STATE OF COLORADO

DEPARTMENT OF TRANSPORTATION

Region 2 – Hydraulics Unit
South Program
905 Erie Avenue
Pueblo, Colorado 81001
Phone (719) 562-5580
Fax (719) 546-5702

5/11/2009

To: Amanullah Mommandi, M.S.,P.E.
State Senior Hydraulics Engineer
4201 E. Arkansas Ave. Room 290
Denver, CO. 80222
Tel. (303) 757-9044

From: Dennis Cress, P.E., R2 South Hydraulics Engineer

RE: Prioritization of Scour Critical Bridges in Region 2

The Region 2 Inter-disciplinary Team submits this priority of bridges in Region 2 meeting the criteria set forth in the February 5, 2009 Memorandum from Mr. Rick Gabel, Director, Staff Branches, with the Subject: Plan of Action (POA) for Scour Critical Bridges and Bridges with Unknown Foundations.

Attached to this memorandum is the Scour Plan of Action and Recommendations for Structure I-17-EG / EQ . This structure report is attached as a demonstration of the time and effort needed to complete the 86 bridges that have been prioritized for Region 2.

Xc: R2 Program Engineers w/ enclosures
Inter-Disciplinary Team Members w/ enclosures
David L Miller, PE, Resident Engineer w/ enclosures

Enclosures: Interdisciplinary Team Organization Chart

Priority of Region 2 Critical Bridges
POA for I-17-EG / EQ

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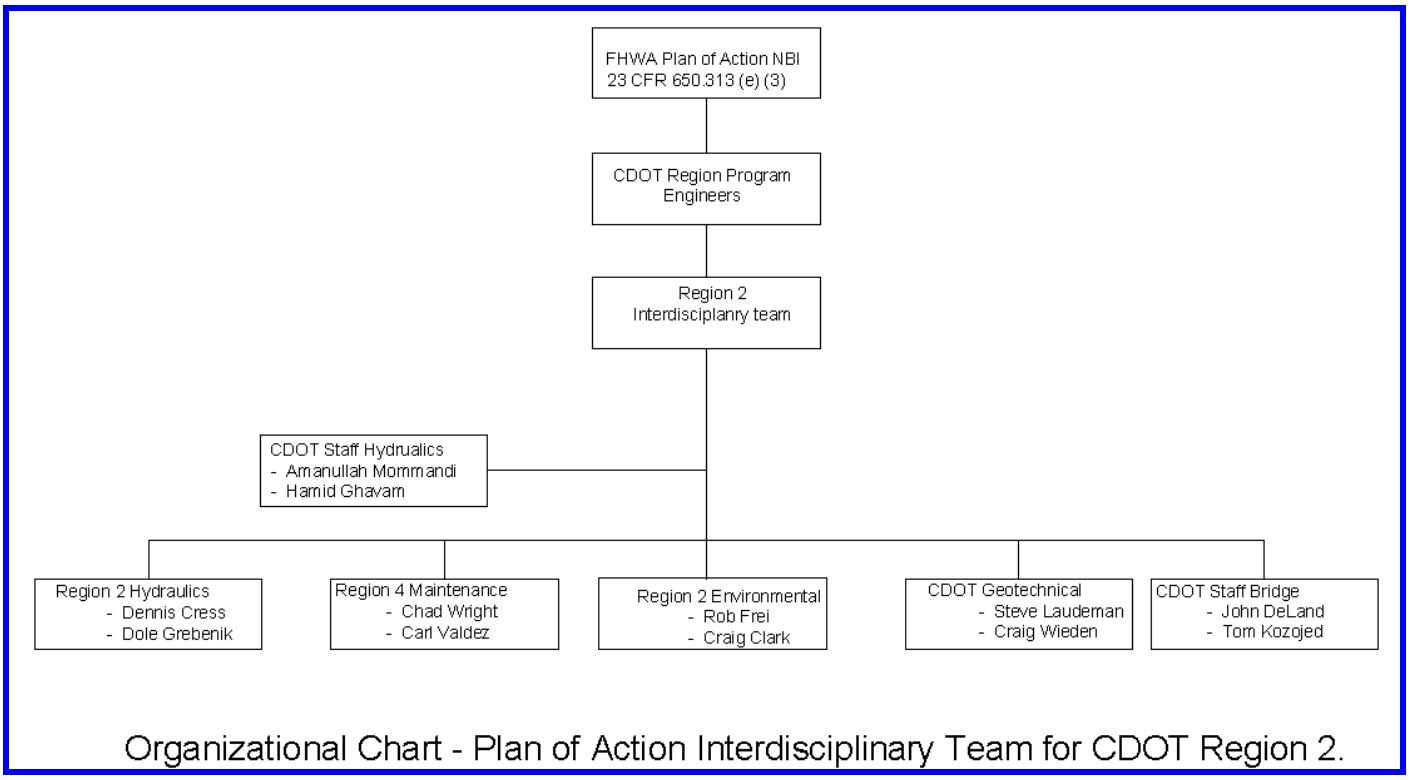


Organizational Chart - Plan of Action Interdisciplinary Team for CDOT Region 2.

Scour Critical Bridge Priority

for

Colorado Department of Transportation - Region 2

Prepared for
FHWA / Colorado Department of Transportation - Region 2

Prepared by the Region 2 Interdisciplinary Team for Scour Critical Bridges and Bridges with Unknown Foundations

May 2009

3. Prioritize the list of scour critical bridges in each Region based on risk level. Consider the following factors for establishing risk level.

- Route classification
- AADT
- Detour length should the structure be closed
- Age of structure
- Condition of structure
- Waterway adequacy
- Schedule for replacing the bridge

DATE: February 5, 2009

TO: Region Program Engineers

FROM: Rick Gabel, Director, Staff Branches

SUBJECT: Plan of Action (POA) for Scour Critical Bridges and Bridges with Unknown Foundations

Reference to procedure used. POA memorandum.

Route Classification and AADT are considered consistent with one another, not changing order, therefore only AADT is used as a factor heading.

priority Equal

rank	aadt	rank	detour length	rank	age	rank	condition	rank	waterway	rank	Replacement	rank
1	H-17-L	1	I-15-AK	1	K-14-X	1	I-18-G	1	K-16-V	1	no data	1
2	H-17-AG	2	P-18-L	2	K-16-X	2	N-16-L	2	M-16-C	2	no data	2
3	I-17-JA	3	J-15-A	3	K-18-R	3	N-17-N	3	J-18-B	3	no data	3
4	I-17-GN	4	M-16-C	4	P-17-H	4	K-18-R	4	L-19-H	4	no data	4
5	I-17-EG	5	N-16-L	5	P-17-L	5	P-17-H	5	K-15-H	5	no data	5
6	I-17-EQ	6	P-17-H	6	L-17-CD	6	L-26-H	6	H-17-L	6	no data	6
7	I-17-JB	7	P-17-A	7	K-16-T	7	H-16-K	7	H-17-AG	7	no data	7
8	I-18-G	8	P-17-K	8	J-18-B	8	H-19-C	8	I-17-JA	8	no data	8
9	J-18-B	9	P-17-L	9	M-23-A	9	O-26-L	9	I-17-EG	9	no data	9
10	I-17-R	10	P-17-J	10	N-16-L	10	N-21-C	10	I-17-EQ	10	no data	10
11	K-18-R	11	N-18-AC	11	I-18-G	11	H-19-B	11	I-17-JB	11	no data	11
12	K-16-B	12	L-24-F	12	M-24-I	12	K-16-Y	12	I-18-G	12	no data	12
13	K-17-H	13	L-24-I	13	P-22-D	13	H-16-L	13	I-17-R	13	no data	13
14	N-17-AM	14	N-21-C	14	P-22-A	14	H-17-AJ	14	K-17-H	14	no data	14
15	M-17-AQ	15	N-28-G	15	J-14-C	15	M-24-I	15	M-17-AQ	15	no data	15
16	K-16-X	16	M-24-I	16	N-17-N	16	I-16-AA	16	K-16-X	16	no data	16
17	L-18-R	17	I-16-AA	17	O-28-F	17	J-18-B	17	L-18-R	17	no data	17
18	K-16-Y	18	O-28-F	18	H-20-Q	18	H-19-A	18	K-16-Y	18	no data	18
19	O-18-BY	19	P-21-G	19	O-28-E	19	L-22-B	19	O-18-BY	19	no data	19
20	O-18-CD	20	P-23-A MINOR	20	M-22-T	20	O-26-I	20	O-18-CD	20	no data	20
21	N-17-N	21	P-22-D	21	H-19-C	21	K-16-V	21	N-17-N	21	no data	21
22	N-17-BN	22	P-22-A	22	H-19-B	22	N-17-BH	22	N-17-B	22	no data	22
23	N-17-B	23	N-28-H	23	H-19-A	23	N-17-BN	23	H-17-AJ	23	no data	23
24	H-17-AJ	24	J-14-C	24	I-15-AK	24	M-23-A	24	H-19-C	24	no data	24
25	K-16-V	25	L-16-R	25	P-18-L	25	I-17-EG	25	H-19-B	25	no data	25
26	H-19-C	26	K-15-H	26	P-17-A	26	I-17-EQ	26	H-19-A	26	no data	26
27	H-19-B	27	L-22-B	27	P-17-K	27	L-24-F	27	L-26-H	27	no data	27
28	H-19-A	28	H-16-K	28	P-17-J	28	N-17-BM	28	K-18-BN	28	no data	28
29	L-26-H	29	H-16-L	29	L-24-I	29	N-17-BO	29	M-22-X	29	no data	29
30	K-18-BN	30	H-17-AJ	30	N-21-C	30	I-15-AK	30	K-17-AC	30	no data	30
31	M-22-X	31	K-14-M	31	K-15-H	31	L-18-R	31	K-18-BZ	31	no data	31
32	K-17-AC	32	L-17-CD	32	L-22-B	32	K-18-BY	32	I-15-AK	32	no data	32
33	N-17-BH	33	M-16-O	33	K-16-Y	33	H-20-Q	33	H-20-Q	33	no data	33
34	N-17-BM	34	P-17-F	34	I-16-AA	34	P-17-F	34	H-16-K	34	no data	34
35	N-17-BO	35	P-16-A	35	O-19-J	35	L-24-I	35	H-16-L	35	no data	35
36	K-18-BY	36	K-16-T	36	N-28-G	36	K-18-BN	36	J-25-E	36	no data	36
37	K-18-BZ	37	K-16-V	37	N-28-H	37	K-16-T	37	K-19-A	37	no data	37
38	I-15-AK	38	K-18-BN	38	P-17-F	38	M-16-C	38	M-23-A	38	no data	38
39	H-20-Q	39	H-20-Q	39	P-16-A	39	M-23-E	39	M-23-E	39	no data	39
40	L-19-H	40	K-19-A	40	H-16-K	40	M-22-X	40	L-14-C	40	no data	40
41	H-16-K	41	K-16-W	41	H-16-L	41	P-18-L	41	L-17-CD	41	no data	41
42	H-16-L	42	O-26-L	42	O-26-L	42	L-14-C	42	P-17-F	42	no data	42
43	K-15-H	43	O-26-I	43	O-26-I	43	K-14-X	43	P-16-A	43	no data	43
44	J-25-E	44	O-28-E	44	K-14-M	44	J-15-A	44	K-16-T	44	no data	44
45	K-19-A	45	I-17-JA	45	K-17-H	45	K-18-BZ	45	J-14-C	45	no data	45
46	I-16-AA	46	J-18-B	46	K-16-B	46	K-15-H	46	K-14-X	46	no data	46
47	P-18-L	47	I-17-R	47	K-16-V	47	J-14-C	47	N-16-L	47	no data	47
48	M-23-A	48	K-17-H	48	K-16-W	48	H-17-L	48	O-19-J	48	no data	48
49	M-23-E	49	L-18-R	49	H-17-AG	49	I-17-R	49	O-26-L	49	no data	49
50	L-14-C	50	M-22-T	50	H-17-L	50	N-17-AM	50	M-16-O	50	no data	50
51	J-15-A	51	I-17-JB	51	L-19-H	51	K-16-W	51	P-17-H	51	no data	51
52	L-17-CD	52	K-16-Y	52	L-14-C	52	O-19-J	52	P-17-K	52	no data	52
53	K-16-W	53	H-19-C	53	M-16-O	53	M-22-T	53	P-17-L	53	no data	53
54	P-17-F	54	H-19-B	54	M-23-E	54	L-17-CD	54	P-17-J	54	no data	54
55	P-16-A	55	H-19-A	55	P-21-G	55	K-19-A	55	N-18-AC	55	no data	55
56	K-16-T	56	J-25-E	56	K-18-BY	56	P-16-A	56	O-26-I	56	no data	56
57	J-14-C	57	L-14-C	57	K-18-BZ	57	P-21-G	57	L-24-F	57	no data	57
58	K-14-X	58	K-14-X	58	P-23-A MINOR	58	P-23-A MINOR	58	L-24-I	58	no data	58
59	M-16-C	59	O-19-J	59	L-16-R	59	N-28-G	59	K-14-M	59	no data	59
60	N-16-L	60	H-17-L	60	L-18-R	60	O-18-BY	60	O-28-F	60	no data	60
61	O-19-J	61	H-17-AG	61	O-18-BY	61	P-22-D	61	O-28-E	61	no data	61
62	O-26-L	62	I-17-GN	62	M-22-X	62	H-17-AG	62	M-22-T	62	no data	62
63	M-16-O	63	I-17-EG	63	K-18-BN	63	K-14-M	63	P-21-G	63	no data	63
64	P-17-H	64	I-17-EQ	64	N-17-BH	64	P-17-A	64	P-23-A MINOR	64	no data	64
65	P-17-A	65	I-18-G	65	N-17-BM	65	N-28-H	65	P-22-D	65	no data	65
66	P-17-K	66	K-18-R	66	N-17-BO	66	P-22-A	66	P-22-A	66	no data	66
67	P-17-L	67	K-16-B	67	H-17-AJ	67	P-17-L	67	N-28-H	67	no data	67
68	P-17-J	68	N-17-AM	68	I-17-EG	68	P-17-K	68	N-28-G	68	no data	68
69	N-18-AC	69	M-17-AQ	69	I-17-EQ	69	I-17-JA	69	M-24-I	69	no data	69
70	O-26-I	70	K-16-X	70	M-16-C	70	P-17-J	70	K-18-R	70	no data	70
71	L-22-B	71	O-18-BY	71	K-19-A	71	N-18-AC	71	K-16-B	71	no data	71
72	L-24-F	72	O-18-CD	72	I-17-R	72	I-17-JB	72	N-17-AM	72	no data	72
73	L-24-I	73	N-17-N	73	M-17-AQ	73	K-17-H	73	N-17-BN	73	no data	73
74	N-21-C	74	N-17-BN	74	L-24-F	74	I-17-GN	74	N-17-BH	74	no data	74
75	K-14-M	75	N-17-B	75	J-15-A	75	L-19-H	75	N-17-BM	75	no data	75
76	O-28-F	76	L-26-H	76	N-17-AM	76	M-17-AQ	76	N-17-BO	76	no data	76
77	O-28-E	77	M-22-X	77	N-17-BN	77	O-28-F	77	K-18-BY	77	no data	77
78	M-22-T	78	K-17-AC	78	N-17-B	78	N-17-B	78	I-16-AA	78	no data	78
79	L-16-R	79	N-17-BH	79	L-26-H	79	M-16-O	79	P-18-L	79	no data	79
80	P-21-G	80	N-17-BM	80	I-17-GN	80	O-28-E	80	J-15-A	80	no data	80
81	P-23-A MINOR	81	N-17-BO	81	O-18-CD	81	K-17-AC	81	K-16-W	81	no data	81
82	P-22-D	82	K-18-BY	82	J-25-E	82	O-18-CD	82	P-17-A	82	no data	82
83	P-22-A	83	K-18-BZ	83	K-17-AC	83	L-16-R	83	L-22-B	83	no data	83
84	N-28-H	84	L-19-H	84	N-18-AC	84	K-16-B	84	N-21-C	84	no data	84
85	N-28-G	85	M-23-A	85	I-17-JA	85	J-25-E	85	L-16-R	85	no data	85
86	M-24-I	86	M-23-E	86	I-17-JB	86	K-16-X	86	I-17-GN	86	no data	86
	1		1		1		1		1		1	

