HYDROLOGY AND HYDRAULICS REPORT

US 24 MM 379.292
East of Limon, Co.
Bridge G-22-CD

Prepared For:

CDOT Region 1 – Limon Residency
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January 2009

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CDOT Region 1 Hydraulics

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1.0 Introduction

1.1 Background

CDOT project BRS R100-156 sub account 16818 on US 24G over an un-named draw will replace the 75 year old existing bridge structure number G-22-J. The report discusses the analysis of the bridge hydraulic conditions and also presents the final design and scour analysis for the new structure G-22-CD over un-named draw.

1.2 Site Location

The existing structure No. G-22-J over un-named draw is located at MM 379.292 on US 24 approximately 1 mile east of Limon. Limon Municpal Airport is directly adjacent to US 24 and located immedietly to the north and slightly west of the project. The eastern most part where the runways are located runs parallel to the upstream segment of the un-named draw.

The existing structure is a three span timber bridge that is 30 feet in width and approximately 71 ft in length that was built in 1934. The legal location is Township 9 South, Range 56 W, and Section 16. Limon is approximately 90 miles west of the Kansas border and 85 miles southeast of Denver. See Figure 1-1 Site Map Location.

Figure 1-1 Site Map Location

2.0 Hydrology

2.1 Basin Drainage Description

The land use for this area is primarily agricultural with interspersed range land. The terrain is gently sloping with grades between 1-3%. The areas along the main channel have pockets of vegetation consisting mostly of forbs and grasses. A stand of 8-10 cottonwood trees form downstream of the bridge and are interspersed in and along the channel.

2.2 Basin and Channel Description

The drainage basin area for un-named draw is approximately 6.63 square miles. The un-named draw flows from the north to the south. The water from the un-named draw flows south and joins with Lake Creek and flows under the Railroad and then further south down under I-70. Water flows from north to south and runoffis intermittent and is a result of mostly intense summer thunderstorms.

The channel is very defined with widths ranging from 100 ft just upstream of the bridge to 75 ft as you go further downstream from the highway to the RR bridge. Channel longitudinal slopes in the basin average 0.5%. Elevations in the drainage basin range from 5700 ft at the most upstream point to 5350 ft at the bridge crossing. Channel length upstream is approximately 6 miles long.

2.3 Precipitation and Climate

Climate is semi-arid with the average yearly rainfall at approximately 15 inches with 75% of that occurring during the summer months. Intense storm events typically occur from May through September over relatively small areas with their duration being fairly short. The average annual snowfall is approximately 25 inches. The temperature ranges from a high of 104° F to a low of -30° degrees F. The mean daily temperature is 47.1° F. NOAA Point rainfall values for the area are listed in Table 2-1 below.

Table 2-1 NOAA Point Rainfall

Recurrence Interval	**6-hour Duration** inch	**24-hour Duration** inch
10 year	2.37	2.90
50 year	3.22	3.95
100 year	3.60	4.41
500 year	4.53	5.55

2.4 Soils

The soils in this area are mostly clay loams. From the CDOT *Final Geotechnical Report US 24 G-22-J Bridge Replacement* by Steve Laudeman, the D50 of material near the existing bridge is 0.10 mm while the D90 is 3.75 mm. This is an average from two samples taken around the bridge. The soils in the area as classified by USGS Web Soil Survey as: 1) Midway-Razor Clay loams on 5-15% slopes at 26.1 %, 2) Fort Collins-Razor on 5-15% slopes at 24.7%, 3) Manzanst Clay Loams on 1- 5% slopes at 19.3%, 4) Shingle-Midway complex on 1-9% slopes at 5.7%, 5) Nunn-Sampson on 0-3% slopes at 4.1% and finally 6) Fort Collins Karval on 5-25% slopes at 3.8%. The soil information presented here is from the NRCS website - Web Soil Survey section. See Appendices for additional information on soil types in the area.

2.5 Flood History

The existing US 24 roadway spans across the entire channel and roadway height above the thalweg (invert of the channel) is approximately on average 10-12 ft. The channel and floodplain just upstream of the bridge is approximately 100 ft across. Farther upstream in the basin the channel opens out in to wide floodway that is several hundred feet in width.

As discussed above, flooding on eastern streams is common during the months of May through September. Flooding is typically the result of short high intensity thunderstorms. Flooding has occurred in the area in 1900, 1933, 1937, 1948 and 1958 from information obtained from local residents. The Big Sandy Creek has a 312 square mile drainage basin that has had large floods occurring in 1921, 1927, 1933, 1937, 1946, 1950, 1954, 1956 and 1965. CDOT Maintenance personnel have stated they had not observed high flows or flows that approached .the elevation of the roadway at the existing bridge structure.

2.6 Design Discharge

2.6.1 Major Structure

The drainage basin was delineated manually using a Planix Tamaya digital planimeter along with several United State Geological Survey (USGS) 7.5 minute quadrangle maps. The maps included the Limon and Genoa, Co. USGS quadrangles.

One hydrological method was used, *Analysis of the Magnitude and Frequency of Floods in Colorado* by J.E. Vaill, *USGS Regression Equations-2000* to determine flood frequency flows. Per CDOT Drainage Design Manual criteria, the 50 year frequency design was selected. The basis for selecting the 50 yr frequency is 1) a two lane rural road and 2) the design flow is less than 4000 cfs. A summary of the hydrological information is provided in Table 2-2 Recurrence Interval vs Discharge below.

Table 2-2 Recurrence Interval vs. Discharge

Recurrence Interval	**Discharge**	**Comment**
Year	Cubic feet per second	
5	420	Detour Culvert
10	780	Stormdrain design
25	1530	
50	2345	Bridge opening design
100	3420	Roadway overtopping
500	7255	Scour analysis

2.6.2 Minor Drainage

The hydrologic analysis to determine design discharges for the temporary detour culvert sizing are based on the method in CDOT's research report *Detour Drainage Structure Design Procedure* by Dr. Albert Molinas from CSU. This research report was developed for CDOT in March, 2005. The Rational Detour Drainage Structure Design (DDSD) method was selected for this project's detour culvert design. The procedure uses the monthly distribution of runoff during the service life of the project to achieve a cost efficient design. Design tables are provided for estimating monthly peak precipitation for rainfall stations across Colorado. Information from these tables can be input into the SCS TR-55 method to obtain peak discharges.

2.6.3 Bridge Deck Drainage

Runoff from the bridge decks was analyzed with HEC-21 *Design of Bridge Deck Drainage*. Design discharges are calculated using the Rational Method. Runoff coefficients were selected from the Urban Drainage and Flood Control District's (UDFCD) *Urban Storm Drainage Criteria Manual Criteria Number 1.* Rainfall intensities are calculated by constructing an Intensity Duration Curve (IDF) as described by method in the *National Oceanic Atmospheric Atlas (NOAA) Atlas 2 – Precipitation Frequency Atlas of the Western United States Volume 11-Colorado*. Precipitation maps were obtained from the Western Regional Climate Center (WRCC) website. The Rational Method is applicable for basins less than 160 acres. Since the structure length is relatively short at about 75 ft there is no need for inlets on the bridge. Embankment protectors may be necessary at the low ends of the structure.

3.0 Existing Structure

3.1 Structure G-22-J, Un-named Draw

The existing bridge is a 71 ft timber structure that spans the the channel. It is a 5 span timber stringer and timber deck (TSS) with railings that was built in 1934. According to the Region 1 Bridge unit the existing timber structure is structurally deficient and is on the FHWA Select List. The new structure will have increased capacity with the roadway having (2)-12 ft lanes with (2)-6 ft paved shoulders. Structure G-22-J will be replaced with the new structure G-22-CD.

There is approximately 10-12 ft of clearance between the thalweg of the creek and the low girder of the existing structure. Additional information is provided in the Design Discussion section below.

4.0 Design Discussion

4.1 Basis for Design Frequency

4.1.1 Major Structure

The 50-year frequency discharge was selected for the design. This frequency was selected based on criteria from the CDOT *Drainage Design Manual*. The proposed structure is to conform to FEMA regulations for sites covered by the National Flood Insurance Plan (NFIP). For those sites the hydraulic design must provide adequate freeboard for the 100 yr discharge without increasing the water surface elevation by more than 1 ft.

The US 24 East of Limon bridge G-22-J location is not a mapped area by FEMA. The *CDOT Drainage Design Manual* states that for sites not covered by NFIP "increases in backwater greater than 1 ft are acceptable if there is adequate justification showing the design is the only practical alternative and the design will only cause minimal impacts." The existing structure appears to have adequate capacity based on field inspections as there isn't any evidence of scour or erosion upstream or downstream of the structure in the channel.

