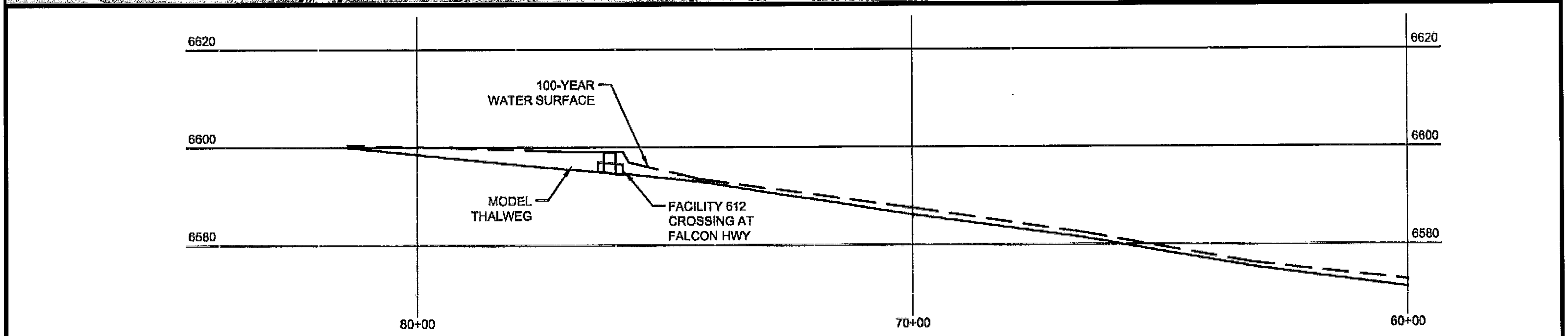


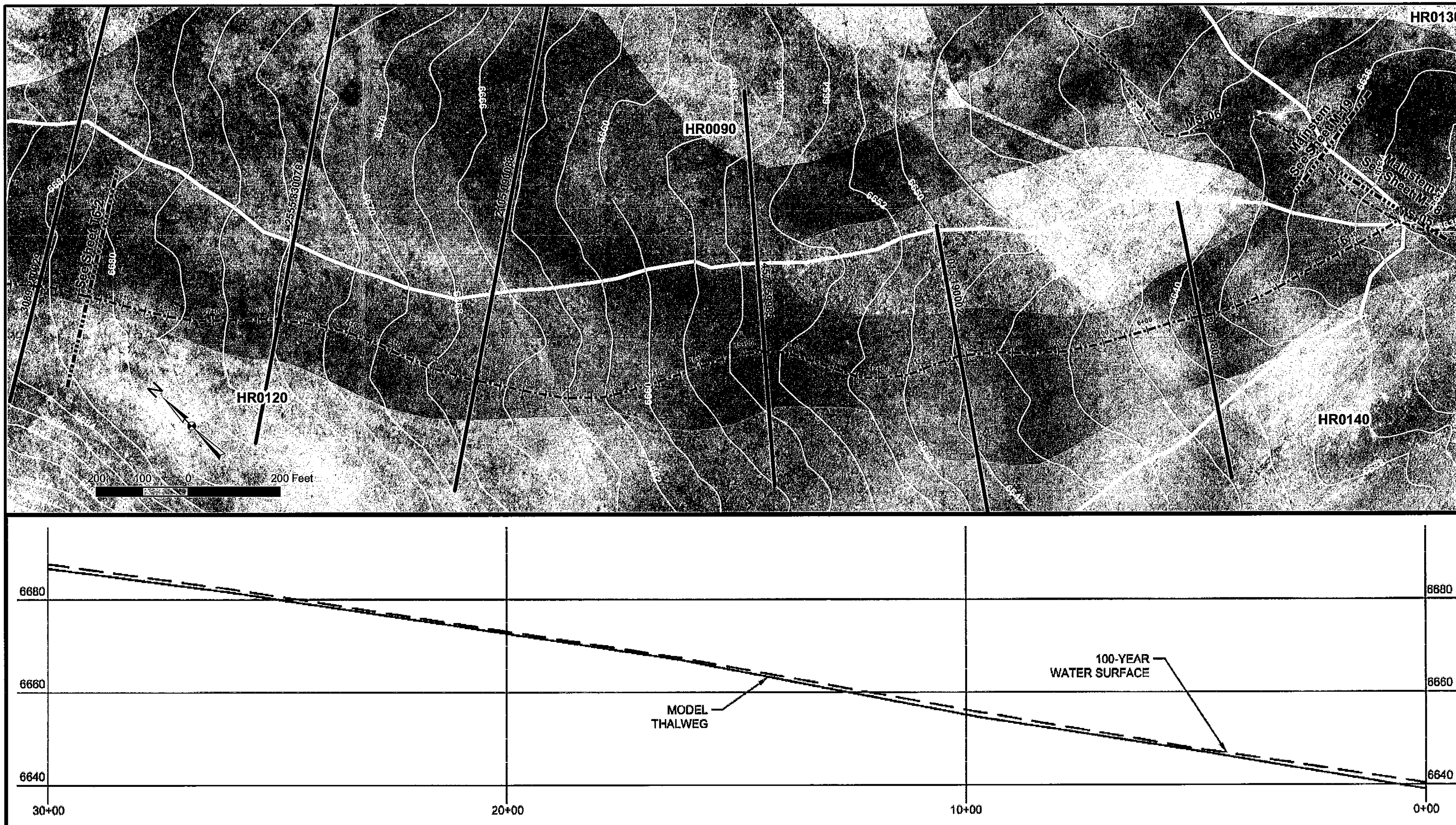
URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

Potential Wetlands
Subbasin Boundaries
Approximate 100-Year Floodplain
Thalweg
Cross Sections
2' Contours

DATE: 05/08

HAEGLER RANCH DRAINAGE BASIN
APPROXIMATE 100-YEAR FLOOD LIMITS
SHEET T5-3
FIGURE 5-4

URS NO. 21711039



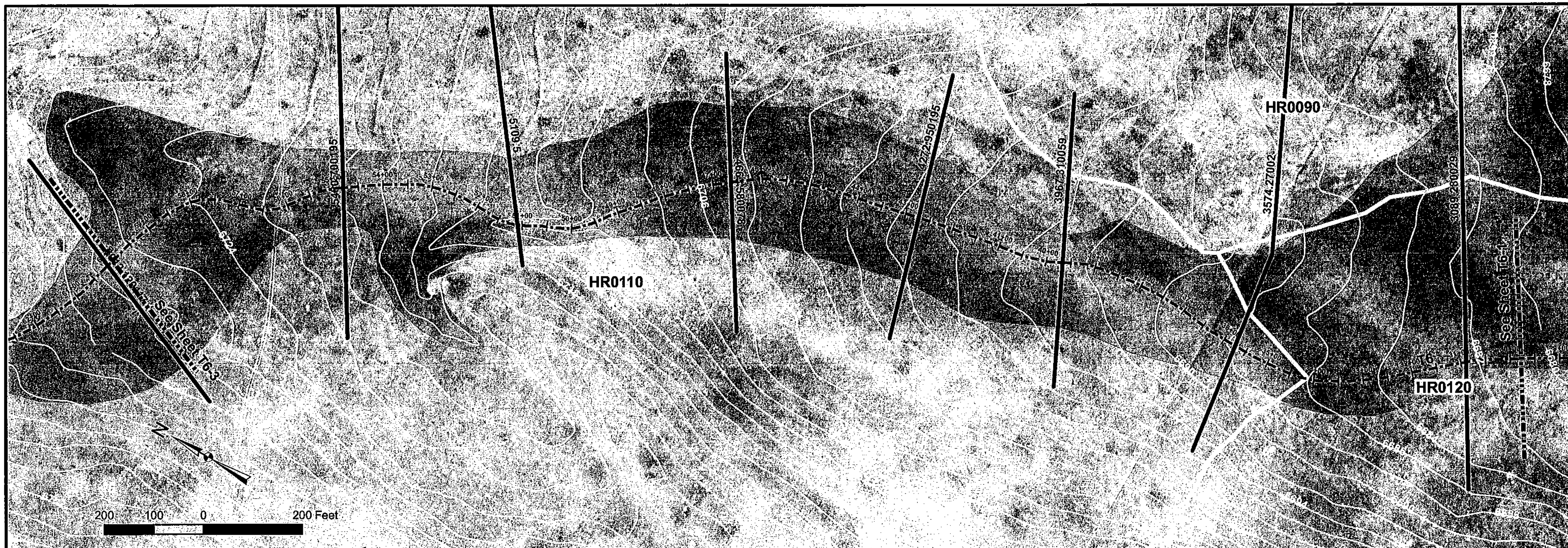
URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

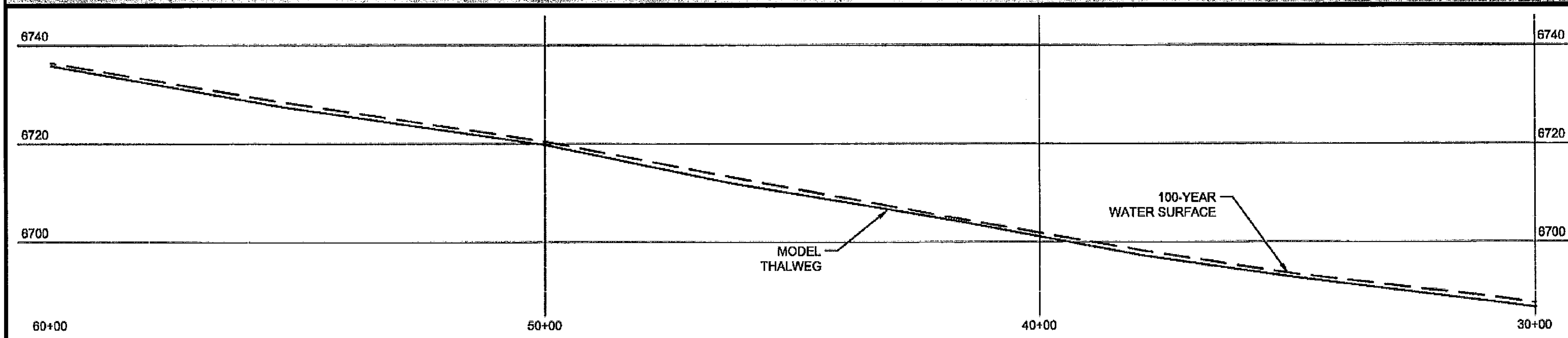
Subbasin Boundaries
Approximate 100-Year Floodplain
Thalweg
Cross Sections
2' Contours

