STRUCTURE GEOTECHNICAL REPORT
KEAN AVENUE CULVERT AT STATION 52+92.56
EX SN 016-1254, PR SN 016-2297
COOK COUNTY, ILLINOIS

For
Collins Engineers, Inc.
123 North Wacker Drive, Suite 900
Chicago, IL 60606

Submitted by
Wang Engineering, Inc.
1145 North Main Street
Lombard, IL 60148

Original Report: August 16, 2017
Revised Report: December 13, 2017

Technical Report Documentation Page

1. Title and Subtitle Structure Geotechnical Report, Kean Avenue Culvert at Station 52+92.56		**2. Original Date:** August 16, 2017 **Revised Date:** December 13, 2017 **3. Report Type** ☒ SGR ☐ RGR ☐ Draft ☒ Final ☒ Revised
4. Route / Section / County/ District/ Region FAU 2721/ 10-37-12 / Cook/ 1/ 1		**5. Contract** IDOT 62D40
6. PTB / Item No. 182/04	**7. Existing Structure Number(s)** SN 016-1254	**8. Proposed Structure Number(s)** SN 016-2297
9. Prepared by Wang Engineering, Inc. 1145 N Main Street Lombard, IL 60148	**Contributor(s)** Author: M. Kothawala, P.E., D.GE QA/QC: Mickey L. Snider, P.E. PM: M. Kothawala, P.E., D.GE	**Contact** (630) 953-9928 ext. 1036 mkothawala@wangeng.com
10. Prepared for Collins Engineers, Inc. 123 N Wacker Drive Suite 900 Chicago, IL, 60606	**Design Engineer** HBM Engineering Group, LLC 4415 West Harrison Street Hillside, IL 60162	**Contact** (773) 236-0960 Mahmoud.issa@hbmengineering.com

11. Abstract

The existing culvert at Station 52+92.56 carrying Kean Avenue over an Unnamed Ditch will be removed and replaced with a new single-cell concrete box culvert. The new culvert will have an interior opening of 5-foot wide by 5-foot high. The culvert length will measure 36.0 feet. Invert elevations will be at 635.40 feet at the upstream end and 635.30 feet at the downstream end. The culvert will have 9-foot long horizontal wingwalls at each corner. This report provides geotechnical recommendation for the design and construction of the proposed culvert and wingwalls.

Beneath the pavement and up to 6.5 feet of fill material, the general lithologic profile includes up to 8 feet silty clay loam to clay loam with organics and sand lenses followed by loose silty loam to silt. Deeper foundation soils include stiff to hard silty clay to silty clay loam. The groundwater level was measured at elevations ranging from 632 to 637 feet, primarily within the sand and silt. The Estimated Water Surface Elevation is 637.40 feet, and temporary dewatering system or diversion of ditch for the foundation excavations will be required.

The proposed culvert installation as well as recommended removal and replacement will require excavations up to 15.5 feet from existing grade. It will be feasible to construct the culvert on shallow foundations; however, as an alternative to the removal and replacement, the culvert could be supported on driven metal shell piles. With the recommended removal and replacement, settlement analyses show the foundation soils along the culvert will undergo a maximum consolidation settlement of 0.5 inch or less with the differential settlement of 0.5 inch or less.

The proposed wingwall length of 9.0 feet complies with the requirements for horizontal cantilever walls as per IDOT *Culvert Manual* (2017).The horizontal cantilever walls should be founded a minimum of 3.0 feet below the invert elevation.

For open cut excavations, our slope stability analysis indicates that a temporary slope of 1:1 (V:H) will have an adequate FOS of 1.3. Any slopes that cannot be sloped 1:1 (V:H) or flatter should be properly shored with temporary sheet piling. Our analyses indicate that temporary sheet pile design in accordance with IDOT AGMU 3.13.1 Charts will be feasible.

12. Path to archived file

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Wang Engineering

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STRUCTURE GEOTECHNICAL REPORT
KEAN AVENUE CULVERT AT STATION 52+92.56
EX SN 016-1254, PR SN 016-2297
COOK COUNTY, ILLINOIS
FOR
COLLINS ENGINEERS, INC.

1.0 INTRODUCTION

This report presents the results of the Wang Engineering, Inc. (Wang) subsurface investigation, laboratory testing, and geotechnical evaluations to support the design and reconstruction of a culvert carrying Kean Avenue over an Unnamed Ditch at Station 52+92.56 in Palos Hills, Cook County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Based on the *TSL Plan* provided by HBM Engineering Group, Inc. (HBM) on August 9, 2017, the proposed culvert will be a 36.0-foot long concrete box with an interior opening of 5-foot wide by 5-foot high. The upstream invert elevation will be established at 635.40 feet, while the downstream invert elevation will be at 635.30 with the flow from east to west. The new structure will be constructed in the same location as the existing culvert; however, the proposed culvert will be longer and taller than existing one. The proposed culvert will have 9-foot long horizontal wingwalls at each corner. The proposed roadway grade elevation will be 643.09 feet. The TSL plan is included in Appendix C.

It is understood the proposed culvert design will be in accordance with 2014 AASHTO *LRFD Bridge Design Specifications* with 2015 and 2016 interims except as modified by 2017 IDOT *Culvert Manual*.

1.2 Existing Structure and Land Use

The existing culvert is a 34.75-foot long single cell cast-in-place concrete box culvert with an interior opening of 5-foot wide by 3-foot high. The surrounding land is the Cook County Forest Preserve's open wetland area on both sides of Kean Avenue.

The purpose of this investigation was to characterize the site soil and groundwater conditions, perform geotechnical analyses, and provide recommendations for the design and construction of the proposed culvert and wingwalls.

2.0 METHODS OF INVESTIGATION

2.1 Field Investigation

The subsurface investigation consisted of two structure borings, designated as 1254-CUL-01 and 1254-CUL-02. The borings were drilled by Wang on July 18 and 19, 2017. The as-drilled northings, eastings, and elevations were acquired with a mapping-grade GPS unit. Stations and offsets were provided by HBM. Boring location data are presented in the *Boring Logs* (Appendix A). The as-drilled boring locations are shown in the *Boring Location Plan* (Exhibit 2).

A truck- mounted drilling rig, equipped with hollow stem augers, was used to advance and maintain open boreholes. Soil sampling was performed according to AASHTO T 206, "*Penetration Test and Split Barrel Sampling of Soils*." The soil was sampled at 2.5-foot intervals to 30 feet below ground surface (bgs) and at 5-foot intervals, thereafter. Soil samples collected from each sampling interval were placed in sealed jars and transported to the laboratory for further examination and laboratory testing.

Field boring logs, prepared and maintained by Wang geologists, include lithological descriptions, visual-manual soil classifications (IDH Textural), results of Rimac and pocket penetrometer unconfined compressive strength testing on cohesive soils, and results of Standard Penetration Tests (SPT) recorded as blows per 6 inches of penetration.

Groundwater observations were made during and at the end of drilling operations. Due to safety considerations, boreholes were backfilled immediately upon completion with soil cuttings and/or chips. The pavement surface was restored to its original condition.

2.2 Laboratory Testing

The soil samples were tested in the laboratory for moisture content (AASHTO T265). Atterberg limits (AASHTO T89/T90) and particle size (AASHTO T88) analyses were performed on selected samples. Field visual descriptions of the soil samples were verified in the laboratory and index tested samples were classified according to the IDH Soil Classification System. Laboratory test results are shown in

the *Boring Logs* (Appendix A) and in the *Laboratory Test Results* (Appendix B).

3.0 INVESTIGATION RESULTS

Detailed descriptions of the soil conditions encountered during the subsurface investigation are presented in the attached *Boring Logs* (Appendix A) and in the *Soil Profile* (Exhibit 3). Please note that strata contact lines represent approximate boundaries between soil types. The actual transition between soil types in the field may be gradual in horizontal and vertical directions.

