FALCON DRAINAGE BASIN PLANNING STUDY

SELECTED PLAN REPORT

FINAL - SEPTEMBER 2015

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6.0 PLAN DEVELOPMENT DESIGN

6.1. Introduction

The purpose of the plan development design effort was to refine the selected detention and reach alternatives for the Falcon Watershed and finalize proposed infrastructure improvements and associated implementation costs. The recommended detention and reach alternatives, outlined in Section 5.0, were vetted through one public meeting and several project team meetings. The Sub Regional Detention Alternative along with the corresponding reach alternatives were selected to carry forward into plan development. The detention pond and reach components from the selected alternative were analyzed using a more detailed set of criteria to ensure that the recommendation would be feasible for future implementation. The outcome of the selected plan development design is a conceptual set of infrastructure improvements and costs for use in the fee development phase of this DBPS. All backup calculations and data are provided in Appendix D.

6.2. Selected Detention Alternative

The Sub Regional Detention Alternative that was recommended in Section 5.3 was refined by:

- Performing rough grading at each potential location.
- Maximizing storage for ponds based on existing site conditions.
- Modifying the SSD curves to target EURV or WQCV, and 100-yr volume with no spillway overtopping as outlined in Section 5-3. The EURV target outflow was based on releasing the EURV over 72 hours. The WQCV drain time was 40 hours. 100-yr target outflows were historical 100-yr flow where possible given storage constraints; selected as either the existing 100-yr flow or the lowest attainable 100-yr peak flow based on pond limitations. Release rates were greater than historic in some cases due to storage limitations. Storage and discharge requirements were calculated based on the guidelines outlined in the UDFCD DCM, Vol. 2.
- Assessing the hydrologic benefit of each pond.
- Spillway overtopping based on stage and storage calculations at 2 ft above the spillway elevation.

Full spectrum detention was incorporated into all existing and proposed detention ponds where applicable for this alternative. However, in some cases other controls were used due to pond volume limitations. A detailed analysis and summary for all of the detention ponds in the selected alternative are provided in Appendix D.

6.2.1. Detention Pond Classification

The selected detention alternative consists of 23 ponds that fall within 2 different classifications: existing constructed ponds and proposed ponds. All ponds are shown graphically in Figure 6-1.

Existing Constructed Ponds

Existing constructed ponds include PBH C, PBH A, PBH B1, PBH B2, M 1, R WUS, WH H, M 2, R MN, WH 5, PB 4, WH 1N, WH 1S, WH 2, WH 3, and WH 4. These ponds are currently constructed and functioning within the Falcon Watershed. Each of these ponds was evaluated to determine if it could be retrofit to provide a benefit to the selected detention alternative. Table 6-1 shows the proposed modification to the outlet stages of each of the existing constructed ponds.

Table 6-1. Existing Pond Outlet Modifications

Pond	Proposed Outlet Stages
Paintbrush Hills Pond C	EURV + 100-yr
Paintbrush Hills Pond A	WQCV + 100-yr
Paintbrush Hills Pond B1	Existing Configuration
Paintbrush Hills Pond B2	EURV + 100-yr
The Meadows Pond #1	EURV + 100-yr
Regional Pond WU South	EURV + 100-yr
Woodmen Hills Pond H	Existing Configuration
The Meadows Pond #2	EURV + 100-yr
Regional Pond MN	WQCV + 100-yr
Woodmen Hills Pond #5	EURV + 100-yr
Paint Brush Hills Pond #4	Existing Configuration
Woodmen Hills Pond #1 North	100-yr Only
Woodmen Hills Pond #1 South	EURV Only
Woodmen Hills Pond #2	EURV + 100-yr
Woodmen Hills Pond #3	WQCV + 100-yr
Woodmen Hills Pond #4	EURV + 100-yr

Both Woodmen Hills Pond H and Paint Brush Hills Pond #4 are grossly undersized and both of the spillways currently overtop during the 100-yr storm. As a result, no retrofit solution was provided for these ponds. It is recommended that on-site detention be incorporated upstream of these ponds to reduce flooding at these locations. The drainage area that needs to be mitigated by an EURV or WQCV at these pond locations was accounted for in downstream detention ponds.

Proposed Ponds

Proposed ponds include ponds SR 1, SR 2, SR 3, SR 4, R 1, SR 6, and R 2. These ponds are not constructed or planned for and are recommended as a part of the selected detention alternative. Table 6-2 shows the hydraulic configurations for the proposed ponds.

Table 6-2. Proposed Pond Outlet Configurations

Pond	Outlet Stages
Sub Regional Pond SR1	WQCV + 100-yr
Sub Regional Pond SR2	EURV Only
Sub Regional Pond SR3	EURV Only
Sub Regional Pond SR4	WQCV + 100-yr
Regional Pond R1	EURV + 100-yr
Sub Regional Pond SR6	EURV + 100-yr
Regional Pond R2	EURV Only

6.2.2. Hydrologic Results

The hydrologic results for the selected detention alternative are shown in Table 6-3. These results reflect all 23 ponds shown in Figure 6-1.

Table 6-3. Selected Detention Alternative Results

Location	HEC-HMS Element	Sub Regional Peak Flow (cfs)	
		2-year	100-year
West Tributary			
Raygor Rd.	JWT030	9	85
Stapleton Rd.	JWT120	55	710
Woodmen Rd.	JWT210	81	1,000
Hwy. 24	JWT250	64	980
Falcon Hwy.	JWT260	70	1,000
Garrett Rd.	JWT320	80	1,500
East Blaney Rd.	JWT354	140	2,200
Upstream of Bennett Ranch Tributary	JWT374_Outlet	140	2,200
Middle Tributary			
Woodmen Hills Dr.	JMT010	5	99
Woodmen Rd.	JMT070	31	840
Hwy. 24	JMT106	33	840
Falcon Hwy.	JMT110	34	860
Confluence with West Tributary	RMT114	34	860
East Tributary			
Stapleton Dr.	JET020	9	200
Woodmen Hills Dr.	JET040	10	260
Eastonville Rd.	JET060	13	360
Hwy. 24	JET090	31	300
Pinto Pony Rd.	JET100	32	300
Falcon Hwy.	JET120	50	400
Garrett Rd.	JET160	67	640
Confluence with West Tributary	RET164	66	630

6.2.3. Detention Pond Sizes & Cost Estimate

The detention ponds sizes and costs estimate as a result of selected detention alternative are provided in Table 6-4. Assumptions that were used in developing the detention pond cost estimate are as follows:

- Land requirement for proposed ponds is based on proposed rough grading and the corresponding footprint at the spillway stage.
- Construction cost based on $24,500/ac-ft as documented in the Jimmy Camp Creek DBPS - FSD Costs Memo. Engineering costs were removed from construction cost and added later to the subtotal.
- Land cost was estimated as $50,000/ac based on the current (2013) El Paso County Parks land value of $46,954/ac.
- Improvement cost was estimated at $20,000 per modified pond to retrofit existing outlet structures for EURV/WQCV and 100-yr flood control. Not all existing ponds were retrofit.