DATE: 05/08

HAEGLER RANCH DRAINAGE BASIN
APPROXIMATE 100-YEAR FLOOD LIMITS
SHEET T6-1
FIGURE 5-4

URS NO. 21711039





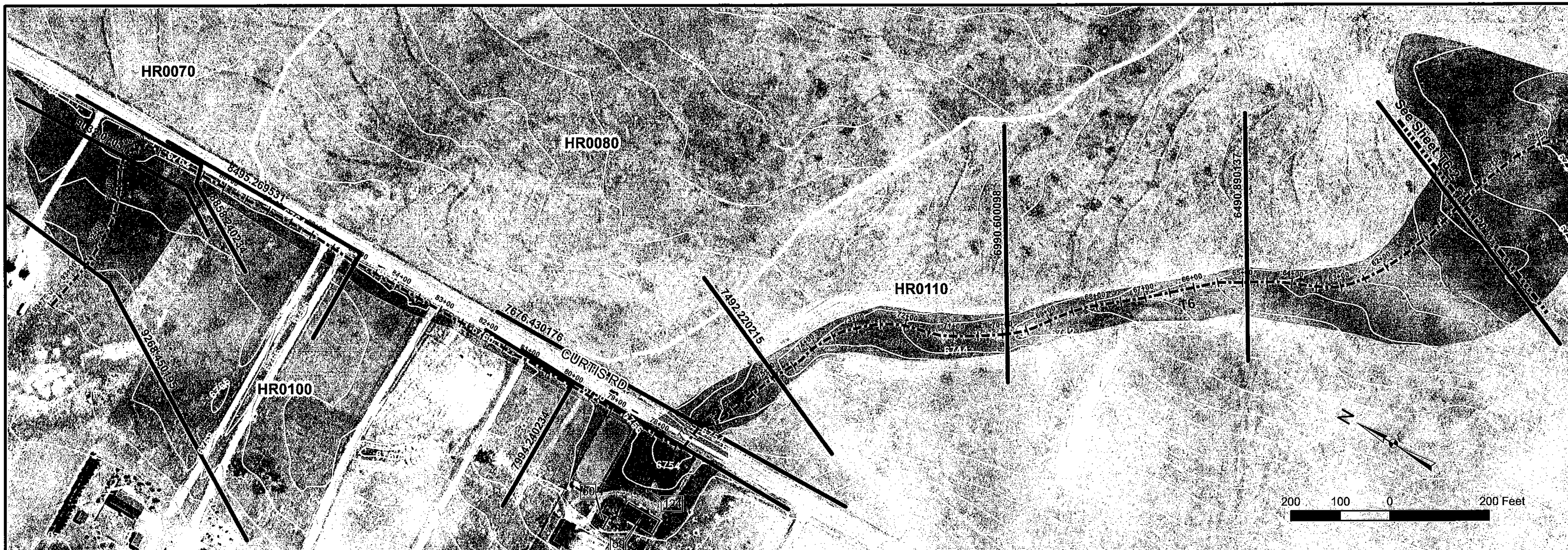
URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

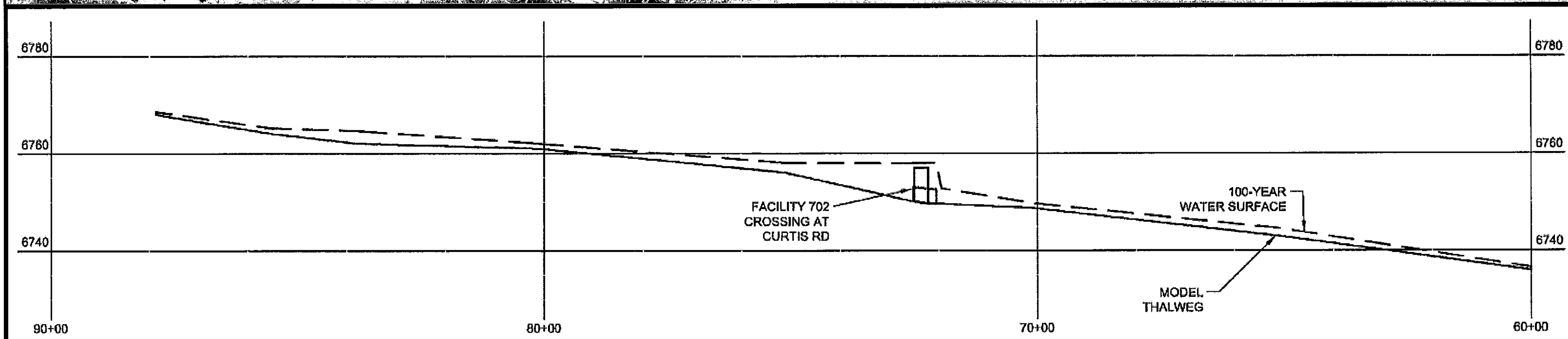
Subbasin Boundaries
Approximate 100-Year Floodplain
Thalweg
Cross Sections
2' Contours

DATE: 05/08

HAEGLER RANCH DRAINAGE BASIN
APPROXIMATE 100-YEAR FLOOD LIMITS
SHEET T6-2
FIGURE 5-4

URS NO. 21711039





URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

Subbasin Boundaries
Approximate 100-Year Floodplain
Thalweg
Cross Sections
2' Contours

DATE: 09/08

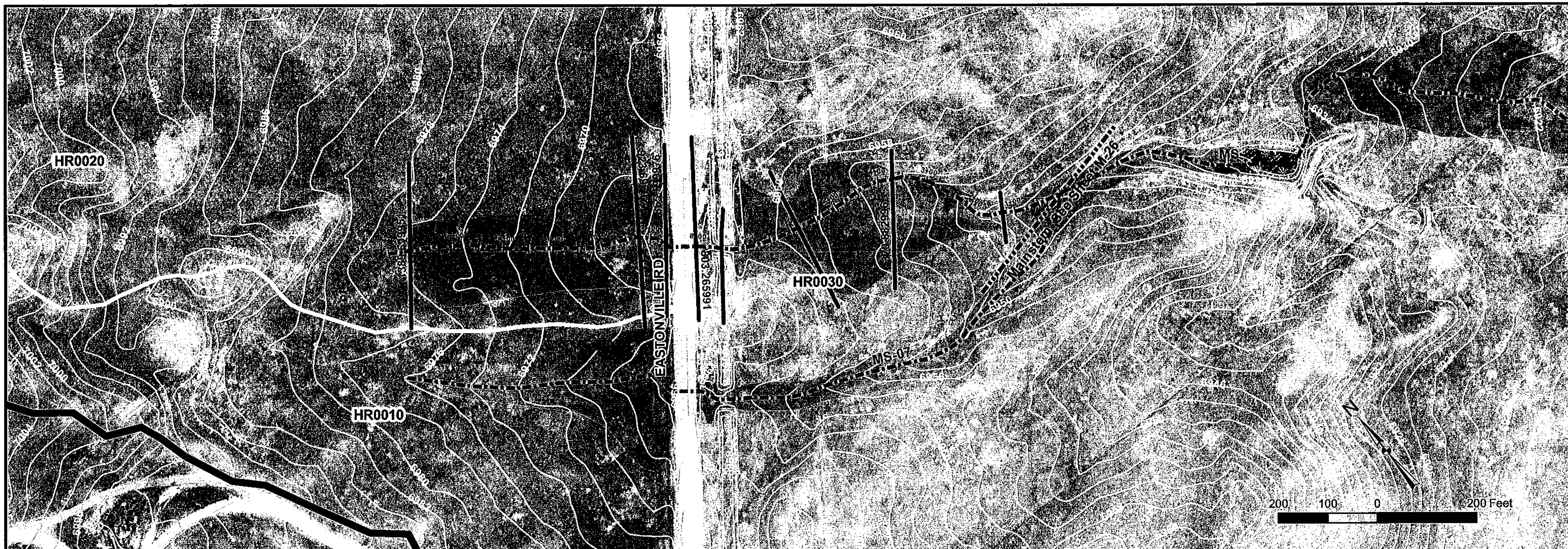
HAEGLER RANCH DRAINAGE BASIN

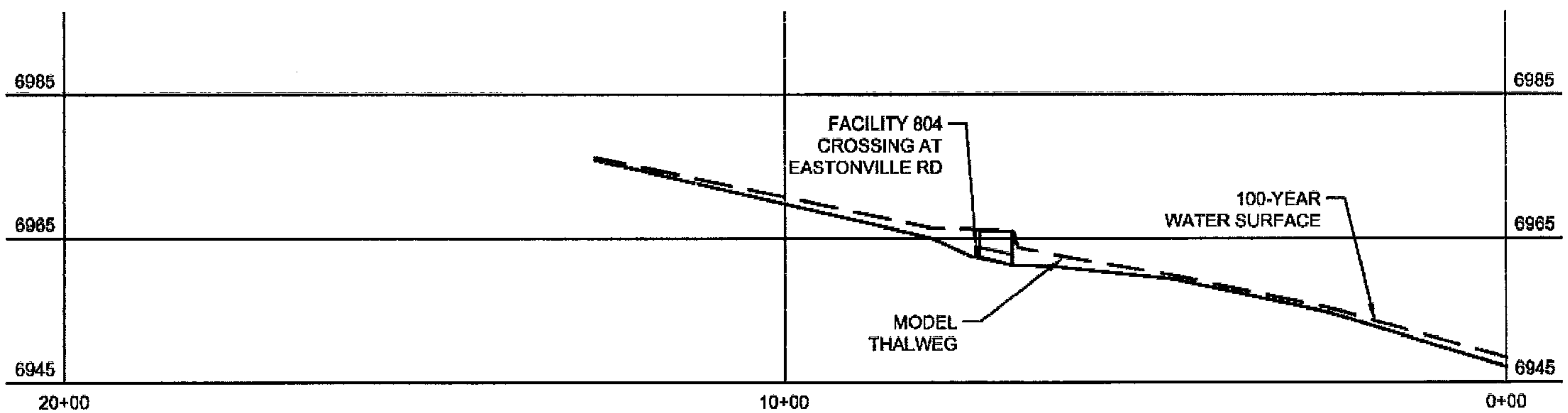
APPROXIMATE 100-YEAR FLOOD LIMITS

SHEET T6-3

FIGURE 5-4

URS NO. 21711039





URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

Haegler Basin Boundary
Potential Wetlands
Subbasin Boundaries
Approximate 100-Year Floodplain
Thalweg
Cross Sections
2' Contours

DATE: 05/08

HAEGLER RANCH DRAINAGE BASIN

APPROXIMATE 100-YEAR FLOOD LIMITS

SHEET T7-1

FIGURE 5-4

URS NO. 21711039

6.0 ALTERNATIVES

To manage increases in runoff to Haegler Ranch Basin from future development, alternatives for flood control have been developed conceptually so that feasibility and cost of flood control alternatives can be determined and compared. The objectives of this alternatives evaluation are to identify cost effective measures to control developed runoff from the watershed such that: 1) runoff rates leaving the basin are not greater than existing, 2) potential for damages to conveyances and structures within the watershed from the design flood is minimized, and 3) flood control measures can be implemented effectively as development occurs. Once a feasible aternative is developed, the costs of implementing the alternative will be estimated and compared with the costs of other alternatives.

