

Executive Summary

TO: Brent Soderlin, PE, CFM, Director of Public Works and Utilities, Littleton, Colorado (City)
FROM: Tim Phelan, PE
SUBJECT: Slaughterhouse Gulch Flume
DATE: December 6, 2024
CC:

Benesch recently conducted an inspection of the structure supporting the Slaughterhouse Gulch Flume located in Slaughterhouse Gulch Park within Littleton, Colorado. The inspection report, provided in **Appendix A**, identified the following concerns:

- Corrosion, holes, and leaks in multiple locations throughout the flume deck.
- Corroded and impacted steel members supporting the flume.
- Spalled concrete and a missing anchor bolt at the northern-most abutment.
- Undermining of the soil supporting the pier below the truss support resulting in 10 percent remaining bearing capacity. The undermining resulted from Slaughterhouse Gulch channel flows at the pier.
- Heavy vegetation growth under and around the structure.

Based on these observations, Benesch provided recommendations to stabilize the footings around the undermined pier and install riprap to prevent further erosion. The extent of the foundation support undermining is considered a serious condition that needs to be addressed prior to further undermining that could lead to a potential collapse of the structure in this location. In addition, Benesch recommended repairs of the flume exhibiting holes and leaks that can affect underlying structural components from prolonged moisture exposure and corrosion of the steel members. Furthermore, removal of the vegetation under and around the structure may result in a compromised structure as the vegetation grows.

Given the apparent age of the structure, Benesch retained the services of DS Environmental Consulting to test the accessible materials of the flume structure for lead based paint. Their report, provided in **Appendix B**, identified isolated areas *“of lead paint higher than the State of Colorado regulatory levels”* and recommended *“lead safe’ work practices are required when disturbing, removing, or impacting the tested components.”* It should be noted that not all elements could be accessed given the vegetation and height of the structure and additional testing may be required prior to conducting such work or ensuring that such work practices are implemented.

It is Benesch’s understanding that the function of the flume to convey water will no longer be necessary in the near future, but the exact timeframe is currently in flux. To evaluate options of what to do with the structure once it has been decommissioned, the City requested Benesch to provide a rough order magnitude cost estimate for varying conditions to assist with their evaluation. It was also requested that Benesch consider the costs of maintaining the operable nature of the flume to convey water in some manner to be determined. **Appendix C** outlines the costs for the three conditions requested, as outlined below:

- 1) Repair the existing structure per the observations and recommendations provided in the inspection report. These costs identified the necessary expenses to address the concerns identified, such as repair of the undermined pier, replace portions of the flume that leaked, clean and paint the corroded areas,

remove vegetation in the vicinity, patch concrete areas, install new anchor bolts, and address the impacted members.

- 2) Future standard maintenance costs to preserve the structure periodically (estimated to be approximately every 10 years). These costs included painting the entire structure, removing vegetation in the vicinity as it regrows, and replacing assumed areas that are anticipated to leak over time should the flume continue to carry water.
- 3) Costs to disassemble and reassemble the structure to another location for prominent display within the park. These costs were broken down into moving the truss and supports only, moving a single span of the flume support only, and miscellaneous elements that will need to be considered for the detachment and replacement of the structures. The total number of spans was considered as those that were not associated with being supported by concrete abutments or piers and provided a total price if all spans unsupported by abutments and piers were considered for displacement. Mechanical systems for pumping water through the flume were not considered in the cost estimate.

A 40% contingency was provided for the cost estimates to cover unknown factors that often occur when repairing or moving existing structures, to account for taxes, overhead, and profit, variability of current costs, as well as variability of future anticipated costs given the unknowns of when work on the structure may occur. As stated, these costs are a rough order magnitude for comparison purposes and may be easily adjusted to account for such changes in costs or any known costs available to the City.

Please feel free to contact us with any questions about this project.

Respectfully submitted,

A handwritten signature in blue ink, appearing to read "Tim R. Phelan", followed by a horizontal line.

Timothy "Tim" R. Phelan, PE
Project Manager

Amar Jaishi, EIT, CBSI
Designer

Appendix A: Structure Inspection Report
Appendix B: Lead-Based Paint Inspection Report
Appendix C: Costs Estimates