Table 6-4. Detention Pond Cost Estimate

Pond	Pond Volume (ac-ft)	Land Requirement (ac)	Construction Cost ($)	Land Cost ($)	Improvement Cost ($)	Total Cost ($)
Paint Brush Hills Pond #4	1.34	-	$ -	$ -	$ -	$ -
Paint Brush Hills Pond A	2.62	-	$ -	$ -	$ 20,000	$ 20,000
Paint Brush Hills Pond B1	9.17	-	$ -	$ -	$ -	$ -
Paint Brush Hills Pond B2	12.09	-	$ -	$ -	$ 20,000	$ 20,000
Paint Brush Hills Pond C	6.77	-	$ -	$ -	$ 20,000	$ 20,000
Regional Pond MN	7.53	-	$ -	$ -	$ 20,000	$ 20,000
Regional Pond R1	25.00	18.8	$ 532,609	$ 940,420	$ -	$ 1,473,028
Regional Pond R2	3.13	5.1	$ 66,634	$ 255,974	$ -	$ 322,608
Regional Pond WU South	39.54	-	$ -	$ -	$ 20,000	$ 20,000
Sub Regional Pond SR1	11.03	3.4	$ 234,987	$ 170,782	$ -	$ 405,769
Sub Regional Pond SR2	2.05	5.2	$ 43,674	$ 257,529	$ -	$ 301,203
Sub Regional Pond SR3	1.03	0.8	$ 21,943	$ 27,609	$ -	$ 49,552
Sub Regional Pond SR4	19.37	20.5	$ 412,665	$ 1,022,834	$ -	$ 1,435,500
Sub Regional Pond SR6	11.82	6.7	$ 251,817	$ 334,260	$ -	$ 586,078
The Meadows Pond #1	3.25	-	$ -	$ -	$ 20,000	$ 20,000
The Meadows Pond #2	7.94	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #1 North	7.13	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #1 South	8.78	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #2	9.18	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #3	8.35	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #4	40.45	-	$ -	$ -	$ 240,000	$ 240,000
Woodmen Hills Pond #5	4.10	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond H	2.66	-	$ -	$ -	$ -	$ -
				Subtotal		$ 5,053,738
				Engineering/ Construction Admin. (15%)		$ 758,061
				Contingency (20%)		$ 1,010,748
				Total		**$ 6,822,546**

Additional costs as a percentage of the subtotal construction cost include Engineering/Construction Administration (15%), and Contingency (20%). Detailed quantities and cost estimates are provided in Appendix D.

6.2.4. Detention Pond Phasing Priority

Detention pond construction or modification should be phased so that detention ponds located at the upper end of tributaries are constructed first and detention ponds located on the main stem are constructed last. This method of phasing helps reduce sediment issues that may be caused by construction activities if upstream ponds are developed after ponds on the main stem. In addition to pond location, consideration must also be given to the timing of new development. Detention ponds should generally be constructed or modified along with upstream development with an interim condition in place to mitigate the increased sediment load caused by construction.

Table 6-5 lists the phasing priority for each of the existing and proposed ponds. A phasing priority of "1" means the pond should be constructed or modified immediately or as soon as upstream/adjacent development begins. Higher phasing priority numbers indicate more upstream detention ponds must be built prior to construction of the pond in question.

Table 6-5. Detention Pond Phasing Priority

Pond	Phasing Priority	Constraint
Paint Brush Hills Pond #4	2	None
Paint Brush Hills Pond A	1	Modify after PBH-C
Paint Brush Hills Pond B1	1	None
Paint Brush Hills Pond B2	1	Modify after PBH-B1
Paint Brush Hills Pond C	1	Modify after SR1
Regional Pond MN	3	None
Regional Pond R1	4	Construct after R-WU, R-MN, and WH5
Regional Pond R2	4	Construct after R1 and WH4
Regional Pond WU South	3	Modify after SR3
Sub Regional Pond SR1	1	None
Sub Regional Pond SR2	2	Construct after PBH-A and PBH-B2
Sub Regional Pond SR3	3	Construct after SR2 and M1
Sub Regional Pond SR4	3	Construct after M2 and WH-H
Sub Regional Pond SR6	2	Construct after PBH4
The Meadows Pond #1	2	None
The Meadows Pond #2	2	None
Woodmen Hills Pond #1 North	3	Construct after SR6
Woodmen Hills Pond #1 South	3	Construct after WH1n
Woodmen Hills Pond #2	3	Construct after WH1s
Woodmen Hills Pond #3	3	Construct after WH2
Woodmen Hills Pond #4	4	Construct after WH3
Woodmen Hills Pond #5	3	None
Woodmen Hills Pond H	2	None

6.3. Selected Reach Alternatives

The selected reach alternatives, as defined in Section 5-4, were refined using the flows reported in Section 6.2. Additionally, all bridge and culvert crossings were evaluated as a part of the selected reach alternatives. A summary of the selected reach alternatives is provided graphically in Figure 6-1.

6.3.1. Reach Evaluation

A summary of the reach screening results is provided in Table 6-6.

Table 6-6. Selected Reach Alternatives

Alternative	Length (ft)
Natural Channel Design	13,216
Protect in Place	64,325
Roadside Ditch Improvement	7,519
Small Drop Structures w/Toe Protection	50,751
Total	**135,811**

6.3.2. Bridge & Culvert Crossing Evaluation

All of the bridge and culvert crossings on the main stem of the creek were evaluated for adherence to DCM criteria. Bridge and culvert crossings were analyzed using the 100-year peak flow from the selected detention alternative. The culvert and bridge design criteria listed in the DCM, Pg. 6-10 was used to evaluate the adequacy of each crossing. The results of the evaluation are provided in Table 6-7.

