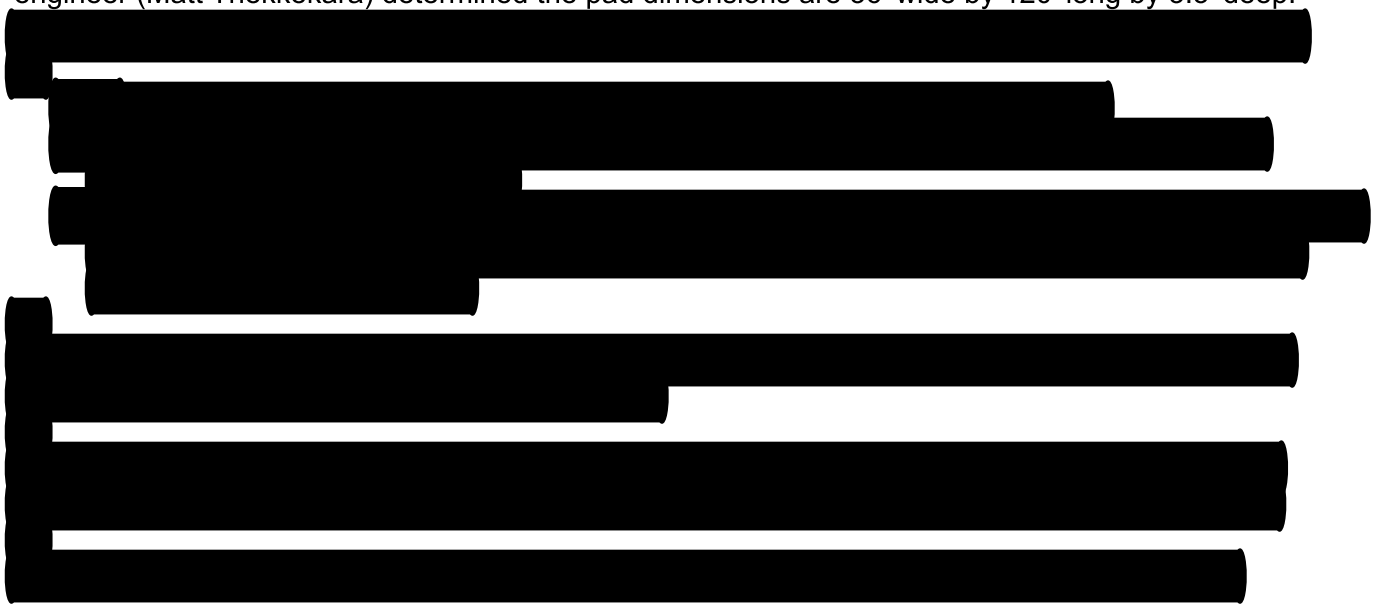
$q_n = 0 + 115\ pcf * 3.5' * 14.7 * 1.05 * 1 * 1 * 1 + 0.5 * 114\ pcf * 12' * 16.7 * .96 * 1 * 1$

$q_n = 0\ psf + 6{,}213\ psf + 10{,}966\ psf = 17{,}179\ psf$

$q_R = \varphi_b q_n = 0.45 * 17{,}176\ psf = 7{,}730\ psf$

Recommended q_R = 3,000 psf

We've been asked to design a structural pad for 14 large (30k gal) magnesium tanks. The structural engineer (Matt Thekkekara) determined the pad dimensions are 36' wide by 120' long by 3.5' deep.



Thanks,
Jason

Jason M. Gardner
Principal Geotechnical Engineer

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10.5.5.2.2—Spread Footings

The resistance factors provided in Table 10.5.5.2.2-1 shall be used for strength limit state design of spread footings, with the exception of the deviations allowed for local practices and site-specific considerations in Article 10.5.5.2.

C10.5.5.2.2

Table 10.5.5.2.2-1—Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State

Method/Soil/Condition			Resistance Factor
Bearing Resistance	φ_b	Theoretical method (Munfakh et al., 2001), in clay	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using *CPT*	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using *SPT*	0.45
		Semi-empirical methods (Meyerhof, 1957), all soils	0.45
		Footings on rock	0.45
		Plate Load Test	0.55
Sliding	φ_τ	Precast concrete placed on sand	0.90
		Cast-in-Place Concrete on sand	0.80
		Cast-in-Place or precast Concrete on Clay	0.85
		Soil on soil	0.90
	φ_{ep}	Passive earth pressure component of sliding resistance	0.50

The resistance factors in Table 10.5.5.2.2-1 were developed using both reliability theory and calibration by fitting to Allowable Stress Design (ASD). In general, ASD safety factors for footing bearing capacity range from 2.5 to 3.0, corresponding to a resistance factor of approximately 0.55 to 0.45, respectively, and for sliding, an ASD safety factor of 1.5, corresponding to a resistance factor of approximately 0.9. Calibration by fitting to ASD controlled the selection of the resistance factor in cases where statistical data were limited in quality or quantity.

The resistance factor for sliding of cast-in-place concrete on sand is slightly lower than the other sliding resistance factors based on reliability theory analysis (Barker et al., 1991). The higher interface friction coefficient used for sliding of cast-in-place concrete on sand relative to that used for precast concrete on sand causes the cast-in-place concrete sliding analysis to be less conservative, resulting in the need for the lower resistance factor. A more detailed explanation of the development of the resistance factors provided in Table 10.5.5.2.2-1 is provided in Allen (2005).

The resistance factors for plate load tests and passive resistance were based on engineering judgment and past ASD practice.

10.5.5.2.3—Driven Piles

Resistance factors shall be selected from Table 10.5.5.2.3-1 based on the method used for determining the driving criterion necessary to achieve the required nominal pile bearing resistance.

Regarding load tests, and dynamic tests with signal matching, the number of tests to be conducted to justify the design resistance factors selected should be based on the variability in the properties and geologic stratification of the site to which the test results are to be applied. A

C10.5.5.2.3

Where nominal pile bearing resistance is determined by static load test, dynamic testing, wave equation, or dynamic formulas, the uncertainty in the nominal resistance is strictly due to the reliability of the resistance determination method used in the field during pile installation.

In most cases, the nominal bearing resistance of each production pile is field-verified based on compliance with a driving criterion developed using a dynamic method

Spread footings shall be located below the depth of frost potential. Depth of frost potential shall be determined on the basis of local or regional frost penetration data.

10.6.1.3—Effective Footing Dimensions

For eccentrically loaded footings, a reduced effective area, $B' \times L'$, within the confines of the physical footing shall be used in geotechnical design for settlement or bearing resistance. The point of load application shall be at the centroid of the reduced effective area.

The reduced dimensions for an eccentrically loaded rectangular footing shall be taken as:

$$B' = B - 2e_B \qquad (10.6.1.3\text{-}1)$$

$$L' = L - 2e_L$$

where:

e_B = eccentricity parallel to dimension B (ft)
e_L = eccentricity parallel to dimension L (ft)

Footings under eccentric loads shall be designed to ensure that the factored bearing resistance is not less than the effects of factored loads at all applicable limit states.

For footings that are not rectangular, similar procedures should be used based upon the principles specified above.

10.6.1.4—Bearing Stress Distributions

When proportioning footing dimensions to meet settlement and bearing resistance requirements at all applicable limit states, the distribution of bearing stress on the effective area shall be assumed to be:

- uniform for footings on soils, or
- linearly varying, i.e., triangular or trapezoidal as applicable, for footings on rock.

The distribution of bearing stress shall be determined as specified in Article 11.6.3.2.

Consideration may be given to over-excavation of frost susceptible material to below the frost depth and replacement with material that is not frost susceptible.

C10.6.1.3

The reduced dimensions for a rectangular footing are shown in Figure C10.6.1.3-1.

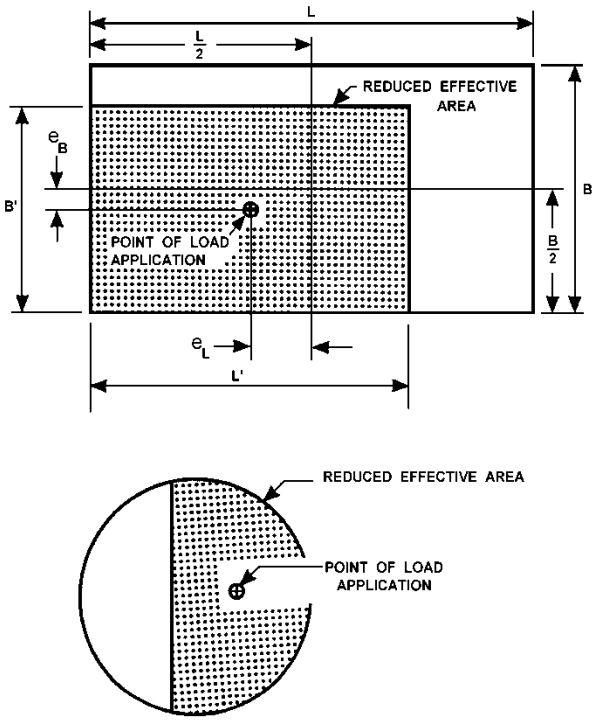


Figure C10.6.1.3-1—Reduced Footing Dimensions

For footings that are not rectangular, such as the circular footing shown in Figure C10.6.1.3-1, the reduced effective area is always concentrically loaded and can be estimated by approximation and judgment. Such an approximation could be made, assuming a reduced rectangular footing size having the same area and centroid as the shaded area of the circular footing shown in Figure C10.6.1.3-1.

Consideration should be given to the relative change in the computed nominal resistance based on effective versus gross footing dimensions for the size of footings typically used for bridges. Judgment should be used in deciding whether the use of gross footing dimensions for computing nominal bearing resistance at the strength limit state would result in a conservative design.

10.6.3.1.2—Theoretical Estimation

10.6.3.1.2a—Basic Formulation

C10.6.3.1.2a

The nominal bearing resistance shall be estimated using accepted soil mechanics theories and should be based on measured soil parameters. The soil parameters used in the analyses shall be representative of the soil shear strength under the considered loading and subsurface conditions.

The nominal bearing resistance of spread footings on cohesionless soils shall be evaluated using effective stress analyses and drained soil strength parameters.

The nominal bearing resistance of spread footings on cohesive soils shall be evaluated for total stress analyses and undrained soil strength parameters. In cases where the cohesive soils may soften and lose strength with time, the bearing resistance of these soils shall also be evaluated for permanent loading conditions using effective stress analyses and drained soil strength parameters.

For spread footings bearing on compacted soils, the nominal bearing resistance shall be evaluated using the more critical of either total or effective stress analyses.

Except as noted below, the nominal bearing resistance of a soil layer, in ksf, should be taken as:

$$q_n = cN_{cm} + \gamma_q D_f N_{qm} C_{wq} + 0.5\gamma_f B N_{\gamma m} C_{w\gamma} \quad (10.6.3.1.2a\text{-}1)$$

The bearing resistance formulation provided in Eqs. 10.6.3.1.2a-1 though 10.6.3.1.2a-4 is the complete formulation as described in the Munfakh et al. (2001). However, in practice, not all of the factors included in these equations have been routinely used.

in which:

$$N_{cm} = N_c s_c i_c \quad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \quad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \quad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ_q = total (moist) unit weight of soil above the bearing depth of the footing (kcf)
γ_f = total (moist) unit weight of soil below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
$C_{wq}, C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ, s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = depth correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation determined from Eq. 10.6.3.1.2a-10 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

Most geotechnical engineers nationwide have not used the load inclination factors. This is due, in part, to the lack of knowledge of the vertical and horizontal loads at the time of geotechnical explorations and preparation of bearing resistance recommendations.

Furthermore, the basis of the load inclination factors computed by Eqs. 10.6.3.1.2a-5 to 10.6.3.1.2a-8 is a combination of bearing resistance theory and small scale load tests on 1.0 in. wide plates on London Clay and Ham River Sand (Meyerhof, 1953). Therefore, the factors do not take into consideration the effects of depth of embedment. Meyerhof further showed that for footings with a depth of embedment ratio of $D_f/B = 1$, the effects of load inclination on bearing resistance are relatively small. The theoretical formulation of load inclination factors were further examined by Brinch-Hansen (*1970*), with additional modification by Vesic (*1973*) into the form provided in Eqs. 10.6.3.1.2a-5 to 10.6.3.1.2a-8.

It should further be noted that the resistance factors provided in Article 10.5.5.2.2 were derived for vertical loads. The applicability of these resistance factors to design of footings resisting inclined load combinations is not currently known. The combination of the resistance factors and the load inclination factors may be overly conservative for footings with an embedment of approximately $D_f/B = 1$ or deeper because the load inclination factors were derived for footings without embedment.

