SH 7A (Lower)
Raymond to Lyons
Site Repairs between Mileposts 19 and 33

Boulder County
COLORADO

Damage Assessment Report

Prepared For:
FEDERAL HIGHWAY ADMINISTRATION

Prepared By:
COLORADO DEPARTMENT OF TRANSPORTATION

100% DRAFT
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Table of Contents

List of Figures

Appendices

APPENDIX A – SIGNED DDIR's

APPENDIX B – SH 7A CANYON DAMAGE PRESENTATIONS

Acronyms

AADT	Average Annual Daily Traffic
ABC	Aggregate Base Course
APE	Area of Potential Effects
cfs	Cubic feet per second
CBC	Concrete Box Culvert
CDOT	Colorado Department of Transportation
CFL	Central Federal Lands
CIP	Complete in Place
CMP	Corrugated Metal Pipe
CR	County Road
CSP	Corrugated Steel Pipe
CY	Cubic Yards
DAR	Damage Assessment Report
DDIR	Detailed Damage Inspection Report
ER	Emergency Repair
FEMA	Federal Emergency Management Agency
FES	Flared End Section
FHWA	Federal Highway Administration
FT	Feet
FWD	Falling Weight Deflectometer
HMA	Hot Mix Asphalt
LF	Linear Feet
LWCFA	Land and Water Conservation Fund Act
MCR	Minor Contract Revisions
MP	Milepost
MSE	Mechanically Stabilized Earth
NEPA	National Environmental Policy Act
NPS	National Park Service
PCCP	Portland Cement Concrete Pavement
PR	Permanent Repair
R4	Region 4
RCP	Reinforced Concrete Pipe
RE	Resident Engineer
ROW	Right of Way
SHPO	State Historic Preservation Office
STR	Structure
USACE	United States Army Corps of Engineers

1. OVERVIEW

1.1. Map of State of Colorado Showing Flood Affected Areas

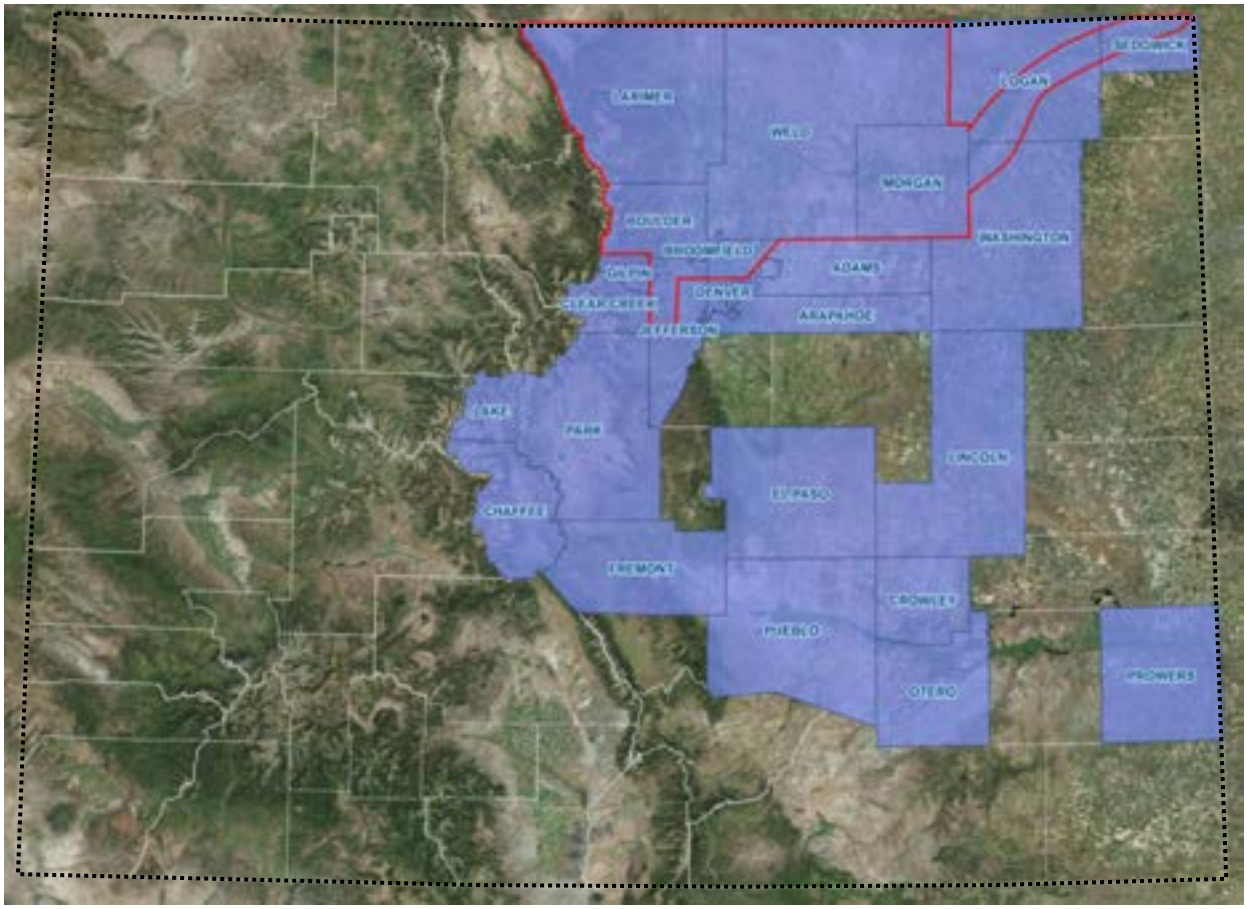

Figure 1 - Flood affected counties in Colorado (shaded) and CDOT highways damage boundary (outlined in red)

1.2. Flood Event Description

During the week starting on September 9, 2013, a slow-moving cold front stalled over Colorado, clashing with warm humid air from the South, resulting in a severe rain event that intensified on September 11th and 12th. The heavy rains caused catastrophic flooding and damages along Colorado's Front Range from Colorado Springs north to Fort Collins. Boulder County, for example, received 9 inches of rainfall on September 12th and the overall event rainfall in this area reached 85 percent of annual precipitation. The rainfall incident period started September 9 and intensified on September 11 and 12 and extended until September 16, 2013. The resulting flood damage occurred through the month of September as the flood water progressed from the mountains to the lower-lying eastern plains along the South Platte River to the Nebraska border.

Damages were widespread across Northern Colorado. The disaster impact area was unprecedented, spanning almost 200 miles (North-South) by approximately 50 miles (East-West), affecting over 400 miles of roadways and adjacent areas and impacting over 120 bridges and structures.

The flood event was estimated to have peaked between a 100-year and 500-year event in numerous locations along the affected streams and rivers. Severe, heavy rainfall caused rockslides, landslides and mudslides onto roadways and washout damages to corridors, bridge structures, slopes and embankments, Rights of Way (ROW), and culverts. Other disaster damages observed included debris-plugged culverts and destroyed abutments and bridges, which contributed to water overflow and roadway overtopping. Destruction of bridges and dam overflows, such as the Lake Estes Dam, contributed an additional 6,000 cubic feet per second (cfs), increasing flood flows to as much as 19,600 cfs into the Big Thompson River near Loveland, CO. Flooding was so severe that, in some locations, it rerouted sections of riverine waterways.

Colorado Governor, John Hickenlooper, declared a disaster emergency on September 12, 2013. A Major (Presidential) Disaster Declaration was issued on September 14, 2013 (DR-4145) for severe storms, flooding, landslides, and mudslides. The declared area includes the following 18 counties: Adams, Arapahoe, Boulder, Clear Creek, Crowley, Denver, El Paso, Fremont, Gilpin, Jefferson, Lake, Larimer, Lincoln, Logan, Morgan, Sedgwick, Washington, and Weld. On October 9, 2013 Governor Hickenlooper signed an Executive Order declaring an additional 6 counties to the declared area: Broomfield, Chaffee, Otero, Park, Prowers and Pueblo. The Governor also directed the Colorado Department of Transportation (CDOT) to make all roadways passable by December 1, 2013 to allow residents to return to their homes and businesses. This goal was accomplished through an intensive, temporary, Emergency Repair (ER) effort.

1.3. Description of CDOT Roadway Maintenance/State of Good Repair

CDOT takes its stewardship responsibilities seriously and performs regular maintenance on all infrastructure facilities in order to maintain a State of Good Repair. CDOT assesses the conditions of highway pavements annually. In support of this commitment, CDOT employs 1,500 full time maintenance staff to maintain 23,000+ lane miles of infrastructure.

Major capital investments for high priority corridors occur on a 10-20 year life cycle, depending upon the original highway design and other site conditions. For low traffic volume corridors, pavement surfaces are treated via thin surface seals (e.g. chip seals, thin overlays) every 10 years. In fiscal year 2014, CDOT invested $249M in its infrastructure. CDOT's historic expenditures on Statewide Maintenance are illustrated below:

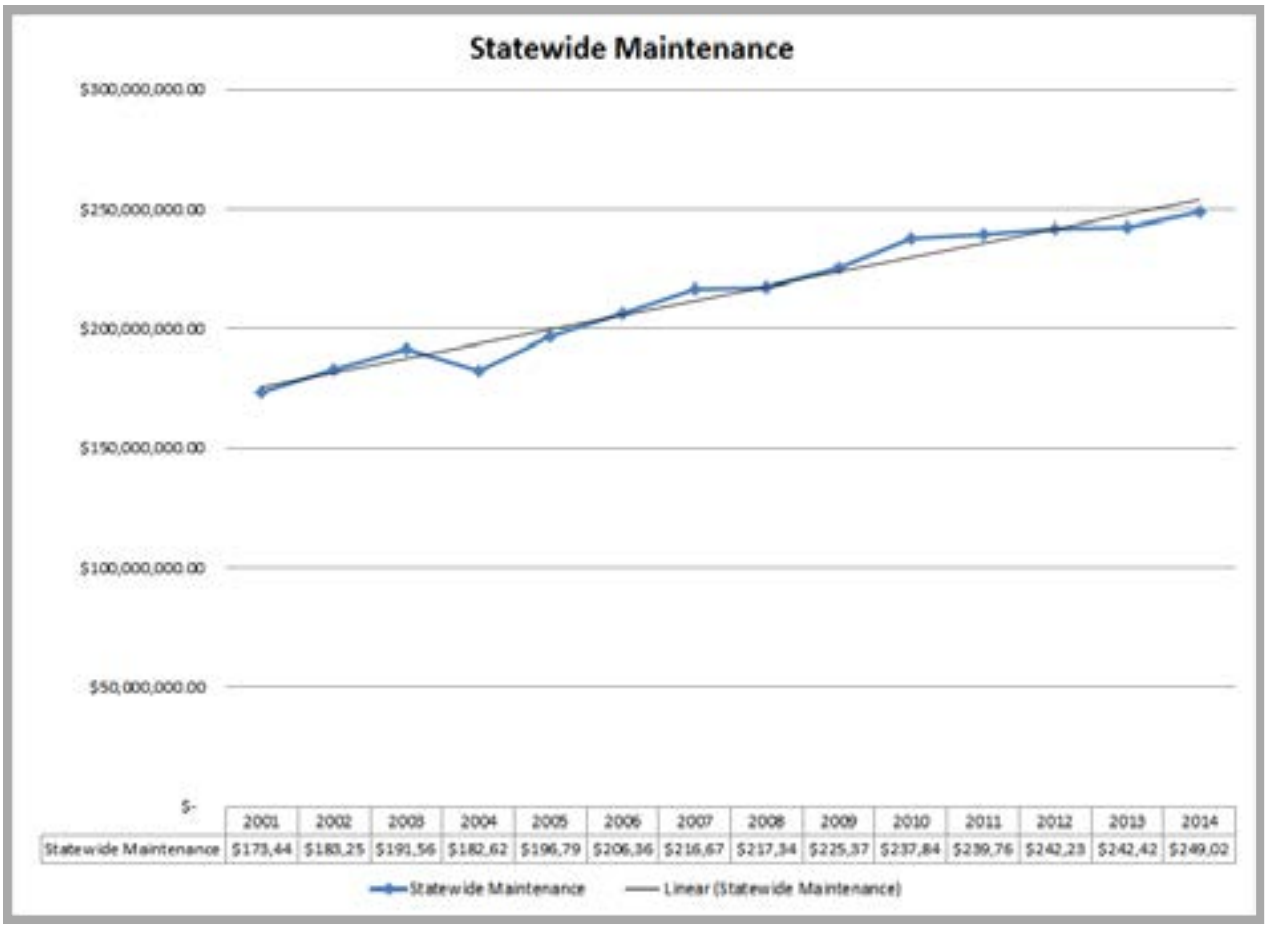

Figure 2 - CDOT Statewide Maintenance Historical Expenditures

1.4. General Overview: The Damage Assessment Report and Post-Flood CDOT Activities

1.4.1. Damage Assessment Report (DAR)

This Damage Assessment Report (DAR) serves to describe a specific milepost (MP), or mileposts, of a roadway and damage sustained at those mileposts as a result of the September 2013 flood event. It also describes:

- What ER work was performed to restore essential traffic, minimize the extent of damage and/or protect remaining facilities;
- What Permanent Repairs (PR) are recommended to restore the highway in-kind to its pre-disaster conditions to meet CDOT standards and specifications;
- What Resiliencies, if any, can be introduced to prevent similar flood damages in the future.