Appendix A: Structure Inspection Report



Routine Inspection Flume Structure Inspection and Inventory Report

Bridge Key: Slaughterhouse Gulch

Inspection Date 90: 07/30/2024

Sufficiency Rating: N/A

SD

NBI Reporting ID:	Slaughterhouse Gulch			Main Mat/Design 43A/B:	3	09	Bridge Cost 94:	\$0		
Region/Sect 2E/2M:	Reg 1	MSec 5		Appr Mat/Design 44A/B:	3	03	Roadway Cost 95:	\$0		
Tran Region 2T:	6	Greater Denver		Main Spans Unit 45:	1		Total Cost 96:	\$0		
County Code 3:	005	Arapahoe		Approach Spans 46:	12		Year of Cost Estimate 97:			
				Horizontal Clrnc 47:	6.3 ft		Brdr Brdg Code/% 98A/B:	-	-	
Place Code 4:	45255	Littleton		Max Span 48:	48.0 ft		Border Bridge No. 99:			
				Structure Length 49:	230.2 ft		Defense Highway 100:	0	No	
Route (On/Under) 5A:	1	Route On Structure		Curb Width L/R 50A/B:	0.0 ft	0.0 ft	Parallel Structure 101:	N	No bridge exists	
Signing Prefix 5B:	8	Other (describe)		Width Curb to Curb 51:	6.3 ft		Direction of Traffic 102:	0	No Vehicles	
Level of Service 5C:	0	None		Width Out to Out 52:	6.9 ft		Temporary Structr 103:			
Direction Suffix 5E:	0	N/A		Deck Area:	1588.38 sf		Highway Systems 104:	0	Not on NHS	
Feature Intersected 6:				Min Clr ovr Brdg 53:	99.9 ft		Fed Lands Hwy 105:	0	Not Applicable	
	Slaughterhouse Gulch			Min Undrclr Ref 54A:	N Not over hwy/RR		Year Reconstructed 106:			
Facility Carried 7:				Min Underclr 54B:	0.0 ft		Deck Type 107:	9	Other	
	City Ditch			Min Lat Clrnce Ref R 55A:	N Not over hwy/RR		Wearing Surface 108A:	0	None	
Alias Struc No. 8A:				Min Lat Undrclr R 55B:	0.0 ft		Membrane 108B:	9	Other	
				Min Lat Undrclr L 56:	0.0 ft		Deck Protection 108C:	0	None	
Parallel Struc No. 8P:				Deck Rating 58:	5	Fair	Truck ADT 109:			
				Superstructure Rating 59:	6	Satisfactory	Truck Net 110:	0	No	
Location 9:				Substructure Rating 60:	3	Serious	Pier Protection 111:			
	Slaughterhouse Gulch Park			Channel/Protectn Rtg 61:	6	Freq Minor Dam	NBIS Length 112:	Y	Bridge Length	
Max Clearance 10:	99.9 ft			Culvert Rating 62:	N	Not Applicable	Scour Critical 113:	2	Unstable (Condition	
Base Hwy Net 12:	0	Not on Base Ntwk		Operating Rtg Method 63:	5	No Rating	Scour Watch 113M:	N	No watch	
LRS Inv Route 13A:	0000000000			Operating Rating 64:			Future ADT 114:			
LRS Sub Route No 13B:	00			Operating Factor 64:			Year of Future ADT 115:			
Latitude 16:	39° 37' 02.12"			Inv Rating Method 65:	5	No Rating	CDOT Struct Type 120A:	SDT	Steel Deck Truss	
Longitude 17:	105° 00' 36.62"			Inventory Rating 66:			CDOT Constr Type 120B:	00	Not Appl/Unknown	
Detour Length 19:	1.0 mi			Inventory Factor 66:			Inspection Indic 122A:			
Toll Facility 20:	3	On Toll Free Road		Asphalt/Fill Thick 66T:	0.0 in		Inspection Trip 122AA:			
Custodian 21:	04	City/Municipal Hwy		Structure Evaluation 67:	3	Correct - Intoler.	Scheduling Status 122B:	0	Not applicable	
Owner 22:	04	City/Municipal Hwy		Deck Geometry 68:	N	Not Applicable	Maintenance Patrol 123:			
Functional Class 26:	19	Urban Local		Undrclr Vert/Horiz 69:	N	Not Applicable	Expansion Dev/Type 124:	O	None	
Year Built 27:	1901			Posting 70:	N	Not Applicable	rdg Rail Type/Mod 125A/B:			
Lanes On 28A:	00			Water Adequacy 71:	8	Deck > approach	Posting Trucks 129A/B/C:	-	-	-
Lanes Under 28B:	00			Approach Alignment 72:	8	Desirable	Structure Rating Date 130:			
ADT 29:	0			Type of Work 75A:			Special Equipment 133:	00	None	
Year of ADT 30:	1901			Work Done By 75B:			Vert Clr N/E 134A/B/C:	X	99'	00'
Design Load 31:	0	Unknown/Other		Lngth of Imprvmt 76:	0.00 ft		Vert Clr S/W 135A/B/C:	X	99'	00'
Apr Rdwy Width 32:	0.0 ft			Insp Team Indicator 90B:	Benesch		Vertical Clearance Date:	1/1/1901		
Median 33:	0	No Median		Inspector Name 90C:	AJAISHI		Weight Limit Color 139:	0	White	
Skew 34:	0.00°			Frequency 91:	12 months		Struct Billing Type:			
Structure Flared 35:	0	No Flare		FC Frequency 92A:			Userkey 1, Insp System:			
Safety Rail 36A/B/C/D:	N	N	N	UW Frequency 92B:			Userkey 4, Insp Sched:			
Rail Height 36H:	0.0 in			OS Frequency 92C:			Userkey 5, UW Sched:			
Hist Significance 37:	5	Not Eligible		FC Insp Date 93A:			Userkey 6, Pin Sched:			
Posting Status 41:	K	Bridge closed		UW Insp Date 93B:			Inspection Key:			
Service On/under 42A/B:	0	5		OS Insp Date 93C:						



Routine Inspection

Structure Inspection and Inventory Report

Element Inspection Report

Inspection Date: 7/30/2024

Elm/Env	Description	Unit	Total Qty	% in 1	CS 1	% in 2	CS 2	% in 3	CS 3	% in 4	CS 4
60/1	Other Deck	(SF)	1589	92%	1469	0%	0	5%	81	2%	39
Deck is a steel open half cylinder flume with rubber liner with (2) bolt bands at each joint and (1) intermediate bolt band at 3 foot spacing; painted gray. Top: Mostly covered with liner filled with water, no major deficiencies noted. Bottom: Paint is peeling off throughout, primarily along joints. Span 5 near Pier 6 has active leakage along joints (1SF CS4). Spans 5 through 13 along bolt banks have isolated R2-R3 corrosion (58SF CS3). Span 6 at 9 feet from Pier 7 has 4.5 feet x 3 feet area of R3-R4 corrosion (14SF CS3). Span 6 near mid-point has 3 feet x 3 feet area of R4 corrosion (9SF CS4). Span 8 has area of pinhole R2 corrosion with rust staining up to 1 inch diameter (9SF CS3). Span 9 has 6 feet long x 3 feet wide area of impact damage and 3 inch diameter (2) corrosion holes (20SF CS4). Span 11 bolt band near Pier 11 has 3 feet x 3 feet area of R4 corrosion (9SF CS4).											
107/1	Steel Open Girder	(LF)	362	0%	0	100%	362	0%	0	0%	0
(2) C-channel beams with frequent web splice plates welded to north beam and bolted to south beam; transverse bracing at 3 feet spacing; painted gray. Beam flanges and webs have R1 corrosion throughout (362LF CS2). Span 12 bottom flange has (2) open holes at (2) locations.											
120/1	Steel Truss	(LF)	96	0%	0	100%	96	0%	0	0%	0
Span 6 is a welded truss; painted gray. Both trusses lower chords have isolated R1 corrosion throughout (96LF CS2). Active water leakage through diversion and water splashing Truss 6A lower chord. Truss 6A lower chord at mid-point has a 4 foot upward bend (4LF CS2 overlap).											
205/1	R/Conc Column	(EA)	2	50%	1	50%	1	0%	0	0%	0
Pier 13 has (2) trapezoidal columns. East column on top has S2 scaling (1EA CS2).											
207/1	Steel Tower	(LF)	100	66%	66	34%	34	0%	0	0%	0
Steel trestle sitting on concrete footings at all piers except Pier 13. Trestle diagonals, base plates, horizontal and vertical members have isolated R1 corrosion up to 3 foot (33LF CS2). Pier 3 trestle verticals have (2) open holes. Pier 7 middle horizontal member at weld connection is bent north by 0.25 inch (1LF CS2). Piers 9, 10, and 11 trestles have kickers welded between vertical columns and beam bottom flange.											
215/1	R/Conc Abutment	(LF)	14	86%	12	0%	0	14%	2	0%	0
CIP abutments with step outs for bearings. Abutment 14 along joint has active leakage. Abutment 14 west end has 8 inch x 1 foot x 3 inch deep edge spall (1LF CS3). Abutment 14 east end has 8 inch x 20 inch x 5 inch deep spall (1LF CS3).											
220/1	R/Conc Pile Cap/Footing	(LF)	22	91%	20	0%	0	5%	1	5%	1
Concrete trapezoidal footings under steel trestles. Concrete footings have S1 scaling. Pier 6 west footing south and west faces fully exposed with 36 inch x 36 inch deep undermining and 10 percent remaining bearing capacity (1EA CS4). Pier 6 east footing south face fully exposed with no undermining (1EA CS3).											
311/1	Movable Bearing	(EA)	6	83%	5	0%	0	0%	0	17%	1
Moveable bearings at both abutments and Pier 13. Abutment 14 east end bearing has missing anchor bolt and up to 40 percent bearing area loss (1EA CS4).											
313/1	Fixed Bearing	(EA)	22	100%	22	0%	0	0%	0	0%	0
Fixed bearings at all piers except Pier 13. No significant defects noted.											