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

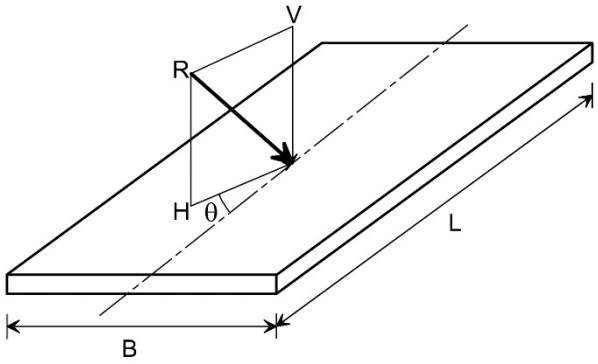


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1 + \left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1 - 0.4\left(\frac{B}{L}\right)$	$1 + \left(\frac{B}{L}\tan\phi_f\right)$

$$d_q = 1 + 2\tan\phi_f(1-\sin\phi_f)^2 \arctan\left(\frac{D_f}{B}\right) \quad \text{(10.6.3.1.2a-10)}$$

where:

d_q = depth correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation(dim)
ϕ_f = angle of internal friction of soil (degrees)
D_f = footing embedment depth (ft)
B = footing width (ft)

Arctan (D_f/B) is in radians.

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0. The depth correction factor, d_q, shall not exceed 1.4.

Eq. 10.6.3.1.2a-10 has been verified to cover a range of friction angle, ϕ_f, of 32 degrees to 42 degrees, and a range of D_f/B of 1 to 8. Depth correction factor values beyond this range have not been verified at this time.

10.6.3.1.2b—Considerations for Punching Shear

C10.6.3.1.2b

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \quad \text{(10.6.3.1.2b-1)}$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \quad \text{(10.6.3.1.2b-2)}$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

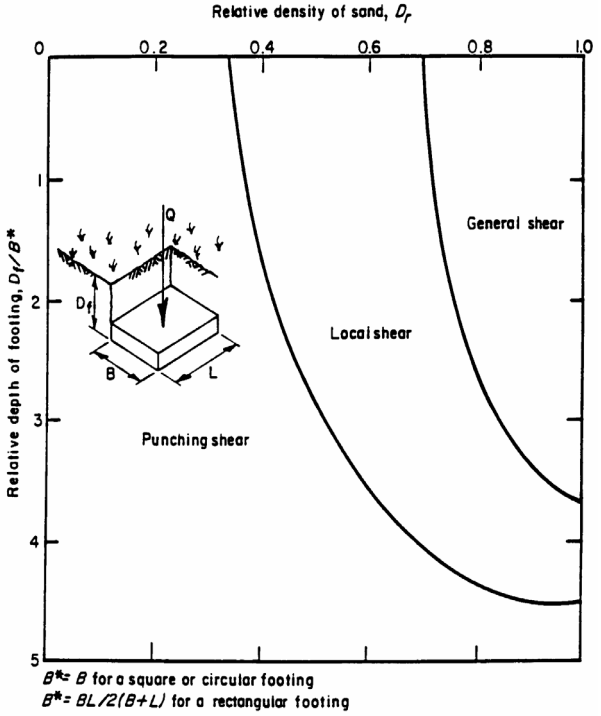


Figure C10.6.3.1.2b-1—Modes of Bearing Capacity Failure for Footings in Sand

10.6.3.1.2c—Considerations for Footings on Slopes

C10.6.3.1.2c

For footings constructed on or adjacent to slopes, the nominal bearing resistance shall be determined using a reduction coefficient (RC_{BC}) as presented in Tables 10.6.3.1.2c-1 and 10.6.3.1.2c-2. The reduction coefficient should be applied directly to the nominal bearing resistance calculated from Eq.10.6.3.1.2a-1 for footings on level ground and supported on the same foundation soil conditions.

The nominal resistance of footings on or adjacent to slopes shall be taken as:

$$q_{n-sloping\ ground} = RC_{BC} q_n = RC_{BC}\left(cN_c + 0.5\gamma BN_\gamma\right) \quad (10.6.3.1.2c\text{-}1)$$

where:

$q_{n\text{-}sloping\ ground}$ = the nominal footing bearing resistance considering the effect of sloping ground (ksf)
RC_{BC} = reduction coefficient for bearing resistance due to slope effects (dim)

and other variables are as defined in Article 10.6.3.1.2a and Figure 10.6.3.1.2c-1. The bearing capacity factors N_c and N_γ are obtained in accordance with Article 10.6.3.1.2a.

Reduction coefficients (RC_{BC}) should be determined using the definitions illustrated in Figure 10.6.3.1.2c-1

A rational approach for determining a modified bearing resistance for footings on or adjacent to a slope is presented in Leshchinsky (2015) and Leshchinsky and Xie (2016). These methods are considered valid and applicable to structure foundations in addition to the MSE retaining wall example presented in the reference papers. The reduction coefficients provided in Tables 10.6.3.1.2c-1 and 10.6.3.1.2c-2 are modified and reconfigured by the author of the cited papers to allow for more convenient use in practice. See the original papers for the complete tabulation of reduction coefficient values.

The reduction coefficients are applicable to purely cohesive, purely cohesionless and c-ϕ soils. The RC_{BC} factors are based on no footing embedment for footings either on or adjacent to slopes and may be conservative for deep footing embedment depths.

Limit analysis, or limit equilibrium analysis, should be considered to estimate the nominal bearing resistance of footings on or adjacent to slopes composed of soils and/or site conditions that are not consistent with the parameters and conditions described in the reference documents (i.e. embedment >0, layered soils, steeper slopes).

The schematic shown in Figure 10.6.3.1.2c-1 is provided only for illustrating and defining the terms used in the design equations and tables. This figure should not be used as the basis for locating footings on slopes regarding embedment depth and setback.

REFERENCE 2

By: BEH 03/26
Checked By: GSB 03/26

GFT	SUBJECT: Port of Kansas – Structural Pad	SHEET NO. 1 OF 3
	Soil Parameter Backup	JOB NO. AO003043
	BY: BEH 02/26 CHKD BY: GSB 03/26	

Objective:

Develop soil parameters for use in geotechnical design calculations for the Port of Kansas proposed Structural Pad for Magnesium Tanks.

References:

1) GFT, Port of Kansas Structural Pad Boring Summary Calculation, February 2026.
2) Missouri Department of Transportation (MoDOT), Standard Specifications for Highway Construction, Third Edition, January 2026.
3) AASHTO, LRFD Bridge Design Specifications, 9th Edition, 2020.
4) Bowles, Joseph E., Foundation Analysis and Design, Fifth Edition, 1997.
5) UFC, Soil Mechanics (DM 7.1), January 2026.

Assumptions:

1. Overexcavation and replacement will be performed for the proposed structural pad in order to improve the bearing material. The overexcavated material will be replaced with MoDOT Type 5 Aggregate per Section 1007.3 (Ref. 2). Additionally, geogrid will be placed within the aggregate to further improve bearing and reduce settlement. Develop parameters for this Engineered Fill Layer.
2. In-situ soil layers based on Reference 1 calculation.
3. Due to 5-foot interval sampling, select conservative parameters due to the uncertainty of intermediate materials between samples.
4. Saturated unit weights are assumed to be moist unit weight + 5 pcf.

Calculation: (see attached for summary of developed parameters)

In-Situ Layer 1 (0.0' – 8.5'):

← Use layer for 0'-3.5' and 6.5'-8.5'

- Fine-grained soil (CL) with average N_{60} = 11 bpf. Dut to being a stiff clay, analyze using drained parameters.
- Ref. 4 Table 3-4 for Medium Density and Fine-Grained, Φ' = 30-34° and γ_m = 110-130 pcf.
- Ref. 3 Table C10.4.6.3-1 for Stiff Clay, E_s = 2.08-6.94 ksi and v = 0.4 - 0.5
- Recommended Parameters:

γ_m = 115 pcf, γ_{sat} = 120 pcf, Φ' = 28°, c' = 0 psf, E_s = 3.00 ksi, v = 0.40

In-Situ Layer 2 (8.5' – 18.5'):

- Coarse-grained soil (SP) with average N_{60} = 15 bpf.
- Ref. 4 Table 3-4 for Medium Density and Medium-Grained, Φ' = 32-36° and γ_m = 110-130 pcf
- Ref. 3 Table C10.4.6.3-1 for Medium Dense Sand, E_s = 4.17-6.94 ksi and v = 0.20-0.40
- Recommended Parameters:

γ_m = 120 pcf, γ_{sat} = 125 pcf, Φ' = 30°, c' = 0 psf, E_s = 4.17 ksi, v = 0.30

In-Situ Layer 3 (18.5' – 28.5'):

- Fine-grained soil (CL) with average N_{60} = 4 bpf. No consolidation, pocket penetrometer, or Atterberg Limits testing was completed for this material. Therefore, analyze layer using very conservative drained parameters.
- Ref. 4 Table 3-4 for Loose and Fine-Grained, Φ' = 28-30° and γ_m = 90-115 pcf
- No consolidation, pocket penetrometer, or Atterberg Limits testing was completed for this material. Therefore, analyze using very conservative elastic settlement parameters (E_s and v). Ref. 3 Table C10.4.6.3-1 for Medium Stiff Clay, E_s = 0.347-2.08 ksi and v = 0.4-0.5
- Recommended Parameters:

γ_m = 105 pcf, γ_{sat} = 110 pcf, Φ' = 24°, c' = 0 psf, E_s = 0.347 ksi, v = 0.40

In-Situ Layer 4 (28.5' – 38.5'):

- Fine-grained non-cohesive soil (ML) with average N_{60} = 8 bpf.
- Ref. 4 Table 3-4 for Medium Density and Fine-Grained, Φ' = 30-34° and γ_m = 110-130 pcf.
- Ref. 3 Table C10.4.6.3-1 for Silt, E_s = 0.278-2.78 ksi and v = 0.30-0.35
- Recommended Parameters:

Friction angle greater than In-Situ Layer 3. Assume Critical Depth for bearing ends at top of this layer (i.e., bearing failure will occur in Layer 3 before Layer 4)

γ_m = 115 pcf, γ_{sat} = 120 pcf, Φ' = 28°, c' = 0 psf, E_s = 1.67 ksi, v = 0.30

In-Situ Layer 5 (38.5' – 88.5'):

- Predominantly coarse-grained soil (SP/SM/SC/CL/CH) with average N_{60} = 29 bpf.
- Ref. 4 Table 3-4 for Medium Density and Medium-Grained, Φ' = 32-36° and γ_m = 110-130 pcf
- Ref. 3 Table C10.4.6.3-1 for Medium Dense Sand, E_s = 4.17-6.94 ksi and v = 0.20-0.40
- Recommended Parameters:

γ_m = 125 pcf, γ_{sat} = 130 pcf, Φ' = 34°, c' = 0 psf, E_s = 6.94 ksi, v = 0.30

In-Situ Layer 6 (88.5' – 98.9'):

- Weathered Shale with Refusal blow counts. Analyze as very dense gravel.
- Ref. 4 Table 3-4 for Very Dense and Medium Grained, $\Phi' < 50°$ and γ_m = 130-150 pcf
- Ref. 3 Table C10.4.6.3-1 for Dense Gravel, E_s = 13.89-27.78 ksi and v = 0.30-0.40
- Recommended Parameters:

γ_m = 140 pcf, γ_{sat} = 145 pcf, Φ' = 38°, c' = 0 psf, E_s = 13.89 ksi, v = 0.30

Engineering Fill (Compacted MoDOT Type 5 Aggregate with Geogrid Reinforcement):

- Based on gradation of MoDOT Type 5 aggregate provided in Ref. 2, Section 1007.3.2, material likely classifies as either GP, GW, SP, or SW soils depending on actual gradation.
- Ref. 5, Table 8-2 for Φ', GW > 38°, GP > 37°, SW = 38°, and SP = 37°.
- Ref. 4 Table 3-4 for Dense and Medium to Coarse Grained, Φ' = 36-50° and γ_m = 110-140 pcf
- Ref. 3 Table C10.4.6.3-1 for Dense Sand, E_s = 6.94-11.11 ksi and v = 0.20-0.40, and for Dense Gravel, E_s = 13.89-27.78 ksi and v = 0.30-0.40
- Due to the addition of geogrids within the engineered fill, assume it has no effect on the soil friction angle (Φ'), but it does increase in the soil's apparent Modulus of Elasticity (E_s) due to the geogrid providing additional tension reinforcement and confinement when load is applied. Due to this, utilize an Es value that is on the higher end of recommended values, and a v value that is on the lower end of recommended values.
- Recommended Parameters:

γ_m = 120 pcf, γ_{sat} = 125 pcf, Φ' = 38°, c' = 0 psf, E_s = 20.00 ksi, v = 0.20

Use layer for 3.5'-6.5' (i.e., 3' overex and replacement)