6.1. Summary of Criteria

Generally, the criteria and methods used to develop detention and conveyance requirements follow the DCM. The criteria and process for estimating right-of-way and the financial costs, such as use of assessor's data for property costs or City of Colorado Springs data for estimating costs of structures, were established in discussions with El Paso County. Except as noted, the conceptual design of each alternative was bound by the criteria presented in the Manual. Culverts, for example, were generally designed to pass the design storm with a headwater over depth ratio of less than 1.5. For bridges, 1-foot of freeboard between the computed water-surface elevation and the minimum low-chord elevation is required. Each alternative was also developed to reduce impacts to private property, especially property that is highly developed. Alternative plans have been developed to address flood impacts, and consider stream stability, cost effectiveness, implementation, and aesthetics.

6.1.1. Flood Impacts

Development will cause stormwater flows in the Haegler Ranch Basin to increase, causing impacts to channels and culverts within the basin and downstream receiving streams. Damage to conveyance channels and structures could potentially occur due to an increase in the flood flows. The flood impacts within the basin along channels and crossings as well as impacts to downstream reaches need to be mitigated as development occurs.

6.1.2. Stream Stability

For the purposes of this evaluation, it is assumed that the channel forming flow is the 2-year peak flow. As noted in the hydrologic analysis, the 2-year peak flows increase dramatically from development within the watershed. With an increase in the 2-year peak flow, channel instability may occur resulting in degradation or aggradation of downstream conveyance channels. This instability could propagate upstream and downstream without proper maintenance and repairs, therefore alternatives need to address control of the 2-year flow in order to address stream stability.

6.1.3. Cost Effectiveness

Each alternative will have an associated construction cost. Construction costs are estimated for each alternative and compared to other alternatives along with an evaluation of how well each alternative addresses the other criteria. Cost effectiveness depends not only on the bottom line construction cost but also the benefits of the cost expenditure in achieving all the goals of this Drainage Basin Planning Study.

6.1.4. Implementation

To be effective, the preferred alternative must be implemented as development occurs so that the adverse impacts to the watershed are controlled. If a developer is dependant on improvements disconnected from the site to mitigate impacts, other requirements may be placed on the developer to control stormwater release rates. The overall purpose of the Drainage Basin Planning Study is to create a plan to address flood impacts on a regional basis, which can be implemented cost effectively by individual developers. Alterations to this plan can be made, but should not reduce the effectiveness.

6.1.5. Aesthetics

Since the Haegler Ranch basin is in a rural setting, aesthetics of the proposed conveyance channels and structures is important. Generally, concrete channels do not fit well with the aesthetics of the surrounding environment, and their use should be limited. Grass-lined channels are more consistent with the characteristics of the Haegler Ranch.

6.2. Design Methods

The 100-year flows for the Haegler Ranch Basin vary from 25 cfs at the upstream end to 5600 cfs at the outlet into Geick Ranch Basin. Culverts and channels have been designed using the methods discussed in the following paragraphs. Note that, prior to construction, these conceptual designs need to be engineered for the infrequent major storm event and the frequent minor storm event, per current El Paso County standards. This could include additional low flow channels, culverts and riprap to provide erosion protection through the basin.

6.2.1. Channel Design

Generally, conceptual channel geometry was developed from the DCM and HEC 15 (FHWA 2005), and consists of a trapezoidal section with a minimum bottom width of 4 feet, side slopes 2:1 or greater, and a design depth of less than 5 feet. Manning's roughness coefficients for each channel lining were estimated from typical values for each material from the DCM and HEC-15. The selected "n' values used for design are listed in Table 6-1.

Table 6-1 Constructed Channel Manning's Roughness Coefficients

Channel Linings	Manning's Roughness Coefficients
Grass	0.035
Riprap	0.047

The channel bottom width must be at least twice the flow depth per the DCM Section 10.5.3. Side slopes are 4:1(H:V) for grass-lined channels, 3:1 for riprap, and 2:1 for concrete linings. The flow depth is assumed to be at normal depth. Freeboard is calculated using Section 10.5.5 from the DCM and rounded up to the nearest even foot. Grass lined channels were selected as the preferred channel type for this study. Grass lined channels were calculated to be the most cost effective in terms of capital cost for most cases. Grass lined channels also mimic the existing channels and their side slope requirement will reduce head-cutting into tributary channels when compared to other channel linings.

Grass channels are designed for depths and velocities to be within the limits of allowable shear stress. Grass lined channels are limited to 1.0 psf shear stress. If calculated shear stress is above this, drop structures must be added to flatten the natural slope of the channel.

Using these criteria, several channel sections were developed to accommodate a range of future flow rates from 100 cfs to 3500 cfs, as shown in Table 6-2. The approximate channel sections were used in the alternatives to accommodate future flows as necessary,

Table 6-2 Channel Dimensions based on Flow Rates

Q (cfs)	Grass		
	Sideslope (h:v)	Bottom (ft)	Depth (ft)
300	4	6	5
500	4	8	5
600	4	15	5
800	4	20	5
900	4	25	5
1000	4	30	5
1500	4	50	5
2000	4	80	5
3000	4	120	5
3500	4	140	5

6.2.2. Culvert Design

Culvert sizes for use in alternative evaluation were estimated based on full flow capacity of reinforced concrete pipe with a minimum slope of 0.50% and concrete end sections. For flows up to 300 cfs single RC pipe culverts with a maximum of 72" diameter were used. For greater flows, multiple RC pipes or 6-foot by 6-foot concrete box culverts with headwalls and flared wingwalls were used. Proposed culverts sizes based on existing flow rates are listed in Table 6-3.

Table 6-3 Existing Conditions Culvert Design

Facility Number	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency	Necessary Facility
N/A	Peyton Highway	Tributary 1 (T1)	No Culvert	500	Overtops	2-72" RCPs
N/A	Falcon Highway	Tributary 1 (T1)	No Culvert	33	Overtops	36" RCP
301	Peyton Highway	Main Stem (MS-02)	2-33"X48" CMPs	2,500	Overtops	7-6'X6' RCBs
401	Jones Road	Tributary 1 (T1)	2-24" CMPs	370	Overtops	6'X6' RCB
403	Jones Road	Main Stem (MS-03)	3-60" CMPs	2,300	Overtops	6-6'X6' RCBs
405	Murr Road	Main Stem (MS-04)	66" RCP	1,700	Overtops	5-6'X6' RCBs
407	Murr Road	Tributary 3 (T3-01)	66" RCP	670	Overtops	2-6'X6' RCBs
507	Peerless Farms Road	Tributary 3 (T3-01)	60" CMP	600	Overtops	2-6'X6' RCBs
509	Murr Road	Tributary 1 (T1)	2-15" RCPs	220	Overtops	66" RCP
601	Whiting Way	Tributary 1 (T1)	24" CMP	220	Overtops	66" RCP
604	Max Road	Tributary 1 (T1)	18" CMP	220	Overtops	66" RCP
609	Falcon Highway	Tributary 3 (T3-02)	18" CMP	180	Overtops	66" RCP
610	Falcon Highway	Tributary 4 (T4)	24" CMP	200	Overtops	66" RCP
612	Falcon Highway	Tributary 5 (T5)	24" CMP	150	Overtops	60" RCP
628	Falcon Highway	Main Stem (MS-05)	2-60" CMPs	1,000	Overtops	3-6'X6' RCBs
702	Curtis Road	Tributary 6 (T6)	36" CMP	120	Overtops	54" RCP
703	Curtis Road	Main Stem (MS-06)	24" CMP	590	Overtops	2-6'X6' RCBs
704	Judge Orr Road	Main Stem (MS-06)	Blocked Culvert	540	Overtops	2-72" RCPs
801	Pedestrain Bridge	Main Stem (MS-06)	Bridge	350	Meets Capacity	Existing Bridge
802	US24	Main Stem (MS-06)	2-66" CMPs	350	Meets Capacity	Existing Culvert
803	Eastonville Road	Main Stem (MS-07)	27"X21" CMP	25	Overtops	30" RCP
804	Eastonville Road	Tributary 7 (T7)	18" CMP	99	Overtops	48" RCP

6.2.3. Detention Design

All detention pond design is based on Chapter 10, Storage, of the UDFCD SDCM. All ponds were assumed to be "full spectrum" per the SDCM. For final design to be performed later, some of the ponds may be separated into a water quality pond and an off-line major detention pond.

For the Regional Detention Alternative, either the simplified full spectrum sizing method or the hydrograph method was used to size the facility. If the contributing area is less than 160 acres and no detention occurred upstream, the Simplified Full-Spectrum Detention Sizing (Excess Urban Runoff Flow Control) method was used. For all other "full spectrum detention" ponds, the Hydrograph Routing Detention Sizing Procedure was applied and the Excess Urban Runoff Volume (EURV) is sized using the same equations as in the Full-Spectrum Detention Sizing.

For Sub-Regional Detention Alternative, the Hydrograph Routing Detention Sizing Procedure in Chapter 10, Storage, of the UDFCD SDCM was applied using the major 100-year storm event in the HEC-HMS model.

If another detention pond needed to be sized downstream of a proposed pond, the Hydrograph Routing Detention Sizing Procedure was applied and the corresponding outflow storage curve was used to simulate the detention pond in HEC-HMS. The new hydrology model was then run to determine the inflow hydrograph for the downstream elements. If necessary, the outflow storage curve was extrapolated in HEC-HMS, but the outflow was limited to the 100-year existing flow rate.

Using the Simplified Full-Spectrum Detention and Hydrograph Routing Detention, required volumes were determined for each detention pond. To estimate an area necessary for construction, a maximum of 5 feet was assumed for the pond depth due to the potential for high ground water levels. The corresponding area was increased by 10% to account for grading buffers and access.

6.3. Conceptual Alternatives

Basic alternative flood control concepts for major and minor flood events, and their associated impacts throughout the basin, are listed in Table 6-4. As noted in the Table, some of the impacts would propagate to receiving streams downstream of the Haegler Ranch.

The first alternative, Channel Improvements with No detention, consists of releasing all developed flows without any detention. This alternative would require that channels and culverts downstream of the developing areas would need to be sized to convey future developed peak flows. Because development in the Haegler Ranch is occurring in the upper watershed and not the lower watershed, and because these downstream improvements would need to be in place before development occurs in order to mitigate potential flooding and stream stability problems, this alternative does not satisfy the implementation criterion and therefore is considered to be infeasible. Detention is required in the Haegler Ranch Basin in order to control stormwater flows from development.