4.2 Major Structure

4.2.1 Hydraulic Analysis

The hydraulic analysis software for the bridge opening that was used is the Hydrologic Engineering Center (HEC) - River Analysis System (HEC-RAS) hydraulic software vs. 3.1.2. HEC-RAS is used to evaluate alternative waterway opening sizes, predict water surface elevations and backwater depths, and determine outlet velocities and roadway overtopping depths. The HEC-RAS model in this situation for sub-critical flow assumes a normal water surface elevation (or slope) at a downstream location. Topographical drawing files were provided by CDOT survey unit in Microstation from which channel cross sections were constructed. The Limon roadway design group cut cross sections for the entire length of the channel 1200 ft upstream and downstream.

Scour analysis and riprap design was performed by analyzing the worst case scenario from among the 50, 100 and 500 year flood flow frequencies. All scour and riprap calculations were performed in accordance with FHWA's HEC-18 *Evaluating Scour at Bridges* 4th Ed. 2001. Hydraulic variables for scour were calculated using HEC-RAS.

4.2.2 Structure G-22-J

Please see Table 4-1 Hydraulic Information**.** For additional information please see HEC-RAS Standard Tables in the Appendices.

Table 4-1 Hydraulic Information

	Frequency Design	**Flow cfs**	**Water Surface**	**Thalweg**	**Free board**	**Low Girder**
Natural	50	2350	5340.72	5335		
None	100	3425	5341.8	5335		
Existing	50	2350	5340.72	5335		
71 ft	100	3425	5341.8	5335		
Proposed	50	2350	5341.58	5335	2.12	5343.7
75 ft	100	3425	5342.72	5335	0.98	5343.7

Scour has been estimated based on guidance provided in the FHWA Hydraulic Engineering Circular Number 18 (HEC 18) *Evaluating Bridge Scour at Bridges.* The publication recommends estimating potential scour from flow contraction as well as from flow interaction with abutments and piers. Scour results are provided in Table 4-2 Existing - Predicted Scour.

Table 4-2 Existing - Predicted Scour

Recurrence Interval	Contraction	Abutment	Pier	Total
yr	ft	ft	ft	ft
50	2.32	23.19	13.08	25.51
100	2.31	24.85	16.95	27.16
500	3.90	27.46	21.26	31.36

Scour calculations are conservative in that they assume the scoured material at the surface is representative of the entire depth of material. This is not what happens in the real world because as you go deeper beneath the soil greater scour resistant material is encountered.

4.3 Minor Drainage

4.3.1 Bridge Deck Drainage

Runoff from the bridge was analyzed with methods from HEC-21 *Design of Bridge Deck Drainage*. No inlets are required on the bridge deck as water depths and spread-width criteria are not exceeded. All runoff will be collected at the corners of the structure by embankment protectors. This runoff should not be discharged directly to the creek but allowed to flow overland if at all possible. D50 nine inch riprap will be required at the pipe outlets (or asphalt) of the embankment protectors.

5.0 Design Recommendation

5.1 Structure G-22-CD Unnamed Draw

A new one span bridge structure with a 75 ft opening width will be constructed over the un-named draw. The new structure will have vertical abutments.

5.1.1 Scour Recommendations

Since the new structure is clear span and will not have piers the combined scour includes only contraction and abutment scour values. Due to the high predicted theoretical scour at both abutments we recommend going down into bedrock with the foundations beyond the theoretical calculation of 22.2 ft depth of scour for the 500 year frequency flood interval. See Table 5-1 Proposed – Predicted Scour.

Table 5-1 Proposed – Predicted Scour

Recurrence Interval	Contraction	Abutment	Pier	Total
yr	ft	ft	ft	ft
50	1.71	-	-	1.71
100	1.63	-	-	1.63
500	2.53	19.69	-	22.22

5.2 Stormwater Management

This project site is along US 24 approximately 1 mile East of Limon. This area is outside of the Phase II Municipal Separate Storm Sewer System (MS4) area. Therefore it does not require stormwater detention or permanent stormwater quality features to be implemented. Approved CDOT water quality Best Management Practices (BMPs) that address temporary erosion and sediment control will be implemented. Those may include erosion hay bales, erosion logs, silt fencing, soil retention blankets. Temporary stabilization along revegetation will be used during construction. The location of these items will be included in the Stormwater Management Plan (SWMP) that will be prepared by Environmental Programs Branch Region 1 Landscape Architect. In order to comply with Colorado Department of Health and Environment (CDPHE) requirements (disturbance greater than or equal to 1 acre) Region 1 may need to apply for coverage under the Construction Stormwater Permit (CSP).

6.0 Summary

An existing 3 span 71 ft long timber bridge Structure No. G-22-J that was built in 1934 is located approximately 1 mile east of Limon Colorado at MM 379.292 and will be replaced. The bridge will be replaced with a one span 75 ft long structure. According to FHWA the structure is identified as scour critical and as such is on the Plan of Action Scour Critical list for Region 1. As part of the scour critical plan of action R1 Hydraulics is recommending that the bridge abutment foundations be taken down below the calculated scour depth of approximately 22.5 ft.

7.0 References

1. ***CDOT Drainage Design Manual*** CDOT Staff Hydraulics Unit 2004.

2. ***CDOT Field Log of Structures*** CDOT Staff Bridge Unit May 2005.

3. ***Detour Drainage Structure Design Procedure.*** Dr. Albert Molinas Hydrau-Tech. March 2005.

4. ***Flood Insurance Study (FIS) Town of Limon*, Colorado**. Lincoln County. FEMA. 1984.

5. ***Geotechnical Report US 24 for Structure G-22-J*** Steve Laudeman CDOT Material and Geotechnical Section December 2008.

6. ***HEC-18 Evaluating Scour at Bridges*** 4th Ed. 2001 FHWA.

7. ***HEC-21 Design of Bridge Deck Drainage*** May 1993 FHWA.

8. ***Hydrologic Engineering Center – River Analysis System*** (HEC-RAS) manual and software vs. 3.1.2. www.hec.usace.army.mil.

9. ***NOAA Atlas 2 – Precipitation Frequency Atlas of the Western United States Volume II – Colorado*** by J.F. Miller, R.H Frederick and R. J. Tracy 1973.

10. ***Structure Selection Report for Structure G-22-J on SH 24 at MP 379.476 Over a Draw***, CDOT Staff Bridge by Teddy Meshesha. December 2008.

11. ***Urban Storm Drainage Criteria Manual No. 1.*** Urban Drainage and Flood Control District Denver, Co. 1999.

APPENDICE

1.0 Scour Critical POA

SCOUR CRITICAL BRIDGE - PLAN OF ACTION

1. GENERAL INFORMATION

Structure number: G-22-J	**City, County, State:** Limon, Lincoln County, Colorado	**Waterway:** Un-named Draw
Structure name: ______	**State highway or facility carried:** 0024G	**Owner:** CDOT

Year built: 1934	**Year rebuilt:** 0	**Bridge replacement plans (if scheduled):** 2010 **Anticipated opening date:** 2011

Structure type: ☒ Bridge ☐ Culvert
Structure size and description: 71 ft - Treated Timber Stringer with Timber Deck

Foundations: ☒ Known, type:Timber Pile Depth: ☐ Unknown

Subsurface soil information (*check all that apply*): ☒ Non-cohesive ☐ Cohesive ☐ Rock

Bridge ADT: 2400	**Year/ADT:** 2005	**% Trucks:** 7

Does the bridge provide service to emergency facilities and/or an evacuation route (Y/N)? N
If so, describe:

2. RESPONSIBILITY FOR POA

Author(s) of POA (name, title, agency/organization, telephone, pager, email):
Alfred Gross, Hydraulic Engineer PE for Region 1 Colorado Department of Transportation, 720-497-6927-Alfred.Gross@DOTState.Co.US
Date: September 15, 2009

Concurrences on POA (name, title, agency/organization, telephone, pager, email):
Amanullah Momandi, PE 2, State Hydraulic Engineer, Staff Hydraulics, Colorado Department of Transportation Denver Colorado 303-757-9044

POA updated by (name, title, agency, organization): Alfred Gross **Date of update:** September 15, 2009
Items update: POA

POA to be updated every 24 **months by (name, title, agency/organization):** Alfred Gross

Date of next update: September, 2011

3. SCOUR VULNERABILITY

a. Current Item 113 Code: ☒ 3 ☐ 2 ☐ 1 Other: ______

b. Source of Scour Critical Code: ☐ Observed ☐ Assessment ☒ Calculated Other: ______

c. Scour Evaluation Summary:

d. Scour History:

4. RECOMMENDED ACTION(S) (see Sections 6 and 7)

	Recommended		Implemented	
a. Increased Inspection Frequency	☐ Yes	☒ No	☐ Yes	☐ No
b. Fixed Monitoring Device(s)	☐ Yes	☒ No	☐ Yes	☐ No
c. Flood Monitoring Program	☒ Yes	☐ No	☐ Yes	☐ No
d. Hydraulic/Structural Countermeasures	☒ Yes	☐ No	☐ Yes	☐ No

5. NBI CODING INFORMATION

		Current	Previous
Inspection date			
Item 113	Scour Critical	3	3
Item 60	Substructure	5	5
Item 61	Channel & Channel Protection	8	8
Item 71	Waterway Adequacy	8	8
Comments: (drift, scour holes, etc. - depict in sketches in Section 10)		_____	_____

6. MONITORING PROGRAM

☒ **Regular Inspection Program** ☐w/surveyed cross sections
Items to Watch: water level

☐ **Increased Inspection Frequency of __ mo.** ☐w/surveyed cross sections
Items to Watch: _____

☐ **Underwater Inspection Required**
Items to Watch: _____

☐ **Increased Underwater Inspection Frequency of __ mo.**
Items to Watch: _____

☐ **Fixed Monitoring Device(s)**
Type of Instrument: _____
Installation location(s): _____
Sample Interval: ☐ 30 min. ☐ 1 hr. ☐ 6 hrs. ☐ 12 hrs. ☐ Other: _____
Frequency of data download and review: ☐ Daily ☐ Weekly ☐ Monthly ☐ Other _____
Scour alert elevation(s) for each pier/abutment: _____
Scour critical elevations(s) for each pier/abutment:_____
Survey ties: _____
Criteria of termination for fixed monitoring: _____

☐ **Flood Monitoring Program**
Type: ☒ Visual inspection
☐ Instrument (*check all that apply*):
☐ Portable ☐ Geophysical ☐ Sonar ☐ Other: _____
Flood monitoring required: ☒ Yes ☐ No
Flood monitoring event defined by (*check all that apply*):
☐ Discharge _____ ☐ Stage _____
☒ Elev. measured from low girder-substructure ☐ Rainfall _____ (in/mm) per _____ (hour)
☐ Flood forecasting information: _____
☐ Flood warning system: _____
Frequency of flood monitoring: ☒1 hr. ☐3 hrs. ☐6 hrs. ☐ Other: _____
Post-flood monitoring required: ☐ No ☒Yes, within 1 days
Frequency of post-flood monitoring: ☒Daily ☐Weekly ☐Monthly ☐Other: _____
Criteria for termination of flood monitoring: over 5 ft of Freeboard
Criteria for termination of post-flood monitoring: _____
Scour alert elevation(s) for each pier/abutment: _____
Scour critical elevation(s) for each pier/abutment: _____

Note: Additional details for action(s) required may be included in Section 8.
Action(s) required if scour alert elevation detected (*include notification and closure procedures*): monitor until water recedes
Action(s) required if scour critical elevation detected (*include notification and closure procedures*): _____

Agency and department responsible for monitoring: CDOT Staff Bridge and R1 Maintenance

Contact person (*include name, title, telephone, pager, e-mail*): Terry Hubble LTC OPS 1 - Lincoln Patrol, Office:719-346-7455 and Cell:719-740-1324

7. COUNTERMEASURE RECOMMENDATIONS

Prioritize alternatives below. Include information on any hydraulic, structural or monitoring countermeasures.

☒ **Only monitoring required (see Section 6 and Section 10 – Attachment F)**
Estimated cost $ - Bridge replaced as part of construction project in progress.

☐ **Structural/hydraulic countermeasures considered (see Section 10, Attachment F):**

Priority Ranking — **Estimated cost**

(1) deep foundations into bedrock — $ _____

(2) riprap abutment sideslopes

(3) — _____ $

(4) $ _____

(5) $ _____

Basis for the selection of the preferred scour countermeasure: Consultant recommendation

Countermeasure implementation project type:

☒ Proposed Construction Project ☐ Maintenance Project
☐ Programmed Construction - Project Lead Agency:
☐ Bridge Bureau ☒ Road Design ☐ Other _____

Agency and department responsible for countermeasure program (if different from Section 6 contact for monitoring): _____

Contact person (*include name, title, telephone, pager, e-mail*): _____

Target design completion date: 2011

Target construction completion date: 9/2010

Countermeasures already completed: No

8. BRIDGE CLOSURE PLAN

Scour monitoring criteria for consideration of bridge closure:

☐ Water surface elevation reaches _____ at _____
☒ Overtopping road or structure
☐ Scour measurement results / Monitoring device (See Section 6)
☒ Observed structure movement / Settlement
☐ Discharge: _____ cfs/cms
☐ Flood forecast: _____
☒ Other: ☐ Debris accumulation ☐ Movement of riprap/other armor protection
☒ Loss of road embankment

Emergency repair plans (*include source(s), contact(s), cost, installation directions*): _____

Agency and department responsible for closure: _____

Contact persons (name, title, agency/organization, telephone, pager, email): _____

Criteria for re-opening the bridge: _____

Agency and person responsible for re-opening the bridge after inspection: _____

9. DETOUR ROUTE

Detour route description (route number, from/to, distance from bridge, etc.) - Include map in Section 10, Attachment E. – **Close Road.**

Bridges on Detour Route:

Bridge Number	Waterway	Sufficiency Rating/ Load Limitations	Item 113 Code

Traffic control equipment (detour signing and barriers) and location(s): _____

Additional considerations or critical issues (susceptibility to overtopping, limited waterway adequacy, lane restrictions, etc.) : Not applicable

News release, other public notice (include authorized person(s), information to be provided and limitations): Not applicable

10. ATTACHMENTS

Please indicate which materials are being submitted with this POA:

☒ **Attachment A: Boring logs and/or other subsurface information**

☐ **Attachment B: Cross sections from current and previous inspection reports**

☒ **Attachment C: Bridge elevation showing existing streambed, foundation depth(s) and observed and/or calculated scour depths**

☐ **Attachment D: Plan view showing location of scour holes, debris, etc.**

☐ **Attachment E: Map showing detour route(s)**

☒ **Attachment F: Supporting documentation, calculations, estimates and conceptual designs for scour countermeasures.**