Scoring Matrix ranked by the six factors given in the POA memorandum equally weighted risk

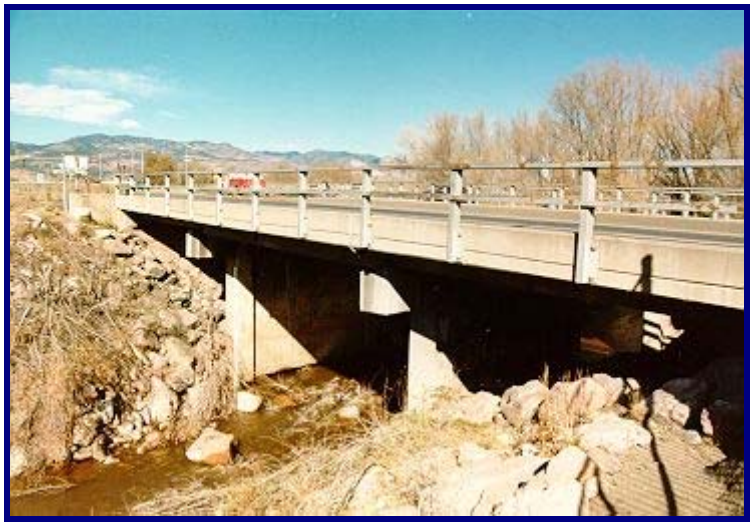
	aadt	detour length	age	condition	waterway	Replacement	ranking
J-18-B	9	46	8	17	3	0	83
I-18-G	8	65	11	1	12	0	97
I-15-AK	38	1	24	30	32	0	125
N-16-L	61	5	10	2	47	0	125
K-16-V	25	37	47	21	1	0	131
P-17-H	65	6	4	5	51	0	131
H-19-C	26	53	21	8	24	0	132
K-16-Y	18	52	33	12	18	0	133
N-17-N	21	73	16	3	21	0	134
H-19-B	27	54	22	11	25	0	139
H-19-A	28	55	23	18	26	0	150
H-16-K	41	28	40	7	34	0	150
K-15-H	43	26	31	46	5	0	151
K-18-R	11	66	3	4	70	0	154
H-17-AJ	24	30	67	14	23	0	158
H-16-L	42	29	41	13	35	0	160
H-20-Q	39	39	18	33	33	0	162
H-17-L	1	60	50	48	6	0	165
I-17-EG	5	63	68	25	9	0	170
L-18-R	17	49	60	31	17	0	174
M-16-C	60	4	70	38	2	0	174
I-17-EQ	6	64	69	26	10	0	175
H-17-AG	2	61	49	62	7	0	181
K-16-T	57	36	7	37	44	0	181
L-17-CD	53	32	6	54	41	0	186
J-14-C	58	24	15	47	45	0	189
K-16-X	16	70	2	86	16	0	190
I-17-R	10	47	72	49	13	0	191
I-16-AA	47	17	34	16	78	0	192
K-17-H	13	48	45	73	14	0	193
K-18-BN	30	38	63	36	28	0	195
P-18-L	48	2	25	41	79	0	195
M-24-I	87	16	12	15	69	0	199
P-17-L	68	9	5	67	53	0	202
P-17-F	55	34	38	34	42	0	203
M-23-A	49	85	9	24	38	0	205
O-26-L	63	42	42	9	49	0	205
K-14-X	59	58	1	43	46	0	207
L-24-I	74	13	29	35	58	0	209
I-17-JA	3	45	85	69	8	0	210
N-21-C	75	14	30	10	84	0	213
L-26-H	29	76	79	6	27	0	217
P-17-K	67	8	27	68	52	0	222
I-17-JB	7	51	86	72	11	0	227
P-16-A	56	35	39	56	43	0	229
O-18-BY	19	71	61	60	19	0	230
P-17-J	69	10	28	70	54	0	231
O-26-I	71	43	43	20	56	0	233
L-22-B	72	27	32	19	83	0	233
M-22-X	31	77	62	40	29	0	239
L-14-C	51	57	52	42	40	0	242
L-24-F	73	12	74	27	57	0	243
P-22-D	83	21	13	61	65	0	243
P-17-A	66	7	26	64	82	0	245
M-17-AQ	15	69	73	76	15	0	248
K-19-A	46	40	71	55	37	0	249
O-28-F	77	18	17	77	60	0	249
P-22-A	84	22	14	66	66	0	252
K-18-BZ	37	83	57	45	31	0	253
L-19-H	40	84	51	75	4	0	254
J-15-A	52	3	75	44	80	0	254
O-19-J	62	59	35	52	48	0	256
M-22-T	79	50	20	53	62	0	264
N-28-G	86	15	36	59	68	0	264
M-23-E	50	86	54	39	39	0	268
N-17-BN	22	74	77	23	73	0	269
N-17-BH	33	79	64	22	74	0	272
K-14-M	76	31	44	63	59	0	273
O-18-CD	20	72	81	82	20	0	275
K-16-W	54	41	48	51	81	0	275
P-21-G	81	19	55	57	63	0	275
N-17-B	23	75	78	78	22	0	276
N-28-H	85	23	37	65	67	0	277
M-16-O	64	33	53	79	50	0	279
K-16-B	12	67	46	84	71	0	280
N-17-AM	14	68	76	50	72	0	280
N-17-BM	34	80	65	28	75	0	282
O-28-E	78	44	19	80	61	0	282
P-23-A MINOR	82	20	58	58	64	0	282
K-18-BY	36	82	56	32	77	0	283
N-17-BO	35	81	66	29	76	0	287
N-18-AC	70	11	84	71	55	0	291
K-17-AC	32	78	83	81	30	0	304
J-25-E	45	56	82	85	36	0	304
I-17-GN	4	62	80	74	86	0	306
L-16-R	80	25	59	83	85	0	332

Scour Critical Bridge Plan of Action and Recommendations

for

US Highway 24 – Structure I-17-EG / EQ
Bridge over Fountain Creek

Prepared for
FHWA / Colorado Department of Transportation - Region 2



DEPARTMENT OF TRANSPORTATION

Prepared by Region 2 Hydraulics Unit

May 2009

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References:

US Department of Transportation, Federal Highway Administration, Colorado Division, Technical Services, Central Federal Lands Highway Division, Lakewood, Colorado – *"Final Hydraulic Report Structure No. 107006700.30929, Green Pipe Bridge-CR 67, Routt County, Colorado, March 2009", and "Final Hydraulic Report Bridge Structure No. G-21-F I-70 EB over Agate Creek, MP 341, CDOT, Elbert County, Colorado, both dated March 2009" and prepared by Dr.Thiet Nguyen.*
CDOT Drainage Design Manual
HECSSP & HECRAS
WMS software, BYU, EMSI, inc
Floodplain Modeling Using HEC-RAS; Haestead Dyhouse Hatchett Benn, first ed.
HEC Circular 18 & 23
Storm Drainage Design Criteria and Drainage Policies for City of Pueblo, Colorado June 1997
USGS Website NED data
Regional Flood Frequency Equations, Colorado, Water Resources Investigations Report 99-4190, "Analysis of the Magnitude and Frequency of Floods in Colorado".