3.1 Lithological Profile

The borings advanced through pavement encountered 10 inches of asphalt over 6 inches of sandy gravel. In descending order, the general lithologic succession encountered beneath the surface includes: 1) man-made ground (fill); 2) soft to medium stiff silty clay loam to clay loam; and 3) stiff to very stiff silty clay to silty clay loam.

1) Man-made Ground (Fill)

Beneath the pavement, the borings revealed 1.7 to 6.5 feet of fill materials. The fill is cohesive, consisting of medium stiff to stiff silty clay loam. The unconfined compressive strength (Q_u) values range from 0.8 to 1.3 tsf with an average of 1.0 tsf and the moisture content values range from 16 to 32%.

2) Soft to medium stiff silty clay loam to clay loam

Beneath the fill, at elevations of 635 to 640 feet, the borings encountered 7 to 8 feet of very soft to medium stiff, dark brown to gray silty clay loam to clay loam with organic matter. The cohesive soils have Q_u values of 0.25 to 0.95 tsf. The moisture content values range from 33 to 63%. Laboratory index testing on a sample from this layer shows a liquid limit (L_L) value of 49% and a plastic limit (P_L) value of 24%.

3) Stiff to very stiff silty clay to silty clay loam

Beginning at elevations ranging from 627 to 633 feet, the borings encountered gray, stiff to very stiff silty clay to silty clay loam with sand lenses. The unit has Q_u values of 1.2 to 5.7 tsf and moisture content values of 13 to 22%. Loose, gray silt and sand lenses has N value of 6 blows per foot and moisture content values of 22%.

3.2 Groundwater Conditions

Groundwater was encountered while drilling at elevations of 633 and 635 (8 and 10.5 feet bgs). At the completion of drilling, the groundwater was observed at elevations of 604 to 605 feet (39 feet bgs). As per the TSL plan, the Estimated Water Surface Elevation (EWSE) is 637.40 feet.

4.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the culvert are included in the following sections. Wang has performed bearing capacity, settlement, and global stability analyses for the culvert barrel and wingwalls. In addition, Wang has also evaluated the feasibility of cast-in-place and precast options based on foundation soils and embankment loads.

4.1 Culvert Foundations

Based on our subsurface investigation, the foundation soils at the base of the culvert barrel are primarily soft to medium stiff, high moisture silty clay loam to clay loam with organic matter followed by loose granular soils or stiff to hard cohesive soils. The soft to medium stiff soils are up to 2.5 feet thick along the upstream portion and up to 7 feet thick along the downstream portion. We recommend removing these soft soils to elevation 632 at the upstream end and 627 feet at the downstream end and replacing it with Rockfill. The Rockfill should be capped with 6 inches of CA-7 and satisfy IDOT Standard Specifications. There is no removal and replacement information available under the existing culvert construction. We recommend showing removal and replacement on the plan for the full length of the proposed culvert. The actual depth of removal and replacement should be determined in the field during construction. The removal and replacement material should extend a minimum of two feet beyond each side of the box, then extending down to the base of the undercut depth at a minimum of 1:1 slope.

Considering the recommended removal and replacement, the recommended factored bearing resistance for culvert barrels is 3,000 psf with a bearing resistance factor of 0.45 (AASHTO, 2014). Culvert barrels should be designed based on the diagrams in accordance with the IDOT *Culvert Manual* (IDOT, 2017).

As an alternative to the removal and replacement, the proposed culvert could be supported on metal shell piles. The pile lengths were calculated with the spreadsheet, *IDOT Static Method of Estimating Pile Length vs Resistance*. The R_F, R_N, estimated pile tip elevations, and pile lengths for

12-inch diameter Metal shell piles (MSP) are summarized in Table 1. The lengths shown in the table assume a 1-foot pile penetration into the pile cap. We estimate the relative settlement between the pile and soil will be more than 0.4 inches; therefore, there will be downdrag load on piles.

Table 1: Estimated Pile Lengths and Tip Elevations for 12-inch Diameter w/0.25-inch Wall Metal Shell Piles

Limits (Reference Boring)	Culvert Base Elevation (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
Downstream 1254-CUL-01	634.4	106	10	19	30	20	615.4
		124	10	19	40	22	613.4
		142	10	19	50	25	610.4
		165(*)	10	19	62	29	606.4
Upstream 1254-CUL-02	634.5	73	3	7	30	11	624.5
		91	3	7	40	12	623.5
		109	3	7	50	17	618.5
		128	3	7	60	19	616.5
		146	3	7	70	21	614.5
		227(*)	3	7	115	29	606.5

(*) Maximum Nominal Bearing at boring termination depth.

The proposed wingwalls will be about 9.0 feet long. The wingwall length complies with the requirements for horizontal cantilever walls as per IDOT *Culvert Manual* (IDOT 2017). The horizontal cantilever walls should be founded a minimum of 3.0 feet below the invert elevation.

We recommend that the horizontal or L- type wingwalls be designed for an at-rest earth pressure of 60 psf foot depth for a horizontal embankment slope considering drainable backfill. For cantilever T-type or sheet piling walls, an active earth pressure of 40 psf foot depth should be considered. For a slope steeper than horizontal, the earth pressure and live load surcharge should

be in accordance with the IDOT *Culvert Manual*.

4.2 Settlement

Since there is no grade raise proposed, the consolidation settlement of foundation soils under the proposed culvert is estimated to be less than one inch across the existing embankment portion; however, without removal and replacement the culvert in the widening portion of embankment will experience up to 1.5 inches consolidation settlement on the upstream end and up to 3.0 inches of settlement on the downstream end.

Following the recommended removal and replacement, we estimate the foundation soils will experience consolidation settlement of 0.5 inch in the widening portion of the culvert with the differential settlement of less than 0.5 inch.

4.3 Global Stability

Since the horizontal cantilever wingwalls will be utilized at all corners, we do not anticipate any global instability concerns.

4.4 Cast-In-Place or Precast Culvert Considerations

The results of the settlement analyses indicate that both the cast-in-place and precast culvert options are feasible if the unstable soil is removed and replaced with aggregate. The differential settlement will be about 0.5 inch which will not cause excessive separation of the precast sections. A cast-in-place culvert will be required if the culvert is supported on piles.

4.5 Stage Construction

The construction will be in one stage since the traffic will be fully detoured.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Site Preparation

Vegetation, surface topsoil, and debris should be cleared and stripped where the structure will be placed. If unstable or unsuitable materials are exposed during excavation, they should be removed and replaced with compacted fill as described in Section 6.3.

5.2 Excavation, Dewatering, and Utilities

Excavations should be performed in accordance with local, state, and federal regulations. The potential effect of ground movements upon nearby utilities should be considered during construction. The proposed culvert installation as well as recommended removal and replacement will require excavations up to 15.5 feet from existing grade. We performed global slope stability analysis for a temporary excavation slope along the length of the culvert (across the roadway) considering undrained condition (short term). The minimum factor of safety (FOS) calculated was 1.30 for a temporary slope of 1:1 (V:H) with traffic load and 1.50 with traffic load. The IDOT accepts minimum FOS of 1.30 for a temporary cut slope. Any slopes that cannot be sloped 1:1 (V:H) or flatter should be properly shored with temporary sheet piling. Our analyses indicate that temporary sheet pile design in accordance with the IDOT *AGMU 3.13.1 Charts* will be feasible.

During the subsurface investigation, the groundwater was encountered at elevations ranging from 632 to 635 feet and the Estimated Water Surface Elevation is 637.40 feet. At the culvert, the groundwater will be encountered at the foundation level and will be 2 to 7 feet above the anticipated excavation levels. A temporary dewatering system or diversion of the ditch for the foundation excavations will be required to construct the culvert.