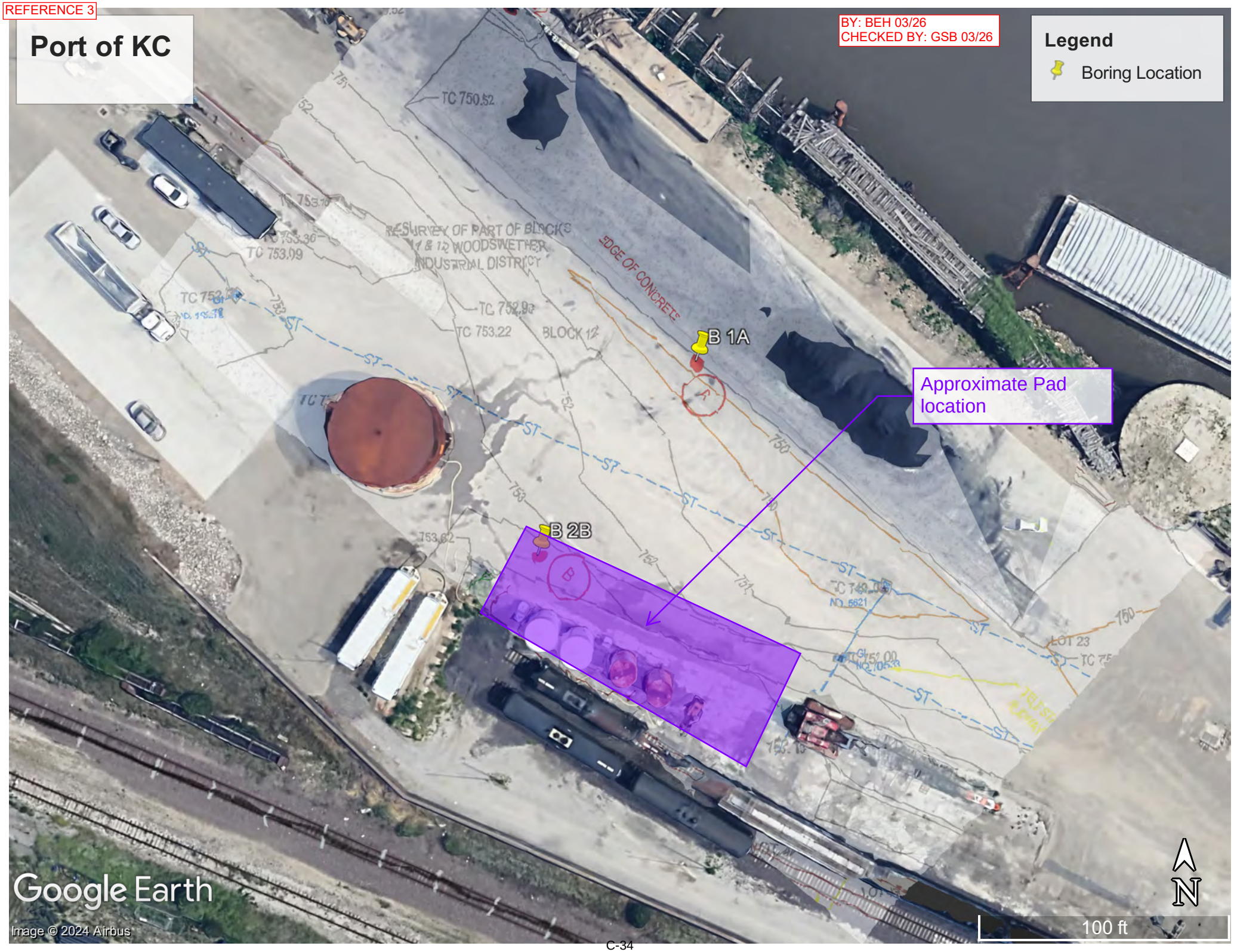
REFERENCE 3

Port of KC

BY: BEH 03/26
CHECKED BY: GSB 03/26

Legend

Boring Location



REFERENCE 3

BY: BEH 03/26
CHECKED BY: GSB 03/26

ALPHA-OMEGA GEOTECH

LOG OF BORING
No. B2B

PROJECT: PORT OF KC **PROJECT NO.:**
CLIENT: MASSMAN CONSTRUCTION CO.
PROJECT LOCATION: 1769 MARKET ST., KCMO
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: KK **LOGGED BY:** CW/NN
DRILLING METHOD: POWER AUGER **DATE:** 11/5/24
DEPTH TO - WATER> INITIAL: ▽ 28.5' **AFTER 24 HOURS:** ▽ **CAVING>** ℄ NONE

Elevation / Depth (ft.)	Soil Symbols, Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
0		Gravel with ASPHALT								0'
		1.0								
		Gray FAT/LEAN CLAY (Possible FILL)				In-Situ Layer 1				CH-CL
		2.5								
		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)				BFE (3.5')				CL
	3 4 4									3.5'
		3.5								CL
5		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)				Overex and Replace 3' (Engineered Fill)				CL
		5.0								6.5'
		Brown, mottled olive brown and gray LEAN CLAY (Possible FILL)				In-Situ Layer 1				
		8.5								8.5'
	3 4 4	Poorly graded sand (Possible FILL)								SP
10		10.0								
		Poorly graded sand (Possible FILL)								SP
						In-Situ Layer 2				
		13.5								SP
	2 7 7	Poorly graded sand (Possible FILL)								
15		15.0								SP
		Poorly graded sand (Possible FILL)								
		18.5								18.5'
	2 1 2	Dark brown, mottled dark gray LEAN CLAY (Possible FILL)								CL
20		20.0								CL
		Dark brown, mottled dark gray LEAN CLAY (Possible FILL)								
		23.5				In-Situ Layer 3				CL
	1 2 1	Dark brown, mottled dark gray silty LEAN CLAY (Possible FILL)								
25		25.0								CL
		Dark brown, mottled dark gray silty LEAN CLAY (Possible FILL)								
	GW at 28.5'									
		28.5				Assumed Critical Depth (28.5')				28.5'
	1 3 3	Brown, mottled gray silt								ML
30		30.0								ML
		Brown, mottled gray silt								
		33.5				In-Situ Layer 4				ML
	1 3 3	Brown, mottled gray sandy silt								
35		35.0								ML
		Brown, mottled gray sandy silt								

ROCSCIENCE

Port of Kansas - Structural Pad
GFT Infrastructure, Inc.
Report Creation Date: 2026/03/04, 14:47:33

By: BEH 03/26
Checked By: GSB 03/26

Table of Contents

By: BEH 03/26
Checked By: GSB 03/26

Settle3 Analysis Information

Port of Kansas - Structural Pad

Project Settings

Document Name	Port of Kansas_Settlement Analysis_Overex.s3z
Project Title	Port of Kansas - Structural Pad
Analysis	Settlement Evaluation with Overexcavation
Author	B. Harlacher
Company	GFT Infrastructure, Inc.
Date Created	3/2/2026, 4:46:06 PM
Last saved with Settle3 version	5.027
Stress Computation Method	Boussinesq
Stress Units	Imperial, stress as ksf
Settlement Units	inches

Advanced Settings

Start of secondary consolidation (% of primary)	95
Min. stress for secondary consolidation (% of initial)	1
Reset time when load changes for secondary consolidation	No
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Update Cv in each time step (improves consolidation accuracy)	
Ignore negative effective stresses in settlement calculations	
Add field points to load edges	

Soil Profile

Layer Option	Horizontal Soil Layers
Vertical Axis	Depth below ground surface

Stage Settings

Stage #	Name
1	Stage 1 - Existing
2	Stage 2 - Excavation
3	Stage 3 - Replacement (Type 5 with Geogrid)
4	Stage 4 - Foundation Load

By: BEH 03/26
Checked By: GSB 03/26

Results

Time taken to compute: 19.4574 seconds

Stage: Stage 1 - Existing

Data Type	Minimum	Maximum
Total Settlement [in]	0	0
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	0
Loading Stress ZZ [ksf]	0	0
Loading Stress XX [ksf]	0	0
Loading Stress YY [ksf]	0	0
Effective Stress ZZ [ksf]	0	8.04254
Effective Stress XX [ksf]	0	8.04254
Effective Stress YY [ksf]	0	8.04254
Total Stress ZZ [ksf]	0	12.4355
Total Stress XX [ksf]	0	12.4355
Total Stress YY [ksf]	0	12.4355
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0
Pore Water Pressure [ksf]	0	4.39296
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.020125	8.03395
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0

Stage: Stage 2 - Excavation

By: BEH 03/26
Checked By: GSB 03/26

Data Type	Minimum	Maximum
Total Settlement [in]	-1.05203	0
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	-1.05203	0
Loading Stress ZZ [ksf]	-0.4025	0
Loading Stress XX [ksf]	-0.248543	0.052352
Loading Stress YY [ksf]	-0.358076	0.0272659
Effective Stress ZZ [ksf]	-5.55112e-17	8.03655
Effective Stress XX [ksf]	0	8.05129
Effective Stress YY [ksf]	0	8.04511
Total Stress ZZ [ksf]	-5.55112e-17	12.4295
Total Stress XX [ksf]	0	12.4443
Total Stress YY [ksf]	0	12.4381
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00667562	0
Pore Water Pressure [ksf]	0	4.39296
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.048875	8.03395
Over-consolidation Ratio	1	10.3324
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0

Stage: Stage 3 - Replacement (Type 5 with Geogrid)

By: BEH 03/26
Checked By: GSB 03/26

Data Type	Minimum	Maximum
Total Settlement [in]	-1.05203	0
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	-1.05203	0
Loading Stress ZZ [ksf]	-0.4025	0
Loading Stress XX [ksf]	-0.248543	0.052352
Loading Stress YY [ksf]	-0.358076	0.0272659
Effective Stress ZZ [ksf]	-5.55112e-17	8.03655
Effective Stress XX [ksf]	0	8.05129
Effective Stress YY [ksf]	0	8.04511
Total Stress ZZ [ksf]	-5.55112e-17	12.4295
Total Stress XX [ksf]	0	12.4443
Total Stress YY [ksf]	0	12.4381
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00667562	0
Pore Water Pressure [ksf]	0	4.39296
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.048875	8.03395
Over-consolidation Ratio	1	10.3324
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0

Stage: Stage 4 - Foundation Load

By: BEH 03/26
Checked By: GSB 03/26

Data Type	Minimum	Maximum
Total Settlement [in]	0	3.26752
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	3.26752
Loading Stress ZZ [ksf]	0	2.85753
Loading Stress XX [ksf]	-8.0116	5.81442
Loading Stress YY [ksf]	-8.64165	5.15335
Effective Stress ZZ [ksf]	0	8.289
Effective Stress XX [ksf]	-4.5675	12.4617
Effective Stress YY [ksf]	-5.99274	12.0858
Total Stress ZZ [ksf]	0	12.682
Total Stress XX [ksf]	-4.5675	16.8546
Total Stress YY [ksf]	-5.99274	16.4787
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	16.094
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	16.094
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.000527769	0.0220437
Pore Water Pressure [ksf]	0	4.39296
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.048875	8.28078
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0.04765

Loads

1. Rectangular Load: "Rectangular Load 1"

Length	120 ft
Width	36 ft
Rotation angle	0 degrees
Load Type	Rigid
Area of Load	4320 ft2
Load	2 ksf
Depth	3.5 ft
Installation Stage	Stage 4 - Foundation Load

Coordinates

By: BEH 03/26
Checked By: GSB 03/26

X [ft]	Y [ft]
-10.017	40.047
109.983	40.047
109.983	76.047
-10.017	76.047

Excavations

1. Excavation: "Pad Excavation"

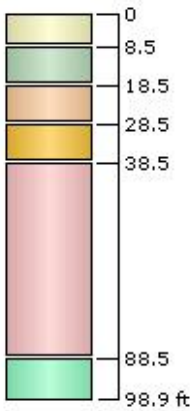
Depth	3.5 ft
Installation Stage	Stage 2 - Excavation

Coordinates

X [ft]	Y [ft]
-10.017	40.047
109.983	40.047
109.983	76.047
-10.017	76.047

Soil Layers

Layer #	Type	Thickness [ft]	Depth [ft]
1	In-Situ Layer 1	8.5	0
2	In-Situ Layer 2	10	8.5
3	In-Situ Layer 3	10	18.5
4	In-Situ Layer 4	10	28.5
5	In-Situ Layer 5	50	38.5
6	In-Situ Layer 6	10.4	88.5



Soil Properties

By: BEH 03/26
Checked By: GSB 03/26

Property	In-Situ Layer 1	In-Situ Layer 2	In-Situ Layer 3	In-Situ Layer 4
Color				
Unit Weight [kips/ft3]	0.115	0.12	0.105	0.115
Saturated Unit Weight [kips/ft3]	0.12	0.125	0.11	0.12
K0	1	1	1	1
Immediate Settlement	Enabled	Enabled	Enabled	Enabled
Es [ksf]	432	600.5	50	240.5
Esur [ksf]	432	600.5	50	240.5
Undrained Su A [kips/ft2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Property	In-Situ Layer 5	In-Situ Layer 6	Engineered Fill
Color			
Unit Weight [kips/ft3]	0.125	0.14	0.12
Saturated Unit Weight [kips/ft3]	0.13	0.145	0.125
K0	1	1	1
Immediate Settlement	Enabled	Enabled	Enabled
Es [ksf]	999.4	2000.2	2880
Esur [ksf]	999.4	2000.2	2880
Undrained Su A [kips/ft2]	0	0	0
Undrained Su S	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8
Piezo Line ID	1	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft3