1. FHWA Plan of Action for Scour Critical Bridges

SCOUR CRITICAL BRIDGE - PLAN OF ACTION

1. GENERAL INFORMATION

Structure number: I-17-EG & I-17-EQ	**City, County, State:** El Paso County	**Waterway:** Fountain Creek
Structure name:	**State highway or facility carried:** US 24 A	**Owner:** CDOT
Year built: 1964	**Year rebuilt:** ____	**Bridge replacement plans (if scheduled):** _____ **Anticipated opening date:** _____

Structure type: ☒ Bridge ☐ Culvert
Structure size and description: _____

Foundations: ☒ Known, type: piles Depth: 28' ☐ Unknown

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

Bridge ADT: 20,370	**Year/ADT:** 2003	**% Trucks:** 10

Does the bridge provide service to emergency facilities and/or an evacuation route (Y/N)? y
If so, describe: serves town of Manitou Springs and El Paso county

2. RESPONSIBILITY FOR POA

Author(s) of POA (name, title, agency/organization, telephone, pager, email):
Dennis Cress, PE, Region 2 Hydraulics Unit, Colorado Department of Transportation, 719 562 5580, dennis.cress@dot.state.co.us
Date: May 6, 2009
Concurrences on POA (name, title, agency/organization, telephone, pager, email):
Amanullah Mommandi, PE, Staff Hydraulics Denver, 303 757-9044

POA updated by (name, title, agency, organization): Dennis Cress **Date of update:** May 6, 2009
Items update: POA
POA to be updated every 24 **months by (name, title, agency/organization):**Dennis Cress

Date of next update: April 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: Total Scour has an expected depth of 32 feet (500 yr). Abutment 1, east side of bridge, is subject to greatest observed scour.

d. Scour History: The inspection history begins in 1998, and occurs generally every 2 years until 2008, the depth of scour has been measured and recorded at abutment 1, pier 2, the center of channel, pier 3 and abutment 4. Abutment 1 has scoured in the range of -1 to -6 feet below channel bottom elevation of 6099. Pier 2, between 0 and -15.8 feet; center of channel, -15' to -18'; pier 3, 0 to -19.7'; abutment 4, 0 to -6'.

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		**11/28/2006**	
Item 113	**Scour Critical**	**3**	**3**
Item 60	**Substructure**		
Item 61	**Channel & Channel Protection**		
Item 71	**Waterway Adequacy**		
Comments: (drift, scour holes, etc. - depict in sketches in Section 10)			

6. MONITORING PROGRAM

☒ **Regular Inspection Program** ☐w/surveyed cross sections
Items to Watch: piers and abutment

☐ **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 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: below elev. 6030; over 5' 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: 6086.75

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*): close approaches until channel is repaired.

Agency and department responsible for monitoring: CDOT region 4 maintenance

Contact person (*include name, title, telephone, pager, e-mail*): Chad Wright, (719) 485-3250

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 $ 0

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

Priority Ranking		**Estimated cost**
(1) _____		$ _____
(2) _____	$ _____	
(3) _____		$ _____
(4) _____		$ _____
(5) _____		$ _____

Basis for the selection of the preferred scour countermeasure: _____

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: _____

Target construction completion date: _____

Countermeasures already completed: _____

8. BRIDGE CLOSURE PLAN

Scour monitoring criteria for consideration of bridge closure:

☒ Water surface elevation reaches 6034 at or is 5 feet below substructure.
☐ 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.

Bridges on Detour Route:

Bridge Number	Waterway	Sufficiency Rating/ Load Limitations	Item 113 Code
N 21st Street	Fountain Creek		

Traffic control equipment (detour signing and barriers) and location(s): Place detour notice west of N 21 st Street. Place barriers just east of N 21 st Street intersection with US hwy 24.

Additional considerations or critical issues (susceptibility to overtopping, limited waterway adequacy, lane restrictions, etc.) : _____

News release, other public notice (include authorized person(s), information to be provided and limitations): _____

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) (shown in Report under attachment H).**

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

☐ **Attachment G: Photos**

☒ **Attachment H: Other information:** Bridge Hydraulic Report by CDOT Region 2 Hyd Unit May 2009

2. Summary

Structure I-17-EG / EQ crosses Fountain Creek and experiences scour in its channel, at its abutments, and piers. The structure is rated as scour critical, Item Number 113 in the Structure Inventory and Appraisal of the Nation's Bridges (item 113 = 3). The Colorado Department of Transportation (CDOT) Bridge Inspection personnel make bi-annual inspections of this structure. The records indicate that the channel experiences a lowering in elevation between 1 and 3 feet approximately. The pile cap / footing of the piers have previously been exposed due to scour. The bottom of the right abutment has been reported to have material washed away from it causing voided areas. The void created by the washout has been repaired with flow fill and rip rap.

This bridge is found to be in good condition while the channel has not maintained its condition as well. The channel is monitored regularly. This is the current method of scour countermeasure for the bridge. Structural changes to the channel such as armoring with rip rap, and slope protection, are not required at this time and are not recommended. The "Scour Plan of Action" recommendation is to monitor the structure during periods when Fountain Creek is experiencing high flows. At a stream elevation that comes to within 5 feet of the low chord of the substructure, it is recommended that the bridge be closed to traffic. A detour for traffic is to be made at the intersection of North 21st Street and US Highway 24. This detour will be used until the Fountain Creek stage subsides.

3. Introduction

3.1. Project Description

The bridge over Fountain Creek on US Highway 24 is experiencing scour in the channel under the bridge. The damage to the channel has been repaired with rip rap and fill material as countermeasures to the ongoing This report will estimate the flow and velocities in the channel, at the piers, and at the abutments to be used in the preparation of a Scour Plan of Action for this structure.

3.2. Bridge Location

Structure I-17-EG / EQ is located at mile post 302.2 on US Highway 24 in El Paso County.

4. Hydrology

4.1. Drainage Basin Description

The basin that contributes runoff to the US 24 bridge that crosses the Fountain Creek is approximately 103 square miles and lies near the town of Manitou Springs.

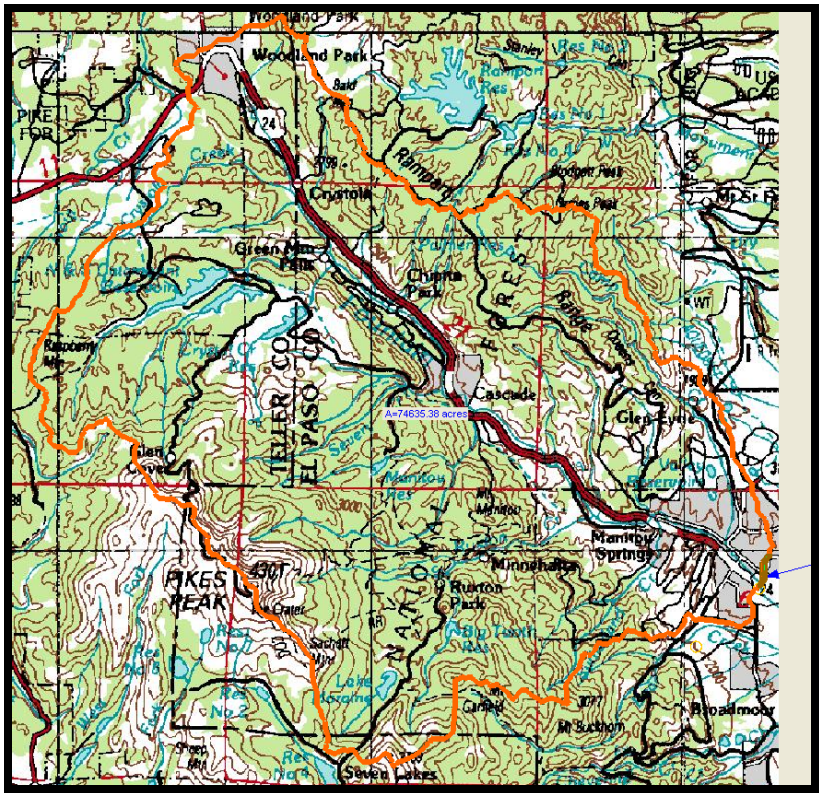


Figure 1. Fountain Creek Bridge Basin, Structure I-17-EG / EQ Basin, WMS model

4.2. Basin Peak Flow Estimates

Two methods were used to estimate the design peak flow for Fountain Creek. The methods used are: flood frequency analysis of the annual peak flow recordings from USGS gage 7103700 and the use of the USGS Regression Equations.

The basin annual peak flows at this location are analyzed using the Bulletin17B Flood Frequency Analysis (FFA).

The regression equations are obtained from table 1, Regional Flood Frequency Equations, Colorado, Water Resources Investigations Report 99-4190, “Analysis of the Magnitude and Frequency of Floods in Colorado”.

Peak Flows for the Fountain Creek Basin (103 SM) (cfs)			
Return Frequency	USGS Mountain Regression Equation	17b FFA	USGS Plains Regression Equation
50 year	1,487	2,320	6,866
100 year	1,655	2,949	9,904
250 year	--	3,200	--
500 year	2,019	4,790	20,566

Table 1. Peak Flow Comparison, lists the results of the methods described above.

5. Hydraulic Analysis

5.1. Criteria

The criteria for the roadway design, the bridge design, and design of bank protection against scour are given in the CDOT Drainage Design Manual (CDOT DDM), mainly in Chapters 7, 10 and 17.

For US Highway 24, the classification of the highway is an urban multilane lane road. From Table 7.2 of the CDOT DDM, shown below in Table 2, the 100 year event will govern the road and bridge hydraulic design and the scour countermeasure design. Chapter 10.4.3 in the DDM requires the 500 yr event for the scour analysis of the foundation of the bridge.

Table 7.2 Table of Design Frequencies

Drainage Type		Frequency
A.	Cross Drainage	
	Multilane Roads - including interstate	
	In Urban Areas	100-year*
	In Rural Areas	50-year
	Two-Lane Roads	
	In Urban Areas	100-year
	In Rural Areas	
	Q_{50} : ≥ 4000 cfs	50-year
	Q_{50} < 4000 cfs	25-year
	Culvert Outlet Scour Protection	10-year
	Pedestrian Walkways and Bikeways	2 to 5-year
	Bridge Foundation Scour	100 and 500-year
B.	Parallel Drainage	
	Roadway Overtopping and Revetment	Same as for Cross Drainage
	Side Drains	2 to 10-year#
C.	Storm Drains	
	Major System	100-year
	Minor System	2 to 5-year
D.	Detour Culverts	monthly discharges for 2 to 5-year

Notes: *Urban cross culverts (not Interstate); if Q_{100} < 100 cfs, consider designing the culvert using the storm drain Minor System Frequency.
#Side drains shall not cause water to flow onto the highway at a greater probability than applies to cross drainage.

Table 2. Design Frequencies, CDOT Drainage Design Manual

Bridge scour analysis will be based upon four selected events, the 50 year, 100 year, 250 year, and the 500 year event using the procedures outlined in HEC 18 and HEC 23, 2001 ed. Only the results of the 500 year analysis and the recommended revetment countermeasures are given in appendix C.

5.2. Fountain Creek at I-17-EG and I-17-EQ

5.2.1. River Channel Characteristics

Fountain Creek is a steep channel at this location. The bed is comprised of gravel and cobbles and the banks are vegetated.

5.2.2. Survey

The basin for Fountain Creek was modeled using the Watershed Modeling Software (WMS) and with topographic data from the USGS. The cross

sectional data from the CDOT record drawings was used in combination with the DEM surface to obtain the general surface and channel geometry at the bridge.

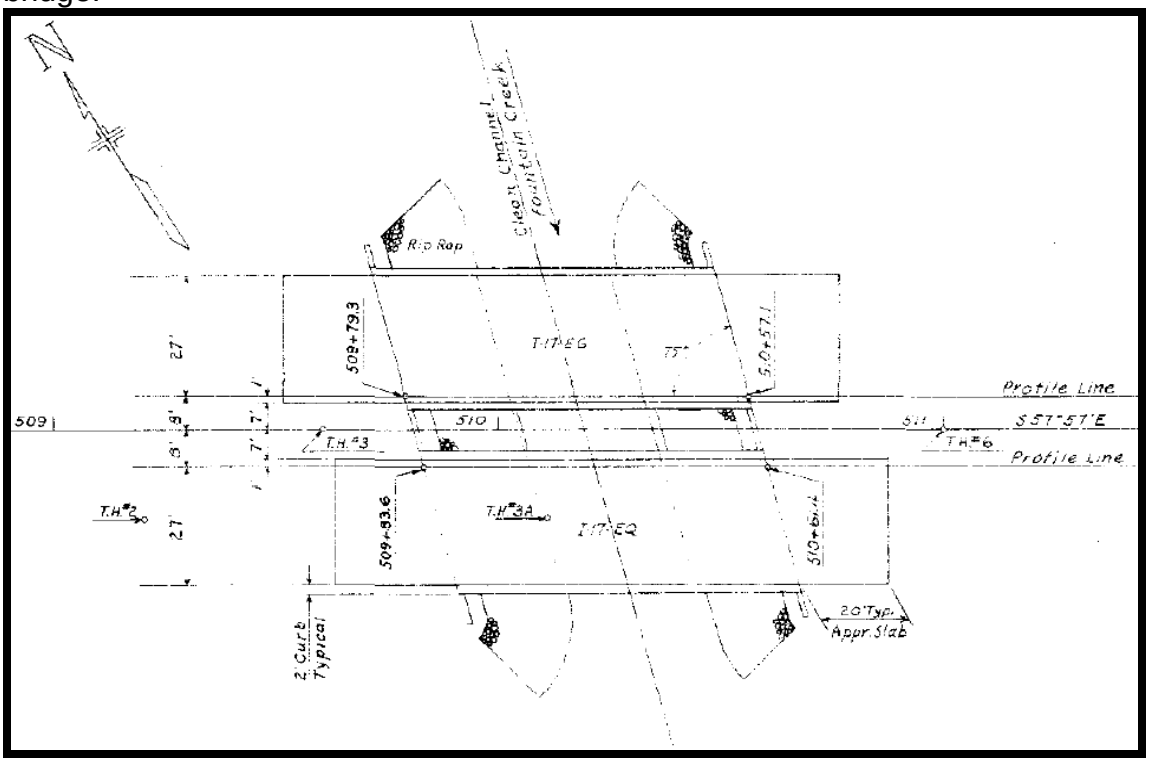


Figure 2. CDOT survey from original plans.

