DTA Culvert

Miller Creek under DTA Bus Garage

Condition Report

December 2019

DTA Culvert Inlet

LHB Project No. 190558.00

LHB
PERFORMANCE
DRIVEN DESIGN.

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INTRODUCTION

In 1980, the DTA Bus Garage was constructed over Miller Creek. A reinforced concrete box culvert was constructed beneath the garage to carry Miller Creek (DTA Culvert). The original construction plans are not on file with DTA maintenance staff, thus were not available at the time of inspection.

An inspection of the DTA Culvert was conducted in the fall of 2019 by LHB. The culvert is in overall fair condition. The following report details the culvert's current condition as well as recommendations for repair and monitoring.

CONDITION ASSESSMENT AND REPAIR RECOMMENDATIONS

Assessment Methodology

A comprehensive field assessment was performed on September 4, 2019 by LHB (Lisa Karlgaard, P.E. & Kyle Marynik, P.E.). All elements of the DTA Culvert were assessed in detail. The assessment was a hands-on and visual inspection. No aerial equipment was used to assist in the inspection. There was approximately 2-to-3 inches of water in the center of the culvert at the time of inspection. The culvert floor was visible beneath the water. See Appendix A for field inspection notes.

General Description and Findings

The DTA Culvert is a single span reinforced concrete box culvert with cast-in-place concrete headwalls and wingwalls at the inlet and outlet. The culvert opening measures 16 feet wide by approximately 10 feet 4 inches high. The culvert length is approximately 525 feet. The culvert runs beneath both the DTA Bus Garage and the building's parking lot.

The culvert is in generally fair condition with some elements in poor condition. The walls and ceilings of box culvert units are in good condition, but the floor is in fair-to-poor condition with a large scour area at the inlet. The box culvert joints are in fair condition with the floor joints deteriorating and the sealant on the walls and ceiling also failing. The headwalls and wingwalls are in good condition, with the railings at the tops of the walls in fair condition with some corrosion present and one location of damage due to tree growth.

Condition and Recommendations by Element

Box Culvert – Concrete Box Segments

Description and Existing Condition

The reinforced concrete box culvert consists of 18 culvert segments. The culvert inlet is located at the west building face and has a straight alignment beneath the building. It has two kink points/bends throughout the length of the culvert. One is located at the east building face and the other at the east edge of the parking lot to realign the culvert with the natural channel.

Existing Condition

The culvert walls and ceilings are in good condition, with no significant cracking, leaching or efflorescence present (Photo 1, typical condition). There are two locations (Photos 2 & 3) of exposed vertical reinforcing in the culvert walls with minor surface spalling of approximately 1/2-inch-deep and surface corrosion of the reinforcing (no section loss).

Photo 1: Typical Culvert Wall & Ceiling Condition

Photo 2: Culvert Section 1 (inlet, north wall) Exposed and Corroding Reinforcement
also note crack in wingwall with rust staining

Photo 3: Culvert Section 6 (north wall) Exposed and Corroding Reinforcement

The culvert floor is scoured, especially at the inlet of the culvert. The average scour depth at the inlet is 1 inch over 14 feet of the 16-foot-width (Photo 4). Additionally, at the culvert inlet (segment 1), there is an area of deep scour up to 3 1/2 inches deep with exposed reinforcing. This scour is located beneath the outlet of a storm drainage pipe (30-inch RCP) in the wall of the box culvert (Photo 5). The area of deep scour measures 7 feet long by 2 feet wide. There is exposed reinforcing which has experienced minor loss of steel section.

Photo 4: Culvert Floor Typical Condition
note scour through middle & intact floor at edge

Photo 5: Deep Scour in Floor at RCP Outlet near Inlet of Culvert
note exposed reinforcing in floor

Recommendations

The surface spalling and reinforcement corrosion is occurring due to the limited cover provided over the reinforcing bar in these isolated regions during construction. This is not currently a critical deficiency, but preventative maintenance could prove to be beneficial. The exposed reinforcement should be cleaned and epoxy-coated to slow future corrosion. This repair should occur in the near term (the next 0-5 years).