Depending upon prevailing climatic conditions and the time of the year when construction take place, control of runoff and maintenance of existing flows will require temporary water diversion and control. The temporary water diversion could be achieved by routing the ditch channel to adjacent channels. Water that does accumulate in open excavations by seepage or runoff should be immediately removed by sump pump method.

5.3 Filling and Backfilling

Fill material required to attain the final design subgrade elevations should be in accordance with Section 205, Embankment (IDOT 2016). All fill and backfill materials should be pre-approved by the site engineer. The fill should be free of organic materials and debris.

Replacement material below the culvert barrel should be Rockfill capped with 6 inches of CA-7 and satisfy the IDOT Standard Specifications.

Backfill materials for the wingwalls should be pre-approved by the Resident Engineer. We recommend porous granular material conforming to the requirements specified in the 2017 IDOT

Supplemental Specification, *Granular Backfill for Structures.*

5.4 Earthwork Operations

The required earthwork can be accomplished with conventional construction equipment. Moisture and traffic will cause deterioration of exposed subgrade soils. Precautions should be taken by the Contractor to prevent water erosion of the exposed subgrade. A compacted subgrade will minimize water runoff erosion.

Earth moving operations should be scheduled to not coincide with excessive cold or wet weather (early spring, late fall or winter). Any soil allowed to freeze or soften due to the standing water should be removed. Wet weather can cause problems with subgrade compaction.

It is recommended that an experienced geotechnical engineer be retained to inspect the exposed subgrade, monitor earthwork operations, and provide material inspection services during the construction phase of this project.

6.0 QUALIFICATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on the boring logs and in Exhibit 2. This report does not reflect any variations that may occur between the borings or elsewhere on the site, variations whose nature and extent may not become evident until the course of construction. In the event that any changes in the design and/or location of the structure are planned, we should be timely informed so that our recommendations can be adjusted accordingly.

It has been a pleasure to assist Collins Engineers, Inc. and the Illinois Department of Transportation on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

WANG ENGINEERING, INC.

Mohammed Kothawala, P.E., D.GE.
Sr. Project Manager/Sr. Geotechnical Engineer

Mickey L. Snider, P.E.
QA/QC Reviewer

Nesam S. Balakumaran, P.Eng.
Project Geotechnical Engineer

REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS (2014) "AASHTO LRFD Bridge Design Specifications." United States Depart of Transportation, Washington, D.C.

IDOT (2015) *Geotechnical Manual*, Illinois Department of Transportation.

IDOT (2016) *Standard Specifications for Road and Bridge Construction.* Illinois Department of Transportation. 1098 pp.

IDOT (2017) *Culvert Manaul.* Illinois Department of Transportation

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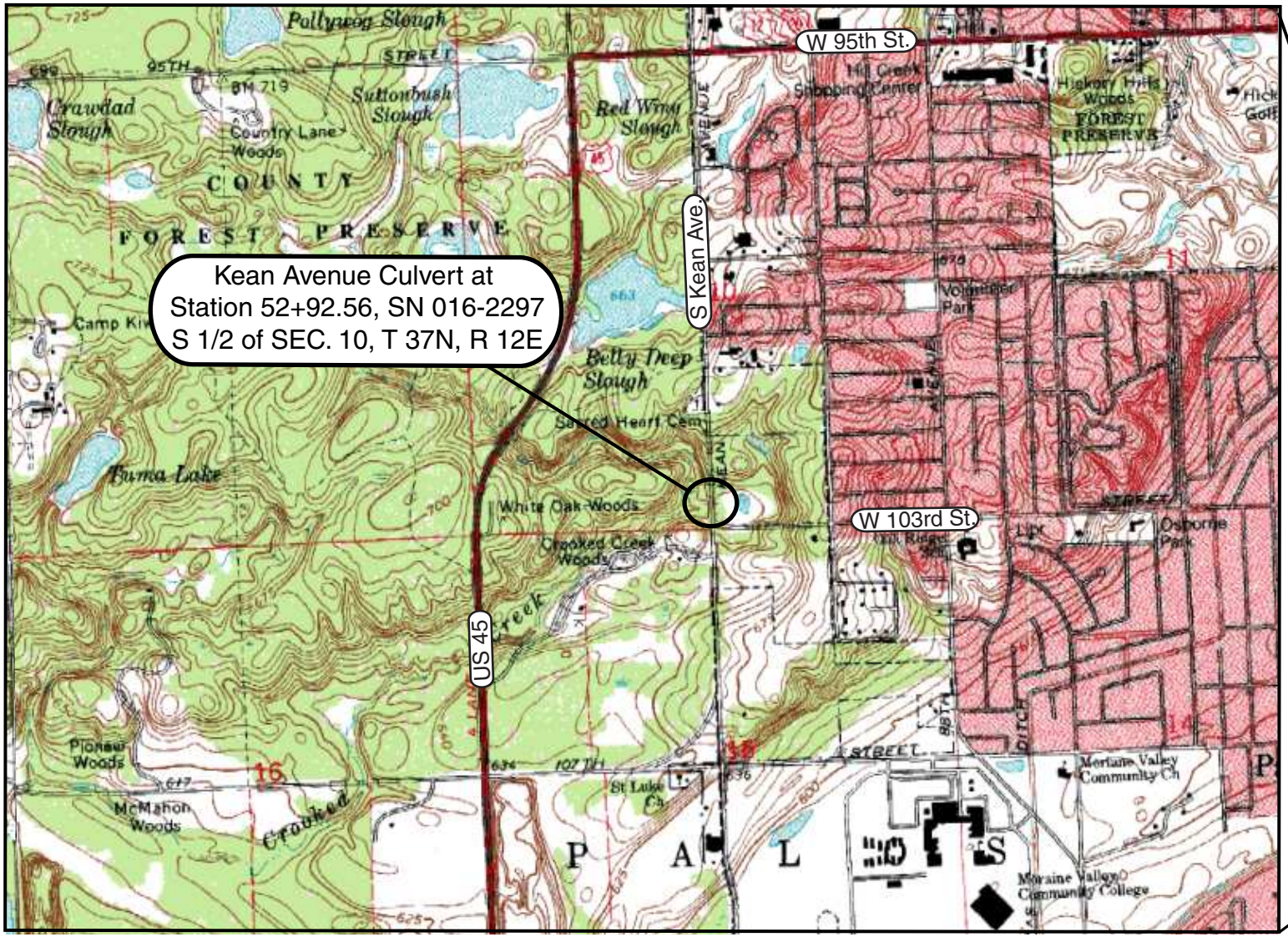
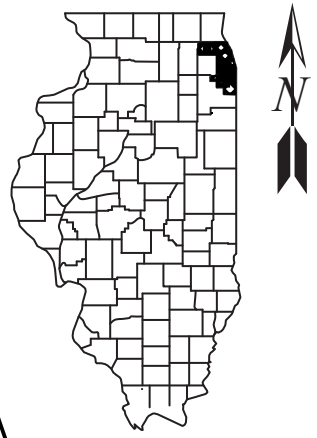
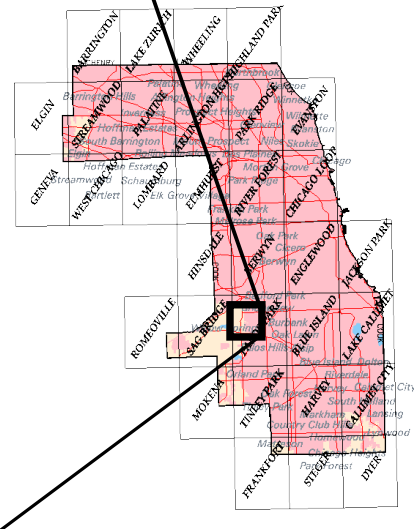
EXHIBITS