Piezometric Line Entities

ID	Depth (ft)
1	28.5 ft

Ground Improvement Regions

Overexcavation and Replacement (Type 5 Aggregate with Geogrid)

By: BEH 03/26
Checked By: GSB 03/26

Area	4320 ft2
Type	Soil Replacement
Soil Property	Engineered Fill
Top Depth	3.5 ft
Bottom Depth	6.5 ft
Stage In	Stage 3 - Replacement (Type 5 with Geogrid)

Query

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
2	Query Point 1	2.231, 58.187	Auto: 71

Field Point Grid

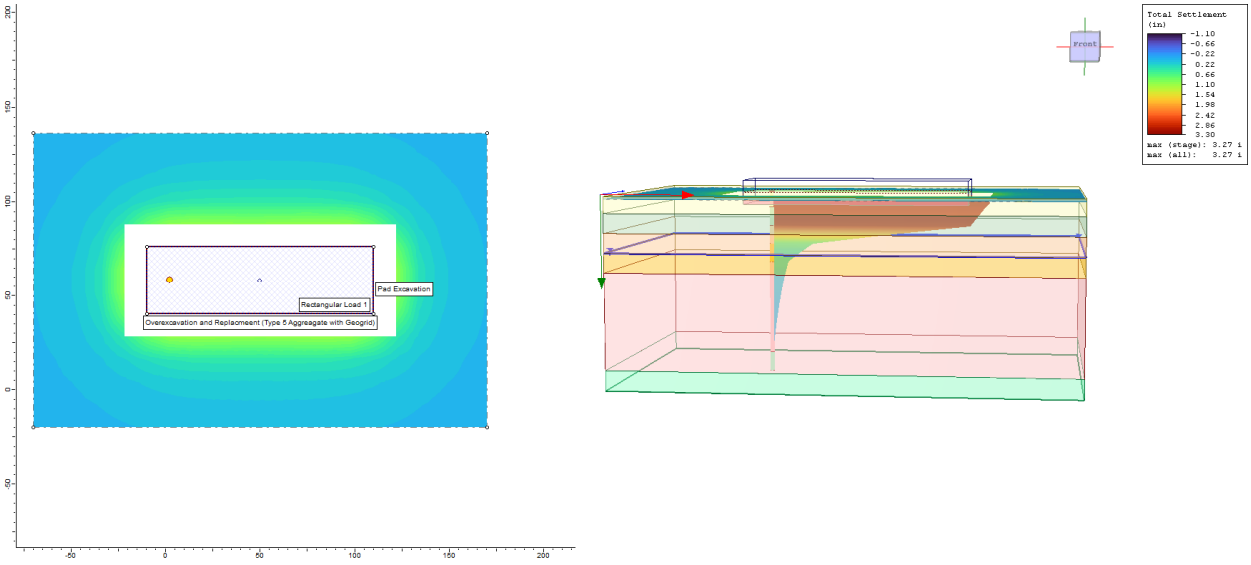
Number of points	294
Expansion Factor	2

Grid Coordinates

X [ft]	Y [ft]
169.983	136.047
169.983	-19.953
-70.017	-19.953
-70.017	136.047

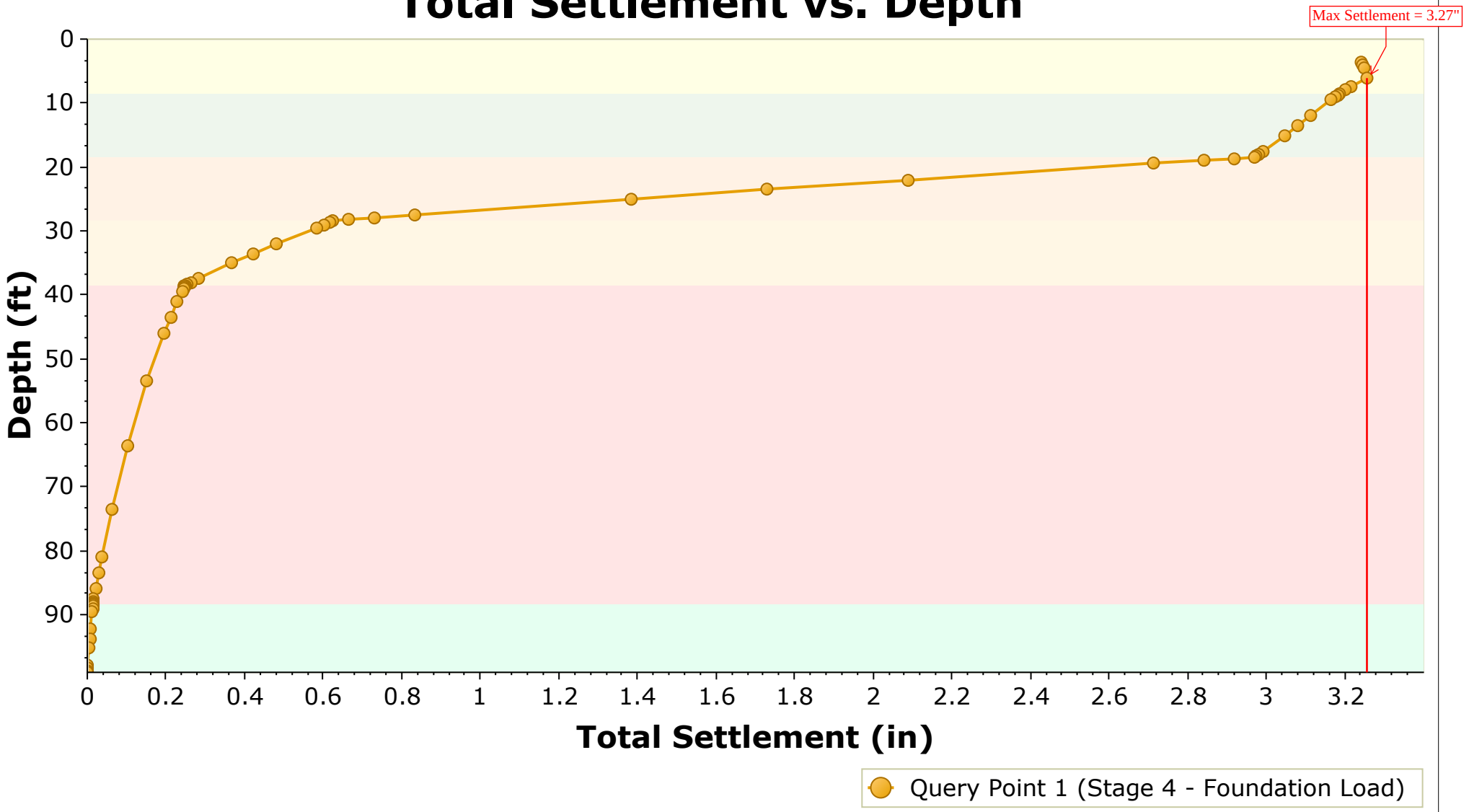
Report Views

Plan/3D View 1 1



By: BEH 03/26
Checked By: GSB 03/26

Total Settlement vs. Depth



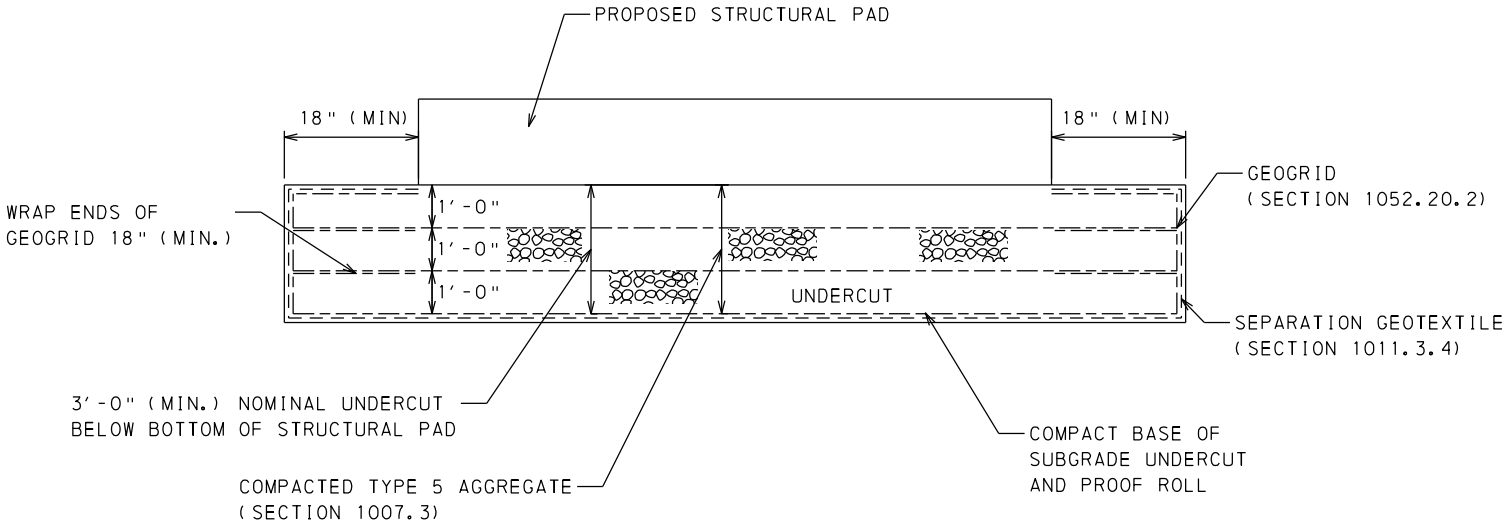
Reference Stage: Stage 1 - Existing

ROCSCIENCE	Project	Port of Kansas - Structural Pad	
	Analysis Description	Settlement Evaluation with Overexcavation	
	Drawn By	B. Harlacher	Company: GFT Infrastructure, Inc.
	Date	3/2/2026, 4:46:06 PM	File Name: Port of Kansas_Settlement Analysis_Overex.s3z

SETTLE3 5.027

APPENDIX D

Subgrade Undercut Typical Detail



SUBGRADE UNDERCUT DETAIL

NOT TO SCALE

CONSTRUCTION NOTES:

1. OVER-EXCAVATE A MINIMUM OF 3'-0" BELOW THE BOTTOM OF STRUCTURAL PAD. EXTEND THE EXCAVATION A MINIMUM OF 18" BEYOND THE EDGES OF THE PAD.

2. COMPACT THE SUBGRADE AND PERFORM A PROOF ROLL IN THE PRESENCE OF A QUALIFIED THIRD-PARTY INSPECTOR. DO NOT PERFORM THE PROOF ROLL WHEN THE SUBGRADE IS SATURATED. REMOVE ANY SOFT OR UNSUITABLE MATERIAL OBSERVED DURING THE PROOF ROLL AND REPLACE WITH COMPACTED TYPE 5 AGGREGATE TO THE BOTTOM OF SUBGRADE.

3. ONCE THE SUBGRADE HAS BEEN APPROVED, LINE THE EXCAVATION WITH SEPARATION GEOTEXTILE. OVERLAP STRIPS OF GEOTEXTILE A MINIMUM OF 12".

4. PLACE THE BOTTOM LAYER OF GEOGRID ON TOP OF THE SEPARATION GEOTEXTILE. OVERLAP STRIPS OF GEOGRID A MINIMUM OF 12". REMOVE SLACK FROM THE GEOGRID AND PIN AS NECESSARY. PLACE 12" OF COMPACTED TYPE 5 AGGREGATE OVER THE GEOGRID AND WRAP THE ENDS OF GEOGRID AROUND THE AGGREGATE A MINIMUM OF 18". A MINIMUM OF 6" OF TYPE 5 AGGREGATE IS TO BE PLACED ON GEOGRID BEFORE PERMITTING COMPACTION. LOOSE LIFTS OF TYPE 5 AGGREGATE SHALL NOT EXCEED 8" BEFORE COMPACTION.

5. PLACE ADDITIONAL LAYERS OF GEOGRID AND TYPE 5 AGGREGATE AS PREVIOUSLY DESCRIBED IN NOTE 4 UP TO THE BOTTOM OF STRUCTURAL PAD. GEOGRID LAYERS ARE TO BE SPACED 1'-0" VERTICALLY WITH THE TOP LAYER LOCATED 1'-0" BELOW THE BOTTOM OF STRUCTURAL PAD. A MINIMUM OF 3 LAYERS OF GEOGRID IS RECOMMENDED.