☐ **Attachment G: Photos**

☐ **Attachment H: Other information:** _____

2. Hydrology

Regression Equations-Calculations

Hydrology
US 24 Bridge Replacement

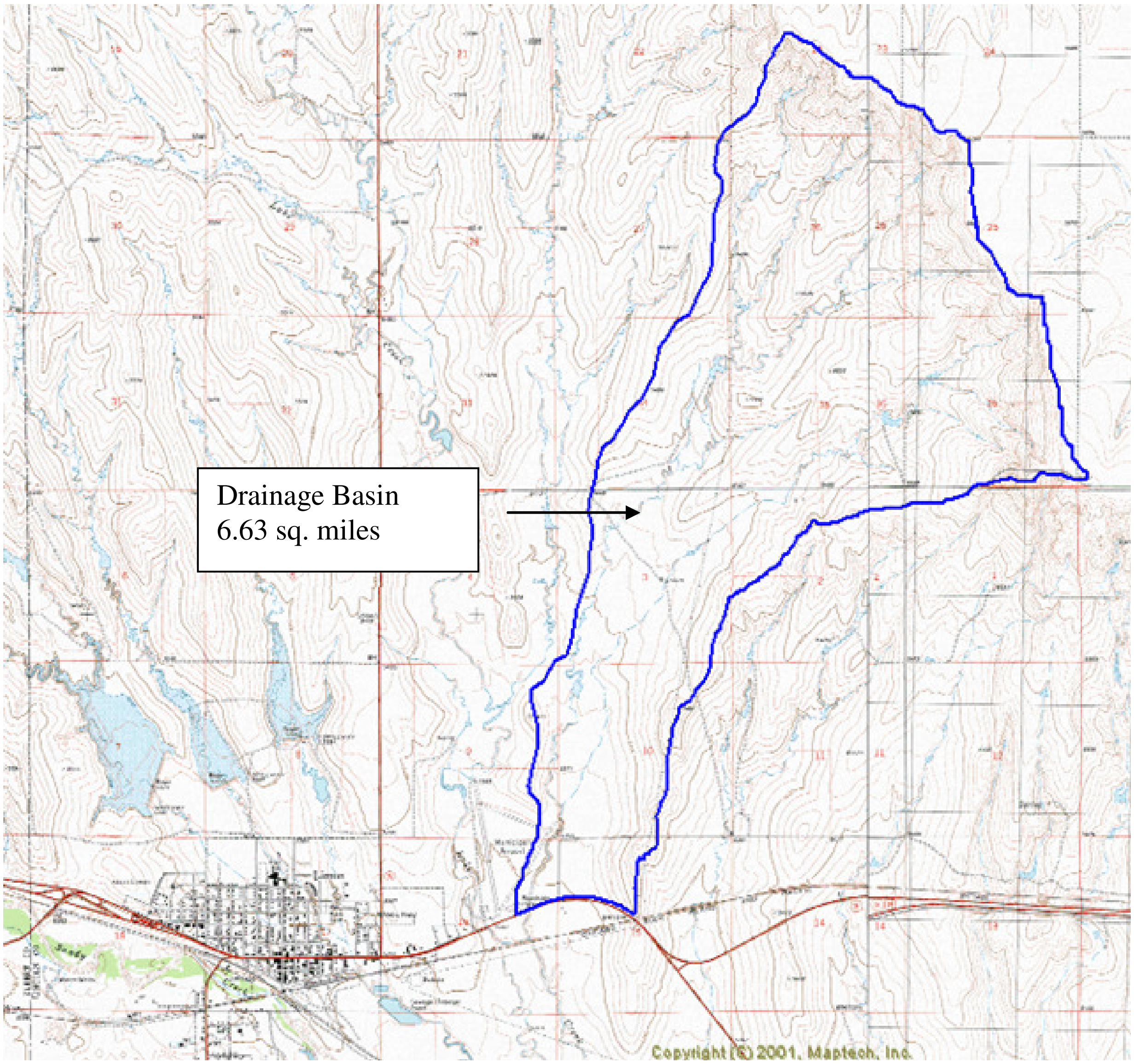
1) Limon & Genoa USGS Maps

Area 1	1366	1377	1377	4120	1373.333
Area 2	2868	2887	2856	8611	2870.333
		Total			4243.67 acres
		Basin Area =			6.63 sq miles

2) Analysis of the Magnitude and Frequency of Floods in Colorado - J.E. Vaill
Regression Equation - Eastern Plains

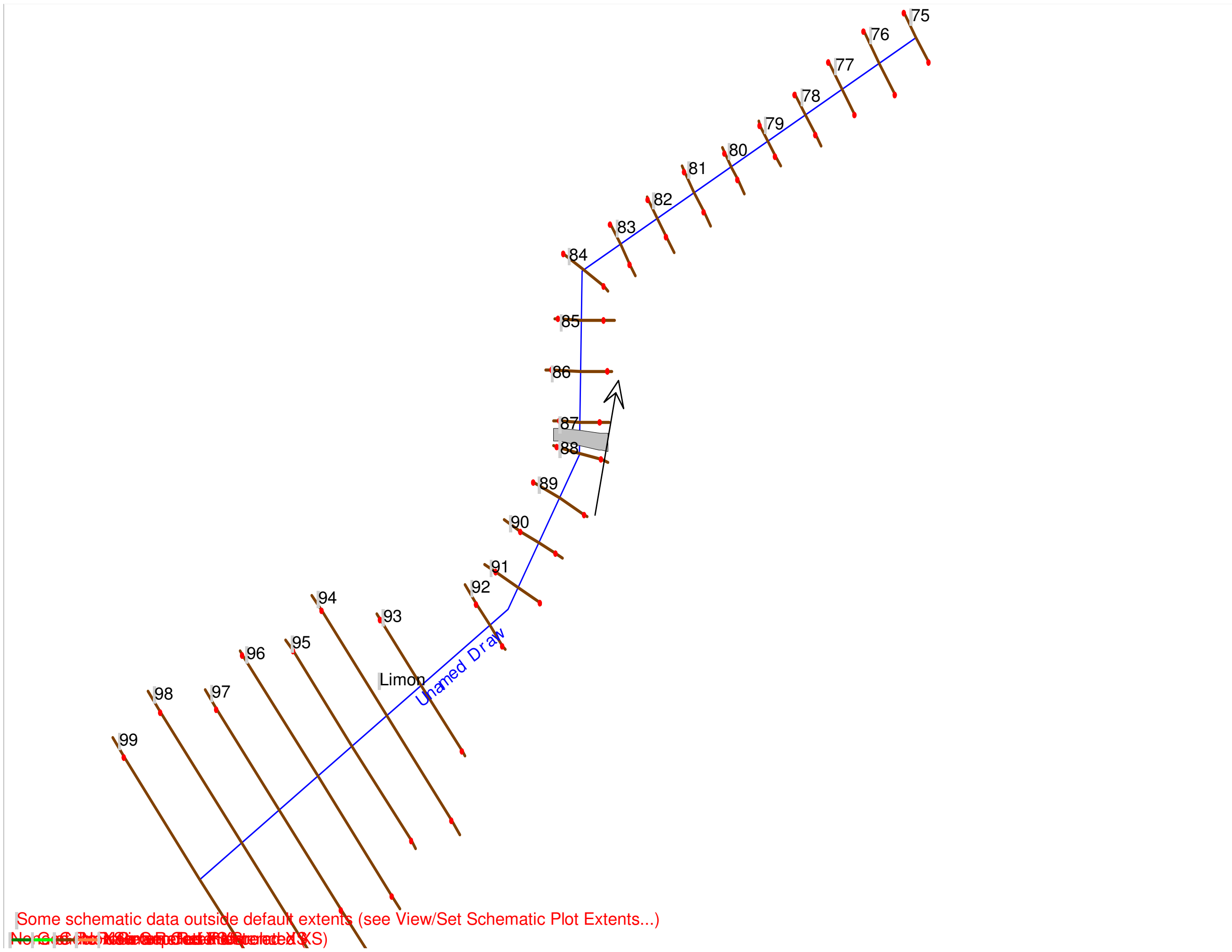
Q5 =	195.8(A)^0.399	
Area	6.630729	
Q5=	416.5006	420 cfs
Q10 =	364.6(A)^0.400	
Area	6.630729	
Q10	777.0361	780 cfs
Q25 =	725.3(A)^0.395	
Area	6.630729	
Q25 =	1530.575	1530 cfs
Q50= 1116(A)^0.392		
Area =	6.630729	
Q50=	2342.698 cfs	2345 cfs
Q100 = 1640(A)^0.388		
Area =	6.630729	
Q100=	3416.722 cfs	3420 cfs
Q500 =	3535(A)^0.380	
Area =	6.630729	
Q500 =	7254.086	7255 cfs