Table 6-7. Existing Bridge and Culvert Crossing Evaluation

Crossing	Location	Q100 (cfs)	Structure Class[1]	Existing Size	Within Criteria[2]	Reason
WT 14	Burgess Rd.	89	Culvert	1.5'dia	No	Overtops, Does Not Meet Hw/D
WT 13	Pine Park Trl.	89	Culvert	2.5'dia	No	Overtops, Does Not Meet Hw/D
WT 11	Arroya Ln	480	Culvert	1'dia	No	Overtops, Does Not Meet Hw/D
WT 10	Woodmen Rd.	1,000	Culvert	8.75'x 18.92'	Yes	
WT 9	Meridian Rd.	1,100	Bridge	(4) 6'x 10'	No	Does Not Meet Freeboard
Pond WU Inlet	Tamlin Rd.	1,100	Culvert	(3) 1.5'dia	No	Overtops, Does Not Meet Hw/D
WT 7-2	Rail Road	970	Bridge	7.41'x 54'	Yes	
WT 7-1	Hwy. 24	970	Bridge	(3) 6'x 12'	No	Does Not Meet Freeboard
WT 6	Falcon Hwy.	1,000	Culvert	(2) 5.58'x 8.25'	No	Overtops
WT 5	Meridian Rd.	1,100	Culvert	2'dia	No	Does Not Meet Hw/D
WT 5-2	Meridian Rd.	1,100	Culvert	1.5'dia	No	Overtops, Does Not Meet Hw/D
WT 4	W. Condor Rd.	1500	Bridge	4'dia	No	Overtops, Does Not Meet Freeboard
WT 3	Garrett Rd.	1,500	Bridge	(3) 7.33'x 12'	No	Does Not Meet Freeboard
WT 1	Blaney Rd.	2,200	Bridge	(2) 3'dia	No	Overtops, Does Not Meet Freeboard
MT 7	Owl Ln.	299	Culvert	1.25'x 1.75'	No	Overtops, Does Not Meet Hw/D
MT 6	Woodmen Rd.	840	Culvert	(3) 4'dia	No	Overtops, Does Not Meet Hw/D
MT 6-2	Woodmen Rd.	840	Culvert	(3) 4'dia	No	Overtops, Does Not Meet Hw/D
MT 5-1	McLaughlin Rd.	820	Bridge	5.22'x 27'	No	Does Not Meet Freeboard
MT 4	Rail Road	840	Bridge	9.17'x 77'	Yes	
MT 3	Hwy. 24	840	Bridge	(2) 6'x 12'	No	Does Not Meet Freeboard
MT 2	Swingline Rd.	860	Bridge	6.83'x 20'	No	Does Not Meet Freeboard
MT 1	Falcon Hwy.	860	Culvert	2'dia	No	Overtops, Does Not Meet Hw/D
ET 32	Liberty Grove Dr.	200	Culvert	(2) 3.5'dia	No	Does Not Meet Hw/D
ET 31	Stapleton Dr.	200	Culvert	(2) 2.5'x 6'	No	Overtops, Does Not Meet Hw/D
ET 30	Royal County Down Rd.	270	Culvert	6'dia	Yes	
ET 26	Rio Secco Ln.	270	Culvert	(3) 4'dia	No	Overtops, Does Not Meet Hw/D
ET 19	Eastonville Rd.	530	Culvert	6'dia	No	Does Not Meet Hw/D
ET 15	Rail Road	300	Bridge	6.5' x 67'	No	Does Not Meet Freeboard
ET 14	Hwy. 24	300	Bridge	(2) 4.83'x 12'	No	Does Not Meet Freeboard
ET 13	Pinto Pony Rd.	300	Culvert	(2) 4'dia	No	Overtops, Does Not Meet Hw/D
ET 11	Falcon Hwy.	400	Culvert	(2) 5'dia	No	Overtops, Does Not Meet Hw/D
ET 10	N. Condor Rd.	590	Culvert	3.17'x 4.67'	No	Overtops, Does Not Meet Hw/D
ET 9	Sunset Trl.	590	Culvert	4'dia	No	Overtops, Does Not Meet Hw/D
ET 4	Garrett Rd.	640	Culvert	3.17'x 4.67'	No	Overtops, Does Not Meet Hw/D

Notes:
[1]According to the Drainage Criteria Manual

6.3.3. Plans & Profiles

Sheets 6-2 through 6-50 provide more detailed plan and profile views of selected reach improvements for each planning reach. These conceptual plans show stream centerline, detention ponds and associated data, proposed grade control structures, drainageway crossings and proposed improvements, and the approximate 100-yr floodplain along with existing infrastructure such as roadways and storm sewers. Hydraulic grade lines shown on the profile, representing the WSE for 5- and 100-year storm events, were generated using HEC-RAS along the main stem of each major tributary.

Sheets 6-51 through 6-56 provide typical details and section views of proposed reach grade control structures, detention pond profiles, and proposed roadside ditch improvements.

6.3.4. Reach Quantities & Cost Estimate

The assumptions and methods used to calculate the quantities and costs for each alternative category listed in Table 6-6 and defined in Section 5.4 are provided in the following sections. Additional costs as a percentage of the subtotal construction cost include Engineering/Construction Administration (15%) and Contingency (20%). Detailed quantities and cost estimates are provided in Appendix D.

Roadside Ditch Sizing

The quantities for this reach alternative include the infrastructure necessary to provide sufficient capacity for roadside ditches only. The required roadside ditch sizes were assumed to have the same slope and roughness as the infrastructure that is being replaced. The quantities and costs for all infrastructure sizing reaches are provided in Table 6-8.

Table 6-8. Roadside Ditch Cost Estimate

Reach	Length (ft)	Q100 (cfs)	Total Cost ($)
RWT344	1,379	250	$ 167,006
RWT354	16	2,200	$ 23,544
RET140	4,052	85	$ 295,914
RET164	2,072	630	$ 132,703
		Subtotal	$ 619,166
		Engineering/Construction Admin. (15%)	$ 92,875
		Contingency (20%)	$ 123,833
		Total	**$ 835,874**

Natural Channel Design

The quantities for this reach alternative include the number of structures per reach. Natural channel design costs were developed with the following assumptions:

- The crest width for a natural channel drop structure is the channel width associated with the low flow (bankfull) event as defined in the DCM update Section 3.1.1.1.
- Natural channel structures were spaced at increments of 7 times the low flow channel width.
- Cost per structure based on $24,400 per structure plus $420 times the width of the low flow channel.

The quantities and costs for all natural channel design reaches are provided in Table 6-9.

Table 6-9. Natural Channel Design Reaches Cost Estimate

Reach	Length	Number of Structures	Cost
RET120	1,379	2	$ 72,798
RET154	2,357	14	$ 468,927
RET156	942	2	$ 73,722
RWT094	2,145	7	$ 1,474,717
RWT122	518	2	$ 424,187
RWT150	3,741	24	$ 765,482
RWT210_upstream	2,132	16	$ 593,011
		Subtotal	$ 2,291,521
		Engineering/Construction Admin. (15%)	$ 343,728
		Contingency (20%)	$ 548,304
		Total	**$ 3,093,554**

Small Drop Structures

The quantities for this reach alternative include earthwork, rip rap toe protection, vegetation, and small (3ft vertical) drop structures. Note that small drop structures span the low flow channel width. Small drop structure reach costs were developed with the following assumptions:

- Earthwork is required to fill the existing degraded channel area to approximate the original section. Earthwork was estimated to cost $15 per cubic yard.
- Revegetation is required to cover the area equal to the earthwork area. Revegetation was estimated to cost $0.50 per square foot.
- Small drop structures are 3ft vertical with a 3ft key depth for a 6ft total height. The cost for small drop structures is estimated using a regression equation developed for this DBPS and is a function of their total height of 6ft and the low flow channel width. The average cost per small drop structure is about $208,000.
- Small drop structures are to be spaced by assuming that the existing channel slope degrades to a design slope less than 0.4 percent and the total drop structure height (6ft) is utilized.

The quantities and costs for all small drop structure reaches are provided in Table 6-10.