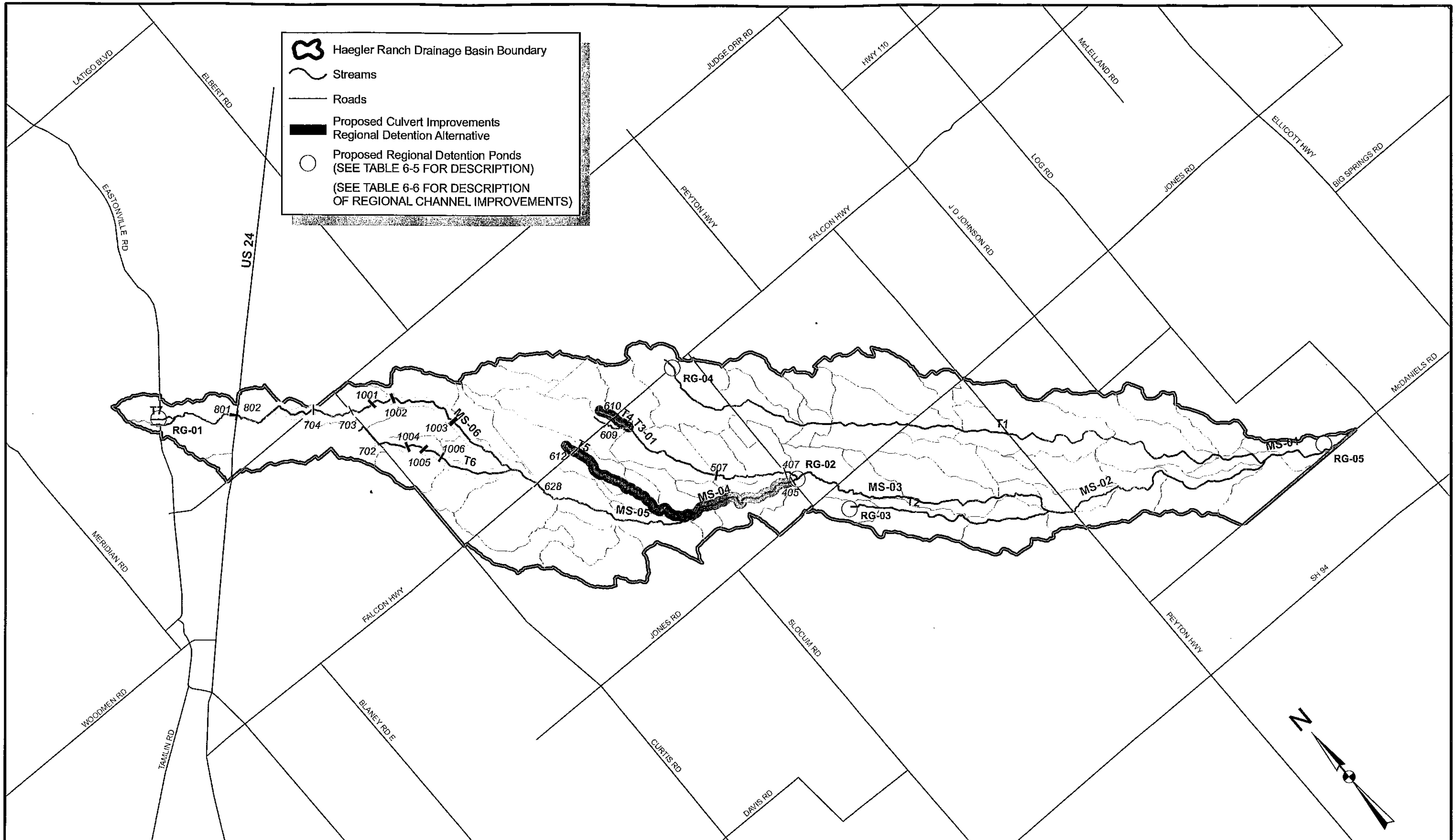
Table 6-4 Basic Flood Control Concepts

Alternative	100-Year			2 Year		
	Channel / Culvert Improvements (Within Basin)	Downstream Flood Impact (Outside Basin)	Detention	Degradation / Sedimentation Issues (Within Basin)	Downstream Stability Issues (Outside Basin)	Detention
Channel Improvements with No Detention (Not Feasible)	Yes	Yes	No	Yes	Yes	No
Channel Improvements with Regional Detention	Yes	No	Yes	Yes	Yes	No
Channel Improvements w/ Subregional Detention	Minimal	No	Yes	No	No	Yes

6.3.1. Regional Detention

This first detention alternative places regional detention ponds strategically within the basin to release 100-year peak flows at existing conditions rates. Regional detention ponds are sized using the procedure described above for traditional detention, and are located within the basin as shown on Figure 6-1. The proposed locations were selected to be near proposed developments to intercept runoff before it entered the main stream. Regional detention ponds are sized to address local and regional development. Two developments that were isolated from the regional detention pond were evaluated independently to reduce improvements along the channels. A summary of the proposed Regional detention ponds is listed in Table 6-5.

This page intentionally left blank.



URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

5,000 2,500 0 5,000 Feet
1" = 5,000'

DATE: 05/08

HAEGLER RANCH DRAINAGE BASIN
REGIONAL DETENTION
ALTERNATIVES
FIGURE 6-1

URS NO. 21711039

Table 6-5 Regional Detention Pond Summary

Pond	Volume (AF)	Peak Inflow (cfs)		Peak Outflow (cfs)	
		2-yr	100-yr	2-yr	100-yr
RG-01	9.02	100	320	11	63
RG-02	170	600	4800	150	2200
RG-03	0.04	3	70	2	9
RG-04	1.07	19	140	1	55
RG-05	0.03	12	120	11	3

For the 100-year peak flow, flood impacts downstream from the regional detention pond will not increase.

6.3.1.1. Channels

Channels upstream of the regional detention ponds need to be sized for the future undetained 100-year peak flow rates from development, while culverts and channels downstream of regional ponds are sized for the existing 100-year peak flow rates. Proposed channel improvements along the corresponding reaches are summarized in Table 6-6.

Table 6-6 Channel Designs for Regional Detention Alternative

Channel	Existing 100-yr Flow (cfs)	Proposed 100-yr Flow (cfs)	Design Flow (cfs)	Channel Length (ft)	Material
Main Stem (MS-04)	1700	3400	3500	7140	Riprap
Main Stem (MS-05)	1500	3000	3000	11100	Grass
Main Stem (MS-06)	590	890	900	7330	Grass
Main Stem (MS-06)	660	930	1000	3170	Grass
Main Stem (MS-06)	720	1500	1500	4450	Grass
Main Stem (MS-06)	750	1600	2000	3330	Grass
Tributary 3 (T3-01)	720	1500	1500	10710	Grass
Tributary 4 (T4)	200	570	600	1840	Grass
Tributary 5 (T5)	150	240	300	930	Grass
Tributary 5 (T5)	270	410	500	7770	Grass
Tributary 6 (T6)	200	440	500	4270	Grass
Tributary 6 (T6)	240	570	600	3940	Grass

6.3.1.2. Culverts

As with the channels, culverts upstream of a regional detention pond need to be sized for the future undetained 100-year peak flow rates, while culverts and channels downstream are sized for the existing 100-year peak flow rates. Proposed culvert improvements along the corresponding reaches are summarized in Table 6-7 for the Regional Detention Alternative.

Table 6-7 Culvert Designs for Regional Detention

Facility Number	Road Crossing	Channel	Existing Size	Proposed 100-yr Flow (cfs)	Deficiency	Necessary Facility for Proposed 100-year Flow
405	Murr Road	Main Stem (MS-04)	66" RCP	3,400	Overtops	6-10'X6' RCBs
507	Peerless Farms Road	Tributary 3 (T3-01)	60" CMP	1200	Overtops	2-10'X6' RCBs
609	Falcon Highway	Tributary 3 (T3-02)	18" CMP	460	Overtops	2-66" RCPs
610	Falcon Highway	Tributary 4 (T4)	24" CMP	570	Overtops	2-72" RCPs
612	Falcon Highway	Tributary 5 (T5)	24" CMP	240	Overtops	72" RCP
628	Falcon Highway	Main Stem (MS-05)	2-60" CMPs	2,200	Overtops	4-10'X6' RCBs
702	Curtis Road	Tributary 6 (T6)	36" CMP	140	Overtops	60" RCP
703	Curtis Road	Main Stem (MS-06)	24" CMP	890	Overtops	2-8'X6' RCBs
704	Judge Orr Road	Main Stem (MS-06)	Blocked Culvert	830	Overtops	2-8'X6' RCBs
1001	Future Pastura Street	Main Stem (MS-06)	N/A	930	Future Road	2-8'X6' RCBs
1002	Future Arroyo Hondo Blvd. N.	Main Stem (MS-06)	N/A	930	Future Road	2-8'X6' RCBs
1003	Future Arroyo Hondo Blvd. S.	Main Stem (MS-06)	N/A	1500	Future Road	3-8'X6' RCBs
1004	Future Pastura Street	Tributary 6 (T6)	N/A	440	Future Road	2-66" RCPs
1005	Future El Vado Road	Tributary 6 (T6)	N/A	440	Future Road	2-66" RCPs
1006	Future Socorro Trail	Tributary 6 (T6)	N/A	440	Future Road	2-66" RCPs

Note: Changes recommended to other culverts under existing conditions still apply

6.3.2. Subregional Detention

For this alternative, subregional detention ponds are located and sized to address development as it will occur. Locations of proposed subregional detention ponds are shown in Figure 6-2 and are summarized in Table 6-8. A connectivity diagram for the sub-regional HEC-HMS model is shown in Figure 6-3.

Table 6-8 Subregional Detention Pond Summary

Pond	Size (AF)	Peak Inflow (cfs)		Peak Outflow (cfs)	
		2-yr	100-yr	2-yr	100-yr
SR-01	10	100	320	8	90
SR-02	5	14	300	3	250
SR-03	16	210	640	29	530
SR-04	25	200	1120	33	740
SR-05	24	76	570	9	250
SR-06	9	14	180	1	20
SR-07	5	6	140	1	88
SR-08	5	23	240	15	210
SR-09	20	50	430	3	66
SR-10	23	85	860	23	600
SR-11	2	3	70	1	61
SR-12	9	19	140	1	35
SR-13	3	12	120	6	110

Subregional ponds have been sized using the hydrograph routing method described above. In this alternative, all proposed channels and culverts are sized for the existing 100-year peak flow rates, except within proposed developments where it is necessary to provide conveyance for developed flow rates. Flood impacts for the 100-year peak flow downstream of the subregional, full spectrum detention ponds will not increase.