Cook County

Scale

0 0.5 1.0 Mile

SITE LOCATION MAP: KEAN AVENUE CULVERT AT STATION 52+92.56, SN 016-2297, COOK COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: R. KC CHECKED BY: NSB

Wang Engineering
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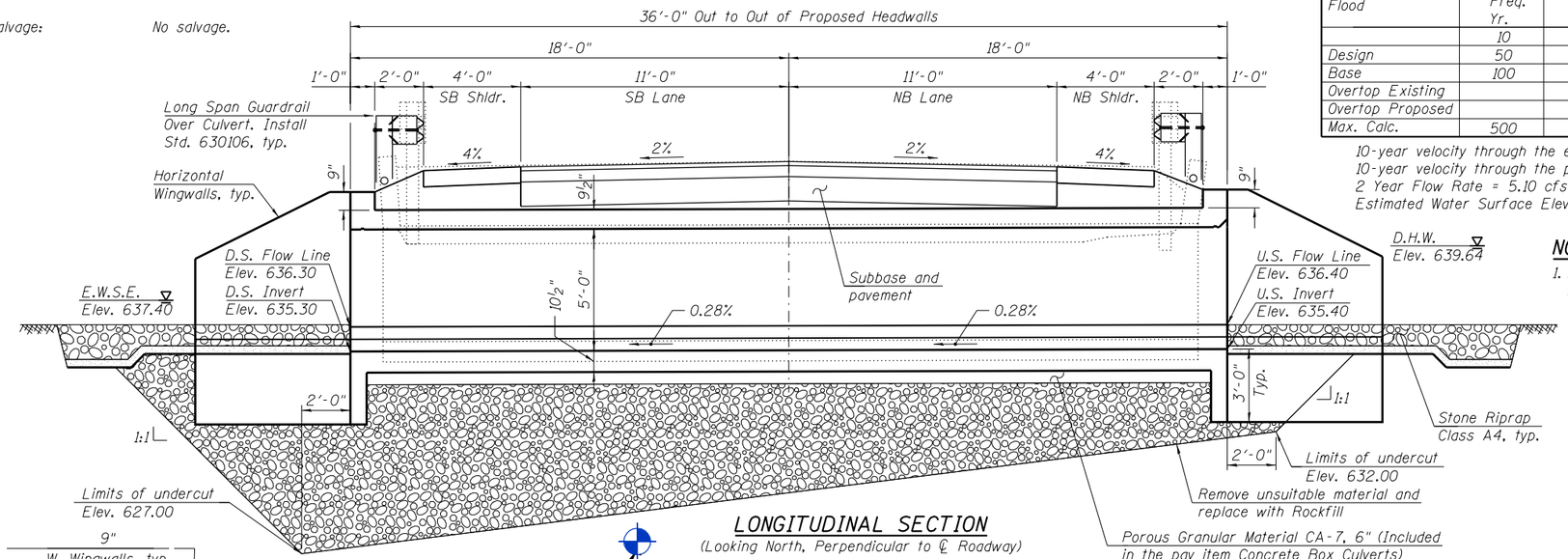
FOR COLLINS ENGINEERS, INC. 486-23-01

Bench Mark: Found Iron rod with cap on north end of guardrail at approx. Sta. 53+45.00 Elevation 641.83

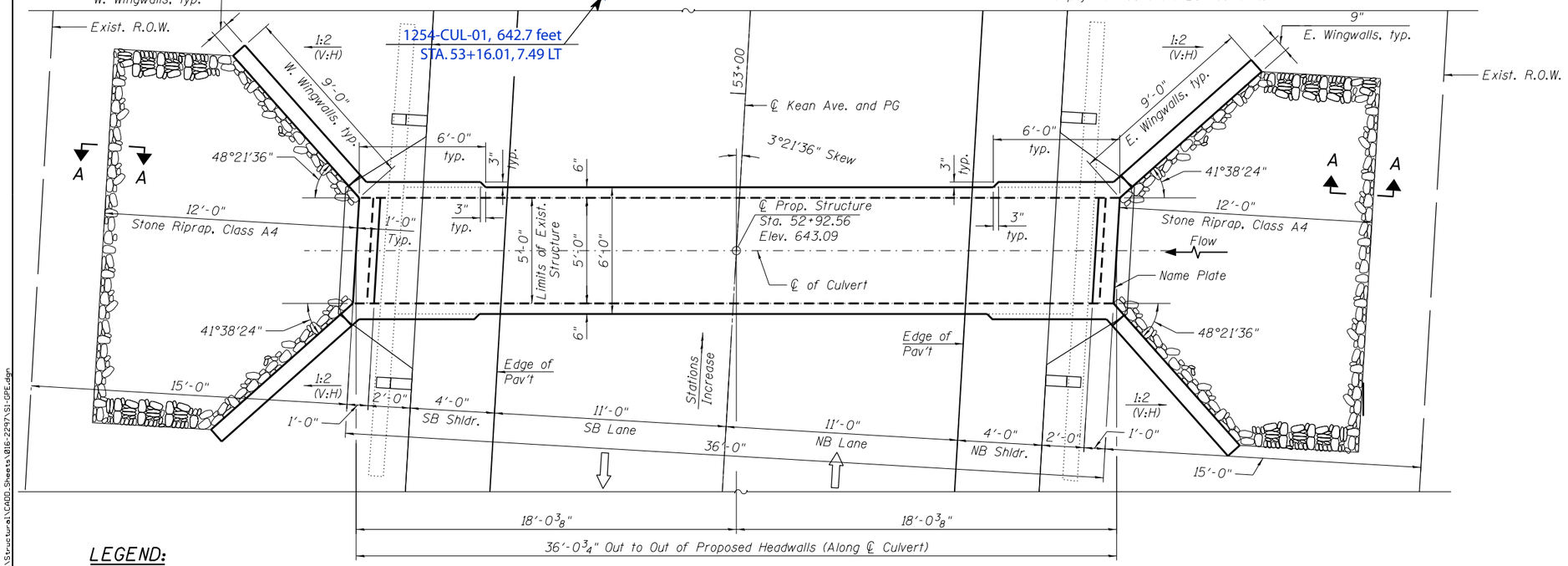
Existing Structure: SN 016-1254 originally constructed as a single cast-in-place box culvert 5′ wide by 3′ high and 34′-9" long. The date of construction is unknown. The existing structure to be removed and replaced with a cast-in-place single box culvert 5′ wide by 5′ high and 36′-0" long. Traffic will be detoured during construction.

Salvage: No salvage.



LONGITUDINAL SECTION

(Looking North, Perpendicular to ℄ Roadway)



LEGEND:

Soil Boring

Boring	Station	Offset
1254-CUL-01	Sta. 53+16.01	7.49 Lt.
1254-CUL-02	Sta. 52+76.27	6.10 Rt.