Table 6-10. Small Drop Structure Reaches Cost Estimate

	Reach	Length	Cost ($)	
	RET020	1,915	$ 1,169,444	
	RET030	5,042	$ 1,405,908	
	RET040	1,820	$ 1,073,275	
	RET100	1,791	$ 1,342,120	
	RET110	2,751	$ 1,055,516	
	RET152	2,030	$ 1,081,390	
	RET162	3,256	$ 656,460	
	RMT050	1,508	$ 814,189	
MID	RMT062	5,688	$ 2,381,127	400lf @ $418.62/lf = $167,448
EAST	RMT064	3,358	$ 1,231,110	450lf @ $366.32/lf = $164,844
	RMT102	1,021	$ 636,082	
	RMT104	874	$ 186,349	
	RMT106	226	$ 212,322	
	RMT112	3,372	$ 1,276,142	
	RMT114	1,667	$ 853,693	
	RWT054	2,497	$ 1,414,531	
	RWT080	3,494	$ 2,345,153	
	RWT092	626	$ 414,434	
	RWT124_upstream	1,246	$ 640,054	
	RWT174	1,871	$ 606,335	
	RWT234	2,129	$ 976,863	
	RWT296	1,134	$ 223,458	
	RWT372	1,377	$ 947,221	
	Subtotal		$ 22,943,176	
	Engineering/Construction Admin. (15%)		$ 3,441,476	
	Contingency (20%)		$ 4,588,635	
	Total		**$ 30,973,288**	

Bridge and Culvert Crossing Replacements

The proposed size for crossing replacements includes the infrastructure necessary to provide the bridge or culvert with sufficient capacity to adhere to DCM criteria. Costs were estimated using a regression equation developed for this DBPS that was based on 2012 UDFCD master plan costs. Note that several crossings (e.g., WT 5-2, WT 4, WT 1, and MT 1) require such a large number of cells to comply with criteria that the proposed configurations are likely impractical. These locations may necessitate consideration of a more comprehensive capital improvement project including raising the roadway profile to achieve feasibility. The quantities and costs for all crossing replacements are provided in Table 6-11.

Table 6-11. Crossing Replacement Cost Estimate

Crossing	Location	Q100 (cfs)	Proposed Size	Length	Total Cost
WT 14	Burgess Rd.	89	5'	66	$ 31,585
WT 13	Pine Park Trl.	89	5'	53	$ 28,525
Pond WU Inlet Structure	Tamlin Rd.	1,110	(8) 6' x 12'	74	$ 658,410
WT 6	Falcon Hwy.	1,000	(5) 6' x 12'	43	$ 249,775
WT 5	Meridian Rd.	1,100	3'	43	$ 8,651
WT 5-2	Meridian Rd.	1,100	(25) 3' x 10'	43	$ 718,121
WT 4	W. Condor Rd.	1,500	(11) 5' x 12'	48	$ 528,324
WT 3	Garrett Rd.	1,500	(3) 9' x 12'	46	$ 218,292
WT 1	Blaney Rd.	2,200	(16) 5' x 12'	40	$ 636,648
MT 7	Owl Ln.	299	(9) 2' x 4'	58	$ 207,465
MT 6	Woodmen Rd.	840	(3) 5'	200	$ 166,177
MT 6-2	Woodmen Rd.	840	(3) 5'	220	$ 181,365
MT 5-1	McLaughlin Rd.	820	(3) 7' x 12'	48	$ 191,098
MT 2	Swingline Rd.	840	(3) 8' x 12'	83	$ 343,147
MT 1	Falcon Hwy.	860	(11) 4' x 12'	45	$ 433,032
ET 31	Stapleton Dr.	200	(2) 4' x 12'	302	$ 525,026
ET 19	Eastonville Rd.	530	7' x 10'	39	$ 63,340
ET 13	Pinto Pony Rd.	300	(2) 6' x 8'	50	$ 113,991
ET 11	Falcon Hwy.	400	(2) 6' x 8'	40	$ 84,348
ET 10	N. Condor Rd.	590	(3) 7' x 10'	44	$ 162,656
ET 9	Sunset Trl.	490	(2) 6' x 8'	40	$ 84,102
ET 4	Garrett Rd.	640	(2) 5' x 8'	61	$ 106,060
				Subtotal	$ 5,740,139
				Engineering/Construction Admin. (15%)	$ 861,021
				Contingency (20%)	$ 1,148,028
				Total	**$ 7,749,187**

No crossing improvements were necessary at WT 10, WT 7-2, MT 4, or ET 30 since the hydraulic condition at these locations were within criteria as noted in Table 6-7. Crossings WT 7-1, MT 3, and ET 14 were not resized because they are CDOT structures. Crossing WT 11 was not resized because it is located under a private drive. Other crossings, including WT 9, ET 32, ET 26, and ET 15, were not resized because the degree of criteria exceedance was so minor that they did not warrant replacement.

6.3.5. Immediate Action Required

There are 6 locations where immediate action is required in order to preserve the existing reach conditions as shown in Figure 6-1. These locations are at points adjacent to pristine channel reaches, or Natural Channel Design reaches, where current erosion or deposition has been identified. If left unmitigated, the issues at these locations have the potential to propagate and worsen the existing condition, thereby necessitating additional reach improvement costs. These locations can be addressed by implementing the recommended reach alternative for the impaired reach at the sites that are identified while improvements for the remainder of the impaired reaches can be constructed at a later date.

6.3.6. Protect In Place

There are several relatively pristine reaches of channel throughout the Falcon Watershed that are currently in a stable condition. Additionally, there are several reaches throughout the Falcon Watershed that have already been improved and appear to be stable. Preserving both of these reach conditions would not require a direct reach improvement cost. However, upstream detention improvements may be required depending on the location of the reach.

6.3.7. Reach Phasing Priority

Reach construction should be phased so that planned upstream detention ponds are constructed prior to reach construction. This method of phasing protects the reach alternatives from being damaged as a result of higher than designed for flows being released into the reach. A phasing priority of 1 means the reach can be constructed. Higher phasing priority numbers indicate more upstream detention ponds should be built prior to construction of the reach in question. The phasing priority for each of the reaches is provided in Appendix D.

6.4. Cost Summary

Costs for all detention ponds, reach improvements, bridge and culvert replacements, and roadside ditches are summarized in Table 6-12.