5.2.3. Bridge – Structure I-17-EG / EQ

The bridge has two lanes on a deck with a width of 62 feet. The bridge span is approximately 78 feet. The side slopes are steep and covered in rip rap. The channel shape, the span and the bridge length are taken from the record as-built information.

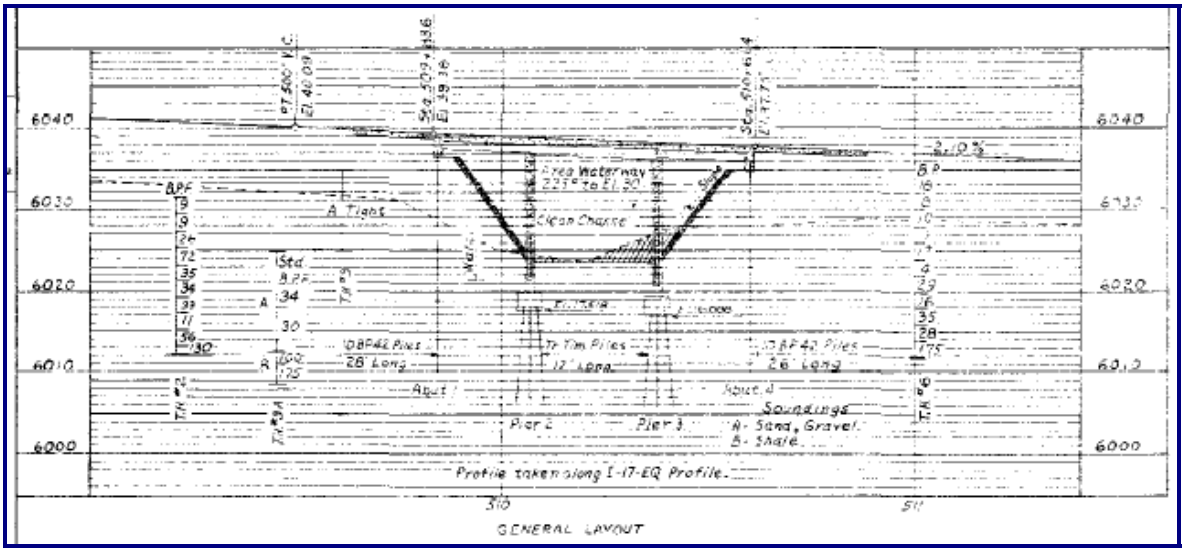


Figure 3. Existing Bridge I-17-EG, record drawings, 1965 CDOT, facing up stream.

6. Recommendations for Scour Countermeasures

This structure shall be monitored regularly to ensure that its channel is not scoured at the bridge abutments, piers, or at its center. Closure of the structure is to happen if the Fountain Creek stages elevate to within 5 feet of the substructure of this bridge. A detour is available and traffic shall be rerouted upon warranted conditions.

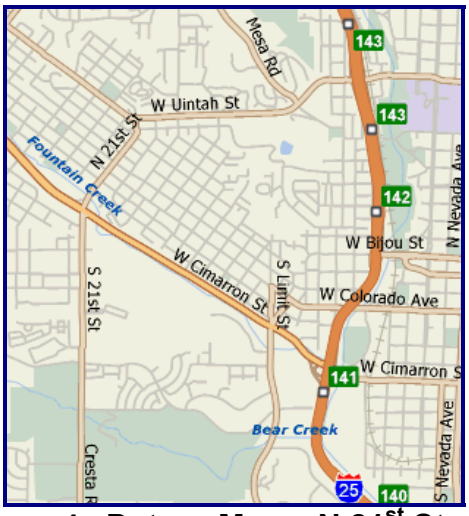


Figure 4. Detour Map – N 21st Street to Uintah Street to I – 25.

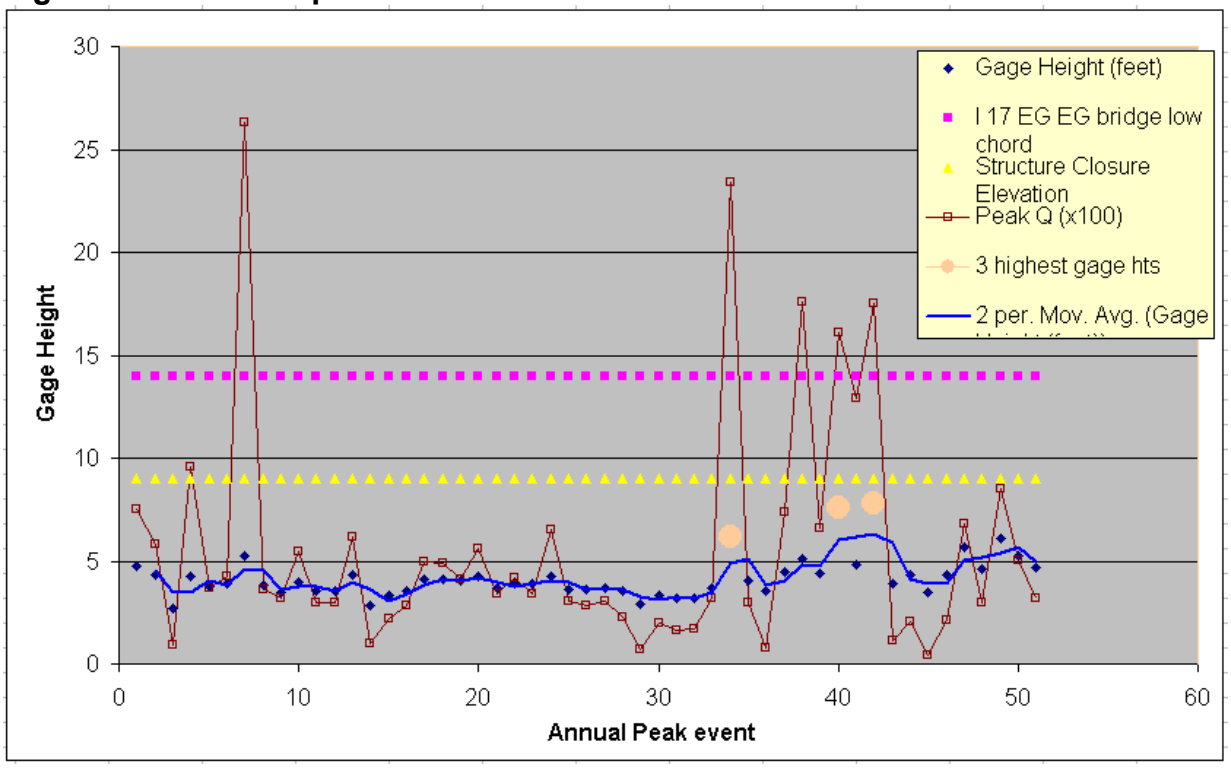


Figure 5. - Gage Height vs Flow. The approximate return frequency associated with the closure elevation is the 50 year storm (Q ≈ 2300 cfs). Several assumptions are made in this estimate of the closure elevation which may be found in appendix A under the FFA.

APPENDIX A - Hydrology

HEC-SSP and USGS Regression RESULTS FOR:

- **Fountain Creek Basin upstream of CDOT I-17-EG / EQ**

BASIN MAP

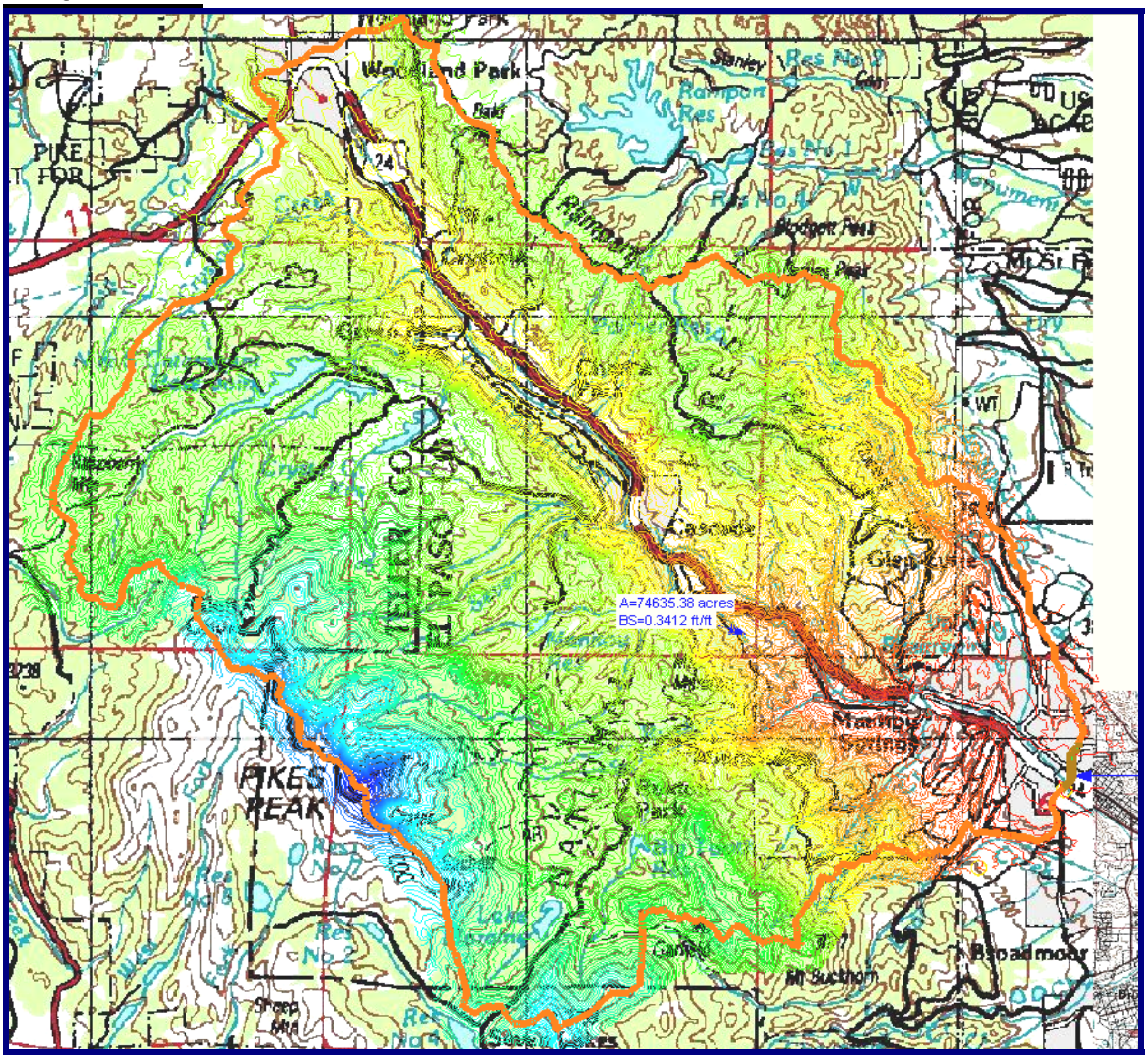


Figure A1. Fountain Creek Gaging Station watersheds.