Repair to the floor would require dewatering of the floor to allow for the repair work to be completed in the dry. Temporary plugging or diverting of the storm drainage pipe would also be required to ensure the repair area remains dry. The concrete around the exposed reinforcing should be removed in order to anchor the new patch concrete to the existing concrete. This repair should be considered in the next 5 years. Prior to repair, the condition of the concrete and reinforcing should be monitored on an annual basis to ensure loss of concrete or steel reinforcing section is not occurring at an accelerated rate.

Due to the presence of scour throughout the culvert floor, a larger scale rehabilitation of the culvert should consider placing a new concrete invert throughout the entire floor. This would substantially extend the service life of the structure.

Box Culvert - Joints

Description

There are joints between each of the 18 box culvert segments (17 joints total). See Photo 6 for typical joint. The lower region of the joints (floor joints) is composed of a 1 1/2" polystyrene (styrofoam) joint filler with a hot-pour tar applied over the filler. The floor joints consist of the horizontal floor joint as well as 4-to-8 inches up the wall joints. The remainder of the wall joints and the ceiling joints also have a styrofoam joint with the interior surface filled with backer rod and sealant. See Photo 7 for lower joint configuration.

Photo 6: Typical Joint between Box Culvert Segments
joint 2 (north) pictured

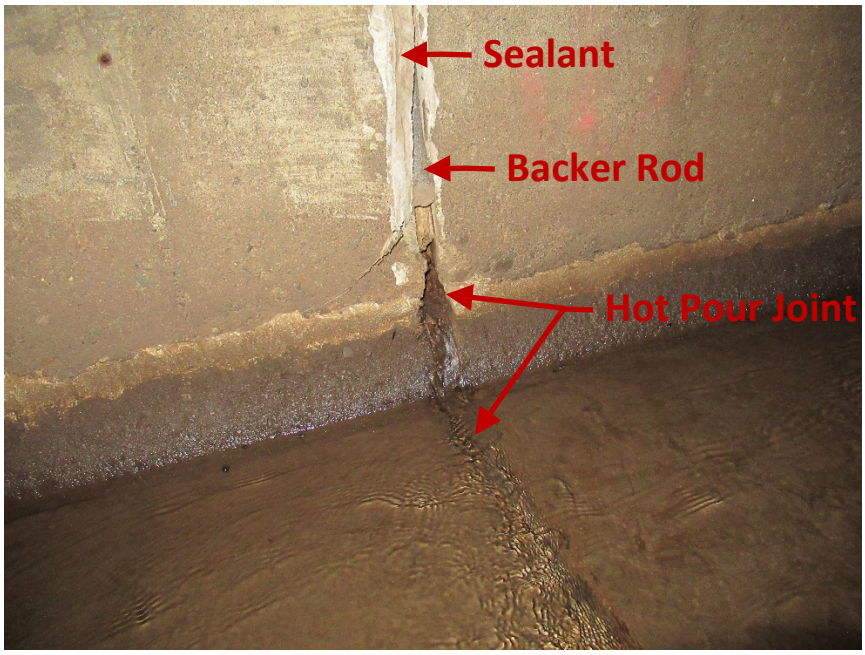


Photo 7: Typical Joint Condition
joint 7 pictured

Photo 8: Typical Deteriorated Floor Joint
joint 2 pictured

Existing Condition

The hot pour surface of the horizontal portion of the floor joints has failed for the full length of the joint with the polystyrene deteriorated or missing up to 4" beneath the existing floor surface. The majority of the joint filler in the lower 8" of the walls is missing with some locations where the joint filler is intact but in a deteriorated state. See Photo 8 for a typical deteriorated floor joint. The backer rod and sealant in the walls is generally cracked and/or separated from the concrete with the backer rod still present in the joints. Along the ceiling joint the sealant is generally intact with some areas of cracked or separated sealant. The wall and ceiling joints have been resealed though previous maintenance projects. There is no evidence of moisture or fill leaching through the wall or ceiling joints.

Recommendations

Although the hot pour joints are failing, there is no evidence of loss of material/fill through the joints. Immediate repair of the joints is not required. However, with a future comprehensive rehabilitation where a new concrete floor invert is placed, the joints would be cleaned out and filled and control joints would be perpetuated though the new slab. Following floor invert replacement, the backer rods and sealant in walls and ceiling joints could be removed and replaced, however the function of this interior sealing is unknown and may not be required for long term serviceability of the culvert.