Table 6-12. Cost Summary

Alternative	Cost[1]
Detention Ponds	$ 6,822,546
Roadside Ditches	$ 835,874
Reaches[2]	$ 34,066,842
Bridge & Culvert Crossings	$ 7,749,187
Total	**$ 49,474,449**

Notes:
[1]Includes all construction and additional costs
[2]Reaches includes both Natural Channel Design and Small Drop Structure reaches

Falcon DBPS

Sub Regional Detention Alternative[1]

Pond	Q_2 In (cfs)	Q_2 Out (cfs)	Q_{100} In (cfs)	Q_{100} Out (cfs)	Required Volume (AF)[2]	Land Requirement (ac)[3]	Construction Cost[4]	Land Cost[5]	Improvement Cost[6]	Total Cost
Paint Brush Hills Pond #4	38	29	200	150	1.34	0	$ -	$ -	$ -	$ -
Paint Brush Hills Pond A	35	7	170	140	2.62	0	$ -	$ -	$ 20,000	$ 20,000
Paint Brush Hills Pond B1	80	51	420	270	9.17	0	$ -	$ -	$ -	$ -
Paint Brush Hills Pond B2	51	10	270	180	12.09	0	$ -	$ -	$ 20,000	$ 20,000
Paint Brush Hills Pond C	56	3	300	140	6.77	0	$ -	$ -	$ 20,000	$ 20,000
Regional Pond MN	65	32	850	820	7.53	0	$ -	$ -	$ 20,000	$ 20,000
Regional Pond R1	110	77	1,600	1,500	25.00	18.8	$ 532,609	$ 940,420	$ -	$ 1,473,028
Regional Pond R2	140	140	2,200	2,200	3.13	5.1	$ 66,634	$ 255,974	$ -	$ 322,608
Regional Pond WU South	47	22	1,100	930	39.54	0		$ -	$ 20,000	$ 20,000
Sub Regional Pond SR1	54	42	610	510	11.03	3.4	$ 234,987	$ 170,782	$ -	$ 405,769
Sub Regional Pond SR2	65	65	840	840	2.05	5.2	$ 43,674	$ 257,529	$ -	$ 301,203
Sub Regional Pond SR3	72	72	910	910	1.03	0.6	$ 21,943	$ 27,609	$ -	$ 49,552
Sub Regional Pond SR4	130	27	1,000	730	19.37	20.5	$ 412,665	$ 1,022,834	$ -	$ 1,435,500
Sub Regional Pond SR6	74	9	390	200	11.82	6.69	$ 251,817	$ 334,260	$ -	$ 586,078
The Meadows Pond #1	11	0	70	0	3.25	0	$ -	$ -	$ 20,000	$ 20,000
The Meadows Pond #2	28	5	210	100	7.94	0	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #1 North	65	61	390	260	7.13	0	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #1 South	61	10	260	260	8.78	0	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #2	37	10	270	250	9.18	0	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #3	110	13	530	360	8.35	0	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #4	110	15	790	260	40.45	0	$ -	$ -	$ 240,000	$ 240,000
Woodmen Hills Pond #5	40	1	130	20	4.10	0	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond H	140	110	750	750	2.66	0	$ -	$ -	$ -	$ -

Subtotal	$ 5,053,738
Engineering (15%)	$ 758,061
Contingency (20%)	$ 1,010,748
Total	$ 6,822,546

Notes

[1] Represents future hydrology with retrofit existing detention ponds and 7 new sub regional detention ponds

[2] Required volume to highest WSE, either EURV or 100-yr respectively, not including embankment

[3] Land requirement is based on approximate grading at spillway stage. Refer to Conceptual Plan GIS mapbook. Copied as value from GIS attribute.

[4] Based on $24,500/AF as documented in the Jimmy Camp Creek DBPS - FSD Costs Memo. The published value includes engineering costs - so dividing this cost by 1.15 to represent construction portion only.

[5] From Jeff Rice via comment letter on 5/24/13: Use $50,000/Ac. for land purchase costs, with a note that the actual current (2013) Parks fees are based on land value of $46,954/Ac.

[6] Includes costs to retrofit existing outlet structures for EURV/WQCV and 100-yr flood control. This costs assumes a plate can be placed over a low flow orifice and/or an opening be cut out of the existing drop structure OR 2 CDOT Type C inlets w/ 100LF of 48" RCP be used for the retrofit. Not all existing ponds are retrofit. Woodmen Hills Pond #4 improvement cost was taken directly from the March 2011 Wilson & Co. Pond 4 Assessment Report Preliminary Cost Estimates table for Alternative 2 on pg. 21.

Falcon DBPS

Crossing Upsize and Cost

Crossing	Location	Proposed Size						Length	Cost ($/LF)	Culvert Cost ($)	End Treatment			Total Culvert Cost ($)
		# of Cells	Diameter (ft.)	Diameter (in)	Rise (ft)	x	Span (ft)				Flared End	Headwall	Wingwall	
WT 14	Burgess Rd.	1	5	60				66	$ 253	$ 16,600		$ 3,244	$ 11,741	$ 31,585
WT 13	Pine Park Trl.	1	5	60				53	$ 253	$ 13,539		$ 3,244	$ 11,741	$ 28,525
Pond WU Inlet Structure	Tamlin Rd.	8		0	6	x	12	74	$ 8,637	$ 642,018			$ 16,392	$ 658,410
WT 6	Falcon Hwy.	5		0	6	x	12	43	$ 5,398	$ 233,383			$ 16,392	$ 249,775
WT 5	Meridian Rd.	1	3	36				43	$ 126	$ 5,431	$ 3,220			$ 8,651
WT 5-2	Meridian Rd.	25		0	3	x	10	43	$ 16,550	$ 713,283			$ 4,837	$ 718,121
WT 4	W. Condor Rd.	11		0	5	x	12	48	$ 10,704	$ 516,582			$ 11,741	$ 528,324
WT 3	Garrett Rd.	3		0	9	x	12	46	$ 4,014	$ 182,723			$ 35,569	$ 218,292
WT 1	Blaney Rd.	16		0	5	x	12	40	$ 15,570	$ 624,906			$ 11,741	$ 636,648
MT 7	Owl Ln.	3		0	2	x	4	58	$ 3,533	$ 204,974			$ 2,491	$ 207,465
MT 6	Woodmen Rd.	3	5	60				200	$ 759	$ 151,872		$ 2,564	$ 11,741	$ 166,177
MT 6-2	Woodmen Rd.	3	5	60				220	$ 759	$ 167,059		$ 2,564	$ 11,741	$ 181,365
MT 5-1	McLaughlin Rd.	3		0	7	x	12	48	$ 3,528	$ 169,345			$ 21,753	$ 191,098
MT 2	Swingline Rd.	3		0	8	x	12	83	$ 3,786	$ 314,837			$ 28,310	$ 343,147
MT 1	Falcon Hwy.	11		0	4	x	12	45	$ 9,420	$ 425,111			$ 7,921	$ 433,032
ET 31	Stapleton Dr.	2		0	4	x	12	302	$ 1,713	$ 517,104			$ 7,921	$ 525,026
ET 19	Eastonville Rd.	1		0	7	x	10	39	$ 1,063	$ 41,587			$ 21,753	$ 63,340
ET 13	Pinto Pony Rd.	2		0	6	x	8	50	$ 1,713	$ 85,680			$ 28,310	$ 113,991
ET 11	Falcon Hwy.	2		0	6	x	8	40	$ 1,713	$ 67,956			$ 16,392	$ 84,348
ET 10	N. Condor Rd.	3		0	7	x	10	44	$ 3,188	$ 140,903			$ 21,753	$ 162,656
ET 9	Sunset Trl.	2		0	6	x	8	40	$ 1,713	$ 67,710			$ 16,392	$ 84,102
ET 4	Garrett Rd.	2		0	5	x	8	61	$ 1,546	$ 94,319			$ 11,741	$ 106,060
													Subtotal	$ 5,740,139
													Engineering/Construction Admin (15%)	$ 861,021
													Contingency (20%)	$ 1,148,028
													Total	**$ 7,749,187**