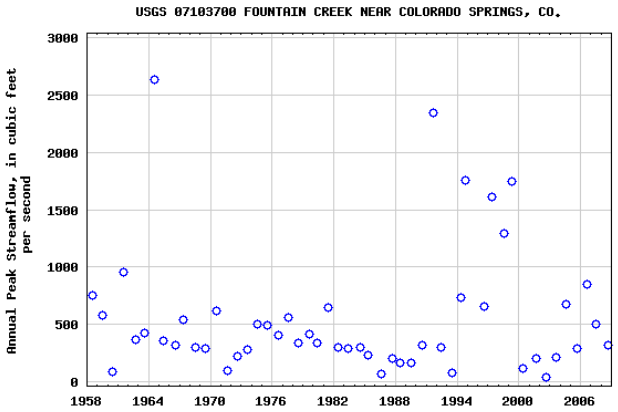
Latitude 38°51'17", Longitude 104°52'39" NAD27

Figure A2. USGS Gage location on Fountain Creek. Approximately 1.5 miles upstream from I-17-EG, and 70 feet higher in elevation.

El Paso County, Colorado
Hydrologic Unit Code 11020003
Latitude 38°51'17", Longitude 104°52'39" NAD27
Drainage area 103 square miles
Gage datum 6,110.00 feet above sea level NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format



Download a presentation-quality graph

Figure A3. Peak flows at gage.

USGS Regression Equations

Table 1. Regional flood-frequency equations, Colorado

[Q, discharge, in cubic feet per second; A, drainage area, in square miles; P, mean annual precipitation, in inches; S, mean drainage-basin slope, in foot per foot]

Recurrence interval, in years	Regression equation	Standard error of the model, in percent	Average standard error of prediction, in percent
Mountain region			
2	$Q = 11.0\ (A)^{0.663}\ (S+1.0)^{3.465}$	58.5	59.6
5	$Q = 17.9\ (A)^{0.677}\ (S+1.0)^{2.739}$	47.7	48.6
10	$Q = 23.0\ (A)^{0.685}\ (S+1.0)^{2.364}$	43.7	44.6
25	$Q = 29.4\ (A)^{0.695}\ (S+1.0)^{2.004}$	41.4	42.3
50	$Q = 34.5\ (A)^{0.700}\ (S+1.0)^{1.768}$	41.4	42.3
100	$Q = 39.5\ (A)^{0.706}\ (S+1.0)^{1.577}$	42.4	43.4
200	$Q = 44.6\ (A)^{0.710}\ (S+1.0)^{1.408}$	44.2	45.2
500	$Q = 51.5\ (A)^{0.715}\ (S+1.0)^{1.209}$	47.5	48.6
Rio Grande region			
2	$Q = 0.03\ (A)^{0.979}\ (P)^{1.615}$	77.7	82.6
5	$Q = 0.12\ (A)^{0.940}\ (P)^{1.384}$	64.0	67.9
10	$Q = 0.25\ (A)^{0.914}\ (P)^{1.277}$	58.2	89.1
25	$Q = 0.52\ (A)^{0.884}\ (P)^{1.117}$	53.4	56.8
50	$Q = 0.81\ (A)^{0.864}\ (P)^{1.121}$	51.2	54.5
100	$Q = 1.19\ (A)^{0.846}\ (P)^{1.074}$	49.9	53.3
200	$Q = 1.67\ (A)^{0.828}\ (P)^{1.036}$	49.5	52.9
500	$Q = 2.48\ (A)^{0.808}\ (P)^{0.995}$	50.0	53.6
Southwest region			
2	$Q = 28.7\ (A)^{0.699}$	85.0	87.3
5	$Q = 50.5\ (A)^{0.693}$	74.1	76.1
10	$Q = 66.0\ (A)^{0.697}$	71.4	73.4
25	$Q = 86.3\ (A)^{0.704}$	71.2	73.4
50	$Q = 102.0\ (A)^{0.709}$	72.8	75.0
100	$Q = 118.4\ (A)^{0.715}$	75.6	78.0
200	$Q = 135.5\ (A)^{0.720}$	79.1	81.7
500	$Q = 159.4\ (A)^{0.728}$	85.0	87.9
Northwest region			
2	$Q = 0.39\ (A)^{0.684}\ (P)^{1.304}$	82.6	85.6
5	$Q = 2.84\ (A)^{0.674}\ (P)^{0.833}$	71.5	74.0
10	$Q = 7.56\ (A)^{0.671}\ (P)^{0.601}$	68.5	70.9
25	$Q = 20.6\ (A)^{0.669}\ (P)^{0.362}$	67.1	69.7
50	$Q = 38.8\ (A)^{0.667}\ (P)^{0.210}$	67.2	69.8
100	$Q = 104.7\ (A)^{0.624}$	75.0	76.7
200	$Q = 118.5\ (A)^{0.624}$	77.8	79.6
500	$Q = 137.6\ (A)^{0.623}$	83.1	85.1
Plains region			
2	$Q = 39.0\ (A)^{0.486}$	233.7	258.5
5	$Q = 195.8\ (A)^{0.399}$	204.2	223.8
10	$Q = 364.6\ (A)^{0.400}$	212.4	233.7
25	$Q = 725.3\ (A)^{0.395}$	231.8	256.2
50	$Q = 1116\ (A)^{0.392}$	249.5	278.3
100	$Q = 1640\ (A)^{0.388}$	267.3	300.0
200	$Q = 2324\ (A)^{0.385}$	284.5	321.3
500	$Q = 3534\ (A)^{0.380}$	305.8	347.9

Figure A4. A = 103 sm; S = 0.3412 ft/ft.

The Mountain Region Equations for the 50, 100, and 500 year return frequencies are used to estimate the Fountain Creek peak flows for the Bridge analysis.

Flood Frequency Analysis of Fountain Creek gage data

The USGS gaging station 7103700 has a basin area of approximately 103 square miles.

The Army Corps of Engineers Bulletin 17b Flood Frequency Analysis is used on the gage data for the Fountain Creek to determine the basin's peak flow rates for the desired range of return frequencies. The resulting peak flows were compared to the peak flow rates estimated generated by the use of the Regression Equations.

HEC-SSP - I-17-EG US 24

Frequency Curve for: usgs 7103700				
Percent Chance Exceedance	Computed Curve Flow in cfs	Expected Prob. Flow in cfs	Confidence Limits Flow in cfs	
			0.05	0.95
0.2	4,790	5,558	8,261	3,198
0.5	3,672	4,110	6,039	2,533
1.0	2,949	3,221	4,667	2,088
2.0	2,320	2,480	3,525	1,689
5.0	1,619	1,688	2,320	1,225
10.0	1,177	1,208	1,607	918
20.0	799	810	1,038	641
50.0	381	381	468	311
80.0	182	179	227	140
90.0	124	120	158	90
95.0	90	86	119	63
99.0	49	45	70	31

System Statistics	
Log Transform: Flow,	
Statistic	Value
Mean	2.5812
Standard Dev	0.3819
Station Skew	-0.0251
Regional Skew	0.0
Weighted Skew	-0.0187
Adopted Skew	0.0

Number of Events	
Event	Number
Historic Events	0
High Outliers	0
Low Outliers	0
Zero Or Missing	0
Systematic Events	51
Historic Period	0

Figure A5. Results of the FFA for the USGS Gaging Station 7103700 data at Fountain Creek

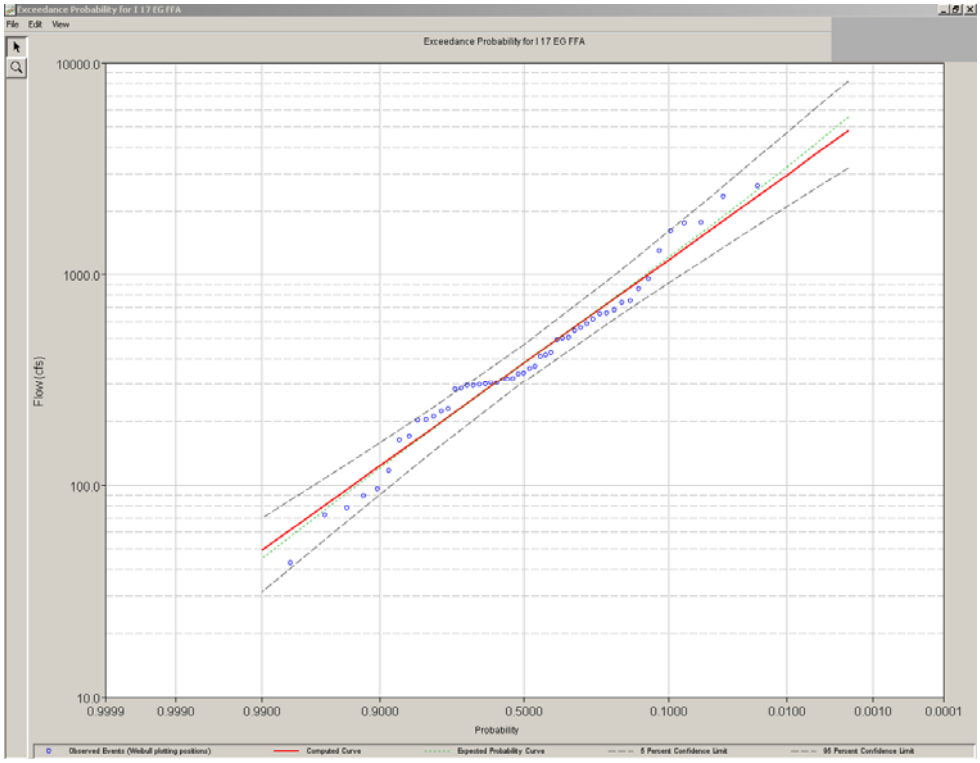


Figure A6. Graph of Flood Frequency Analysis for Fountain Creek usgs gage 7103700.

In determining the return frequency associated with the recommended closure elevation for Structure I-17-EG/EQ, there are several assumption made that are listed here:

- ◊ **Since the gage used in this analysis is 1.5 miles upstream from L-17-EG, approximately 70 feet higher in elevation, the gage height had to be transferred in elevation to the study location. This was done by subtraction of the 70 feet from the recorded gage heights to account for the lower elevation at the bridge of interest.**
- ◊ **The "K" value for the gage is assumed not to change between the two locations. This assumes gage station skew would not change if a gage were placed at the bridge under study.**
- ◊ **The flow rate associated with the closure elevation is based upon the average of the flow rates associated with the three highest stages recorded at the gage. This is a judgment made by the author of the report. The average flow rate of the 3 highest gage points is 1888cfs. The bridge closure elevation is slightly higher than the 3 highest stages recorded at the gage, and is estimated to be associated with a flow rate of 2300cfs. This flow rate is used with the FFA to determine the return frequency, shown below.**

Log Q = Avg + K * S									
G =	-0.0189								
	1888	average of the flows associated with the three highest stages, 2304cfs, 1610cfs, 1750cfs: stages 6.15, 7.58, 7.81							
Q =	2300	estimated Flow for closure.							
Log Q =	3.3617278								
Avg =	2.5812482								
S =	0.3818771								
K =	**2.043798**								
							G		
Prob. =	0.02			P		0	K(-0.0189)	-0.1	
Tr =	50	yr		2	0.5	0.00000	0.00314	0.01662	
				5	0.2	0.84162	0.84247	0.84611	
				10	0.1	1.28155	1.27944	1.27037	
				25	0.04	1.75069	1.74410	1.71580	
				37			1.88485		
				50	0.02	2.05375	**2.04355**	1.99973	
				68	0.015		2.1386248		
				100	0.01	2.32635	2.31242	2.25258	
				500	0.002	2.87816	2.85529	2.75706	

Figure A7. - Estimate of closure elevation return frequency.