Drainage Basin Map

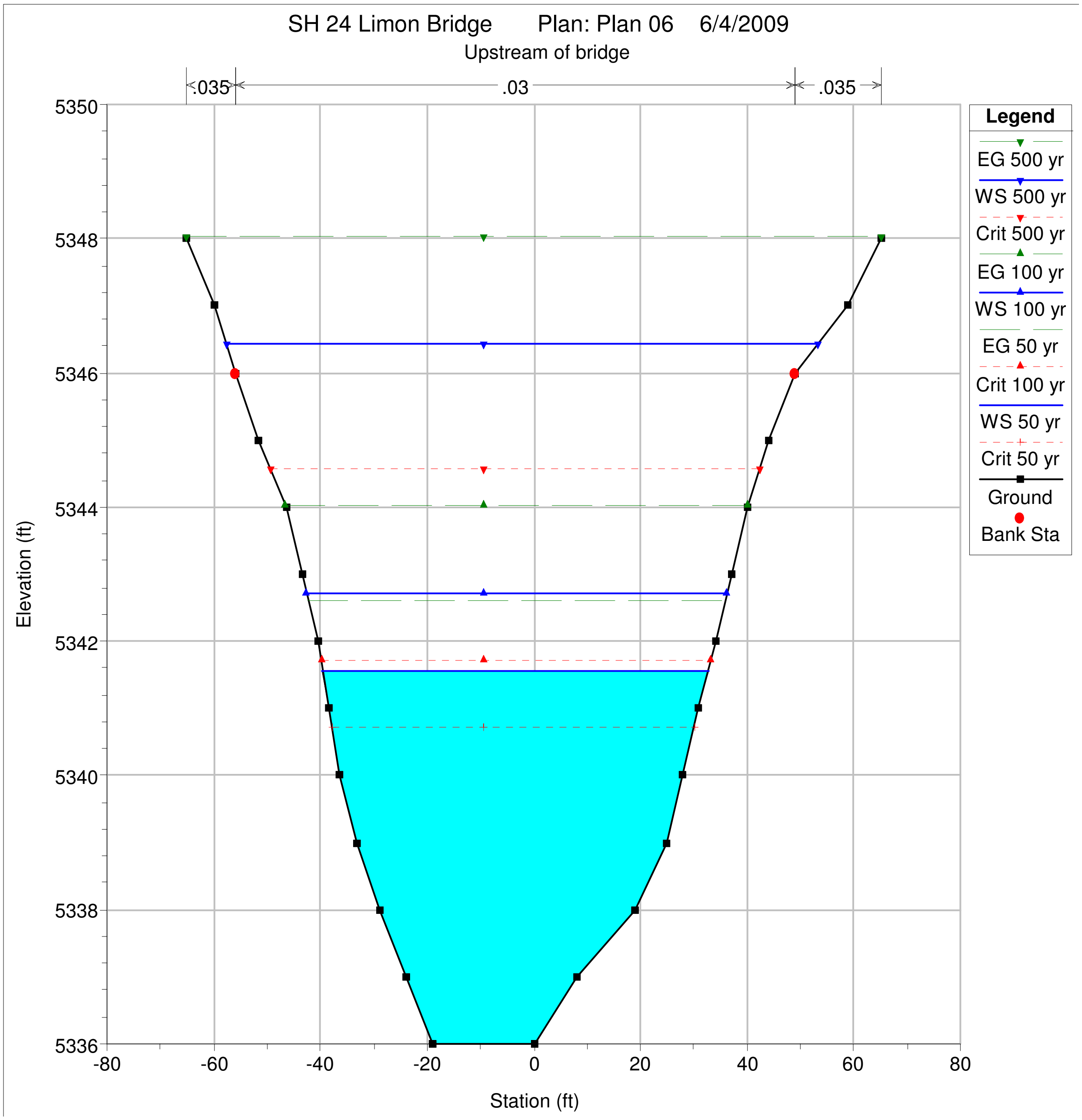


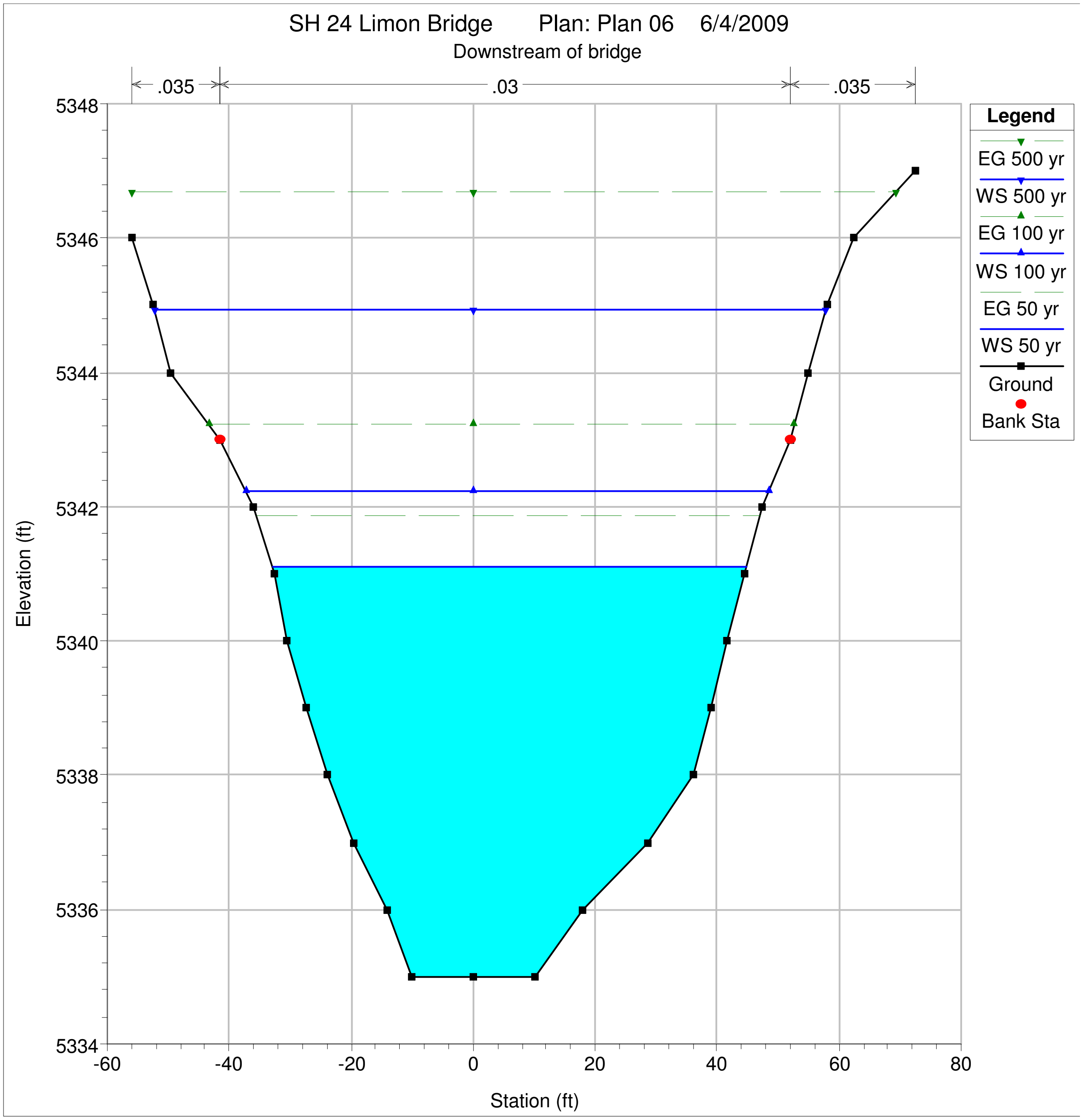
3. Hydraulics

HEC-RAS Input



HEC-RAS Output




SH 24 Limon Bridge Plan: Plan 06 6/4/2009
Downstream of bridge
.035
.03
.035
Legend
EG 500 yr
WS 500 yr
EG 100 yr
WS 100 yr
EG 50 yr
WS 50 yr
Ground
Bank Sta
Elevation (ft)
5348
5346
5344
5342
5340
5338
5336
5334
-60
-40
-20
0
20
40
60
80
Station (ft)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Limon	99	50 yr	2350	5341	5344.79		5344.83	0.000277	1.54	1528.92	606.27	0.17
Limon	99	100 yr	3425	5341	5346.16		5346.19	0.00014	1.46	2369.59	622.89	0.13
Limon	99	500 yr	7250	5341	5349.73		5349.77	0.00007	1.59	4673.85	666.77	0.1
Limon	98	50 yr	2350	5340	5344.8		5344.81	0.000035	0.81	2950.89	673.8	0.07
Limon	98	100 yr	3425	5340	5346.17		5346.18	0.000031	0.9	3881.71	689.98	0.07
Limon	98	500 yr	7250	5340	5349.74		5349.76	0.000028	1.16	6414.32	719	0.07
Limon	97	50 yr	2350	5338	5344.8		5344.81	0.000035	0.86	2959.31	676.75	0.07
Limon	97	100 yr	3425	5338	5346.16		5346.17	0.000031	0.95	3894.5	692.93	0.07
Limon	97	500 yr	7250	5338	5349.73		5349.76	0.000029	1.23	6402.27	703	0.07
Limon	96	50 yr	2350	5337	5344.79		5344.8	0.000029	0.79	3025.61	618.38	0.06
Limon	96	100 yr	3425	5337	5346.16		5346.17	0.000027	0.9	3873.28	623.05	0.06
Limon	96	500 yr	7250	5337	5349.73		5349.75	0.000028	1.21	6113.54	628.5	0.07
Limon	95	50 yr	2350	5337	5344.79		5344.8	0.000037	0.93	2556.31	493.5	0.07
Limon	95	100 yr	3425	5337	5346.15		5346.17	0.000037	1.08	3233.88	499.89	0.07
Limon	95	500 yr	7250	5337	5349.72		5349.75	0.000039	1.47	5036.93	507	0.08
Limon	94	50 yr	2350	5338	5344.79		5344.79	0.000021	0.75	3181.26	562.5	0.05
Limon	94	100 yr	3425	5338	5346.15		5346.16	0.000023	0.89	3955.21	572.5	0.06
Limon	94	500 yr	7250	5338	5349.72		5349.74	0.000026	1.24	6024.81	581	0.07
Limon	93	50 yr	2350	5338	5344.73		5344.78	0.000247	1.94	1211.11	310.07	0.17
Limon	93	100 yr	3425	5338	5346.08		5346.15	0.000202	2.09	1646.1	330	0.16
Limon	93	500 yr	7250	5338	5349.63		5349.73	0.000153	2.58	2857.68	346	0.15
Limon	92	50 yr	2350	5336.42	5343.32	5342.95	5344.53	0.006853	8.83	266.12	82.61	0.87
Limon	92	100 yr	3425	5336.42	5344.83		5345.94	0.004713	8.45	405.93	107.52	0.75
Limon	92	500 yr	7250	5336.42	5348.54		5349.56	0.001959	8.43	952.76	155.67	0.54
Limon	91	50 yr	2350	5335.02	5343.31		5343.95	0.002708	6.39	367.67	91.87	0.56
Limon	91	100 yr	3425	5335.02	5344.82		5345.49	0.002253	6.6	518.98	107.64	0.53
Limon	91	500 yr	7250	5335.02	5348.47		5349.34	0.001515	7.55	1000.43	150.62	0.47
Limon	90	50 yr	2350	5334.69	5342.05		5343.48	0.005843	9.6	244.75	58.13	0.82
Limon	90	100 yr	3425	5334.69	5343.23	5342.7	5345.03	0.006224	10.75	318.51	66.94	0.87
Limon	90	500 yr	7250	5334.69	5346.91	5345.91	5348.98	0.004464	11.56	642.45	127.31	0.78
Limon	89	50 yr	2350	5333.63	5342.27		5342.93	0.001998	6.5	361.63	69.23	0.5
Limon	89	100 yr	3425	5333.63	5343.49		5344.39	0.002437	7.58	451.97	79.84	0.56
Limon	89	500 yr	7250	5333.63	5347.22		5348.36	0.002647	8.59	851.9	147.91	0.6
Limon	88	50 yr	2350	5336	5341.56	5340.71	5342.6	0.004508	8.21	286.11	72.28	0.73
Limon	88	100 yr	3425	5336	5342.72	5341.71	5344.02	0.004419	9.16	374.08	78.83	0.74
Limon	88	500 yr	7250	5336	5346.43	5344.57	5348.02	0.003336	10.12	717.68	111.05	0.68
Limon	87.5		Bridge									
Limon	87	50 yr	2350	5335	5341.09		5341.86	0.002955	7.03	334.21	77.61	0.6
Limon	87	100 yr	3425	5335	5342.23		5343.23	0.003193	8.03	426.3	85.75	0.64
Limon	87	500 yr	7250	5335	5344.92		5346.68	0.003418	10.66	693.58	110.03	0.7
Limon	86	50 yr	2350	5333.73	5340.28	5339.6	5341.37	0.005287	8.39	280.02	77.49	0.78
Limon	86	100 yr	3425	5333.73	5341.54		5342.78	0.004606	8.91	384.23	87.42	0.75
Limon	86	500 yr	7250	5333.73	5344.57		5346.25	0.004397	10.39	697.9	121.59	0.76
Limon	85	50 yr	2350	5332.94	5338.82	5338.77	5340.64	0.008658	10.81	217.41	58.84	0.99
