APPENDIX E - CONCEPTUAL HYDRAULICS REPORT

AECOM

TECHNICAL MEMORANDUM

TO: I-70 Project Folder

FROM: Kevin Klimek, PE (AECOM), Allison Ako, PE (AECOM)

DATE: November 27, 2018 (Revised 02/11/19)

RE: I-70 Structure F-13-S_Minor

Existing Drainage Conditions

This memorandum provides an overview of the existing drainage conditions at the I-70 Structure F-13-S_Minor located over Forest Road at MM 211 and the surrounding drainage facilities. AECOM was tasked with analyzing the existing drainage conditions to supplement the *I-70 over Forest Road Structure F-13-S_Minor Replacement Study.*

Site Visit and Data Acquisition

AECOM employees Kevin Klimek, Allison Ako, and Elliot Drumwright visited the project site on September 21, 2018 to document the existing conditions and infrastructure. Kevin and Allison focused on hydrology, hydraulics, and stormwater infrastructure in the project corridor whereas Elliot focused on geotechnical related matters including land slide condition. Elliot's observations and efforts are documented elsewhere.

The main goals of the site visit were to:

- Document the existing drainage conditions.
- Verify the existence of stormwater infrastructure documented by other studies and plans.
- Validate the completed tributary basins' delineations.
- Identify stormwater features that should be picked up by pending site survey efforts.
- Gather enough information to create an exhibit that identifies all of the existing stormwater infrastructure within the project vicinity (See Exhibit 1).

The project site is a local low spot where all runoff is directed during extreme events or if upstream drainage infrastructure is compromised. The site visit confirmed that the project vicinity could receive additional runoff due to bypass flows from areas upstream of the I-70 culvert. This was especially evident along the westbound shoulder of I-70 where several small inlets are at risk of being clogged due to sediment and debris potential or buried by snow storage efforts.

Existing Studies and Plans

A variety of plan sets were provided by CDOT and reviewed as part of the completed efforts. The most relevant plans included:

- 2012 18758 212 landslide repair – final phase C_0703-379
- F-13-S_Minor Extension Plans
- F-13-S_Minor Original Plans I-70-3(22)217
- I 70-3(66)212 Plans
- Pages from 2009 IM 0702 251_15052 I70 Sediment Control Phase III
- Pages from C_0703-371
- STE(CX) 070-3(197)

Existing Drainage System

I-70 Concrete Box Culvert (CBC)

The existing CBC is primarily used as turnaround passage for emergency, maintenance, and snow plow vehicles, not as a drainage passage. Flows are captured prior to the culvert through a storm drainage system located along the shoulder of the Interstate. However, the CBC likely conveys flows during the spring runoff when the adjacent stormwater infrastructure is covered with snow and during severe rainfall events when the adjacent stormwater infrastructure is at capacity or impacted by debris and/or sediment. Drainage improvements contemplated for the project vicinity as well as the I-70 culvert replacement options should be aware of this condition during the option evaluation and design efforts.

I-70 Westbound (WB)

The I-70 WB lanes are super elevated directing flow from the left lane toward the right lane. Flows are conveyed to an existing natural swale located between the shoulder and the toe of the slope. Four groundwater relief drains were installed into the side slope located east of the CBC along the WB lanes. Seepage collected and conveyed by these pipes along with additional seepage at the base of the toe produce constant flow in the existing roadside ditch paralleling the WB shoulder. Flow continues to the west into existing modified Type D inlets located north of the CBC. Record information drawings indicate that there are three Type D (Special) inlets (Inlets A, B, and C) in series for sediment and flow collection just upstream of the Type D inlet (Inlet D). The downstream inlet has an orifice plate that regulates flows collected by the three inlets. After passing through the orifice plate, flows are then are conveyed to an additional Type D inlet that then conveys flows under I-70 in a 48” reinforced concrete pipe (RCP) and outfalls on the Eastbound side slope, directly into Straight Creek. The RCP has been lined and has a conveyance capacity equal to a 36” pipe.

Only the tops of the three Type D inlets were identified during the site visit but survey indicates that the inlet rims are greater than 2 ft below the existing sediment level. A natural swale has formed directly over the three Type D inlets and passes flow directly to the last inlet, thereby suggesting that the covered inlets are at maximum sediment capacity.

I-70 Eastbound (EB)

The I-70 EB lanes are super elevated and flatten toward the West. Roadway runoff is collected in the grassed median and in a concrete swale located on the shoulder. Flow collected in the median is conveyed under I-70 to inlets located in the median. Flows east of the CBC that are collected along the shoulder flow west toward a trench drain connected to a Type 13 inlet and outfall into a sediment basin located just east of the east CBC downstream wing wall. This existing sediment pond appears to be

somewhat undersized; however, routine sediment removal appears to be occurring and the system appears to be functioning as intended. Flows discharged by the sediment pond ultimately are directed to Straight Creek.

A small area of flow is collected in a Type C inlet located near the west CBC downstream wing wall and outfalls on the EB side slope, directly into Straight Creek.

Drainage Features

A comprehensive list of existing drainage pipes and structures was completed within the project vicinity using survey data and record plans received from CDOT. See Table 1 for pipe properties, Table 2 for structure properties, and Exhibit 1 for pipe and structure locations within the project vicinity.

Table 1 – Drainage Features - Pipes

Drainage Feature	Feature Name	Type/ Material	Size / Diameter	Length (FT)	Invert In	Invert Out	Notes
Pipe	1	RCP	18"	15.53	10287.05	10286.72	Between Type D Inlet; Invert elevations estimated per *Pages from 2009 IM 0702 251_15052 I70 Sediment control Phase III*.
Pipe	2	RCP	18"	16.28	10286.72	10286.40	Between Type D Inlet; Invert elevations estimated per *Pages from 2009 IM 0702 251_15052 I70 Sediment control Phase III*.
Pipe	3	CSP	24”	33.65	10287.96	10287.33	
Pipe	4	RCP	48"	466.15	10285.85	10237.50	Pipe profile was estimated per *STE(CX) 070-3(197)* plans and survey. Pipe was relined and has a conveyance capacity of a 36” pipe.

Pipe	5	CSP	18"	8	10285.10	10278.39	Invert in estimated per *F-13-S_Minor Original Plans I-70-3(22)217*; Invert out estimated per straight line slope of 36" CPP.
Pipe	6	CSP	12"	28.12	10288.65	10277.64	Blind connection to 36" assumed. Invert out assumed per straight line slope of 36" CPP.
Underdrain	7	CSP	8"	48.13	N/A	N/A	Location estimated per *I 70-3(66)212* plans which indicates an 8" underdrain.
Pipe	8	CSP	18"	24.1	10266.92	10252.10	Invert in estimated per *F-13-S_Minor Original Plans I-70-3(22)217*; Invert out estimated per straight line slope of 36" CPP.
Pipe	9	RCP	24"	76.58	10281.58	10279.24	
Pipe	10	RCP	24"	21.11	10278.99	N/A	No additional information on this pipe found; unable to determine continued location or invert.
Pipe	11	CSP	24"	99.97	10316.05	10314.41	
Pipe	12	CSP	16"	24	N/A	10314.75	No additional information on this pipe found; unable to determine continued location or invert.
Pipe	13	CPP	24"	88.34	10314.21	10276.19	

Pipe	14	RCP	24"	23.75	10270.71	N/A	No additional information on this pipe found; unable to determine continued location or invert.
Pipe	15	CPP	24"	30.5	10274.52	10274.64	
Pipe	16	PP	48”	226.69	10237.50	10148.59	Pipe profile was estimated per *STE(CX) 070-3(197)* plans and survey.
Horizontal Drain	HD - 1	PVC	2"	110	10345.20	10331.72	Horizontal drain added per *2012 18758 212 Landslide Repair - Final Phase C_0703-379.* Upstream invert estimated per angle indicated on plans.
Horizontal Drain	HD - 2	PVC	2"	200	10371.40	10332.48	Horizontal drain added per *2012 18758 212 Landslide Repair - Final Phase C_0703-379.* Upstream invert estimated per angle indicated on plans.
Horizontal Drain	HD - 3	PVC	2"	150	10345.40	10332.30	Horizontal drain added per *2012 18758 212 Landslide Repair - Final Phase C_0703-379.* Upstream invert estimated per angle indicated on plans.

Horizontal Drain	HD - 4	PVC	2"	105	10342.40	10331.39	Horizontal drain added per *2012 18758 212 Landslide Repair - Final Phase C_0703-379.* Upstream invert estimated per angle indicated on plans.
French Drain	FD - 1	French Drain	18"x48"	175	N/A	N/A	French drain added per *2012 18758 212 Landslide Repair - Final Phase C_0703-379.* Not seen on site visit or indicated in survey. Location approximated per plans.

Table 2 – Drainage Features - Structures

Drainage Feature	Feature Name	Type/ Material	Structure Top	Structure Invert	Notes
Inlet	K	Type 13	10318.11	10314.21	
Inlet	H	Type C	10281.58	10281.58	Survey indicates inlet as other. *I 70-3(66)212* plans indicated numerous inlets in the area were updated to Type C. This inlet was not shown on those plans; unable to determine inlet type.
Inlet	F	Type C	10291.86	10288.65	
Inlet	J	Type C	10319.76	10316.76	
Inlet	I	Type C	10282.95	10278.99	
Inlet	L	Type C	10273.39	10270.71	
Inlet	D	Type D	10294.58	10285.85	

Inlet	M	4'x8' Concrete Water Quality Inlet	10278.34	10274.52	
Inlet	A	Type D Special	10292.63	10287.05	Structure not found on survey. Structure length and top/invert elevations estimated per *Pages from 2009 IM 0702 251_15052 I70 Sediment control Phase III.*
Inlet	B	Type D Special	10292.62	10286.72	Structure not found on survey. Structure length and top/invert elevations estimated per *Pages from 2009 IM 0702 251_15052 I70 Sediment control Phase III.*
Inlet	C	Type D Special	10292.62	10286.40	Structure not found on survey. Structure length and top/invert elevations estimated per *Pages from 2009 IM 0702 251_15052 I70 Sediment control Phase III.*
Inlet	G	Type C	10269.82	10266.82	Structure not found on survey. Structure location and top/invert elevations estimated per *F-13-S_Minor Original Plans I-70-3(22)217* which indicates a Type A inlet with an 18"x27' CMP connection to the 48" CPP at location approximated on the figure.
Inlet	E	Type C	10288.10	10285.10	Structure not found on survey. Structure location and top/invert elevations estimated per *F-13-S_Minor Original Plans I-70-3(22)217* which indicates a Type B inlet with an 18"x27' CMP connection to the 48" CPP at location approximated on the figure.

Additional Observations

Based on the observations made during the site visit and subsequent off-site hydrologic investigations, the existing drainage system appears to have sufficient storage and capacity to handle the 100-yr event when the system is properly maintained. Required maintenance activities primarily consist of removal of built up sediment and debris from existing inlets.

Hydrology Flows

The 50-year frequency was chosen for analysis, per Table 7.2 in CDOT's Drainage Design Manual for interstate cross drainage flows in rural areas. Preliminary flows for the 50-year and 100-year event were calculated using the United States Geological Survey (USGS) StreamStats which uses regression equations developed for specific geographic regions to calculate peak runoff flows. The StreamStats 50-year peak flow can be found in Table 3 below.

Previous drafts of this report included 100-year hydrologic estimates based on the Natural Resources Conservation Service's TR-55 methodology. The results of the 100-year TR-55 methodology were in relative agreement with the results provided by StreamStats' TR-55 based analysis; however, the results of StreamStats' regression equation based analysis are significantly different than the TR-55 based analysis completed by the project team. It is recommended that future evaluation efforts and final design efforts evaluate the 50-year criteria based on the unique setting of the structure and the ramifications resulting from experiencing an event greater that the 50-year event. The structure's elevation, snow melt hydrology, land slide conditions, observed sediment and debris loading, and snow storage requirements may warrant a design recurrence interval greater than the 50-year event.

Note that roadway flows were not analyzed as part of this report because they are considered minor in comparison to the off-site tributary area and are assumed to pass through the existing drainage features prior to arrival of the off-site flows. See Figure 1 for basin delineation. Off-site flows discharging to the project area were estimated and are presented in Table 3. Basin 1 is the area estimated to discharge directly to the project area. Basin 2 is the area discharging upstream (east) of the project that could be conveyed to the project area if the inlet responsible for capturing this discharge were clogged with sediment/debris or blocked by snow.

Figure 1 – Basin Delineation

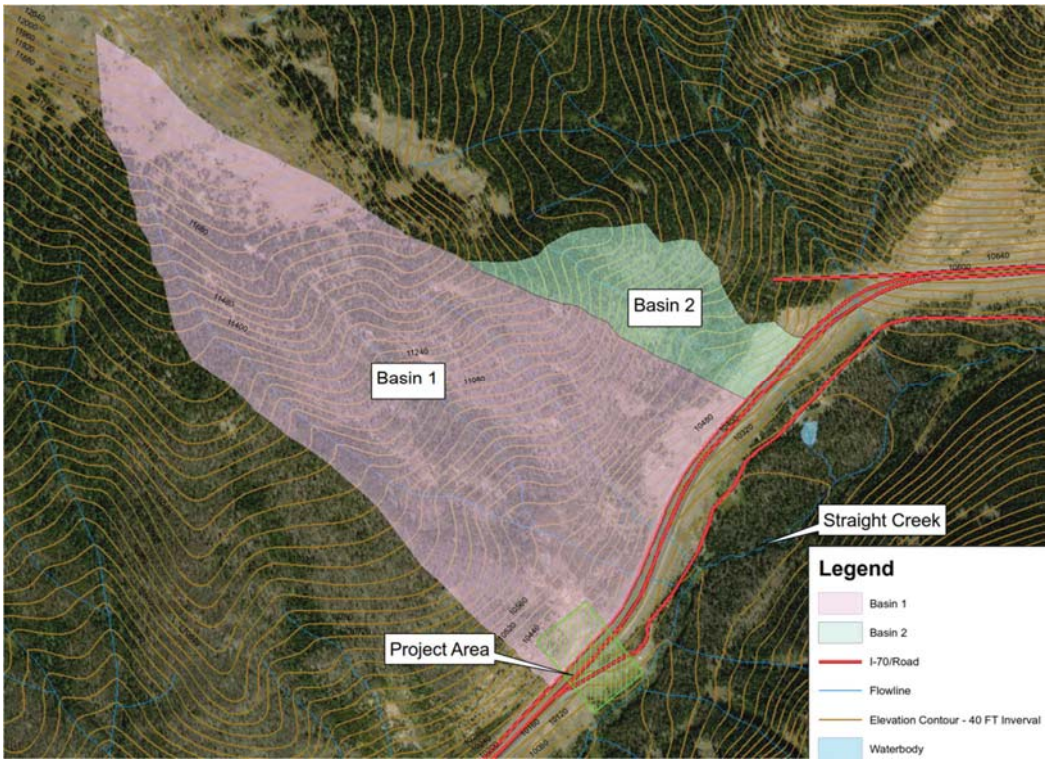


Table 3 – Estimated Off-Site Tributary Flows

Basin	StreamStats 50-YR Peak FLOWS (cfs)	StreamStats 100-YR Peak FLOWS (cfs)	TR-55 100-YR Peak FLOW (cfs)
1	16.4	18.1	226
2	4.6	5.1	41

Basin delineation efforts, a site visit, and a review of available documents indicated that AECOM's efforts were estimating increased runoff areas compared to previous studies. A definitive reason for the increase was not identified. AECOM's efforts were based on USGS topographic maps. Subsequent to the site visit, it was determined that the upper basin area (area immediately north of the I-70 culvert) has had cross ditches installed to divert flows away from the culvert entrance and presumably from the landslide area.

It is recommended that future design efforts should include:

- An evaluation of the cross ditches and an assessment of their effectiveness and remaining lifespan.
- An evaluation of flows and bypass potential for all project inlets.
- An evaluation of tributary roadway flows.
- Appropriate debris and clogging factors, given the project's ongoing debris and roadway sanding and ice-slicer operations.
- A consideration of, or evaluation of, snow melt hydrology, given the project's elevation.
- An evaluation of bypass potential from upstream inlets along I-70 that are clogged or covered with snow.

Sediment and Debris

As identified during the site visit, the majority of the existing inlets are impacted by sediment, debris, and/or the materials generated by roadway sanding and ice-slicer operations.

The existing stormwater infrastructure located on the north side of I-70 is experiencing sedimentation and debris accumulations from materials predominately generated from the hillside and landslide area north and east of the I-70 culvert as well as from roadway sanding and ice-slicer operations.

The existing stormwater infrastructure located on the south side of I-70 is generally free from sediment and debris with the exception of the existing sediment pond located east of the east CBC downstream wing wall which is designed to accommodate sanding and ice-slicer operations associated with the outside eastbound I-70 lanes.

Roadway sanding and ice-slicer placement in I-70's westbound lanes and the inside shoulder (and possibly the inside lane) of I-70's eastbound lanes are conveyed by drainage systems features that do not include sediment ponds. It would appear that these systems are discharged directly to CDOT's right-of-way and then to Straight Creek via the infrastructure documented in Exhibit 1.

Snow Storage

As discussed with CDOT Maintenance during the project's Kick-Off Meeting, the areas east and west of the existing I-70 culvert are used for snow storage. During heavy snowfall years, the snow accumulation can inundate the existing drainage inlets and impact inlet functionality. Drainage improvements contemplated for the project vicinity should be designed with additional capacity or redundancy to accommodate snow storage.

Proposed Drainage System

The proposed structure alternatives noted in the *I-70 over Forest Road Structure F-13-S_Minor Replacement Study* include two categories of alternatives: Cut and Cover Alternatives and Tunnel Alternatives. A summary of the drainage impacts are described based on alternative type.

Cut and Cover Alternatives

The Cut and Cover Alternatives utilize the existing inverts of the F-13-S_Minor structure. The surrounding drainage features would not be impacted and no drainage improvements would be needed. However, as identified above, sediment and debris considerations are warranted.

Tunnel Alternatives

The Tunnel Alternatives propose lowering of the existing inverts approximately 4' to 8' below the existing structure. Inlets adjacent to the existing structure wing walls would need to be lowered to meet the proposed inverts. As no record information on the profile of Pipe 4 (48" Pipe) was found, further investigation would need to be completed to see if Inlet F can be retied into the existing drainage system. The drainage system associated with Inlet L and Pipe 14 may need to be completely redone based on the existing outfall invert. See Exhibit 1 for pipe and structure reference.

MOT Considerations

Temporary lane shifts and other MOT considerations needed for accommodating construction activities should recognize the existence of existing inlets within the median on the inside shoulder of the eastbound lane, and consider the ramifications to horizontal and vertical modifications made in an effort to accommodate alternatives involving open cut or lane drops.

Additional Recommendations

Recommendations include the following:

1. Existing drainage facilities are not being maintained to a level where they are providing their intended hydraulic and storage functionality.
2. The existing sediment pond located east of the east CBC downstream wing wall should be formally evaluated based on maintenance records for sanding and ice-slicer placement.

These recommendations are independent of the structure replacement; rather, they are intended for addressing items observed during the site visit and for providing a properly working drainage system. The system appears to have sufficient capacity but is underutilized as Inlet A, B, and C were completely clogged with sediment at the time of the site visit. See Exhibit 1 for pipe and structure reference.

Conclusions

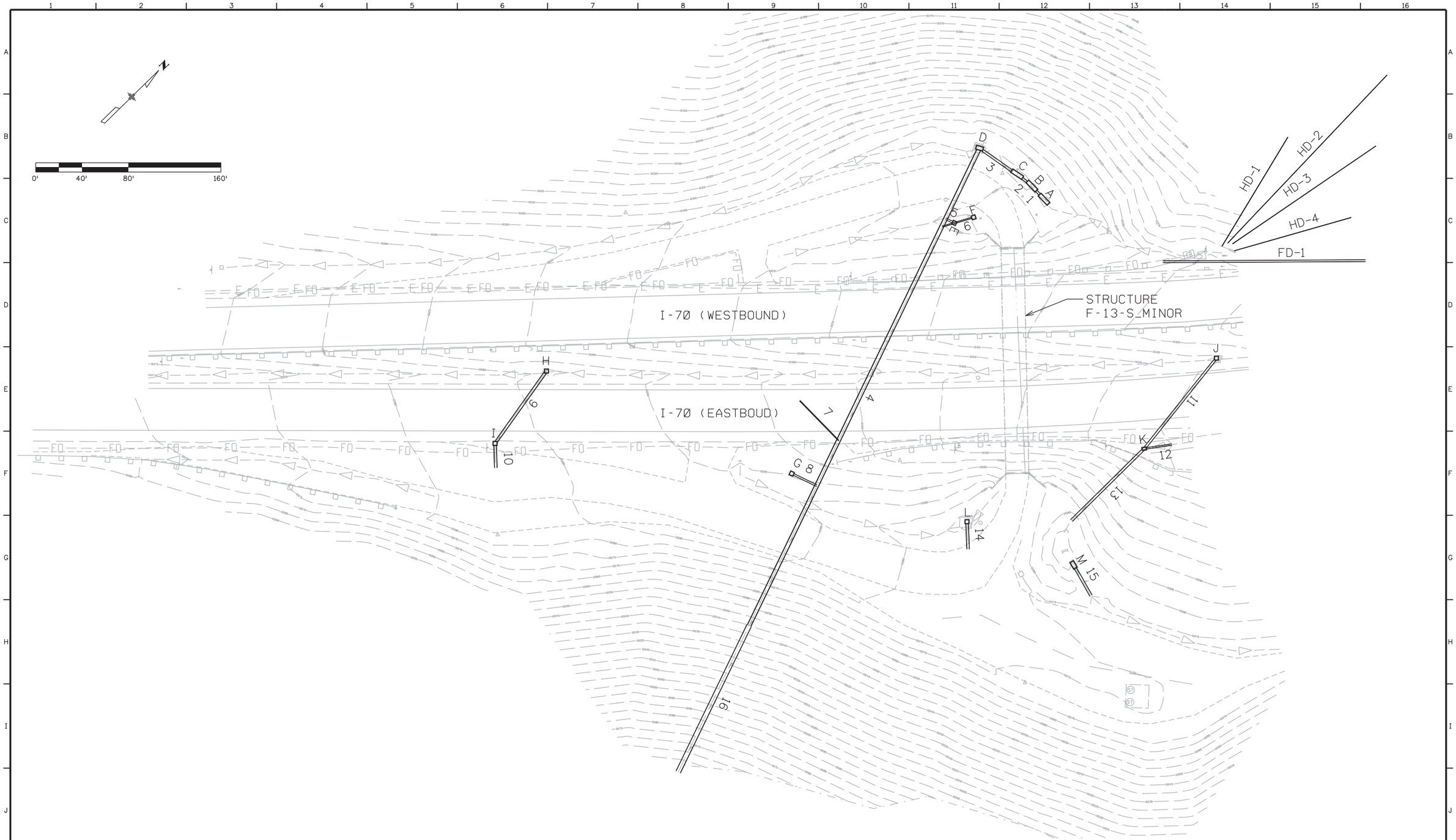
The existing drainage infrastructure responsible for capturing and conveying rainfall and snowmelt runoff in the project vicinity appears to be adequate for the existing conditions provided it is maintained correctly. Some improvements are warranted for preventing sediment and roadway sand and ice-slicer

from being discharged to Straight Creek. Alternatives being considered for replacing the existing I-70 culvert will require modifying existing drainage infrastructure. Replacement designs should consider the impacts of upstream bypass, snow storage, debris, and sediment.

cc: Project File
Gary Maji (AECOM)
Maegan Vause (AECOM)

Reviewed By: Gary Maji (AECOM)

Attachments: Exhibit 1 – Existing Drainage
Exhibit 2 – Pipe 4 Existing Profile
Photo Log



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Designed By			Detailed By				Quantities By			
Checked By			Checked By				Checked By			

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Sheet Revisions		
Date:	Comments	Init.