6.3.2.1. Channels

In this alternative, only channel improvements through proposed developments are included, unless an area is undersized for existing conditions. Existing deficiencies are the responsibility of the current land owner or the County, and not the developer, and corrective measures for existing deficiencies are not included in the cost estimates. Proposed channel improvements along the corresponding reaches are summarized in Table 6-9.

Table 6-9 Channel Design for Subregional Detention Alternative

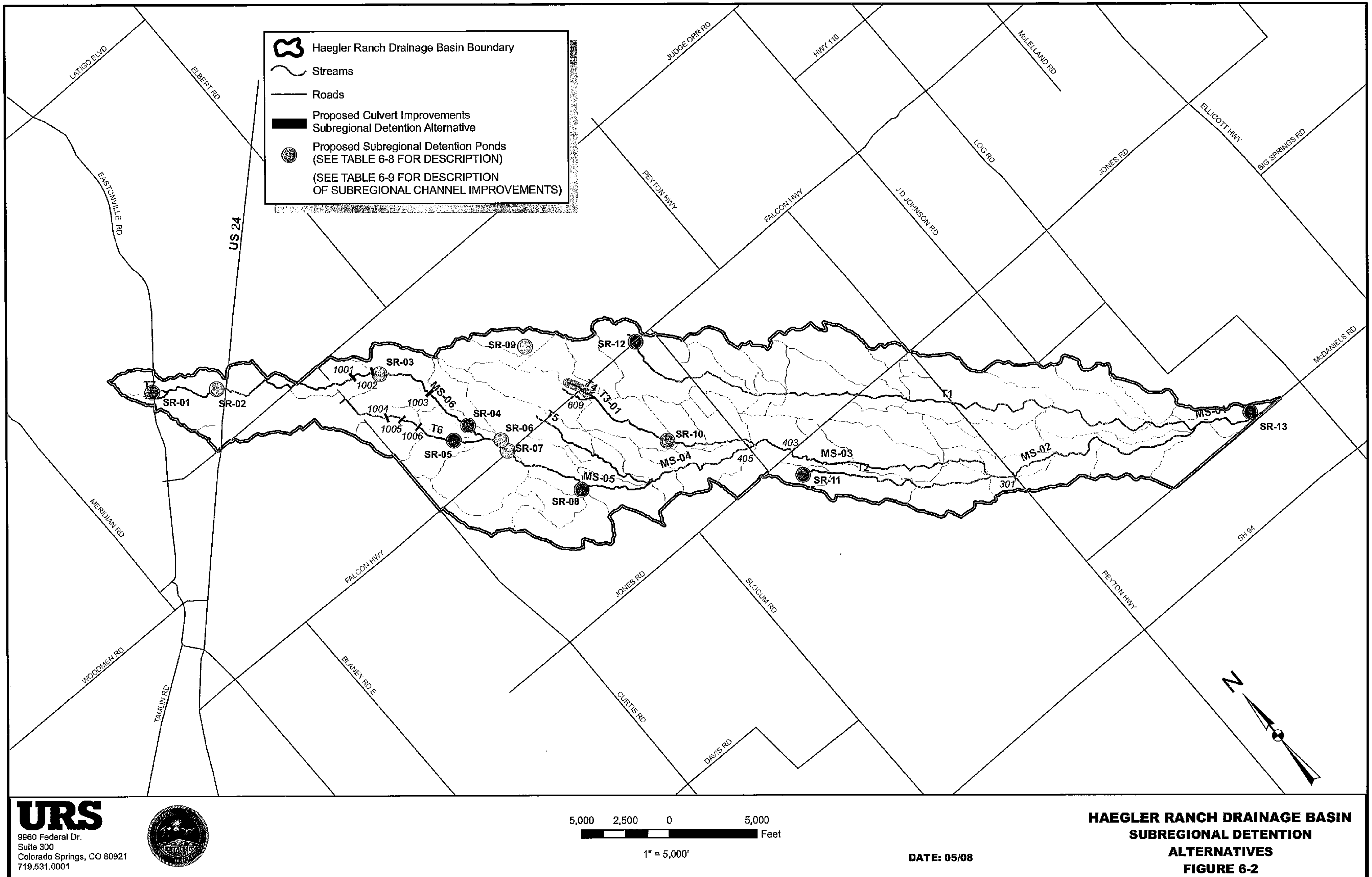
Channel	Existing 100-yr Flow (cfs)	Proposed 100-yr Flow (cfs)	Design Flow (cfs)	Channel Length (ft)	Material
Main Stem (MS-05)	1460	1680	2000	1560	Grass
Main Stem (MS-06)	660	530	600	3120	Grass
Main Stem (MS-06)	720	970	1000	4535	Grass
Main Stem (MS-06)	750	740	800	3190	Grass
Tributary 3 (T3-01)	600	600	600	5000	Grass
Tributary 3 (T3-02)	220	500	500	420	Grass
Tributary 4 (T4)	220	500	500	940	Grass
Tributary 6 (T6)	200	440	500	4280	Grass
Tributary 6 (T6)	240	250	300	1400	Grass

6.3.2.2. Culverts

As with the channels, only the culverts through proposed developments will be effected unless an area is undersized for existing conditions. Any existing deficiencies in the roadway culverts are the responsibility of the County and not the developer, and required culvert improvements are not included in the cost estimates for the alternative. Proposed culvert improvements are summarized in Table 6-10.

Table 6-10 Culvert Design for Subregional Detention Alternative

Facility Number	Road Crossing	Channel	Proposed 100-yr Flow (cfs)	Deficiency	Necessary Facility for Proposed 100-year Flow
301	Peyton Highway	Main Stem (MS-02)	3,370	Overtops	9-6'X6' RCBs
403	Jones Road	Main Stem (MS-03)	2,970	Overtops	8-6'X6' RCBs
405	Murr Road	Main Stem (MS-04)	2,870	Overtops	8-6'X6' RCBs
609	Falcon Highway	Tributary 3 (T3-02)	460	Overtops	2-6'X6' RCBs
1001	Future Pastura Street	Main Stem (MS-06)	930	Future Road	3-6'X6' RCBs
1002	Future Arroyo Hondo Blvd. N.	Main Stem (MS-06)	930	Future Road	3-6'X6' RCBs
1003	Future Arroyo Hondo Blvd. S.	Main Stem (MS-06)	1500	Future Road	4-6'X6' RCBs
1004	Future Pastura Street	Tributary 6 (T6)	440	Future Road	2-66" RCPs
1005	Future El Vado Road	Tributary 6 (T6)	440	Future Road	2-66" RCPs
1006	Future Socorro Trail	Tributary 6 (T6)	440	Future Road	2-66" RCPs