MATERIAL NOTES:

1. TYPE 5 AGGREGATE: MEETING THE REQUIREMENTS OF MODOT STANDARD SPECIFICATION 1007.3.

2. SEPARATION GEOTEXTILE: MEETING THE REQUIREMENTS OF MODOT STANDARD SPECIFICATION 1011.3.4.

3. GEOGRID: MEETING THE REQUIREMENTS OF MODOT STANDARD SPECIFICATION 1052.20.2.

ELECTRONICALLY RECORDED
JACKSON COUNTY, MISSOURI
06/29/2019 09:26:39 AM
COV FEE:$60.00 14PGS

INSTRUMENT NUMBER
2019E0049045

THIS SPACE FOR RECORDER'S USE ONLY

RECORDING REQUESTED BY
AND WHEN RECORDED MAIL TO: **KANSAS CITY PORT AUTHORITY, a public body and political subdivision of the State of Missouri, Attn: Mark Coulter, 110 Berkley Plaza, Kansas City, MO 64120**

Name of Document:	**SPECIAL WARRANTY DEED**
Grantor:	**THE CITY OF KANSAS CITY, MISSOURI, a municipal corporation of the State of Missouri, A/K/A Kansas City, Missouri Attn: Water Services Department, 4800 E 6rd St, Kansas City, MO 64130**
Grantee(s):	**KANSAS CITY PORT AUTHORITY, a public body and political subdivision of the State of Missouri, Attn: Mark Coulter, 110 Berkley Plaza, Kansas City, MO 64120**
Date of Document:	**As of** June 25, **2019**
Grantor's Mailing Address:	**See above**
Grantee's Mailing Address:	**See above**
Statutory Recording Reference:	**None**
Legal Description:	**All of Lots 36, 37, 38, 40, 41, 42, 43, 44, 46, 47, 48, 49, 50, 51, part of Lots 39 and 45 Block 11, together with part of vacated Market Street, together with all of Lots 1 and 2, together with part of Lot 23, Block 12 together with a part of Block 12, WOODSWETHER INDUSTRIAL DISTRICT (RESURVEY OF PART OF BLOCKS 11 & 12 WOODSWETHER INDUSTRIAL DISTRICT) a subdivision in Kansas City, Jackson County, Missouri**

When Recorded Return To: Thy Ha
First American Title Insurance Company
National Commercial Services
1201 Walnut, Suite 700
Kansas City, MO 64106
File No: NCS 925459

E-RECORDED simplifile
ID: 2019E0049045
County: Jackson
Date: 6-27-19 Time: 9:26:39 AM

THIS SPACE FOR RECORDER'S USE ONLY

RECORDING REQUESTED BY AND WHEN RECORDED MAIL TO: KANSAS CITY PORT AUTHORITY, a public body and political subdivision of the State of Missouri, Attn: Mark Coulter, 110 Berkley Plaza, Kansas City, MO 64120

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Grantee(s):	**KANSAS CITY PORT AUTHORITY, a public body and political subdivision of the State of Missouri, Attn: Mark Coulter, 110 Berkley Plaza, Kansas City, MO 64120**
Date of Document:	**As of** June 25**, 2019**
Grantor's Mailing Address:	**See above**
Grantee's Mailing Address:	**See above**
Statutory Recording Reference:	**None**
Legal Description:	**All of Lots 36, 37, 38, 40, 41, 42, 43, 44, 46, 47, 48, 49, 50, 51, part of Lots 39 and 45 Block 11, together with part of vacated Market Street, together with all of Lots 1 and 2, together with part of Lot 23, Block 12 together with a part of Block 12, WOODSWETHER INDUSTRIAL DISTRICT (RESURVEY OF PART OF BLOCKS 11 & 12 WOODSWETHER INDUSTRIAL DISTRICT) a subdivision in Kansas City, Jackson County, Missouri**

When Recorded Return To: T Hyden
First American Title Insurance Company
National Commercial Services
1201 Walnut, Suite 700
Kansas City, MO 64106
File No: NCS 925459

SPECIAL WARRANTY DEED

THE CITY OF KANSAS CITY, MISSOURI a Municipal home rule charter City of the State of MISSOURI, a/k/a Kansas City, Missouri, **GRANTOR**, with a business address for this purpose of Kansas City Water Services Department, Attn: Office of the Director and Attn: Office of the City Manager, 4800 E. 63rd St, Kansas City, Missouri, 64130 for a consideration of One and No/100 Dollars (receipt of which is hereby acknowledged) and other valuable consideration including the future redevelopment of the property, by this Special Warranty Deed does by these presents SELL and CONVEY unto **KANSAS CITY PORT AUTHORITY**, a public body and political subdivision of the State of Missouri, as **GRANTEE**, its successors and assigns, whose mailing address is 300 Wyandotte St, Suite 100, Kansas City, Missouri 64105, the following described land in Kansas City, Jackson County, Missouri, to wit:

All of Lots 36, 37, 38, 40, 41, 42, 43, 44, 46, 47, 48, 49, 50, 51, part of Lots 39 and 45 Block 11, together with part of vacated Market Street, together with all of Lots 1 and 2, together with part of Lot 23, Block 12 together with a part of Block 12, WOODSWETHER INDUSTRIAL DISTRICT (RESURVEY OF PART OF BLOCKS 11 & 12 WOODSWETHER INDUSTRIAL DISTRICT) a subdivision in Kansas City, Jackson County, Missouri more particularly described as follows:

BEGINNING AT THE SOUTHEAST CORNER OF LOT 51, SAID BLOCK 11, SAID POINT BEING THE BEGINNING OF A NON-TANGENT CURVE CONCAVE TO THE NORTHEAST HAVING A RADIUS OF 1571.38 FEET AND AN INITIAL TANGENT BEARING OF N64'37'45"W; THENCE NORTHWESTERLY 97.42 FEET ALONG SAID CURVE AND SOUTH LINE OF LOTS 51, 50 AND 49 THROUGH A CENTRAL ANGLE OF 3'33'08"; THENCE N61'04'38"W ALONG THE SOUTH LINE OF LOTS 49 AND 48, A DISTANCE OF 54.21 FEET TO THE BEGINNING OF A CURVE CONCAVE TO THE SOUTHWEST HAVING A RADIUS OF 1571.38 FEET, TANGENT TO THE LAST DESCRIBED COURSE; THENCE NORTHWESTERLY ALONG THE SOUTH LINE OF LOTS 48, 47 AND 46, A DISTANCE OF 119.16 FEET (PLAT=119.52 FEET) ALONG SAID CURVE THROUGH A CENTRAL ANGLE OF 4'20'41" TO THE SOUTHWEST CORNER OF LOT 46, SAID BLOCK 11; THENCE N23'09'49"E ALONG THE WEST LINE OF SAID LOT 46, A DISTANCE OF 8.71 FEET TO THE BEGINNING OF A NON-TANGENT CURVE CONCAVE TO THE SOUTHWEST HAVING A RADIUS OF 1580.09 FEET AND AN INITIAL TANGENT BEARING OF N65'25'47"W; THENCE NORTHWESTERLY 40.01FEET (PLAT=40.00 FEET) ALONG SAID CURVE THROUGH A CENTRAL ANGLE OF 1'27'02"; THENCE N66'52'50"W TANGENT TO THE LAST DESCRIBED CURVE, A DISTANCE OF 4.99 FEET (PLAT=5.00 FEET) TO A POINT ON THE WEST LINE OF LOT 45, SAID BLOCK 11; THENCE S23'09'55"W ALONG SAID WEST LINE, A DISTANCE OF 8.71 FEET TO THE SOUTHWEST CORNER OF SAID LOT 45; THENCE N66'52'50"W ALONG THE SOUTH LINE OF LOTS 44, 43, 42, 41, AND 40, ALL IN SAID BLOCK 11, A DISTANCE OF 225.00 FEET TO THE SOUTHWEST CORNER OF SAID LOT 40; THENCE N23'10'07"E ALONG THE WEST LINE OF SAID LOT 40, A DISTANCE OF 45.52 FEET TO A POINT ON THE PERMANENT NORTH LINE OF LEVEE AS ESTABLISHED BY CONDEMNATION ORDINANCE #9046 PASSED MARCH 12TH, 1945; THENCE N45'22'40"W ALONG SAID NORTH LINE, A DISTANCE OF 48.35 FEET TO A POINT ON THE WEST LINE OF LOT 39, SAID BLOCK 11; THENCE S23'10'20"W ALONG THE WEST LINE OF SAID LOT 39, A DISTANCE OF 63.24 FEET TO THE SOUTHEAST CORNER OF LOT 38, SAID BLOCK 11; THENCE N66'52'50"W ALONG THE SOUTH LINE OF LOTS 38, 37 AND 36, SAID BLOCK 11, A DISTANCE OF 135.00 FEET TO THE SOUTHWEST CORNER OF SAID LOT 36; THENCE N23'10'23"E ALONG THE WEST LINE OF SAID LOT 36 AND THE NORTHERLY PROLONGATION THEREOF, A DISTANCE OF 137.33 FEET (RECORD=137.32 FEET) TO THE CENTERLINE OF VACATED MARKET STREET; THENCE N65'59'30"W ALONG SAID CENTERLINE, A DISTANCE OF 208.71 FEET TO THE NORTHERLY PROLONGATION OF THE EAST LINE OF STATE STREET AS IT NOW EXISTS; THENCE N24'00'30"E ALONG SAID NORTHERLY PROLONGATION, A DISTANCE OF 21.50 FEET TO A POINT ON THE SOUTH LINE OF LOT 23, SAID BLOCK 12; THENCE N65'59'30"W ALONG SAID SOUTH LINE, A DISTANCE OF 142.49 FEET TO THE MOST SOUTHERLY SOUTHWEST CORNER OF SAID LOT 23; THENCE N53'36'04"W ALONG THE SOUTHERLY LINE OF SAID LOT 23, A DISTANCE OF 17.06 FEET (PLAT=17.15 FEET) TO THE MOST WESTERLY CORNER OF SAID LOT 23; THENCE S73'59'23"E ALONG THE NORTHERLY LINE OF SAID LOT 23, A DISTANCE OF 95.87 FEET (PLAT=95.94 FEET); THENCE S65'59'30"E CONTINUING ALONG SAID NORTHERLY LINE, A DISTANCE OF 148.49 FEET TO THE MOST EASTERLY CORNER OF LOT 4, SAID BLOCK 12 SAID POINT BEING THE BEGINNING OF A NON-TANGENT CURVE CONCAVE TO THE NORTHEAST HAVING A RADIUS OF 955.00 FEET AND AN INITIAL TANGENT BEARING OF N65'59'30"W; THENCE NORTHWESTERLY 206.45 FEET ALONG SAID CURVE AND ALONG THE NORTHERLY LINE OF SAID LOT 4, THROUGH A CENTRAL ANGLE OF 12'23'10"; THENCE N53'36'20"W

CONTINUING ALONG THE NORTHERLY LINE OF SAID LOT 4, A DISTANCE OF 116.81 FEET (PLAT=116.94 FEET) TO A POINT ON THE STATE LINE BETWEEN MISSOURI AND KANSAS; THENCE N00'23'14"W ALONG SAID STATE LINE, A DISTANCE OF 413.82 FEET (PLAT=415.62 FEET) TO A POINT ON THE HARBOR LINE ON THE RIGHT BANK OF THE MISSOURI RIVER AS ESTABLISHED BY THE WAR DEPARTMENT IN 1904 SAID POINT BEING THE BEGINNING OF A NON-TANGENT CURVE CONCAVE TO THE SOUTHWEST HAVING A RADIUS OF 10,338.80 FEET AND AN INITIAL TANGENT BEARING OF S46'09'43"E; THENCE SOUTHEASTERLY 414.36 FEET (PLAT=414.02 FEET) TO THE BEGINNING OF A REVERSE CURVE CONCAVE TO THE NORTHEAST HAVING A RADIUS OF 3375.00 FEET; THENCE SOUTHEASTERLY 977.90 FEET CONTINUING ALONG SAID HARBOR LINE AND ALONG SAID CURVE THROUGH A CENTRAL ANGLE OF 16'36'05" TO THE WEST RIGHT OF WAY LINE OF LIBERTY STREET AS IT NOW EXISTS; THENCE S23'09'21"W ALONG SAID WEST RIGHT OF WAY LINE, A DISTANCE OF 228.00 FEET (PLAT=229.73 FEET) TO THE POINT OF BEGINNING, SAID TRACT CONTAINING 350,559 SQUARE FEET OR 8.048 ACRES MORE OR LESS.

Subject to building lines, easements, reservations, restrictions, covenants and conditions of record, and to any zoning laws or ordinance affecting the foregoing real estate, including, but not limited to the Grantor retained interest as a municipality in the recorded easements or ordinances which are not merged in or extinguished by this conveyance.

Further, Grantor specifically reserves and Grantee specifically accepts the conveyance subject to easements for the purpose of location, construction, operation, maintenance, repair, use, and access of sewer lines, outfalls, facilities, appurtenances and related improvements as may be currently situated or needed by KCMO in the future, all as more fully set forth on **Exhibits B, C and D** attached hereto and incorporated by reference.