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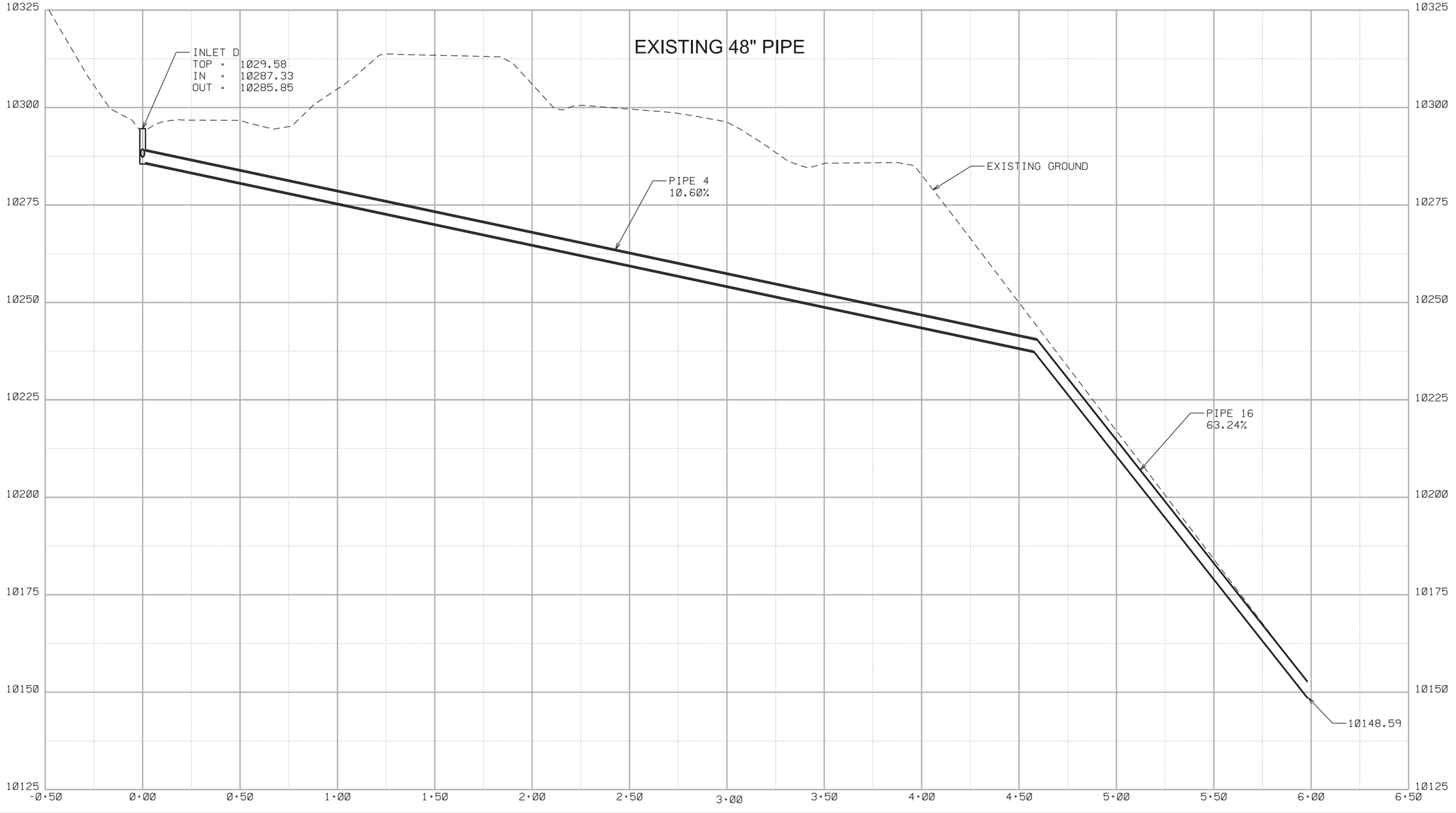
GLA

As Constructed
No Revisions:
Revised:
Void:

EXHIBIT 1
BASIN DELINEATION

Designer:	A. AKO	Structure Numbers	
Detailer:	A. AKO		
Subset:	DRAINAGE	Subset Sheets:	of

Project No./Code
FBR 0702-385
22712
Sheet Number



PRINT DATE: 2/6/2019		Sheet Revisions			Colorado Department of Transportation
File Name: EX-DR.dgn		Date:	Comments	Init.	CDOT
HORIZ. SCALE: 1:50 VERT. SCALE: AS NOTED					Mountain Residency, West Portal Frisco, CO 80443 Phone: 303-512-5600 FAX:
Unit Information Unit Leader Initials					Region 3 GLA

AS CONSTRUCTED	EXHIBIT 2 PIPE 4 EXISITNG PROFILE			PROJECT NO./CODE
No Revisions:				FBR 0702-385
Revised:	Designer: A. AKO	STRUCTURE Numbers		22712
Void:	Detailer: A. AKO			Sheet Number
	DRAINAGE:	SUBSET SHEETS:		

Upstream end of Structure F-13-S Minor and surrounding features, looking southeast

Type D Inlet at upstream end of 36" reinforced concrete outfall pipe located at upstream end of Structure F-13-S Minor; See Structure D on Exhibit 1 – Existing Drainage

Weir structure with live water flow located upstream of the Type D Inlet and downstream of the three (3) buried Type D Special Inlets; See Structure C on Exhibit 1 – Existing Drainage for nearest Type D Special Inlet

Live water flow over location of three (3) Buried Type D Special Inlets, looking southeast; See Structures A, B, and C on Exhibit 1 – Existing Drainage

Live water flowpath, east of Structure F-13-S Minor looking east adjacent to the westbound traffic

Live water flowpath at upstream end of Structure F-13-S Minor, looking southwest

Weep holes with live water flow; See Pipes HD-1, HD-2, HD-3, and HD-4 on Exhibit 1 – Existing Drainage

Sediment Pond and surrounding features at southeast corner of Structure F-13-S Minor

Sediment Pond at southeast corner of Structure F-13-S Minor; See Structure M on Exhibit 1 – Existing Drainage

24" corrugated plastic inflow pipe to sediment pond; See Pipe 13 on Exhibit 1 – Existing Drainage

APPENDIX F – GEOTECHNICAL INVESTIGATION REPORT

Geotechnical Investigation
I-70 Box Replacement Study at Mile Marker 211
FBR 0702-385 (22712)
CDOT Region 3 – Mountain Residency
Summit County, Colorado

Prepared for:

AECOM

6200 South Quebec Street
Greenwood Village, Colorado 80111

Attention: Gary Maji, PE
Colorado Bridge Lead/Senior Project Manager

March 18, 2019

RockSol Project No. 511.01

RockSol
Consulting Group, Inc.

12076 Grant Street
Thornton, Colorado 80241

Geotechnical Investigation
I-70 Box Replacement Study at Mile Marker 211
FBR 0702-385 (22712)
CDOT Region 3 – Mountain Residency
Summit County, Colorado

Prepared by:

RockSol Consulting Group, Inc.
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March 18, 2019

RockSol
Consulting Group, Inc.

Table of Contents

ATTACHMENTS

1.0 PROJECT PURPOSE AND DESCRIPTION

RockSol Consulting Group, Inc. (RockSol) has performed a geotechnical investigation for the Interstate 70 (I-70) Structure F-13-S_Minor over Forest Service Road at Mile Marker (MM) 211 Replacement Project. The existing underpass structure is classified as structurally deficient and eligible for replacement or repair through the Colorado Bridge Enterprise. The Colorado Department of Transportation (CDOT) has requested a feasibility study for alternative designs for replacing or rehabilitating the structure. RockSol understands this feasibility study is for preliminary design only and not for final design.

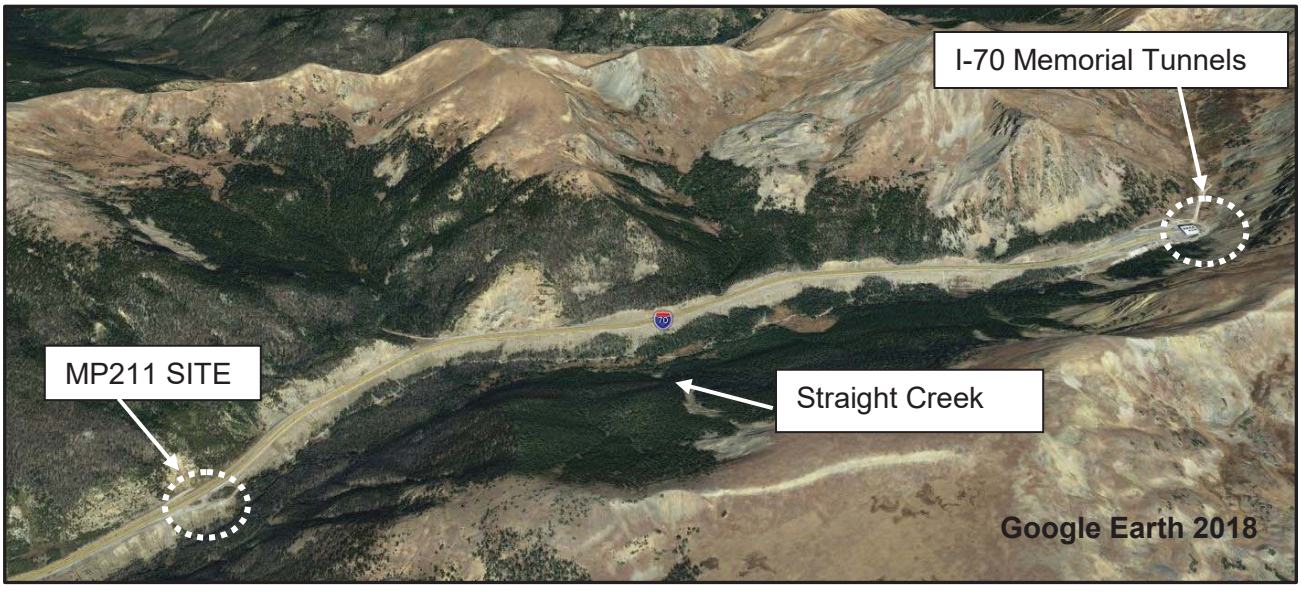
The scope of work for this geotechnical investigation included:

- Preparing a drilling program to perform a subsurface investigation and implementing the program to collect subsurface samples for characterization and laboratory testing.
- Performing laboratory tests and analyzing the data.
- Preparing a report presenting the field and laboratory data obtained, geological conditions and hazards, and preliminary geotechnical design parameters and foundation recommendations.
- Coordinating landslide evaluation with AECOM personnel.

Surface and groundwater hydrology, hydraulic engineering, and environmental studies including contaminant characterization were not included in RockSol's geotechnical scope of work.

2.0 PROJECT SITE CONDITIONS

The I-70 Structure F-13-S_Minor over Forest Service Road at MM 211 is in Summit County, Colorado approximately 2.6 miles west of the Eisenhower - Johnson Memorial Tunnels (See Google Earth image below) and 6 miles east of Silverthorne, Colorado. The existing underpass structure is situated within a mountain valley, approximately 85 feet above Straight Creek. The forest service road begins near the southeast portion of the existing structure and generally follows Straight Creek east along the base of the valley toward the Continental Divide.



Eastbound and westbound lanes of I-70 are divided by an approximate 35-foot wide non-paved center median with a vertical elevation offset of approximately 15 feet (westbound I-70 higher in elevation). Both eastbound and westbound I-70 have three flexible asphalt paved lanes.

3.0 GEOLOGICAL CONDITIONS AND HAZARDS

The I-70 alignment follows Straight Creek to the west of the Continental Divide. Metamorphic gneiss (Idaho Springs Formation and the Swandyke Hornblende Gneiss) and igneous intrusions (pegmatite) of the Silver Plume Granite from the Precambrian period are mapped at or near the surface of the project site by the United States Geological Survey (USGS). Glacial till deposits are also mapped by the USGS at or near the surface along the steep slopes and within the Straight Creek valley

Based on information presented in the *Report of Geological Investigations and Recommendations on the Straight Creek Landslide*, by Robert K Barrett and Dale M. Cochran, dated December 1971, initial construction of I-70 triggered multiple landslides on the north side of the Interstate following slope cutting operations between approximate MM 210 and MM 212. The landslides were identified as Slides 1 through 4 and Slides A and B. These landslides are remnants from earlier slope failures. Slide 1 (1969 State Highway NO. 70, Plan Set Sta. No.290 to 302) was identified to the east of the location where Structure F-13-S_Minor was constructed. Slide 1 was investigated and mitigated with rubber membrane-lined ditches, flattened slopes, cut ditches and subsurface drain pipes to reduce the hydrostatic pore pressure buildup within the colluvium and decomposed bedrock material.

The western edge of the active landslide area of Slide 1 appears to be approximately 160 feet east of the existing MP 211 underpass structure. Based on recent discussions with CDOT Region 3 Maintenance personnel, the landslide material appears to be encroaching into the outside shoulder and cut-ditch area along westbound I-70 at an approximate rate of 3-inches to 6-inches per year. This active zone of the Slide 1 is not expected to impact the replacement of the existing underpass structure, provided that excavation operations do not extend eastward into the toe of the landslide mass.

As discussed in the *1971 Straight Creek Landslide Report*, excavation within the toe of the active landslide is not recommended. If excavation operations are needed for access or working area, a free draining buttress should be placed at the toe to provide resistance and to reduce the hydrostatic pressure buildup within the colluvium and decomposed bedrock material. Excavation cuts should be limited in size to allow for quick buttress replacement operations. Excavation operations should not be performed during late spring through early summer due to the increase in water runoff and high groundwater conditions.

Based on information provided in the *1971 Straight Creek Landslide Report,* a zone of disturbed bedrock between the surface and a depth of 32 to 65 feet was encountered within the Slide 1 area. Historical movement observed in the fractured and altered bedrock was related to periods of high groundwater. The western portion of a deep-seated movement in this bedrock material may encroach onto the proposed underpass project limits.

It is recommended that monitoring of the landslide through visual inspection by qualified personnel, instrumentation, or survey bench marks, be performed during construction. Leaving the existing eastern underpass wall in place during the construction operations should also be considered to reduce the amount of shoring needed for the new structure construction and to reduce the risk of destabilizing the western edge of Slide 1.

Exposed bedrock outcrops on the cut slope north of the underpass structure appear to be stable; however, numerous boulders/rocks were noted within the ditch area. The catchment ditch area should be maintained during construction operations or the placement of temporary concrete barriers should be considered to help protect construction personnel from rockfall.

Maintaining proper drainage on the cut slope and fill slope areas of the project is recommended. Erosion of the fill slope was noted on the south fill slope, southeast of the existing southern underpass portal, resulting in near vertical slope sections. These vertical slope sections pose a risk to losing additional slope edge material as the slope reposes to its stable slope angle.

Based on information provided in the *1971 Straight Creek Landslide Report,* large mud flows have been reported in the Slide 1 area. Mud/debris flows within the Slide 1 area could impact the proposed underpass project area and traffic along I-70.

4.0 SUBSURFACE EXPLORATION

RockSol drilled three boreholes for the I-70 Box Replacement (B-1 through B-3) project. The locations of the geotechnical investigation boreholes are shown on Figure 1, Borehole Location Plan.

The boreholes were field marked prior to drilling by RockSol personnel. Horizontal and vertical locations were provided to RockSol by AECOM for inclusion on the borehole location sheet and on the borehole logs. A truck mounted CME-120 drill rig was used for drilling and sampling. The boreholes were approximately 5-inches in diameter and were advanced using an ODEX Downhole Hammer System drilling method to maximum depths of approximately 50 feet to 75 feet below existing grades. The boreholes were drilled September 12 through 14, 2018. The boreholes were logged in the field by a representative of RockSol with the depth to groundwater noted at the time of drilling and subsequent to drilling operations. Each boring was backfilled either at the completion of drilling or after subsequent groundwater measurements.

Subsurface materials were sampled and resistance of the soil to penetration of the sampler was performed using modified California barrel and standard split spoon samplers. The modified California barrel sampler has an outside diameter of approximately 2.5 inches and an inside diameter of 2 inches. The standard split spoon sampler used had an outside diameter of 2 inches and an inside diameter of 1⅜-inches. Brass tube liners were used with the modified California barrel sampler. Brass tube liners are not used with the standard split spoon sampler.

Penetration Tests were performed at selected intervals using a rope-cathead hammer lift system. The standard split spoon sampling method is the Standard Penetration Test (SPT) described by ASTM Method D-1586. Penetration Tests were performed using the modified California barrel and standard split spoon samplers with a standard hammer weighing 140 pounds falling 30 inches per ASTM D3550. The modified California Barrel sampling method is like the SPT test with the difference being the sampler dimensions and the number of 6-inch intervals driven with the hammer. It is RockSol's experience that blow counts obtained with the modified California sampler tend to be slightly greater than a standard split spoon sampler. Penetration resistance values (blow counts) were recorded for each sampling event. Blow counts, when properly evaluated, indicate the relative density or consistency of the soils.

Penetration testing typically was not performed where cobbles and boulders were noted during ODEX downhole hammer drilling operations. Samples from the ODEX drilling operations were obtained within these zones of cobbles and boulders. However, it should be noted that gravel

and cobbles typically larger than 2 inches in diameter are broken/fractured by the drilling method and are considered disturbed samples.

5.0 LABORATORY TESTING

Soil samples retrieved from the borehole locations were examined by the project geotechnical engineer in the RockSol laboratory. Selected samples were tested and classified according to the Unified Soil Classification System (USCS). The following laboratory tests were performed in accordance with the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and current local practices:

- Natural Moisture Content (ASTM D-2216)
- Dry Density (ASTM D-2937)
- Liquid and Plastic Limits (ASTM D-4318)
- Gradation (ASTM D6913)
- Soil Classification (ASTM D-2487, ASTM D-2488, and AASHTO M145)
- Unconfined Compression Test of Rock (ASTM D7012)
- Water Soluble Sulfate Content (CDOT CP-L 2103)
- Water Soluble Chloride (AASHTO T291-91 and ASTM D4327)
- Standard Test Method for pH of Soils (ASTM D4972-01)
- Soil Resistivity (ASTM G187 - Soil Box)

Laboratory test results are presented in Appendix B and are also summarized on the Borehole Logs presented in Appendix A.

Laboratory test results were used to characterize the engineering properties of the subsurface material. For soil classification, RockSol conducted sieve analyses and visual determination of Atterberg Limits (non-plastic). Laboratory testing was also performed on selected samples to determine the water-soluble sulfate content of subsurface materials to assist with cement type recommendations.

6.0 SUBSURFACE CONDITIONS

Boreholes B-1 and B-3 were drilled on the south and north sides of the existing box structure and Borehole B-2 was drilled in the center median area of eastbound I-70 on the west side of the existing structure.

Medium dense to very dense silty to gravelly sand with boulders/cobbles in parts was encountered to depths of 50 feet at Borehole B-2; to a depth of 75 feet at Borehole B-1; and to an approximate depth of 33 feet at Borehole B-3. Overburden soils predominately classified as A-1-b(0) soils with A-1-a(0) and A-2-4(0) soils also present. A picture of a sample of overburden soil obtained from Borehole B-1 at a depth of 20 feet is shown below.

Metamorphic (Gneiss) bedrock with igneous (pegmatite) intrusions was encountered at Borehole B-3 at an approximate depth of 33 feet (approximate elevation of 10,265 feet) below existing grade. Bedrock core samples were obtained from 40 feet to 50 feet below the existing grade at Borehole B-3. Bedrock was not encountered to the depths drilled at Boreholes B-1 (75 feet) and B-2 (50.5 feet). RQD values ranged from 0% to 29%. An unconfined compression test result of approximately 13,500 psi was obtained from a section of recovered bedrock. A picture of a sample of bedrock obtained from Borehole B-3 is shown below.

Groundwater was noted at an approximate depth of 55 feet below existing grade at B-1 and 35 feet below existing grade at B-3. Minor groundwater seepage was noted within Borehole B-3 at an approximate depth of 9 feet below grade.

Depths at which the samples were taken, the type of sampler and drilling method used, and the blow counts that were obtained are shown on the Borehole Logs for each borehole. Individual Borehole Logs are included in Appendix A.

Water Soluble Sulfate Content

Cementitious material requirements for concrete in contact with site soils or groundwater is based on the percentage of water soluble sulfate. Mix design requirements for concrete exposed to water soluble sulfates in soils or water is considered by CDOT as shown in Table 6.1 and in the Standard Specifications for Road and Bridge Construction, dated 2017.

Table 6.1
Requirements to Protect Against Damage to Concrete by Sulfate Attack from External Sources of Sulfate

Severity of sulfate exposure	Water-soluble sulfate (SO_4), in dry soil, percent	Sulfate (SO_4), in water, ppm	Water cementitious ratio, maximum	Cementitious material requirements
Class 0	0.00 to 0.10	0 to 150	0.45	Class 0
Class 1	0.11 to 0.20	151 to 1,500	0.45	Class 1
Class 2	0.21 to 2.0	1,500 to 10,000	0.45	Class 2
Class 3	2.01 or greater	10,001 or greater	0.40	Class 3

The concentration of water soluble sulfates measured in nine samples obtained from RockSol's exploratory boreholes ranged from 0.00 to 0.01 percent by weight. Based on the results of the water-soluble sulfate testing, concrete in contact with subgrade materials may be constructed with cement meeting the requirements for Exposure Class 0.

Corrosion Resistance Discussion

Water soluble chloride content, pH and electrical resistivity tests were performed on bulk samples obtained from the boreholes and are summarized in Table 6.2. The electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-187). Water Soluble Chloride Ion Content tests were performed by Colorado Analytical Laboratories.

Table 6.2 – Corrosion Resistance Summary

Borehole Location	Sample Depth (ft)	Water Soluble Chloride (%)	Saturated Resistivity (ohm-cm) at Moisture content (%)	Water Soluble Sulfate (% by weight)	pH	CR Level
B-1	0 – 15	**0.0648**	1,000 @ 16.2	0.00	7.4	**CR 1**
B-1	15 – 25	0.0385	1,400 @ 14.0	0.01	7.3	CR 0
B-1	25 – 45	0.0219	2,000 @ 15.4	0.00	7.1	CR 0
B-1	45 – 55	0.0176	2,100 @ 15.1	0.00	7.3	CR 0
B-1	65 – 75	0.0292	1,500 @ 19.4	0.00	7.1	CR 0
B-2	0 – 29	**0.0819**	200 @ 14.6	0.00	7.0	**CR 1**
B-2	30 – 49	0.0334	2,000 @ 11.4	0.00	7.2	CR 0
B-3	0 – 30	0.0325	1,400 @ 18.9	0.00	7.2	CR 0
B-3	30 – 38	0.0205	2,200 @ 17.2	0.00	7.1	CR 0

Comparison of the test results of the sulfate, chloride, and pH testing performed with *Table 1 - Guidelines for Selection of Corrosion Resistance Levels as presented in the CDOT Pipe Materials Selection Guide,* dated April 30, 2015*,* suggests corrosion resistance (CR) levels of CR 0 and CR 1 are present within the project limits. Of the three variables (water-soluble sulfate, water-soluble chloride, and pH) that are used in determining the CR level, the water-soluble chloride content is the predominant component affecting the CR level selection.

In addition, electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-187). Comparison of the results of the electrical resistivity testing performed with *Table 2 – Minimum Pipe Thickness For Metal Pipes Based On The Resistivity And pH Of The Adjacent Soil* as presented in the *CDOT Pipe Materials Selection Guide,* effective April 30, 2015*,* suggests the minimum required gauge thickness for metal pipe material, if used, for this project is *0.052 inches (18 Gauge) Polymer Coated*.

7.0 FOUNDATION RECOMMENDATIONS

Preliminary Foundation Recommendations

Feasible foundation types for the new underpass structure include shallow foundations and drilled shafts. Due to the presence of boulder-sized material within the existing fill material and native soils, the use of driven piles is not recommended for permanent foundation systems without careful consideration of the risks and through discussions with the design team. RockSol recommends an additional geotechnical evaluation when a structure type is selected, and configurations are finalized. Discussion of the preliminary foundation types and the recommended foundation design parameters is presented below.

Shallow Foundation System

Based on conditions encountered in Boreholes B-1 through B-3, preliminary bearing resistances are presented in Table 7.1 for retaining wall systems and a new concrete box culvert structure

bearing on shallow foundation systems. Values for AASHTO LRFD strength limit state and strength limit state methodology are presented. A resistance factor of 0.45 is used to determine the factored bearing resistance for LRFD strength limit state evaluation.

Table 7.1 – Preliminary Bearing Resistances – Shallow Foundation Systems

Structure Type	Bearing Material	Strength Limit (LRFD)		Service Limit (LRFD)
		Ultimate (Nominal) Resistance (ksf)	Factored Resistance (ksf)	Service Bearing Resistance (ksf)
Concrete Box Culvert	(Native and Fill) Silty to gravelly SAND with Boulders/Cobbles	25.0	11.0	8.0
Permanent Median Grade-Separation Wall	Suitable Roadway Embankment Material (Meeting Class 2 Structural Backfill Requirements)	12.4	5.6	4.0

Vertical Earth Load Parameters

In addition to traffic loads, vertical earth loads will be applied from soil and pavement placed above the structure. Vertical earth-loads imposed on the structure will be affected by whether the backfill condition is a trench condition or an embankment condition. Modification of vertical earth loads to address embankment and trench conditions is presented in the AASHTO LRFD Bridge Design Specifications, 2014, Section 12.11.2.2. Where fill material is to be placed, RockSol recommends placement of CDOT Structure Backfill (Class 1 or Class 2) material adjacent to and immediately above the structure. For design, an unfactored earth load of 130 pounds per cubic foot (pcf) is recommended as a minimum value for CDOT Structure Backfill (Class 1 or Class 2). Pavement material will impose a greater unit weight than soil. For design consideration, RockSol recommends a minimum of 12 inches of pavement be considered, with a pavement unit weight of 150 pcf.