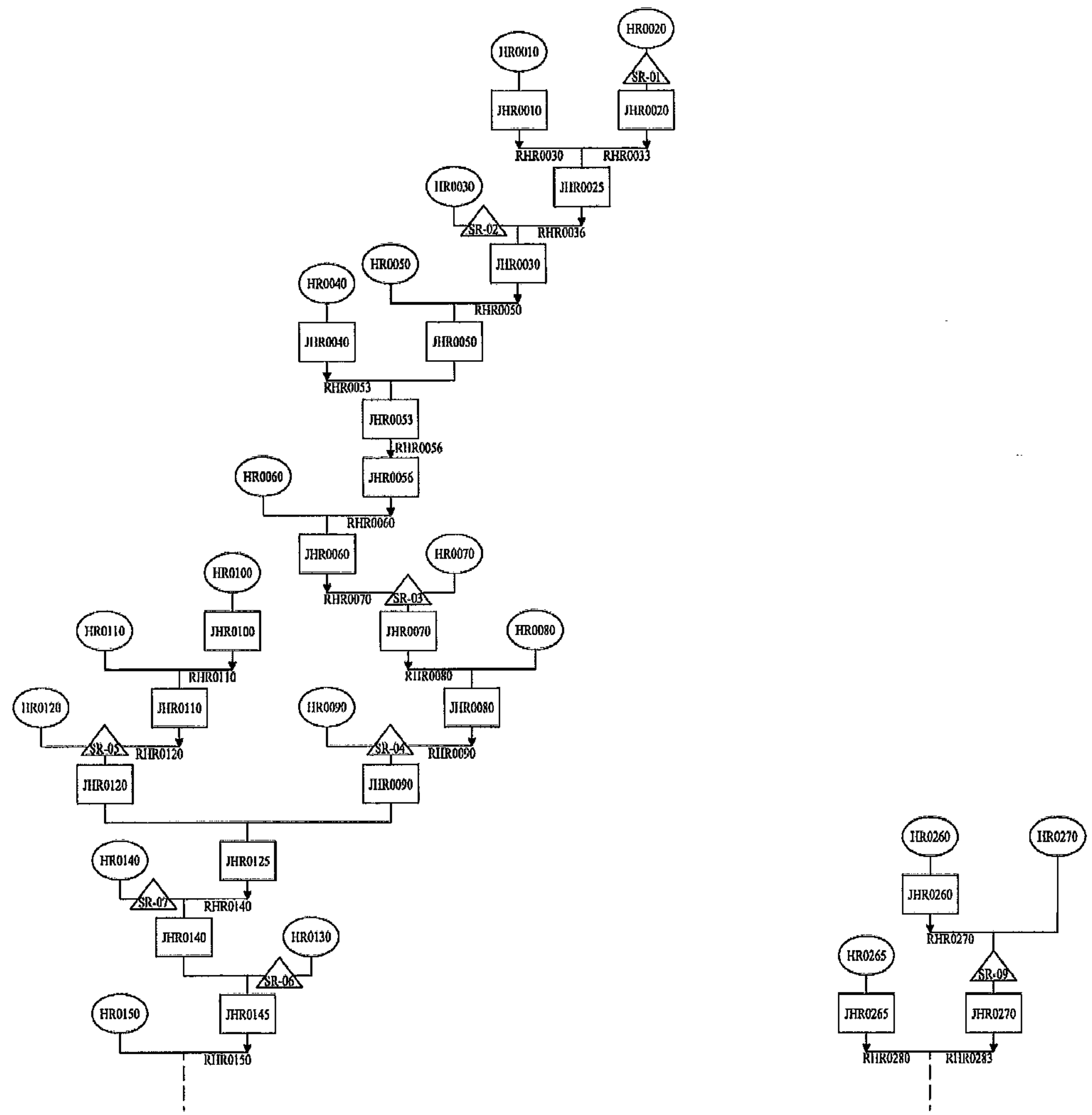


URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

DATE: 05/08

HAEGLER RANCH DRAINAGE BASIN
SUBREGIONAL DETENTION ALTERNATIVES
FIGURE 6-2

URS NO. 21711039



URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

DATE: 05/08

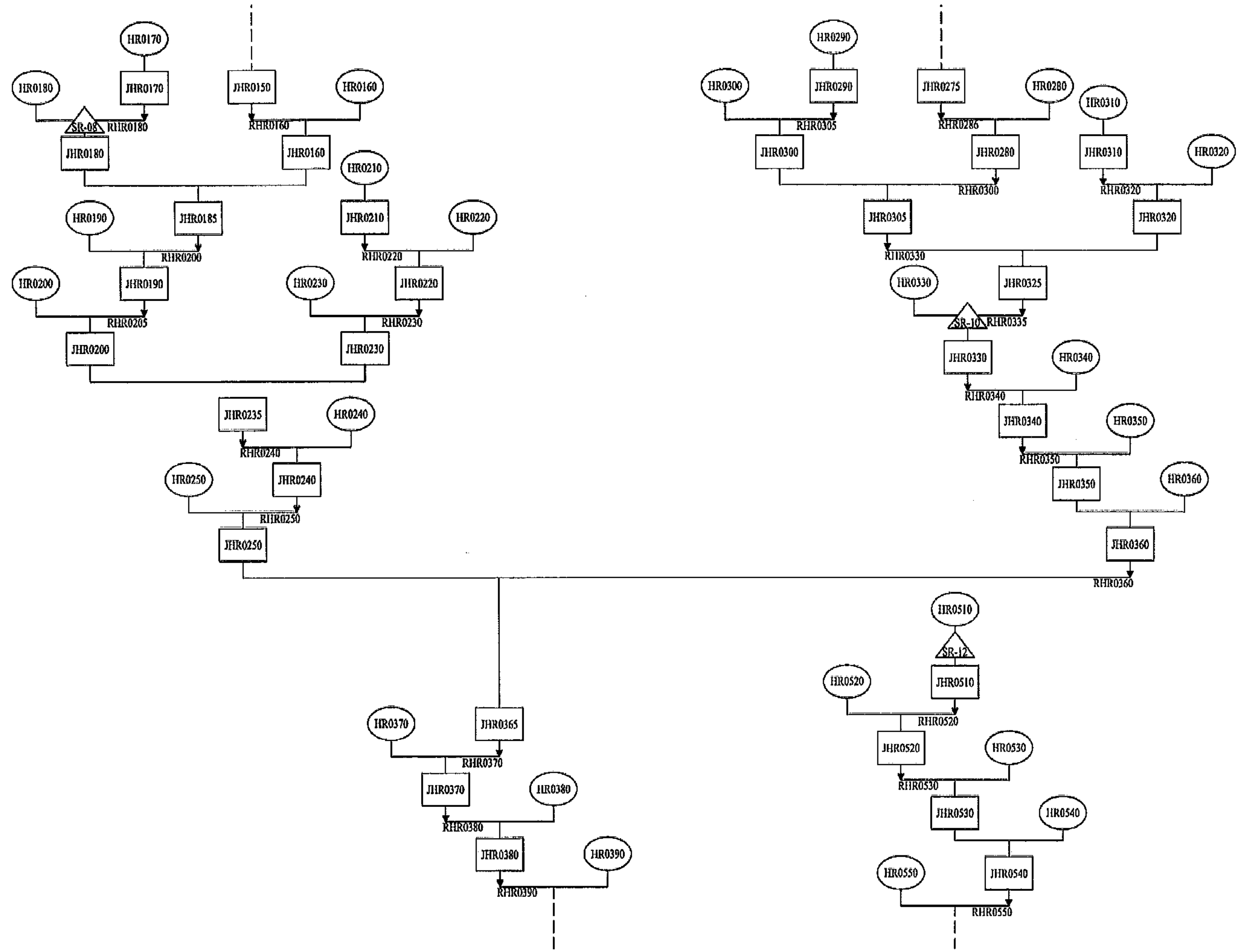
HAEGLER RANCH DRAINAGE BASIN

SUBREGIONAL DETENTION ALTERNATIVE

SHEET 1

FIGURE 6-3

URS NO. 21711039



URS

9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

DATE: 05/08

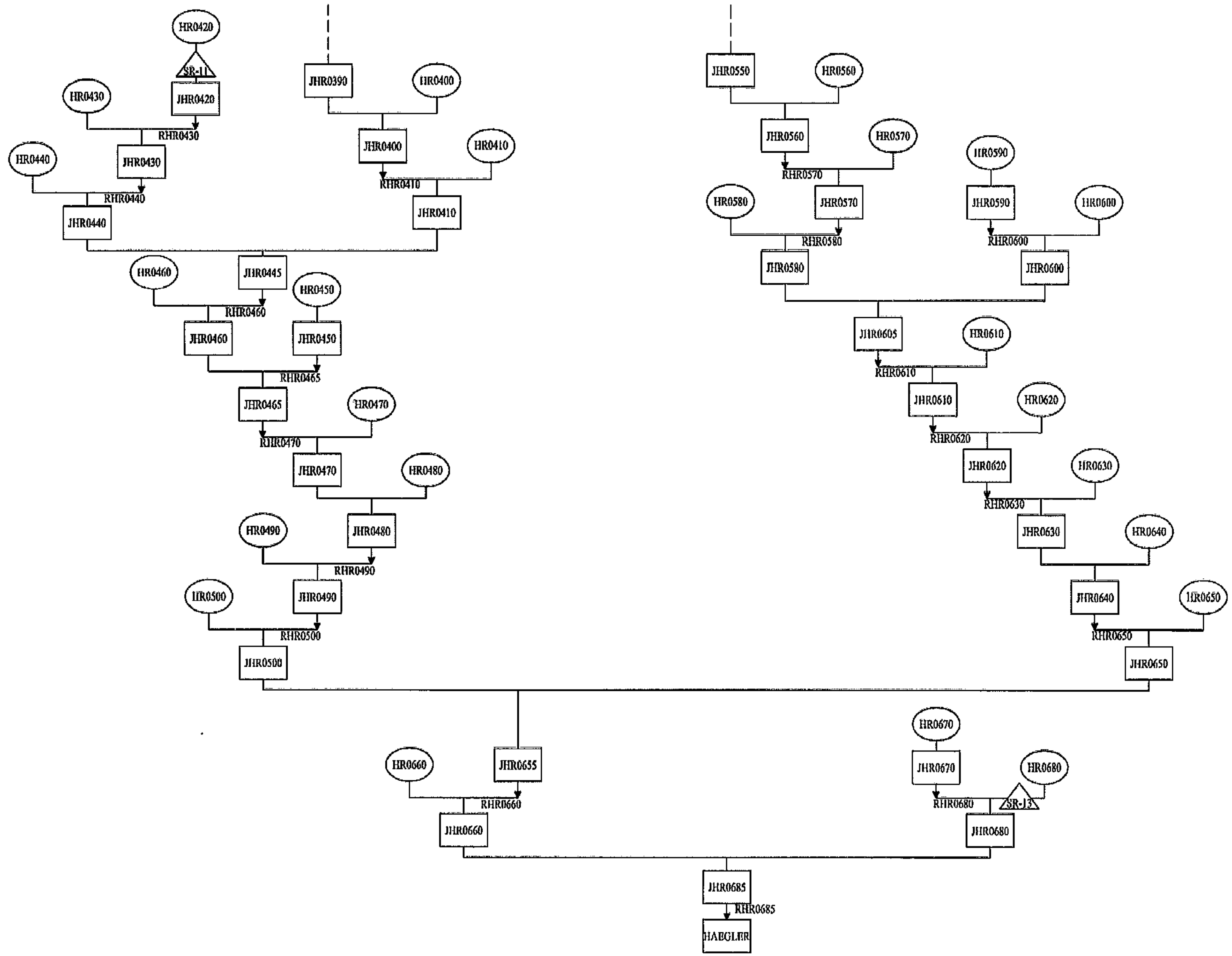
HAEGLER RANCH DRAINAGE BASIN

SUBREGIONAL DETENTION ALTERNATIVE

SHEET 2

FIGURE 6-3

URS NO. 21711039



URS
9960 Federal Dr.
Suite 300
Colorado Springs, CO 80921
719.531.0001

DATE: 05/08

HAEGLER RANCH DRAINAGE BASIN

SUBREGIONAL DETENTION ALTERNATIVE

SHEET 3

FIGURE 6-3

URS NO. 21711039

6.4. Cost Estimates

The regional and subregional detention alternatives have been evaluated by assembling necessary design requirements using the above criteria and estimating the capital cost of the improvements. Proposed improvements are separated into existing or future, depending on whether facilities are designed for the existing or future peak flow rates. Unit rates for all cost estimating are based on an average of the bid tabulations published by CDOT for 2006. These unit rates are presented in Table 6-11. Land acquisition costs were included only for the detention facilities in the alternatives analysis, because channel improvements would essentially be in floodplain areas not otherwise developable. Cost estimates are included in Appendix C.

Table 6-11 Unit Rates

Item Number	Description	Units	URS Estimated Unit Price
203-00010	Unclassified Excavation (Complete In Place)	CY	$7.00
203-00060	Embankment Material (Complete In Place)	CY	$9.00
207-00205	Topsoil	CY	$8.00
212-00006	Seeding (Native)	ACRE	$580.00
420-00100	Geotextile (Erosion Control) (Class A)	SY	$3.00
506-00206	Riprap (6 Inch)	CY	$80.00
506-00212	Riprap (12 Inch)	CY	$76.00
506-00218	Riprap (18 Inch)	CY	$64.00
507-00100	Concrete Slope and Ditch Paving (Reinforced)	CY	$300.00
601-03030	Concrete Class D (Box Culvert)	CY	$435.00
602-00000	Reinforcing Steel	LB	$1.10
603-01185	18 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$48.00
603-01245	24 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$56.00
603-01305	30 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$68.00
603-01365	36 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$80.00
603-01425	42 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$100.00
603-01485	48 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$110.00
603-01545	54 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$145.00
603-01605	60 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$185.00
603-01665	66 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$210.00
603-01725	72 Inch Reinforced Concrete Pipe (Complete In Place)	LF	$230.00
603-05018	18 Inch Reinforced Concrete End Section	EACH	$735.00
603-05024	24 Inch Reinforced Concrete End Section	EACH	$850.00
603-05030	30 Inch Reinforced Concrete End Section	EACH	$1,100.00
603-05036	36 Inch Reinforced Concrete End Section	EACH	$1,275.00
603-05042	42 Inch Reinforced Concrete End Section	EACH	$1,550.00
603-05048	48 Inch Reinforced Concrete End Section	EACH	$1,990.00
603-05054	54 Inch Reinforced Concrete End Section	EACH	$2,150.00
603-05060	60 Inch Reinforced Concrete End Section	EACH	$2,275.00
603-05066	66 Inch Reinforced Concrete End Section	EACH	$2,300.00
603-05072	72 Inch Reinforced Concrete End Section	EACH	$2,400.00
603-70606	6x6 Foot Concrete Box Culvert (Precast)	LF	$475.00
603-70806	8x6 Foot Concrete Box Culvert (Precast)	LF	$535.00
603-71006	10x6 Foot Concrete Box Culvert (Precast)	LF	$570.00
N/A	Land Acquisition	ACRE	$55,000

Note: Land acquisition costs were provided by El Paso County

Cost estimates have been prepared for public roadway crossing facilities designed for existing peak flow rates and are shown in Table 6-12.