Box Culvert – Stormwater/Drain Inlets

Description

There are three stormwater inlets through the box culvert walls. There is a 30-inch reinforced concrete pipe (RCP) through the north wall in segment 1 (Photo 5), an 18-inch RCP through the south wall in segment 15 (Photos 9/10) and a 24-inch RCP through the north wall in segment 17 (Photos 11/12). Additionally, there are 8-inch metal pipes through the tops of the culvert walls (north and south) in segments 3, 6 and 9 (Photos 1, 13 & 14).

Existing Condition

The 30-inch RCP is in good condition. The 18-inch RCP transitions into an 18-inch corrugated metal pipe (CMP) after the second pipe segment. There is rust staining at the outlet of the pipe indicating likely corrosion of the CMP invert. The lower portion of the CMP was filled with gravel. The 24" RCP is disjointed between the first and second pipe segments, approximately 2.5 feet from the wall face.


Photos 9/10: 18” RCP Storm Inlet - *segment 15, south wall*


Photos 11/12: 24” RCP Storm Inlet - *segment 17, north wall*

Photo 13: 8” Metal Drain Pipes

Photo 14: 8” Metal Drain Pipe Corrosion

The metal drain pipes have active corrosion on the pipe ends (interior and exterior). Rust staining was not observed beneath the pipes. It is unclear whether the pipes are active or not.

Recommendations

No repair is recommended for the 30-inch RCP. The condition of the invert of the 18-inch CMP should be investigated to determine if there is section loss. Severe sections loss may require replacement or re-lining of this pipe. The 24-inch RCP is disjointed. As a temporary repair, the pipe inverts could be cleaned and hand-patched with mortar or grout to prevent water from flowing through the disjointed joint and causing scour of the fill on the exterior of the pipe. A long-term repair would consist of excavation, removal, and replacement of this pipe.

Inlet & Outlet Headwalls & Wingwalls

Description and Existing Condition

The headwalls and wingwalls are constructed of cast-in-place reinforced concrete. The headwalls extend 2 feet above the box culvert opening. The wingwalls flare slightly from the box culvert segments and in three of the 4 corners (excluding the northeast) the wingwall turns and extends north/south. There is an open metal railing affixed with bolts to the tops of the headwalls and wingwalls. There is a vertical sealant joint in both west flared wingwalls.

Photo 15: Northwest Wingwall

Photo 16: Southwest Wingwall

Photo 17: Inlet Headwall/Wingwall Metal Railing

The inlet and outlet headwall and wingwall concrete is in good condition with no major deterioration. There is a vertical crack with rust staining near the culvert at the tops of both the northwest and southwest wingwalls (see Photo 1).

Photo 18/19: Railing Base Plate & Coating Condition

The metal railing and base plates are in similar condition at both the inlet and the outlet. The grout beneath the base plates has deteriorated and/or is missing. And, the top coat of the railing has failed (Photo 18). The galvanized coating is largely intact with some areas of surface corrosion at the welded interfaces of the railing (Photo 19). The limb of a tree is growing through the railing of the northeast wingwall which has caused a portion of the railing to break (Photo 21).

Photo 20: Outlet Headwall and Wingwalls

Photo 21: Northeast Wingwall
Note tree through railing and no turn on this wall

Photo 22: Outlet Headwall/Wingwall Metal Railing

Recommendations

The tree growing through the northeast wingwall railing should be removed and the railing section repaired. In a comprehensive rehabilitation project, the railing should be removed, re-galvanized and re-set. No repairs to the concrete wingwalls and headwall are recommended at this time.

SUMMARY & COSTS

The work scope and cost estimates presented herein are based on the condition of the culvert during the field inspection in September of 2019. The costs are separated into an estimate for items to be repaired in the short term (in 0-5 years) and the scope of a comprehensive rehabilitation to the culvert (estimated to occur in 15-20 years).

The short-term repair includes patching of the deep scour in the culvert floor at the inlet, which includes dewatering of the area to be patched. Additional scope to be considered in the short term is cleaning and painting of the exposed and corroding reinforcement on the culvert walls, grout-filling of the invert of the disjointed storm pipe, and removal of the tree growing though the northeast wingwall railing.