APPENDIX B - Hydraulics

HEC-RAS Model

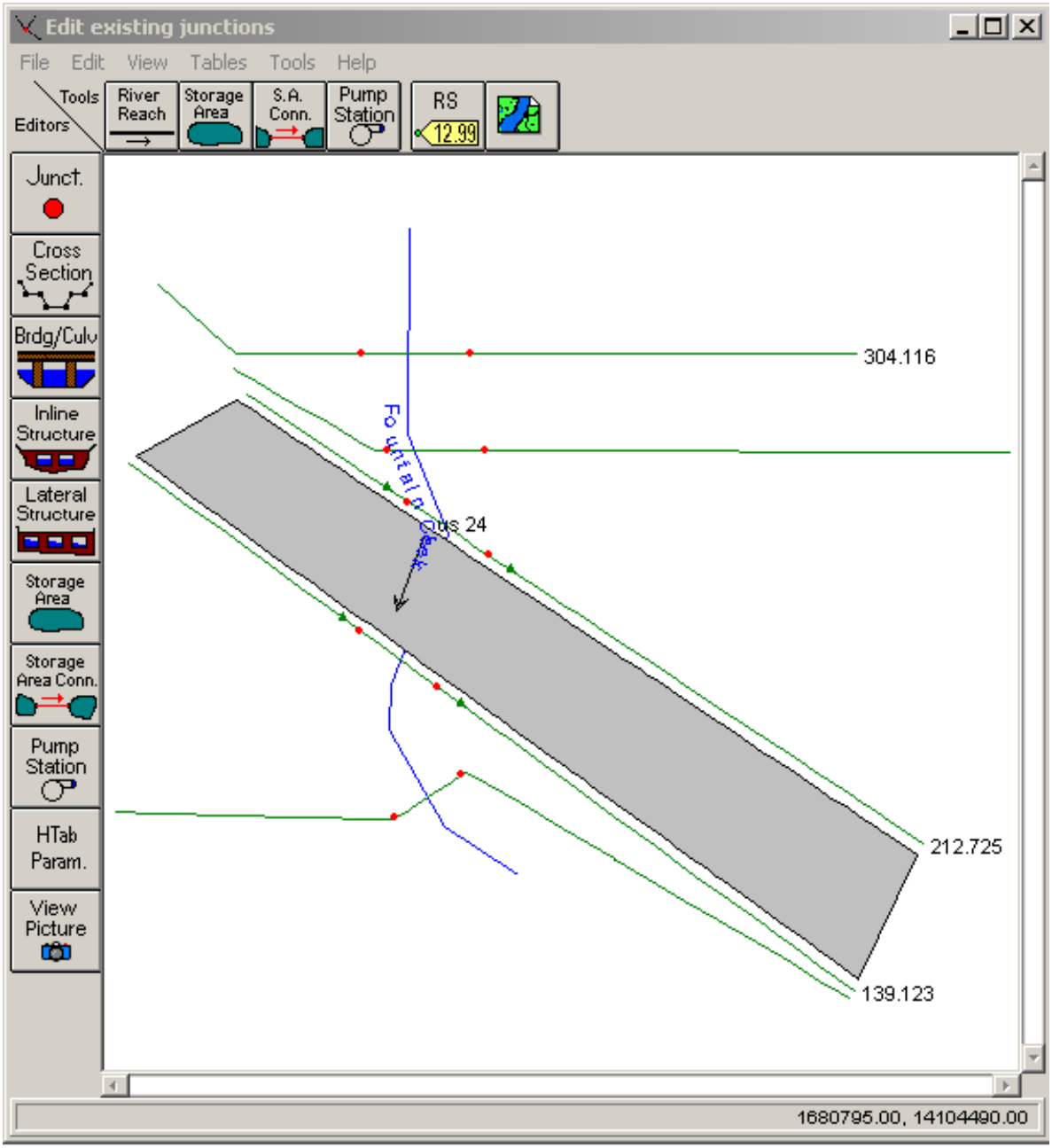


Figure B1. HECRAS model of CDOT structure I-17-EG / EQ.

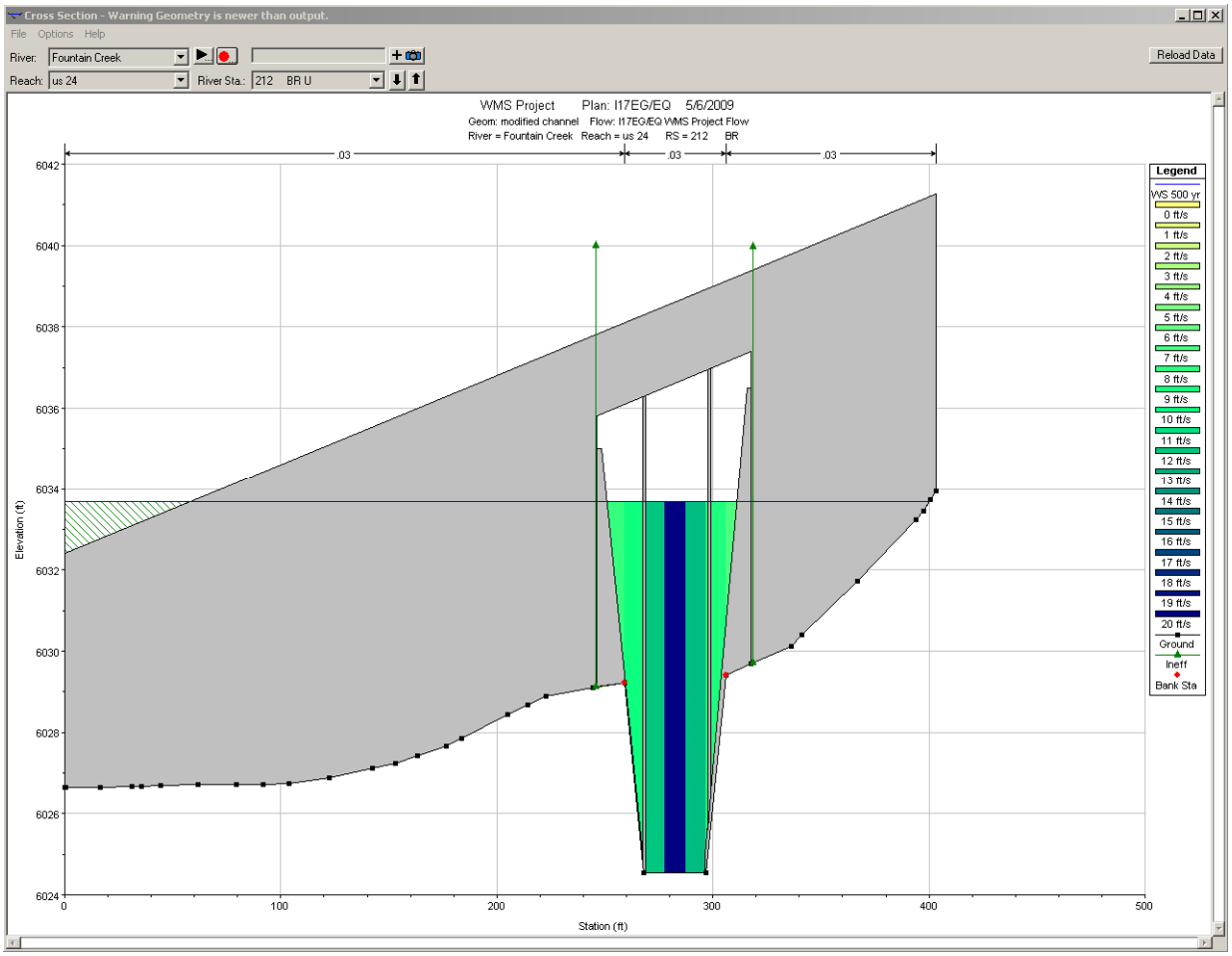


Figure B2. Bridge cross section facing downstream.

Results - hecras model at bridge

Profile Output Table - Six XS Bridge

File Options Std. Tables Locations Help

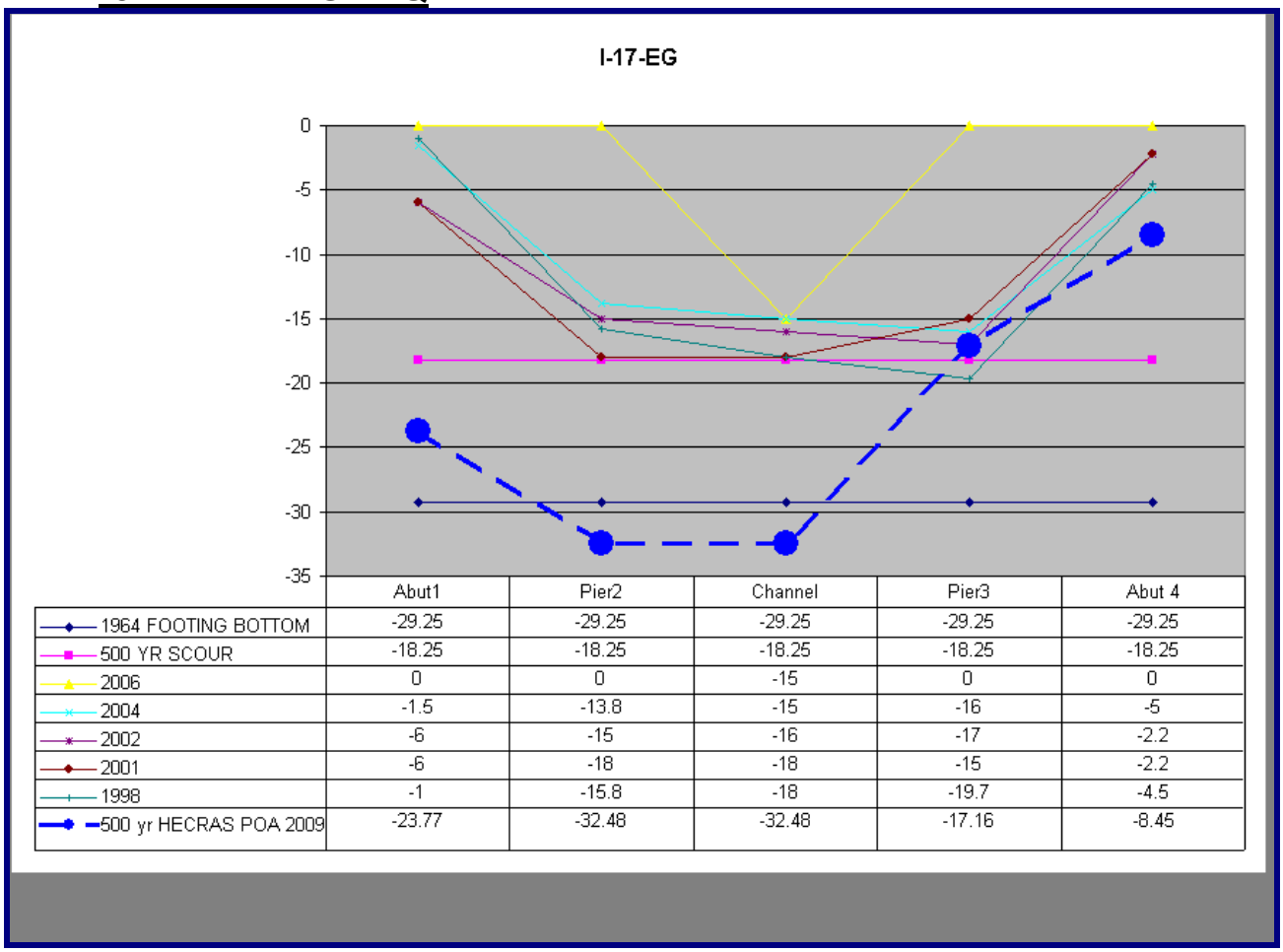
HEC-RAS Plan: I17EG River: Fountain Creek Reach: us 24

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Frctn Loss (ft)	C & E Loss (ft)	Top Width (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)
us 24	212.725	50 yr	6032.55	6031.76	6029.83	0.03	0.11	367.28	73.46	2182.11	64.43	7.32
us 24	212.725	100 yr	6033.70	6032.82	6030.55	0.03	0.13	386.35	124.90	2707.56	117.55	7.77
us 24	212.725	500 yr	6036.46	6035.26	6032.21	0.03	0.14	403.27	284.22	4219.97	285.81	9.09
us 24	212 BR U	50 yr	6032.41	6030.52	6030.19	0.76	0.03	46.43	3.32	2316.34	0.34	11.05
us 24	212 BR U	100 yr	6033.55	6031.39	6031.04	0.75	0.03	49.80	16.49	2927.44	6.06	11.83
us 24	212 BR U	500 yr	6036.29	6033.69	6033.15	0.70	0.06	58.67	132.58	4571.49	85.93	13.16
us 24	212 BR D	50 yr	6031.63	6029.44	6029.44	0.07	0.07	44.46	2.53	2317.47		11.89
us 24	212 BR D	100 yr	6032.77	6030.26	6030.26	0.07	0.09	47.32	13.76	2936.00	0.24	12.74
us 24	212 BR D	500 yr	6035.54	6032.37	6032.37	0.06	0.08	54.63	111.03	4648.88	30.09	14.43
us 24	139.123	50 yr	6030.95	6028.99	6028.99	0.08	0.46	302.25	42.80	2277.20		11.34
us 24	139.123	100 yr	6031.95	6029.74	6029.74	0.08	0.51	310.18	89.74	2857.10	3.16	12.08
us 24	139.123	500 yr	6034.38	6031.48	6031.48	0.08	0.64	334.35	240.08	4462.03	87.90	14.00

Figure B3. Results for 50yr, 100yr, and 500yr events.