Note: does not include concrete aprons

Falcon DBPS

Small Drop Cost

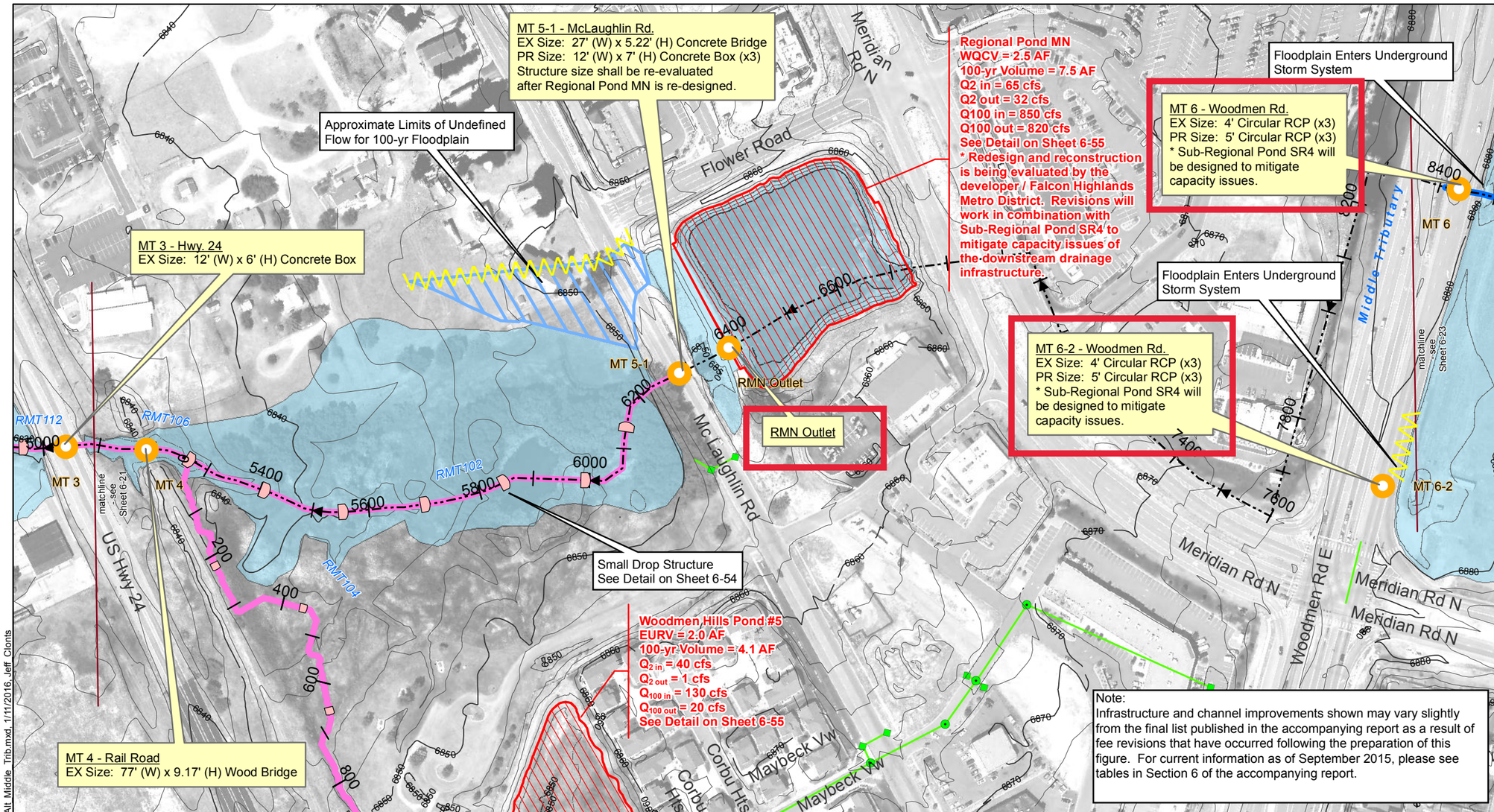
Reach	Reach Alternative	Reach Length (ft)	Reach Slope (ft/ft)	$W_{Low\ Flow}$ (ft)	Low Flow Design Slope (ft/ft)	# of Structures	Structure Height (ft)	Cost Per Structure	Total Structure Cost	Earthwork Length (ft)	Earthwork Average Width (ft)	Earthwork Depth (ft)	Earthwork Adjusted Depth (ft)	Earthwork (CY)	Earthwork Cost	Erosion Control Blanket (SY)	Erosion Control Blanket Cost	Revegetation (SF)	Revegetation Cost	Total Reach Cost
RET020	Small Drop Structures w/ Toe Protection	1,915	0.025	18	0.0079	6	6	$ 193,564	$ 1,161,384	963	4	1	0	143	$ 999	428	$ 5,136	3,852	$ 1,926	$ 1,169,444
RET030	Small Drop Structures w/ Toe Protection	5,042	0.015	21	0.0078	7	6	$ 200,035	$ 1,400,242	593	4	1	0	88	$ 1,318	264	$ 3,163	2,372	$ 1,186	$ 1,405,908
RET040	Small Drop Structures w/ Toe Protection	1,820	0.021	23	0.0075	5	6	$ 203,656	$ 1,018,282	1,130	12	4	0	2,009	$ 30,133	1,507	$ 18,080	13,560	$ 6,780	$ 1,073,275
RET100	Small Drop Structures w/ Toe Protection	1,791	0.022	28	0.0075	5	6	$ 214,267	$ 1,071,335	1,747	30	6	0	11,647	$ 174,700	5,823	$ 69,880	52,410	$ 26,205	$ 1,342,120
RET110	Small Drop Structures w/ Toe Protection	2,751	0.016	28	0.0075	4	6	$ 214,538	$ 858,152	1418; 1306	4; 30	2; 5	0	7,676	$ 115,136	4,984	$ 59,803	44,852	$ 22,426	$ 1,055,516
RET152	Small Drop Structures w/ Toe Protection	2,030	0.019	29	0.0072	5	6	$ 216,278	$ 1,081,390	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 1,081,390
RET162	Small Drop Structures w/ Toe Protection	3,256	0.011	20	0.0066	3	6	$ 218,820	$ 656,460	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 656,460
RMT050	Small Drop Structures w/ Toe Protection	1,568	0.019	23	0.0062	4	6	$ 203,547	$ 814,189	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 814,189
RMT062	Small Drop Structures w/ Toe Protection	5,688	0.020	20	0.0081	12	6	$ 198,427	$ 2,381,127	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 2,381,127
RMT064	Small Drop Structures w/ Toe Protection	3,358	0.016	24	0.0060	6	6	$ 205,185	$ 1,231,110	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 1,231,110
RMT102	Small Drop Structures w/ Toe Protection	1,021	0.023	27	0.0061	3	6	$ 212,027	$ 636,082	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 636,082
RMT104	Small Drop Structures w/ Toe Protection	874	0.015	15	0.0083	1	6	$ 186,349	$ 186,349	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 186,349
RMT106	Small Drop Structures w/ Toe Protection	226	0.004	27	0.0030	1	6	$ 212,322	$ 212,322	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 212,322
RMT112	Small Drop Structures w/ Toe Protection	3,372	0.015	27	0.0060	6	6	$ 212,690	$ 1,276,142	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 1,276,142
RMT114	Small Drop Structures w/ Toe Protection	1,667	0.018	27	0.0060	4	6	$ 213,423	$ 853,693	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 853,693
RWT054	Small Drop Structures w/ Toe Protection	2,497	0.023	22	0.0076	7	6	$ 202,076	$ 1,414,531	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 1,414,531
RWT080	Small Drop Structures w/ Toe Protection	3,494	0.027	19	0.0080	12	6	$ 194,670	$ 2,336,037	516	6	2	0	229	$ 3,440	344	$ 4,128	3,096	$ 1,548	$ 2,345,153
RWT092	Small Drop Structures w/ Toe Protection	626	0.019	25	0.0069	2	6	$ 207,217	$ 414,434	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 414,434
RWT124_upstream	Small Drop Structures w/ Toe Protection	1,246	0.018	27	0.0064	3	6	$ 213,351	$ 640,054	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 640,054
RWT174	Small Drop Structures w/ Toe Protection	1,871	0.016	22	0.0078	3	6	$ 202,112	$ 606,335	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 606,335
RWT234	Small Drop Structures w/ Toe Protection	2,129	0.020	19	0.0076	5	6	$ 195,373	$ 976,863	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 976,863
RWT296	Small Drop Structures w/ Toe Protection	1,134	0.010	32	0.0056	1	6	$ 223,458	$ 223,458	0	0	0	0	0	$ -	0	$ -	0	$ -	$ 223,458
RWT372	Small Drop Structures w/ Toe Protection	1,377	0.020	38	0.0036	4	6	$ 235,012	$ 940,048	406	6	2	0	180	$ 2,707	271	$ 3,248	2,436	$ 1,218	$ 947,221