Limon	85	100 yr	3425	5332.94	5340.15	5340.03	5342.11	0.007914	11.25	304.42	72.67	0.97
Limon	85	500 yr	7250	5332.94	5343.55	5342.93	5345.71	0.005565	11.79	622.54	133.53	0.86
Limon	84	50 yr	2350	5332.51	5338.54		5339.82	0.00514	9.09	258.43	61.01	0.78
Limon	84	100 yr	3425	5332.51	5339.78		5341.36	0.005227	10.1	339.27	69.24	0.8

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Limon	99	50 yr	5344.83	5344.79	0.04	0.01	0.01	0.94	2348.47	0.59	606.27
Limon	99	100 yr	5346.19	5346.16	0.03	0.01	0.01	9.83	3409.31	5.86	622.89
Limon	99	500 yr	5349.77	5349.73	0.04	0.01	0.01	91.94	7103.76	54.29	666.77
Limon	98	50 yr	5344.81	5344.8	0.01	0	0	8.97	2329.55	11.48	673.8
Limon	98	100 yr	5346.18	5346.17	0.01	0	0	24.23	3374.69	26.09	689.98
Limon	98	500 yr	5349.76	5349.74	0.02	0	0	125.99	7016.31	107.7	719
Limon	97	50 yr	5344.81	5344.8	0.01	0	0	30.19	2092.99	226.82	676.75
Limon	97	100 yr	5346.17	5346.16	0.01	0	0	60.06	2962.98	401.96	692.93
Limon	97	500 yr	5349.76	5349.73	0.02	0	0	216.12	5954.2	1079.68	703
Limon	96	50 yr	5344.8	5344.79	0.01	0	0	3.87	2328.09	18.04	618.38
Limon	96	100 yr	5346.17	5346.16	0.01	0	0	10.9	3375.51	38.59	623.05
Limon	96	500 yr	5349.75	5349.73	0.02	0	0	40.31	7073.02	136.67	628.5
Limon	95	50 yr	5344.8	5344.79	0.01	0	0	17.3	2329.47	3.22	493.5
Limon	95	100 yr	5346.17	5346.15	0.02	0	0	39.29	3376.53	9.19	499.89
Limon	95	500 yr	5349.75	5349.72	0.03	0	0	137.45	7060.73	51.82	507
Limon	94	50 yr	5344.79	5344.79	0.01	0.01	0	23.69	2310.33	15.99	562.5
Limon	94	100 yr	5346.16	5346.15	0.01	0.01	0.01	49.3	3342.15	33.55	572.5
Limon	94	500 yr	5349.74	5349.72	0.02	0.01	0.01	167.81	6948.41	133.78	581
Limon	93	50 yr	5344.78	5344.73	0.06	0.14	0.12	0.44	2349.56		310.07
Limon	93	100 yr	5346.15	5346.08	0.07	0.11	0.1	6.64	3418.35	0	330
Limon	93	500 yr	5349.73	5349.63	0.1	0.07	0.09	74.35	7147.46	28.2	346
Limon	92	50 yr	5344.53	5343.32	1.21	0.41	0.17		2350		82.61
Limon	92	100 yr	5345.94	5344.83	1.11	0.32	0.13	0.28	3424.72		107.52
Limon	92	500 yr	5349.56	5348.54	1.03	0.17	0.05	580.81	6607.76	61.43	155.67
Limon	91	50 yr	5343.95	5343.31	0.63	0.38	0.08		2350		91.87
Limon	91	100 yr	5345.49	5344.82	0.68	0.35	0.11		3425		107.64
Limon	91	500 yr	5349.34	5348.47	0.87	0.24	0.12	123.22	7121.19	5.59	150.62
Limon	90	50 yr	5343.48	5342.05	1.43	0.32	0.23		2350		58.13
Limon	90	100 yr	5345.03	5343.23	1.8	0.37	0.27		3425		66.94
Limon	90	500 yr	5348.98	5346.91	2.07	0.34	0.28	27.17	7215.16	7.67	127.31
Limon	89	50 yr	5342.93	5342.27	0.66	0.29	0.04		2350		69.23
Limon	89	100 yr	5344.39	5343.49	0.89	0.32	0.04		3425		79.84
Limon	89	500 yr	5348.36	5347.22	1.14	0.3	0.04	9.85	7236.13	4.01	147.91
Limon	88	50 yr	5342.6	5341.56	1.05	0.08	0.12		2350		72.28
Limon	88	100 yr	5344.02	5342.72	1.3	0.08	0.14		3425		78.83
Limon	88	500 yr	5348.02	5346.43	1.59	0.07	0.43	0.32	7248.86	0.82	111.05
Limon	87.5		Bridge								
Limon	87	50 yr	5341.86	5341.09	0.77	0.39	0.1		2350		77.61
Limon	87	100 yr	5343.23	5342.23	1	0.38	0.07		3425		85.75
Limon	87	500 yr	5346.68	5344.92	1.76	0.39	0.04	34.49	7202.59	12.92	110.03
Limon	86	50 yr	5341.37	5340.28	1.09	0.67	0.07		2350		77.49
Limon	86	100 yr	5342.78	5341.54	1.23	0.59	0.07		3425		87.42
Limon	86	500 yr	5346.25	5344.57	1.68	0.49	0.05		7250		121.59
Limon	85	50 yr	5340.64	5338.82	1.81	0.66	0.16		2350		58.84
Limon	85	100 yr	5342.11	5340.15	1.97	0.64	0.11		3425		72.67
Limon	85	500 yr	5345.71	5343.55	2.15	0.56	0.01	0.93	7238.19	10.88	133.53
Limon	84	50 yr	5339.82	5338.54	1.28	0.67	0.06		2350		61.01
Limon	84	100 yr	5341.36	5339.78	1.58	0.66	0.07		3425		69.24
Limon	84	500 yr	5345.14	5343.02	2.11	0.48	0.05		7250		108.3
Limon	83	50 yr	5339.09	5337.19	1.9	0.89	0.01		2350		56.9
Limon	83	100 yr	5340.64	5338.38	2.26	0.82	0		3425		63.82
Limon	83	500 yr	5344.61	5342.65	1.96	0.55	0.13		7174.11	75.89	116.47
Limon	82	50 yr	5338.14	5336.12	2.02	0.4	0.41		2350		51.76