The comprehensive rehabilitation scope includes the placement of a concrete overlay atop the existing culvert floor and the associated stream diversion and dewatering. Costs have also been included for re-sealing the interior culvert segment wall and ceiling joints, re-galvanizing the headwall and wingwall railings, and replacement of the disjointed 24-inch storm pipe near the outlet of the structure.

Not included in the cost estimates is engineering and permitting costs, which could be estimated at approximately 15% of the construction cost for the comprehensive rehabilitation. Miller Creek is public waters and a trout stream, thus any work in the stream will require a permit from the Minnesota Department of Natural Resources (DNR). During past work in this stream (the culvert immediately upstream, running beneath 26th Avenue West), it has been required by the DNR to construct a low flow channel in the floor and rock baffles to allow for fish passage.

The opinion of probable construction cost provided below is presented in 2019 dollars. The estimated cost represents an opinion based on background knowledge of historic unit prices and comparable work performed on other structures. The opinion of cost is intended to provide a programming level of estimated cost. A 20 percent contingency has been included in the construction cost estimate for the short-term repair and a 20 percent contingency for a comprehensive rehabilitation.

Construction Costs (refer to the work item breakdown on the next page)

Opinion of Short-Term Repair Cost:	$	34,750
Opinion of Comprehensive Rehabilitation Cost:	$	658,190

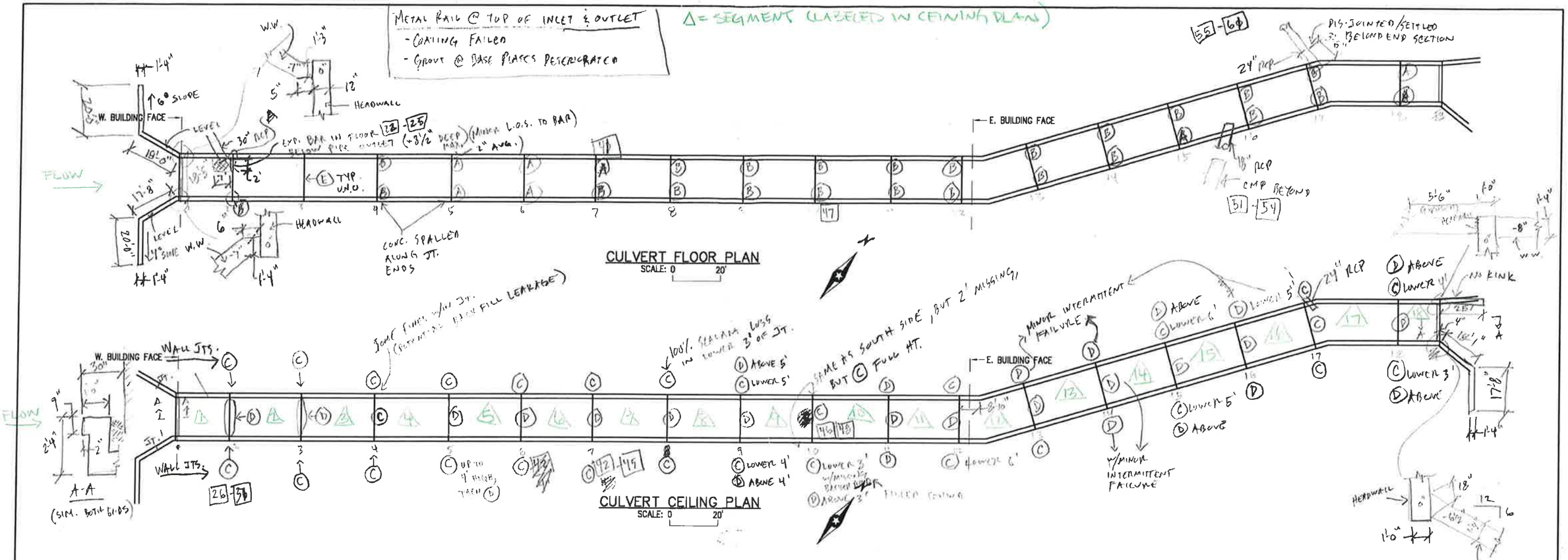
REPAIR COST ESTIMATE (2019 DOLLARS)
DTA CULVERT
December 19, 2019