The data within this DAR was derived from information gathered by two (2) CDOT led field assessment teams mobilized from November 4 to December 6, 2013. Each 12-15 person team included professional roadway engineers and specialists in the fields of environmental, structures, ROW, materials, stream morphology, hydraulics, and utilities. Additionally, the teams included representatives from the Federal Highway Administration (FHWA) and Central Federal Lands (CFL).

The Appendix of this report includes the signed Detailed Damage Inspection Reports (DDIR) and costs of ER work performed, PR work proposed and resiliencies proposed as they apply to the subject roadway. DDIR documents, PR and Resiliency cost estimates were developed based on quantities obtained by roadway Assessment Teams.

Only major items such as earthwork, structures and pavement were quantified. Minor construction items were quantified by using typical project percentages. Unit costs were developed based on CDOT bid histories. Similar projects in scope and location were used to determine unit costs.

The following section describes general considerations of ER and PR, as well as typical construction methods for PR.

1.4.2. Emergency Repair (ER)

ER work was conducted as a stop gap measure to remove debris from the roads and temporarily repair corridors in order to re-open the roads for vehicles to pass. During ER, every attempt was made to adhere to the CDOT Standard Specifications for Road and Bridge Construction (2011) to the greatest practical extent. In many cases, due to road opening deadlines, weather conditions, site conditions, availability of repair materials and equipment, and availability of labor resources, CDOT Standards could not be followed in total.

Performance of Work

CDOT Maintenance performed ER work at various locations. Force account compensation procedures per CDOT specifications Section 109.04 were used to document and compensate the work for all emergency projects except for two sites on State Highway 72A at MP 5.446 and MP 14-18.

Prevailing Conditions at Time of Repair

Complex conditions existed when performing ER work, including such situations as: debris across the roadway, partial and complete roadway washouts and high water remaining for more than a week, making the use of Force Account tracking and payment the most effective means for payment in lieu of unit bid prices. With winter fast approaching, work took place 7 days a week, in most cases, to get roadways open and minimize winter/cold weather rework in the PR phase.

Plans or Design Drawings

No plans or design drawings were developed specifically for the ER phase projects. Some corridors, however, may have had associated shop drawings. They are included in this report if available.

Final ER Costs

ER phase projects have been finalized and all documentation, including costs, can be found in the Emergency Repair Project Notebook.

1.4.3. Permanent Repair (PR)

PR work will be needed in the future to restore the line and grade of the roadway, restore pavement surfaces, reconstruct damaged bridges and culverts, and replace signs, guardrails, fences and other highway appurtenances to their pre-disaster condition. Special considerations will be taken for environmental concerns, river morphology, structures, and utilities.

For PR, ER work must be evaluated on a case-by-case basis, using available ER documentation and re-testing those areas for materials suitability and conformance to CDOT standards.

Quantities and Dimensions

All quantities and dimensions included in this report are approximations only, based on direct observation at the site and best engineering judgment. More exact measurements will be developed during the Project Development phase.

Compliance

CDOT and all its contractors, sub-contractors, and agents will comply with all Federal, State and Local laws in performance of recommended PR work or approved resiliencies as described in this document.

1.4.4. Typical Repair Methodologies (PR)

This section includes typical repair methodologies as they apply to the development of PR DDIR quantities.

Embankment Repair Adjacent to an Existing Embankment

A common type of damage that occurred as a result of the flood event was damage to roadway embankments. It is not considered good construction practice to build new roadway embankment adjacent to existing embankment using a vertical or nearly-vertical face, as this provides a weak plane that is prone to failure. A better practice is to "key" the new construction into the old, either using a stair-step technique, or a flatter joint. For PR quantity estimating purposes, it is assumed that the entire width of the pavement, subgrade and embankment will be removed and replaced to avoid a potential failure plane as described.

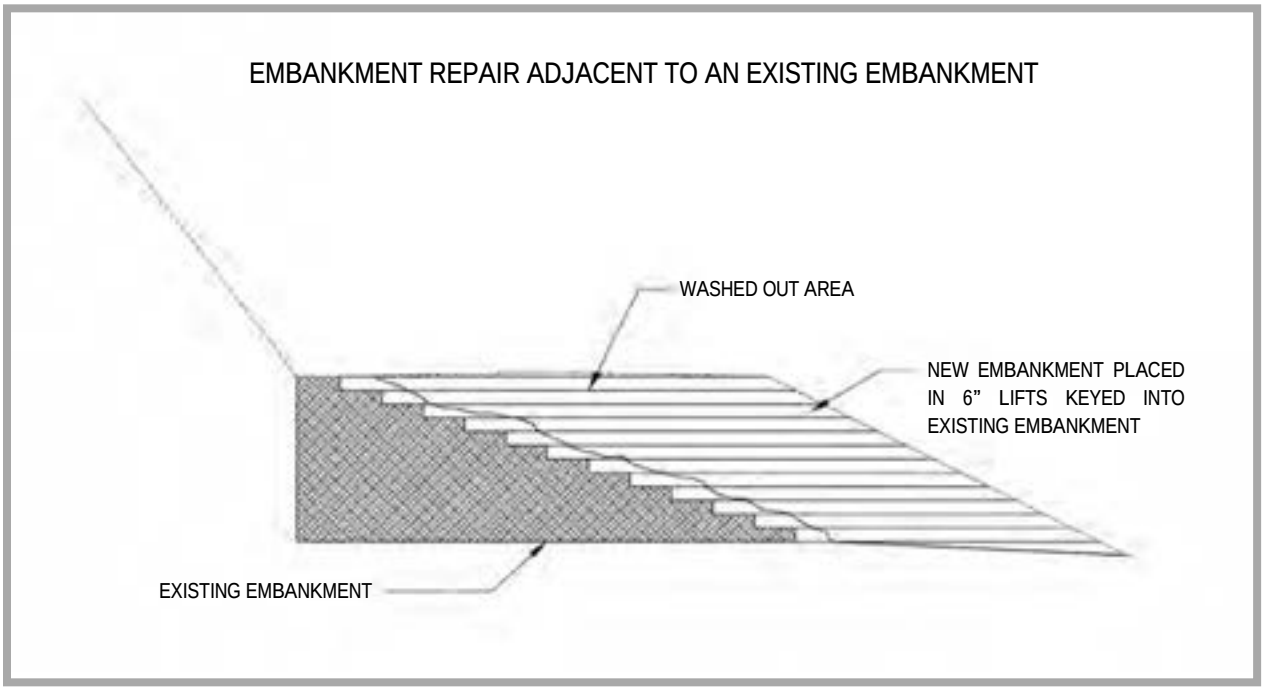

Figure 3 - Roadway Embankment Repair Adjacent to an Existing Embankment (Typical)

Typical Embankment Repair End Conditions

The illustrations in Figure 4 below represent the different typical embankment repair end condition configurations used in the repair process.

- Fill layer placed
- Cut with ditch within embankment
- Retaining wall to protect embankment
- Riprap (Boulders) placed against slope embankments for protection

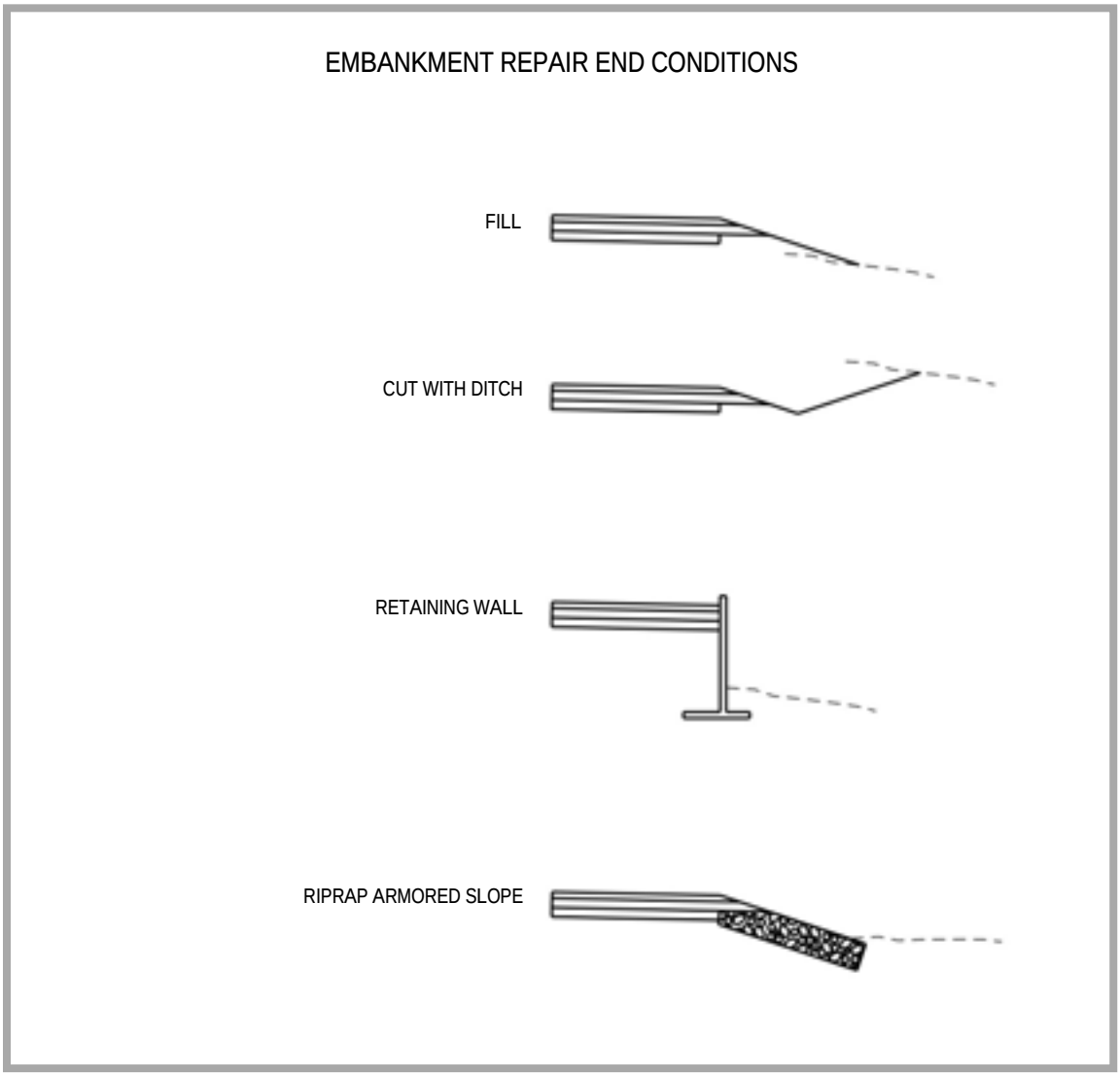

Figure 4 - End Conditions (Typical)

Typical Roadway Section

Many roadway sections were overtopped, undermined or breached during the flood event. A typical pavement section is shown in Figure 5. The example dimensions shown below are the basis for calculating quantities included in the DDIRs.