Subtotal:	$ 22,943,176
Engineering/ Construction Admin(15%):	$ 3,441,476
Contingency(20%):	$ 4,588,635
Total:	$ 30,973,288

Notes:

1 Structure cost from Unit Cost Spreadsheet. 72400 + 880(B) + 13700(H) + 210(B)(H) 4H:1V slope,36" boulders, includes reveg, excav, 20' stilling basin, 20' width of riprap along banks and 10' at toe.
2 Drop height = 3 ft drop + 3 ft key
3 Width of drops = low flow channel width
4 Earthwork = $15/CY, 3/19/15 adjusted to $7/CY for unplatted, developer reach RET020
5 Erosion Control Blanket = $12/SF
6 Revegetation = $0.50/SF
7 Earthwork, Erosion Control Blanket, and Revegetation quantities calculated from GIS file "Estimated_Earthwork.shp"
8 Low Flow Design Slope and # of Structures adjusted per phone conversation with Jeff Rice and Graham Thompson 3/14/14.

Sheet 6-22
Falcon DBPS
Conceptual Plan
Middle Tributary
El Paso County, CO



Note:
Infrastructure and channel improvements shown may vary slightly from the final list published in the accompanying report as a result of fee revisions that have occurred following the preparation of this figure. For current information as of September 2015, please see tables in Section 6 of the accompanying report.

Drainageway Crossing
Stream Centerline
Existing Approximate 100-yr Floodplain*
Floodplain Study Limit

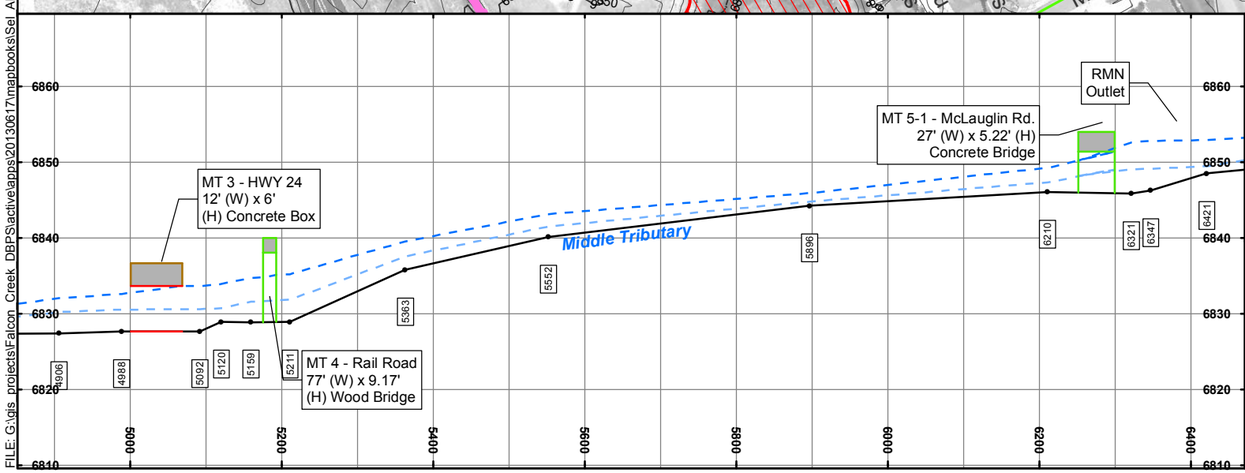
Storm Sewer
- Inlet
- Manhole
- Pipe

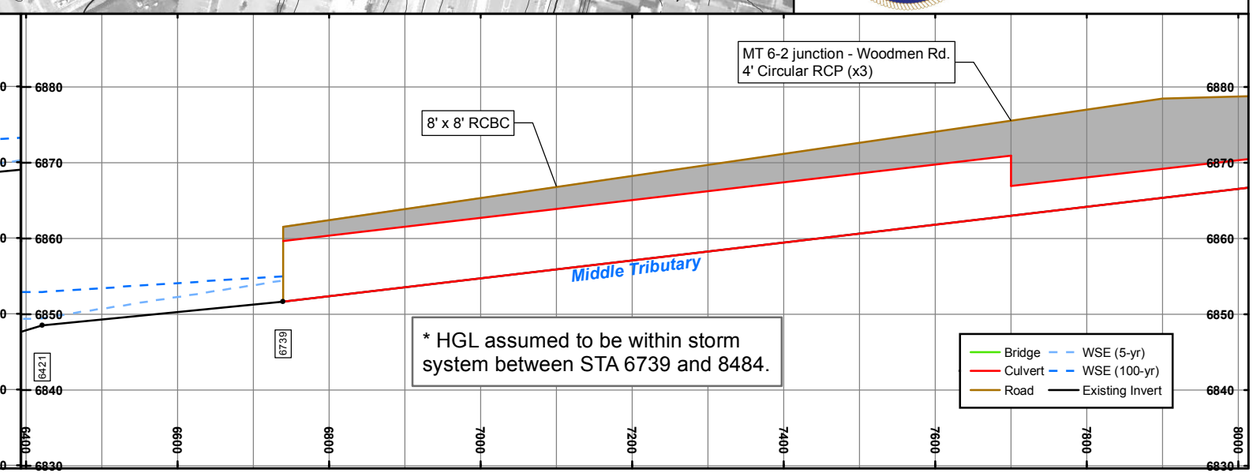
Reach Improvements
- Natural Channel Design
- Protect In Place
- Roadside Ditch Improvement
- Small Drop Structures w/ Toe Protection
- Existing Detention
- Proposed Detention
- Proposed Detention Grading
- Small Drop Structure
- Cross Vane
- Immediate Action Required to Preserve Existing Condition