Lateral Earth Pressure Parameters

Lateral earth pressures will occur from soils adjacent to the sides of the structure and will be influenced by the width of the backfill zone adjacent to the structure walls. For narrow backfill zones, lateral earth pressures will be influenced by the existing, in-place soils. For relatively wide backfill zones, lateral earth pressures will be influenced by the backfill soils. RockSol recommends the use of CDOT Class 1 Structure backfill material or Class 2 Structure backfill for backfill of the structure walls. Class 2 Structure backfill shall be composed of suitable materials developed on the project (Refer to CDOT Standards and Specifications Section 703.08). To assist with design, lateral earth pressure parameters are presented in Table 7.2 for the existing soils (CDOT Class 2 Structure backfill) encountered in Boreholes B-1 through B-3. Also included are parameters for CDOT Class 1 Structure backfill material. Based on the subsurface conditions encountered in the boreholes, silty to gravelly sand material with boulders and cobbles is anticipated to be predominately encountered at elevations above and adjacent to the floor of the structure.

Table 7.2 – Lateral Earth Pressure Parameters

Soil Type	Total Unit Weight (γ) pcf	Effective Friction Angle, ϕ′ (degrees)	Cohesion (psf)	Lateral Earth Pressure Coefficients (Notes 1 and 2)		
				Active (k_a)	At-Rest (k_o)	Passive (k_p) (Note 3)
CDOT Class 1 Structure Backfill (CDOT Section 703.08)	130	34	0	0.352	0.44	6.88
(Fill and Native) SAND, silty to gravelly with cobbles/boulders (CDOT Class 2)	130	34	0	0.352	0.44	6.88

Note 1: Based on Coulomb Theory of earth pressure
Note 2: For 3H:1V backslope and horizontal foreslope.
Note 3: Full value, no reduction applied.

Evaluation of Sliding

Backfill operations adjacent to the structure should maintain relatively consistent fill height on both sides. For the evaluation of sliding for structure wingwalls, parameters for the general soil encountered at Boreholes B-1 through B-3 are presented in Table 7.3.

For cohesionless soil, the nominal sliding resistance between soil and foundation per AASHTO LRFD Equation 10.6.3.4-2 is $R_t = V\tan\delta$. The value of $\tan\delta$ is presented in Table 7.3. A resistance factor of 0.80 is recommended, per AASHTO LRFD Table 10.5.5.2.2-1 for evaluation of sliding with cast-in-place concrete on sand.

If passive resistance is included to resist sliding, passive pressures may be estimated by AASHTO LRFD Equation 3.11.5.4-1. Consideration should be given to possible future removal of the soil in front of the structure. If passive resistance is included, a resistance factor of 0.50 is recommended, per AASHTO LRFD Table 10.5.5.2.2-1.

Table 7.3 – Sliding Resistance Parameters

Foundation Bearing Material	Total Unit Weight (pcf)	Effective Friction Angle, ϕ′ (degree's)	Tan δ	Undrained Shear Strength (Cohesion) (psf)
(Fill and Native) SAND, silty to gravelly	130	34	0.675	0

Subgrade Preparation

Prior to construction of a new structure, the underlying soils should be properly prepared by removal of all loose or otherwise disturbed material, debris, and any deleterious material identified by the Project Engineer.

Structure Backfill Recommendations

RockSol recommends backfill of a new structure meet the requirements for CDOT Class 1 or Class 2 Structure Backfill as indicated in Section 206 of the CDOT Standard Specifications for Road and Bridge Construction. Structure Backfill (Class 1 and Class 2) shall be compacted to a density not less than 95 percent of maximum dry density determined by AASHTO T180. Roadway embankment placed above the structure fill material shall be compacted to the

requirements indicated in Section 203.07 of the CDOT Standard Specifications for Road and Bridge Construction.

Deep Foundations

The new underpass structure may be supported on drilled shafts (caissons). Due to the depth of bedrock, use of end-bearing caissons may not be feasible so use of "friction piers" is anticipated. A minimum caisson length of 30 feet is assumed to be required, depending on the number and diameter of caissons considered. Based on the subsurface conditions encountered and our evaluation, preliminary allowable side resistance values for the silty to gravelly sand material are presented in Table 7.4. A resistance factor of 0.55 is recommended to determine the factored side resistance for LRFD strength limit state evaluation.

Table 7.4
Preliminary Nominal Side Resistance Values for Drilled Shafts

Borehole No.	Material Type	Elevation (ft)	Side Resistance (ksf)
B-1	(Fill) SAND, silty to gravelly with boulders/cobbles	10,275 – 10,250	2.5
	(Native) SAND, silty to gravelly with boulders/cobbles	10,250 – 10,245	2.0
		10,245 – 10,225	3.5
B-2	(Fill and Native) SAND, silty to gravelly with boulders/cobbles	10,305 – 10,279	2.5
	(Native) SAND, silty to gravelly with boulders/cobbles	10,279 – 10,271	2.0
		10,271 – 10,255	3.5
B-3	(Fill) SAND, silty to gravelly, clayey in parts	10,298 – 10,290	1.2
		10,290 – 10,287	0.6
	(Native) SAND, silty to gravelly with boulders and cobbles, clayey in parts	10,287 – 10,281	1.5
		10,281 – 10,265	2.0
	Bedrock (Gneiss and Pegmatite)	10,265 – 10,250	15.0

When evaluating the side resistance of the drilled shaft, the lower 1.0-diameter length above the shaft tip should be ignored. It is recommended that the drilled shafts terminate in similar material to reduce the potential of differential movement.

Drilled shaft diameters shall be sufficient to satisfy axial, bending, and lateral load resistance requirements.

Additional preliminary design and construction considerations for drilled shafts are presented below.

(a) The construction of the drilled shafts should follow the guidelines specified in the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 503, 2017."

(b) Pre-drilling may be required due to the presence of boulders within the existing fill material and native soils.

(c) Prior to the placement of the concrete, the drilled shaft excavation, including the bottom should be cleaned of all loose material. Caving conditions may occur due to the presence of granular soils and groundwater. Temporary casing of the drilled shafts may be required during construction.

(d) Drilled shafts should be constructed with spacing at least four shaft diameters center to center. For closely spaced drilled shafts, the axial and lateral capacities should be reduced with a reduction factor of 0.90.

Preliminary Lateral Resistance Parameters (Deep Foundations)

Recommended lateral resistance parameters for drilled shafts and driven piles constructed for the new underpass structure are presented in Table 7.5. The parameters listed are for use with LPILE® or equivalent COM624 software.

Table 7.5 - Preliminary Drilled Shaft and Driven Pile Lateral Resistance Parameters

Borehole Material	L-Pile Soil Type (#)	Undrained Shear Strength (Cohesion) (psf)	Angle of Internal Friction (degrees)	Subgrade Reaction Coefficient, (pci)	Strain Factor ε_{50} (%)	Unit Weight (pcf)
(Native) SAND, silty to gravelly with boulders/cobbles above water table	Sand (#4)	0	34	90	--	130 (Total)
(Native) SAND, silty to gravelly with boulder/cobbles below water table	Sand (#4)	0	34	60	--	65 (Submerged)

Total unit weight indicated in Table 7.5 includes soil plus moisture content.

Temporary Shoring Discussion

Based on RockSol's understanding of the proposed construction phasing (See Appendix C – Conceptual Shoring Plan), temporary shoring systems may be required to maintain slope stability and maintain traffic flow in both directions for the proposed structure replacement project. Based on the subsurface conditions encountered during our field investigation, driven steel piles with wood lagging are considered a feasible option for temporary shoring for the *Slide Mitigation* wall and a soil nail system is considered a feasible option for the *Phase 1, 2, and 3 Shoring* walls.

8.0 SEISMICITY DISCUSSION

Borehole B-3 terminated at an approximate depth of 100 feet below the top of eastbound I-70 pavement surface. Based on the subsurface conditions encountered, it is our opinion that the subject site meets criteria for Seismic Site Class D, as defined by the 2017 AASHTO Guide Specifications for LRFD Seismic Bridge Design, Section 3.10.3.1. Shear wave velocity testing was not performed by RockSol. Soil conditions necessary for Site Class E and F were not encountered in RockSol's boreholes. Seismic design parameters for Seismic Site Class D are discussed below.

8.1 Seismic Design Parameters

Seismic design parameters were obtained from the United States Geological Survey (USGS) Seismic Design Web Services using Seismic Design Maps with Design Code Reference ASCE7-16. Interpolated values for Peak Ground Acceleration Coefficient (PGA), Spectral Response Acceleration Parameter for Short Period (S_s), and Spectral Response Acceleration Parameter at 1-s Period (S_1) were obtained using the latitude and longitude for the project site. The seismic acceleration coefficients obtained from the USGS Seismic Design Web Services are presented in Table 8.1.

Table 8.1 – Seismic Acceleration Coefficients

Project Location (Latitude°/Longitude°)	Peak Ground Acceleration (PGA)	Spectral Acceleration Coefficient - S_s (Short Period)	Spectral Acceleration Coefficient - S_1 (1-s Period)
39.66575°/-105.97784°	0.182	0.324	0.083

A summary of the Site Factor values obtained are shown in Table 8.2.

Table 8.2 – Seismic Site Factor Values

Project Location (Latitude°/Longitude°)	F_{pga} (at zero-period on acceleration spectrum)	F_a (for short period range of acceleration spectrum)	F_v (for long period range of acceleration spectrum)
39.66575°/-105.97784°	1.436	1.541	2.4

Values for S_1 and F_v are presented in Tables 8.1 and 8.2, shown above. Table 8.3 summarizes the Seismic Design Category determination and horizontal response spectral Acceleration Coefficients (S_{DS} *and* S_{D1}) obtained for the proposed structure.

Table 8.3 – Seismic Performance Zone

Project Location (Latitude°/Longitude°)	Acceleration Coefficient (S_{D1})	Seismic Design Category	Acceleration Coefficient, S_{DS}
39.66575°/-105.97784°	0.133	C	0.332

9.0 EARTHWORK

9.1 Embankment

Where new embankment is required, the ground surface underlying all fills should be carefully prepared by removing all organic matter (topsoil), scarification to a minimum depth of 6 inches and recompacting to at least 95 percent of the maximum dry density (AASHTO T-99) prior to fill placement. Materials used to construct embankments, including slopes, should meet requirements for soil embankment constructed with moisture density control as required in Section 203.07 (and subsequent revisions) of the CDOT Standard Specifications for Road and Bridge Construction. Where fill material is to be placed on existing slopes steeper than 4 (H):1 (V), benching must be performed to tie the new fill into the existing slope. Benching into the native ground shall be sufficient to allow sufficient bench width to accommodate placing and compaction equipment to operate in a horizontal orientation.

9.2 Structure Backfill

Structure backfill (Class 1, Class 2, and Flow-Fill) shall meet requirements of CDOT Section 206, revised April 26 and July 19, 2012.

9.3 Aggregate Base Course

Aggregate Base Course (ABC) shall be crushed stone, crushed slag, crushed gravel, natural gravel, crushed reclaimed concrete or reclaimed asphalt pavement materials as indicated in CDOT Section 304 and 703, revised April 26, 2012.

9.4 Utility Trench Backfill

Material excavated from the utility trenches may be used for backfill provided it does not contain unsuitable material or particles larger than 4 inches. Unsuitable material includes, but is limited to, topsoil, vegetation, brush, sod, trash, and other deleterious substances.

9.5 Compaction Specifications

All embankment, structure backfill, and utility trench backfill material shall be compacted to as shown in Table 9.5.

Table 9.5 – Embankment Compaction

Soil Type AASHTO Classification	Minimum Relative Compaction (Percentage of MDD), %	Moisture Content (Deviation from OMC)
A-1, A-2-4, A-2-5, A-3,	95% of AASHTO T180 or 100% of AASHTO T99	As required to obtain required relative compaction
A-2-6, A-2-7, A-4, A-5, A-6 and A-7	95% of AASHTO T99 or 90% of AASHTO T180	-2 to +2

Note: MDD = Maximum Dry Density, OMC = Optimum Moisture Content

To reduce the risk of excessive compaction induced lateral earth pressures on retaining walls, thin lifts (6 to 8 inches maximum) and small manually operated equipment should be used within close proximity of the inside wall face. Compaction equipment or methods that produce horizontal or vertical earth pressures, which may cause excessive displacement or overturning, or may damage structures, shall not be used.

9.6 Subgrade Preparation

At locations where existing pavement will be removed and subgrade soils are exposed prior to construction of new pavement, moisture treatment (reconditioning) of the exposed subgrade material to a minimum depth of 6 inches is recommended prior to pavement section construction. For all areas with exposed subgrade, proof rolling with pneumatic tire equipment shall be performed using a minimum axle load of 18 kips per axle after specified subgrade compaction has been obtained. Areas found to be weak and those areas which exhibit soft spots, non-uniform deflection or excessive deflection as determined by the project engineer shall be ripped, scarified, wetted or dried if necessary, and re-compacted to the requirements for density and moisture. Complete coverage of the proof roller will be required.

All pavement subgrade preparation, pavement materials, and pavement construction shall conform to CDOT Standard Specifications for Road and Bridge Construction (most current version). At a minimum, subgrade moisture conditioning and compaction should meet the compaction specifications outlined in Table 9.5.

10.0 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

Proper construction practices, in accordance with CDOT Standard Specifications for Road and Bridge Construction, should be followed during site preparation, earthwork, excavations, and embankment, culvert and retaining wall construction for the suitable long term performance of the proposed improvements.

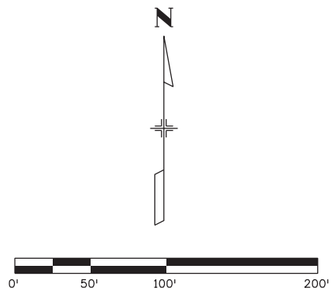
Excavation support should be provided to maintain onsite safety and the stability of excavations and slopes. Excavations shall be constructed in accordance with local, state and federal regulations including OSHA guidelines. The contractor must provide a competent person to determine compliance with OSHA excavation requirements. For preliminary planning, existing fill material and native soils may be considered as OSHA Type C soils.

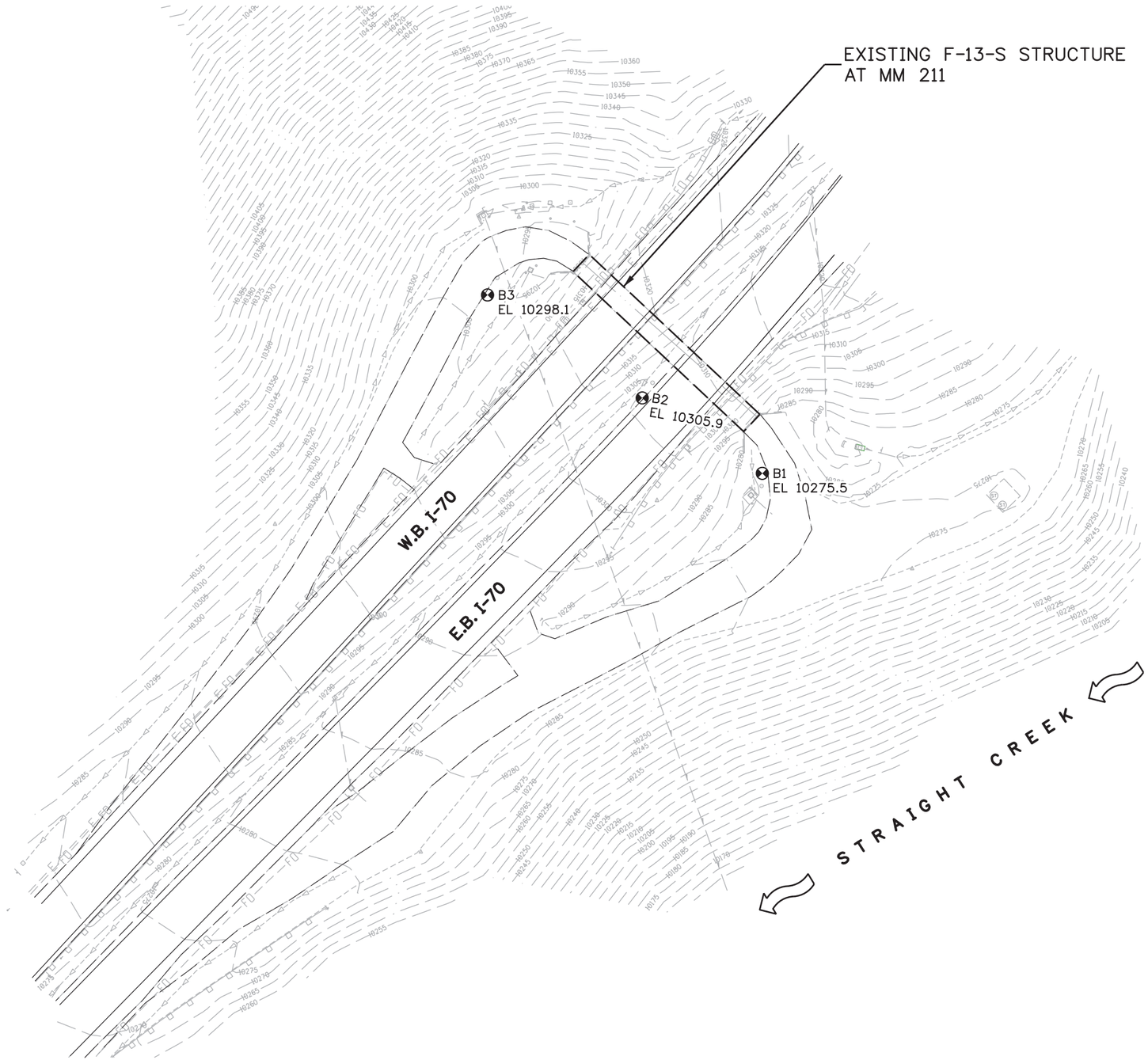
Surface drainage patterns may be altered during construction and local landscape irrigation (if any) must be controlled to prevent excessive moisture infiltration into the subgrade soils during and after construction.

Environmentally contaminated material, if encountered, should be characterized and removed under the direction of the project environmental consultant. Design and construction plans should be reviewed and onsite construction should be observed by the professional engineers.

11.0 LIMITATIONS

This geotechnical field investigation and laboratory results were conducted in general accordance with the scope of work. This report has been prepared for use by AECOM and the Colorado Department of Transportation for the project described in this report. The report is based on our exploratory boreholes and does not take into account variations in the subsurface conditions that may exist between boreholes. Additional investigation is required to address such variation. If during construction activities, materials or water conditions appear to be different from those described herein, RockSol should be advised at once so that a re-evaluation of the preliminary recommendations presented in this report can be made. RockSol is not responsible for liability associated with interpretation of subsurface data by others.





Know what's below. Call before you dig.

Print Date: 11/13/2018	Sheet Revisions	Colorado Department of Transportation	As Constructed
File Name: 51101_Boreholes.dgn	Date: Comments: Init.	Street Adress: Eisenhower Tunnel, West Portal, PO Box 2236, Frisco, CO 80443	No Revisions:
Horiz. Scale: 1:200 Vert. Scale:		REGION 3: Mountain Residency G.A.	Revised:
AECOM 6200 S. Quebec St. Greenwood Village, CO 80111, USA www.aecom.com; RockSol Consulting Group, Inc. 12076 Grant Street Thornton, CO 80241 (303) 962-9300 main www.rocksol.com			Void:

BOREHOLE LOCATION PLAN I-70 BOX REPLACEMENT STUDY AT MM 221			Project No./Code
Designer: R. Lepro	Structure Numbers		FBR 0702-385
Detailer: D. Gonzales			22712
Subset:	Subset Sheets: of		Figure 1

APPENDIX A

LEGEND
AND
INDIVIDUAL BOREHOLE LOGS

LEGEND

RockSol Consulting Group, Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** I-70 MM 211.0

LITHOLOGY


Fill - SAND, gravelly


Native - SAND, gravelly


Bedrock - Gneiss and Pegmatite


Native - SAND, silty


Native - BOULDERS AND COBBLES

SAMPLE TYPE


Auger Cuttings


GRAB SAMPLE
FROM CUTTINGS


MODIFIED CALIFORNIA SAMPLER
2.5" O.D. AND 2" I.D.
WITH BRASS LINERS INCLUDED


SPLIT SPOON SAMPLER
2" O.D. AND 1 3/8" I.D.
NO LINERS

15/12 Indicates 15 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 12 inches.

50/11 Indicates 50 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 11 inches.

5,5,5 Indicates 5 blows, 5 blows, 5 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 18 inches.

SR Indicates sampler rebound

▼ GROUND WATER LEVEL NOTED AT THE TIME OF DRILLING

RockSol Consulting Group, Inc.

BORING : B-1

CLIENT AECOM
PROJECT NAME I-70 Structure F-13-S at MM 211
ROCKSOL PROJECT NUMBER 511.01
CLIENT PROJECT NUMBER CDOT Region 3 I-70 MM 211.0
DATE STARTED 9/13/18 **COMPLETED** 9/13/18
GROUND ELEVATION 10274.9 ft
DRILLING CONTRACTOR
NORTH 100.0 **EAST** 200.0
DRILLING METHOD Odex **HOLE SIZE** 4.0"
BORING LOCATION: SW Corner of Underpass Entrance
LOGGED BY R. Lepro
GROUND WATER LEVELS:
NOTES ~20' W & 40' S of Tunnel/ Underpass
WATER DEPTH 57' on 9/13/18

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
10275	0		(Fill) SAND, silty to gravelly with cobbles/boulders in parts, slightly moist to moist, brown, very dense	BULK			0.00			21	20	1	19.6
				MC	50/11			133.9	5.5				12.8
				SS	20/30/33				5.3				16.7
10265	10			SS	SR				2.2				
				BULK			0.01			21	20	1	17.0
				SS	12/22/35				7.4				16.4
10255	20			SS	20/25/16				3.9				11.4
			(Native) SAND, silty to gravelly, moist to very moist, dense to very dense, brown to grey	BULK									
				SS	8/12/19		0.00		8.3	17	19	NP	16.3
10245	30			GB					7.4				15.1
				SS	SR				7.2				20.1
10235	40			GB					7.6				16.8
				BULK									19.6
				SS	20/28/33		0.00		6.0	21	21	NP	17.0
10225	50			GB					6.7				16.5
				SS	50/3				2.9				
			Interbedded Boulders and Cobbles	GB					11.7	NP	NP	NP	4.8
10215	60		(Native) SAND, silty to gravelly, moist to very moist, dense to very dense, brown to grey	GB					11.6				
				SS	16/27/36		0.00		12.6	24	21	3	12.6
				BULK									21.8
10205	70			GB					10.0				
			Bottom of hole at 75.0 feet.	SS	50/2				11.5				14.7

LOG - CLIENT STANDARD 51101_I-70 CBC MM211.GPJ 2/6/19

RockSol Consulting Group, Inc.

BORING : B-2

CLIENT AECOM
PROJECT NAME I-70 Structure F-13-S at MM 211
ROCKSOL PROJECT NUMBER 511.01
CLIENT PROJECT NUMBER CDOT Region 3 I-70 MM 211.0
DATE STARTED 9/12/18 **COMPLETED** 9/12/18
GROUND ELEVATION 10304.9 ft
DRILLING CONTRACTOR
NORTH 110.0 **EAST** 210.0
DRILLING METHOD Odex **HOLE SIZE** 4.0"
BORING LOCATION: EB I-70 off Inside Shoulder
LOGGED BY R. Lepro
GROUND WATER LEVELS:
NOTES ~25' W of Existing Underpass Structure
WATER DEPTH None Encountered on

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
10305	0		(Fill) SAND, silty to gravelly with boulders/cobbles in parts, brown to brown/grey, slightly moist to moist, dense	BULK			0.00			20	20	NP	15.8
				MC	SR				3.9	NP	NP	NP	15.8
10295	10			SS	31/23/22				5.8				15.5
10285	20			SS	25/21/27				5.7				16.5
			(Native) SAND, silty to clayey, gravelly in parts, moist, very dense	SS	21/25/22				7.5				17.3
10275	30			SS BULK	12/12/11		0.00		3.5	23	21	2	16.7
10265	40			SS	17/20/22				5.3	NP	NP	NP	14.5
			(Native) BOULDERS and COBBLES, light grey to white, dense to very dense	GB					0.9	NP	NP	NP	5.2
			(Native) SAND, slightly silty to gravelly, slightly clayey in parts, slightly moist to moist, brown/grey, very dense										
10255	50			SS	15/25/31				7.0	NP	NP	NP	14.9
			Bottom of hole at 50.5 feet.										

LOG - CLIENT STANDARD 51101_I-70 CBC MM211.GPJ 2/6/19

RockSol Consulting Group, Inc.