- 1st layer at top – Assumed 6 inch asphalt/Assumed 9 inch concrete pavement
- 2nd layer – Assumed 6 inch Aggregate Base Course (ABC)
- 3rd layer – Embankment fill material
- 4th layer – Existing ground

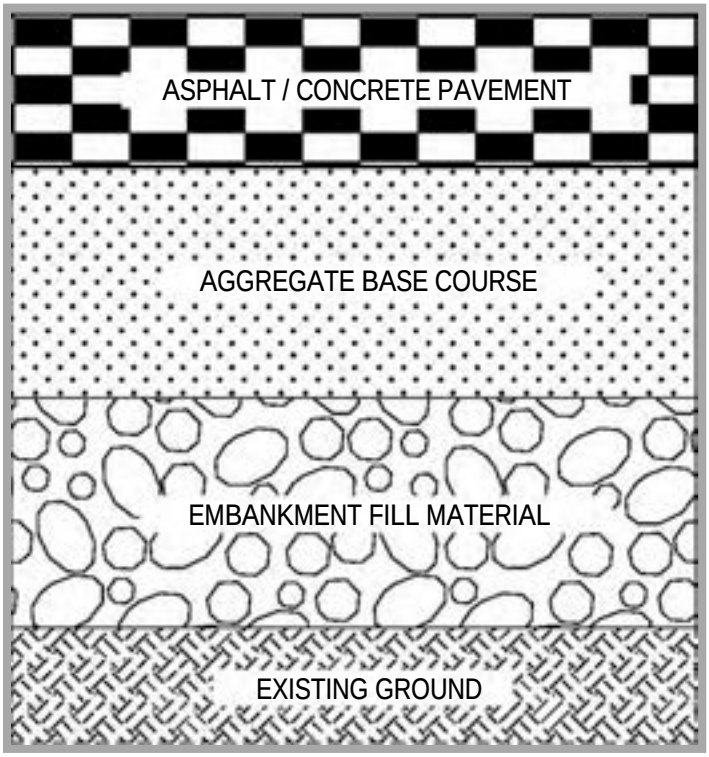

Figure 5 - Pavement Section (Typical)

1.5. Environmental Considerations

All flood-related projects are required to comply with FHWA and CDOT environmental laws, regulations, processes and procedures. While not inclusive or applicable to all projects, the following environmental considerations are highlighted due to longer coordination timeframes that need to be planned in setting schedules for permanent repairs. This overview is intended to provide guidance for project teams to coordinate environmental compliance requirements into project schedules. It is not intended to supersede, replace, or otherwise interfere with CDOT and FHWA's established processes, which apply for all permanent repairs.

- National Environmental Policy Act (NEPA) compliance is required for all flood-recovery projects. NEPA provides an umbrella for CDOT's compliance with environmental laws and regulations for transportation projects, and CDOT's NEPA Manual (http://www.coloradodot.info/programs/environmental/nepa-program/nepa-manual) provides guidance for both NEPA processes and resource-specific compliance. In most cases, projects will fall under Categorical Exclusions (categories of small-scale projects that have been shown by experience to have limited environmental impacts) that can be completed within one (1) to three (3) months. For more complicated Categorical Exclusions (such as those involving Section 4(f) evaluation as outlined below), the process can take six (6) months or longer. For projects where repairs are occurring outside of ROW or involve substantial road (or stream) modifications/realignments, an Environmental Assessment may be required, which can take a minimum of six (6) months up to two (2) years or longer.
- Section 4(f) of the US Department of Transportation Act of 1966 protects publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites from use in transportation projects unless no other feasible and prudent alternative to the use of those protected lands exists. Agencies such as CDOT that receive money (and approvals) from FHWA must demonstrate that there is no feasible and prudent alternative to the use of such lands, and must include all possible planning to minimize harm to the property. For proposed improvements that require use of Section 4(f) properties, the coordination process can take six (6) weeks to more than six (6) months.
- Section 6(f) lands are those that have been developed using funds provided by the Land and Water and Conservation Fund Act (LWCFA) to develop recreational facilities – either land or amenities. If acquisition of any properties that received LWCFA monies is required, CDOT must coordinate with the Colorado Department of Game and Parks and the National Park Service (NPS) in determining the impacts and appropriate mitigation for the affected portion of the property. At a minimum, the LWCFA requires a minimum replacement of lands at a 1:1 ratio, for both quality and quantity. If proposed improvements impact 6(f) properties, the coordination process can take three (3) months to more than six (6) months. Additionally, if ROW acquisition is required for replacement properties, the process can take even longer.

- Section 106 of the National Historic Preservation Act of 1966 requires federal agencies to take into account the effects of their undertakings on historic properties. The Section 106 process consists of four basic steps:
    - Define the Area of Potential Effects (APE) for the undertaking
    - Identify historic properties within the APE
    - Determine project effects on historic properties. Effects fall into three categories:
        - No Historic Properties Affected
        - No Adverse Effect
        - Adverse Effect
    - Mitigate any Adverse Effects through a negotiated Memorandum of Agreement.

Each of these steps requires coordination with the State Historic Preservation Office (SHPO), Native American tribes, and any interested consulting parties. The Advisory Council on Historic Preservation must be provided an opportunity to comment on Adverse Effects and Memoranda of Agreement. CDOT complies with Section 106 for both its Federal Aid projects and for state-led projects. If there is no effect on any Section 106 property ("no historic properties affected"), it can take approximately two (2) months for coordination under normal non-emergency circumstances. Coordination for a No Adverse Effect determination can take approximately four (4) months. If a Section 106-eligible property is adversely affected by a project ("adverse effect"), coordination can take six (6) months or more. Both No Adverse Effect and Adverse Effect determinations also require Section 4(f) evaluation. A No Adverse Effect determination qualifies as a de minimis use and requires only a minimal additional coordination with FHWA (approximately two (2) weeks). Adverse effects require a full Section 4(f) evaluation, which requires additional analysis, documentation and review that can take an additional three (3) months to more than six (6) months on top of the Section 106 consultation timeframes.

- Section 404 of the Clean Water Act regulates dredging and filling of wetlands and other waters of the United States. Each activity affecting wetlands or other waters of the U.S. will require a 404 permit issued by the US Army Corps of Engineers (USACE). Many flood-related projects will fall under Nationwide Permits, which can take approximately one (1) to three (3) months to coordinate. For projects that fall outside the criteria for a Nationwide Permit (generally impacts of greater than 0.5 acres in area or stream modifications greater than 300 linear feet), an Individual Permit will be required, which can take three (3) month or longer to coordinate. Additionally, wetland delineations can only be performed and accepted when vegetation is visible, so seasonal restrictions can further delay permitting.
- CDOT Region 4 (R4) Environmental strongly recommends that the Resident Engineer (RE) determine the maximum disturbance limits as soon as possible and allow R4 Environmental to begin clearance and coordination. Some clearances (Preble's Meadow Jumping Mouse, Ute Ladies' Tresses Orchids, migratory birds, etc.) have seasonal restrictions, which can further impact schedules.

1.6. Additional Considerations

1.6.1. Sediment Removal

Sediment removal is eligible for FHWA ER funding if sediment on the roadway or under a bridge is removed and reused in ER or PR work or must be pushed out of the way in order to perform the necessary ER work.

1.6.2. Debris Removal

Debris removal is not eligible for FHWA ER funding. However, some debris removal has the potential to be eligible for *FEMA Category A: Debris Removal* which states:

> "Debris Removal is the clearance, removal, and/or disposal of items such as trees, woody debris, sand, mud, silt, gravel, building components, wreckage, vehicles, and personal property.
>
> For debris removal to be eligible, the work must be necessary to:
>
> - Eliminate an immediate threat to lives, public health and safety
> - Eliminate immediate threats of significant damage to improved public or private property
> - Ensure the economic recovery of the affected community to the benefit of the community-at-large
> - Mitigate the risk to life and property by removing substantially damaged structures and associated appurtenances as needed to convert property acquired through a FEMA hazard mitigation program to uses compatible with open space, recreation, or wetlands management practices
>
> Examples of eligible debris removal activities include:
>
> - Debris removal from a street or highway to allow the safe passage of emergency vehicles
> - Debris removal from public property to eliminate health and safety hazards
>
> Examples of ineligible debris removal activities include:
>
> - Removal of debris, such as tree limbs and trunks, from natural (unimproved) wilderness areas
> - Removal of pre-disaster sediment from engineered channels
> - Removal of debris from a natural channel unless the debris poses an immediate threat of flooding to improved property
>
> Debris removal from private property is generally not eligible because it is the responsibility of the individual property owner. If property owners move the disaster-

related debris to a public right-of-way, the local government may be reimbursed for curbside pickup and disposal for a limited period of time. If the debris on private business and residential property is so widespread that public health, safety, or the economic recovery of the community is threatened, FEMA may fund debris removal from private property, but it must be approved in advance by FEMA."

Source: http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit/categories-work

1.6.3. Repair /Replacement of Damage/Missing ROW Fence

Some sites include repair/replacement of damaged/missing ROW fence. Many sites are included in a multi-site fencing contract to systematically repair/reset fence damage. In such cases an amended FHWA form 1547 will be issued to address and include quantity changes to adequately place and complete the final PR.

1.7. Map of Roadway & Key Map

Figure 6 - SH 7, MP 19-33, Boulder County

Figure 7 - CDOT Region Map and Project Location

2. MILEPOSTS 19.06 TO 21.93

2.1. Roadway Facility Description/Dimensions

- The existing roadway consists of two 12 ft lanes with 3- 11 ft outside shoulders and 12 ft wide turn lanes. The roadway is functionally classified as a Minor Arterial with an average daily traffic (AADT) of 1,300 with 5.3 percent being trucks.
- No pedestrian or bike facilities are present at the site.
- The ROW at this site varies from approximately 132 ft to 200 ft total width.
- Generally, the surrounding terrain is mountainous and slopes down from west to east.
- This segment of SH 7 provides east-west access from Raymond to Lyons.

2.2. Hydraulic/Structural Facility Description/Dimensions

- The Middle Saint Vrain Creek generally flows west to east, paralleling the south side of SH 7 from MP 20.5 to MP 23.55 where it converges with South Saint Vrain Creek.

Summary of Culverts:

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	19.00	1	CMP	2	66
007A	19.10	1	CMP	2	88
007A	19.20	1	CMP	2	60
007A	19.50	1	CMP	2	66
007A	19.60	1	CMP	2	122
007A	19.80	1	CMP	2	84
007A	19.90	1	CMP	2	52
007A	20.00	1	NA	3	390
007A	20.10	1	CMP	2	206
007A	20.30	1	CMP	2	152
007A	20.40	1	CMP	2	144
007A	20.60	1	CMP	2	52
007A	20.70	1	CMP	2.5	212
007A	20.90	1	CMP	2	54
007A	21.00	1	CMP	2	30
007A	21.00	1	CMP	2	50
007A	21.10	1	CMP	2	102
007A	21.20	1	CMP	2	54

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	21.30	1	CMP	2	70
007A	21.44	1	CMP	2	72
007A	21.50	1	CMP	2	84
007A	21.60	1	CMP	2	66
007A	21.70	1		2	70
007A	21.70	1	CMP	2	58
007A	21.80	1	CMP	2	85

2.3. Causation

2.3.1. Aerial views

Figure 8 - MP 19.06-21.93 Pre-disaster aerial photo (Post-disaster aerial photo not available)

2.3.2. Severity of damages

FHWA has reviewed this site and has determined that the damage was ☐ severe ☒ not severe.

Based on the memorandum *CDOT/CWCB Hydrology Investigation, Phase 1 – 2013 Flood Peak Flow Determinations* and observed flows at this site during the September 2013 flood event, the flood frequency of Middle Saint Vrain Creek at this location during the flood is assumed to be between the 50-year and100-year storm events.

Runoff from the Middle Saint Vrain Creek watershed saturated the mountainous terrain and caused numerous material slides and wash out of the roadside ditches throughout SH 7 between MP 19.06 and MP 21.93. In the section where Middle Saint Vrain Creek parallels the south side of SH 7 the creek flows directly adjacent to the roadway embankment between MP 21.8 and MP 22.0. In this area the high flows caused wash out of some of the embankment at the toe of the slope and wash out of the local access road bridge crossing at MP 21.925.

2.3.3. Detailed damage description

The table below lists the breakdown of the damage experienced within the highway ROW for this segment of US 34 as a result of the September 2013 flood event.