0 100 200 Feet

* These approximate 100-yr floodplain boundaries are for planning purposes only. This information is not intended to replace the information provided on the FEMA Flood Insurance Rate Maps for this area.
** These are conceptual design drawings and are subject to change. These drawings are not intended for construction purposes.

Index Map





* HGL assumed to be within storm system between STA 6739 and 8484.

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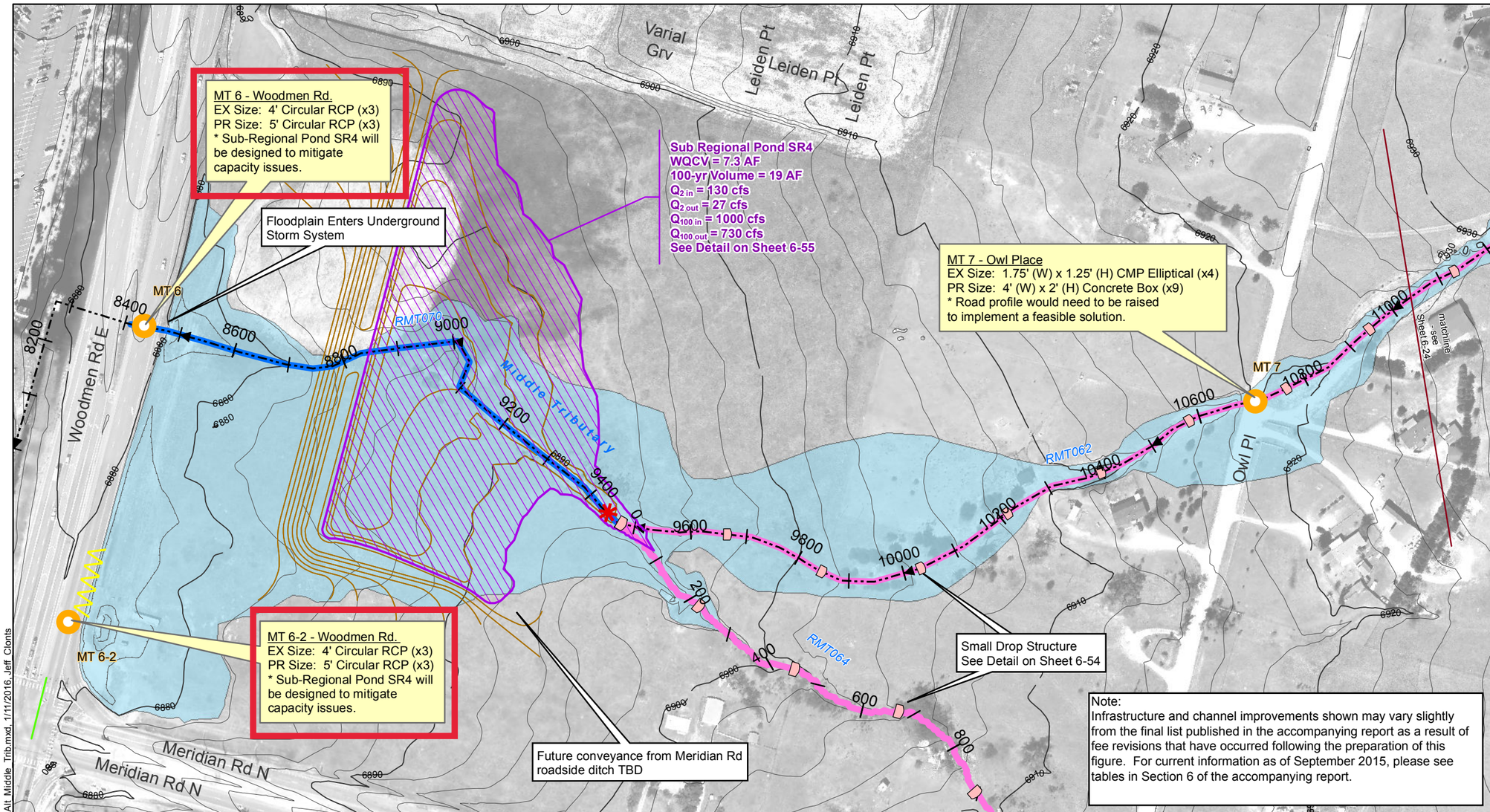
Sheet 6-23
Falcon DBPS
Conceptual Plan
Middle Tributary
El Paso County, CO



Storm Sewer

- Drainageway Crossing
- Stream Centerline
- Existing Approximate 100-yr Floodplain*
- Floodplain Study Limit
- Inlet
- Manhole
- Pipe

Reach Improvements

- Natural Channel Design
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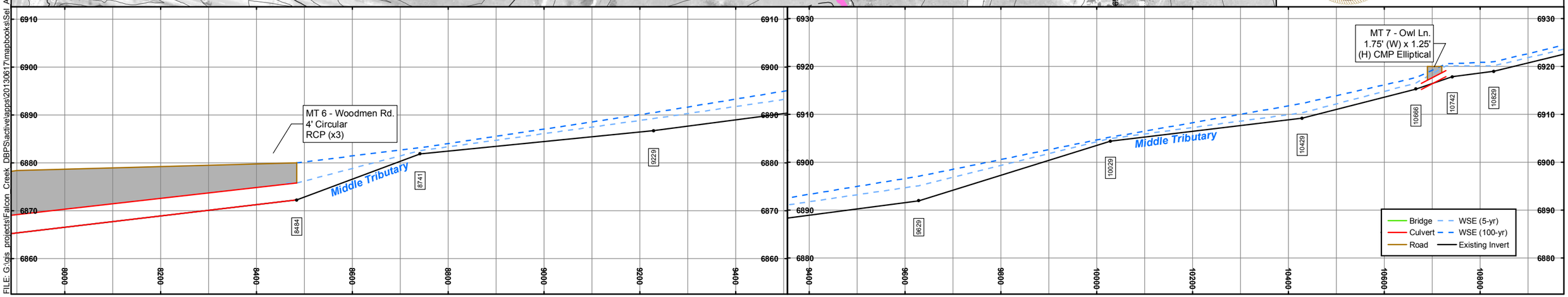

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