Further, The Grantor hereby reserves an easement for utilities and railroad facilities constructed and currently installed on the Property, such easement being for the use of Kansas City, Missouri, and with Kansas City's permission, railroad and utility companies franchised to operate in Kansas City, Missouri, to locate, construct, reconstruct, operate, repair and maintain facilities including, but not limited to, railroad, gas, electricity, drainage, underground conduits, pad mounted transformers, service pedestals, poles, pipes, ducts and wires, any and all of them upon, over, under and along the property situate in Kansas City, Jackson County, Missouri, where existing utilities are now located and such area adjacent thereto as reasonably necessary for the purpose of constructing, maintaining and repairing the existing utility improvements and appurtenances thereto. Notwithstanding the foregoing, Exhibits B, C, and D reflect the only wastewater and levee related easements to be reserved herein and there are no water line easements being specifically reserved in those exhibits.

Further subject to the following restrictive covenants, that the Grantee as to the Property hereby conveyed, for the Grantee and the Grantee's successors and assigns and with the intent to bind all persons in whom the Property hereby conveyed shall at any time be vested, hereby covenants with the Grantor and its successors and assigns that 1724 Market and its appurtenances shall be used, maintained and operated in conformance with the provisions of Section 68.025 RSMO.

TO HAVE AND TO HOLD the property with together with appurtenances belonging or in any way pertaining to the property, unto said Grantee, its successors and assigns, forever, subject to all encumbrances of record and any encumbrances that would be shown by a survey or visual inspection of the property.

THE CITY OF KANSAS CITY, MISSOURI covenants that the property is free and clear of any encumbrance to it, except those to which the property is subjected to and listed above or otherwise ascertainable through a title commitment, and that it will warrant and defend the title to the property unto Grantee and its successors and assigns forever, against the lawful claims and demands of all persons claiming under it.

THE CITY OF KANSAS CITY, MISSOURI has caused this Special Warranty Deed to be subscribed by its Director of Water Services, Terry Leeds, attested by the City Clerk this 25 day of June, 2019, both acting pursuant to Ordinance No. 190203 passed March 28, 2019.

By: CITY OF KANSAS CITY, MISSOURI
A/K/A Kansas City, Missouri
By and Through its Director of Water Services

Terry Leeds

Attested by:

Marilyn Sanders, City Clerk

Approved as to Form:

Charlotte Ferns, Assistant City Attorney

ACKNOWLEDGMENT

STATE OF MISSOURI)
) ss
COUNTY OF JACKSON)

On this 25th day of June, 2019, before the undersigned, Notary Public, personally appeared Terry Leeds and being duly sworn, did say that he is the Director of Water Services for The City of Kansas City, Missouri, A/K/A Kansas City, Missouri and that the Special Warranty Deed was signed on behalf of The City of Kansas City, Missouri by authority of Ordinance Number 190203 and he acknowledged the instrument to be the free act and deed of The City of Kansas City, Missouri.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal at my office in Kansas City, the day and year last above written.

RICHARD N. SNEDEGAR
Notary Public - Notary Seal
State of Missouri
Commissioned for Jackson County
My Commission Expires: April 14, 2022
Commission Number: 14604913

Notary Public

SEAL

My Commission Expires: April 14, 2022

ACKNOWLEDGMENT

STATE OF MISSOURI)
) ss
COUNTY OF JACKSON)

On this 25 day of June, 2019, before the undersigned, Notary Public, personally appeared Marilyn Sanders and being duly sworn, did say that she is the City Clerk of The City of Kansas City, Missouri, and that the Special Warranty Deed was attested to on behalf of The City of Kansas City, Missouri by authority of Ordinance Number 190203 and the acknowledged the instrument to be the free act and deed of the City of Kansas City, Missouri.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal at my office in Kansas City, the day and year last above written.

Notary Public

SEAL

KRISTY CHERI TYSON PUGH
Notary Public - Notary Seal
Jackson County - State of Missouri
Commission Number 14973498
My Commission Expires Sep 3, 2022

My Commission Expires: September 3, 2022

Acceptance of Property

It is understood and agreed that Grantee or Grantee's representative, has conducted whatever inspections of the Property that Grantee has deemed appropriate. Grantee by acceptance of this Special Warranty Deed takes the Property "as is" and "where is." The Grantee acknowledges that such Property may have received minimal maintenance over an extended period of time and may contain hazardous conditions, which in most instances would be unknown to Grantor, and Grantor's representatives, employees or agents.

Grantor, has obtained and shared with Grantee a title report prepared by First American Title Insurance Company, but for itself, its employees and agents has not searched the records for subordinate property interests, such as easements or liens. Sale of the property is "as is" and "where is" without any guarantees as to condition or location or interests such as easements. The Grantee shall have no recourse against Grantor for any defects to title that should have been disclosed by a title commitment obtained by Grantee, whether or not one was obtained or disclosed.

Grantee hereby waives any and all claims that it has or may have in the future against the Grantor, its officers, employees, contractors, volunteers, agents, representatives, successors and assigns (who are collectively referred to in the rest of this document as the "Releasees") and release the Releasees from any and all liability for any loss, damage, expense or injury that Grantee may suffer as a result of conditions on the property, including environmental conditions.

The Grantee further acknowledges that the Grantor is reserving easements as more fully set forth on Exhibits B, C and D for the purpose of location, construction, operation, maintenance, repair, use, and access of sewer lines, outfalls, facilities, appurtenances and related improvements as may be currently situated or needed by KCMO in the future and for activities associated with the levee. The easements shall be reserved for the primary and dominant use of KCMO, however, KCMO shall utilize such easements in a manner so as not to unreasonably interfere with the Port Authority's development and use of 1724 Market for its port operations. Notwithstanding the foregoing, the parties acknowledge and agree that KCMO's facilities currently located within the easements and those which may be located there in the future are critical to KCMO's operations, and any future development of the site shall not compromise their operation or integrity. The Grantee acknowledges and agrees for itself and its heirs, successors, or assigns, that no change in the earth cover over the permanent easements reserved by the GRANTOR, will be made without the written approval of the Director. Grantee further acknowledges that Grantor is reserving easements necessary to accommodate existing utilities and railroad right of way as provided herein.

IN WITNESS WHEREOF, Grantee by and through its duly authorized manager vested with authority to manage the Grantee, has accepted this Special Warranty Deed the day and year first above written.

KANSAS CITY PORT AUTHORITY

By: _____
Jon Stephens

ATTEST:

By: _____
Brian Rabineau

PORT AUTHORITY
CORPORATE SEAL
OF KANSAS CITY, MO

STATE OF MISSOURI)
) ss
COUNTY OF JACKSON)

On this 25th day of JUNE, 2019 before me appeared JON STEPHENS, to me personally known, and who, being by me duly sworn, did say that he/she is PRESIDENT / CEO of the Kansas City Port Authority, and that this instrument was signed in behalf of said municipal corporation by authority duly conferred upon him/her.

In Testimony Whereof, I have hereunto set my hand and affixed my official seal the day and year last above written.

JOLENE M. MEAD
Notary Public, Notary Seal
State of Missouri
Jackson ~~Clay~~ County
Commission # 14610421
My Commission Expires 04-29-2022

_____
Notary Public

Jolene M. Mead
(Printed Name)

My Commission Expires:
April 29, 2022

EASEMENTS TO WHICH THE PROPERTY EXPRESSLY SUBJECT

See attached

EXHIBIT B

FLOOD WALL MAINTENANCE EASEMENT DESCRIPTION:

ALL THAT PART OF LOTS 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 AND 51, BLOCK 11, WOODSWETHER INDUSTRIAL DISTRICT (RESURVEY OF PART OF BLOCKS 11 & 12 WOODSWETHER INDUSTRIAL DISTRICT) A SUBDIVISION IN KANSAS CITY, JACKSON COUNTY, MISSOURI MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF SAID LOT 51, BLOCK 11, SAID POINT BEING ON THE WEST RIGHT-OF-WAY LINE OF LIBERTY STREET AS IT NOW EXISTS; THENCE N23°09'21"E, ALONG THE WEST RIGHT-OF-WAY LINE OF SAID LIBERTY STREET, 11.48 FEET TO THE NORTHERLY LINE OF A TRACT OF LAND CONDEMNED FOR LEVEE PURPOSES BY ORDINANCE NO. 9046, PASSED MARCH 12, 1945, SAID POINT BEING THE POINT OF BEGINNING; THENCE ALONG THE NORTHERLY LINE OF SAID TRACT OF LAND THE FOLLOWING COURSES AND DISTANCES: N65°27'10"W, 50.76 FEET; THENCE N62°21'10"W, 83.62 FEET; THENCE N61°28'10"W, 84.23 FEET; THENCE N64°43'10"W, 84.54 FEET; THENCE N67°03'10"W, 146.49 FEET; THENCE N45°22'40"W, 24.37 FEET; THENCE LEAVING THE NORTHERLY LINE OF SAID TRACT OF LAND, S67°03'10"E, 169.32 FEET; THENCE S64°43'10"E, 84.97 FEET; THENCE S61°28'10"E, 84.41 FEET; THENCE S62°21'10"E, 83.30 FEET; THENCE S65°27'10"E, 50.30 FEET TO THE WEST RIGHT-OF-WAY LINE OF SAID LIBERTY STREET; THENCE S23°09'21"W, ALONG SAID WEST RIGHT-OF-WAY LINE, 9.00 FEET TO THE POINT OF BEGINNING, SAID TRACT CONTAINING 4,149 SQUARE FEET MORE OR LESS.

STATE OF MISSOURI
RICKY E. GARD
NUMBER LS-2069
REGISTERED LAND SURVEYOR

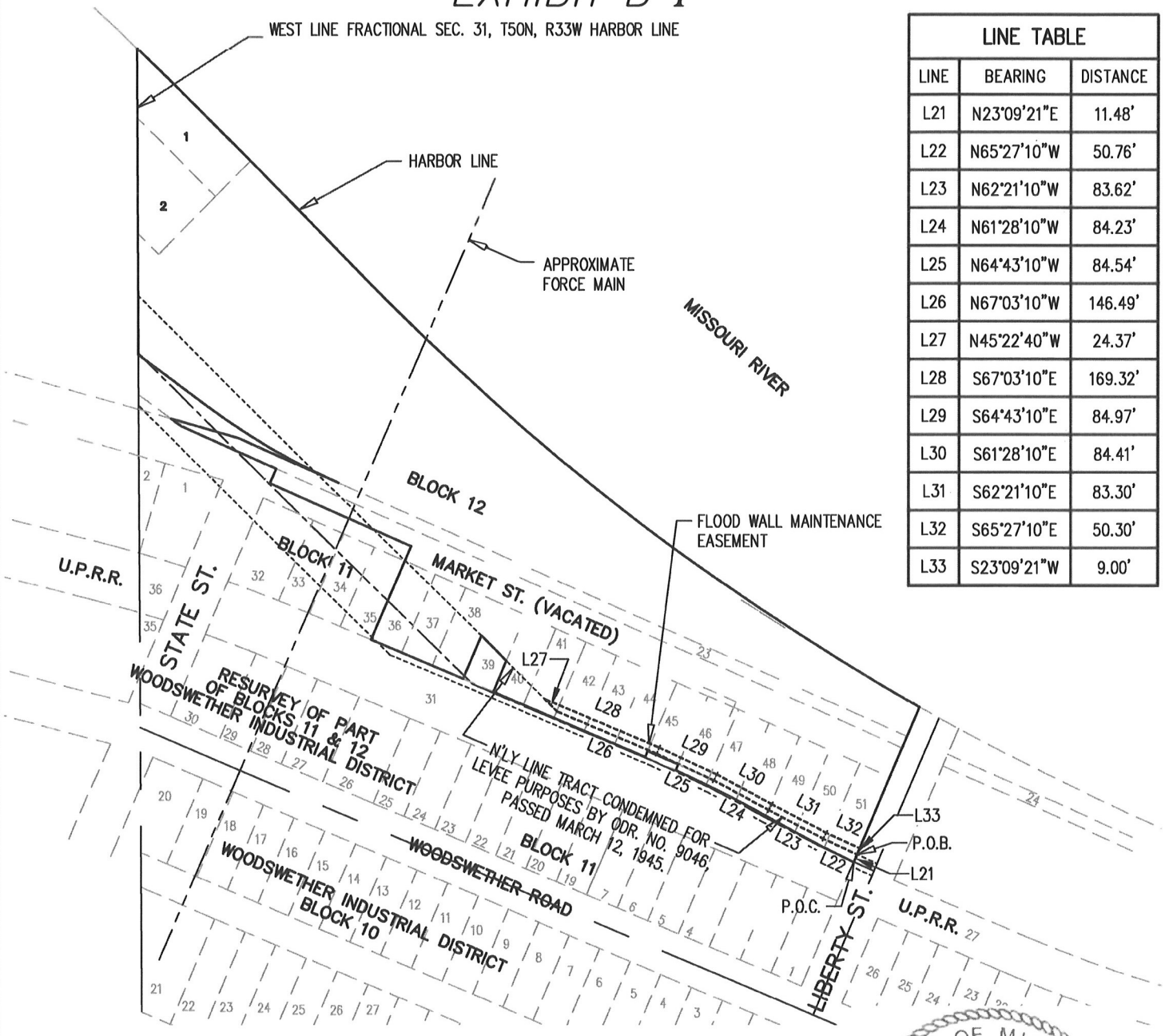
8-22-2018

PART OF BLOCKS 11 AND 12, WOODSWETHER INDUSTRIAL DISTRICT KANSAS CITY, JACKSON COUNTY, MISSOURI FLOOD WALL MAINTENANCE EASEMENT	
DRAWN: M.T.I. CHECKED: V.A.H.	DATE: 8/10/2018