Milepost		Description of Damage
Start	End	
19.06	19.35	The roadside ditches on both sides of highway experienced erosion scour damage, washing out approximately 5-6 ft wide and 2-4 ft deep the full length of this section. Underground utilities were exposed in areas as a result.
19.40	19.50	The eastbound roadside ditch experienced minor erosion scour damage, washing out approximately 0.5-1 ft deep and 1-2 ft wide in areas along this section.
19.54	19.57	The westbound roadside ditch experienced minor erosion scour damage, washing out approximately 0.5-1 ft deep and 1-2 ft wide in areas along this section.
19.65	19.95	The westbound roadside ditch experienced minor erosion scour damage, washing out approximately 0.5-1 ft deep and 1-2 ft wide in areas along this section.
20.40	20.64	The westbound roadside ditch experienced minor erosion scour damage, washing out approximately 0.5-1 ft deep and 1-2 ft wide in areas along this section.
20.58	20.66	The eastbound roadside ditch experienced minor erosion scour damage, washing out approximately 0.5-1 ft deep and 1-2 ft wide in areas along this section.
20.59	20.66	Material slide into westbound roadside ditch causing the ditch runoff to overtop the road and wash out some of the eastbound roadway embankment.
20.68	20.97	The westbound roadside ditch experienced minor erosion scour damage, washing out approximately 0.5-1 ft deep and 1-2 ft wide in areas along this section.
20.84	20.88	For approximately 1,500 ft there was a material slide into the westbound roadside ditch causing ditch runoff and sediment to overtop the road.
21.02	21.10	The westbound roadside ditch experienced minor erosion scour damage, washing out approximately 0.5-1 ft deep and 1-2 ft wide and an old access cross culvert was exposed at MP 21.1.
21.20	21.40	Material slides into the westbound roadside ditch occurred at intermittent locations along this section depositing sediment on the roadway as runoff from the slide and ditch flowed across the road.
21.68	21.72	Material slides into the westbound roadside ditch occurred at intermittent locations along this section depositing sediment on the roadway as runoff from the slide and ditch flowed across the road.
21.92	21.93	High flows in Middle Saint Vrain Creek caused severe scour damage to a local access bridge over the creek resulting in wash out of the bridge and scour damage to the eastbound roadway embankment slope upstream and downstream of bridge.

2.3.4. Damage Photos

Figure 9 - MP 19.15, Eastbound ditch damage.

Figure 10 - MP 19.34, Westbound ditch damage.

Figure 11 - MP 20.66, Westbound ditch damage and material slide.

Figure 12 - MP 20.86, Material slide onto road.

Figure 13 - MP 21.68, Material slide onto road.

Figure 14 - MP 21.68, Local access bridge washed out and embankment damaged upstream and downstream of structure.

2.4. Emergency Repair (ER)

2.4.1. Descriptions of ER work performed

The table below lists ER work performed by milepost for this segment of SH 7.

Milepost		ER Work
Start	End	
19.06	19.35	The damaged ditches were filled with locally available materials and regraded.
19.40	19.50	
19.54	19.57	
19.65	19.95	
20.4	20.64	
20.58	20.66	
20.59	20.66	The material deposited in the ditch and on the road was removed, the ditch was regraded and the eastbound embankment was repaired.
20.68	20.97	The damaged ditches were filled with locally available materials and regraded.
20.84	20.88	The material deposited in the ditch and on the road was removed and the ditch was regraded.
21.02	21.10	The ditch was re-graded and the embankment material around the exposed cross-culvert was replaced.
21.20	21.40	The material deposited in the ditch and on the road was removed and the ditch was regraded.
21.68	21.72	The material deposited in the ditch and on the road was removed and the ditch was regraded.
21.92	21.93	The damaged roadway embankment slope was repaired.

2.4.2. Photo of ER work during construction

Figure 15 - MP 22, Emergency repair.

2.5. Permanent Repair (PR)

2.5.1. Description of recommended PR work

- Pending analysis of roadway stability using a falling weight deflectometer (FWD), remove and replace asphalt that was overtopped by flood water but not damaged during this event.
- Remove material placed during the emergency repairs and replace using appropriate materials and construction methods consistent with standard specifications.
- Reestablish/place native grass seed and erosion control blanket on all roadway embankment slopes disturbed during emergency and permanent repairs.
- Repair exposed and/or damaged utilities. The ownership, relocation, and repairs need to be identified and coordinated with the utility owner during initial planning and design.

The table below lists recommended PR work by milepost for this segment of SH 7.

Milepost		PR Work
Start	End	
19.06	19.35	Place topsoil and vegetate.
19.40	19.50	Place topsoil over rock filled ditches and vegetate.
19.54	19.57	
19.65	19.95	
20.40	20.64	

Milepost		PR Work
Start	End	
20.58	20.66	
20.59	20.66	Place topsoil over rock filled ditches and vegetate.
20.68	20.97	Place topsoil over rock filled ditches and vegetate.
20.84	20.88	None.
21.02	21.10	Place topsoil.
21.20	21.40	None.
21.68	21.72	None.
21.92	21.93	Place topsoil and re-vegetate.

2.5.2. Description of Resiliency

Proposed site resiliencies are to be determined during the initial design phase of the project.

2.5.3. PR/Resiliency Detailed Damage Inspection Reports (DDIRs)

See Appendix A

3. MILEPOSTS 22.14 TO 22.97

3.1. Roadway Facility Description/Dimensions

- This road segment consists of two 12 ft lanes with 2 - 4 ft outside shoulders. The roadway is functionally classified as a Minor Arterial with an AADT of 1,300 with 5.3 percent being trucks.
- No pedestrian or bike facilities are present at the site.
- The ROW in this area is varies from 132 - 156 ft total width. Approximately 5 - 10 percent of this section of SH 7 lies in Forest Service Land.
- Generally, the surrounding terrain is mountainous and slopes down from west to east.
- This segment of SH 7 provides east-west access from Raymond to Lyons.

3.2. Hydraulic/Structural Facility Description/Dimensions

- The Middle Saint Vrain Creek generally flows west to east, paralleling the south side of SH 7 from MP 20.5 to MP 23.55 where it converges with South Saint Vrain Creek.

Summary of Culverts:

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	22.20	1	CMP	2	72
007A	22.28	1	CMP	2	76
007A	22.40	1		2.5	98
007A	22.50	1	CMP	2	56
007A	22.60	1	CMP	2	54
007A	22.70	1	CMP	2	90
007A	22.80	1	CMP	2	88
007A	22.90	1	CMP	2	62
007A	22.90	1	CMP	2	64

3.3. Causation

3.3.1. Aerial views

Figure 16 - MP 22.14 to 22.97 Pre-disaster aerial photo (Post-disaster aerial photo not available)

3.3.2. Severity of damages

FHWA has reviewed this site and has determined that the damage was ☐ severe ☒ not severe.

High flows and velocities in Middle Saint Vrain Creek caused lateral scour damage to the adjacent eastbound roadway embankment. Much of this type of scour damage occurred at the outside bends in the creek. Also, large amounts of debris and sediment were deposited in the creek and along its banks compromising the hydraulic capacity of the creek and constricting the flow, ultimately contributing to the embankment scour damage throughout this segment of SH 7. Additionally, due to saturation of the surrounding mountainous terrain there were several material slides along this segment.

Based on the memorandum *CDOT/CWCB Hydrology Investigation, Phase 1 – 2013 Flood Peak Flow Determinations* and observed flows at this site during the September 2013 flood event, the flood frequency of Middle Saint Vrain Creek at this location during the flood is assumed to be between the 50-year and100-year storm events.

3.3.3. Detailed damage description

The table below lists the breakdown of the damage experienced within the highway ROW for this segment of SH 7 as a result of the September 2013 flood event.

Milepost		Description of Damage
Start	End	
22.14	22.18	The eastbound roadway embankment experienced lateral scour damage along the outside bend in the creek, approximately 20 ft wide and 5-10 ft deep. This site includes a gravel pullout adjacent to the eastbound lane which prevented damage to the roadway at this location.
22.24	22.27	The eastbound roadway embankment experienced lateral scour damage, approximately 20 ft wide and 5-10 ft deep. Large amounts of debris and sediment were deposited in the creek in this area.
22.42	22.50	The eastbound roadway embankment experienced lateral scour damage upstream and downstream of the local access bridge over the creek at MP 22.495. Large amounts of debris and sediment were deposited in the creek in this area. There was a material slide at MP 22.43 onto the westbound roadside ditch causing minor overtopping of the roadway with runoff and sediment.
22.54	22.58	There was a material slide at about MP 22.58 onto the westbound roadside ditch causing minor overtopping of the roadway with runoff and sediment. The eastbound roadway embankment experienced lateral scour damage along the outside bend in the creek, approximately 1,200 ft long x 5 ft wide x 15 ft deep
22.59	22.61	There was a material slide onto the westbound roadside ditch causing minor overtopping of the roadway with runoff and sediment for approximately 30 ft.
22.84	22.85	There was a material slide onto the westbound roadside ditch causing minor overtopping of the roadway with runoff and sediment for approximately 50 ft.
22.95	22.97	There was a material slide onto the westbound lane causing minor overtopping of the roadway with runoff and sediment. The outlet of the existing cross culvert was undermined.

3.3.4. Damage Photos

Figure 17 - MP 22.13, Eastbound roadway embankment scour damage.

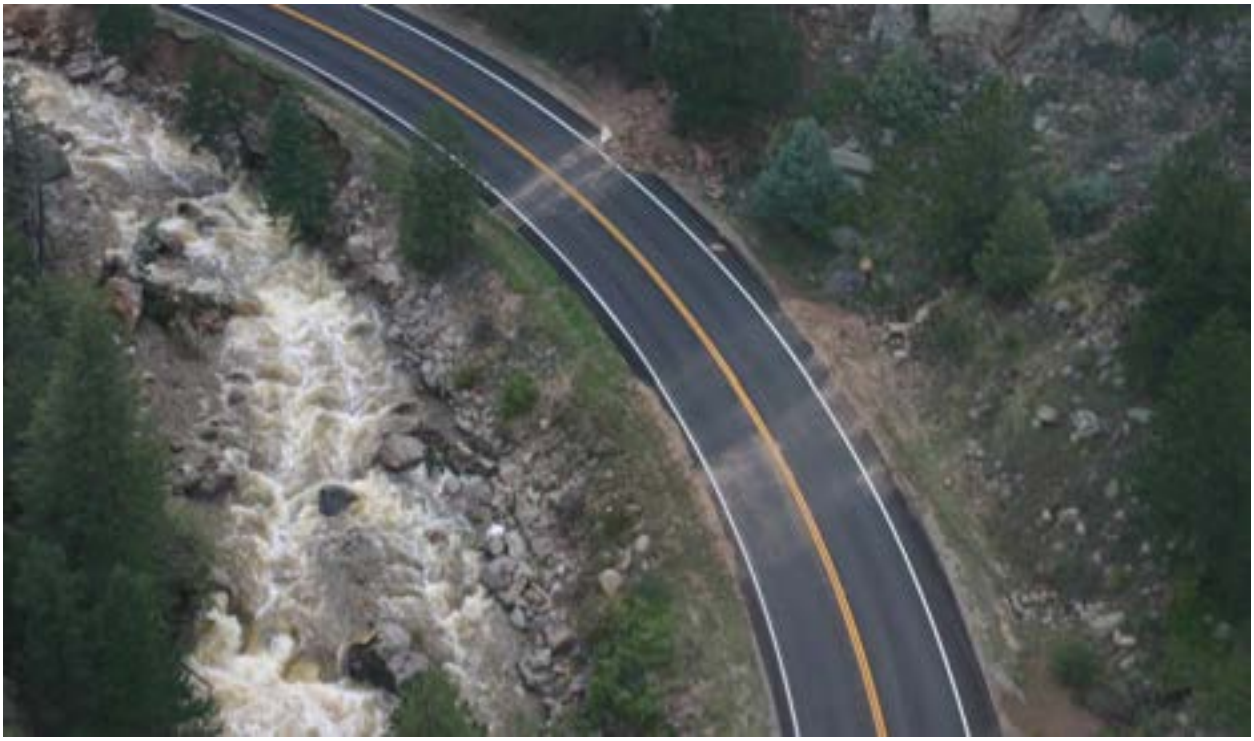

Figure 18 - MP 22.5, Riverside embankment loss and material slide onto the roadway.

Figure 19 - MP 22.83, Material slide onto roadway.

3.4. Emergency Repair (ER)

3.4.1. Descriptions of ER work performed

The table below lists ER work performed by milepost for this segment of SH 7.