PLAN

1254-CUL-02, 643.1 feet
STA. 52+76.27, 6.10 RT

WATERWAY INFORMATION

Drainage Area = 60.2 acres

Existing Overtopping Elev. = 643.05 at Sta. 53+00
Proposed Overtopping Elev. = 643.01 at Sta. 53+32.50

Flood	Freq. Yr.	Discharge C.F.S	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	37.9	-	-	-	-	-	638.56	638.59
Design	50	70.8	-	-	-	-	-	639.61	639.64
Base	100	89.8	-	-	-	-	-	640.15	640.18
Overtop Existing									
Overtop Proposed									
Max. Calc.	500	118.5	-	-	-	-	-	640.89	640.92

10-year velocity through the existing culvert = 5.72 fps.
10-year velocity through the proposed culvert = 5.68 fps.
2 Year Flow Rate = 5.10 cfs
Estimated Water Surface Elevation = 637.40 ft

NOTES:

1. For General Notes, Index of Sheets and Total Bill of Materials, see Sheet S-2.

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition, with 2015 and 2016 Interims

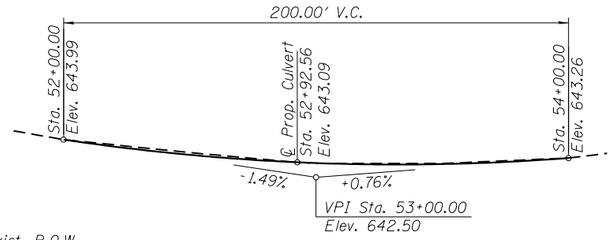
LOADING HL-93

Allow 50 lb/sq. ft. for future wearing surface.

DESIGN STRESSES

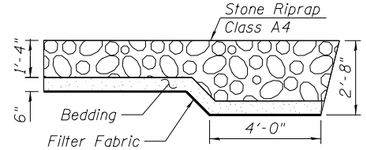
FIELD UNITS

f'_c = 3,500 psi (Concrete)
f_y = 60,000 psi (Reinforcement)



PROFILE GRADE

(Along ℄ Roadway)



SECTION A-A

BORING LOCATION PLAN: KEAN AVENUE CULVERT AT STATION 52+92.56, SN 016-2297, COOK COUNTY, ILLINOIS

SCALE: GRAPHICAL | EXHIBIT 2 | DRAWN BY: R. KC CHECKED BY: NSB

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FOR COLLINS ENGINEERS, INC. | 486-23-01

STATE OF ILLINOIS
MOUSSA A. ISSA
081-005738
CHICAGO, ILLINOIS
LICENSED STRUCTURAL ENGINEER

Signed _____
Moussa A. Issa, HBM Il. Lic. No. 081-005738
Expires 11-30-2018

Date _____ For Sheets S-1 Thru S-6 (Total of 6 Sheets)

GENERAL PLAN AND ELEVATION
KEAN AVENUE OVER UNNAMED DITCH
F.A.U. 2721- SEC. 2016-054B
COOK COUNTY
STATION 52+92.56
STRUCTURE NO. 016-2297

HBM ENGINEERING GROUP, LLC

S1-GPE.dgn	DESIGNED - MAA, LAB	REVISED -	
USER NAME = Kendrabant	DRAWN - MAA	REVISED -	
PLOT SCALE = 60.0000 '/ in.	CHECKED - MI	REVISED -	
PLOT DATE = 8/18/2017	DATE - 08/18/2017	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: | SHEET S-1 OF S-6 SHEETS | STA. | TO STA.

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
2721	2016-054B	COOK	13	1
		CONTRACT NO. 62D40		
ILLINOIS FED. AID PROJECT				

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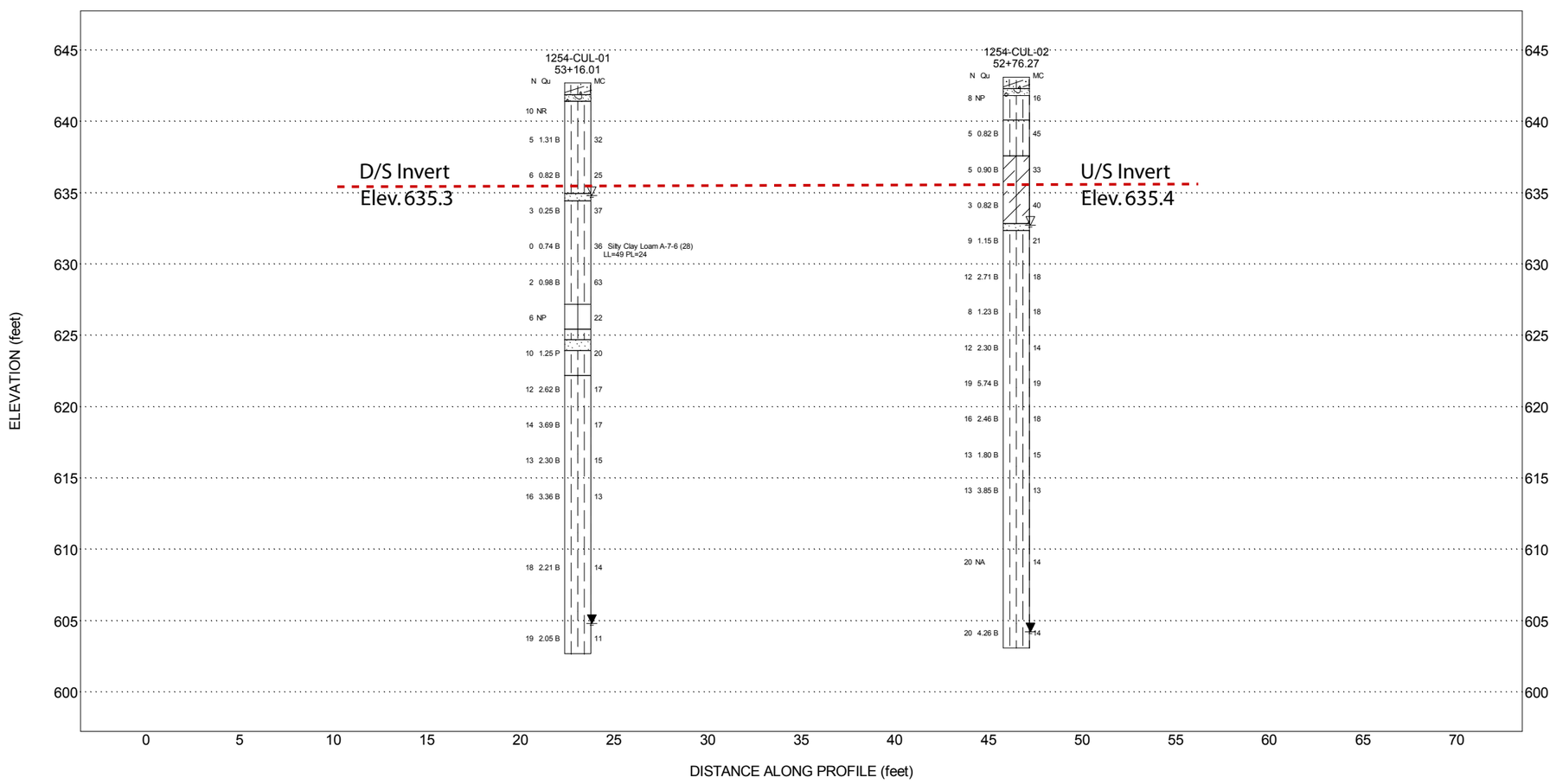
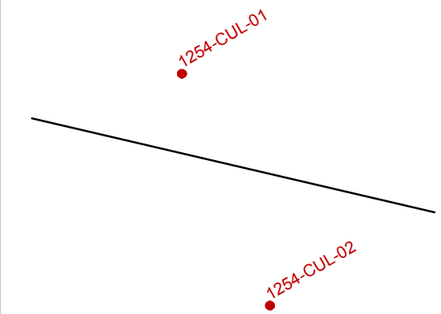


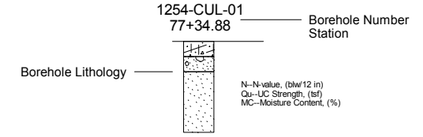
Lithology Graphics

- Pavement
- Gravelly sand, sandy gravel
- IDH Silty Clay, Silty Clay Loam
- IDH Sand, Sandy Loam
- IDH Silt, Silty Loam
- IDH Clay Loam



Site Map Scale 1 inch equals 25 feet

Explanation:



Water Level Reading at time of drilling.