BORING : B-3

CLIENT AECOM
PROJECT NAME I-70 Structure F-13-S at MM 211
ROCKSOL PROJECT NUMBER 511.01
CLIENT PROJECT NUMBER CDOT Region 3 I-70 MM 211.0
DATE STARTED 9/14/18 **COMPLETED** 9/14/18
GROUND ELEVATION 10297.5 ft
DRILLING CONTRACTOR
NORTH 120.0 **EAST** 220.0
DRILLING METHOD Odex/NX Coring **HOLE SIZE** 4.0"
BORING LOCATION: ~40' W & 30' N of Underpass Structure
LOGGED BY R. Lepro
GROUND WATER LEVELS:
NOTES Bottom of I-70 Embankment @ Entrance to Underpass
WATER DEPTH 34.4 ft and 9 ft on 9/14/18

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
10298	0		(Fill) SAND, silty to gravelly, clayey in parts, moist to very moist, brown, loose to medium dense Possible thin layer of perched water at 9'	BULK			0.00			22	21	1	5.4
				SS	8/10/12				6.2	NP	NP	NP	20.1
10288	10			SS	2/2/3				9.2	24	20	4	21.2
			(Native) SAND silty to gravelly, clayey in parts, boulders/cobbles in parts, very moist to wet, brown, medium dense	SS	5/11/12				9.2				
10278	20			SS	SR				13.7	NP	NP	NP	18.2
				SS	19/15/6				12.4	26	24	2	19.7
10268	30			GB					7.8				14.5
				BULK			0.00			NP	NP	NP	14.3
			(Metamorphic bedrock) Gneiss with igneous (Pegmatite) intrusions Core Run 1 (39'-40'): 0% RQD Core Run 2 (40'-45'): 1% RQD Core Run 3 (45'-46'): 0% RQD Core Run 4 (46'-49'): 29% RQD Compressive Strength: 13,509 psi									
10258	40			RC				161.5	0.1				
			Bottom of hole at 49.0 feet.										

LOG - CLIENT STANDARD 51101_I-70 CBC MM211.GPJ 2/6/19

APPENDIX B

LABORATORY TEST RESULTS

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT AECOM

PROJECT NAME I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01

PROJECT LOCATION CDOT Region 3 I-70 MM 211.0

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
B-1	0-15	21	20	1		20	SM	A-1-b (0)				0.00	1000 Ohms-cm @16.2%	7.4	0.0648			
B-1	2					13			5.5	133.9								
B-1	5					17			5.3									
B-1	10								2.2									
B-1	15					16			7.4									
B-1	15.1-25	21	20	1		17	SM	A-1-b (0)				0.01	1400 Ohms-cm @14.0%	7.3	0.0385			
B-1	20					11			3.9									
B-1	25					15			8.3									
B-1	25.1-45	17	19	NP		16	SM	A-1-b (0)				0.00	2000 Ohms-cm @15.4%	7.1	0.0219			
B-1	30					20			7.4									
B-1	35					17			7.2									
B-1	40					20			7.6									
B-1	45								6.0									
B-1	45.1-55	21	21	NP		17	SM	A-1-b (0)				0.00	2100 Ohms-cm @ 15.1%	7.3	0.0176			
B-1	50					17			6.7									
B-1	55								2.9									
B-1	56	NP	NP	NP		5	SP	A-1-a (0)	11.7									
B-1	60								11.6									
B-1	64					13			12.6									
B-1	65.1-75	24	21	3		22	SM	A-1-b (0)				0.00	1500 Ohms-cm @ 19.4%	7.1	0.0292			
B-1	70								10.0									
B-1	75					15			11.5									
B-2	0-29	20	20	NP		16	SM	A-1-b (0)				0.00	200 Ohms-cm @ 14.6%	7.0	0.0819			
B-2	9	NP	NP	NP		16	SM	A-1-b (0)	3.9									
B-2	14					16			5.8									
B-2	19					17			5.7									
B-2	24					17			7.5									
B-2	29								3.5									
B-2	30-49	23	21	2		17	SM	A-1-b (0)				0.00	2000 Ohms-cm @ 11.4%	7.2	0.0334			
B-2	39	NP	NP	NP		15	GM	A-1-b (0)	5.3									

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT AECOM

PROJECT NAME I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01

PROJECT LOCATION CDOT Region 3 I-70 MM 211.0

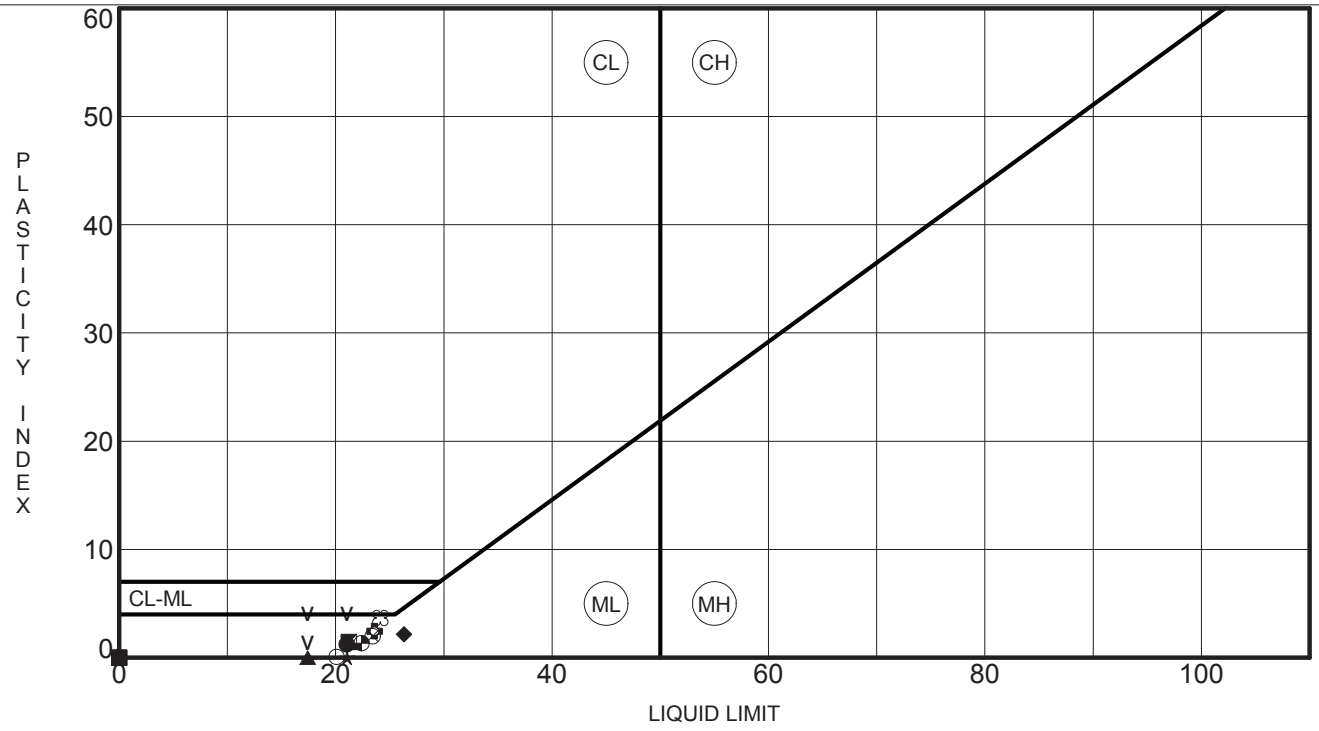
Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
B-2	45	NP	NP	NP		5	SW-SM	A-1-a (0)	0.9									
B-2	49	NP	NP	NP		15	SM	A-1-b (0)	7.0									
B-3	0-30	22	21	1		5	SP-SM	A-1-b (0)				0.00	1400 Ohm-cm @18.9%	7.2	0.0325			
B-3	4	NP	NP	NP		20	SM	A-1-b (0)	6.2									
B-3	9	24	20	4		21	SC-SM	A-1-b (0)	9.2									
B-3	14								9.2									
B-3	19	NP	NP	NP		18	SM	A-1-b (0)	13.7									
B-3	24	26	24	2		20	SM	A-2-4 (0)	12.4									
B-3	29.1					14			7.8									
B-3	30.1-38	NP	NP	NP		14	SM	A-1-b (0)				0.00	2200 Ohm-cm @17.2%	7.1	0.0205			
B-3	46.85								0.1	161.5	13,509.0							

RockSol Consulting Group, Inc.

ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



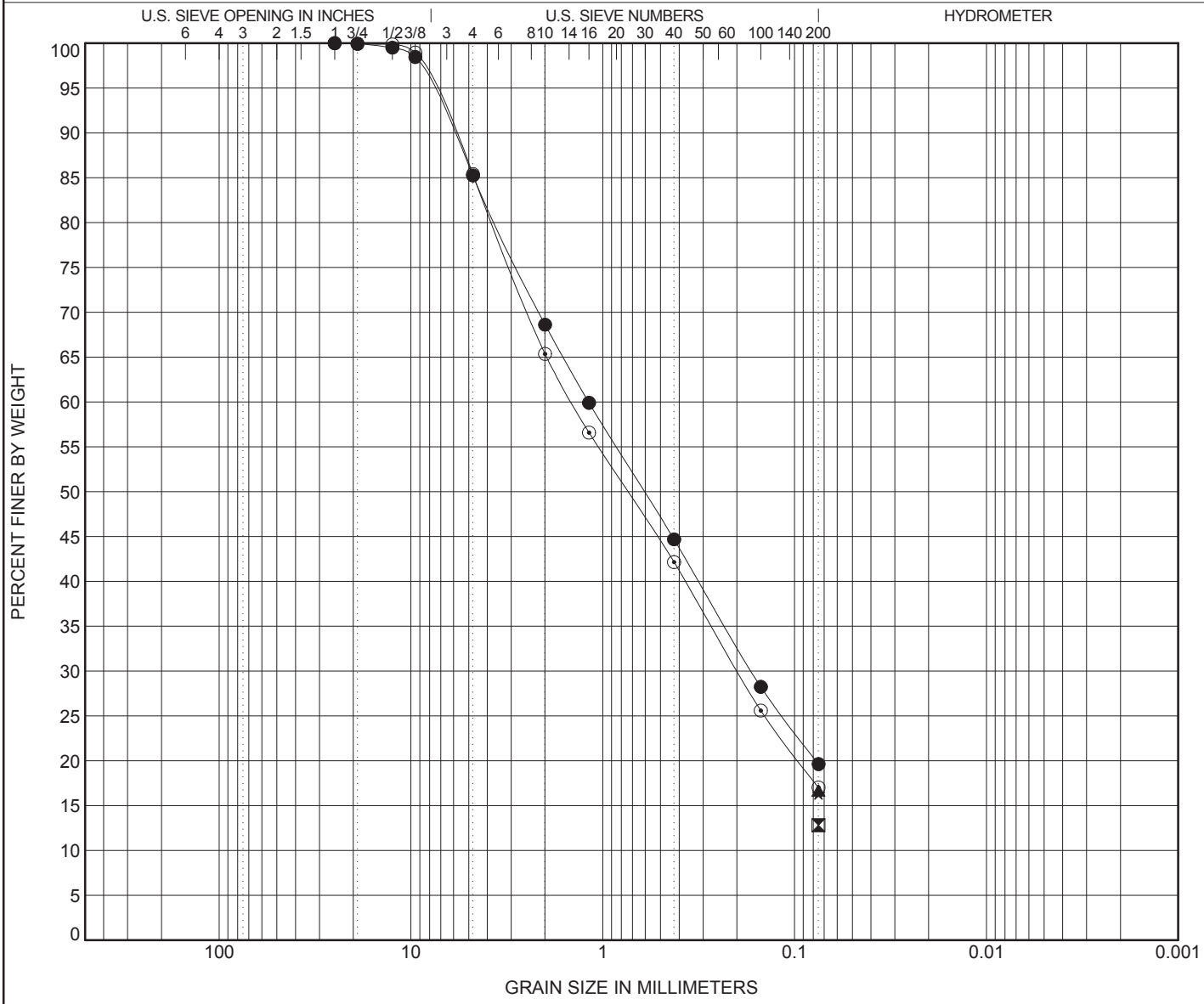
	Specimen Identification		LL	PL	PI	Fines	Classification
●	B-1	0.0-15.0	21	20	1	19.6	SILTY SAND (SM) (A-1-b)
⊠	B-1	15.1-25.0	21	20	1	17.0	SILTY SAND (SM) (A-1-b)
▲	B-1	25.1-45.0	17	19	NP	16.3	SILTY SAND with GRAVEL (SM) (A-1-b)
★	B-1	45.1-55.0	21	21	NP	17.0	SILTY SAND (SM) (A-1-b)
⊙	B-1	56.0	NP	NP	NP	4.8	POORLY GRADED SAND with GRAVEL (SP) (A-1-a)
✿	B-1	65.1-75.0	24	21	3	21.8	SILTY SAND (SM) (A-1-b)
○	B-2	0.0-29.0	20	20	NP	15.8	SILTY SAND (SM) (A-1-b)
△	B-2	9.0	NP	NP	NP	15.8	SILTY SAND with GRAVEL (SM) (A-1-b)
⊗	B-2	30.0-49.0	23	21	2	16.7	SILTY SAND with GRAVEL (SM) (A-1-b)
⊕	B-2	39.0	NP	NP	NP	14.5	SILTY GRAVEL with SAND (GM) (A-1-b)
□	B-2	45.0	NP	NP	NP	5.2	WELL-GRADED SAND with SILT and GRAVEL (SW-SM) (A-1-a)
⊛	B-2	49.0	NP	NP	NP	14.9	SILTY SAND with GRAVEL (SM) (A-1-b)
◒	B-3	0.0-30.0	22	21	1	5.4	POORLY GRADED SAND with SILT (SP-SM) (A-1-b)
☆	B-3	4.0	NP	NP	NP	20.1	SILTY SAND with GRAVEL (SM) (A-1-b)
⊠	B-3	9.0	24	20	4	21.2	SILTY, CLAYEY SAND with GRAVEL (SC-SM) (A-1-b)
■	B-3	19.0	NP	NP	NP	18.2	SILTY SAND with GRAVEL (SM) (A-1-b)
◆	B-3	24.0	26	24	2	19.7	SILTY SAND (SM) (A-2-4)
◇	B-3	30.1-38.0	NP	NP	NP	14.3	SILTY SAND (SM) (A-1-b)

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	0.0-15.0	SILTY SAND (SM) (A-1-b)	21	20	1		
⊠	B-1	2.0	SILTY SAND with gravel					
▲	B-1	5.0	SILTY SAND with gravel					
★	B-1	15.0	SILTY SAND with gravel					
⊙	B-1	15.1-25.0	SILTY SAND (SM) (A-1-b)	21	20	1		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-1	0.0-15.0	25	1.187	0.168		31.4	23.9	25.1	19.6	
⊠	B-1	2.0	0.075							12.8	
▲	B-1	5.0	0.075							16.7	
★	B-1	15.0	0.075							16.4	
⊙	B-1	15.1-25.0	25	1.449	0.198		34.6	23.2	25.1	17.0	

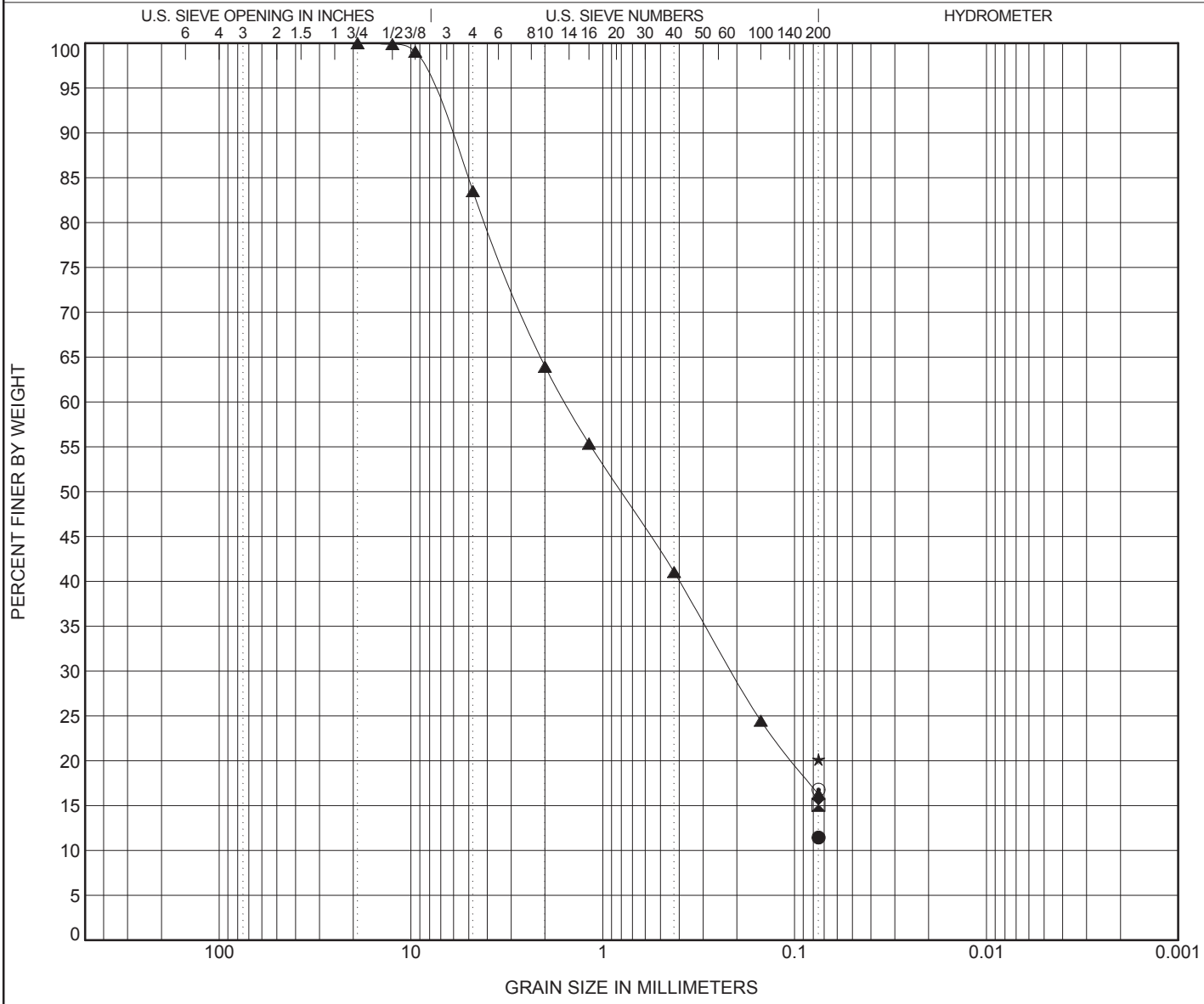
GRADATION - AASHTO 51101_I-70 CBC MM211.GPJ ROCKSOL TEMPLATE.GDT 2/6/19

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	20.0	SILTY SAND with gravel					
⊠	B-1	25.0	SILTY SAND with gravel					
▲	B-1	25.1-45.0	SILTY SAND with GRAVEL (SM) (A-1-b)	17	19	NP		
★	B-1	30.0	SILTY SAND with gravel					
⊙	B-1	35.0	SILTY SAND with gravel					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-1	20.0	0.075							11.4	
⊠	B-1	25.0	0.075							15.1	
▲	B-1	25.1-45.0	19	1.57	0.212		36.1	22.9	24.8	16.3	
★	B-1	30.0	0.075							20.1	
⊙	B-1	35.0	0.075							16.8	

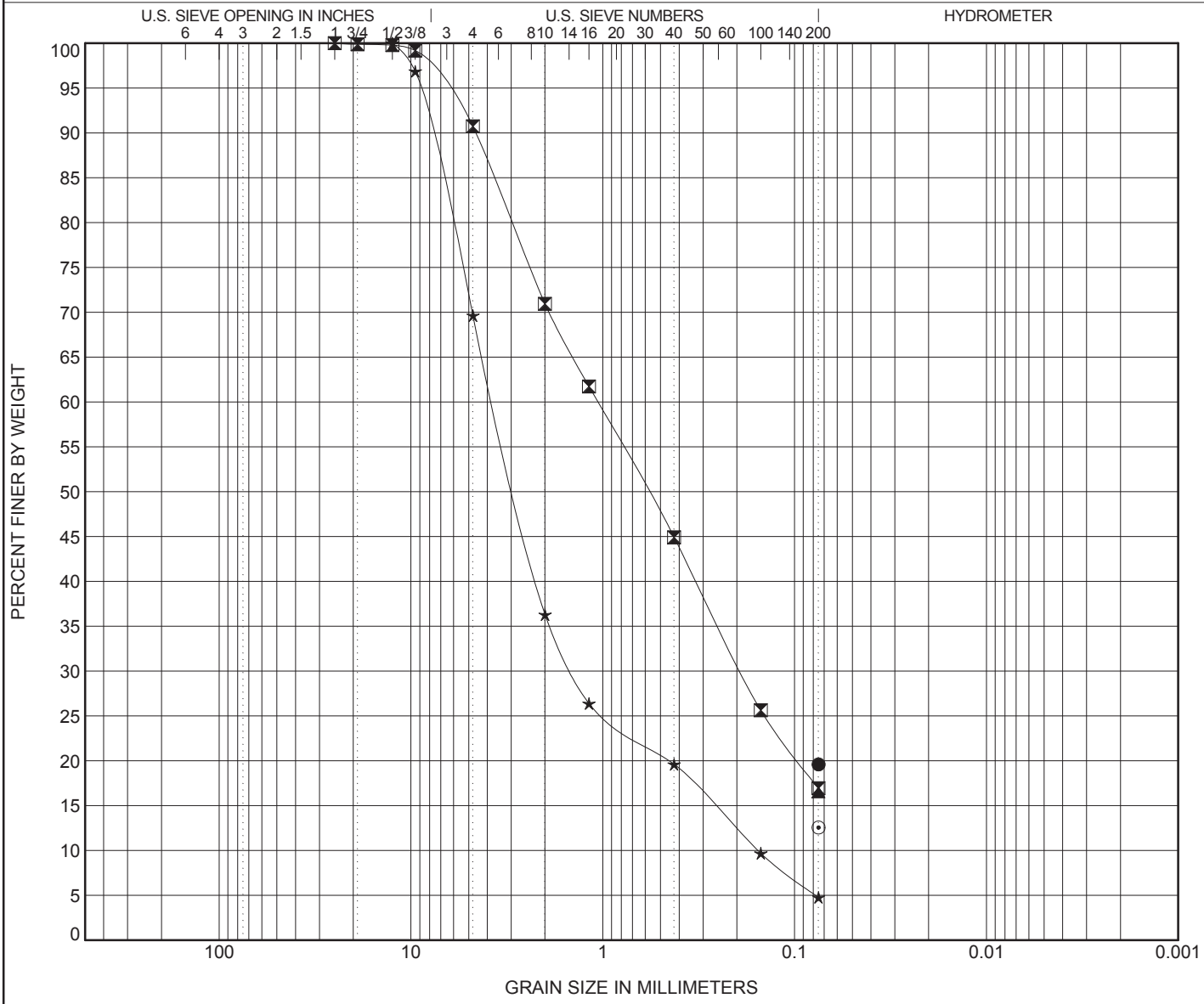
GRADATION - AASHTO 51101_I-70 CBC MM211.GPJ ROCKSOL TEMPLATE.GDT 2/6/19

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	40.0	SILTY SAND with gravel					
⊠	B-1	45.1-55.0	SILTY SAND (SM) (A-1-b)	21	21	NP		
▲	B-1	50.0	SILTY SAND with gravel					
★	B-1	56.0	POORLY GRADED SAND with GRAVEL (SP) (A-1-a)	NP	NP	NP	3.57	23.88
⊙	B-1	64.0	SAND, gravelly					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-1	40.0	0.075							19.6	
⊠	B-1	45.1-55.0	25	1.063	0.19		29.0	26.0	28.0	17.0	
▲	B-1	50.0	0.075							16.5	
★	B-1	56.0	12.5	3.699	1.43	0.155	63.7	16.7	14.8	4.8	
⊙	B-1	64.0	0.075							12.6	