Milepost		ER Work
Start	End	
22.14	22.18	The roadway embankment was repaired with rock and embankment material and the gravel pullout was rebuilt.
22.24	22.27	The roadway embankment was repaired with rock and embankment material.
22.42	22.45	
22.54	22.59	The slide material was removed, the westbound roadside ditch was regraded as needed and sediment was removed from the roadway. The roadway embankment was repaired with rock and embankment material.
22.59	22.61	The slide material was removed, the westbound roadside ditch was regraded as needed and sediment was removed from the roadway.
22.84	22.85	
22.95	22.97	The slide material was removed, the westbound roadside ditch was regraded as needed and sediment was removed from the roadway. The damaged culvert outlet was repaired.

3.4.2. Photos of ER work during construction and after completion

Figure 20 - MP 22.49, Eastbound roadway embankment repair.

Figure 21 - MP 22.95, Removal of material from slide and regarding of westbound roadside ditch.

3.5. Permanent Repair (PR)

3.5.1. Description of recommended PR work

- Pending analysis of roadway stability using a FWD, remove and replace asphalt that was overtopped by flood water but not damaged during this event.
- Remove material placed during the emergency repairs and replace using appropriate materials and construction methods consistent with standard specifications.
- Reestablish/place native grass seed and erosion control blanket on all roadway embankment slopes disturbed during emergency and permanent repairs.
- Repair exposed and/or damaged utilities. The ownership, relocation, and repairs need to be identified and coordinated with the utility owner during initial planning and design.

The table below lists recommended PR work by milepost for this segment of SH 7.

Milepost		PR Work
Start	End	
22.14	22.18	Remove and replace embankment material and rock place during ER. Revegetate disturbed slopes.
22.24	22.27	Remove and replace embankment material and rock place during ER. Revegetate disturbed slopes.
22.42	22.50	
22.54	22.59	Place riprap and vegetate.
22.59	22.61	None.
22.84	22.85	
22.95	22.97	None.

3.5.2. Description of Resiliency

Proposed site resiliencies are to be determined during the initial design phase of the project.

3.5.3. PR/Resiliency Detailed Damage Inspection Reports (DDIRs)

See Appendix A

4. MILEPOSTS 23.34 TO 30.54

4.1. Roadway Facility Description/Dimensions

- This road segment consists of two 12 ft lanes with varying 2-4 ft outside shoulders.
- The roadway is functionally classified as a Minor Arterial with an AADT of 1,300 with 5.3 percent being trucks.
- No pedestrian or bike facilities are present.
- The ROW in this area is varies from 66-216 ft total width. Approximately 80 percent of this section of SH 7 lies in Forest Service Land.
- Generally, the surrounding terrain is mountainous and slopes down from west to east.
- This segment of SH 7 provides east-west access from Raymond to Lyons.

4.2. Hydraulic/Structural Facility Description/Dimensions

- Middle Saint Vrain Creek flows west to east, generally paralleling the south side of SH 7 up to MP 23.55 where it converges with South Saint Vrain Creek. South Saint Vrain Creek continues along the south side of SH 7 until it converges with North Saint Vrain Creek in the Town of Lyons and becomes Saint Vrain Creek.

Summary of Culverts:

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	23.30	1	CMP	2	116
007A	23.40	1	CMP	4	108
007A	23.50	1	CMP	2	76
007A	23.60	1	CMP	2	82
007A	23.70	1	CMP	2	60
007A	23.80	1	CMP	3.5	110
007A	23.90	1	CMP	2	70
007A	24.00	1	CMP	2	84
007A	24.20	1	CMP	3	78
007A	24.30	1	CMP	2.5	90
007A	24.40	1	CMP	2	94
007A	24.50	1	CMP	2	90

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	24.60	1	CMP	2	104
007A	24.70	1		3	60
007A	24.70	1	CMP	2	78
007A	24.80	1	CMP	2	60
007A	24.90	1	CMP	2	62
007A	24.90	1	CMP	2	60
007A	25.00	1	CMP	2	60
007A	25.10	1	CMP	2	82
007A	25.10	1	CMP	2	62
007A	25.30	1	CMP	2	70
007A	25.40	1	CMP	2	116
007A	25.40	1	CMP	3	70
007A	25.50	1	CMP	2	92
007A	25.70	1	CMP	2	88
007A	25.90	1	CMP	2	64
007A	25.90	1	CMP	2	62
007A	26.00	1	CMP	2	58
007A	26.10	1	CMP	2	72
007A	26.20	1	CMP	2	58
007A	26.20	1	CMP	2	64
007A	26.26	1	CMP	2	85
007A	26.30	1	CMP	2	84
007A	26.50	1	CMP	3	55
007A	26.60	1	CMP	2	57
007A	26.70	1	CMP	2	
007A	26.80	1	CMP	2	

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	26.80	1	CMP	2	
007A	27.10	1	CMP	2	
007A	27.10	1	CMP	2	
007A	27.20	1	CMP	2	
007A	27.30	1	CMP	2	
007A	27.40	1	CMP	2	
007A	27.40	1	CMP	2	
007A	27.50	1	CMP	2	
007A	27.60	1	CMP	2	
007A	27.70	1	CMP	2	
007A	27.70	1	CMP	2	
007A	27.80	1	CMP	2	
007A	27.90	1	CBC	10x10	
007A	28.00	1	CMP	2	
007A	28.00	1	CMP	2	
007A	28.20	1	CMP	2	
007A	28.30	1	CMP	2	
007A	28.30	1	CMP	2	
007A	28.40	1	CMP	2	
007A	28.50	1	CMP	2	
007A	28.60	1	CMP	2	
007A	28.70	1	CMP	2	64
007A	28.80	1	CMP	2	50
007A	28.90	1	CMP	2	52
007A	29.00	1	CMP	2	60
007A	29.10	1	CMP	2	26

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	29.10	1	CMP	2	56
007A	29.30	1	CMP	2.5	58
007A	29.40	1	CMP	2	58
007A	29.45	1	CBC	7x5	50
007A	29.50	1	CMP	2	56
007A	29.60	1	CMP	2	58
007A	29.60	1	CMP	3	64
007A	29.70	1	CMP	2	60
007A	29.80	1	CMP	2.5	74
007A	29.90	1	CMP	2	74
007A	29.90	1	CMP	2	52
007A	30.00	1	CMP	3	54
007A	30.10	1	CMP	2	52
007A	30.10	1	CMP	3	56
007A	30.20	1	CMP	2	68
007A	30.30	1	CMP	2	68
007A	30.42	1	CMP	2.5	80

4.3. Causation

4.3.1. Aerial views

Figure 22 - MP 25.5 Pre-disaster aerial photo

Figure 23 - MP 25.5 Pre-disaster aerial photo

4.3.2. Severity of damages

FHWA has reviewed this site and has determined that the damage was ☒ severe ☐ not severe.

High flows and velocities in South Saint Vrain Creek caused lateral scour damage to the adjacent eastbound roadway embankment and in turn to the highway pavement at numerous locations throughout this segment of SH 7. Much of this type of scour damage occurred at the outside bends in the creek and in areas where the flows exceeded the capacity of the creek and overtopped the highway. Also, large amounts of debris and sediment were deposited in the creek and along its banks compromising the hydraulic capacity of the creek, constricting and/or redirecting the flow, and ultimately contributing to the scour damage. Additionally, due to saturation of the surrounding mountainous terrain, several material slides were triggered along this segment.

Based on the memorandum *CDOT/CWCB Hydrology Investigation, Phase 1 – 2013 Flood Peak Flow Determinations* and observed flows at this site during the September 2013 flood event, the flood frequency of South Saint Vrain Creek at this location during the flood is assumed to be the 50- year storm event at the upper limits of the reach and above the 100-year storm event at the lower limits of the reach.

4.3.3. Detailed damage description

The table below lists the breakdown of the damage experienced within the highway ROW for this segment of SH 7 as a result of the September 2013 flood event.

Milepost		Description of Damage - *All Dimensions are "Approximate"*
Start	End	
23.34	23.36	Loss of the riverside embankment. The eastbound paved shoulder was undermined for 2,000 ft.
23.50	23.53	Loss of the eastbound lane with a vertical drop at the centerline of the roadway 100 ft.
23.55	23.63	Riverside embankment loss and eastbound lane undermined with some paved shoulder loss 500 LF.
23.76	23.83	Complete loss of the 2 lane roadway.
23.83	23.90	Embankment loss on the edge of the paved pullout, approximately 2,000 LF.
23.99	24.00	Material slide covered the roadway, approximately 300 LF.
24.03	24.06	Riverside embankment loss (approximately 5 ft) and partial loss of the entrance to the paved pullout (50 ft x15 ft).
24.14	24.18	Material slide covered the roadway. Riverside embankment loss with paved shoulder undermined for 100 LF.
24.25	24.35	Significant material slide onto roadway, a vertical drop at the edge of paved shoulder for 100 ft, landslide covered 150 ft of roadway, roadway overtopped with water for 350 ft.
24.40	24.43	Material slide covered the roadway, eastbound lane undermined for 50 ft.
24.54	24.61	Material slide completely covered the roadway.
24.70	24.80	Eastbound lane loss, significant material slide onto roadway and damaged gravel pullout at MP 24.8 (200 ft x50 ft).
24.98	25.01	Embankment loss and eastbound lane undermined at shoulder line, material slide covered up westbound lane with sediment and material.
25.10	25.12	Material slide into the westbound shoulder/ditch line.
25.23	25.27	Riverside embankment loss and the eastbound lane undermined and 20 ft of eastbound lane loss.
25.32	25.34	Riverside embankment loss and almost vertical drop from paved shoulder edge.
25.36	25.38	Material slide that covered up the roadway, partial loss of paved pullout (50 ft x15 ft).
25.48	25.53	Complete loss of the 2 lane roadway.
25.56	25.61	Loss of gravel pullout in an inset flood plan type scenario.
25.68	25.72	Complete loss of the eastbound lane, vertical drop at centerline of roadway.
25.72	25.82	Riverside embankment loss and paved pullout loss (200 ft x15 ft), rock slide at MP 25.78.
25.82	25.93	Riverside embankment loss and approximately 1/2 of this section had eastbound paved shoulder undermined.

Milepost		Description of Damage - *All Dimensions are "Approximate"*
Start	End	
26.02	26.09	Riverside embankment loss and 2 areas of EB paved shoulder undermined (approximately 30 ft+100 ft).
26.11	26.14	Riverside embankment loss and loss of half of the eastbound lanes, remainder of the eastbound lane undermined.
26.17	26.20	Riverside embankment loss and undermined paved shoulder.
26.23	26.27	Loss of the riverside embankment and a paved pullout (225 ft x20 ft), major uphill landslide through the drainage chute at MP 26.24, which left major deposits of sediment and material across the entire roadway.
26.30	26.35	Riverside embankment loss and undermining of the paved shoulder.
26.35	26.50	Soil loss over the riprap on the riverside embankment.
26.52	26.56	Gravel pullout surface damage (200 ft x15 ft).
26.57	26.65	Complete 2 lane roadway loss.
26.65	26.70	Inside ditch washout and riverside embankment loss, eastbound paved shoulder undermined or lost.
26.70	26.75	The eastbound lane was a complete loss up to the centerline.
26.75	26.85	Inside ditch washouts and westbound shoulder pavement undermining, riverside embankment loss with approximately 300 LF of eastbound pavement undermining.
26.85	26.9	Inside ditch washouts and some shoulder pavement undermining.
26.90	27.10	Inside ditch washout and undermined westbound shoulder, 400 LF of complete 2 lane roadway loss, 500 LF of eastbound lane loss and undermined westbound lane.
27.10	27.15	Inside ditch washout and roadway appears to have been overtopped.
27.15	27.22	Riverside embankment loss, undermined 20 LF of eastbound paved shoulder.
27.22	27.28	Complete loss of the 2 lane roadway.
27.28	27.31	Embankment slope of pullout loss.
27.35	27.38	Eastbound pavement loss to the centerline of the roadway.
27.38	27.41	Loss of the embankment slope at the pullout.
27.50	27.62	Eastbound lane either undermined or lost. Guardrail losses and rock fall at 27.5.
27.62	27.75	Complete 2 lane roadway loss, 25 LF of old block retaining wall remains from the original, approximately 300 LF.
27.75	27.87	Riverside embankment loss and some minor guardrail undermining.
27.87	27.95	Embankment loss and eastbound lane undermined at shoulder line.
28.06	28.10	Embankment, guardrail, & eastbound pavement loss.