4. Scour

HEC-RAS Output

US 24 E. Limon Bridge
Hydraulic Design Data
Existing 50 yr Scour

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):		5.41	
	Approach Velocity (ft/s):		6.1	
	Br Average Depth (ft):		3.45	
	BR Opening Flow (cfs):		2350	
	BR Top WD (ft):		64.95	
	Grain Size D50 (mm):		0.15	
	Approach Flow (cfs):		2350	
	Approach Top WD (ft):		71.26	
	K1 Coefficient:		0.69	
Results				
	Scour Depth Ys (ft):		2.32	
	Critical Velocity (ft/s):		1.17	
	Equation:		Live	

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Round nose
	Pier Width (ft):	2
	Grain Size D50 (mm):	0.15
	Depth Upstream (ft):	4.39
	Velocity Upstream (ft/s):	7.09
	K1 Nose Shape:	1
	Pier Angle:	90
	Pier Length (ft):	30
	K2 Angle Coef:	5
	K3 Bed Cond Coef:	1.1
	Grain Size D90 (mm):	4
	K4 Armouring Coef:	1
	Set K1 value to 1.0 because angle > 5 degrees	
Results		
	Scour Depth Ys (ft):	23.19
	Froude #:	0.6
	Equation:	CSU equation

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	-40.02	40.01
	Toe Sta at appr (ft):	-45.8	62.04
	Abutment Length (ft):	8.57	4.82
	Depth at Toe (ft):	0.41	-1.83
	K1 Shape Coef:	0.82 - Vert. with wing walls	
	Degree of Skew (degrees):	90	90
	K2 Skew Coef:	1	1
	Projected Length L' (ft):	8.57	4.82
	Avg Depth Obstructed Ya (ft)	5.41	5.41
	Flow Obstructed Qe (cfs):	282.79	159.06
	Area Obstructed Ae (sq ft):	46.35	26.07
Results			
	Scour Depth Ys (ft):	13.08	
	Qe/Ae = Ve:	6.1	
	Froude #:	0.46	
	Equation:	Froehlich	Default

Combined Scour Depths

Pier Scour + Contraction Scour (ft):

Channel: 25.51

Left abutment scour + contraction scour 15.39

US 24 E. Limon Bridge
Hydraulic Design Data
Existing 100 yr Scour

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):		5.8	
	Approach Velocity (ft/s):		7.03	
	Br Average Depth (ft):		4.27	
	BR Opening Flow (cfs):		3425	
	BR Top WD (ft):		69.99	
	Grain Size D50 (mm):		0.15	
	Approach Flow (cfs):		3425	
	Approach Top WD (ft):		84.02	
	K1 Coefficient:		0.69	
Results				
	Scour Depth Ys (ft):		2.31	
	Critical Velocity (ft/s):		1.19	
	Equation:		Live	

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Round nose
	Pier Width (ft):	2
	Grain Size D50 (mm):	0.15
	Depth Upstream (ft):	5.22
	Velocity Upstream (ft/s):	7.88
	K1 Nose Shape:	1
	Pier Angle:	90
	Pier Length (ft):	30
	K2 Angle Coef:	5
	K3 Bed Cond Coef:	1.1
	Grain Size D90 (mm):	4
	K4 Armouring Coef:	1
	Set K1 value to 1.0 because angle > 5 degrees	
Results		
	Scour Depth Ys (ft):	24.85
	Froude #:	0.61
	Equation:	CSU equation

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	-40.02	40.01
	Toe Sta at appr (ft):	-45.8	62.04
	Abutment Length (ft):	10.11	5.69
	Depth at Toe (ft):	1.71	-0.54
	K1 Shape Coef:	1.00 - Vertical abutment	
	Degree of Skew (degrees):	90	90
	K2 Skew Coef:	1	1
	Projected Length L' (ft):	10.11	5.69
	Avg Depth Obstructed Ya (ft)	5.8	5.8
	Flow Obstructed Qe (cfs):	412.15	231.81
	Area Obstructed Ae (sq ft):	58.63	32.97
Results			
	Scour Depth Ys (ft):	16.95	
	Qe/Ae = Ve:	7.03	
	Froude #:	0.51	
	Equation:	Froehlich	Default

Combined Scour Depths

Pier Scour + Contraction Scour (ft):

Channel: 27.16

Left abutment scour + contraction scour 19.26

US 24 E Limon Bridge
Hydraulic Design Data
Existing 500 yr Scour

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	1.66	7.11	1.15
	Approach Velocity (ft/s):	2.07	7.64	1.84
	Br Average Depth (ft):		6.6	
	BR Opening Flow (cfs):		7250	
	BR Top WD (ft):		76.02	
	Grain Size D50 (mm):		0.15	
	Approach Flow (cfs):	21.1	7209.93	18.98
	Approach Top WD (ft):	6.13	132.81	8.97
	K1 Coefficient:	0.59	0.69	0.59
Results				
	Scour Depth Ys (ft):		3.9	
	Critical Velocity (ft/s):		1.23	
	Equation:		Live	

Pier Scour

	All piers have the same scour depth	
Input Data		
	Pier Shape:	Round nose
	Pier Width (ft):	2
	Grain Size D50 (mm):	0.15
	Depth Upstream (ft):	7.87
	Velocity Upstream (ft/s):	8.74
	K1 Nose Shape:	1
	Pier Angle:	90
	Pier Length (ft):	30
	K2 Angle Coef:	5
	K3 Bed Cond Coef:	1.1
	Grain Size D90 (mm):	4
	K4 Armouring Coef:	1
	Set K1 value to 1.0 because angle > 5 degrees	
Results		
	Scour Depth Ys (ft):	27.46
	Froude #:	0.55
	Equation:	CSU equation

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	-40.02	40.01
	Toe Sta at appr (ft):	-45.8	62.04
	Abutment Length (ft):	22.11	17.96
	Depth at Toe (ft):	5.72	3.48
	K1 Shape Coef:	1.00 - Vertical abutment	
	Degree of Skew (degrees):	90	90
	K2 Skew Coef:	1	1
	Projected Length L' (ft):	22.11	17.96
	Avg Depth Obstructed Ya (ft)	5.6	4.13
	Flow Obstructed Qe (cfs):	888.72	506.97
	Area Obstructed Ae (sq ft):	123.78	74.21
Results			
	Scour Depth Ys (ft):	21.26	16.95
	Qe/Ae = Ve:	7.18	6.83
	Froude #:	0.53	0.59
	Equation:	Froehlich	Froehlich

Combined Scour Depths

Pier Scour + Contraction Scour (ft):		
	Channel:	31.36
Left abutment scour + contraction scour		25.16
Right abutment scour + contraction scou		20.84

Hydraulic Design Data
Contraction Scour
Proposed

	Left	Channel	Right	
Input Data				
Average Depth (ft):	0.90	6.35	0.39	
Approach Velocity (ft/s):	1.78	8.59	1.14	
Br Average Depth (ft):		6.12		
BR Opening Flow (cfs):		7250.00		
BR Top WD (ft):	85.06			
Grain Size D50 (mm):		0.15		
Approach Flow (cfs):	9.85	7236.13		4.01
Approach Top WD (ft):	6.13	132.81	8.97	
K1 Coefficient: 0.590	0.690	0.590		
Results				
Scour Depth Ys (ft):		2.53		
Critical Velocity (ft/s):		1.20		
Equation:	Live			