TALIAFERRO & BROWNE, INC.
CONSULTING ENGINEERS-SURVEYORS
1020 EAST 8TH ST., KANSAS CITY, MO, 64106
PH: (816) 283-3456 FAX: (816) 283-0841

S:\NETJOB\09-0750-001-WOODSWETHER INDUSTUSTRIAL DISTRICT-LIBERTY STREET\DWG (WORKING) 09-0750V-LC01.DWG, Flood Wall Easement Exhibit A and B, EXHIBIT A

EXHIBIT B-1



LINE TABLE		
LINE	BEARING	DISTANCE
L21	N23°09'21"E	11.48'
L22	N65°27'10"W	50.76'
L23	N62°21'10"W	83.62'
L24	N61°28'10"W	84.23'
L25	N64°43'10"W	84.54'
L26	N67°03'10"W	146.49'
L27	N45°22'40"W	24.37'
L28	S67°03'10"E	169.32'
L29	S64°43'10"E	84.97'
L30	S61°28'10"E	84.41'
L31	S62°21'10"E	83.30'
L32	S65°27'10"E	50.30'
L33	S23°09'21"W	9.00'

N
W E
S

FLOOD WALL EASEMENT AREA= 4,149 SQ. FT. MORE OR LESS

0' 100' 200'
1" = 200'

STATE OF MISSOURI
RICKY E. GARD NUMBER LS-2069
REGISTERED LAND SURVEYOR

8-22-2018

PART OF BLOCKS 11 AND 12,
WOODSWETHER INDUSTRIAL DISTRICT
KANSAS CITY, JACKSON COUNTY, MISSOURI
FLOOD WALL MAINTENANCE EASEMENT

DRAWN: M.T.I.
CHECKED: V.A.H.

DATE: 8/10/2018

TALIAFERRO & BROWNE, INC.
CONSULTING ENGINEERS-SURVEYORS
1020 EAST 8TH ST., KANSAS CITY, MO, 64106
PH: (816) 283-3456 FAX: (816) 283-0841

S:\NETJOB\09-0750-001-WOODSWETHER INDUSTUSTRIAL DISTRICT-LIBERTY STREET\DWG (WORKING)
09-0750V-LC01.DWG, Flood Wall Easement Exhibit A and B, EXHIBIT B

EXHIBIT C

FORCE MAIN EASEMENT DESCRIPTION:

ALL THAT PART OF BLOCK 12, ALL OF LOTS 36, 37, 38 AND PART OF LOT 39, BLOCK 11, AND PART OF LOT 23, BLOCK 12, TOGETHER WITH PART OF VACATED MARKET STREET, WOODSWETHER INDUSTRIAL DISTRICT (RESURVEY OF PART OF BLOCKS 11 & 12 WOODSWETHER INDUSTRIAL DISTRICT) A SUBDIVISION IN KANSAS CITY, JACKSON COUNTY, MISSOURI MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT THE SOUTHEAST CORNER OF SAID LOT 38, BLOCK 11; THENCE N66°52'50"W, ALONG THE SOUTH LINE OF LOTS 38, 37 AND 36, SAID BLOCK 11, A DISTANCE OF 135.00 FEET TO THE SOUTHWEST CORNER OF SAID LOT 36; THENCE N23°10'23"E, ALONG THE WEST LINE OF SAID LOT 36 AND THE NORTHERLY PROLONGATION THEREOF, A DISTANCE OF 137.33 FEET (RECORD=137.32 FEET) TO THE CENTERLINE OF VACATED MARKET STREET; THENCE N65°59'30"W, ALONG SAID CENTERLINE, A DISTANCE OF 123.99 FEET; THENCE N25°01'51"E, 272.49 FEET TO THE HARBOR LINE ON THE RIGHT BANK OF THE MISSOURI RIVER AS ESTABLISHED BY THE WAR DEPARTMENT IN 1904; THENCE IN A SOUTHEASTERLY DIRECTION, ALONG SAID HARBOR LINE, ALONG A CURVE TO THE LEFT, HAVING A RADIUS OF 3375.00 FEET THROUGH A CENTRAL ANGLE OF 005°05'35", WITH AN INITIAL TANGENT BEARING OF S45°50'13"E, AN ARC DISTANCE OF 300.00 FEET; THENCE S30°53'53"W, A DISTANCE OF 255.56 FEET TO THE WEST LINE OF LOT 39, SAID BLOCK 11; THENCE S23°10'20"W, ALONG THE WEST LINE OF SAID LOT 39, A DISTANCE OF 63.24 FEET TO THE POINT OF BEGINNING, SAID TRACT CONTAINING 81,662 SQUARE FEET MORE OR LESS.

8-22-2018

PART OF BLOCKS 11 AND 12, WOODSWETHER INDUSTRIAL DISTRICT KANSAS CITY, JACKSON COUNTY, MISSOURI FORCE MAIN EASEMENT	
DRAWN: M.T.I. CHECKED: V.A.H.	*DATE: 8/10/2018*

TALIAFERRO & BROWNE, INC.
CONSULTING ENGINEERS-SURVEYORS
1020 EAST 8TH ST., KANSAS CITY, MO, 64106
PH: (816) 283-3456 FAX: (816) 283-0841

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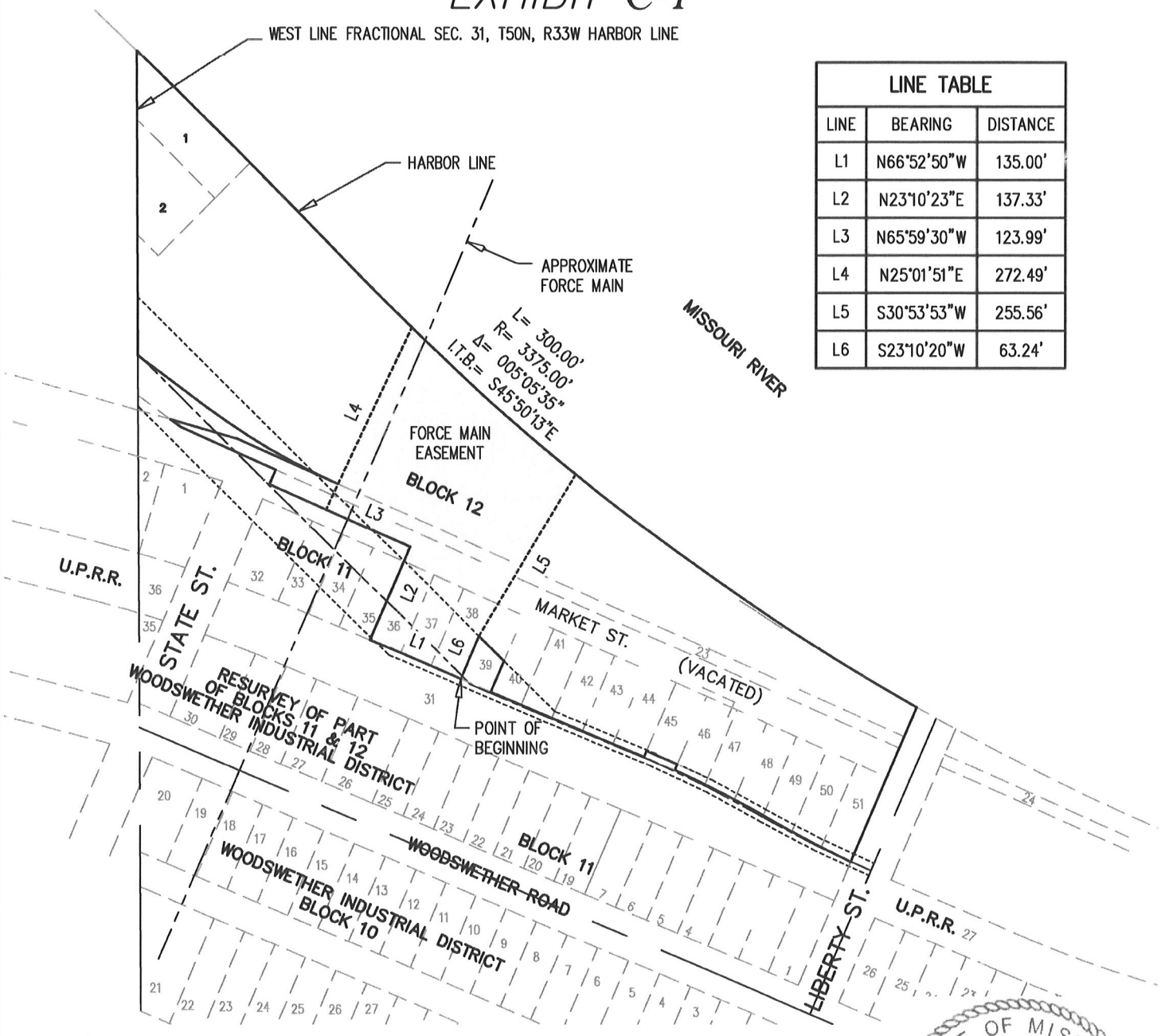
EXHIBIT C-1



LINE TABLE		
LINE	BEARING	DISTANCE
L1	N66°52'50"W	135.00'
L2	N23°10'23"E	137.33'
L3	N65°59'30"W	123.99'
L4	N25°01'51"E	272.49'
L5	S30°53'53"W	255.56'
L6	S23°10'20"W	63.24'

N
W E
S

FORCE MAIN EASEMENT AREA= 81,662 SQ. FT. MORE OR LESS

0' 100' 200'

1" = 200'

STATE OF MISSOURI
RICKY E. GARD
NUMBER LS-2069
REGISTERED LAND SURVEYOR

8-22-2018

PART OF BLOCKS 11 AND 12,
WOODSWETHER INDUSTRIAL DISTRICT
KANSAS CITY, JACKSON COUNTY, MISSOURI
FORCE MAIN EASEMENT

DRAWN: M.T.I.
CHECKED: V.A.H.

DATE: 8/10/2018

TALIAFERRO & BROWNE, INC.
CONSULTING ENGINEERS-SURVEYORS
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EXHIBIT D

TRACT A OUTFALL EASEMENT DESCRIPTION:

ALL THAT PART OF BLOCK 12, PART OF LOTS 40 AND 41, BLOCK 11, AND PART OF LOT 23, BLOCK 12, TOGETHER WITH PART OF VACATED MARKET STREET, WOODSWETHER INDUSTRIAL DISTRICT (RESURVEY OF PART OF BLOCKS 11 & 12 WOODSWETHER INDUSTRIAL DISTRICT) A SUBDIVISION IN KANSAS CITY, JACKSON COUNTY, MISSOURI MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHWEST CORNER OF SAID LOT 40, BLOCK 11; THENCE S66°52'50"E, ALONG THE SOUTH LINE OF SAID LOT 40, A DISTANCE OF 9.19 FEET TO THE POINT OF BEGINNING; THENCE N23°16'57"E, 310.68 FEET TO THE HARBOR LINE ON THE RIGHT BANK OF THE MISSOURI RIVER AS ESTABLISHED BY THE WAR DEPARTMENT IN 1904; THENCE IN A SOUTHEASTERLY DIRECTION, ALONG SAID HARBOR LINE, ALONG A CURVE TO THE LEFT, HAVING A RADIUS OF 3375.00 FEET THROUGH A CENTRAL ANGLE OF 000°52'43", WITH AN INITIAL TANGENT BEARING OF S51°17'24"E, AN ARC DISTANCE OF 51.76 FEET; THENCE S23°16'57"W, A DISTANCE OF 297.15 FEET TO THE SOUTH LINE OF SAID LOT 41, BLOCK 11; THENCE N66°52'50"W, ALONG THE SOUTH LINE OF SAID LOTS 40 AND 41, A DISTANCE OF 50.00 FEET TO THE POINT OF BEGINNING, SAID TRACT CONTAINING 15,192 SQUARE FEET MORE OR LESS.