Milepost		Description of Damage - *All Dimensions are "Approximate"*
Start	End	
28.10	28.35	Riverside embankment washouts, sections of guardrail undermined, gravel pullout loss (100 ft x10 ft) at MP 28.3, local access gravel road and bridge complete loss at MP 28.3, local access bridge was not directly connected to the highway.
28.35	28.50	Roadway overtopping, riverside embankment loss and eastbound paved shoulder undermining.
28.50	28.60	Complete loss of the 2 lane roadway.
28.60	28.70	Roadway overtopping and sediment deposited on the highway, riverside embankment loss, inside ditch washouts.
28.70	28.75	Complete loss of the 2 lane roadway.
28.75	28.84	Riverside embankment loss, wash out of the outer edge of the gravel pullout.
28.84	28.86	Rock fell onto part of the roadway and blocked the ditch.
28.88	28.96	Eastbound lane loss and undermining.
29.00	29.06	Pavement loss to just past the centerline of highway.
29.24	29.30	Eastbound lane loss and undermining, approximately 5 ft deep of embankment loss down entire slope to river.
29.45	29.46	Both sides of the roadway embankment washed out at the CBC and undermined the surrounding pavement.
29.55	29.65	Complete loss of the 2 lane roadway.
29.65	29.94	The riverside roadway embankment experienced scour damage which washed out the top layer of embankment material and exposed the underlying buried riprap.
29.94	30.08	The roadway overtopped, the mountain side ditch was washed out and the pavement was undermined on westbound lane, the riverside embankment was washed out and the eastbound lane was undermined and lost through this section.
30.08	30.20	The roadway overtopped, the shoulder and ditch were damaged, the eastbound paved shoulder undermined and a portion was lost.
30.30	30.40	Material slide from a loose, steep rock face, filled in the ditch with material and covered the paved shoulder.
30.48	30.54	The 2 lane roadway was a complete loss for approximately 300 LF.

4.3.4. Damage Photos

Figure 24 - MP 23.54, Roadway embankment damage, partial wash out of EB lane.

Figure 25 - MP 23.8, Complete 2 lane roadway wash out.

Figure 26 - MP 24.0, Rock slide covering both roadway lanes.

Figure 27 - MP 24.6, Rock slide, debris and sediment covering both roadway lanes.

Figure 28 - MP 24.75, Rock slide and debris covering roadway lanes, embankment and roadway washout.

Figure 29 - MP 24.75, Rock slide covering roadway lanes. Embankment and roadway washout.

Figure 30 - MP 25.5, Embankment and roadway washout.

Figure 31 - MP 25.75, Embankment and partial roadway washout.

Figure 32 - MP 25.8, Embankment/pavement washout and rockslide.

Figure 33 - MP 26.25, Rock slide and debris covering both roadway lanes.

Figure 34 - MP 26.61, Complete roadway loss due to overtopping.

Figure 35 - MP 26.9, Complete roadway loss due to overtopping at the river bend

Figure 36 - MP 26.9, Roadway undermined and washed out embankment.

Figure 37 - MP 27.28, Complete roadway loss due to embankment scour damage at the river bend.

Figure 38 - MP 27.61, Riverside embankment and eastbound lane damage due to lateral scour and overtopping of the roadway.

Figure 39 - MP 27.68, Wash out of riverside embankment and roadway due to lateral scour and overtopping of the roadway.

Figure 40 - MP 28.3, Scour damage to gravel pullout, EB embankment and guardrail; and material slides.

Figure 41 - MP 28.5, Complete wash out of the roadway due to lateral scour and overtopping of the roadway.

Figure 42 - MP 30.08, Wash out of the roadway embankment and pavement due to lateral scour and overtopping of the roadway. Sediment and debris deposition throughout.

Figure 43 - MP 30.1, Wash out of the roadway embankment and pavement due to lateral scour and overtopping of the roadway. Sediment and debris deposition throughout.

Figure 44 - MP 30.49, Complete roadway loss

4.4. Emergency Repair (ER)

4.4.1. Descriptions of ER work performed

The table below lists ER work performed by milepost for this segment of SH 7. Sediment removal referenced in the table is discussed in Section 1.6.1.

Milepost		ER Work
Start	End	
23.34	23.36	The damaged embankment and undermined paved shoulder were repaired.
23.50	23.53	The eastbound undermined roadway was repaired.
23.55	23.63	The damaged embankment and undermined eastbound paving and paved shoulder were repaired.
23.76	23.83	Both damaged lanes, full width, were repaired.
23.83	23.90	The embankment and the pullout were repaired.
23.99	24.00	Sediment from the landslide was removed.
24.03	24.06	The embankment and the pullout were repaired.
24.14	24.18	Sediment from the landslide was removed. The damaged embankment and undermined paved shoulder were repaired.
24.25	24.35	Sediment from the landslide was removed. The shoulder and overtopped roadway were repaired.
24.40	24.43	Sediment from the landslide was removed. The undermined eastbound lane was repaired.
24.54	24.61	Sediment from the landslide was removed.
24.70	24.80	Sediment from the landslide was removed. The pullout was repaired.
24.98	25.01	Sediment from the landslide was removed. The embankment and paved shoulder loss were repaired.
25.10	25.12	Sediment from the landslide was removed. The ditch was re-graded.
25.23	25.27	The damaged embankment and the undermined roadway were repaired.
25.32	25.34	The damaged embankment and undermined paved shoulder were repaired.
25.36	25.38	Sediment from the landslide was removed. The damaged pullout was repaired.
25.48	25.53	Both damaged lanes, full width, were repaired.
25.56	25.61	The damaged pullout was repaired.
25.68	25.72	The eastbound lane loss was repaired.
25.72	25.82	Sediment and rock from the landslide was removed from landslide. The damaged pullout and embankment were repaired.
25.82	25.93	The damaged embankment and undermined paved shoulder were repaired.
26.02	26.09	The damaged embankment and undermined paved shoulder were repaired.
26.11	26.14	The damaged embankment and undermined eastbound lane were repaired.

Milepost		ER Work
Start	End	
26.17	26.2	The damaged embankment and undermined paved shoulder were repaired.
26.23	26.27	Sediment from the landslide and rock were removed. The damaged pullout and embankment were repaired.
26.30	26.35	The damaged embankment and undermined paved shoulder were repaired.
26.35	26.5	The embankment was re-vegetated.
26.52	26.56	The damaged pullout was repaired.
26.57	26.65	The full width roadway loss was repaired.
26.65	26.70	The damaged embankment and undermined paved shoulder were repaired. The ditch was re-graded.
26.70	26.75	The pavement was repaired.
26.75	26.85	The damaged embankment and undermined paved shoulder were repaired. The ditch was re-graded.
26.85	26.90	The pavement and ditch were repaired.
26.90	27.10	The damaged embankment and undermined paved shoulder were repaired. The ditch was re-graded.
27.10	27.15	The overtopped paving was repaired. The ditch was re-graded.
27.15	27.22	The damaged embankment and undermined paved shoulder were repaired.
27.22	27.28	The full roadway width was repaired.
27.28	27.31	The damaged pullout and embankment were repaired.
27.35	27.38	The damaged pavement was repaired.
27.38	27.41	The damaged pullout and embankment were repaired.
27.50	27.62	Sediment and rocks were removed from the roadway. Repaired the damaged roadway and placed temporary guardrail.
27.62	27.75	The full width road loss and retaining wall were repaired.
27.75	27.87	Repaired the damaged roadway embankment and placed temporary guardrail.
27.87	27.95	The damaged embankment and undermined shoulder were repaired.
28.06	28.10	The damaged embankment, guardrail and pavement were repaired.
28.10	28.35	The damaged embankment, guardrail and pavement were repaired. The damaged pullout was repaired.
28.35	28.50	The damaged embankment, paving and undermined paved shoulder were repaired.
28.50	28.60	The full width roadway loss was repaired.
28.60	28.70	Sediment was removed from the roadway. The overtopped road lane embankment were repaired and the ditch re-graded.
28.70	28.75	The full width roadway loss was repaired.

Milepost		ER Work
Start	End	
28.75	28.84	The damaged embankment and pullout were repaired.
28.84	28.86	Rocks were removed from the roadway.
28.88	28.96	The undermined pavement was repaired.
29.00	29.06	The pavement loss was repaired.
29.24	29.30	The damaged embankment and pavement were repaired.
29.45	29.46	The embankment, undermined road and CBC were repaired.
29.55	29.65	The full width roadway loss was repaired.
29.65	29.94	Topsoil and riprap were replaced.
29.94	30.08	The ditch and overtopped pavement were repaired.
30.08	30.20	The damaged embankment, pavement and undermined paved shoulder were repaired.
30.30	30.40	Material in the roadway was removed.
30.48	30.54	The full width roadway loss was repaired.

4.4.2. Photos of ER work during construction and after completion

Figure 45 - MP 23.4 Facing east, Completed ER roadway section.

Figure 46 - MP 23.4, CMP repair.

Figure 47 - MP 23.8 Facing west, Roadway repair.

Figure 48 - MP 23.8 Facing northwest, CMP repair.

Figure 49 - MP 24.7 Facing northeast, Roadway repair.

Figure 50 - MP 25.3 Facing east, Roadway repair.

Figure 51 - MP 25.5 Facing east, Roadway repair.

Figure 52 - MP 25.9 Facing west, Roadway repair.

Figure 53 - MP 26.2 Facing west, Clearing rockfall.

Figure 54 - MP 26.2, CMP Repair.

Figure 55 - MP 26.5, CMP repair.

Figure 56 - MP 26.9, Facing northeast, Roadway repair.

Figure 57 - MP 27.2, Facing north, Roadway and CMP repair.

Figure 58 - MP 27.2, Facing north, Roadway repair.

Figure 59 - MP 27.35, Facing North, Roadway and CMP repair.

Figure 60 - MP 27.4, Looking South.

4.5. Permanent Repair (PR)

4.5.1. Description of recommended PR work

- Pending analysis of roadway stability using a FWD, remove and replace asphalt that was overtopped by flood water but not damaged during this event.
- Remove material placed during the emergency repairs and replace using appropriate materials and construction methods consistent with standard specifications.
- Reestablish/place native grass seed and erosion control blanket on all roadway embankment slopes disturbed during emergency and permanent repairs.
- Repair exposed and/or damaged utilities. The ownership, relocation, and repairs need to be identified and coordinated with the utility owner during initial planning and design.

The table below lists recommended PR work by milepost for this segment of SH 7.

Milepost		PR Work
Start	End	
23.34	23.36	Re-vegetate
23.50	23.53	Remove and replace asphalt placed during ER
23.55	23.63	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
23.76	23.83	Remove and replace asphalt placed during ER
23.83	23.90	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
23.99	24.00	none
24.03	24.06	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
24.14	24.18	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
24.25	24.35	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
24.40	24.43	Remove and replace asphalt placed during ER.
24.54	24.61	none
24.70	24.80	Place topsoil and re-vegetate
24.98	25.01	Place topsoil and re-vegetate
25.10	25.12	Place topsoil and re-vegetate
25.23	25.27	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
25.32	25.34	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
25.36	25.38	Place topsoil and re-vegetate
25.48	25.53	Remove and replace asphalt placed during ER

Milepost		PR Work
Start	End	
25.56	25.61	none
25.68	25.72	Remove and replace asphalt placed during ER
25.72	25.82	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
25.82	25.93	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.02	26.09	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.11	26.14	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.17	26.20	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.23	26.27	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.30	26.35	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.35	26.50	none
26.52	26.56	none
26.57	26.65	Remove and replace asphalt placed during ER
26.65	26.70	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.7	26.75	Remove and replace asphalt placed during ER
26.75	26.85	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
26.85	26.9	Remove and replace asphalt placed during ER.
26.90	27.10	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
27.10	27.15	Remove and replace asphalt placed during ER
27.15	27.22	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
27.22	27.28	Remove and replace asphalt placed during ER
27.28	27.31	Place riprap and erosion blanket.
27.35	27.38	Remove and replace asphalt placed during ER
27.38	27.41	Place riprap and erosion blanket.
27.50	27.62	Remove and replace asphalt placed during ER
27.62	27.75	Remove and replace asphalt placed during ER
27.75	27.87	Place riprap and erosion blanket.