Water Level Reading 24-hr after drilling or at end of drilling

0 7

Horizontal Scale (feet)

Vertical Exaggeration: 1x

Wang Engineering, Inc.
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Lombard, IL 60148

Subsurface Soil Data Profile
Kean Avenue Culvert at Staion 52+92.56
SN 016-2297

WEI SINCE 1982

Kean Avenue Culverts
Palos Hills, Cook County

JOB NUMBER	PLATE NUMBER
486-23-01	EXHIBIT 3

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APPENDIX A

Wang Engineering
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Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG 1254-CUL-01

WEI Job No.: 486-23-01

Client: **Collins Engineers, Inc.**
Project: **Kean Avenue Culverts**
Location: **Palos Hills, Cook County**

Datum: NAVD 88
Elevation: 642.69 ft
North: 1835134.67 ft
East: 1117226.75 ft
Station: 53+16.01
Offset: 7.49 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	641.9	10-inch thick ASPHALT --PAVEMENT--						
	641.4	Brown SANDY GRAVEL --BASE COURSE--						
		Medium stiff to stiff, brown SILTY CLAY LOAM --FILL--			1	7 5 5	NR	
			5		2	3 2 3	1.31 B	32
					3	1 2 4	0.82 B	25
	634.9							
	634.4	Sand; saturated						
		Soft to medium stiff, gray SILTY CLAY LOAM with organic matter; wet	10		4	0 2 1	0.25 B	37
		--L_L(%)=49, P_L(%)=24-- --%Gravel=0.1-- --%Sand=1.2-- --%Silt=70.8-- --%Clay=27.9--			5	0 0 0	0.74 B	36
			15		6	0 0 2	0.98 B	63
	627.2							
		Loose, gray SILTY LOAM to SILT; wet to saturated			7	2 3 3	NP	22
	625.4							
	624.7	Medium stiff (0.75P), gray SILTY CLAY LOAM						
	623.9	Gray, fine SANDY LOAM; wet						
		Stiff, gray SILTY CLAY LOAM, trace gravel; damp	20		8	5 5 5	1.25 P	20
	622.2							
		Very stiff, gray SILTY CLAY, trace gravel			9	3 5 7	2.62 B	17
			25		10	4 6 8	3.69 B	17
					11	5 6 7	2.30 B	15
			30		12	6 7 9	3.36 B	13
			35		13	6 8 10	2.21 B	14
	602.7		40		14	5 7 12	2.05 B	11
		Boring terminated at 40.00 ft						

GENERAL NOTES

Begin Drilling: **07-18-2017** Complete Drilling: **07-18-2017**
Drilling Contractor: **Wang Testing Services** Drill Rig: **CME-55 TMR**
Driller: **JA + JG** Logger: **J. Rowells** Checked by: **NSB**
Drilling Method: **2.25 IDA HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **8.00 ft**
At Completion of Drilling: **38.00 ft**
Time After Drilling: **NA**
Depth to Water: **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

WANGENGINC 4862301.GPJ WANGENG.GDT 8/17/17

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BORING LOG 1254-CUL-02

WEI Job No.: 486-23-01

Client: **Collins Engineers, Inc.**
Project: **Kean Avenue Culverts**
Location: **Palos Hills, Cook County**

Datum: NAVD 88
Elevation: 643.10 ft
North: 1835095.41 ft
East: 1117241.65 ft
Station: 52+76.27
Offset: 6.10 RT

Depth (ft)	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	642.3	9.5-inch thick ASPHALT PAVEMENT					
	641.8	--PAVEMENT--					
		Brown SANDY GRAVEL; dry					
		Stiff, dark brown SILTY CLAY LOAM, trace gravel		1	6 3 5	NP	16
	640.1	--FILL--					
		Medium stiff, dark brown to black SILTY CLAY LOAM, trace organic matter		2	2 2 3	0.82 B	45
5							
	637.6						
		Medium stiff, dark brown to gray CLAY LOAM, trace organic matter		3	1 2 3	0.90 B	33
				4	1 2 1	0.82 B	40
10							
	632.9						
	632.4	SAND; saturated	▽				
		Stiff to hard, gray SILTY CLAY LOAM, trace gravel		5	2 4 5	1.15 B	21
				6	3 5 7	2.71 B	18
15							
				7	3 3 5	1.23 B	18
				8	3 4 8	2.30 B	14
20							
				9	4 8 11	5.74 B	19
				10	3 7 9	2.46 B	18
25							
				11	6 6 7	1.80 B	15
				12	5 6 7	3.85 B	13
30							
				13	6 8 12	NA	14
35							
			▽	14	6 9 11	4.26 B	14
40	603.1	Boring terminated at 40.00 ft					

GENERAL NOTES

Begin Drilling: **07-19-2017** Complete Drilling: **07-19-2017**
Drilling Contractor: **Wang Testing Services** Drill Rig: **CME-55 TMR**
Driller: **JA + JG** Logger: **J. Rowells** Checked by: **NSB**
Drilling Method: **2.25 IDA HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **10.50 ft**
At Completion of Drilling ▼ **39.00 ft**
Time After Drilling **NA**
Depth to Water ▽ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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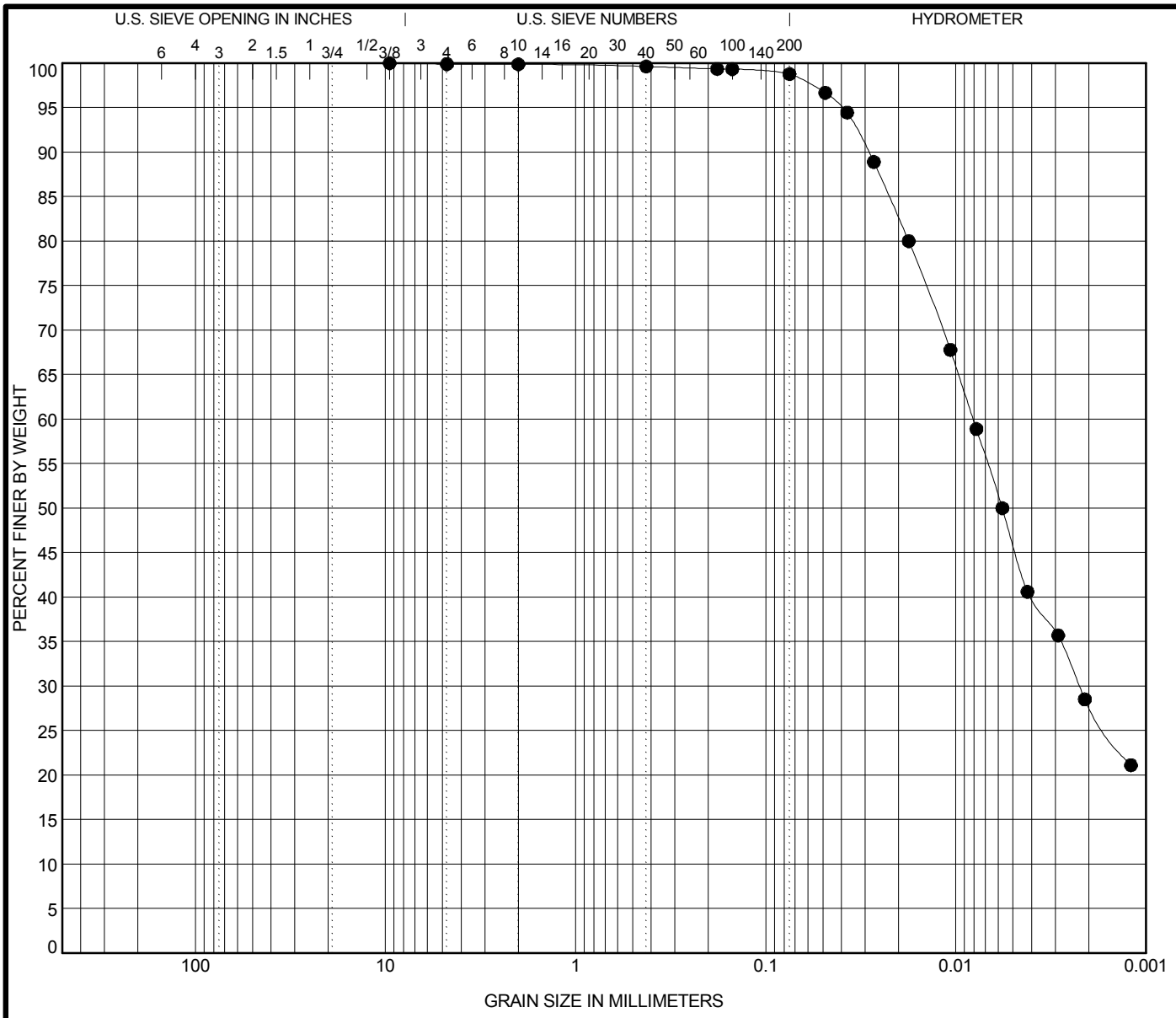
APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification	IDH Classification	LL	PL	PI	Cc	Cu
●	**1254-CUL-01#5 11.0 ft**	**Silty Clay Loam**	**49**	**24**	**25**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**1254-CUL-01#5 11.0 ft**	**9.5**	**0.008**	**0.002**		**0.1**	**1.2**	**70.8**	**27.9**