Table 6-12 Existing Conditions Roadway Crossing Deficiencies and Costs to Correct

Facility Number	Road Crossing	Channel	Necessary Facility	Cost
301	Peyton Highway	Main Stem (MS-02)	7-6'X6' RCBs	$314,535
401	Jones Road	Tributary 1 (T1)	6'X6' RCB	$53,111
403	Jones Road	Main Stem (MS-03)	6-6'X6' RCBs	$270,947
405	Murr Road	Main Stem (MS-04)	5-6'X6' RCBs	$180,371
407	Murr Road	Tributary 3 (T3-01)	2-6'X6' RCBs	$77,801
507	Peerless Farms Road	Tributary 3 (T3-01)	2-6'X6' RCBs	$115,801
509	Murr Road	Tributary 1 (T1)	66" RCP	$19,300
601	Whiting Way	Tributary 1 (T1)	66" RCP	$23,500
604	Max Road	Tributary 1 (T1)	66" RCP	$19,300
609	Falcon Highway	Tributary 3 (T3-02)	66" RCP	$25,600
610	Falcon Highway	Tributary 4 (T4)	66" RCP	$23,500
612	Falcon Highway	Tributary 5 (T5)	60" RCP	$21,200
628	Falcon Highway	Main Stem (MS-05)	3-6'X6' RCBs	$154,741
702	Curtis Road	Tributary 6 (T6)	54" RCP	$23,150
703	Curtis Road	Main Stem (MS-06)	2-6'X6' RCBs	$125,301
704	Judge Orr Road	Main Stem (MS-06)	2-72" RCPs	$83,200
801	Pedestrian Bridge	Main Stem (MS-06)	Existing Bridge	$0
802	US24	Main Stem (MS-06)	Existing Culvert	$0
803	Eastonville Road	Main Stem (MS-07)	30" RCP	$9,680
804	Eastonville Road	Tributary 7 (T7)	48" RCP	$14,980
N/A	Peyton Highway	Tributary 1 (T1)	2-72" RCPs	$51,000
N/A	Falcon Highway	Tributary 1 (T1)	36" RCP	$9,750
Sub-Total				$1,616,769
30% Construction Contingency				$485,031
15% Engineering Contingency				$242,515
Total				$2,344,315

(See Table C3 in Appendix C for details)

6.4.1. Channel & Culvert Costs

Channel costs for each alternative are based on cubic yards of excavation, plus the cost of the channel lining and drop structures. These costs are presented in Table 6-13 and Table 6-14.

Table 6-13 Regional Detention Alternative Channel Cost Estimates

Channel	Design Flow (cfs)	Channel Length (ft)	Total Cost	Drop Structure Cost
Main Stem (MS-04)	3,500	7,140	$1,626,000	none
Main Stem (MS-05)	3,000	11,100	$2,216,000	$2,539,000
Main Stem (MS-06)	900	7,330	$482,000	$589,000
Main Stem (MS-06)	1,000	3,170	$231,000	$268,000
Main Stem (MS-06)	1,500	4,450	$450,000	$548,000
Main Stem (MS-06)	2,000	3,330	$477,000	$636,000
Tributary 3 (T3-01)	1,500	6,710	$1,082,000	$1,302,000
Tributary 4 (T4)	600	1,840	$96,000	$127,000
Tributary 5 (T5)	300	930	$37,000	$36,000
Tributary 5 (T5)	500	7,770	$325,000	$370,000
Tributary 6 (T6)	500	4,270	$179,000	$222,000
Tributary 6 (T6)	600	3,940	$204,000	$253,000
Sub-Total			$7,405,000	$6,888,000
30% Construction Contingency			$2,222,000	$2,066,000
15% Engineering Contingency			$1,110,000	$1,033,000
Total			$10,737,000	$9,988,000

(See Tables C6 and C7 in Appendix C for details)

Table 6-14 Sub-Regional Detention Alternative Channel Cost Estimates

Channel	Design Flow (cfs)	Channel Length (ft)	Total Cost	Drop Structure Cost
Main Stem (MS-05)	2,000	1,560	$224,000	$367,000
Main Stem (MS-06)	600	3,120	$162,000	$295,000
Main Stem (MS-06)	1,000	4,535	$331,000	$375,000
Main Stem (MS-06)	800	3,190	$188,000	$368,000
Tributary 3 (T3-01)	600	5,000	$259,000	$422,000
Tributary 3 (T3-02)	500	420	$18,000	$37,000
Tributary 4 (T4)	500	940	$40,000	$74,000
Tributary 6 (T6)	500	4,280	$179,000	$333,000
Tributary 6 (T6)	300	1,400	$55,000	$107,000
Sub-Total			$1,456,000	$2,374,000
30% Construction Contingency			$430,000	$712,000
15% Engineering Contingency			$218,000	$356,000
Total			$2,111,000	$3,442,000

(See Tables C6 and C8 in Appendix C for details)

Culverts costs are based on a per linear foot of pipe with two flared end sections or two wing walls, as appropriate, complete-in-place. Culvert costs for each alternative are presented in Table 6-15 and Table 6-16.

Table 6-15 Regional Detention Alternative Roadway Crossing Cost Estimate Sumary

Facility Number	Road Crossing	Channel	Existing Size	Proposed 100-yr Flow (cfs)	Necessary Facility for Proposed 100-year Flow	Estimated Cost
405	Murr Road	Main Stem (MS-04)	66" RCP	3,400	9-6'X6' RCBs	$256,000
507	Peerless Farms Road	Tributary 3 (T3-01)	60" CMP	1200	4-6'X6' RCBs	$139,000
609	Falcon Highway	Tributary 3 (T3-02)	18" CMP	460	2-66" RCPs	$51,600
610	Falcon Highway	Tributary 4 (T4)	24" CMP	570	2-72" RCPs	$51,000
612	Falcon Highway	Tributary 5 (T5)	24" CMP	240	72" RCP	$26,000
628	Falcon Highway	Main Stem (MS-05)	2-60" CMPs	2,200	6-6'X6' RCBs	$243,000
702	Curtis Road	Tributary 6 (T6)	36" CMP	140	60" RCP	$29,000
703	Curtis Road	Main Stem (MS-06)	24" CMP	890	3-6'X6' RCBs	$142,000
704	Judge Orr Road	Main Stem (MS-06)	Blocked Culvert	830	3-6'X6' RCBs	$185,000
1001	Future Pastura Street	Main Stem (MS-06)	N/A	930	3-6'X6' RCBs	$99,000
1002	Future Arroyo Hondo Blvd. N.	Main Stem (MS-06)	N/A	930	3-6'X6' RCBs	$99,000
1003	Future Arroyo Hondo Blvd. N	Main Stem (MS-06)	N/A	1500	4-6'X6' RCBs	$143,000
1004	Future Pastura Street	Tributary 6 (T6)	N/A	440	2-66" RCPs	$43,000
1005	Future El Vado Road	Tributary 6 (T6)	N/A	440	2-66" RCPs	$43,000
1006	Future Socorro Trail	Tributary 6 (T6)	N/A	440	2-66" RCPs	$43,000
Sub-Total						$1,591,000
30% Construction Contingency						$477,000
15% Engineering Contingency						$239,000
Total						$2,307,000

(See Table C4 in Appendix C for details)

Table 6-16 Sub-Regional Detention Roadway Crossing Cost Estimate Summary

Facility Number	Road Crossing	Channel	Proposed 100-yr Flow (cfs)	Necessary Facility for Proposed 100-year Flow	Estimated Cost
301	Peyton Highway	Main Stem (MS-02)	3,370	9-6'X6' RCBs	$402,000
403	Jones Road	Main Stem (MS-03)	2,970	8-6'X6' RCBs	$358,000
405	Murr Road	Main Stem (MS-04)	2,870	8-6'X6' RCBs	$283,000
609	Falcon Highway	Tributary 3 (T3-02)	460	2-6'X6' RCBs	$106,000
N/A	Falcon Highway	Tributary 1 (T1)	110	2 - 36" RCP	$20,000
1001	Future Pastura Street	Main Stem (MS-06)	610	2-6'X6' RCBs	$107,000
1002	Future Arroyo Hondo Blvd. N.	Main Stem (MS-06)	610	2-6'X6' RCBs	$87,000
1003	Future Arroyo Hondo Blvd. N.	Main Stem (MS-06)	530	2-6'X6' RCBs	$87,000
1004	Future Pastura Street	Tributary 6 (T6)	440	2-66" RCPs	$43,000
1005	Future El Vado Road	Tributary 6 (T6)	440	2-66" RCPs	$43,000
1006	Future Socorro Trail	Tributary 6 (T6)	440	2-66" RCPs	$43,000
Sub-Total					$1,582,000
30% Construction Contingency					$475,000
15% Engineering Contingency					$237,000
Total					$2,294,000

(See Tables C5 in Appendix C for details)

6.4.2. Detention Pond Costs

The cost of detention ponds, both regional and subregional, is based on the cubic yards of excavation, an estimated outlet structure, and the cost of the land required for the facility. These costs are presented in Table 6-17 and Table 6-18.

Table 6-17 Regional Detention Pond Cost Summary

Facility	Storage (AF)	Total Cost Including Construction and Engineering Contingencies
RG-01 9.02	9.02	$542,000
RG-02 64.52	64.52	$4,053,000
RG-03 0.04	0.04	$146,000
RG-04 1.07	1.07	$160,000
RG-05 0.03	0.03	$146,000
Total		$5,048,000

(See Tables C1 in Appendix C for details)

Table 6-18 Sub-Regional Detention Pond Cost Summary

Facility	Storage (AF)	Total Cost Including Construction and Engineering Contingencies
SR-01	10	$899,000
SR-02	5	$640,000
SR-03	16	$868,000
SR-04	25	$1,453,000
SR-05	24	$1,557,000
SR-06	9	$547,000
SR-07	5	$524,000
SR-08	5	$326,000
SR-09	20	$861,000
SR-10	23	$1,069,000
SR-11	2	$182,000
SR-12	9	$477,000
SR-13	3	$376,000
Total		$9,780,000

(See Table C1 in Appendix C for details)

6.4.3. Other Costs

Design Engineering costs are also included as 15% of the construction costs. Construction contingencies (30%) include such items as utility relocations, mobilization, temporary erosion control, and construction engineering.