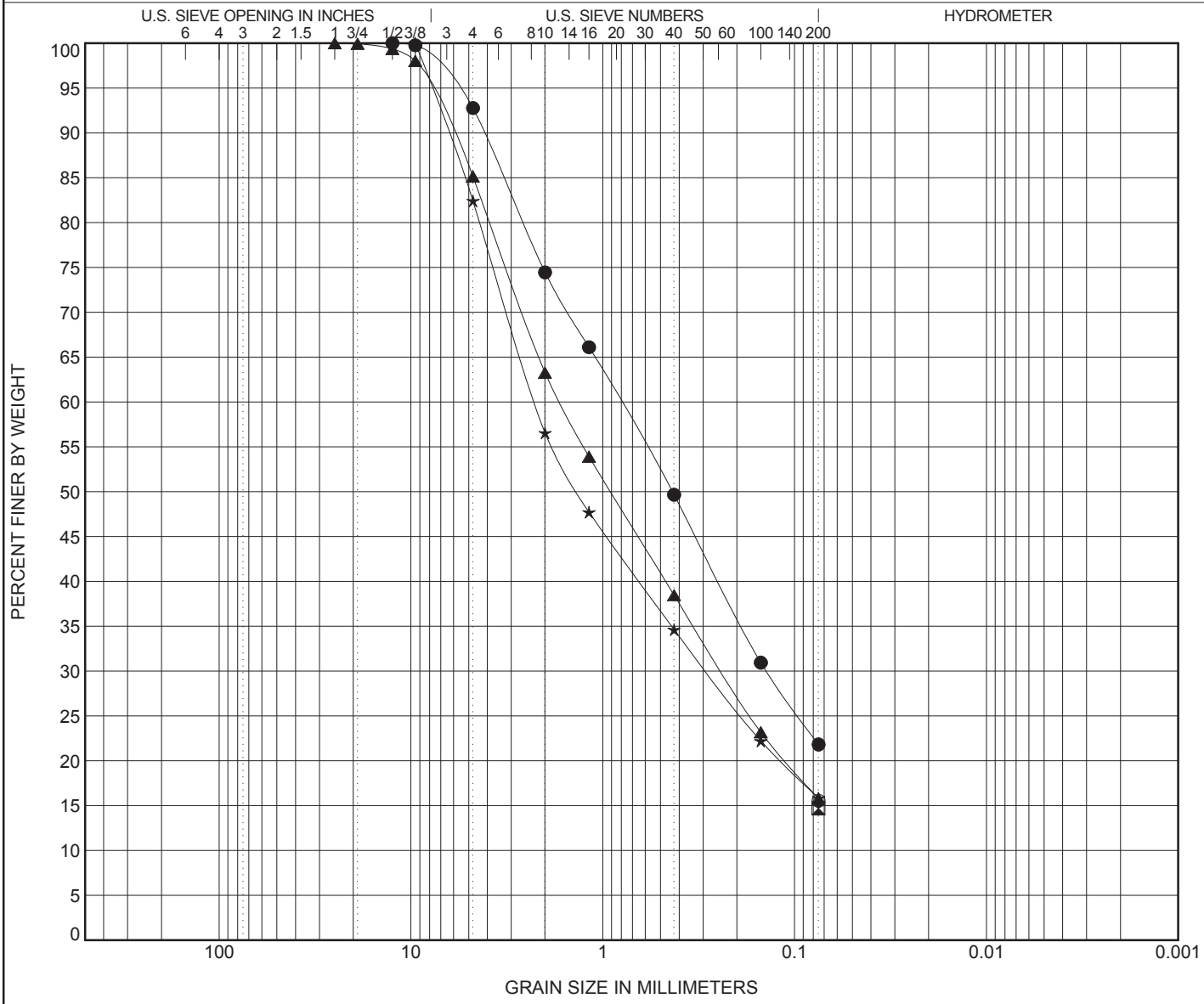
GRADATION - AASHTO 51101_I-70 CBC MM211.GPJ ROCKSOL TEMPLATE.GDT 2/6/19

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	65.1-75.0	SILTY SAND (SM) (A-1-b)	24	21	3		
⊠	B-1	75.0	SILTY SAND					
▲	B-2	0.0-29.0	SILTY SAND (SM) (A-1-b)	20	20	NP		
★	B-2	9.0	SILTY SAND with GRAVEL (SM) (A-1-b)	NP	NP	NP		
⊙	B-2	14.0	SILTY SAND with gravel					

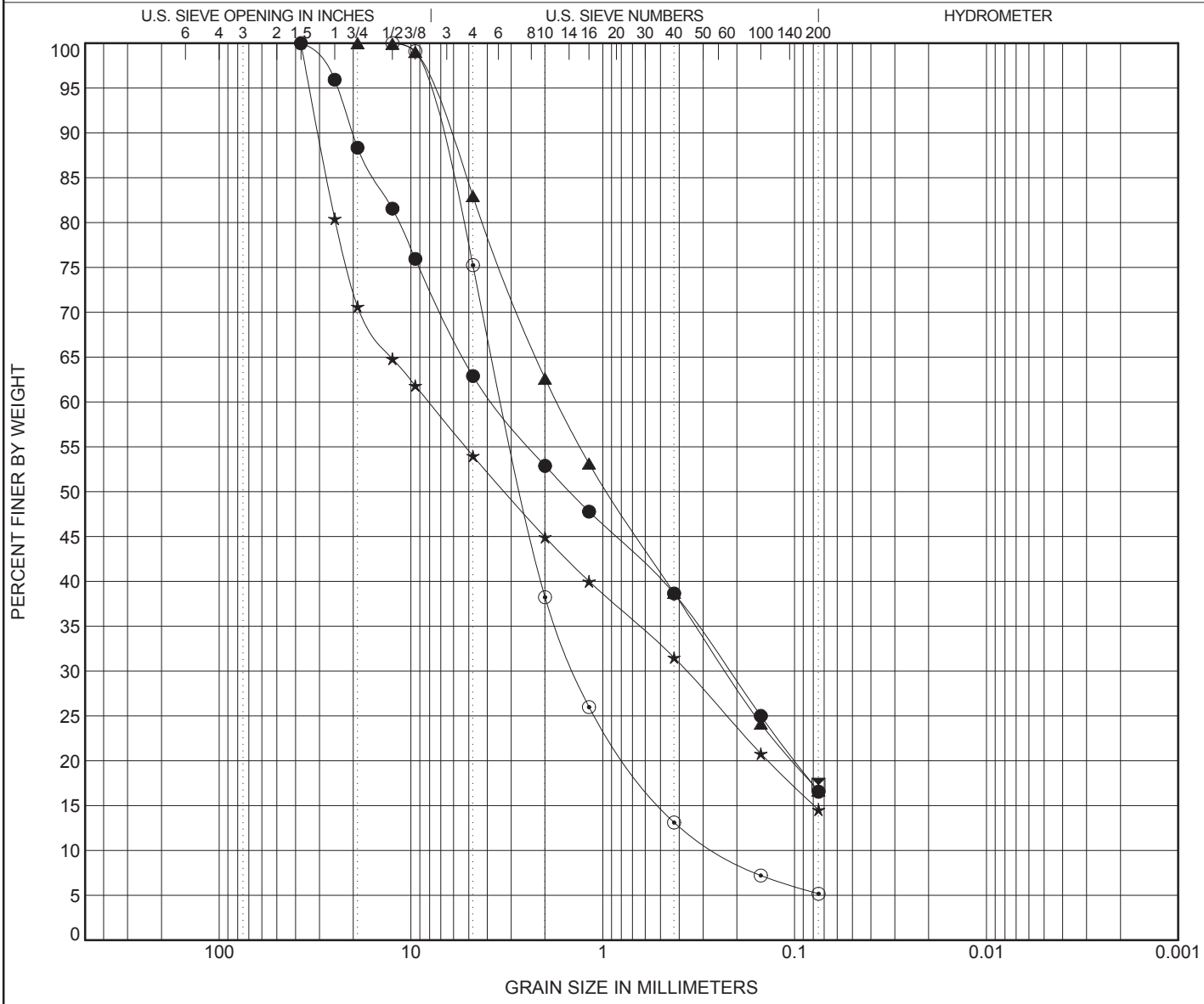
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-1	65.1-75.0	12.5	0.808	0.14		25.6	24.8	27.8	21.8	
⊠	B-1	75.0	0.075							14.7	
▲	B-2	0.0-29.0	25	1.663	0.239		36.7	24.8	22.7	15.8	
★	B-2	9.0	9.5	2.244	0.288		43.4	21.9	18.8	15.8	
⊙	B-2	14.0	0.075							15.5	

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-2	19.0	SILTY SAND with gravel					
⊠	B-2	24.0	SILTY SAND with gravel					
▲	B-2	30.0-49.0	SILTY SAND with GRAVEL (SM) (A-1-b)	23	21	2		
★	B-2	39.0	SILTY GRAVEL with SAND (GM) (A-1-b)	NP	NP	NP		
⊙	B-2	45.0	WELL-GRADED SAND with SILT and GRAVEL (SW-SM) (A-1-a)	NP	NP	NP	2.41	13.55

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-2	19.0	37.5	3.698	0.22		47.1	14.2	22.1	16.5	
⊠	B-2	24.0	0.075							17.3	
▲	B-2	30.0-49.0	19	1.73	0.228		37.4	23.9	22.0	16.7	
★	B-2	39.0	37.5	8.083	0.367		55.1	13.4	17.0	14.5	
⊙	B-2	45.0	12.5	3.326	1.403	0.245	61.8	25.1	7.9	5.2	

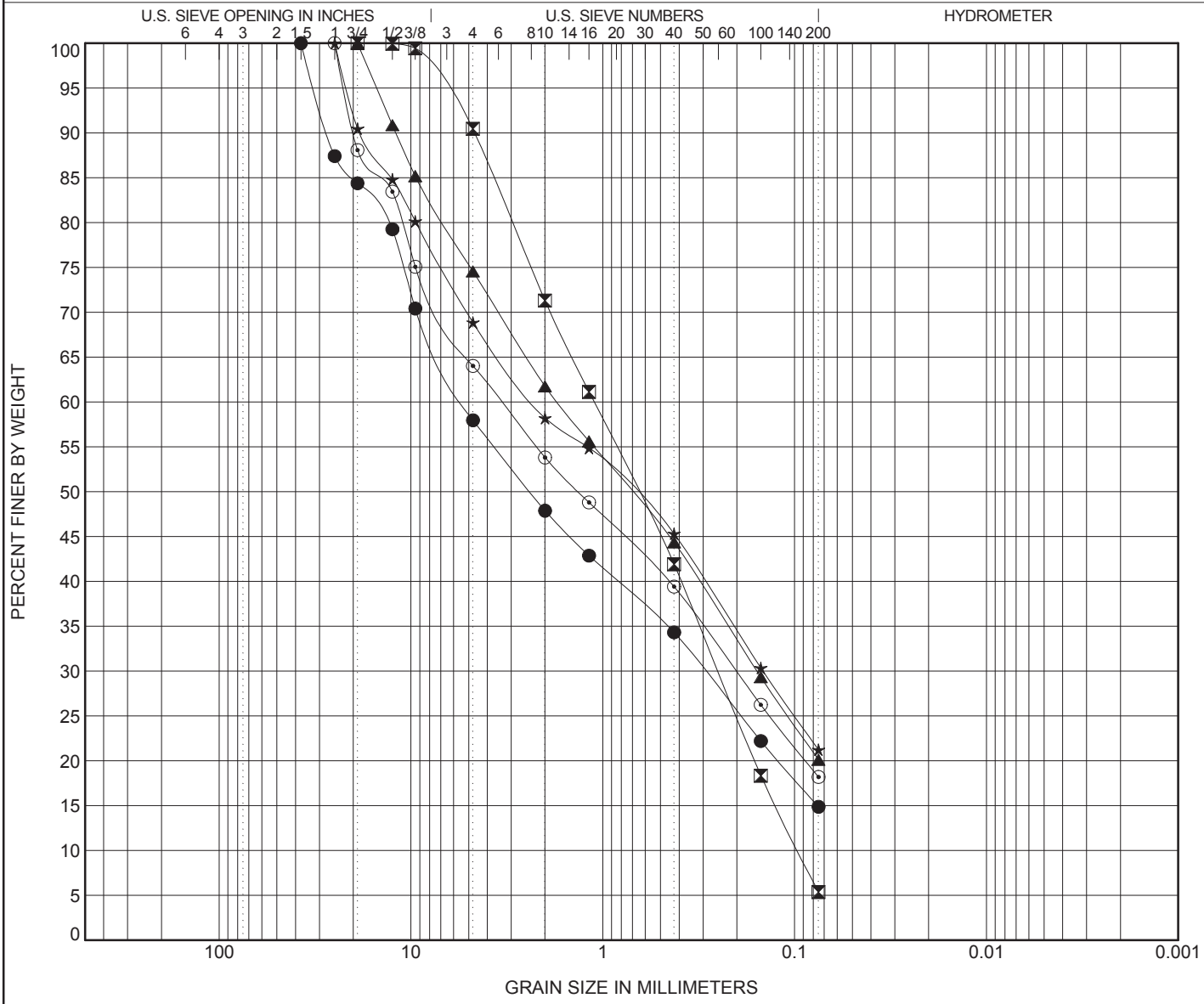
GRADATION - AASHTO 51101_I-70 CBC MM211.GPJ ROCKSOL TEMPLATE.GDT 2/6/19

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-2	49.0	SILTY SAND with GRAVEL (SM) (A-1-b)	NP	NP	NP		
⊠	B-3	0.0-30.0	POORLY GRADED SAND with SILT (SP-SM) (A-1-b)	22	21	1	0.59	11.57
▲	B-3	4.0	SILTY SAND with GRAVEL (SM) (A-1-b)	NP	NP	NP		
★	B-3	9.0	SILTY, CLAYEY SAND with GRAVEL (SC-SM) (A-1-b)	24	20	4		
⊙	B-3	19.0	SILTY SAND with GRAVEL (SM) (A-1-b)	NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-2	49.0	37.5	5.32	0.293		52.1	13.6	19.4	14.9	
⊠	B-3	0.0-30.0	19	1.111	0.251	0.096	28.7	29.4	36.5	5.4	
▲	B-3	4.0	19	1.721	0.157		38.3	17.4	24.2	20.1	
★	B-3	9.0	25	2.314	0.146		41.8	12.9	24.1	21.2	
⊙	B-3	19.0	25	3.38	0.202		46.2	14.4	21.2	18.2	

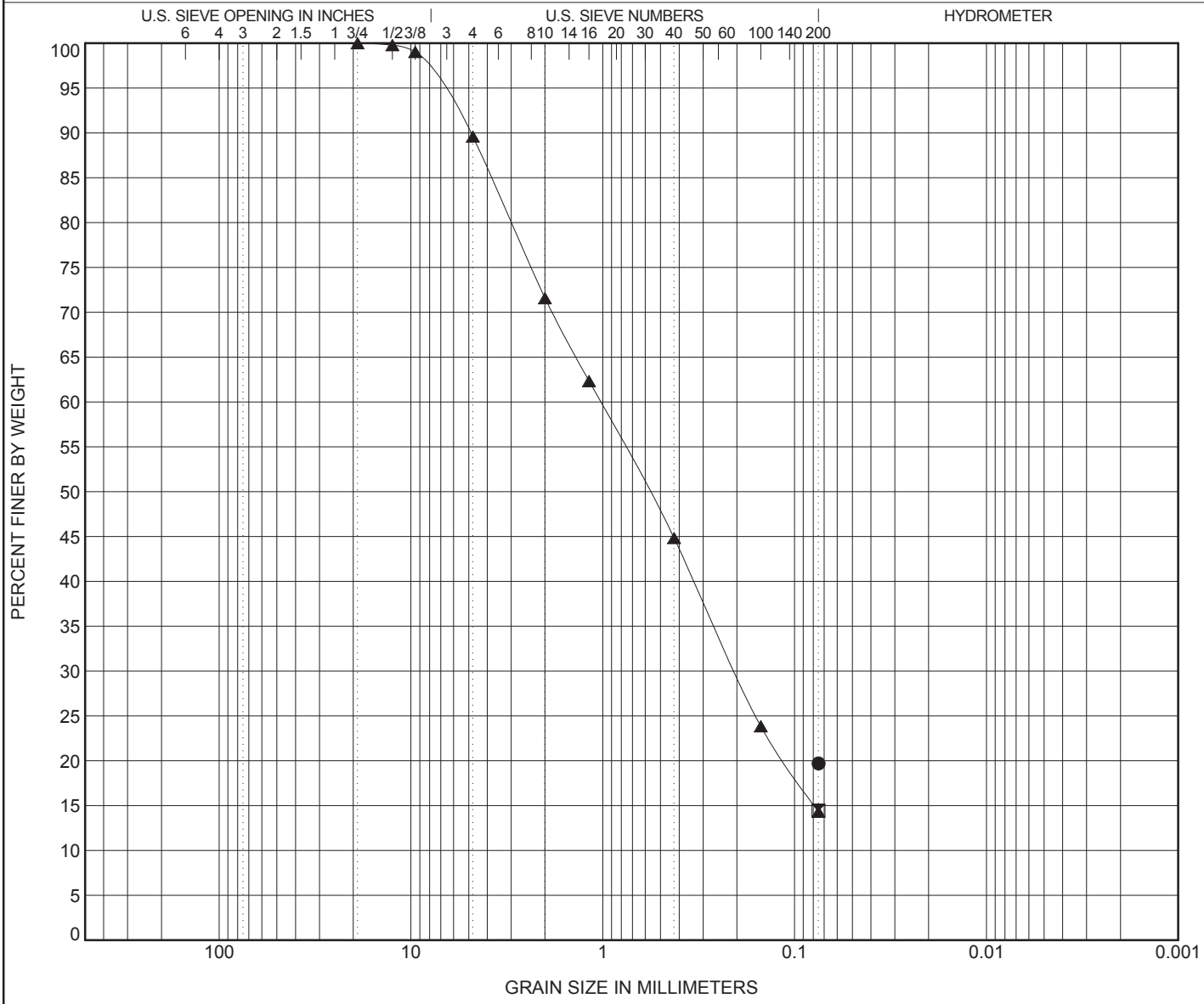
GRADATION - AASHTO 51101_I-70 CBC MM211.GPJ ROCKSOL TEMPLATE.GDT 2/6/19

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group Inc.

CLIENT AECOM **PROJECT NAME** I-70 Structure F-13-S at MM 211

PROJECT NUMBER 511.01 **PROJECT LOCATION** CDOT Region 3 I-70 MM 211.0



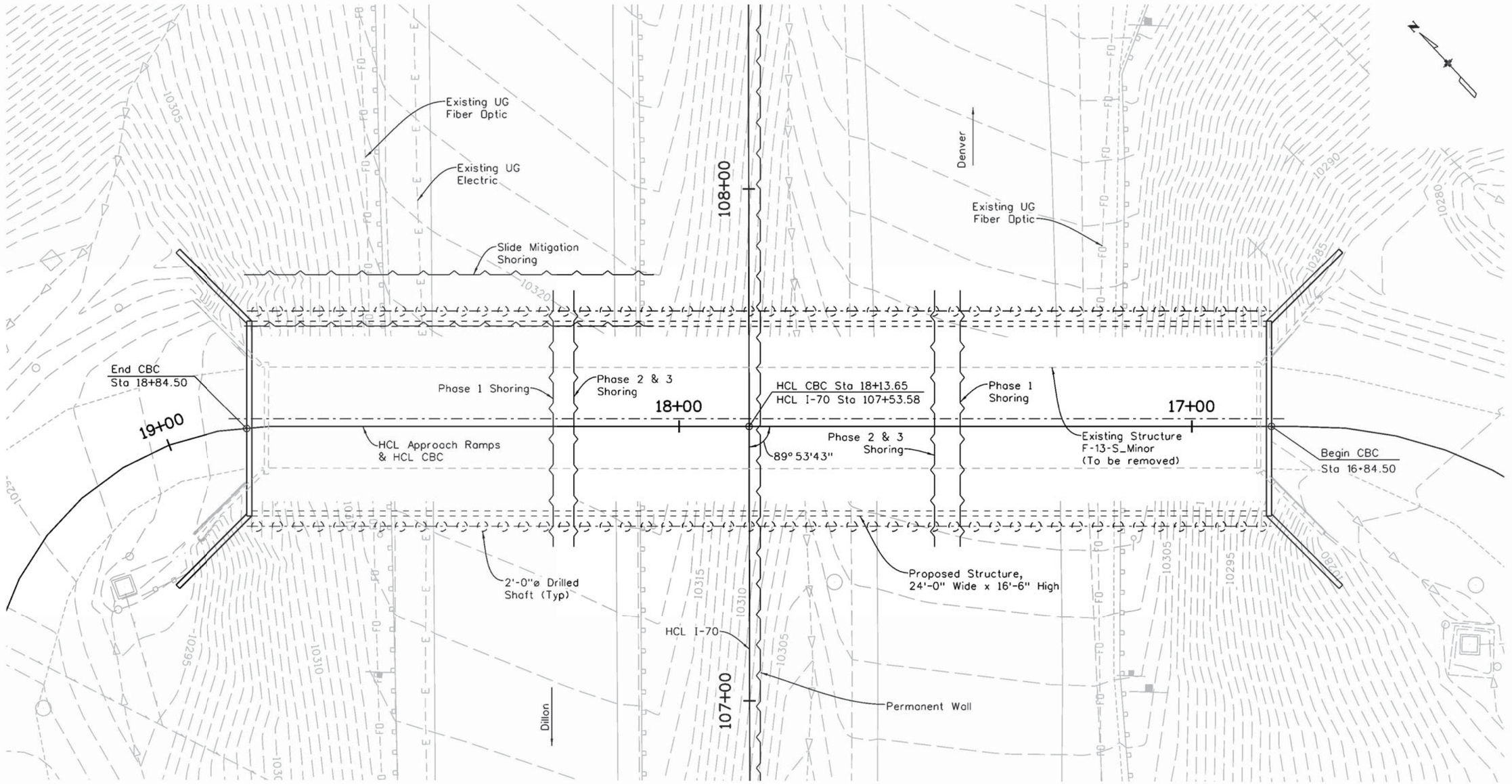
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-3	24.0	SILTY SAND (SM) (A-2-4)	26	24	2		
⊠	B-3	29.1	SILTY SAND					
▲	B-3	30.1-38.0	SILTY SAND (SM) (A-1-b)	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-3	24.0	0.075							19.7	
⊠	B-3	29.1	0.075							14.5	
▲	B-3	30.1-38.0	19	1.03	0.204		28.4	26.8	30.5	14.3	

APPENDIX C

SHORING PLAN CONCEPT
AND
BURIED BRIDGE ALTERNATIVE PLAN
(PROVIDED BY AECOM)



SHORING PLAN

Design			Detail			Quantities		
	INITIAL	DATE		INITIAL	DATE		INITIAL	DATE
Designed By			Detailed By			Quantities By		
Checked By			Checked By			Checked By		

Print Date: 1/24/2019
File Name: Shoring Plan.dgn
Horiz. Scale: 1:20 Vert. Scale: As Noted

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AECOM
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Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
Region 3
Mountain Residency, West Portal
Frisco, CO 80443
Phone: 303-512-5600 FAX:
GLA

As Constructed	
No Revisions:	
Revised:	
Void:	

SHORING PLAN

Designer:	M. Vause	Structure Numbers	
Detailer:	M. Vause		
Subset:	Culvert	Subset Sheets:	of

Project No./Code
FBR 0702-385
22712
Sheet Number

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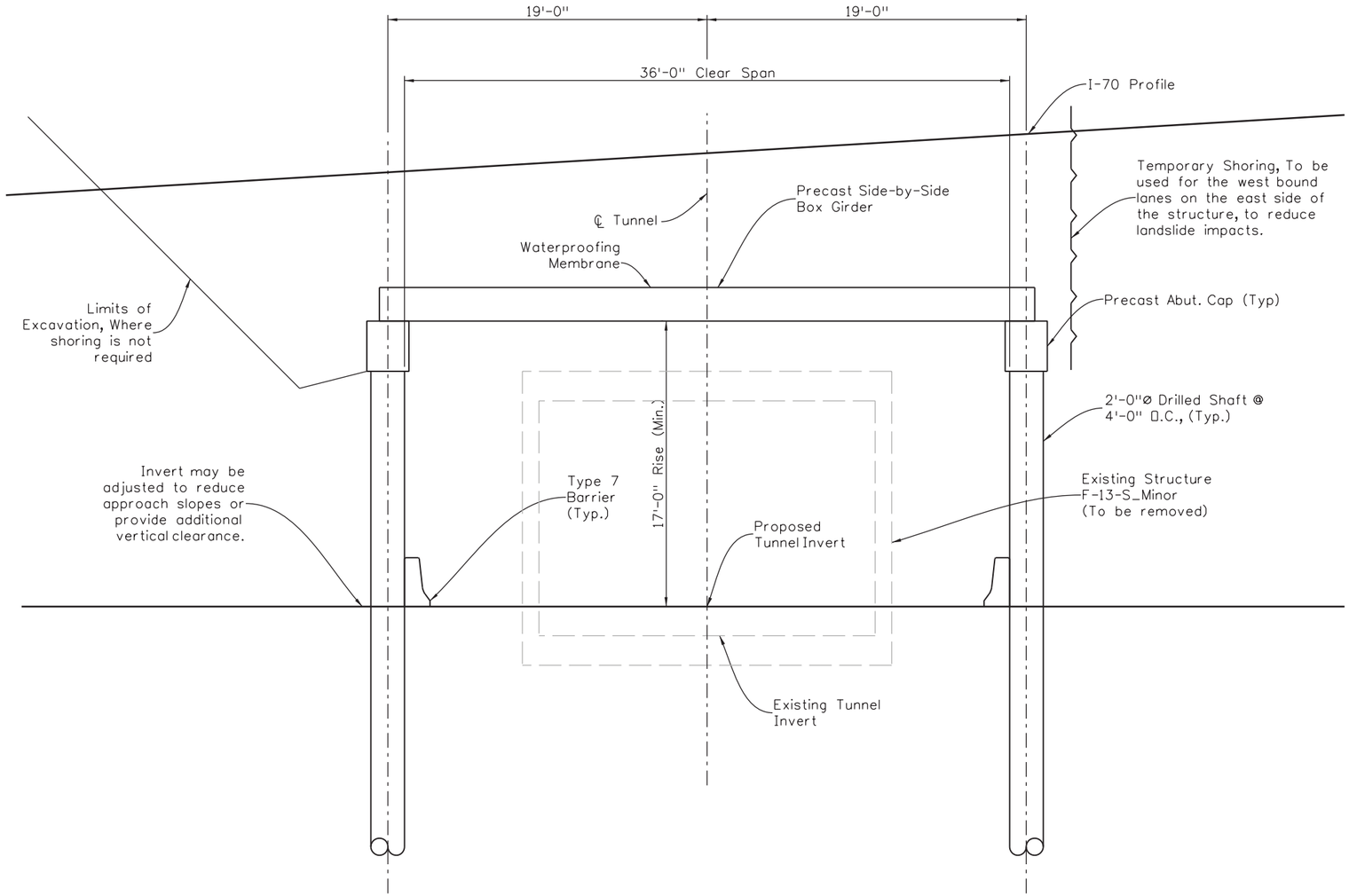

NOTES

1. Drill 2'-0" diameter caissons (4'-0"O.C.) (50 each side, 100 total). Assume 50'-0" length, each.
2. Place temporary shoring walls along I-70 Mainline to accommodate MOT Phase configuration requirements.
3. Remove asphalt pavement and embankment.
4. Place precast abutment caps and place precast box girder.
5. Waterproof and backfill above structure.
6. Place I-70 roadway asphalt & open traffic.
7. Repeat steps 2-5 for remaining construction phases.
8. Excavate remaining fill under newly built bridge & remove existing CBC.
9. Asphalt & place barriers below structure.