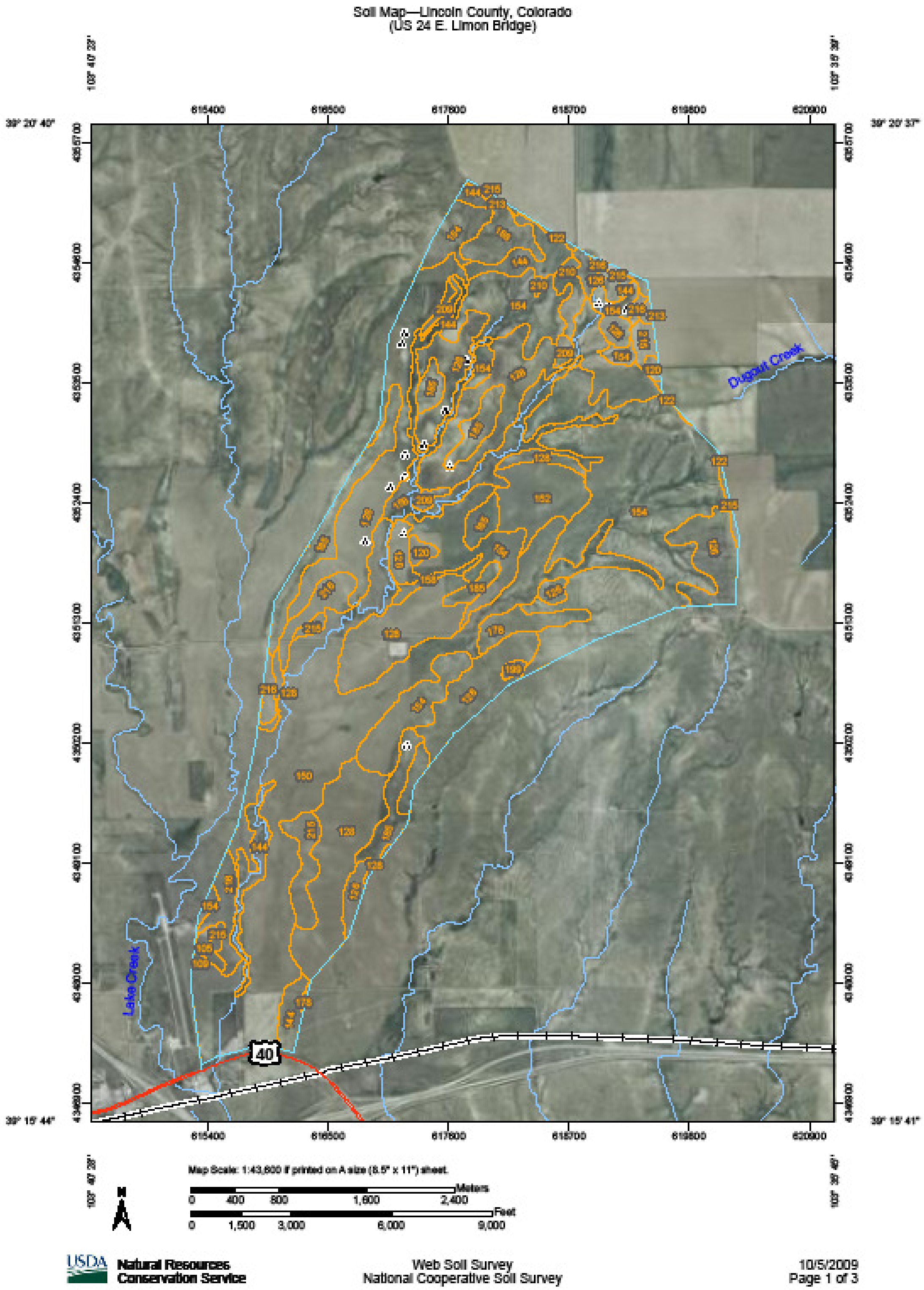
Abutment Scour

	Left	Right
Input Data		
Station at Toe (ft):	-43.01	43.01
Toe Sta at appr (ft):	-48.79	65.04
Abutment Length (ft):	19.12	14.96
Depth at Toe (ft):	3.59	1.68
K1 Shape Coef: 1.00 - Vertical abutment		
Degree of Skew (degrees):	90.00	90.00
K2 Skew Coef: 1.00	1.00	
Projected Length L' (ft):	19.12	14.96
Avg Depth Obstructed Ya (ft):	4.60	2.78
Flow Obstructed Qe (cfs):	717.48	330.52
Area Obstructed Ae (sq ft):	87.96	41.54
Results		
Scour Depth Ys (ft):	19.69	14.49
Qe/Ae = Ve: 8.16	7.96	
Froude #: 0.67	0.84	
Equation:	Froehlich	Froehlich

Combined Scour Depths

Left abutment scour + contraction scour (ft): 22.22
Right abutment scour + contraction scour (ft): 17.02

5. Soils-Web Soil Survey Output



Soil Map–Lincoln County, Colorado
(US 24 E. Limon Bridge)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:43,600 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lincoln County, Colorado
Survey Area Data: Version 7, Apr 30, 2009

Date(s) aerial images were photographed: 7/1/2005; 7/3/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Lincoln County, Colorado (CO073)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
105	Ascalon sandy loam, 5 to 9 percent slopes	12.8	0.3%
109	Ascalon-Haxtun complex, 0 to 3 percent slopes	2.6	0.1%
120	Colby silt loam, 1 to 3 percent slopes	17.6	0.4%
122	Colby-Weld silt loams, 1 to 5 percent slopes	5.3	0.1%
126	Fort Collins-Karval complex, 5 to 25 percent slopes	160.4	3.8%
128	Fort Collins-Razor, moist, complex, 5 to 15 percent slopes	1,054.1	24.7%
144	Kimst loam, 3 to 12 percent slopes	147.3	3.5%
150	Manzanst clay loam, 1 to 5 percent slopes	824.5	19.3%
152	Midway clay loam, moist, 1 to 5 percent slopes	109.1	2.6%
154	Midway-Razor clay loams, moist, 5 to 15 percent slopes	1,115.6	26.1%
158	Nunn-Sampson, rarely flooded, complex, 0 to 3 percent slopes	175.7	4.1%
178	Razor clay loam, moist, 1 to 5 percent slopes	47.9	1.1%
185	Shingle-Midway complex, moist, 1 to 9 percent slopes	243.2	5.7%
188	Travessilla-Rock outcrop complex, 6 to 60 percent slopes	62.5	1.5%
199	Vona sandy loam, 5 to 12 percent slopes	6.4	0.1%
209	Wages loam, 2 to 6 percent slopes	27.8	0.7%
210	Wages loam, 6 to 12 percent slopes	32.0	0.7%
213	Weld silt loam, 0 to 2 percent slopes	7.8	0.2%
215	Wiley silt loam, 0 to 3 percent slopes	100.8	2.4%
216	Wiley silt loam, 3 to 12 percent slopes	115.7	2.7%
Totals for Area of Interest		**4,269.2**	**100.0%**

6. Bridge Hydraulic Information Sheet

Date: November 4, 2008
Revised April 7, 2009

(Construction Project No.)

To: Teddy Meshesha

(P. E. Project No.):
Sub Acc't # 16818

From: Al Gross CDOT Region 1
(Hydraulic Designer)

(Project Name):
U.S. 24, East Side of Limon (G-22-J)

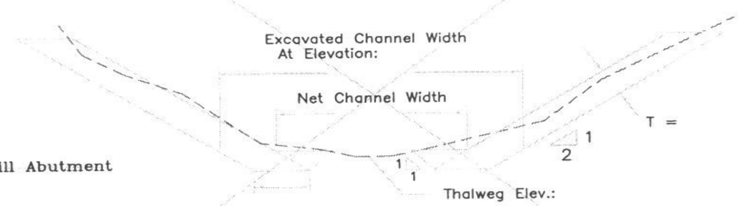
Subject: Transmittal of bridge hydraulic information

Here is the structure opening and hydraulic information required for the bridge across unamed draw on US 24 at/near MM 379.292 just east of Limon .

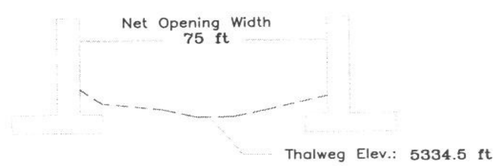
Bridge Information

Existing Structure Number: G-22-J
Station at Centerline of channel: N.A.
Skew: N.A. Minimum Low Girder Elevation: 5343.7 ft

Spill Abutment



Retaining Abutment



Hydraulic Information

D.A. = 6.63 sq. miles
$Q_{(100)}$ = 3425 cfs
HW = 5342.7 ft

$Q_{(50)}$ = 2350 cfs
DHW = 5341.6 ft
OHW = 5336.5 ft.

Please submit to Staff Bridge the information required by Procedural Directive 1905.1 so they may proceed with design. Bridge layout requested: yes ☐ no ☐

Comments: The low girder elevation includes 2.1 ft of freeboard.
There is low potential for debris in the upper basin.

cc: (R1 Bridge Engineer)
(R1 Senior Hydraulics Engineer)