Routine Inspection

Structure Inspection and Inventory Report

Element Inspection Report

Inspection Date: 7/30/2024

Elm/Env	Description	Unit	Total Qty	% in 1	CS 1	% in 2	CS 2	% in 3	CS 3	% in 4	CS 4
326/1	Wingwall	(EA)	4	100%	4	0%	0	0%	0	0%	0
Concrete wingwalls monolithic with abutments. Wingwalls have insignificant to medium cracks with minor edge spalls. Northeast wingwall has S2 scaling.											
501/1	Channel/Bank	(EA)	1	100%	1	0%	0	0%	0	0%	0
Flow is east to west under Span 6 (Truss span). Inlet channel comes in and flows against Pier 6 causing undermining. Channel lined with large sized rocks with concrete weir. Channel bank has vertical erosion on downstream side of structure. Heavy vegetation growth under and around the structure. Storm drain at east side of Pier 5.											
600/1	General Remarks										
Centennial Link Trail path runs under Span 9. High water debris on both sides of flume inlet.											

Maintenance Recommendations	Quantity	Date Recommended	Maintenance Category
Substructure-Rip Rap	2 EA	07/30/2024	Serious
Stabilize and install riprap around Pier 6 footings.			
Substructure-Patch Spalls	120 SF	07/30/2024	High
Patch holes and clean and paint corrosion on deck underside.			
Channel-Remove Debris	1 EA	07/30/2024	High
Clear vegetation under and around the structure.			

Inspection Notes

Inspector(s): A. Jaishi, R. Spicer

Date: 07/30/2024

Time: 7:24 AM

Temp: 67°

Weather: Clear

Calm

Bridge Notes

Inventory route is south to north

East side is upstream

Superstructure is named Beam/Truss A to B from west to east; and truss nodes number upper (U) or lower (L) 0 to 8 from south to north