TYPICAL SECTION

vausem 10:27:57 AM pw:\\aecom-na-pw.bentley.com:AECOM_DS16_NA\Documents\605775556-I70 BDX\900 CAD\910_CAD\20_SHEETS\04_Structural\Tunnel_Section04.dgn

Design			Detail			Quantities		
	INITIAL	DATE		INITIAL	DATE		INITIAL	DATE
Designed By			Detailed By			Quantities By		
Checked By			Checked By			Checked By		

Print Date: 1/16/2019
File Name: Tunnel_Section04.dgn
Horiz. Scale: 1:1 Vert. Scale: As Noted

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Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
Mountain Residency, West Portal
Frisco, CO 80443
Phone: 303-512-5600 FAX:
Region 3 GLA

As Constructed
No Revisions:
Revised:
Void:

BURIED BRIDGE ALTERNATIVE

Designer: M. Vause
Detailer: M. Vause
Subset: Culvert
Structure Numbers
Subset Sheets: of

Project No./Code
FBR 0702-385
22712
Sheet Number

APPENDIX G – CORRESPONDENCE

Pre-Survey Conference

PRESURVEY CONFERENCE – PRELIMINARY SURVEY FORM

COLORADO DEPARTMENT OF TRANSPORTATION (Revised 8/29/2003)

Date: 8/15/18 Conference Location: Conference Call

PROJECT INFORMATION	Project Number FBR 0702-385		Project Location Summit County, I-70 MP 211	Project Code 22712
Highway Number SH-70	From Mile Post 210.5		To Mile Post 211.5	City or County Designation Summit County, Near Dillon
Section(s) 35	Township(s) 4 South	Range(s) 77 West	Principle Meridian 6th	Nearest City / Town Dillon/Silverthorne

Project Schedule Information	Scheduled date	Actual date
Date survey is needed:	Mid-September 2018	_____
FIR date:	_____	_____
FOR date:	_____	_____
Right-of-way Plan Review:	_____	_____
Ad date:	_____	_____

CDOT Project Leadership	**Consultant Firm Project Leadership**
Region: 3 Engineering Section: RE: Mountain Residency PM: Bridge Enterprise Residency Resident Engineer: Grant Anderson	Consultant Firm: AECOM 6200 S. Quebec Street Greenwood Village, CO 80111
CDOT Project Manager Name: Sarah Navarro Phone: 970-328-9936 e-mail: sarah.navarro@state.co.us	Consultant Manager Name: Gary Maji Phone: 303-941-4962 e-mail: Gary.Maji@aecom.com
	Consultant Survey Firm: Eugene Lynne Name: Heath Hildebrand Phone: 720-810-2691 e-mail: hhildebrand@eugenelynne.com
CDOT Project Surveyor In Charge Name: Jonathan Kobylarz, PLS 25954 Phone: 970-683-6236 e-mail: jonathan.kobylarz@state.co.us	Consultant Surveyor In Charge Name: Heath Hildebrand, P.L.S. No. 38211 Phone: See above e-mail: See above
Representative: PLS No.	Representative:
Additional Comments:	Is the surveying firm going to sub-contract any of their work? Yes ☒ No ☐ Utility locates, potholing, and traffic control Company Name : Underground Consulting Solutions Address: 5778 Kelly Ave Littleton, CO 80125 Phone 303-904-7422 Contact Person: Ken Goff Are representatives from subcontracting consultants present? Yes ☐ No ☒

Preliminary Survey Requirements (Compared to the Preliminary Survey Scope Form 1217a and Task Order)	
Proposed project type: Feasibility Study	
Length of survey: < 1 - mile	Width of survey: ROW to ROW
Number of lanes: 6	
Check all that apply:	Comments
☐ Primary Control monuments TMOSS	
☐ Project Control Diagram	
☐ Land Survey Control Diagram	
☒ TMOSS Topography by survey crew	
☐ Secondary Control monuments for aerial methods	
☐ TMOSS topography by aerial methods	
☒ Right-of-way preliminary field ties and investigation	
☐ Aliquot field ties, investigation and records	
☐ Survey for overlay quantities	
☒ Other: Utility field locates	Fiber optic runs along on the North side of I-70, an Xcel gas line runs near the structure, and an electric line provides power to the CBC lighting.

Preliminary Survey Information Supplied By CDOT
Yes ☒ No ☐ NA ☐ Has a Land Survey/Project Control Diagram Control been provided?
Yes ☒ No ☐ NA ☐ Has preliminary design data been provided?
Yes ☐ No ☒ NA ☐ Has preliminary ROW data been provided?
Yes ☐ No ☒ NA ☐ Has monument records been provided?
Yes ☐ No ☒ NA ☐ Has BLM township plats and notes been provided?
Yes ☐ No ☒ NA ☐ Has USGS topographic maps been provided?
Yes ☐ No ☐ NA ☒ Has railroad maps been provided?
Yes ☐ No ☐ NA ☒ Has Subdivision plats been provided?
Yes ☒ No ☐ NA ☐ Has a list of impacted property ownerships been provided?
Yes ☐ No ☐ NA ☒ Has permission to enter all property been obtained?
Yes ☐ No ☒ NA ☒ Has any other additional research evidence been provided?

Survey Requirements

Equipment Calibration

The following survey equipment shall be checked, calibrated if necessary, and the checks documented per procedures described in the CDOT Survey Manual, Chapter 5 – Preliminary Surveys:

1. All electronic measuring devices including GPS, total stations, and their accessories.
2. All leveling equipment and their accessories.
3. All miscellaneous equipment such as tapes, rods, etc.

Monumentation

What monument type(s) and quantities will be set or reset?

- ☒ Control Monuments Type 4 & 6
- ☐ Reference Monuments _____
- ☐ Aliquot Monuments _____
- ☐ ROW Monuments _____
- ☐ Boundary Monuments _____
- ☐ 3-D Deep Rod Monuments _____
- ☒ Other Monuments Secondary Type 5s

Have monument materials been provided by CDOT?
(See CDOT Survey Manual, Chapter 5 – Preliminary Surveys)

Yes ☐ No ☒

May be required if considerable existing control is not found east of the site (i.e. monuments may have to be reset).

Review and Compare to the Preliminary Survey Scope Form 1217a and Task Order

ADDITIONAL COMMENTS:

Gary is to contact Joel Berschauer, 970-683-6288 joel.berschauer@state.co.us, to confirm permission-to-enter requirements.

Surveyor is to provide the RE, Grant Anderson, at least 1-week notice if implementing a lane closure.

Per Jonathan Kobylarz, CDOT surveyor, latitude/longitudes need updating.

Jonathan also gave instructions on how the procedure should be done.

1. The control for this project was done in 2005 and adjusted to 1992 HARN lat /long. Since 2005, existing monuments may have shifted or been destroyed. It was Jonathan's suggestion that re-shooting a couple of monuments each side of the proposed TMOSS survey and rebuilding a site calibration (for analysis purposes) might allow a better analysis of the found control monuments and where to place the base station for data collection.
2. Resurvey existing project control referencing NAD 83 (2011)
3. Set additional secondary "site" project control referencing NAD83 (2011)
   - Purpose for geodetic coordinates to be updated from CHARN to 2011 Adjustment
4. Site calibrate existing project control coordinates to the updated 2011 geodetic coordinates
5. Recovering monumentation:
   - If existing monuments are not found or disturbed, new monuments may need to be set and controlled
   - If existing monuments do not fit the existing project control values within Class B Accuracies, re-controlling of these monuments will be required
   - Secondary control will use Type 4, 5s and 6 monuments.
6. Currently no ROW markers exist near the project site.

USFS requests for there to be no ROW markers or monuments on areas outside of CDOT's HED.

Use appropriate monument types on CDOT's HED, per the CDOT Survey Manual.

Team to ensure the new statues for 811/SUE are met. Contacts are Joe Carter at 970-683-6209 or Chris Williams at 970-328-9944 for additional information.

Presurvey Conference – Preliminary Survey
Attendance Roster

Project No.: FBR 0702-385 **Project Code: 22712** **Date: 8/15/18**

Name	Organization	Phone	Email or Fax
Grant Anderson	CDOT – RE	303-512-5601	grant.anderson@state.co.us
Sarah Navarro	CDOT - PM	303-970-9936	Sarah.navarro@state.co.us
Jonathan Kobylarz	CDOT – Surveyor PLS I	970-683-6236	jonathan.kobylarz@state.co.us
Gary Maji	AECOM – PM	303-941-4962	Gary.maji@aecom.com
Meagan Vause	AECOM - Structural	303-376-2916	Maegan.Vause@aecom.com
Stan Vermilyea	AECOM – ROW/Survey	303-796-4640	stan.vermilyea@aecom.com
Heath Hildebrand	Eugene Lynne – PLS	720-810-2691	heath.hildebrand@eugenelynne.com

Kick-Off Meeting Minutes

COLORADO
Department of Transportation
Division of Engineering Support

Meeting Date	09/11/18	Type	Internal	Team	Progress	Other
Date of Issuance	09/18/18					X
Attendees	See attached signup list					
Location	CDOT Region 3 Mountain Residency Office					

Project team held a kick off meeting with CDOT R3 to discuss the conceptual design of the I-70 Dillon CBC Replacement. The following items were discussed:

Project Scope, Schedule and Deliverables

1. The team will conduct a feasibility study which will encompass structure and tunnel replacement options for I-70 Structure F-13-S_Minor over Forest Service Road at MM 211. Actual structure selection, FIR and FOR design is not included. The structure is classified as structurally deficient and eligible for replacement through the Colorado Bridge Enterprise. The consultant will identify and assess issues and project challenges, work to gather data as required for the NEPA process regarding resources, and to complete a cost estimate and design schedule. The team will also identify and review alternative delivery opportunities for each of the identified structures.

2. The draft feasibility study report is scheduled to be submitted on the 27th of November. CDOT review meeting will be in mid-December followed by a final document in January 2019 (see below for additional information).

Task Name	Duration	Start	Finish
Preconstruction Tasks (Task 1)		**115 days**	
CDOT Kick-off Meeting	0	9/11/2018	9/11/2018
Design Survey	10	9/17/2018	9/27/2018
Structure Investigation	60	9/3/2018	11/2/2018
Concept Hydrology/Hydraulics	60	9/3/2018	11/2/2018
Concept Roadway Design	60	9/3/2018	11/2/2018
Concept Report	25	11/2/2018	11/27/2018
Submit Draft Report to CDOT	16	11/27/2018	12/13/2018
Review meeting with CDOT	0	12/13/2018	12/13/2018
Report Update	28	12/13/2018	1/10/2019
Final Submittal to CDOT	0	1/10/2019	1/10/2019

3. The team will prepare and submit a feasibility study and structure alternatives report which will include a geotechnical report, hydraulic and environmental memorandum. Project construction costs and construction duration will be developed and evaluated for each structure alternative. The report will not identify a preferred alternative but discuss the feasibility of each for purposed structure type.

4. Previous work at this location included the following: 18758 (I-70 Geotech/Pavement Repair/Rockfall Mitigation) 2012; 18293 (Existing CMP Drainage Repairs) 2011; and 15052 (I-70 Hamilton Box Drainage Improvements) 2009. Refer to the as-built plans for additional information.

Project Requirements

Project team & Stakeholder Coordination

5. The Project team will prepare and submit a project team and stakeholder contact list. In addition to the CDOT Region 3 and AECOM team, the following stakeholders were identified: CPW, US Forest Service, US Fish & Wildlife, ALIVE and Colorado Bridge Enterprise. Additional stakeholders that may be contacted included: the Towns of Dillon & Silverthorne, Summit County, and Straight Creek Water District.

6.

Name	Position	Email	Phone Number
Ty Ortiz	CDOT – Geohazards	ty.ortiz@state.co.us	303.398.6601
Jen Klaetsch	SCAP	jennifer.klaetsch@state.co.us	970.683.6223
Tyler Weldon	CDOT Hydraulics	tyler.weldon@state.co.us	303.512.5503

Survey/Utilities

7. The team held a pre-survey conference on the 15th of August with Jon Kobylarz, CDOT R3 Survey/ROW (see the Pre-Survey Conference Form for additional information). The field survey is scheduled the week of September 17th and the team will try to recover monumentation and establish horizontal control. A special use permit has been completed and approved by CDOT. As part of the survey activities, the following items were discussed:
   - Control points need to be "reassigned" since several control points had been knocked out.
   - Upgrade latitudes & longitudes to 2011 coordinate system.
   - The team will use NGVD 29 for vertical control.

8. The team agreed to perform a Quality Level B for utility locates & potholing.

9. Discussed utilities include:
   - Gas & transmission electric lines down in the Straight Creek Valley and out of project limits
   - Only the electric & fiber optic lines are within the project limits.

Environmental

10. Project team reviewed the I-70 PEIS and the Compass database to identify resources and potential project impacts. Review highlights include:
    - Biological and water resources with general wetlands are big concerns. CPW says no mice but toads might be impacted.
    - No concerns on: Hazmat, Noise impacts, Air Quality, Paleo (low sensitivity) and Historic. There should be no visual impacts, if continue to go under I-70
    - White River National Forest on south
    - Team discussed the Sediment Control Action Plan (SCAP). Grant noted that Straight creek has reached some level of achievement, in regards to sediment ponds & service roads. Jen Klaetsch is contact for the SCAP.
    - Lynx were identified. PMJM, Green Back Cut throats, Elk, and Deer are also called out in ALIVE
    - The team can get wildlife accident info from CDOT. Contact Jeff Peterson for additional information.
11. The team considered incorporating a "dirt path" for an animal crossing through/under structure (existing surface is concrete) but then confirmed that the structure would not be designated as wildlife structure nor would wildlife fencing be included. Team agreed to consider as many wildlife crossing requirements as possible (ie opening dimensions, dirt path, etc).
12. ALIVE – requirements fall back to EIS. The MOU between CDOT and the USFWS calls for enhancing corridor for wildlife when structures are replaced. Team will review Appendix E Tier 1 NEPA document for any work on I-70. This is also referenced in PEIS, Zone 9a/9b, Lasky Gulch & Hamilton Gulch. The structure is within one 9b. Team will consider alternatives that satisfy partial wildlife design requirements (no fencing etc) and have it geometrically available for wildlife use to tie into further projects. Additional discussion warranted.
13. Team agreed to target a 100 year design life (75-yrs per the CDOT Bridge Design Manual) due to traffic Impacts and rural location. Within 100 year design life, there's a good chance there will be additional wildlife crossings to tie into.

Maintenance

14. Marc Quintana and Todd Anderson are the Region 3 Maintenance contacts. Todd noted the structure needs to be higher & wider and two lanes would be ideal but not required. The current structure can't accommodate fire trucks, but ambulance, police & tow trucks use the structure. The proposed structure would ideally allow access for fire trucks.
15. All wildlife crossings in Kremlin, CO are 42' wide.
16. Turning radius for plows are very limited. West bound off is worst location. AECOM will get the design vehicle for the Dillon fire truck and run auto turn to see what vehicles can make the turn. Team may need to create special design vehicle for plow.
17. Rundown and erosion issues are present on both ends of box and there is always water in the box. Ground freezes during winter.
18. Truck pull off just east of box could go away. Maintenance says they don't typically use that anymore.

19. Team may consider a better plan to divert water from the double (triple) D inlets so they can be vacuumed out with a vac truck.
20. Team agreed to not change the operational plan. Structure will be signed for “Authorized vehicles Only”.

Right of Way

21. All adjacent ROW is within the highway easement deed through the US Forest Service ROW. No ROW issues are anticipated.

Traffic/Safety

22. Understanding the structure use, maintenance and operational requirements will be critical to defining traffic and safety requirements for the project.
23. CDOT wants to improve the power backbone. There already is a power feed for the VMS near MP 210. Team will consider additional conduits over box for future use.
24. Structure lighting is discouraged and would confuse the wildlife. Maintenance doesn't need lighting and the structure is currently not lit.
25. No particular accident type or safety requirements were identified at this location. Make sure we don't create a new accident problem here.
26. This is not a roadway reconstruction project and reconstructing I-70 profile will not be considered.
27. Frost depth is really deep up here, around 12'. AECOM to confirm.
28. Team discussed the sight distance issues for WB traffic approaching the structure. Team will confirm if additional WB signage for decel & turn-off is warranted.
29. Developing a formal TSMO is not scoped.
30. Traffic control requirements will be based on alternatives investigated. AECOM will coordinate with the R3 Traffic lead to confirm typical user cost information as part of the alternatives evaluation process.
31. Minimum typical section during construction is (2) 11' lanes each way, 2' shoulders, 2' median barrier = 50' min. CDOT (Grant) to confirm and provide an example from a previous project. If you can’t get 11' lanes need median & min. shoulders. Construction might not be possible. This might drive study type.

Geotechnical

32. 3 borings are proposed along the west side of existing structure, one on either end & one in center median to try to characterized the overburden material.
33. Get a shot of toe of slope by creek so we can do "global stability study" borings start tomorrow
34. The mountain is moving into shoulder along the WB lanes. Refer to the landslide just NE of box. Team will try to avoid slide issue. May need to do mitigation or at least propose some mitigation in study. AECOM will arrange a conference call with CDOT staff to discuss the geo-hazards. AECOM will coordinate with Ty Ortiz (ty.ortiz@state.co.us; 303-398-6601 Work; 303-921-2634 Mobile) with geo-hazards, on landslide issue
35. Ty and or Grant can share landslides map

Structures/Bridge Enterprise (BE)

36. The existing structure can't be closed during the winter. Summer is more flexible could maybe close but we can't confirm today.
37. Bridge structures with concrete decks are discouraged due to icing issues. Buried structures are better. Bridge option will consider fill covered bridge decks.
38. 16’-6” clearance is ideal (for typical roadway clearance) – team will need to check clearance in accordance with Bridge Design Manual and coordinate with Patrick Chavez to confirm design vehicle.
39. Construction window May 1st-Oct 1st
40. AECOM will need to establish the project base costs to confirm what work constitutes a design to standards approach vs. incorporating project betterments. Items potentially impacting the structure design (e.g. Additional discussion warranted).

Hydraulics

41. A lot of water impacts on this structure. Vaults along the north entrance were designed to catch mountain seepage that is carried through pipes or the existing structure. A lot of inlets that need to be inspected & dealt with. The 48" main conveyance for drainage basin was lined with a 36” RCP.
42. AECOM to contact Tyler Weldon (tyler.weldon@state.co.us; 303-512-5503 Work; 303-475-7448 Mobile) directly to see if there are any hydraulic reports or has any insight to this project site.
43. Water Quality – this project might not be able to meet all intended requirements due to geometric constraints.
44. Because this is a structure replacement project, AECOM will put back in place the existing infrastructure as much as possible and try to match existing hydraulic intent.

45. Team will need to document hydraulic scope and limits in the report and coordinate with BE to make sure any improvements are covered within their scope.

Project Delivery

46. As part of the structure alternative evaluation, the team will review and/or utilize CDOT's Alternate Delivery Matrix. Delivery options to be considered include: CMGC, Design-Build, or Design-Bid-Build

Critical Issues

47. Critical issues identified during the kick off meeting include: MOT design requirements; confirming and coordinating the Straight Creek Geo-Hazard conditions as it impacts structure selection; matching the structure sizing with operational, potential wildlife and structural design requirements

END OF MEETING

AECOM

Name Gary Maji, PE
Title AECOM Project Manager

The above represents the writer's understanding of the discussions and a complete and accurate record of the decisions and agreements made. Amendments to this record shall be made in writing to the author.

Action Item Log - Summary

COLORADO Department of Transportation
Division of Engineering Support

	I-70 Dillon CBC		Rev: 9/18/2018		Proj FBR 0702-385 (22712)

ID		Department	Owner	Status	Date Entered	Planned Completion	Actual Completion	Comments
1	Review Appendix E of PEIS Tier I doc	DESIGN	AECOM	In Progress	9/11/2018	9/25/2018		
2	Provide I-70 phased construction typical section from previous I-70 projects.	DESIGN	CDOT	In Progress	9/11/2018	9/25/2018		
3	Arrange geo-hazards conference call after the draft geotech report is completed to communicate existing conditions and proposed study efforts.	DESIGN	AECOM	In Progress	9/11/2018	9/25/2018		Call Ty Ortiz, CDOT R3
4	Contact Dillon Fire Department to confirm emergency vehicle requirements and/or applicability for this project.	DESIGN	AECOM	In Progress	9/11/2018	10/1/2018		
5	Review AUTOTURN design requirements for WB traffic access to the structure.	DESIGN	AECOM	In Progress	9/11/2018	10/18/2018		
6	Contact R3 Traffic to identify user cost data for the ABC Matrix and Structure evaluation.	DESIGN	AECOM	In Progress	9/11/2018	10/18/2018		
7	Contact R3 Hydraulics to confirm availability of existing hydraulic reports.	DESIGN	AECOM	In Progress	9/11/2018	9/18/2018		Call Tyler Weldon, CDOT R3
8								
9								

CDOT Region 3 I-70 Box Replacement Study

FBR 0702-385 (22712)

Kick Off Meeting

Name	Phone	Representing
Stuart Gardner	970 (410 0351	CDOT Hydraulics
gary maji	303 941 4962	AECOM - PM
Emmalee Blender	970.683.6280	CDOT Traffic
MAEGAN VANSE	303-376-2916	AECOM
Paula Durkin	970-623-5612	CDOT Envir.
TODD ANDERSON	303-229-5036	CDOT
Sarah Navarro	970-328-9936	CDOT
Sam Abraham	303-757-9193	staff Bridge
Joel Johnson		staff Bridge

5590 West 11th, Greeley, CO 80634

CDOT Region 3 I-70 Box Replacement Study

FBR 0702-385 (22712)

Kick Off Meeting

Name	Phone	Representing
RYAN LEPRO	303-704-1261 (CELL)	RockSol
Grant Andersen		CDOT
Michelle Conardin	970-531-7373	CPW
Mike Heugh	303-376-2943	AECOM Traffic
Tracey MacDonald	720 220 4747	AECOM - Env.
KEVIN KLINGE	303-638-5604	AECOM - H&H
PATRICIA HOLINDA	303-757-9427	BRIDGE ENTERPRISE
Elissa Slezak	970-485-3081	CPW
Heath Hildebrand	(720) 810-2691	Eugene Lynne

FOR Review Meeting Minutes

COLORADO
Department of Transportation
Division of Engineering Support

Region 3 – Mountain Residency

Meeting Date: 12/13/2018

- Location: - CDOT Mountain Residency
- Conference Room - Straight Creek
- Meeting Time: - 2pm – 5pm

Project Name: - I-70 Dillon Structure Replacement MP 211

Project Number: - FBR 0702-385 (22712)

Subject: 22712 Feasibility Study Draft Report Review Meeting

Project team met to discuss the review comments on the draft I-70 box replacement and feasibility report. The following comments were noted below. Action items from this meeting are attached. Detailed review comments are forthcoming.

1. Project Schedule -
   a. Original final report was planned for early-mid January.
   b. Team to discuss new schedule after getting direction from Bridge Enterprise (BE).
   c. Task order goes through August 2019.