Milepost		PR Work
Start	End	
27.87	27.95	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
28.06	28.10	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
28.10	28.35	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
28.35	28.50	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
28.50	28.60	Remove and replace asphalt placed during ER
28.60	28.70	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
28.70	28.75	Remove and replace asphalt placed during ER
28.75	28.84	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
28.84	28.86	none
28.88	28.96	Remove and replace asphalt placed during ER
29.00	29.06	Remove and replace asphalt placed during ER
29.24	29.30	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
29.45	29.46	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
29.55	29.65	Remove and replace asphalt placed during ER
29.65	29.94	none
29.94	30.08	Remove and replace asphalt placed during ER
30.08	30.20	Remove and replace asphalt placed during ER. Vegetate and place erosion blanket on embankment slope
30.30	30.40	none
30.48	30.54	Remove and replace asphalt placed during ER

4.5.2. Description of Resiliency

Proposed site resiliencies are to be determined during the initial design phase of the project.

4.5.3. PR/Resiliency Detailed Damage Inspection Reports (DDIRs)

See Appendix A

5. MILEPOSTS 31.29 TO 32.7

5.1. Roadway Facility Description/Dimensions

- This road segment consists of two 12 ft lanes with 2-5 ft outside shoulders. The roadway is functionally classified as a Minor Arterial with an AADT of 1,300 with 5.3 percent being trucks.
- No pedestrian or bike facilities are present at the site.
- The ROW in this area varies from approximately 132-200 ft total width.
- Generally, the surrounding terrain is mountainous and slopes from west to east.
- This segment of SH 7 provides east-west access from Raymond to Lyons.

5.2. Hydraulic/Structural Facility Description/Dimensions

- South Saint Vrain Creek flows west to east, generally following the south side of SH 7 into the Town of Lyons where it converges with North Saint Vrain Creek and becomes Saint Vrain Creek.

Summary of Culverts:

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	31.30	1	CMP	3.5	80
007A	31.33	1	CMP	2	54
007A	31.38	1	CMP	4	46
007A	31.40	1	CMP	2.5	52
007A	31.50	1	CMP	2.5	50
007A	31.60	1	CBC	7	46
007A	31.70	1	CMP	2.5	44
007A	31.80	1	CMP	2.5	44
007A	31.91	1	CBC	10x5	40
007A	32.00	1	CMP	3	56
007A	32.10	1	CMP	2	50
007A	32.20	1	CMP	3	54
007A	32.24	1	CMP	2	50
007A	32.33	1	CMP	2	64
007A	32.47	1	CMP	2	138
007A	32.53	1	CMP	2	56
007A	32.56	1	CMP	2	48

Route	MP	No. of Pipes	Structure Type	Size (ft.)	Length (ft.)
007A	32.61	1	CMP	2	52

5.3. Causation

5.3.1. Aerial views

Figure 61 - MP 31.2-32.7 Pre-disaster aerial photo

Figure 62 - MP 31.2-32.7 Pre-disaster aerial photo

5.3.2. Severity of damages

FHWA has reviewed this site and has determined that the damage was ☒ severe ☐ not severe.

South Saint Vrain Creek floodwaters exited the canyon and began to spread across the alluvial plain of the creek and in some areas overtopping the roadway and depositing sediment, rocks and debris throughout. The floodwaters caused lateral scour damage to the adjacent eastbound roadway embankment and in turn to the highway pavement which in some cases resulted in complete wash out of the highway. Much of this type of scour damage occurred at the outside bends in the creek and in areas where the flows exceeded the capacity of the creek and overtopped the highway. The large amounts of debris, rocks and sediment deposited in the creek and along its banks compromised the hydraulic capacity of the creek, constricted and/or redirected the flow, and ultimately contributed to the scour damage.

Based on the memorandum *CDOT/CWCB Hydrology Investigation, Phase 1 – 2013 Flood Peak Flow Determinations* and observed flows at this site during the September 2013 flood event, the flood frequency of South Saint Vrain Creek at this location during the flood is assumed to be between the 100-year and 500-year storm event.

5.3.3. Detailed damage description

The table below lists the breakdown of the damage experienced within the highway ROW for this segment of US 34 as a result of the September 2013 flood event.

Milepost		Description of Damage - *All Dimensions are "Approximate"*
Start	End	
31.29	31.36	Complete wash out of the roadway for approximately 400 ft.
31.36	31.45	The riverside embankment washed out, the eastbound lane was undermined for 450 ft and washed out for 500 ft.
31.59	31.66	Complete wash out of the roadway for approximately 400 ft.
31.8	31.94	The roadway was overtopped and covered with sediment and debris and the CBC at MP 31.9 was completely buried in sand and sediment. 200 ft of the roadway washed out just east of the CBC.
32	32.25	The roadway was overtopped through the entire section; there were shoulder and ditch washouts on both sides of road. Both paved shoulders were undermined throughout section.
32.66	32.7	The riverside embankment washed out and the paved shoulder was undermined.

5.3.4. Damage Photos

Figure 63 - MP 31.3 – 31.42, Riverside embankment washout and EB and WB undermined pavement loss.

Figure 64 - MP 31.64, Complete loss of roadway.

Figure 65 - MP 31.64, Roadway overtopped throughout section, shoulder and ditch washouts on both sides.

Figure 66 - MP 32.7, Riverside embankment washout and undermined paved shoulder.

5.4. Emergency Repair (ER)

5.4.1. Descriptions of ER work performed

The table below lists ER work performed by milepost for this segment of SH 7.

Milepost		ER Work
Start	End	
31.29	31.36	Repair full width roadway loss.
31.36	31.45	Repair embankment and pavement loss.
31.59	31.66	Repair full width roadway loss.
31.80	31.94	Remove sediment, replace overtopped road section and washed out roadway. Reset CBC.
32.00	32.25	Repair overtopped and undermined pavement sections. Repair shoulders and re-grade ditch.
32.66	32.70	Repair embankment and undermined shoulder.

5.4.2. Photos of ER work during construction and after completion

Figure 67 - MP 31.2, Facing southwest, ER Roadway repairs.

Figure 68 - MP 31.2, Facing northeast, ER Roadway repairs.

Figure 69 - MP 31.2, Facing northeast, ER Roadway repairs.

Figure 70 - MP 31.2, Facing southwest, ER Roadway repairs.

Figure 71 - MP 31.2, ER CMP Installation.

Figure 72 - MP 31.2, ER CMP installation complete.

Figure 73 - MP 31.7, ER Paving operations.

5.5. Permanent Repair (PR)

5.5.1. Description of recommended PR work

- Pending analysis of roadway stability using a FWD, remove and replace asphalt that was overtopped by flood water but not damaged during this event.
- Remove material placed during the emergency repairs and replace using appropriate materials and construction methods consistent with standard specifications.
- Reestablish/place native grass seed and erosion control blanket on all roadway embankment slopes disturbed during emergency and permanent repairs.
- Repair exposed and/or damaged utilities. The ownership, relocation, and repairs need to be identified and coordinated with the utility owner during initial planning and design.

The table below lists recommended PR work by milepost for this segment of SH 7.

Milepost		PR Work
Start	End	
31.29	31.36	Remove and replace asphalt placed during ER.
31.36	31.45	Remove and replace asphalt placed during ER.
31.59	31.66	Remove and replace asphalt placed during ER.
31.80	31.94	Remove and replace asphalt placed during ER.
32.00	32.25	Remove and replace asphalt placed during ER.
32.66	32.70	Remove and replace asphalt placed during ER. Re-vegetate and place erosion blanket on the embankment slope.

5.5.2. Description of Resiliency

Proposed site resiliencies are to be determined during the initial design phase of the project.

5.5.3. PR/Resiliency Detailed Damage Inspection Reports (DDIRs)

See Appendix A

6. MILEPOST 32.98

6.1. Roadway Facility Description/Dimensions

- This road segment consists of two 12 ft lanes with varying 4-8 ft outside shoulders. The roadway is functionally classified as a Minor Arterial with an AADT of 2,300 with 7.7 percent being trucks.
- No pedestrian or bike facilities are present at the site.
- The ROW in this area is approximately 80 ft total width.
- The highway provides access from Raymond to Lyons. This specific site lies within the town of Lyons.

6.2. Hydraulic/Structural Facility Description/Dimensions

- North Saint Vrain Creek crosses SH 7 at this location.

Summary of Structures:

MP	Structure ID	Intersecting Feature	Span	Length	Width	Year built	Sufficiency Rating	Last Inspection Date	Type	Note
32.98	D-15-A	North St. Vrain Creek	1	66	30	1955	78.5		CRF	1

Notes:

1 Based on the year the structure was built, best available information and engineering judgment, it is assumed that this structure was designed for a 50-year storm event.

6.3. Causation

6.3.1. Aerial views

Figure 74 - MP 32.98 Pre-disaster aerial photo

Figure 75 - MP 32.98 Pre-disaster aerial photo

6.3.2. Severity of damages

FHWA has reviewed this site and has determined that the damage was ☐ severe ☒ not severe.

North Saint Vrain Creek floodwaters overtopped the bridge depositing sediment and debris on and around the structure. The main creek channel experienced widening, aggradation and degradation causing scour of the bridge abutments.

Based on the memorandum *CDOT/CWCB Hydrology Investigation, Phase 1 – 2013 Flood Peak Flow Determinations*, observed flows at this site during the September 2013 flood event, and engineering judgment, the flood frequency of North Saint Vrain Creek at this location during the flood is assumed to be greater than the 500-year event.

6.3.3. Detailed damage description

The table below lists the breakdown of the damage experienced within the highway ROW for this segment of SH 7 as a result of the September 2013 flood event.

Milepost		Description of Damage
Start	End	
32.98	32.98	Structure D-15-A had scour damage at the south abutment, both on the upstream and downstream sides. The pavement was undermined behind the abutment at the southwest corner.

6.3.4. Damage Photos

Figure 76 - MP 32.98, Structure D-15-A with abutment scour and undermined pavement behind abutment.

Figure 77 - MP 32.98, Structure D-15-A with abutment scour and undermined pavement behind abutment.

6.4. Emergency Repair (ER)

6.4.1. Descriptions of ER work performed

Table below lists the ER work completed for this segment of SH 7.

Milepost		ER Work
Start	End	
32.98	32.98	Repaired abutment scour and undermined pavement.

6.4.2. Photos of ER work during construction and after completion

Figure 78 - MP 32.98, Facing west, Structure D-15-A embankment repair.

Figure 79 - MP 32.98, Facing northeast, Structure D-15-A temporary access.

6.5. Permanent Repair (PR)

6.5.1. Description of recommended PR work

- Pending analysis of roadway stability using a FWD, remove and replace asphalt that was overtopped by flood water but not damaged during this event.
- Remove material placed during the emergency repairs and replace using appropriate materials and construction methods consistent with standard specifications.
- Reestablish/place native grass seed and erosion control blanket on all roadway embankment slopes disturbed during emergency and permanent repairs.
- Repair exposed and/or damaged utilities. The ownership, relocation, and repairs need to be identified and coordinated with the utility owner during initial planning and design.

The table below lists recommended PR work by milepost for this segment of SH 7.

Milepost		PR Work
Start	End	
32.98	32.98	Remove and replace ER work. Revegetate.

6.5.2. Description of Resiliency

Proposed site resiliencies are to be determined during the initial design phase of the project.