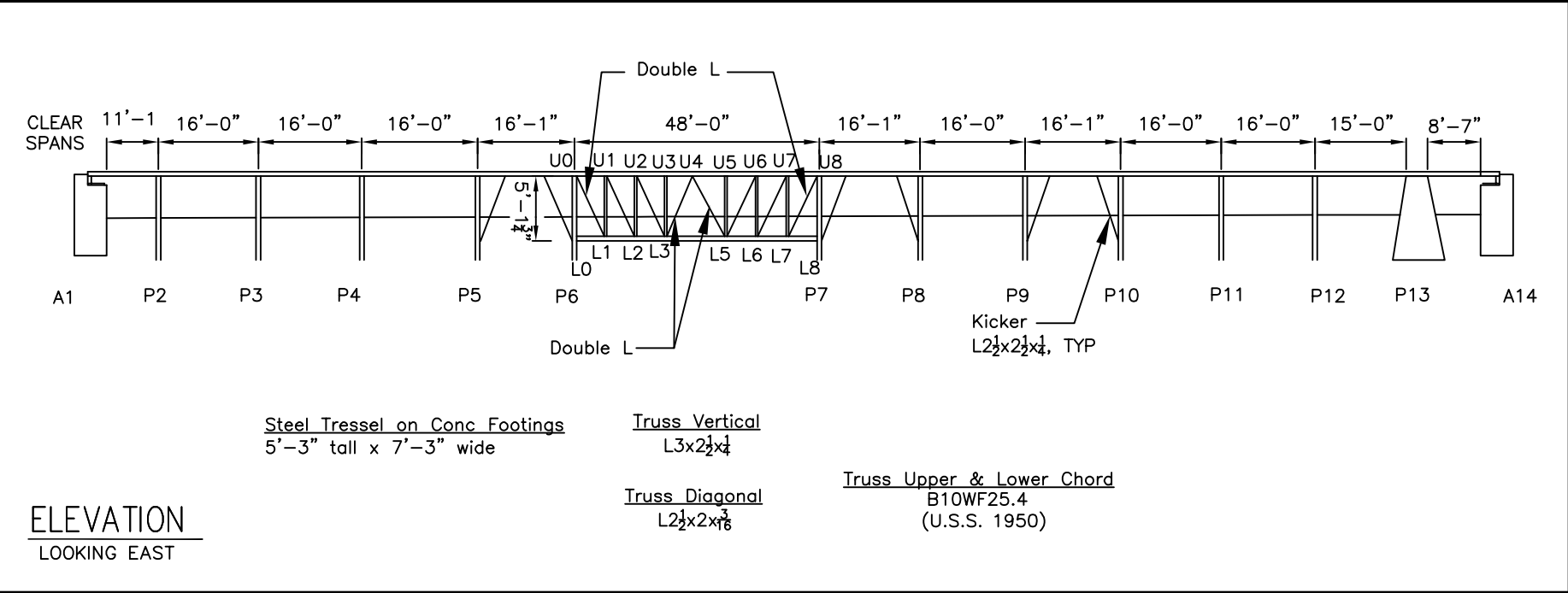
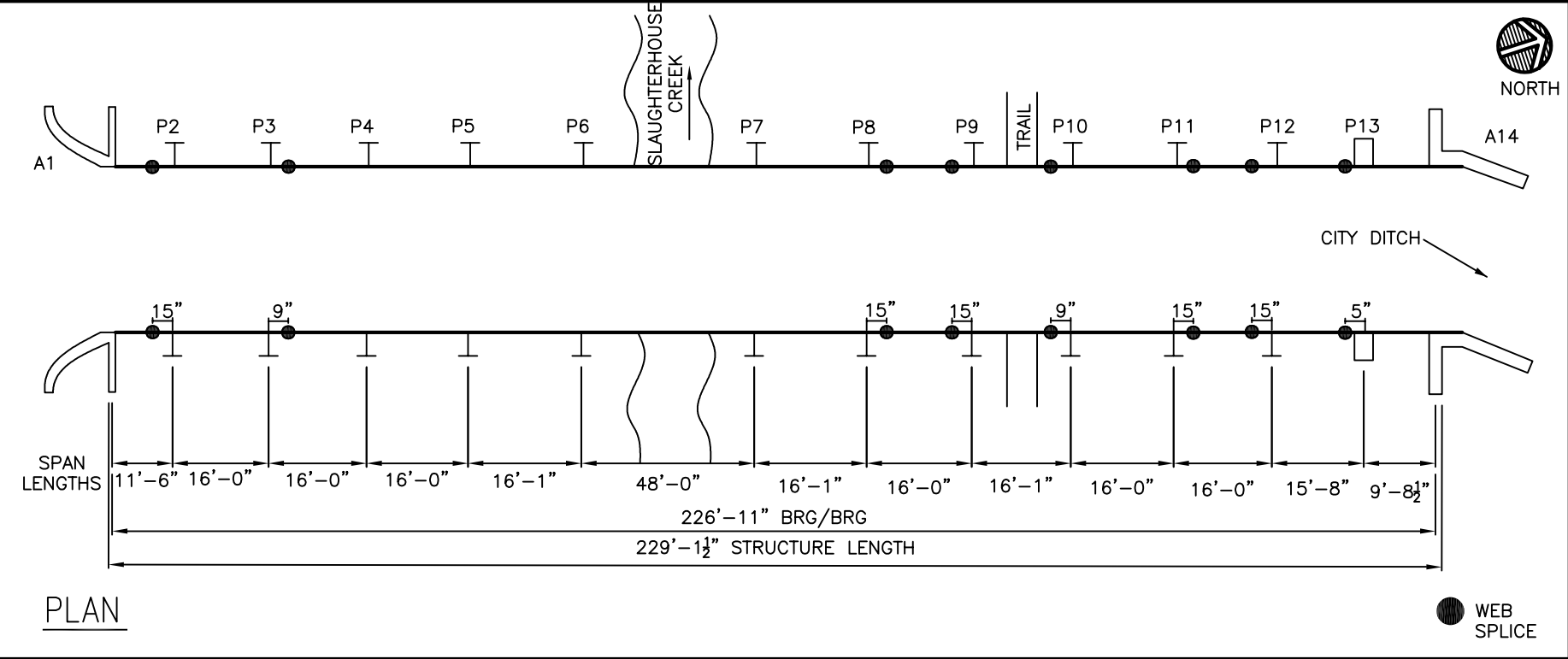
Substructure is numbered 1 through 14 from south to north

Scope:

☒ Routine ☒ Element ☐ Fracture Critical ☐ Underwater ☐ Other Special

Inspection Date: 07/30/2024


Inspector (Team Leader): AJAISHI



benesch

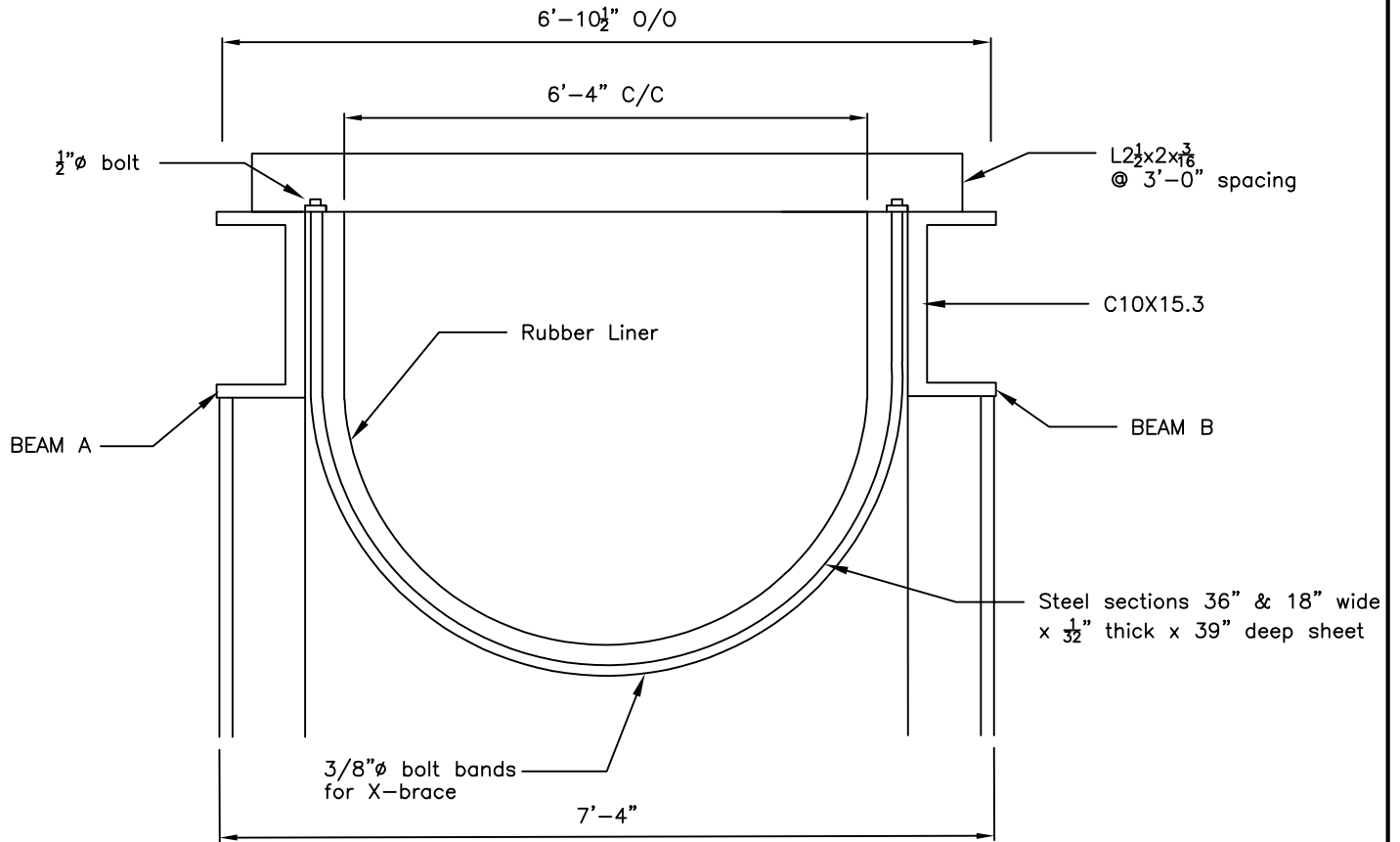


benesch

TITLE: Slaughterhouse Gulch PROJECT: 1525-400003.00

DATE: 7/30/2024

SHEET NO.: 2 OF 2



TRESSELS		
VERTICALS	DIAGONALS	HORIZONTALS
T5WF10.5 (U.S.S. 1950)	L2 1/2 x 2 x 3/8	L2 1/2 x 2 x 3/8

SECTION
LOOKING NORTH



Flume looking northeast.



Flume looking southwest.



Elevation looking southwest.



Elevation looking southeast.



Elevation looking east (Spans 8, 9, and 10).



Elevation looking west (Spans 8, 9, and 10).



Elevation looking northeast towards Abutment 14.



Span 9 underside looking north.



Channel looking east upstream.



Channel looking west downstream.



Concrete weir across channel under Span 6.



Abutment 1 general.



Abutment 14 general.



Deck underside at bolt bands has R2-R3 corrosion, typical.



Deck underside in Span 8 along bolt band has R4 corrosion.



Deck underside in Span 8 has area of pinhole corrosion.



Deck underside in Span 9 has up to 3 inch diameter corrosion holes.



Deck underside in Span 9, 6 feet x 3 feet area of impact damage.



Deck underside in Span 11 has area of R4 corrosion.



Flume looking north (topside).



Flume looking southwest (topside).



Beam A has R1 corrosion, typical.



Moveable bearing at Pier 13, typical.



Abutment 14 east end spall with bearing area loss and missing connection.



Abutment 14 west end spall.



Pier 13 east column at top has S2 scaling.



Truss 6A lower chord bent upwards at mid-point looking east.



Truss 6A lower chord bent upwards at mid-point looking west.



Trestle diagonals have spotty R1 corrosion, typical.



Beam web splice connection at Pier 13, typical.



Pier 7 trestle middle horizontal member bent north.



Pier 10 trestle general.



Pier 12 trestle general.



Pier 6 east footing south face fully exposed with no undermining.



Pier 6 west footing undermined.



Pier 6 west footing has 10 percent remaining bearing capacity.



Pier 6 west footing undermined up to 20 inches vertically.



Northwest bearing between beam and abutment.



Northeast wingwall has S2 scaling.



Northwest end of structure with vegetation growth.



Storm drain at east side of Pier 5.

Appendix B: Lead-Based Paint Inspection Report



“The trusted choice for your environmental & industrial hygiene needs.”

LEAD-BASED PAINT INSPECTION REPORT

Slaughterhouse Gulch Flume

39°37'02.1"N 105°00'36.8"W

Littleton, CO

PRESENTED TO:

Benesch
Tim Phelan, PE
Project Manager
tphelan@benesch.com
Phone: (720) 689-9340
Cell: (720) 614-2926
Office: (303) 771-6868

INSPECTED BY:

Mr. Sean Work
DS Environmental
Cell: (720) 878-1741

A handwritten signature in blue ink that reads 'Sean' with a stylized flourish.

PROJECT DETAILS:

DS Job Number: 27627
Date of Inspection: October 22, 2024



Front Range 7555 W 10th Ave
Suite A, Lakewood, CO 80214

Web dsconsultinginc.com

Mountains PO Box 6864
Avon, CO 81620

Direct (303) 286-9094

Western Slope PO Box 3793
Aspen, CO 81612

Fax (303) 986-0121

Table of Contents

1.0	Introduction
2.0	Definitions
3.0	Scope of Work
4.0	Inspector & Firm Certifications
5.0	Overview of Findings
6.0	Equipment Information
7.0	Inspection & Testing Procedures
8.0	Conclusion & Recommendations
9.0	Disclaimer & Limitations
10.0	Copyright Notice

APPENDIX A	XRF Data Table
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APPENDIX B	Inspector & Firm Certificates
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1.0 Introduction

Mr. Sean Work with DS Environmental Consulting (DS) performed a comprehensive lead-based paint (LBP) inspection and performed in situ X-Ray Florescence (XRF) testing to determine the presence of LBP on painted components of the Slaughterhouse Gulch Flume, running roughly east to west, spanning Slaughterhouse Gulch in Littleton, CO. The coordinates are 39°37'02.1"N 105°00'36.8"W.

The purpose of the inspection was to determine if any of the materials on the flume, or the immediate area around it, contains lead-based paint.

LBP was found on the deck of the flume.

Table 1 and Table 2 in Section 6.0 further details the materials that contain LBP and those that do not. The full table (Table 3), including all XRF readings, can be found in Appendix A.

2.0 Definitions

Lead-based Paint (LBP) is any paint having concentrations of lead greater than 1.0 mg/cm², which is also Colorado's action level.

Paint is any liquid mixture, usually of solid pigment in a liquid form, used as a decorative or protective coating. This includes, but is not limited to, primer, lacquer, polyurethane, wood stain, etc.

X-Ray Florescence (XRF) is a non-destructive analytical technique used to determine the elemental composition of materials. XRF analyzers determine the chemistry of a sample by measuring the fluorescent (or secondary) X-ray emitted from a sample when it is excited by a primary X-ray source.

3.0 Scope of Work

This inspection was comprehensive in its scope and included all areas and suspect, painted components on and in the immediate area of the flume. The LBP inspection did not constitute a hazard assessment.