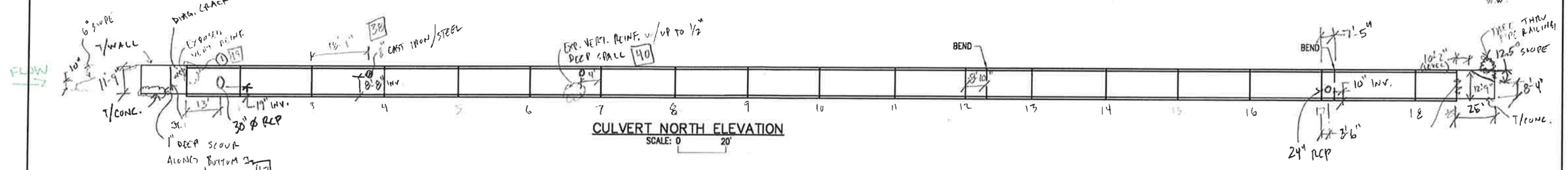
ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITIES AND COST QUANTITY	UNIT COST	TOTAL ESTIMATE
Short-Term Repair					
	MOBILIZATION @ 7%	LUMP SUM	1	$2,000.00	$2,000.00
1	Dewater & Divert Stream	LUMP SUM	1	$10,000.00	$10,000.00
2	Concrete Floor Repair	SQ FT	15	$550.00	$8,250.00
3	Clean & Paint Reinforcement	SQ FT	5	$600.00	$3,000.00
4	Grout-Fill 24" RCP invert	LUMP SUM	1	$2,000.00	$2,000.00
5	Remove Tree (NE Wignwall)	LUMP SUM	1	$2,500.00	$2,500.00
	30% CONTINGENCY	LUMP SUM	1	$7,000.00	$7,000.00
	ESTIMATED SHORT-TERM REPAIR COSTS				**$34,750.00**
Comprehensive Rehabilitation					
	MOBILIZATION @ 7%	LUMP SUM	1	$35,000.00	$35,000.00
1	Dewater & Divert Stream	LUMP SUM	1	$40,000.00	$40,000.00
2	Concrete Floor Overlay (with joint sealing)	SQ FT	8432	$50.00	$421,600.00
4	Remove and Replace Wall & Ceiling Joints	LIN FT	606	$15.00	$9,090.00
5	Remove, Recoat & Reset Railing	LIN FT	175	$100.00	$17,500.00
6	Excavate and Replace 24" CMP	LUMP SUM	1	$30,000.00	$30,000.00
	20% CONTINGENCY	LUMP SUM	1	$105,000.00	$105,000.00
	ESTIMATED COMPREHENSIVE REHABILITAITON COSTS				**$658,190.00**

APPENDIX A – FIELD NOTES

METAL RAIL @ TOP OF INLET & OUTLET
- COATING FAILED
- GROUT @ BASE PLATES DETERIORATED

Δ = SEGMENT (LABELED IN CEILING PLAN)