6.5.3. PR/Resiliency Detailed Damage Inspection Reports (DDIRs)

See Appendix A

APPENDIX A –SIGNED DDIRS

Sheet ______ of ______

U.S. Department of Transportation Federal Highway Administration	**DETAILED DAMAGE INSPECTION REPORT** (Title 23, Federal-aid Highways)	Report Number:
		Inspection Date: 11.11.2013

Location (Name of Road and Milepost)

Route 007A **at Mile Post** 19.00 **to** 33.00

FHWA Disaster Number: CO-13-1

Federal aid Route Number: 007A

State: Colorado

County: Boulder

Description of Damage (ONLY ONE ITEM MAY BE CHECKED)

☐ Emergency Repair ☑ Permanent Repair ☐ Debris Removal

[illegible]

Project Phase (ONLY ONE ITEM MAY BE CHECKED)

☑ Pre-Construction ☐ Construction

Work Order Number Not Maintenance Forces

Cost Estimate

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Major Earthwork Items	CY	$ 45.37	57100		$ 2,590,600.00
Aggregate Base Course	CY	$ 30.00	7700		$ 216,000.00
Surfacing - HMA	TN	$ 81.79	25600		$ 2,093,800.00
Surfacing - Concrete	SY		0		$ -
Structure Repairs	LS	$ -	1		$ -
Walls	SF	$ 150.00	4500		$ 675,000.00
Drainage	LF	$ 84.00	300		$ 25,200.00
Misc. Items	LS	$ 36,000.00	1		$ 36,000.00
General Construction Items	LS	$ 1,606,431.00	1		$ 1,606,431.00
Environmental Assessment	LS	$ 724,303.10	1		$ 724,303.10
Force Account - Miscellaneous	LS	$ 796,733.41	1		$ 796,733.41
Minor Contract Revisions	LS	$ 500,000.00	1		$ 500,000.00
			Construction Estimate Subtotal		$ 9,264,067.51
			Contingencies		$ 1,852,813.50
			ROW		$ 500,000.00
			Preliminary Engineering		$ 1,742,532.15
			Construction Engineering		$ 1,161,688.10
			[illegible]		$ 1,597,321.14

Method: ☐ Local Forces ☐ State Forces ☑ Contract

Estimated Project Total $ 16,118,500.00

Environmental Assessment Recommendation: ☑ Categorical Exclusion ☐ EA/EIS

Prepared By: Carla Groh

Date: 3.31.2014

Concurrence	Name	Signature	Date
Concurrence ☑ Yes ☐ No	FHWA Engineer (Print Name): Monica C Pavlik	FHWA Engineer (Signature): [signature]	Date: 4/24/14
Concurrence ☑ Yes ☐ No	State Engineer (Print Name): Johnny Olson	State Engineer (Signature): [signature]	Date: 4/24/14
Concurrence ☐ Yes ☐ No	Local Agency (Print Name):	Local Agency (Signature):	Date:

FHWA USE ONLY

ERFO Eligible ☐ Yes ☐ No

Form FHWA-[illegible]

[illegible]

Permanent Repair Project Cost Estimate

Project Location:

Name of Road	007A		Initials CCG
Begin MP	19.00	or GPS Coordinates	Date 3 31 14
End MP	33.181		
County	Boulder		

Description of Work Below

Rockfill, embankment, AB(', HMA to rebuild roadside pullouts and third lanes that were not reconstructed during ER phase. Remove all ER HMA, reprocess top 2 feet of embankment, replace 6" ABC, and replace 6" HMA. Repave all areas back to preflood widths. Pending FWD results, remove overtopped HMA and replace. Pending pavement analysis, 2" mill and overlay for all construction damaged surfaces (MP 23.5-30.54). All riprap slopes rebuilt during ER phase - place new 36" + riprap at base of armored slope and reset riprap on remainder of slope. All other miscellaneous items such as guardrail, signage, striping, and drainage.

PROJECT MAJOR CONSTRUCTION ITEMS

This Section not used in Permanent Repair Cost Estimates

	Length (ft)	Width (ft)	Depth (ft)	Unit	Unit Cost	Quantity	Cost
Borrow Pit				CY	$ 30.00	9,600	$288,000.00
Reconstruct & Embankment				CY	$ 12.00	36,300	$441,600.00
Reseding and Blankets (Average Rate 2.1 slope)				AC	$ 10,500.00	0.00	$0.00
Stability and Proof (Under Item 2.1 Above)				AC	$ 3,700.00	0.00	$0.00
Cut Material (Class 1)				CY	$ 25.79	0	$0.00
Cut Material (Class 2)				CY	$ 60.47	0	$0.00
Unsuitable Excavation				CY	$ 42.69	0	$0.00
Hauling (Unsuitable Material) (MV)				CY	$ 9.00	10,750	$97,500.00
Reinforcing Fabric Mat (Flexible)				SY	$ 2.00	0	$0.00
Remove & Dispose Asphalt				SY	$ 5.74	0	$0.00
Remove & Replace Concrete				SY	$ 12.33	0	$0.00
Rehab Rockfall				CY	$ 40.00	0.00	$0.00
Mill Pavement				CY		0	$0.00
Remove & Recycle Asphalt (6")				SY	$ 5.00	45,900	$229,500.00
Remove & Recycle ABC (6" Depth)				SY	$ 5.00	0	$0.00
Subgrade Stabilization (6")				SY	$ 2.00	0	$0.00
Upgrade Pavement				HR	$ 55.34	0	$0.00
Striping (replace stripes)				HR	$ 25.00	0	$0.00
					Estimated Cost Earthwork		$2,400,000

Repave & Pavements	Length (ft)	Width (ft)	Depth (in)	Unit	Unit Cost	Quantity	Cost
6" ABC Class 6				CY	$ 30.00	7,200	$216,000.00
HMA (Reprocess 6", Incorporate Millings) + HMA				TN	$ 75.00	25,600	$1,920,000.00
Mill 2" (Maximum 6", Incorporate Millings)				SY	$ 3.00	0	$0.00
HMA Patching - Anything over from Mill 2"				TN	$ 90.00	0	$0.00
HMA Planing 2"				SY	$ 2.00	96,900	$193,800.00
					Estimated Cost Pavement		$2,304,000

Permanent Repair Project Cost Estimate

Initials CC
Date 3.31.14

	SR 5A
	19.00
	11.701
	Franklin

or GPS Coordinates

Structure Replacement Bridge & Major Culvert (> 20' span)	Length (ft)	Width (ft)	Depth (ft)	Unit	Unit Cost	Quantity	Cost
Bridge Replacement				SF	$ 150.00	0	$0.00
Culvert Replacement - Dimensional LRFD				LF	$ 1,200.00	0	$0.00
					Est'd Cost Str Replace		$0

Structure Repair/Rehabilitation Bridge & Major Culvert (> 20' span)	Length (ft)	Width (ft)	Depth (in) Depth (ft)	Unit	Unit Cost	Quantity	Cost
FIBA Polymer Bridge Deck				TN	$ 149.00	0	$0.00
FIBA Plate Bridge Deck				TN	$ 81.00	0	$0.00
Waterproofing Membrane				SY	$ 15.72	0	$0.00
Approach Slab Replacement				SY	$ 44.00	0	$0.00
Expansion Joint				LF	$ 228.75	0	$0.00
Repair of Deck Overlay				CY	$ 327.86	0	$0.00
Cut Surface Preparation				CY	$ 29.79	0	$0.00
Patch Repair (Deck)				CY	$ 95.00	0	$0.00
Bridge Drains				EA	$ 3,430.00	0	$0.00
Concrete Repair				CY	$ 508.36	0	$0.00
Epoxy Coating				LB	$ 1.02	0	$0.00
Substructure Repair				CY	$ 14.00	0	$0.00
Cut Slope				CY	$ 97.00	0	$0.00
					Est'd Cost Bridge Repair		$0

Walls	Length (ft)	Width (ft)	Depth (ft)	Unit	Unit Cost	Quantity	Cost
Wing Walls				SF	$ 47.00	0	$0.00
MSE Walls				SF	$ 25.68	0	$0.00
Retaining Walls (Cantilever, Counterfort, Etc.)				SF	$ 150.00	4,500	$675,000.00
Cut Retaining (Type I)				CY	$ 30.00	0	$0.00
Mechanically Stabilized Earth				CY	$ 95.00	0	$0.00
Reinforcing Steel				LB	$ 1.02	0	$0.00
							$0.00
					Estimated Cost Walls		$675,000

Drainage	Length (ft)	Width (ft)	Depth (ft)	Unit	Unit Cost	Quantity	Cost
Pipe Removal				LF	$ 96.00	0	$0.00
Inlet Type II (4 Foot)				Each	$ 3,900.00	0	$0.00
18 Inch Reinforced Concrete Pipe				LF	$ 60.00	0	$0.00
24 Inch Reinforced Concrete Pipe				LF	$ 84.00	0	$0.00
18 Inch Corrugated Steel Pipe				LF	$ 90.00	0	$0.00
18 Inch Reinforced Steel Pipe				LF	$ 84.00	300	$25,200.00
24 Inch Reinforced Steel Pipe				LF	$ 120.00	0	$0.00
24 Inch Corrugated Steel Pipe				LF	$ 217.00	0	$0.00
30 Inch Corrugated Steel Pipe				LF	$ 250.00	0	$0.00
36 Inch Reinforced Steel Pipe				LF	$ 275.00	0	$0.00
					Estimated Cost Drainage		$25,200

Misc Items	Length (ft)	Width (ft)	Depth (ft)	Unit	Unit Cost	Quantity	Cost
Erosion Prevention (Seed & Fertilizer)				SY	$ 36.54	0	$0.00
Guardrail - W-Type Type (Steel Spacing)				LF	$ 20.00	1,800	$36,000.00
Guardrail Type III				LF	$ 115.00	0	$0.00
Guardrail Removal				LF	$ 9.00	0	$0.00
Concrete Barrier				LF	$ 2.42	0	$0.00
Remove Concrete Barrier				LF	$ 16.86	0	$0.00
Mailbox Delete				SF	$ 5.76	0	$0.00
Chain Link Fence (Remove)				LF	$ 12.00	0	$0.00
Sidewalk				SY	$ 38.16	0	$0.00
Bike Path				SY	$ 38.16	0	$0.00
Traffic Signals				EA		0	$0.00
Wire Fence				LF	$ 5.00	0	$0.00
Embedment Delete Type I				EA	$ 1,503.00	0	$0.00
Metal Beam Type I				LF			$ -
Pipe Underdrain				EA			$ -
Delineator (Type I)				EA			$ -
Delineator (Type III)				EA			$ -
Paving Asphalt				Gal			$ -
Emulsified Asphalt (Miscellaneous)				Gal	$ -	-	$ -
Concrete Barrier				LF			$ -
Work Allowance				Dol	$ -	-	$ -
							-
					Estimated Cost Misc		$36,000

Permanent Repair Project Cost Estimate

Project Location:			Initials	CCG
[illegible] Road	007A		Date	3.31.14
Begin MP	19.00	or GPS Coordinates		
End MP	33.00			
County	Boulder			

			Total Major Items		$5,636,600
			A Total of Major Items excpet Debris Removal		$5,636,600
B = General Construction Items			Major Item Cost		
B-1 Erosion Control		* 10.0%	of A		[illegible]
B-2 Mobilization		6.0%	of A		[illegible]
B-3 Signing & Striping		2.0%	of A		[illegible]
B-4 Traffic Control		7.0%	of A		[illegible]
B-5 Public Information		0.5%	of A		[illegible]
B-6 Construction Survey		3.0%	of A		[illegible]
B-7 TOTAL OF B					[illegible]
B TOTAL OF A+B				$	7,243,031.00
C-1 Environmental Assessment		10.0%	of B		[illegible]
C TOTAL OF A+B+C				$	7,967,334.10
D-1 Force Account - Mobilization		10.0%	of C		[illegible]
D TOTAL OF A+B+C+D				$	8,764,067.51
E-1 Minor Contract Revisions	**	5.7%	of D		[illegible]
E TOTAL OF A+B+C+D+E				$	9,264,067.51
F-1 Contingencies		20.0%	of E		[illegible]
F TOTAL OF A+B+C+D+E+F				$	11,116,881.01
G-1 Right of Way			Estimated Amount Inserted ------->		[illegible]
G TOTAL OF A+B+C+D+E+F+G				$	11,616,881.01
H-1 Design Engineering		15.0%	of G		[illegible]
H-2 Construction Engineering		10.0%	of G		[illegible]
H-3 Indirects		11.0%	of G+H-1+H-2		[illegible]
H-4 TOTAL OF H					[illegible]
H TOTAL OF A+B+C+D+E+F+G+H				$	16,118,422.40
I TOTAL PROJECT COST Line H (Rounded)				$	16,118,500.00

[illegible]

[illegible]

* 10% was used for Erosion Control due to the proximity to the river and project size

** MCR was capped at $500k, resulting in a decrease in percentage from 12% to 5.7%

Notes/Assumptions Comments by Field Assessment Team

PRINT NAMES OF ALL REPRESENTATIVES PRESENT FOR THIS ASSESSMENT - Approximate scope and quantities have been reviewed

Carin Groh, EIT

APPENDIX B – SH 7A CANYON DAMAGE PRESENTATION