Some components of the flume were inaccessible at the time of inspection; these materials must be assumed to have LBP until further testing is performed. Please refer to the photos in section 5.0 for more details.

*Should any material that would have been impossible to find during this inspection be discovered, that was not subject to this sampling, that material shall be assumed to be LBP if it is painted and must be sampled upon discovery.

4.0 Certifications

Mr. Work is a Colorado State Certified LBP Inspector, having EPA Accreditation #27686. DS Environmental Consulting is a Colorado State Certified Lead Evaluation Firm, license #16918. Mr. Work is certified to operate the Viken Pb200i XRF Lead Paint Spectrum Analyzers by the manufacturer (see Appendix B for certificates).

5.0 Overview of Findings

Table 1: Components that Contain LBP

Read No.	Area	Structure	Paint Cond	Substrate	Paint Color	Lead (mg/cm ²)	Result
14	Flume South End	Deck	Significantly Damaged	Metal	Silver	3.1	POS
18	Flume South End	Deck	Significantly Damaged	Metal	Silver	2.0	POS

Table 2: Components that Do Not Contain LBP

Read No.	Area	Structure	Paint Cond	Substrate	Paint Color	Lead (mg/cm ²)	Result
1	Flume North End	Wing wall	Intact	Concrete	Tan	0.4	Neg
2	Flume North End	Girder	Significantly Damaged	Metal	Silver	0.1	Neg
3	Flume North End	Deck	Significantly Damaged	Metal	Silver	0.1	Neg
4	Flume North End	Spanning Truss	Significantly Damaged	Metal	Silver	0.1	Neg
5	Flume North End	Spanning Truss	Significantly Damaged	Metal	Silver	0.1	Neg
6	Flume North End	Tower	Significantly Damaged	Metal	Silver	0.1	Neg
7	Flume central (near path)	Deck	Significantly Damaged	Metal	Silver	0.1	Neg
8	Flume central (near path)	Tower	Significantly Damaged	Metal	Silver	0.1	Neg
9	Flume Central (over creek)	Truss	Significantly Damaged	Metal	Silver	0.1	Neg
10	Flume South End	Sluice Wheel	Intact	Metal	Orange	0.0	Neg
11	Flume South End	Sluice Frame	Intact	Metal	Silver	0.1	Neg
12	Flume South End	Sluice Frame	Intact	Metal	Black	0.1	Neg
13	Flume South End	Wing wall	Intact	Concrete	Tan	0.3	Neg
15	Flume South End	Girder	Significantly Damaged	Metal	Silver	0.1	Neg
16	Flume South End	Spanning Truss	Significantly Damaged	Metal	Silver	0.1	Neg
17	Flume South End	Tower	Significantly Damaged	Metal	Silver	0.1	Neg



Close-up of the deck. Contains 2.0 -3.1(mg/cm²)



Close-up of a girder. Negative



This component is identified as the Truss in this report. Negative



The vertical supports are identified as Towers in this report. Negative



The wingwall. Negative



These components are identified as spanning trusses in this report. Negative



The accessible sluice gate assembly. Negative



The sluice mechanism pictured here could not be safely accessed during this inspection and must be assumed to have LBP components. Assumed LBP

6.0 Equipment Information

LBP concentrations were obtained using a Viken Pb200i XRF Lead Paint Spectrum Analyzer, which is approved by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD) to determine the concentration of lead in paint.

The XRF was calibrated according to the manufacturer's Performance Characteristic Sheet (PCS). The XRF was calibrated using the calibration standard block of known 1.0 mg/cm² lead content as well as a standard block of known 0.0 mg/cm² lead content. Three (3) calibration readings of each block were taken before the inspection began as well as after the inspection was completed, every four hours of continuous use, and/or following a battery change.

7.0 Inspection & Testing Procedures

The LBP inspection and XRF testing were conducted by a State of Colorado accredited LBP Inspector qualified by experience, education, and training in approved LBP testing techniques. These procedures call for the visual inspection of the areas of concern and the collection of XRF readings for lead concentrations.

This inspection was performed in accordance with the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD) guidelines for lead-hazard inspections, as well as the State of Colorado Air Quality Control Commission Regulation No. 19 for the Control of Lead Hazards. The EPA's 40 CFR Part 745 Final Rule (January 5, 2001) set standards for the identification of dangerous levels of lead. The standards identify when lead-based paint, lead-contaminated dust, and lead-contaminated soil are hazards. It also establishes residential dust clean-up levels (post-abatement clearance levels) and set dust and soil sampling requirements. The lead-based paint readings were collected by XRF analyzation for the purpose of determining lead concentrations as mg/cm².

8.0 Conclusions & Recommendations

Concentrations of lead in paint higher than the State of Colorado regulatory levels were identified; therefore, "lead safe" work practices are required when disturbing, removing, or impacting the tested components. Some components could not be safely accessed and must be assumed to have LBP. Additional testing is required if new materials are discovered or the scope of work changes.

Regarding the deck, the only tested-positive LBP component, it should be noted that not every sampling of the homogeneous components came back as containing lead-based paint. The two tests that came back positive were on the South end of the flume, the 4th and 6th segments of the deck from the end, to be exact. However, it is not feasible to delineate the exact locations of LBP segments of the deck due to environmental conditions. Therefore, all segments should be assumed to have lead-based paint on them.

9.0 Disclaimer & Limitations

This limited-scope inspection does not constitute a lead-hazard assessment. Other areas not tested and conditions existing outside this scope of work may contain lead concentrations above the regulatory action levels. Consequently, to determine whether lead-based paint exists within other areas of the building, a full lead-based paint inspection must occur.