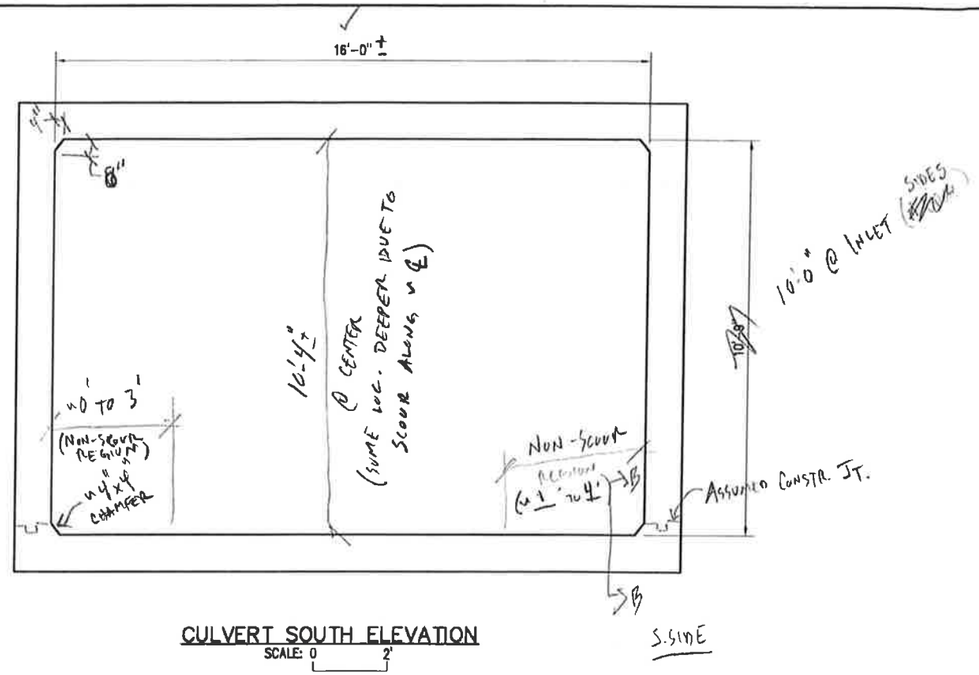




TOTAL LENGTH = 526'-7"
- MEASURED ALONG SOUTH WALL

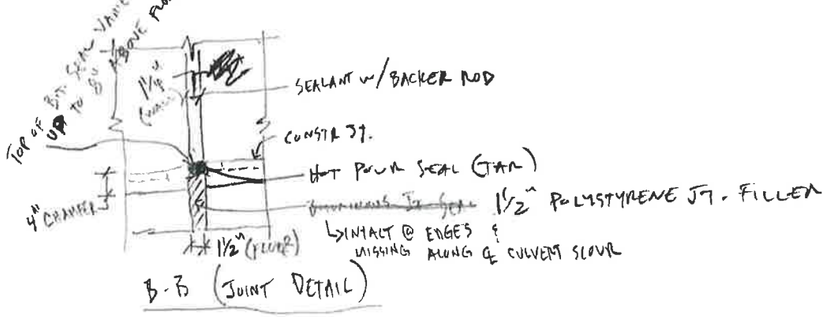
LHB Proj. No. 190558.00	I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA. NAME: _____ LIC. NO. ____ DATE 09-04-2019	TITLE: INSPECTION SHEET KDM/LMK 9/4/19	DES: LMM DR: GAV APPROVED: CHK: JDL CHK: LMM	Bridge No. DTA
			Sheet No. B01 of 02 Sheets	

- Precast Box Culvert
- Constructed in 1979
- Storm/Rainwater Inlet into tunnel



CULVERT SOUTH ELEVATION
SCALE: 0 2'

S. SIDE



B-B (JOINT DETAIL)

Photo Log:

1 - 16 General Inlet
17
17 Inlet Wall Cracks (N. side)
18 " " " (S. side)
20 Culvert Inlet S. side
21 " " N. "
22 - 25 30" RCP Scour
26 - 30 Joint Cond.
38 - Roof Drain Pipes
39 " " Pipe (S. wall)
40 Conc. Spalls w/Exp. Reinf
41 - 45 Joint 7
46 - 48 Joint 10
49 - 50 8" Corrugated Pipe
51 - 54 18" RCP/CMP
55 - 61 24" RCP (Dis-jointed)
62 - End Outlet Wingwalls & General Site

Key Notes: (Sht. 1)

① Minor Cracks (Vert. & Diag.) w/Efflo.

Joint Notes:

B — (A) ~~Jt.~~ Jt. Filler missing up to 6" above Floor

A — (B) ~~Jt.~~ Jt. Intact ~~but~~ but determinated ~~& sealing~~ @ sealant interfaces (hot pour to backer rod)

(C) Sealant cracked &/or peeling from concrete (failed) w/ backer rod present

(D) Sealant & Backer rod intact & appear to be in good cond.

(E) Hot pour ~~joint~~ near or 100% failed for full length w/ polystyrene determinated/missing up to 4" ~~or~~ or more below existing floor surface.

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			Sheet No. B02 of 02 Sheets		