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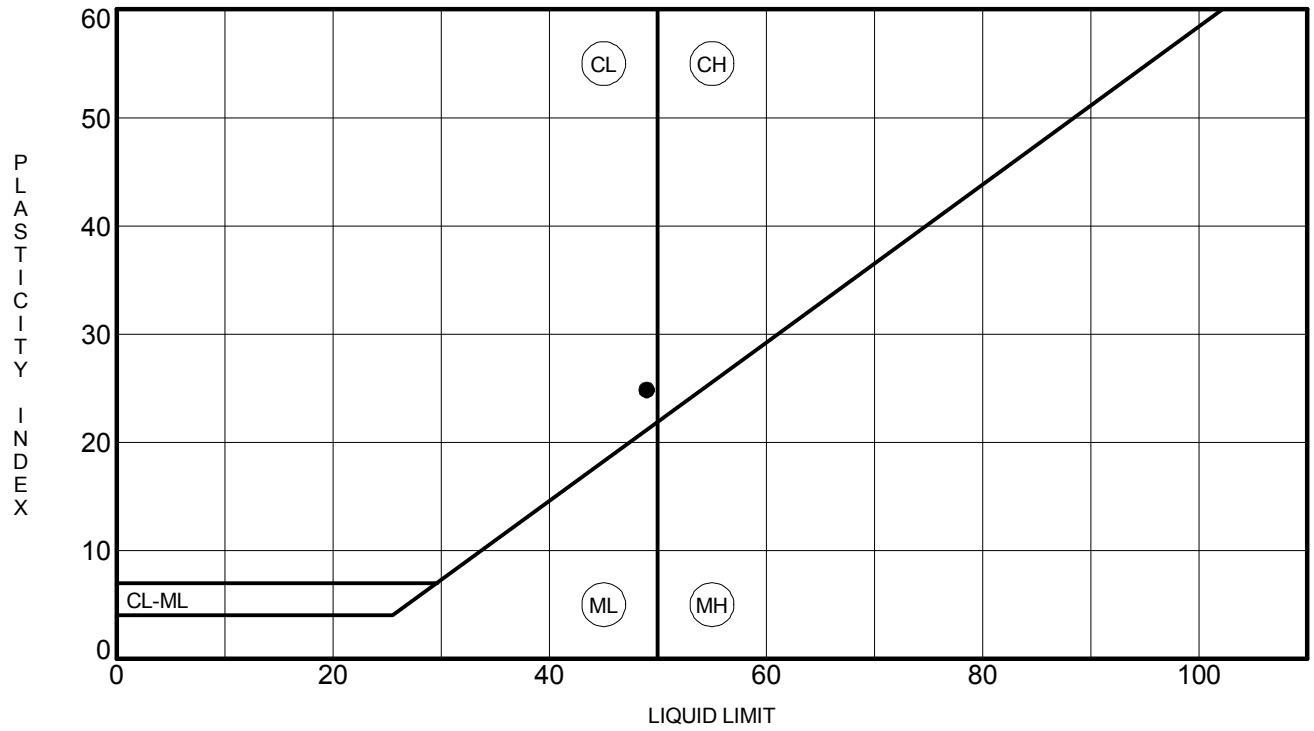
GRAIN SIZE DISTRIBUTION

Project: Kean Avenue Culverts

Location: Palos Hills, Cook County

Number: 486-23-01



Specimen Identification		LL	PL	PI	Fines	IDH Classification
● 1254-CUL-01#5	11.0 ft	49	24	25	99	Silty Clay Loam

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ATTERBERG LIMITS' RESULTS

Project: Kean Avenue Culverts

Location: Palos Hills, Cook County

Number: 486-23-01

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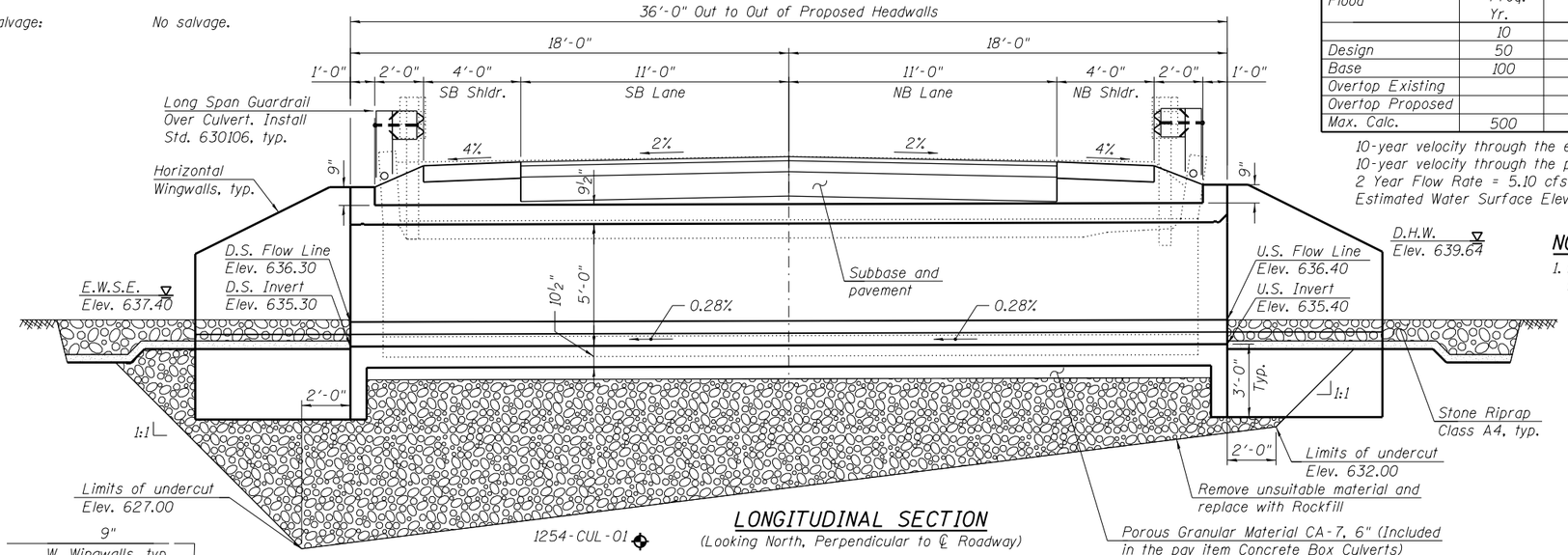
APPENDIX C

Bench Mark: Found Iron rod with cap on north end of guardrail at approx. Sta. 53+45.00 Elevation 641.83

Existing Structure: SN 016-1254 originally constructed as a single cast-in-place box culvert 5' wide by 3' high and 34'-9" long. The date of construction is unknown. The existing structure to be removed and replaced with a cast-in-place single box culvert 5' wide by 5' high and 36'-0" long. Traffic will be detoured during construction.