10.0 Copyright Notice

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APPENDIX A: XRF READINGS

Pre-inspection Calibration – Known LBP Calibration Block						Average: 1.0	PASS
Pre -inspection Calibration – Known LBP Calibration Block							
Pre -inspection Calibration – Known LBP Calibration Block							
Pre -inspection Calibration – Known Negative Calibration Block						Average: 0.0	PASS
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Read No.	Area	Structure	Paint Cond	Substrate	Paint Color	Lead (mg/cm²)	Result
1	Flume North End	Wing wall	Intact	Concrete	Tan	0.0	Neg
2	Flume North End	Girder	Significantly Damaged	Metal	Silver	0.0	Neg
3	Flume North End	Deck	Significantly Damaged	Metal	Silver	0.0	Neg
4	Flume North End	Spanning Truss	Significantly Damaged	Metal	Silver	0.0	Neg
5	Flume North End	Spanning Truss	Significantly Damaged	Metal	Silver	0.0	Neg
6	Flume North End	Tower	Significantly Damaged	Metal	Silver	0.0	Neg
7	Flume central (near path)	Deck	Significantly Damaged	Metal	Silver	0.0	Neg
8	Flume central (near path)	Tower	Significantly Damaged	Metal	Silver	0.0	Neg
9	Flume Central (over creek)	Truss	Significantly Damaged	Metal	Silver	0.0	Neg
10	Flume South End	Sluice Wheel	Intact	Metal	Orange	0.0	Neg
11	Flume South End	Sluice Frame	Intact	Metal	Silver	0.0	Neg
12	Flume South End	Sluice Frame	Intact	Metal	Black	0.0	Neg
13	Flume South End	Wing wall	Intact	Concrete	Tan	0.0	Neg
14	Flume South End	Deck	Significantly Damaged	Metal	Silver	3.1	POS
15	Flume South End	Girder	Significantly Damaged	Metal	Silver	0.0	Neg
16	Flume South End	Spanning Truss	Significantly Damaged	Metal	Silver	0.0	Neg
17	Flume South End	Tower	Significantly Damaged	Metal	Silver	0.0	Neg
18	Flume South End	Deck	Significantly Damaged	Metal	Silver	2.0	POS
Post-inspection Calibration – Known LBP Calibration Block						Average: 1.0	PASS
Post -inspection Calibration – Known LBP Calibration Block							
Post -inspection Calibration – Known LBP Calibration Block							
Post -inspection Calibration – Known Negative Calibration Block						Average: 0.0	PASS
Post -inspection Calibration – Known Negative Calibration Block							
Post -inspection Calibration – Known Negative Calibration Block							

APPENDIX B: INSPECTOR & FIRM CERTIFICATES



Inspector Certification: 17285



Firm Certification: 16918



Viken (formerly Heuresis) Pb200i XRF Certification

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Appendix C: Cost Estimates

Cost Estimate Calculations_Slaughterhouse

 Version: 1	Computed by:	TRP	Date:	11/22/2024	Sheet:	
	Checked by:	APJ	Date:	12/2/2024	Project No.:	1525-400003.01
	Project:	Slaughterhouse Gulch Flume, Littleton, CO				
	Element:	Repair Cost Estimate				

Repair Recommendations	Maintenance Category	Date Recommende	Description	Unit	Cost/Unit		Quantity	Total	Notes	Quantity Basis
					Remove	Replace				
Stabilize and install riprap around Pier 6 Footing	Serious	7/30/2024	FLOWABLE FILL	CY	\$ -	\$ 400.00	1.00	\$ 400.00	Per Report 3'x3'x3' use 1 cu yd	Report
Stabilize and install riprap around Pier 6 Footing	Serious	7/30/2024	RIPRAP (9 IN)	CY	\$ -	\$ 630.00	53.33	\$ 33,600.00	Width of Flume ~ 7' +3' for footings + 10' extend beyond footings x distance between Piers 6 & 7 = 48' x 1.5' depth of rip rap	Report
Patch holes on deck underside	High	7/30/2024	78 INCH EQUIVALENT CORRUGATED STEEL PIPE ARCH	LF	\$ 400.00	\$ 1,100.00	27.0	\$ 40,500.00	Spans with 3' sections of rusted through areas noted in report at 9 locations for replacement using similar pricing for corrugated steel pipe arch	Report
Replace rubber liner at replaced sections	High	7/30/2024	RUBBER LINER	SF	\$ 5.00	\$ 20.00	273.1	\$ 6,827.65	Surface area of flume trough over length of replaced panels	Report
Clean and paint corrosion on deck underside	High	7/30/2024	PAINT EXISTING STRUCTURE	SF	\$ -	\$ 25.00	2328.5	\$ 58,212.07	10.125' long curved section x 230.2 ft length remove corrosion and paint	Report
Clear vegetation under and around structure	High	7/30/2024	CLEARING AND GRUBBING	ACRE	\$ -	\$ 30,000.00	0.10	\$ 3,000.00	Removal of vegetation minimum area of 0.1 acre = 230 ft length = ~19' width on either side of tressel	Assumed
Forestry Services for Clearing and Grubbing	Low	7/30/2024	FORESTRY SERVICES	EA	\$ -	\$ 50,000.00	1.0	\$ 50,000.00	Verify with Littleton for Forestry Services Requirements	Report
Clean and paint corrosion on channel supports	Low	7/30/2024	PAINT EXISTING STRUCTURE	SF	\$ -	\$ 25.00	604.9	\$ 15,122.60	Paint 2 channels outside face = ~20" x 182.2 ft length	Report
Clean and paint corrosion on truss members	Low	7/30/2024	PAINT EXISTING STRUCTURE	SF	\$ -	\$ 25.00	201.8	\$ 5,043.75	Paint 2 sides of 24 diagonals 8' LG and 12 verticals 5.25' LG of Truss Chords	Report
Bent truss member	Low	7/30/2024	ADJUST STRUCTURE	EA	\$ -	\$ 3,000.00	1	\$ 3,000.00	Adjust 4-foot upward bend at lower chord of Truss A	Report
Concrete Abutment Patch	High	7/30/2024	CONCRETE PATCHING ON VERTICAL SURFACES - CLASS 2	SF	\$ 100.00	\$ 400.00	1.78	\$ 888.89	Abutment 14 Concrete Patching 8"x1'x3" and 8" x 20" x 5"	Report
Install Anchor Bolt	High	7/30/2024	INSTALL ANCHOR BOLT	EA	\$ -	\$ 250.00	1.00	\$ 250.00	Abutment 14 install anchor bolt	

Total \$ 216,844.97
 40% Contingency \$ 86,737.99 Contingency covers unknowns, taxes, future costs, etc.
Estimated Repair Cost \$ 303,582.96

 Version: 1	Computed by:	TRP	Date:	11/22/2024	Sheet:	
	Checked by:	APJ	Date:	12/2/2024	Project No.:	1525-400003.01
	Project:	Slaughterhouse Gulch Flume, Littleton, CO				
	Element:	Maintenance Cost Estimate ~ Every 10 years				