APPENDIX C – Scour Estimates

◊ CDOT Bridge Inspection History and Calculated Scour limits for I – 17 – EG / EQ



	Abut1	Pier2	Channel	Pier3	Abut 4
1964 FOOTING BOTTOM	-29.25	-29.25	-29.25	-29.25	-29.25
500 YR SCOUR	-18.25	-18.25	-18.25	-18.25	-18.25
2006	0	0	-15	0	0
2004	-1.5	-13.8	-15	-16	-5
2002	-6	-15	-16	-17	-2.2
2001	-6	-18	-18	-15	-2.2
1998	-1	-15.8	-18	-19.7	-4.5
500 yr HECRAS POA 2009	-23.77	-32.48	-32.48	-17.16	-8.45

Figure C1. Modified Scour History I17EG.xls – the calculated scour from this report has been added to the spreadsheet and shown as the heavy dashed line with large circular data symbol in the above chart and graph.

Bridge Number	I-17-EG			Scour	3
Highway	24	Drainage area	92 Sq. Miles		
Span/type	3 CSG	Stream	Fountain Creek		
	Abut1	**Pier2**	**Channel**	**Pier3**	**Abut 4**
Region 2 POA HECRAS 500yr	**-23.77**	**-32.48**	**-32.48**	**-17.16**	**-8.45**
1964 FOOTING BOTTOM	-29.25	-29.25	-29.25	-29.25	-29.25
500 YR SCOUR	-18.25	-18.25	-18.25	-18.25	-18.25
2008	-3	-14	-16	-16.5	-6
2006	0	0	-15	0	0
2004	-1.5	-13.8	-15	-16	-5
2002	-6	-15	-16	-17	-2.2
2001	-6	-18	-18	-15	-2.2
1998	-1	-15.8	-18	-19.7	-4.5
1996	-1.5	-14.9	-16.8	-15.7	-4.5
1994	-2	-14.6	-16.4	-14.7	-2.5
1992	-2	-14.5	-16.4	-14.5	-2.5
1988	-3	-13.5	-13.5	-13	-3
1977	-3.3	-13	-13.5	-13	-8
1971	-1.1	-5.8	-14.5	-15	-1.8

Colorado Department of Transportation

Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 0024A 1

Mile Post (ON)11: 302.088 mi

Bridge Key: I-17-EG | Inspection Date: 11/28/2006 | Sufficiency Rating: 78.8 FO

Rgn/Sectn 2E/2M:	24		Hist Signif 37:	5		UW Inspection Date 93B:					
Trans Region 2T	01		Posting status 41:	A		SI Date 93C:					
County Code 3:	041		Service on/un 42A/B:	1	5	Bridge Cost 94:	$ 89,900				
EL PASO			Main Mat/Desgn 43A/B:	1	4	Roadway Cost 95:	$ 8,990				
Place Code 4:	16000		Appr Mat/Desgn 44A/B:	0	0	Total Cost 96:	$ 134,850				
COLORADO SPRINGS			Main Spans Unit 45:	3		Year of Cost Estimate 97:	2006				
Rte.(On/Under)5A:	1		Approach Spans 46:	0		Brdr Brdg Code/% 98A/B:					
Signing Prefix 5B:	2		Horiz Clr 47:	28.0 ft		Border Bridge Number 99:					
Level of Service 5C:	1		Max Span 48:	29.5 ft		Defense Highway 100:	0				
Directional Suffix 5E:	0		Str Length 49:	78.0 ft		Parallel Structure 101:	L				
Feature Intersected 6:			Curb Wdth L/R 50A/B:	2.0 ft	2.0 ft	Direction of Traffic 102:	1				
FOUNTAIN CREEK			Width Curb to Curb 51:	28.0 ft		Temporary Structure 103:	_				
Facility Carried 7:			Width Out to Out 52:	32.0 ft		Highway System 104:	1				
US 24 ML WBND			Deck Area:	2,496. sq. ft		Fed Lands Hiway 105:	0				
Alias Str No.8A:			Min Clr Ovr Brdg 53:	99.99		Year Reconstructed 106:	0000				
			Min Undrclr Ref 54A:	N		Deck Type 107:	1				
Prll Str No. 8P			Min Undrclr 54B:	0.0 ft		Wearing Surface 108A:	6				
I-17-EQ			Min Lat Clrnce Ref R 55A:	N		Membrane 108B:	0				
Location 9:			Min Lat Undrclr R 55B:	0.0 ft		Deck Protection 108C:	0				
IN COLORADO SPRINGS			Min Lat Undrclr L 56:	0		Truck ADT 109:	10 %				
Max Clr 10:	99.99		Deck 58:	7		Trk Net 110:	1				
BaseHiway Net12:	1		Super 59:	7		Pier Protection 111:					
IrsinvRout 13A	000000024A		Sub 60:	6		NBIS Length 112:	Y				
IrssubRout No13B:	00		Channel/Protection 61:	6		Scour Critical 113:	3				
Latitude 16:	38d 50' 18"		Culvert 62:	N		Scour Watch 113M:	0				
Longitude 17:	104d 51' 23"		Oprtng Rtg Method 63:	1 LF Load Facto		Future ADT 114:	34,813				
Range18A:	67 W		Operating Rating 64:	61.0		Year of Future ADT 115:	2023				
Township18B:	67		Inv Rtng Method 65:	1		CDOT Str Type 120A:	CSG				
Section18C:	11		Inventory Rating 66:	36.0		CDOT Constr Type 120B:	0.				
Detour Length 19:	0.6 mi		Asph/Fill Thick 66T:	002 "in"		Inspection Indic 122A:					
Toll Facility 20:	3		Str. Evaluation 67:	6		Inspection Trip 122AA:					
Custodian 21:	1		Deck Geometry 68:	2		Scheduling Status 122B:					
Owner 22:	1		Undrclr Vert/Hor 69:	N		Maintenance Patrol 123:	37				
Functional Class 26:	12		Posting 70:	5		Expansion Dev/Type124:	O				
Year Built 27:	1964		Waterway Adequacy 71:	8		Brdg Rail Type/Mod 125A/B:	K	0			
Lanes on 28A:	2		Approach Alignment 72:	8		Posting Trucks 129A/B/C:	0	0	0		
Lanes Under 28B:	0		Type of Work 75A:	33		Str Rating Date 130:	9/29/1994				
ADT 29:	20,370		Work Done By 75B:	1		Speical Equip 133:					
Year of ADT 30:	2003		Length of Improvment 76:	78.1 ft		Vert Clr N/E 134A/B/C:	X	99.99	0.00		
Design Load 31:	5		Insp Team Indicator 90B:	Red Team (Coff		Vert Clr S/W 135A/B/C:	X	99.99	0.00		
Apr Rdwy Width 32:	35.0 ft		Inspector Name 90C:	COFFRINW		Vertical Clr Date:					
Median 33:	1		Frequency 91:	24 months		Weight Limit Color: 139:	0				
Skew 34:	15.00 °		FC Frequency 92A:	24		Str Billing Type:	U				
Structure Flared 35:	0		UW Frequency 92B:	24		Userkey 1 - System:	ONSYS				
Sfty Rail 36a/b/c/d:	0	0	1	1	SI Frequency 92C:	24	Userkey 7-Update Indi:				
Rail ht36h:	41 "in"		FC Inspection Date 93A:								

Inspector Name: COFFRINW

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Element Inspection Report

Elm/En	Description	Units	Total Qty	% in 1	CS 1	% in 2	CS 2	% in 3	CS 3	% in 4	CS 4	% in 5	CS 5
13/1	Unp Conc Deck/AC Ovl	(SF)	2,496	100 %	2,496	0 %	0	0 %	0	0 %	0	0 %	0
110/1	R/Conc Open Girder	(LF)	312	99 %	310	1 %	2	0 %	0	0 %	0	0 %	0
205/1	R/Conc Column	(EA)	4	100 %	4	0 %	0	0 %	0	0 %	0	0 %	0
215/1	R/Conc Abutment	(LF)	66	100 %	66	0 %	0	0 %	0	0 %	0	0 %	0
221/1	Conc Pile Cap/Ftg	(EA)	4	100 %	4	0 %	0	0 %	0	0 %	0	0 %	0
234/1	R/Conc Cap	(LF)	60	90 %	54	10 %	6	0 %	0	0 %	0	0 %	0
308/1	Constr Non Exp Jt	(LF)	66	100 %	66	0 %	0	0 %	0	0 %	0	0 %	0
321/1	R/Conc Approach Slab	(EA)	2	100 %	2	0 %	0	0 %	0	0 %	0	0 %	0
325/1	Slope Prot/Berms	(EA)	2	50 %	1	50 %	1	0 %	0	0 %	0	0 %	0
326/1	Bridge Wingwalls	(EA)	4	75 %	3	0 %	0	25 %	1	0 %	0	0 %	0
334/1	Metal Rail Coated	(LF)	156	0 %	0	100 %	156	0 %	0	0 %	0	0 %	0
338/1	Conc Curbs/SW	(LF)	156	100 %	156	0 %	0	0 %	0	0 %	0	0 %	0
359/1	Soffit Smart Flag	(EA)	1	0 %	0	100 %	1	0 %	0	0 %	0	0 %	0
501/1	Channel Cond	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0
504/1	BankCond	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0
505/1	Debris Smart Flag	(EA)	1	0 %	0	100 %	1	0 %	0	0 %	0	0 %	0

Elem/Env	Description	Element Notes
13/1	Unp Conc Deck/AC Ovl	2 inches of asphalt. Fairly new. Looks good.
110/1	R/Conc Open Girder	Few light vertical tension cracks. Ends of Girders 2-A and 2-D at Pier 3 have light diag. cracks starting.
205/1	R/Conc Column	Light shrinkage cracks. Some hairline vertical cracks with light delam. and scale.
215/1	R/Conc Abutment	Few light vertical cracks. Bottom of #1 exposed from slope washing.
221/1	Conc Pile Cap/Ftg	New check dam downstream has allowed sediment to build up improving conditions at footers. None exposed this inspection.
234/1	R/Conc Cap	Waterstained. Light scaling with delams. and minor spalls at ends, from leaking joints above.
308/1	Constr Non Exp Jt	Leaks under sidewalks a little. No cracking. Open at sidewalks.
321/1	R/Conc Approach Slab	Covered with asphalt. New approach slab placed at Abut. 4 in 1999, due to washout. Refer to letter in folder.
325/1	Slope Prot/Berms	Berm at Abut. 4 formed and flow filled in 1999, due to washout. Slope at Abut. 4 has been builtup and riprap placed. Forms still in place. See 1/03/2001 PHOTO. Abut. 1 berm is 3 in. to 7 in. low, exposing 3 piles. 12 inch low at left end due to erosion trough forming.
326/1	Bridge Wingwalls	Stubs. #4 left is broken and connected only with rebar.
334/1	Metal Rail Coated	Spotted R-1 throughout.