TRACT B OUTFALL EASEMENT DESCRIPTION:

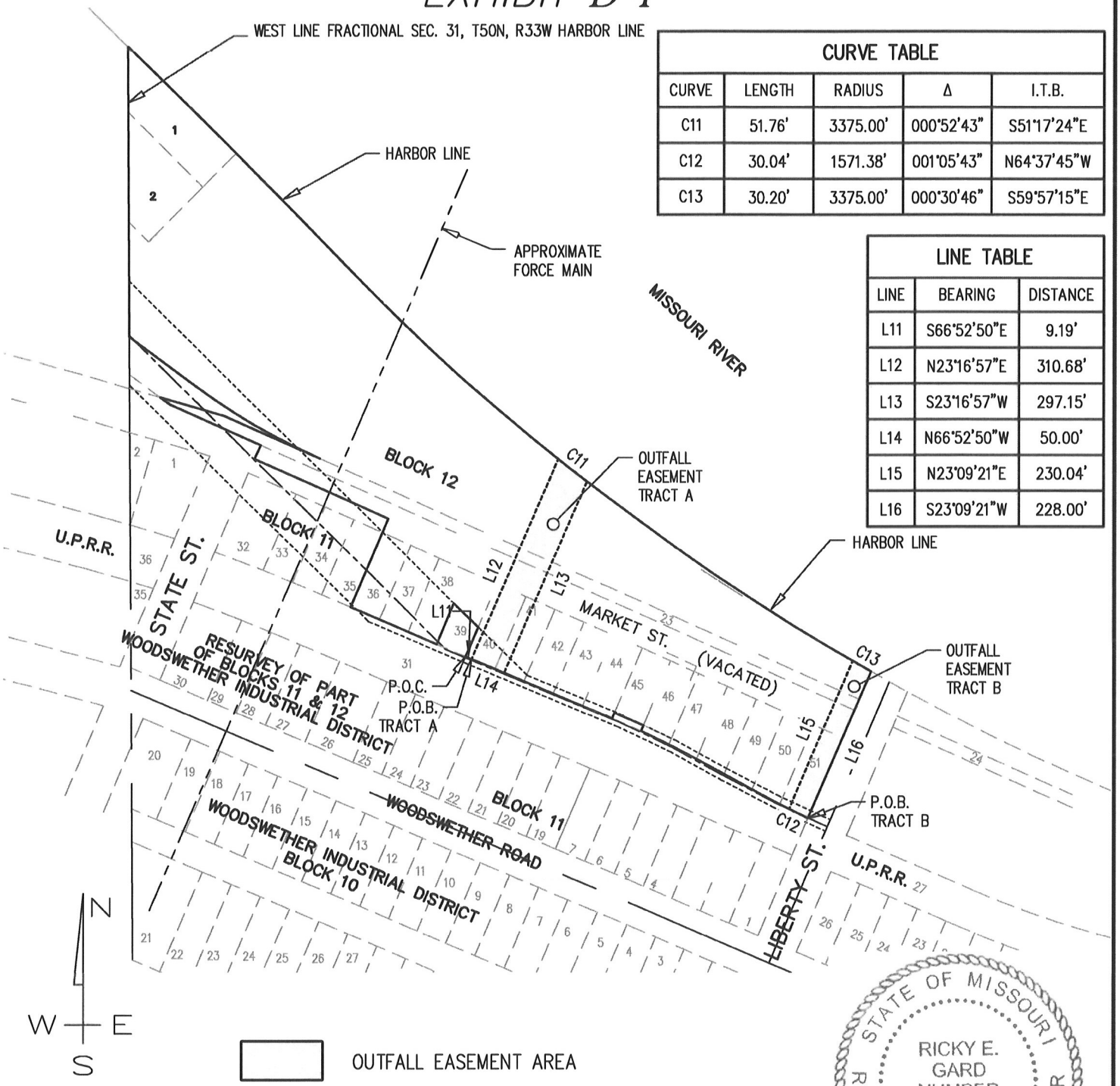
ALL THAT PART OF BLOCK 12, PART OF LOT 51, BLOCK 11, AND PART OF LOT 23, BLOCK 12, TOGETHER WITH PART OF VACATED MARKET STREET, WOODSWETHER INDUSTRIAL DISTRICT (RESURVEY OF PART OF BLOCKS 11 & 12 WOODSWETHER INDUSTRIAL DISTRICT) A SUBDIVISION IN KANSAS CITY, JACKSON COUNTY, MISSOURI MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT THE SOUTHEAST CORNER OF LOT 51, SAID BLOCK 11; THENCE IN A NORTHWESTERLY DIRECTION, ALONG THE SOUTH LINE OF SAID LOT 51, ALONG A CURVE TO THE RIGHT, HAVING A RADIUS OF 1571.38 FEET THROUGH A CENTRAL ANGLE OF 001°05'43", WITH AN INITIAL TANGENT BEARING OF N64°37'45"W, AN ARC DISTANCE OF 30.04 FEET; THENCE N23°09'21"E, 230.04 FEET TO THE HARBOR LINE ON THE RIGHT BANK OF THE MISSOURI RIVER AS ESTABLISHED BY THE WAR DEPARTMENT IN 1904; THENCE IN A SOUTHEASTERLY DIRECTION, ALONG SAID HARBOR LINE, ALONG A CURVE TO THE LEFT, HAVING A RADIUS OF 3375.00 FEET THROUGH A CENTRAL ANGLE OF 000°30'46", WITH AN INITIAL TANGENT BEARING OF S59°57'15"E, AN ARC DISTANCE OF 30.20 FEET TO THE WEST RIGHT-OF-WAY LINE OF LIBERTY STREET AS IT NOW EXISTS; THENCE S23°09'21"W, ALONG THE WEST RIGHT-OF-WAY LINE OF SAID LIBERTY STREET, 228.00 FEET TO THE POINT OF BEGINNING. SAID TRACT CONTAINING 6,871 SQUARE FEET MORE OR LESS.

8-22-2018

PART OF BLOCKS 11 AND 12, WOODSWETHER INDUSTRIAL DISTRICT KANSAS CITY, JACKSON COUNTY, MISSOURI OUTFALL EASEMENT	**TALIAFERRO & BROWNE, INC.** **CONSULTING ENGINEERS-SURVEYORS** **1020 EAST 8TH ST., KANSAS CITY, MO, 64106** **PH: (816) 283-3456 FAX: (816) 283-0841**
DRAWN: M.T.I. CHECKED: V.A.H. / *DATE: 8/10/2018*	S:\NETJOB\09-0750-001-WOODSWETHER INDUSTUSTRIAL DISTRICT-LIBERTY STREET\DWG (WORKING) 09-0750V-LC01.DWG, Outfall Easement Exhibit A and B, EXHIBIT A

EXHIBIT D-1



CURVE TABLE				
CURVE	LENGTH	RADIUS	Δ	I.T.B.
C11	51.76'	3375.00'	000°52'43"	S51°17'24"E
C12	30.04'	1571.38'	001°05'43"	N64°37'45"W
C13	30.20'	3375.00'	000°30'46"	S59°57'15"E

LINE TABLE		
LINE	BEARING	DISTANCE
L11	S66°52'50"E	9.19'
L12	N23°16'57"E	310.68'
L13	S23°16'57"W	297.15'
L14	N66°52'50"W	50.00'
L15	N23°09'21"E	230.04'
L16	S23°09'21"W	228.00'

OUTFALL EASEMENT AREA

TRACT A AREA= 15,192 SQ. FT. MORE OR LESS
TRACT B AREA= 6,871 SQ. FT. MORE OR LESS
TOTAL AREA= 22,063 SQ. FT. MORE OR LESS

STATE OF MISSOURI
RICKY E. GARD
NUMBER LS-2069
REGISTERED LAND SURVEYOR

8-22-2018

PART OF BLOCKS 11 AND 12,
WOODSWETHER INDUSTRIAL DISTRICT
KANSAS CITY, JACKSON COUNTY, MISSOURI
OUTFALL EASEMENT

DRAWN: M.T.I.
CHECKED: V.A.H.

DATE: 8/10/2018

TALIAFERRO & BROWNE, INC.
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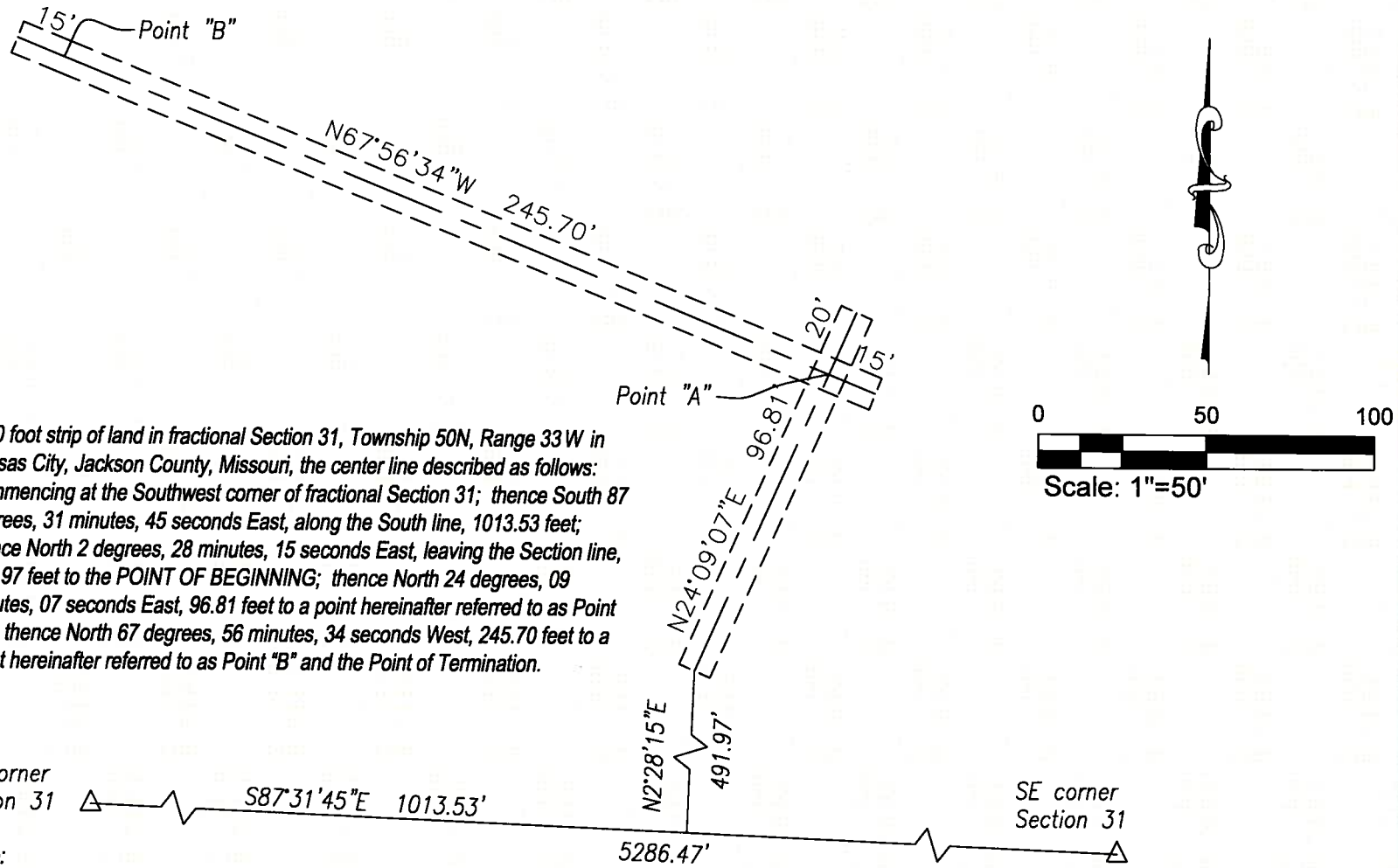

A 10 foot strip of land in fractional Section 31, Township 50N, Range 33W in Kansas City, Jackson County, Missouri, the center line described as follows: Commencing at the Southwest corner of fractional Section 31; thence South 87 degrees, 31 minutes, 45 seconds East, along the South line, 1013.53 feet; thence North 2 degrees, 28 minutes, 15 seconds East, leaving the Section line, 491.97 feet to the POINT OF BEGINNING; thence North 24 degrees, 09 minutes, 07 seconds East, 96.81 feet to a point hereinafter referred to as Point "A"; thence North 67 degrees, 56 minutes, 34 seconds West, 245.70 feet to a point hereinafter referred to as Point "B" and the Point of Termination.

Also:

Beginning at Point "A"; thence North 24 degrees, 09 minutes, 07 seconds East, 20 feet to the Point of Termination.

Beginning at Point "A"; thence South 67 degrees, 56 minutes, 34 seconds East, 15 feet to the Point of Termination.

Beginning at Point "B"; thence North 67 degrees, 56 minutes, 34 seconds West, 15.00 feet to the Point of Termination.

All containing 3925.1 square feet, more or less.

I certify this is an accurate description.

Ronald E. Schroer, MOLS 2569

CFS ENGINEERS
cfse.com
9229 Ward Pkwy, Ste 110, KCMO 64114
o: 816-333-4477 f: 816-333-6688

ELECTRIC LINE EASEMENT EXHIBIT

1724 Market Street
Kansas City, Jackson County, Missouri