Maintenance Recommendations	Description	Unit	Cost/Unit		Quantity	Total	Notes	Quantity Basis
			Remove	Replace				
Replace deteriorated sections of metal flume	78 INCH EQUIVALENT CORRUGATED STEEL PIPE ARCH	LF	\$ 400.00	\$ 1,100.00	6.0	\$ 9,000.00	Spans with 3' sections assumed at 2 locations for replacement using similar pricing for corrugated steel pipe arch per maintenance cycle	Report
Paint existing structure entirely	PAINT EXISTING STRUCTURE	SF	\$ -	\$ 25.00	4778.9	\$ 119,472.78	Paint Structure	Report
Clear vegetation in, under, and around structure	CLEARING AND GRUBBING	ACRE	\$ -	\$ 30,000.00	0.10	\$ 3,000.00	Removal of vegetation minimum area of 0.1 acre = 230 ft length = ~19' width on either side of tressel	Assumed
Replace rubber liner	RUBBER LINER	SF	\$ 5.00	\$ 20.00	2328.5	\$ 58,212.07	Matches surface area of flume trough	Report
Forestry Services for Clearing and Grubbing	FORESTRY SERVICES	EA	\$ -	\$ 50,000.00	1.0	\$ 50,000.00	Verify with Littleton for Forestry Services Requirements	Report

Maintenance costs are estimated to occur approximately every 10 years

Total	\$	239,684.86	
40% Contingency	\$	95,873.94	Contingency covers unknowns, taxes, future costs, etc.
Estimated Maintenance Cost	\$	335,558.80	

 Version: 1	Computed by:	TRP	Date:	11/22/2024	Sheet:	
	Checked by:	APJ	Date:	12/2/2024	Project No.:	1525-400003.01
	Project:	Slaughterhouse Gulch Flume, Littleton, CO				
	Element:	Movement Cost Estimate				

Maintenance Recommendations	Description	Unit	Cost/Unit		Quantity	Total	Notes	Quantity Basis
			Remove	Replace				
Truss Quantities								
Replace deteriorated sections of metal flume for truss	78 INCH EQUIVALENT CORRUGATED STEEL PIPE ARCH	LF	\$ 400.00	\$ 1,100.00	9.0	\$ 13,500.00	Spans with 3' sections of rusted through areas noted in report at 3 locations for replacement in truss using similar pricing for corrugated steel pipe arch	Report
Replace rubber liner throughout truss	RUBBER LINER	SF	\$ 5.00	\$ 20.00	485.5	\$ 12,138.05	Matches surface area of flume trough throughout truss length	Report
Paint existing truss structure entirely	PAINT EXISTING STRUCTURE	SF	\$ -	\$ 25.00	769.6	\$ 19,240.80	Paint Truss Structure	Report
New Foundations for Truss	CONCRETE CLASS D	CY	\$ -	\$ 900.00	6.1	\$ 5,466.67	New concrete foundations below Truss	Assumed
Disassemble and Reassemble Truss w/ 2 tressels	STRUCTURAL STEEL (REMOVE AND REPLACE)	LBS	\$ 10.00	\$ 10.00	7276.7	\$ 145,534.51	Move truss members to new location	Assumed
Disassemble and Reassemble Truss w/ 2 tressels	STRUCTURAL STEEL (NEW STEEL)	LBS	\$ -	\$ 20.00	727.7	\$ 14,553.45	Assume 10% of existing steel needs to be replaced/repared with new material	Assumed

Total to move the truss \$ 210,433.48

40% Contingency \$ 84,173.39 Contingency covers unknowns, taxes, future costs, etc.

Estimated Truss Movement Cost \$ 294,606.88

Typical Span Quantities								
Replace deteriorated sections of metal flume for a typical section	78 INCH EQUIVALENT CORRUGATED STEEL PIPE ARCH	LF	\$ 400.00	\$ 1,100.00	3.0	\$ 4,500.00	Spans with 3' sections of rusted through areas noted in report assumed at 1 location for replacement of typical span using similar pricing for corrugated steel pipe arch	Report
Replace rubber liner throughout span	RUBBER LINER	SF	\$ 5.00	\$ 20.00	162.7	\$ 4,067.09	Matches surface area of flume trough throughout typical span length	Report
Paint existing span structure entirely	PAINT EXISTING STRUCTURE	SF	\$ -	\$ 25.00	602.4	\$ 15,060.73	Paint Structure	Report
New Foundations for one Tressle	CONCRETE CLASS D	CY	\$ -	\$ 900.00	3.0	\$ 2,733.33	New concrete foundations below one tressel of span	Assumed
Disassemble and Reassemble typical span w/ 1 tressel	STRUCTURAL STEEL (REMOVE AND REPLACE)	LBS	\$ 10.00	\$ 10.00	1098.2	\$ 21,964.43	Move span members to new location	Assumed
Disassemble and Reassemble typical span w/ 1 tressel	STRUCTURAL STEEL (NEW STEEL)	LBS	\$ -	\$ 20.00	109.8	\$ 2,196.44	Assume 10% of existing steel needs to be replaced/repared with new material	Assumed

Total to move one span \$ 50,522.02

40% Contingency \$ 20,208.81 Contingency covers unknowns, taxes, future costs, etc.

Estimated Span Movement Cost \$ 70,730.83

Total number of Spans 9.0 Does not include spans with abutments, new abutments omitted

Total Cost for Number of Spans Above \$ 636,577.48

Miscellaneous Elements								
Clear vegetation in, under, and around structure as well as in path of movement	CLEARING AND GRUBBING	ACRE	\$ -	\$ 30,000.00	0.20	\$ 6,000.00	Removal of vegetation around existing and proposed areas	Aerial / Street View
Forestry Services for Clearing and Grubbing	FORESTRY SERVICES	EA	\$ -	\$ 50,000.00	1.0	\$ 50,000.00	Verify with Littleton for Forestry Services Requirements	Assumed
Engineering Design	ENGINEERING DESIGN	EA	\$ -	\$ 50,000.00	1.0	\$ 50,000.00	Verify with Littleton for Forestry Services Requirements	Assumed

Total \$ 106,000.00

40% Contingency \$ 42,400.00 Contingency covers unknowns, taxes, future costs, etc.

Estimated Cost \$ 148,400.00

Estimated Movement cost for the above scope and number of spans indicated \$ 1,079,584.36 Does not include spans with abutments, new abutments omitted from estimate