Colorado Department of Transportation

Structure Inspection and Inventory Report (English Units)

Elem/Env	Description	Element Notes
338/1	Conc Curbs/SW	Few light trans. cracks.
359/1	Soffit Smart Flag	Spots of scattered light map cracking, no efflor. Few small areas of light scale with light efflor. in Span 2.
501/1	Channel Cond	Fountain Creek. Good alignment. Some cutting. Trees and brush. Sandy and cobbles. Check dam 100 feet downstream from parallel bridge. Flow towards Pier 3.
504/1	BankCond	Fairly steep with trees, grass, and brush.
505/1	Debris Smart Flag	Tree branches and trash built up at nose of Pier 3 and along span 3 side of Pier 3 wall.

Maintenance Activity Summary

MMS Activity	Description	Recommended	Status	Year Completed	Est Cost
358.04	Substr	1/3/2001	-1	2003	100

Remove debris at Pier 3.

358.06	Substr	11/28/2006	_	2006	500

Repair wing wall at Abut. 4 left which is badly spalled with exposed rebars.

360.03	App Sl & S	1/3/2001	-1	2003	500

Fill in slope at Abutment #1 where piling and bottom of abutment is exposed.

355.03	Cln & Pnt	1/3/2001	-1	2003	1000

Clean and paint bridge rail.

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Bridge Notes

Inspection Notes

Time: 8:45 Temperature: 40 Degrees Weather: Clear and windy Team leader: WDC

Scope:

☑ NBI: ☑ Element: ☐ Underwater: ☐ Fracture Critical: ☐ Other: Type: Regular NBI

Inspector: COFFRINW Inspection Team:

Inspection Date: 11/28/2006

_____
Inspector

_____
Inspector

◊ HECRAS Scour RESULTS

Contraction Scour			
	Left	Channel	Right
Ys (ft):	0.48	8.71	0.18
Vc (ft/s):	3.07	3.71	2.99
Equation:	Clear	Live	Clear
Pier Scour			
All Piers:	Ys (ft):	4.07	
	Froude #:	0.52	
	Equation:	CSU equation	
Abutment Scour			
	Left	Right	
Abutment Ys (ft):	23.77	8.45	
Ve=	0.00	1.99	
Froude #:	0.40	0.22	
Equation:	HIRE	Froehlich	
Combined Scour Depths			
Pier Scour + Contraction Scour (ft):			
	Channel:	12.78	
Left abut + contr (ft):	32.48		
Right abut + contr (ft):	17.16		

◊ HEC No. 18 Scour RESULTS

Scour Mode Computation

Laursen's Eq $Vc = Ku \times Y1^{1/6} \times D50^{1/3}$ Eq 5.1 HEC 18

500 year Scour analysis

Flow in main Channel width (ft) =	42	
Flow Area in main Channel (ft^2) =	378	
Approach section average channel depth (ft^2), Y1 =	9	ft
Median Grain Size (ft), D50 =	0.0131234	ft
Ku =	11.17	english units
Bed Transport Critical Velocity (fps), Vc =	3.8	fps
Discharge in approach channel (cfs), Q1 =	4790	cfs
Mean Velocity in approach channel (fps), Vm =	12.7	fps

Main channel scour mode Live Bed scour Vc<Vm

Live Bed Contraction Scour

$Ys = Y2 - Y0$

$$Y_2 = ((Q_2/Q_1)^{0.857}((W_1/W_2)^{k1})) * Y_1$$

Energy Slope =	0.0121	
ω Fall Velocity =	0.984	fps
Average Upstream Channel Depth (ft) Y1 =	9.15	
g Grav Accel (ft/sec^2) =	32.2	
V* Shear Velocity in Upstream Section (fps) =	1.88813	fps
V*/ ω =	1.9188281	between 0.5 to 2.0
k_1 from HEC 18 =	0.64	
Discharge in Upstream Channel (cfs), Q_1 =	4790	
Discharge in contracted Channel (cfs), Q_2 =	4571	
Width of Upstream Channel Section (ft), W_1 =	411	
Width of Main Channel Contracted Section (ft), W_2 =	44	
Median Grain Size (ft), D_{50} =	0.0131234	
Computed Water Depth of Contracted Section (ft), Y_2 =	36.7	ft
Avereage Water Depth at Bridge (ft), Y_0 =	8.0	
Average Scour Depth at Contracted Section, Ys =	28.8	ft

Pier Scour Using CSU Equation

500 yr analysis

$Ys = 2.0 * K1 * K2 * K3 * K4 * (Y1 / a)^{0.35} * Fr1^{0.43} * a$

Y1, Flow Depth upstream of the pier, (ft) =	10.72
K1, correction facotre for pier nose shape from Fig 6.3 and Table 6.1 Hec 18 =	0.9
K2, correction factor for angle of attack of flow from Table 6.2 Hec 18 =	1
K3, correction factor for bed condition from Table 6.3 Hec 18 =	1.1
K4, correction factor for armouring by bed material size form EQ 6.5 and Table 6.4 Hec 18 =	1
a, pier width (ft) =	2
L, length of pier (ft) =	62
Fr1, Froude Number directly upstream of the pier =	0.53
Ys =	5.4

$K2 = (\cos \theta + L / a \sin \theta)^{0.65}$

Abutment Scour Using Froehlich's Equation

500 yr analysis

$Y_s / Y_a = 2.27 * K_1 * K_2 \ (L' / Y_a)^{0.43} * Fr^{0.61} + 1$

3.1 Y_s = Scour Depth (ft)

0.55 K_1 = Coefficient for autment shape (Table 7.1)

1 K_2 = Coefficient for angle of embankment to flow

$K_2 = (\theta/90)^{0.13}$ (see Figure 7.5 for definition of θ)

$\theta<90°$ if embankment points downstream

$\theta>90°$ if embankment points upstream

280 L' = Length of active flow obstructed by the embankment, (ft)

1509 A_e = Flow area of the approach cross section obstructed by the embankment, (ft^2)

0.14 Fr = Froude Number of approach flow upstream of the abutment

$V_e/(gy_a)^{1/2}$

1.78463 $V_e = Q_e / A_e$

2693 Q_e = flow obstructed by the abutment and approach embankment, (ft^3/s)

5.4 Y_a = Average depth of flow on the floodplain (A_e/L), (ft)

280 L = Length of embankment projected normal to the flow, (ft)

comparison table	Contrction scour		Pier Scour		Abutment Scour		Total Scour	
	HecRas	HEC no. 18	HecRas	HEC no. 18	HecRas	HEC no. 18	HecRas	HEC no. 18
LT Abut	0.48				23.77		32.5	
RT Abut	0.18				8.45		17.2	
Channel	8.71							
Pier 2		28.8	4.07	5.4		3.1	12.78	34.2
Pier 3		28.8	4.07	5.4		3.1	12.78	34.2

Coomparison Table - HECRAS compared to HEC 18 procedures.

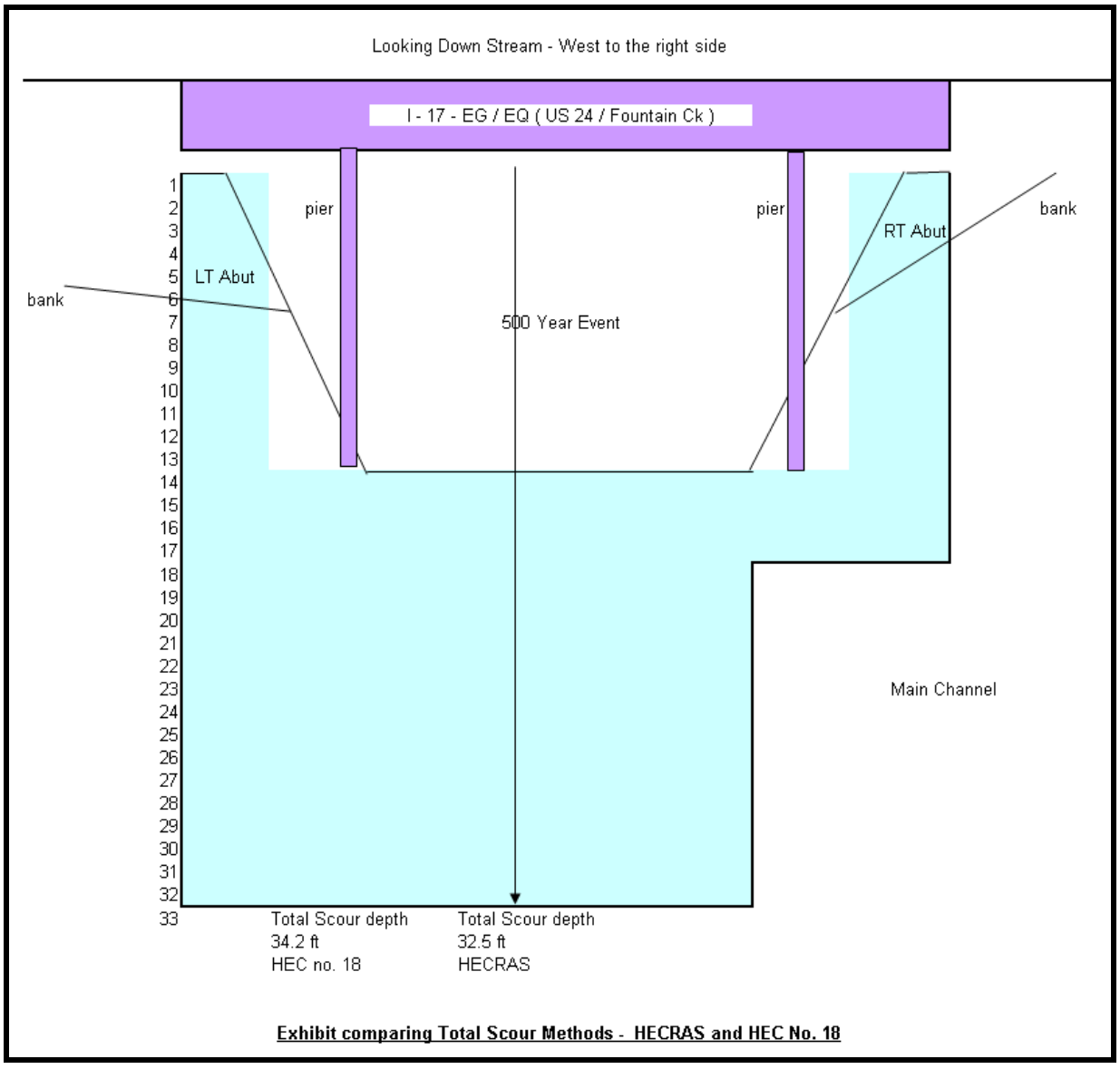


Exhibit comparing Total Scour Methods - HECRAS and HEC No. 18

Revetment RipRap Design Fountain Creek Structure I-17-EG / EQ.

(FHWA HEC No. 23, March 2001)

Average velocity in main channel (Va) = 13.8 fps (500 yr event)
Average depth in main channel (da) = 9 feet

Riprap specific gravity = 2.65; SF = 1.1
Abutment slope 2 horizontal to 1 vertical

$$D_{50} = K_u C V_a^3 / \{ d_{avg}^{0.5} K1^{1.5} \}$$

$K_u = 0.001$ **english units**

$$K1 = [1 - (\sin^2\theta / \sin^2\Phi)]^{0.5} ; \; K1 = 0.73$$

Φ = angle of repose for angular 41°
Θ = angle of horizontal to vertical bank slope 2 : 1. Θ = 26.6°

$$C = 1.61 (SF)^{1.5} / (S_s - 1)^{1.5}; \; C = 0.87$$

$$D_{50} = 0.001 \times 0.87 \times 13.8^{3} / (9^{0.5} \times 0.73^{1.5}) = 1.22 \text{ ft}$$

Use Facing class riprap with gradation: 100% passing 200 lbs at 1.3' dia; 50% passing 75 lbs at 0.95' dia; and 10% passing 5 lbs at 0.4' dia. Cover the slope and 3 feet of the channel with a minimum thickness = 1.5(1.22) = 1.8 ft.

Rip Rap specification recommended for Fountain Creek at CDOT I-17-EG / EQ.