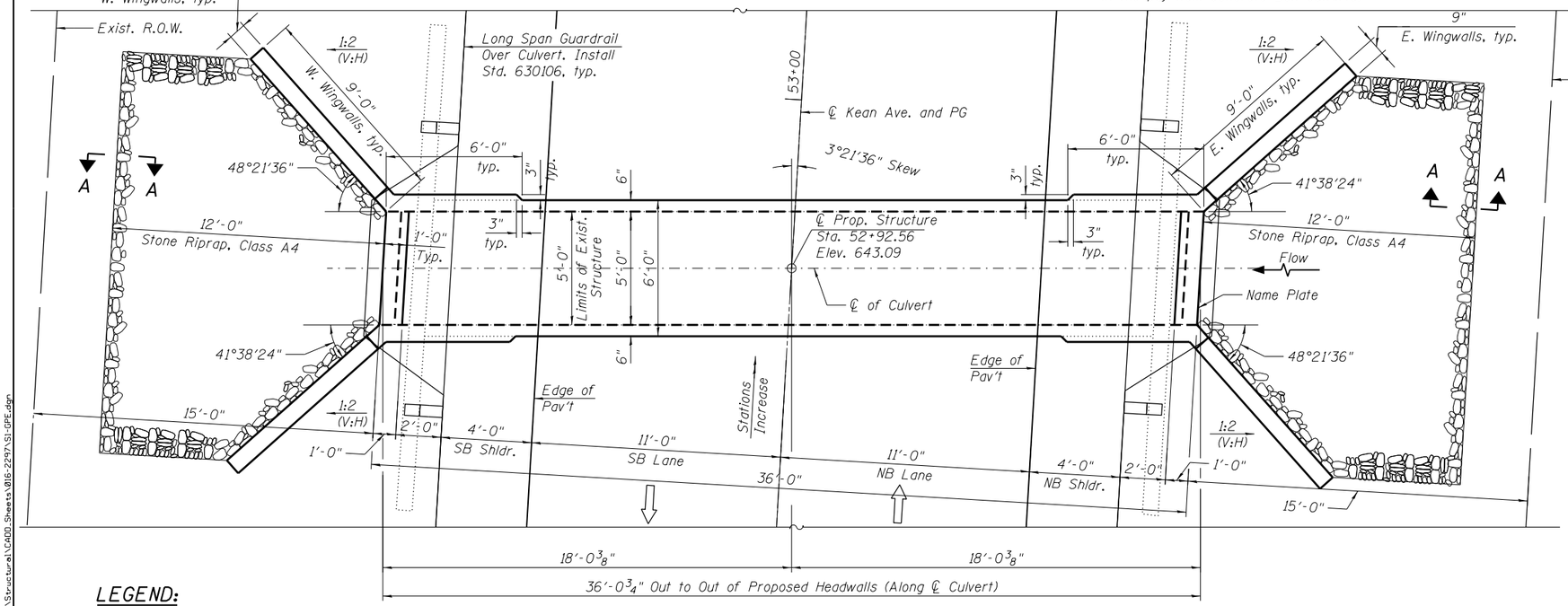
Salvage: No salvage.



1254-CUL-01

LONGITUDINAL SECTION

(Looking North, Perpendicular to ℄ Roadway)



PLAN

1254-CUL-02

LEGEND:

Soil Boring

Boring	Station	Offset
1254-CUL-01	Sta. 53+16.01	7.49 Lt.
1254-CUL-02	Sta. 52+76.27	6.10 Rt.

WATERWAY INFORMATION

Drainage Area = 60.2 acres

Existing Overtopping Elev. = 643.05 at Sta. 53+00
Proposed Overtopping Elev. = 643.01 at Sta. 53+32.50

Flood	Freq. Yr.	Discharge C.F.S	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	37.9	-	-	-	-	-	638.56	638.59
Design	50	70.8	-	-	-	-	-	639.61	639.64
Base	100	89.8	-	-	-	-	-	640.15	640.18
Overtop Existing									
Overtop Proposed									
Max. Calc.	500	118.5	-	-	-	-	-	640.89	640.92

10-year velocity through the existing culvert = 5.72 fps.
10-year velocity through the proposed culvert = 5.68 fps.
2 Year Flow Rate = 5.10 cfs
Estimated Water Surface Elevation = 637.40 ft

NOTES:

1. For General Notes, Index of Sheets and Total Bill of Materials, see Sheet S-2.

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition. with 2015 and 2016 Interims

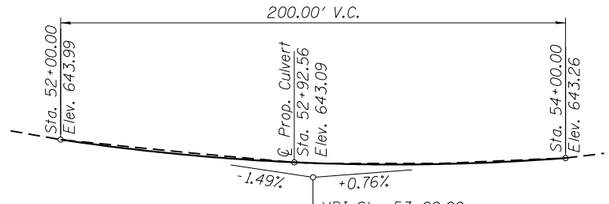
LOADING HL-93

Allow 50 lb/sq. ft. for future wearing surface.

DESIGN STRESSES

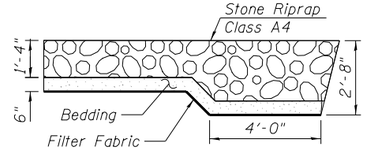
FIELD UNITS

f'_c = 3,500 psi (Concrete)
f_y = 60,000 psi (Reinforcement)

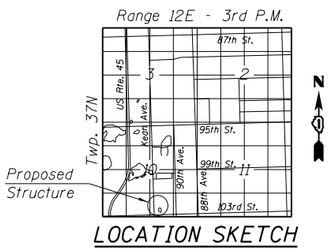


PROFILE GRADE

(Along ℄ Roadway)



SECTION A-A



LOCATION SKETCH

STATE OF ILLINOIS
MOUSSA A. ISSA
081-005738
CHICAGO, ILLINOIS
LICENSED STRUCTURAL ENGINEER

Signed _____
Moussa A. Issa, HBM Il. Lic. No. 081-005738
Expires 11-30-2018

Date _____ For Sheets S-1 Thru S-6 (Total of 6 Sheets)

GENERAL PLAN AND ELEVATION
KEAN AVENUE OVER UNNAMED DITCH
F.A.U. 2721- SEC. 2016-054B
COOK COUNTY
STATION 52+92.56
STRUCTURE NO. 016-2297

FILE PATH = P:\1702-692_PTB182-04_Collins\Structural\CADD_Sheets\016-2297\S1-GPE.dgn

HBM ENGINEERING GROUP, LLC

S1-GPE.dgn	DESIGNED - MAA, LAB	REVISED -	
USER NAME = Ken.drabant	DRAWN - MAA	REVISED -	
PLOT SCALE = 6±0.0000 '' / in.	CHECKED - MI	REVISED -	
PLOT DATE = 8/18/2017	DATE - 08/18/2017	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: | SHEET S-1 OF S-6 SHEETS | STA. | TO STA.

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
2721	2016-054B	COOK	13	1
		CONTRACT NO. 62D40		
	ILLINOIS FED. AID PROJECT			