2. Bridge Opening Requirements/Design Vehicle. The following comments were noted:
   a. Current design is proposing a 24'W by 15'H opening. Team to meet with BE and confirm maximum span BE would fund.
   b. Team agreed that the replacement structure will be designed for a 100-year design life.
   c. Currently, the structure is signed for authorized use only - not open to public.
   d. Patrick Chavez (CDOT Operations) noted that the box is critical for maintenance and emergency. Narrowness of box is really limiting. The design truck is evolving and bigger and bigger equipment is using the structure.
   e. Additional CDOT discussions are warranted to confirm the design vehicle. After meeting with BE design team will coordinate with Patrick Chavez to finalize design vehicle measurements.
   f. Team may consider structure openings that can turn around passenger traffic along I-70 in case of emergency.
   g. Martha Miller (CDOT East Program Engineer) noted this structure should accommodate 2-way traffic with appropriate shoulders and curbs. (31')
   h. Elissa with CPW to send over opening ratio for animal crossings, for reference. Although CDOT's SH 9 wildlife crossing provided a 42' width, CPW would consider a 40' minimum opening width, which is desired opening width for Elk. As applicable, the design team will follow the PEIS requirements in regards to animal crossing at this location.

3. Discipline Review Comments
   a. Geotechnical
      - The draft report contained recommendations to perform additional geotechnical investigation (i.e. consider inclinometers to monitor the landslide movement) east of the box. CDOT has not seen any movement here and suggested not installing the inclinometers. Team agreed to remove this recommendation at this stage.
      - AECOM noted that if the east wall of existing structure was left in place, there would be little risk of mobilizing the slide. If it is removed and ground is disturbed it is more likely to mobilize the slide.
      - Team agreed to include additional discussion in the report about the effects of the landslide and how we are mitigating it.

- RockSol to include discussion on temporary shoring wall design parameters and alternatives in the final geotechnical report.

b. Survey/ROW/Utilities

- Current project was performed using a Quality Level (QL) D approach (original research). QL_B is using equipment to do horizontal location. QL_A is potholing, which would be done at FIR.
- AECOM will contact Chris Williams to complete utility stakeholder information table.

c. Maintenance - no comments

d. Environmental Memorandum comments include:
- Access to Straight Creek must be maintained during construction and permanent access. Add note to report.
- Separate Railroad and Utilities sections and clarify impacts accordingly.

e. Hydraulic
- Design team to verify use of 100 year storm. 50 year would typically be chosen for rural Interstate.
- Grant noted that most of drainage is coming out of landslide. Snow melt is the driver, not rainfall. CDOT typically uses stream stats. Team to check Streamstats to determine if there are any problems with drainage. Trenching water before it gets to the structure of adding a side ditch in the structure could prevent water from flowing In travel areas.
- Design team noted that the design basin was based using GIS information. Discrepancy between CDOT's basin - 267 acres & as-builts we received today = 165 acres. AECOM will review plans and update accordingly.
- AECOM to update pipe profile per as-builts.

f. Roadway Characteristics & Traffic

- Team discussed operational strategies at this site and if CDOT wants to be able to turn semi-trucks around at this location? Additional discussion is warranted.
- Runaway truck ramps are not access points. Reword or remove this reference in the report.
- Design vehicle - WB50 - CDOT to finalize & send to design team.
- Accel/decel discussion included:
  - Existing operations -WB cars are using middle lane to turn off from I-70.
  - Emmalee (CDOT Traffic) noted that Joel Barnett would want a decel lane.
  - Grant noted that this structure is not for public use. Adding decel lane might encourage public use.
  - EB WB - acel/decel lengths are different for grades. Team to elaborate on how they operate differently. Clarify that accel/decel lanes are not currently required but could be required in the future. Safety improvements do not have to meet all requirements.
- WB could use wider shoulders - operational vehicles would know that's their decel lane? Add this option to text.
- Add some general discussion for EB, slow trucks in right lane. Vehicles entering highway from complete stop, etc.
- Design team to look for NCHRP reports or anything on these types of accesses (non-public). How do accel & decel compare to current standards.
- CDOT does not want to evaluate this location similar to an Interchange.
- CDOT to discuss accel/decel lane funding eligibility with BE. Current operation utilizes shoulders for accel/decel.
- Team discussed the construction phasing approach and will review the R3 lane closure policy. VPL should be 1100 not 2200.

- Verify applicable design guides. This is not a typical roadway design.

g. Structure Alternatives
   - Cut & Cover Alternatives. Clarify the advantages vs disadvantages. These are supposed to be stand-alone statements, not comparative.
   - Tunnel Alternative. Discuss fatal flaws regarding some of the tunneling options (i.e. why we are not pushing certain ones forward). Clarify what a Fuko grout hose is. Add statement at end of tunnel section that clarifies only arch tunnel is viable. Others were discussed to be all inclusive.

4. Cost Estimates. Design team to verify shoring costs.

5. Construction Schedule
   a. Estimated project schedules were developed for each alternative and include the total duration (i.e. calendar days) and the estimated MOT days. The construction of the drilled caissons was not included in the MOT days since it was assumed that the caissons could be constructed via nightly lane closures. MOT duration includes work after the caissons are installed and the I-70 traffic is phased. Define MOT (maintenance of traffic) in report.
   b. Construction will require a season wide restriction for permit loads – they will need to go over Loveland Pass.
6. Project Delivery Matrix
   a. Project delivery matrix – make the titled section and table "draft or preliminary"
   b. Team confirmed that if tunneling alternative drops out a more traditional method delivery method would likely be proposed.
   c. Add text noting CDOT will schedule an alternative delivery meeting prior to the next design phase. Please note the table identifies the design team's initial thoughts but recognizes no delivery method is chosen until CDOT's innovative design practice meeting.

Additional Notes (not previously addressed above):

1. CDOT wants design team to consider adding a cut-n-cover precast arch option to the structure alternatives, especially if span increases.
2. Span is going to govern design. If we go much larger than shown in draft report the cbc option would be eliminated.
3. Add shoring plan to Appendix B.
4. Clarify which structure alternative would have shortest construction duration.
5. Call report feasibility study throughout.
6. Structure location:
   - Due to nearby landslide location, structure cannot be moved east. Due to other implications of moving the structure west (drainage, approach slopes, structure cover) the existing alignment is most suitable.
   - The report should include more discussion if box crossing location is moved and what happens to existing structure (e.g. flow-fill, rehab for small mammal, additional costs, etc.).
7. CDOT wants a table in final report that shows base line cost vs cost of additional span width.
8. CDOT noted that user costs when I-70 is completely closed is about $1M per hour (as noted in the PEIS). Add a more qualitative user assessment to report and have numerical user costs and "Attachment B" in Appendix I.
9. Rehab discussion – Structure was considered functionally obsolete prior to obtaining structurally deficient (SD) status (cannot be both on SIA). Include text in the structure history section to say why rehab is not feasible. Full LCCA of rehab vs replacement is NOT required.
10. At this time, CDOT does not foresee widening I-70 at this location.
11. Durability & Maintenance – Include more discussion on why we are not doing a LCCA. Add note about rehabbing the structure would only get us 25-30 and this is why we did not do LCCA.

12. Structure is in highway easement deed on US Forest Service. Add them to the stakeholders list. Remove comment about Comprehensive Plan in 2009.
13. Remove environmental contact list.
14. Design team to verify location of Slide 1. The report noted that Slide 1 is about 160' east of structure. Team to confirm and clarify where the measurement is taken from.
15. Design team to add discussion about icing in structure and what can we do to mitigate.
16. Team needs to involve FHWA regarding interstate access policy. Discussion/topics include:
    - Team was not able to confirm structure use, access and design requirements per applicable FHWA interstate access policy points. Additional discussions with FHWA are warranted.
    - How are they going to consider this interstate access?
    - Is locked gate appropriate? It is specified as only for specific user (not open to public) and inconspicuous. Would we need to have an actual gate?
    - CDOT to set up meeting with Joel Barnett in January to discuss.
    - Sarah to reach out to Region 3 access control manager for additional guidance.

Action Item Log - Summary

	I-70 Dillon Structure Replacement MP 211	Rev: December 18, 2018		Proj FBR 0702-385 (22712)

ID		Department	Owner	Status	Date Entered	Planned Completion	Actual Completion	Comments
1	Differentiate project costs associated with BE and non-BE (wildlife, roadway/safety needs, etc.) items	PM	AECOM		12/17/2018			
2	Include paragraph/statement regarding the risks associated with exploring construction methods that could instigate a potential slide	Design	AECOM		12/17/2018			
3	Team to get BE buy-off on horizontal/vertical clearance diagram	Design	AECOM/ CDOT		12/19/2018			Team discussed minimum opening requirements in meeting with BE on 12/19/2018. Vertical clearance of 16.5' is desirable however 15.5' ("good" rating) is acceptable with justification for a variance. With guidance from CDOT and through discussion with BE the structure width will be updated to accommodate 2-way traffic. Team to confirm design truck and rerun auto-turn to set minimum required opening. Results to be incorporated into the final report.
4	Note why LCCA wasn't explored	Design	AECOM		12/17/2018			
5	Confirm utility contacts with Chris Williams	PM	AECOM		12/17/2018			Chris would like the team to reach out to the utility companies to determine the contacts, team can then run them by him.
6	Send SH 9 utility underpass example plans	PM	CDOT		12/17/2018			Grant sent on 12/19/2019
7	Provide design parameters and discussions in report on temporary wall alternatives	Design	RockSol		12/17/2018			
8	Verify location of Slide 1, in relation to structure, based on Robinson report.	Design	AECOM		12/17/2018			
9	Discuss design vehicle with BE and send AECOM diagrams based on outcome.	Design	CDOT		12/17/2018			Consult with Patrick Chavez. Sarah can assist.
10	Investigate shoring costs and type.	Design	AECOM		12/17/2018			
11	Update hydraulic assumptions based on new as-built information provided by CDOT on 12/13/2018	Design	AECOM		12/17/2018			
12	Elissa to send design team size guide for animal opening requirements.	Design	CPW		12/17/2018			Sarah emailed Elissa on 1/2/2019.
13	Find & Review FHWA documents for access classification.	PM	AECOM/ CDOT		12/17/2018			Grant sent FHWA document on 12/19/2018
14	Set up meeting with Joel Barnett to discuss FHWA's role in project.	PM	CDOT		12/17/2018			Sarah to let team know once meeting has been scheduled.
15	Reach out to R3 Access control manager for additional guidance on FHWA compliance.	PM	CDOT		12/17/2018			Sarah spoke to Dan Roussin on 12/17/2018. He recommends that the team consult with FHWA.
16	Incorporate/document team discussions on wildlife crossing, A-line, CDOT's Special Use Permit and access requirements into the final report.	PM	AECOM		12/19/2018			
17								
18								

Call-Ins CDOT: Paula Durkin, Patrick Chavez, Ty Ortiz
Stuart Gardner, Emmalee Blender, Martha Miller
Cinnamon Levi-Flinn

AECOM:
Elliot Drumright

CDOT Region 3 I-70 Box Replacement Study

FBR 0702-385 (22712)

Draft Study Review Meeting 12/13/2018

Name	Phone	Representing
Elissa Slezak	970-485-3081	CPW
Joel Johnson	303-512-5989	Staff Bridge
RYAN ABRAHAM	303 807-5730	AECOM
MAEGAN VAUBE	303-376-2916	AECOM
Allison AKO	808-206-0201	AECOM
Mike Heugh	303-376-2943	AECOM
Gary May	303.941.4962	AECOM
Sarah Navarro	970-328-9936	CDOT - R3
Grant Anderson	303-512-5601	CDOT - R3 RE

BE Eligibility Meeting Minutes

COLORADO
Department of Transportation
Region 3

22712- BE Eligibility Meeting Minutes

Project Name: I-70 Dillon Structure Replacement MP 211
Project Code: 22712
Project No. FBR 0702-385

Meeting Location: Phone Conference
Meeting Date & Time: Wednesday December 19, 2018 @ 1:30 pm - 2:30 pm
Attendees
CDOT: Sarah Navarro, Grant Anderson, Joel Johnson
Bridge Enterprise: Patrick Holinda
AECOM: Maegan Vause, Ryan Abraham

Topics Discussed	**Action Items**
• Structure Opening Limits (replacing F-13-S_Minor) o The Region indicated that CDOT I-70 Mountain Corridor Manager - Patrick Chavez and R3 East Program Engineer - Martha Miller, are requesting for the new structure to accommodate 2-way traffic (1-lane in each direction with shoulders/buffer). Patrick C. mentioned at the kick-off meeting that the Region would like to have the option to turn passenger cars around (from EB to WB) during emergency events that completely shut down the Eisenhower Tunnel. In the event that this is accommodated in the future, 2-way access through the structure would accommodate passenger cars going in one direction and also plows/emergency personnel possibly headed in the opposite direction. In addition, 2-lanes with shoulders would provide sufficient space to bypass a stalled truck/vehicle. Based on conversations between CDOT R3 – Sarah Navarro and CDOT Maintenance Plow-driver – Robert Bell, instances have occurred on multiple occasions where a plow truck enters the structure and moments later another vehicle/truck enters in the other direction. As a result, the vehicle/truck entering last, has to back up. Backing up without sight distance makes it impossible to know if another truck or vehicle is approaching, it is unsafe. In some instances, when it is dark and icy, the driver backing up can hit the structure (there is evidence on the walls from impact). Therefore, 2-way access through the structure is a need to the Region. ▪ Bridge Enterprise (BE) – Patrick Holinda recommended to set the base line for intended use within reason and not shy away from 2-way maintenance access based on the operational needs and safety considerations for the structure. • The Design Team will set the minimum structure opening width to accommodate 2-way maintenance traffic as a baseline.	AECOM to update the report with justification for 2-way access through structure as mentioned. AECOM to confirm design truck with CDOT - Patrick Chavez. AECOM to rerun auto-turn for 2-way trucks, tandem snow-plows with wings may control design truck for turning radius. Team to follow-up with BE once the design trucks are confirmed.

o CDOT R3 Mountain Resident Engineer - Grant Anderson inquired if there is a cost target/budget set for this structure replacement project which could limit the structure size. ▪ Patrick H. indicated there is not a cost target, the least costly alternative would set the base-cost. Bringing the structure up to standards with consideration to time and planning plays a bigger role in BE projects. Staff Bridge releases the "Poor List" twice a year. BE then programs the poor bridges based on tier ranking. BE will have the ability to program construction funds for the project since it is in the top tier of the prioritization plan (assuming that resources are available). The primary risks to construction funding are significant change orders on major projects currently in construction (Central 70) or other unforeseen costs (emergency projects). • Time is the major factor for BE to allocate construction funds. The sooner the Region advance the project; the sooner construction funds can be programed. It was noted that there is a 1-month lag for budget requests.	
o Sarah indicated that before the structure became structurally deficient (SD), it was classified as functionally obsolete (FO) due to insufficient vertical clearance. The initial vertical clearance was 14-ft, but then became 13.7-ft after the bottom slab was patched/overlaid. Based on FHWA's National Bridge Inventory (NBI) Recording and Coding Guide, a vertical clearance of less than 14.25-ft results in a "poor" (4) rating and anything less than 14-ft results in a "serious" (3) rating. Sarah inquired what the targeted rating for vertical clearance would be per BE. ▪ Patrick H. specified that the vertical clearance would need to be raised to move the structure out of the functionally obsolete classification. He indicated that an "excellent" (9) rating would be desired. To achieve an "excellent" (9) rating, the vertical clearance would need to exceed 16.5-ft. A vertical clearance of 16.5-ft would put Item 63 (on SI&A) at a "very good" (8) rating. However, a rating of "good" (7) would be acceptable to BE if there is a justification for a variance from the CDOT Bridge Design Manual (BDM), which results in a 15.5-ft minimum vertical clearance.	AECOM to update minimum vertical clearance in Report and structure alternatives options.
o Can tunnel alternatives be covered under BE? ▪ Patrick H. informed the team that replacing the existing CBC with a structure that is classified as a tunnel, would not be covered under BE. The BE Program's bridge assets only includes structures which are classified as "bridges". Major bridge structures could be actual bridges or culverts that are 20-ft or greater is span length. Tunnels do not fall under NBIS.	AECOM to reconsider the terming of "tunnel" options in Report.

• Items outside BE Eligibility o Colorado Parks and Wildlife (CPW) is considered one of CDOT's stakeholders. Other areas for a wildlife crossing is limited, especially in regards to locations specified in the Programmatic Environmental Impact Statement (PEIS)/ A Landscape Level of Inventory of Valued Ecosystem Components (ALIVE). Therefore, this may be the only opportunity on Straight Creek to accommodate wildlife. CPW has expressed interest in being able to accommodate wildlife through the structure. At the Review Meeting, CPW – Elissa Slezak indicated that 40-ft minimum could accommodate elk. CPW would like for the structure to be as big as possible so that if the segment of I-70 is fenced for wildlife in the future, the structure could serve as a crossing for at least some animals, if not for Elk. Grant inquired if CDOT could contribute funds to increase the size of the structure. ▪ **If a wildlife crossing is required per the PEIS at this location, it could potentially impact BE eligible limits.** o Since this project is on the Interstate, CDOT will need to consult with the Federal Highway Administration (FHWA). Grant indicated that FHWA may consider the maintenance access point unsafe as there currently are no acceleration or deceleration lanes. In addition, based on the FHWA Interstate Access Policy Guide, the structure only fits the "locked gate" category of interstate access (which may require an actual locked gate for structure access). ▪ If added features to accommodate CPW or to satisfy FHWA requirements are incorporated into this project, it may result in a cost-share between the agencies. According to Patrick H., since the structure would become a BE asset once it is replaced, adding other sources of funds (outside FASTER dollars) would make this a Tabor issue and BE could lose Enterprise status. Some exceptions occur, if CDOT funds the roadway and not the structure itself. The potential exists for CDOT to make "minor" or low dollar contributions toward the structure. In general, BE has the ability to absorb some Tabor impacts, but this may require strategic planning and could impact the project schedule. It was advised that the team be mindful of potential limitations to CDOT contributions due to the tabor impact cap (upper limit). Therefore, it was concluded to avoid CDOT contributions for the actual structure if possible. If acceleration/deceleration lanes need to be added to the interstate approaches, these additional features could be funded through CDOT/FHWA under a separate project number (sub-account) to avoid issues. ▪ AECOM – Ryan Abraham mentioned that over-building the structure to accommodate phasing and maintenance of 4-lanes during construction may be required. If so, then this could accommodate the space for acceleration/deceleration in the widened shoulders. Grant recommended to not actually	AECOM to document wildlife piece in Report. CDOT – Environmental will evaluate wildlife accommodations in their NEPA Review. CDOT to set up meeting with FHWA to determine how they consider this access. (FHWA – Joel Barnett returns from vacation at the end of December.)

stripe the acceleration/deceleration lanes to discourage public use. Maintenance and emergency personnel would be informed and made aware of the dedicated space for acceleration/deceleration to access the structure. • Patrick H. indicated that over-building the structure for phasing and maintenance of traffic would be covered under BE. • Miscellaneous Items o Sarah advised the group about the Access Line (A-line) on Forest Service Road, the A-line crosses Forest Service Road roughly 500-ft east of the structure. Only CDOT personnel can cross the A-line, the road provides access to sediment ponds east of the structure which CDOT maintains. ▪ Where the A-line crosses Forest Service Road, a gate has existed in the past. The gate may need to be re-established under this project. • Sarah held a phone conference with R3 Access Manager – Daniel Roussin, R3 ROW – Doug Killerud, and RE –Grant Anderson on 12/27/18. It was concluded that CDOT built the road on USFS land through a special use permit. The special permit is in the process of being renewed (may result in re-establishing the pre-existing gate) o Sarah and CDOT Staff Bridge - Joel Johnson confirmed that the ABC Evaluation Process will need to be performed as specified in the CDOT LRFD BDM Chapter 39.	AECOM to document A-line, special use permit, and access in Report. On 12/19/18, Joel sent the Team the most recent ABC Package with Attachment B to use on this project.

Correspondence

Maji, Gary

From: Maji, Gary
Sent: Wednesday, October 31, 2018 10:16 AM
To: Vause, Maegan; sarah.navarro@state.co.us; 'grant.anderson@state.co.us'
Cc: Heugh, Michael; Maji, Gary
Subject: October 30th Progress Meeting: I-70 Dillon Structure

Hi Sarah! Here are a few take-aways from Tuesday's status meeting (see below). Feel free to review and/or comment accordingly.

1. Team discussed the draft I-70 structure sizing memorandum. Currently, the team is proposing a 24'W by 15'H structure.
2. Sarah will forward the working copy of the structure opening memo to Patrick at BE for approval/comments. Team will confirm if text is integrated in the report or a stand-alone document
3. AECOM to confirm Dillon fire truck height.
4. Grant will coordinate with R3 Maintenance to finalize design vehicle.
5. Turning movements for the Fire Truck and CDOT Plow were evaluated for the existing condition.
    a. Results confirm turning movements can accommodate a structure located west of the existing without comprising safety.
    b. AECOM will evaluate the turning movements for several design speeds to confirm safety and layout requirements.
6. AECOM will evaluate the pros/cons associated with shifting I-70 WB traffic to the south. Potential decal lane for maintenance vehicles, sight-distance improvements and phased structure construction/constructability opportunities will be considered.
7. Team confirmed that the existing structure can be closed throughout the reconstruction efforts. Vehicles can use the west portal turn-around as a temporary detour.
8. The 2-phased construction approach is most feasible for the structure alternatives.
    a. The existing I-70 pavement width doesn't accommodate a 2-phase approach. Temporary pavement within the median or overbuilding the structure length at the ends will be required.
    b. DOT prefers using the existing median in lieu of overbuilding the structure length.
9. Replacement alternatives that locate the new opening to the west will need to address filling/closing access to the existing under crossing.

Thanks!


I-70 CBC Opening Requirement M...


I-70 traffic info.pdf

Gary Maji, PE
CO Bridge Lead/Sr Project Manager
303-941-4962
gary.maji@aecom.com

-----Original Appointment-----
From: Vause, Maegan
Sent: Tuesday, August 28, 2018 1:43 PM
To: Vause, Maegan; Maji, Gary; sarah.navarro@state.co.us; 'grant.anderson@state.co.us'
Cc: Heugh, Michael
Subject: I-70 Box

When: Tuesday, October 30, 2018 2:30 PM-3:00 PM (UTC-07:00) Mountain Time (US & Canada).
Where: Webex

I have a training all next week so I won't be able to attend but Gary will run the meeting.

Bi-weekly meeting to discuss the I-70 Box. We can add time and people, as needed, as the project progresses.

Agenda:

1. Structure Opening Memo
2. Design Vehicle Discussion
3. Construction Phasing
4. Other

<< File: I-70 CBC Opening Requirement Memo-draft.pdf >>
-- Do not delete or change any of the following text. --

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Meeting Date	10/23/18	Type	Internal	Team	Progress	Other
Date of Issuance	11/19/18					X
Attendees	Gary Maji, Elliot Drumright, Ty Ortiz, Grant Anderson, Don Hunt, Ryan Lepro, Call-in(Maegan Vause, Lars Jennemyr, Reed Brockman, Sarah Navarro)					
Location	CDOT North Holly Office					

Project team held a meeting with CDOT Staff Materials and R3 to discuss the geo-hazards, the potential risks posed to the structure and mitigation alternatives.

Project Scope, Schedule and Deliverables

1. The team will conduct a feasibility study which will encompass structure and tunnel replacement options for I-70 Structure F-13-S_Minor over Forest Service Road at MM 211. Actual structure selection, FIR and FOR design is not included. As part of the study, the project team will identify the existing geo-hazard areas adjacent to the project site, investigate their impacts and discuss any potential mitigation efforts required protect the proposed replacement structure.
2. Project Schedule:
   - Draft Feasibility Study, 11/27/18
   - CDOT Review Meeting, mid-December
   - Final Feasibility Study, January 2019

Existing Conditions and Landslide History along the I-70 Corridor

3. The concrete box culvert structure is classified as structurally deficient and eligible for replacement through the Colorado Bridge Enterprise. It has about 12' to 18' of embankment, yet was designed for a 12' fill. On 10-10-18, AECOM conducted a site inspection of the structure and surroundings to get an updated assessment of the existing conditions. The team confirmed and established several monitoring locations to monitor any potential structure movement.
4. I-70 Dillon CBC should be referenced at MP 211, not 212 as shown on the GoogleEarth KMZ file.
5. There have been several geo-hazard reports generated to discuss the existing landslide conditions along the I-70 Corridor. They are noted as follows:
   - Straight Creek Landslides (i.e Robinson and Associates, Inc. Report), Dec 1971Robinsons.pdf
   - Hydro-Mechanical Analysis of Infiltration-Induced Landslide (i.e. Thunder Report), 2010Thunder_mines_0052N_11050.pdf
   - I-70 Mountain Corridor PEIS Geohazards Tech Report, March 2011Vol4_I-70_Mntn_Corridor_Final_PEIS_Geologic_Hazards_TR.pdf
6. In general, the Robinson report provided an early and overall summary of the existing landslide conditions, identifying slides, A, B and 1 thru 4 all west of the west portal of the tunnel, most of which became active during construction of the roadway embankment. The project team will review these reports and include discussion in the feasibility report to address any potential geo-hazard risks associated with the reconstruction of the subject CBC structure.
7. In the upper portion of several of the slides, CDOT constructed rubber-lined open channels to direct and control surface runoff.
8. Per the numbering system of the Robinson Report, Slide 1 is closest to the existing structure and is immediately east of the CBC (approximately original road station 290 to 304). The slope immediately north of the CBC is mostly exposed bedrock. Just east of the CBC, the sloped embankment north of the WB traffic lanes has moved onto the shoulder, reducing the available width. Overall this sloped area is relatively active and exhibits subsurface moisture movement and exiting seepage on a continual basis. The horizontal drains at this site were constructed a few years ago to help facilitate and control water movement.
9. The team discussed RockSol's draft geotechnical report. They completed (3) borings immediately west of the existing structure. They were able to find bedrock approximately 33 feet below grade at the north boring but not at the median or south boring locations (50.5 and 75 feet, respectively). The maximum boring depth was 75 feet (east boring). In general,

the overburden material was broadly graded, silty to gravelly sand and non-plastic. Boulder- and cobble-sized rock fragments were noted commonly in the overburden material.

Structure Replacement Alternatives

10. Team is considering both structure and tunneled replacement alternatives for this location. All structure options would be constructed below grade with a minimum depth of pavement and subgrade material to prevent any freezing pavement conditions for I-70 mainline traffic. Per Lars, there are digging concerns for the tunneling methods.
11. If practical, CDOT Staff Materials would like to have the design incorporate any mitigating resiliency to address forest fire concerns.
12. Icing in the current structure is a big concern. Continual water movement through the CBC opening creates icing conditions for the vehicles using the structure. Heating the bottom slab of the new structure should not be considered. Team to develop other alternatives.
13. Team may consider alternatives that shift I-70 WB alignment to the south. This shift could permit better accommodate turning alignments for I-70 WB maintenance vehicles entering the area.
14. Cross-over phasing (shifting both WB/EB traffic to one side) alternatives is not practical. CDOT is receptive to 2-lanes in each direction for short duration.

Miscellaneous

15. Dillon Fire department typically doesn't use the underpass and prefers to cross at the West Portal. Sizing of the structure will likely be controlled by CDOT use.
16. Team agreed that any slide or structure movement monitoring efforts can be incorporated later (around project advertisement).

END OF MEETING

AECOM

Name Gary Maji, PE
Title AECOM Project Manager

The above represents the writer's understanding of the discussions and a complete and accurate record of the decisions and agreements made. Amendments to this record shall be made in writing to the author.

Maji, Gary

From: Abraham, Ryan
Sent: Friday, January 18, 2019 5:17 PM
To: Anderson, Grant - CDOT; Navarro - CDOT, Sarah
Cc: Jaeger, Marissa; Vause, Maegan; Maji, Gary
Subject: 22712: I-70 CBC
Attachments: I-70 cross section.pdf; I-70 Shift Exhibits.pdf

Grant and Sarah,

Attached are a couple exhibits for your review. The purpose of these exhibits are to determine the feasibility and approximate length of impact to I-70 to allow the maintenance vehicles to use a 12ft shoulder to turn from I-70 to the underpass structure. Couple of points:

1. Looking at the site, it appears the WB Off vehicle had the most design challenges. Therefore we have only looked at that movement. Once we are all on the same page, we can discuss the other movements.
2. The thought process (mentioned in the 1/14 email from Gary) AECOM will determine the maximum allowable shift of I-70 WB to the south. The median wall will be placed to maximize the WB shift to the south. The southern edge of the I-70 EB shoulder will remain in its current location. The allowable speed for a turning movement of a WB50 from the shoulder that fits within the horizontal limits will then be determined.
3. The attached cross section shows the final configuration of I-70 for the WB lanes. The wall was located as far south based upon the minimum width needed to phase construction of EB I-70. With the wall location set, 17'-6" shift of I-70 WB was determined by the using the minimum offset from the wall for a Type 3 guardrail to be used in lieu of a moment slab to help reduce costs.
4. One plan view exhibit shows a 17'-6" shift of I-70 WB allows the CDOT provided Snow Plow make the turn at 12MPH.
5. The other plan view exhibit shows a 17'-6" shift if I-70 WB allows for a WB50 make the turn at 12MPH with a bit of wheel tracking into the ditch at the bottom of the hill.
6. To minimize widening, the existing shoulder is 8ft wide where we can tie in back to existing lanes. We have tapered the shoulder from 8ft to 12ft. The shoulder is 12ft wide for 355ft prior to the turn-off (shown on the exhibit). If this isn't long enough we can either shift the alignment further south (probably need a moment slab for the barrier) or widen the shoulder to the northside (if there are no conflicts in the existing ditch) for some additional length.

Couple design items:

1. We don't have the super-elevation of I-70. It is not in the as-builts we have and our survey does not extend that far east. We have assumed a super of 8% based upon the radius and design speed of the as-builts and current CDOT design criteria for 65MPH. Survey would be needed to determine the actual super. If the super is less than 8%, these concepts would need to be revised to account for actual supers.
2. The limits of the wall are not known. It has been drawn but survey and additional design would be needed to determine its length.
3. This permanent shift affects all the existing median drainage. It is our understanding there are some inlets in the median this would affect.
4. In developing these exhibits, they were designed in the plan view (2D). Vertical design/profiles were not completed. Addition design would be needed to account for the vertical/profile in the review of these concepts.

The CBC was set at a clear opening of 36' (per the 1/14 email). Couple of points:

1. The snow plow path has an overlap with the head to head snow plow at the corner of 4ft. This can be seen in the plan view exhibit.
2. The WB50 path has an overlap with the head to head WB50's at the corner of 5ft. This can be seen in the plan view exhibit.

Please review and let us know if we are proceeding as expected.

Call with any questions.

Thanks,

Ryan Abraham, **PE**
Denver Highway Group Manager
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Vause, Maegan

From: Powers, Alex <APowers@conteches.com>
Sent: Tuesday, January 22, 2019 3:24 PM
To: Vause, Maegan
Subject: RE: Precast Box/ 3-sided structure
Attachments: 77245-1273.tif; Eisenhower Tunnel Conspan 36 x 8.pdf

Maegan,

See the attached reactions. I think the conspan just didn't come into the PDF very well, but 8' is the min depth for the conspan B-series option. Attached is a photo for a somewhat similar application we did a few years back in Ohio.

A budgetary cost 34 arches delivered to the site (204 LF) is about $375K. This would not include end treatments.

Let me know what else you need.

Thanks,

Alex Powers
Bridge Consultant- Colorado

Contech Engineered Solutions LLC
5670 Greenwood Plaza Blvd, Suite 530 | Greenwood Village, CO 80111
Phone: 303-715-8534 Fax: 720-587-2651
apowers@conteches.com
www.ContechES.com

From: Vause, Maegan [mailto:Maegan.Vause@aecom.com]
Sent: Tuesday, January 22, 2019 2:36 PM
To: Powers, Alex <APowers@conteches.com>
Subject: RE: Precast Box/ 3-sided structure

Sorry missed that last part of your email. I would like the 36x8' reactions but I think it would be best to keep it at 13' of fill because we would try to keep the top of structure at approx. the same elevation and drop the bearing elevation.

Thanks,
Maegan

Maegan Vause, P.E.
Structural Engineer
Transportation
D 303.376.2916
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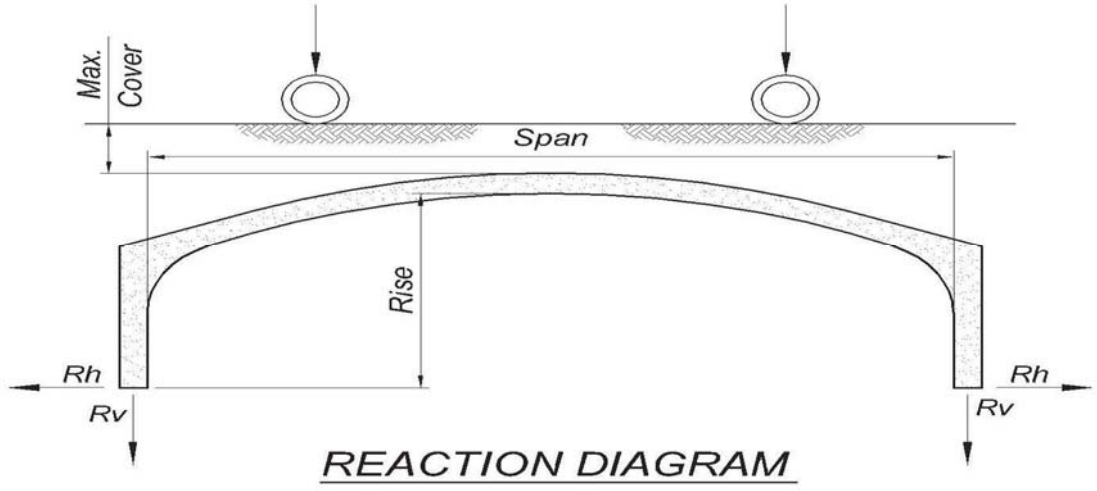
LRFD BRIDGE REACTIONS

JOB #: CDOT
NAME: Maegan Vause
DATE: 22-Jan-19
BY: ASP

LOADS:

cover, at structure center	**13.0 ft, max**	Vertical load, per leg, R_v (Self Weight), DC	**4.30 k/f**
bridge span	**36 ft**	Vertical load, per leg, R_v (Self Weight + Earth Cover), DC+EV	**42.46 k/f**
bridge rise	**8.0 ft**	Vertical load, per leg, R_v (Self Weight + Earth Cover + LL), DC+EV+LL	**45.24 k/f**
live load	**HL-93**	Vertical load, per leg, R_h (Future Wearing Surface, if applicable), DW	**0.00 k/f**
		Horizontal load, per leg, R_h (Self Weight), DC	**2.70 k/f**
		Horizontal load, per leg, R_h (Self Weight + Earth Cover), DC+EH	**23.51 k/f**
		Horizontal load, per leg, R_h (Self Weight + Earth Cover + LL), DC+EH+LL	**25.52 k/f**
		Horizontal load, per leg, R_h (Future Wearing Surface, if applicable), DW	**0.00 k/f**



REACTION DIAGRAM

Notes:
1) Axle load positions are varied to produce critical reactions shown here.
2) Reactions are unfactored loads.
3) Impact is not included.
4) Units are kips/ft.
5) Soil Weight = 120 pcf.
6) Reactions are based on spread foundations.

Vause, Maegan

From: Ryan Lepro <lepro@rocksol.com>
Sent: Tuesday, March 19, 2019 3:04 PM
To: Maji, Gary; Vause, Maegan; Drumright, Elliott
Cc: Don Hunt
Subject: FW: Drill Rate (feet/day)

Please see the information below from Ludwig Drilling. We will review the additional resources he provided as well. Please let us know if there is anything else you may need.

From: Mike Ludwig <Mike@ludwigdrilling.com>
Sent: Monday, March 18, 2019 10:04 PM
To: Ludwig Estimating <Estimating@ludwigdrilling.com>
Cc: Ryan Lepro <lepro@rocksol.com>
Subject: RE: Drill Rate (feet/day)

I think that you could achieve 2 shafts per day (100 LF), and possibly a 3rd depending on the frequency of boulders using a segmental, casing advancement method. 36" diameter may be more comfortable with the larger boulders.

Here are a couple links to tooling and methods that would be best suited to the materials:

http://www.pacoequip.com/products/foundation-drilling/casing/double-walled/double-wall-sectional-casing

https://www.youtube.com/watch?v=z8OtgGrfDrA

Mike

Ludwig Drilling, Inc.
704 Topeka Way, Castle Rock, Colorado, 80109
Phone: 303-932-7500
www.ludwigdrilling.com

Vause, Maegan

From: Ryan Lepro <lepro@rocksol.com>
Sent: Monday, March 18, 2019 4:58 PM
To: Maji, Gary; Vause, Maegan
Cc: Don Hunt
Subject: RE: I-70 Structure replacement
Attachments: Geotechnical Investigation Report_I-70 Box at MM 211 Replacement Study_FBR 0702-385(22712) (20190318).pdf

Hi Gary and Maegan,
Attached is the revised report with "Preliminary" removed from the title. I believe the final invoice will be reviewed by the project controller Wednesday, so it should be sent Thursday or Friday. I'll double check that and let you know if I find out differently.

In review of the earlier emails from Don and Elliot, 100LF/day (12 hour day) seems like an appropriate estimate with suitable drilling equipment. A more conservative estimate would be 50LF/day. I do have a call into a drilling company to see if I can get an estimate from them as well. I'll let you know what they say when I hear back from them.

On a project up in Jamestown they were getting 50LF/day (12 hour day) with 10 feet of bedrock drilling/embedment. The caissons were 24" in diameter and that included steel and concrete placement.

Please let us know if you need anything else at this time.

Best Regards,

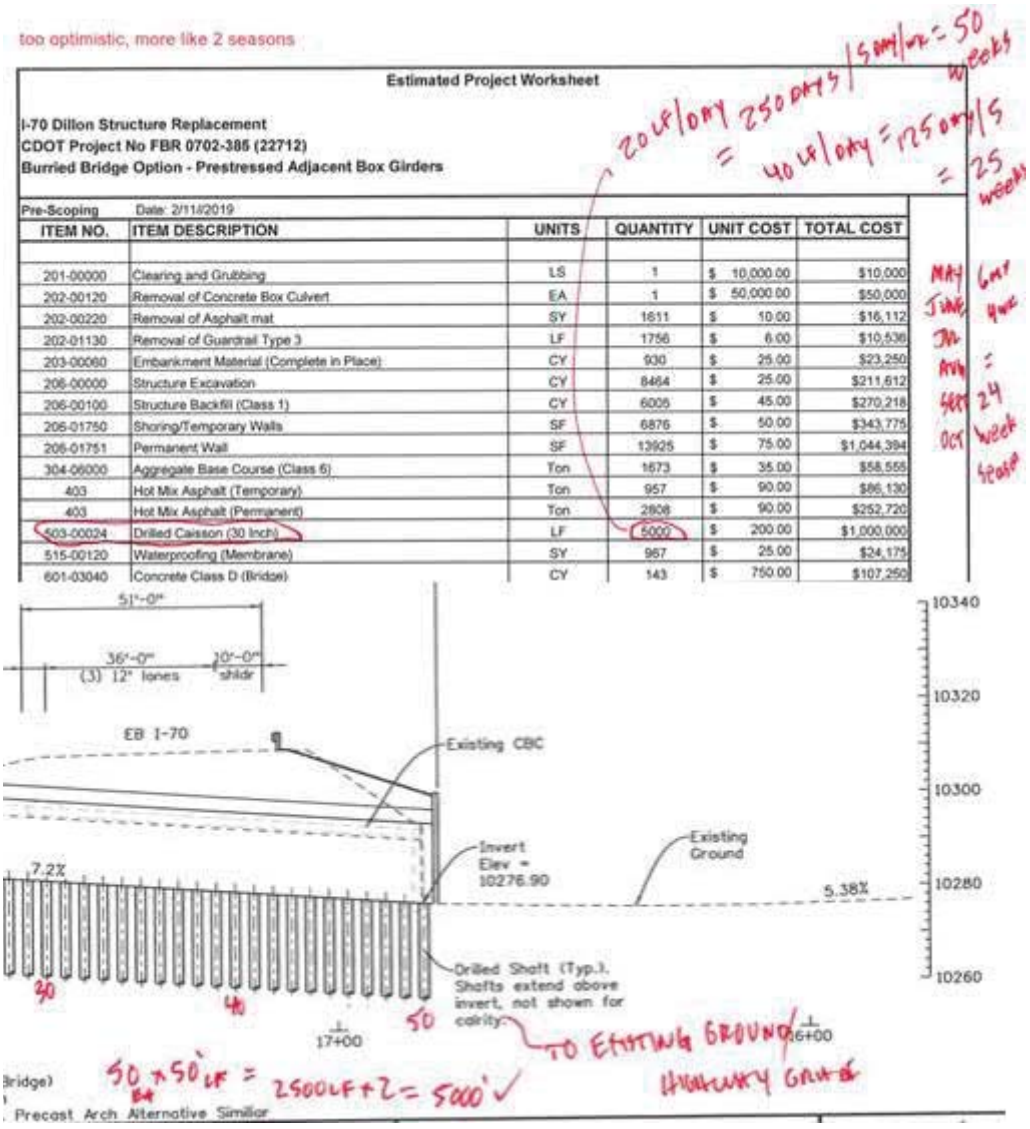
Ryan

Ryan Lepro
Engineering Geologist
RockSol Consulting Group, Inc.
12076 Grant Street, Thornton, CO 80241
Direct 303.962.9305 Cell 303.704.1261
Main Office 303.962.9300 Fax 303.962.9350
Web www.rocksol.com Email lepro@rocksol.com

From: Maji, Gary <Gary.Maji@aecom.com>
Sent: Monday, March 18, 2019 11:17 AM
To: Vause, Maegan <Maegan.Vause@aecom.com>; Don Hunt <hunt@rocksol.com>; Ryan Lepro <lepro@rocksol.com>
Subject: RE: I-70 Structure replacement
Importance: High

Ryan: What is the status of the drilled caisson rate, updated report (remove prelim stamp/title), and final invoice?

Gary Maji, PE
CO Bridge Lead/Sr Project Manager
303-941-4962



too optimistic, more like 2 seasons

Estimated Project Worksheet

I-70 Dillon Structure Replacement
CDOT Project No FBR 0702-385 (22712)
Burried Bridge Option - Prestressed Adjacent Box Girders

Pre-Scoping Date: 2/11/2019

ITEM NO.	ITEM DESCRIPTION	UNITS	QUANTITY	UNIT COST	TOTAL COST
201-00000	Clearing and Grubbing	LS	1	$ 10,000.00	$10,000
202-00120	Removal of Concrete Box Culvert	EA	1	$ 50,000.00	$50,000
202-00220	Removal of Asphalt mat	SY	1611	$ 10.00	$16,112
202-01130	Removal of Guardrail Type 3	LF	1756	$ 6.00	$10,536
203-00060	Embankment Material (Complete in Place)	CY	930	$ 25.00	$23,250
206-00000	Structure Excavation	CY	8464	$ 25.00	$211,612
206-00100	Structure Backfill (Class 1)	CY	6005	$ 45.00	$270,218
206-01750	Shoring/Temporary Walls	SF	6876	$ 50.00	$343,775
206-01751	Permanent Wall	SF	13925	$ 75.00	$1,044,394
304-06000	Aggregate Base Course (Class 6)	Ton	1673	$ 35.00	$58,555
403	Hot Mix Asphalt (Temporary)	Ton	957	$ 90.00	$86,130
403	Hot Mix Asphalt (Permanent)	Ton	2808	$ 90.00	$252,720
503-00024	Drilled Caisson (30 Inch)	LF	5000	$ 200.00	$1,000,000
515-00120	Waterproofing (Membrane)	SY	967	$ 25.00	$24,175
601-03040	Concrete Class D (Bridge)	CY	143	$ 750.00	$107,250

From: Vause, Maegan
Sent: Tuesday, March 05, 2019 3:58 PM
To: hunt@rocksol.com; Ryan Lepro (lepro@rocksol.com)
Cc: Maji, Gary
Subject: I-70 Structure replacement

Hi Don,

We submitted our "pre-final" report to CDOT on 2/12. They have a few final comments including a couple of last requests from your office. First, would you mind removing "Preliminary" from the title of your report and send us an updated stamped version. While they understand there may be some additional geotechnical needs (particularly for the permanent median wall) they want to make sure it's clear that the recommendations provided in the report can be used for design.

Also, we talked a while back about the caisson construction rate (see email exchange below). We were hoping you could provide an approximate LF/Hour so that we could clarify our schedule a bit. Based on your previous emails I am getting approx. 12.5LF/Hr based om 100 LF/ 8 hour shift. Please feel free to call me to discuss.

Thanks,
Maegan

Maegan Vause, P.E.
Structural Engineer
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Gary,

We estimate 2 per day, assuming the shift can be at least 8 hours. 3 per day is not likely. It could be possible that some days will result in only one caisson being constructed, but that is hard to predict.

Donald Hunt, P.E.
Senior Geotechnical Engineer
RockSol Consulting Group, Inc.
12076 Grant Street, Thornton, Colorado 80241
Direct Line 303.962.9325 Cell 303.325.6838
Main Office 303.962.9300 Fax 303.962.9350
Web www.rocksol.com Email hunt@rocksol.com

From: Maji, Gary <Gary.Maji@aecom.com>
Sent: Wednesday, November 21, 2018 8:14 AM
To: Ryan Lepro <lepro@rocksol.com>; Don Hunt <hunt@rocksol.com>
Cc: Drumright, Elliott <Elliott.Drumright@aecom.com>; Maji, Gary <Gary.Maji@aecom.com>; Vause, Maegan <Maegan.Vause@aecom.com>
Subject: FW: I-70 Structure Replacement Schedules

Ryan/Don: What is your best estimate for a production (caissons/day) rate for the shafts on this I-70 project? We have assumed 2-ft shafts placed on 4-ft centers with caissons about 50-ft long. Our approach to the cut-n-cover alternatives assume that the caissons are completed under temporary lane or night closures before we start construction phasing and shift lanes for the pavement and embankment removal.

The alternative shown installs caissons installed through the existing I-70 pavement before any excavation efforts. The temporary void above the top of caisson would be filled with pea gravel or flow-fill after each shaft is poured.

Please call with any Qs.

Gary Maji
303.941.4962

APPENDIX H – PHOTOS

PHOTOS		
Name	**Photo/Map**	**Date (direction)**
East wingwall and embankment at north portal		Looking west
I-70 WB access road		Looking west

Appendix H

PHOTOS		
Name	**Photo/Map**	**Date (direction)**
I-70 WB access road		Looking west
I-70 EB access road		Looking west

PHOTOS		
Name	**Photo/Map**	**Date (direction)**
East wingwall and embankment at south portal		Looking east
I-70 EB access road		Looking east

APPENDIX I – CDOT ABC WORKSHEETS

Project:	FBR 0702-385 (22712)			
By:	GMM	Checked:	MFV	
Date:	12/17/2018		2/7/2019	
Sheet No.	1	of	3	

Pre-Scoping ABC Rating **May 2012**

Enter values for each aspect of the project. Attach applicable supporting data.

Average Daily Traffic Combined on and under Enter 5 for Interstate Highways	5	0 1 2 3 4 5	No traffic impacts Less than 5000 5000 to 10000 10000 to 15000 15000 to 20000 More than 20000
Delay/Detour Time	5	0 1 2 3 4 5	No delays Less than 5 minutes 5-10 minutes 10-15 minutes 15-20 minutes More than 20 minutes
Bridge Importance	5	1 3 5	Normal Bridge - minimal access impacts Essential Bridge - impacts to locals and business Critical Bridge - only access to community or business
User Costs	5	0 1 2 3 4 5	No user costs Less than $10,000 $10,000 to $50,000 $50,000 to $75,000 $75,000 to $100,000 More than $100,000
Economy of Scale (repetitive work or standard details)	3	0 1 2 3	1 span 2 to 3 spans 4 to 5 spans > 5 spans or multiple structures
Safety	4	1 2 3 4 5	Short duration impact with simple MOT scheme Short duration impact with multiple traffic shifts Normal duration impact with multiple traffic shifts Extended duration impact with multiple traffic shifts Extended duration impact with complex MOT scheme
Railroad Impacts	0	0 3 5	No railroad or minor railroad spur One mainline railroad track Multiple mainline railroad tracks
Site Conditions	5	0 3 5	Inhibiting site constraint (e.g. > 1 ft. profile shift) Time sensitive constraint (e.g. utility shedules) Favorable site conditions

Project:	FBR 0702-385 (22712)			
By:	GMM	Checked:		
Date:	12/17/2018			
Sheet No.	2	of	3	

Pre-Scoping ABC Rating **May 2012**

Note: Do not adjust weight factors without prior consultation with CDOT Project Development Manager

ABC RATING SCORE FACTORS AND WEIGHTS					
	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Daily Traffic	5	10	50	5	50
Delay/Detour Time	5	10	50	5	50
Bridge Importance	5	5	25	5	25
User Costs	5	10	50	5	50
Economy of Scale	3	3	9	3	9
Safety	4	10	40	5	50
Railroad Impacts	0	5	0	5	25
Site Conditions	5	5	25	5	25
		Total Score	249	Max. Score	284

ABC Rating Score: 88 % of Maximum Score

The ABC Rating Score is driven by the four most heavily weighted factors: Average Daily Traffic, Delay/Detour Time, User Costs and Safety. For a detailed explanation, review the narrative on page 4 of the ABC Decision Making Process.

Cost Considerations:

Calculate the following costs for use in determining the lowest total project cost

TOTAL PROJECT COST EVALUATION		
	Traditional Const.	ABC Construction
*Construction Costs		
User Costs		
Total Project Cost		

See Construction Costs in Appendix A

* Account for the following Construction Costs that can be dramaticailly reduced with ABC construction:

Detour
Traffic Control
Railroad flagging
Railroad shoefly
Increased Contractor and/or CDOT safety

Project:	FBR 0702-385 (22712)		
By:	GMM	Checked:	
Date:	12/17/2018		
Sheet No.	3	of	3

Pre-Scoping ABC Rating **May 2012**

* Region Director or Chief Engineer to evaluate possible indirect benefits