6.4.4. Conceptual Alternative Costs

The total estimated capital costs for each alternative are based on the sum of the cost of the proposed facilities, plus costs for engineering and construction contingencies. These costs are listed in Table 6-19.

Table 6-19 Conceptual Alternative Costs

	Regional Alternative	Subregional Alternative
Detention Ponds	$5,048,000	$9,780,000
Channel Improvements	$10,737,000	$2,110,000
Drop Structures	$9,988,000	$3,442,000
Roadway Crossing Culverts	$2,307,000	$2,294,000
Total	$28,080,000	$17,627,000

7.0 CONCEPTUAL DESIGN

7.1. Recommendation

Based on the evaluation of flood impacts, stream stability, and cost effectiveness, the subregional detention alternative is preferred and recommended for implementation. Subregional detention will reduce flood impacts not only downstream of the basin but within the basin as well. With smaller detention ponds and fewer channel and culvert improvements, development can occur anywhere in the basin and the associated subregional pond can be constructed. The subregional detention is the most cost effective way to meet all the criteria of the Drainage Basin Planning Study.

The results of the Conceptual Design analysis are summarized in this section. The alternative improvements have been quantitatively and qualitatively evaluated, and presented to El Paso County and other interested agencies and individuals. Field review of specific areas of concern has been conducted in order to refine the channel treatments suggested for use within the Haegler Ranch Basin. The conceptual plan for the recommended alternative is shown on the drawings contained in Appendix D.

7.1.1. Criteria

The DCMI was used in the development of the typical sections and plans for the major drainageways within the Basin. The DCM was supplemented with other criteria manuals with more specific application:

1. "Design Guidelines and Criteria for Channels and Hydraulic Structures on Sandy Soils," prepared by Simons, Li & Associates, Inc., 1981.

2. Urban Storm Drainage Criteria Manual, Volumes I, II, and III, prepared by the Urban Drainage and Flood Control District.

Design plans for roadway and channel improvement projects, either proposed or already constructed in on-going developments, were reviewed in order to prepare the Conceptual Design plans.

7.1.2. Hydrology

The hydrologic model used to evaluate the subregional detention alternative was used for conceptual design of the alternative. The routing schematic used in the developed condition hydrologic model is shown in Figure 6-3. The HEC-HMS model in Appendix A contains hydrologic data to be used for the sizing of major drainageway improvements within the Basin. Peak flow rates for the 100-year frequency incorporate the selected detention alternatives for the Haegler Ranch Basin. A complete list of peak discharges for all the sub-basins and design points shown on Figure 6-3 is in Appendix A.

The sizing of the drainageway improvements for the tributaries will need to be verified during the final design and layout of the proposed drainageway facilities. Land development activities may alter the location of design points along the tributaries, and therefore slight alteration in a sub-basin's length, slope and area may occur. The methods outlined in the DCM are applied during final design analysis. The Rational Method should be used to check the peak flow rates for all tributary drainageways and storm sewers draining areas less than 100 acres in size.

URS performed a check of the results of the HEC-HMS model, and the results for the ultimate design peak flows are listed in Table 7-1.

Table 7-1 Reasonableness Check of Hydrology for Developed Conditions

Hydrologic Method	Design Point JRHR060		Design Point JRHR200	
	A_E (acres)= 1814		A_E (acres)= 3692	
	Q_{100} (cfs)	Q_{100} (cfs/acre)	Q_{100} (cfs)	Q_{100} (cfs/acre)
1. URS HEC-HMS Model	870	0.5	1800	0.5
2. USGS Regression Equations	2457	1.4	3237	0.9
3. CWCB Regression Equations	N/A	N/A	4102	1.1
4. COE HEC-HMS Model	N/A	N/A	N/A	N/A
Hydrologic Method	Design Point JRHR370		Outlet JRHR371	
	A_E (acres)= 10198		A_E (acres)= 10491	
	Q_{100} (cfs)	Q_{100} (cfs/acre)	Q_{100} (cfs)	Q_{100} (cfs/acre)
1. URS HEC-HMS Model	4900	0.5	4900	0.5
2. USGS Regression Equations	4801	0.5	4854	0.5
3. CWCB Regression Equations	7151	0.7	7262	0.7
4. COE HEC-HMS Model	N/A	N/A	5047	0.5

As indicated in Table 7-1, the USGS regional regression equations (Method 2) predict a 100-year peak flow significantly higher than the URS HEC-HMS model for design points JRHR060 and JRHR200, while the peak flow is slightly lower for design points JRHR370 and JRHR371. Figure 2 of the USGS publication excludes areas of "unusually high soil infiltration rate." Since these soils occur within Haegler Ranch Basin, this may explain some of the difference in results. The URS HEC-HMS results are generally on the low end of the values obtained by other methods, but within the same range in terms of cfs/acre in the larger subbasins.

7.1.3. Channels

The recommended channel sections for each reach of drainageway are detailed in plan and profile in Appendix D. The channel sections were chosen based on the criteria in the DCM as described in Section 6.2.1.

7.1.4. Drop Structures and Check Structures

Drop and check structures have been sited along Haegler Ranch Basin in order to lower grades and slow the channel velocity to the recommended 7 feet per second, and to reduce localized and long-term stream degradation of channel linings and overbanks. In the reaches to be channelized, drop structures will help protect the native vegetation from the detrimental effects of headcutting. Several types of structures could be considered for the Haegler Ranch Basin. A maximum drop height of three feet is recommended. The methodology recommended for use when designing vertical drop structures is contained with Volume II of the Urban Storm Drainage Criteria Manual. Materials recommended include soil cement, riprap, boulder, reinforced concrete, or combinations of these materials. A reinforced concrete cut off wall/drop with riprap protection upstream and downstream was used for the Conceptual Design, but it may not be suitable for all locations.

7.1.5. Detention

The recommended plan calls for the construction of nine sub-regional detention basins within the Haegler Ranch Basin. One of these has already been designed as part of the Meridian Ranch Development. The purpose of the Haegler Ranch Basin detention basins is to limit peak discharges throughout the drainage to the existing condition levels. The detention basins in the upper portions of the Haegler Ranch Basin will reduce the peak flows so that the majority of the existing channel sections and bridges along SH 24 will have adequate flow capacity in the future development condition. The detention basins have been designed to accommodate the 100-year future condition volume without overtopping the overflow spillway. Detention ponds are shown in drawings in Appendix D.

7.1.6. Water Quality

Improvement of stormwater quality has become an important issue in drainage basin planning. Some pollutants occur naturally and are associated with sediments from the watershed. Other pollutants such as lawn chemicals, oil and grease, pet feces, lawn clippings and other items are the result of human development. Many of these pollutants can be reduced by implementing erosion control measures at construction sites, educational programs to inform the public as to the proper use of lawn chemicals, oil recycling and street sweeping programs.

Various methods of water quality enhancement have been identified for use in this Conceptual Design. 100-year and 10-year flow channels are lined to reduce erosion, drop/check structures are used to control channel grade, and water quality pools within the detention basins are proposed. The water quality pools for the subregional detention basins have been sized to store runoff generated by the two-year storm to a maximum of 5 Ac-ft. A maximum size for the regional Water Quality Capture Volume (WQCV) is supported by studies by the Urban Drainage and Flood Control District ("Sizing a Capture Volume for Stormwater Quality Enhancement", by Urbonas, Guo, and Tucker, published in the Flood Hazard News. December 1989), which show a diminishing level of return for larger, scarcer storm events. The water quality pool within each detention basin is sized to detain the WQCV over a 40-hour time period. The water quality measures for each sub-regional detention basin includes an inlet forebay, a water quality storage area, a water quality outlet control structure and the introduction of water tolerant vegetation in the basin bottom.

7.1.7. Trails

Major drainageway floodplains may be designated for use as open space and trail corridors. Maintenance access to the drainageway and to existing utilities within the drainageway corridor can offer a multiple use aspect to a trail project. The siting of a trail along a drainageway should be carried out while taking into account hydraulic considerations, utilities in the area, access to dedicated parks and roadway crossings.

7.2. Implementation and Permitting

Many of the channel sections shown on the plans may have to be modified to fit specific site conditions. This will be particularly true in the segments where selective channel treatments are proposed. Drop and check locations are approximate and may be moved to reduce disturbances to existing vegetation, roads, trails, and utilities. Existing right-of-ways will play a key role in the location of future drainageways. Tributary channel sizes, sections and alignments will have to be verified at the time the surrounding land is proposed for development.

It is expected that additional design of the detention ponds will occur as the areas around each one is planned. The Detention Facilities within Woodmen Hills have already been constructed. The acquisition of property for the remaining detention basins can proceed at any time, preferably no later than during the development planning stages of properties that lie adjacent to or surround any of the proposed sites. The timing of construction of the sub-regional detention facilities will mainly be driven by the rate of upstream development, and funding.

Improvements within Haegler Ranch Basin within and adjacent to park areas should be completed with the following general goals in mind: (1) provide a more stable drainage way, (2) maintain and enhance the visual setting of the drainage, and (3) provide multiple uses within the drainageway corridors. Construction of drops or checks could be combined with trail crossings of the creek. Low flow linings could be constructed in order to make the creek more visually pleasing and to protect active park facilities from damages due to frequent flooding or stream bank erosion. Localized creek improvements will be necessary as trails transition at roadway crossings, or at side tributary crossings. Implementation should also be completed in coordination with the Colorado Department of Wildlife comments, provided in Appendix F.

In areas where the existing drainage facilities are inadequate, capital improvement projects will be necessary. This will be particularly true at road crossings and within the East Tributary where extensive channelization is required. Several bridges are presently inadequate or nonexistent. These structures may have to be funded through capital improvement or bridge replacement funds.

7.2.1. Right-of-Way

With the exception of the Meridian Ranch development, the main channel and sub-tributaries which pass through developed portions of the basin (primarily south of SH 24) are not in dedicated drainage tracts, easements, or rights-of-way. This means that the County must have the approval and cooperation of property owners to maintain or improve the channels in these areas. Acquiring drainage easements along the drainageways is needed to provide access to the drainageways for construction and maintenance of improvements.

7.2.2. Roadway Bridge and Culvert Replacements

Bridge and culvert replacements shown on the Conceptual Design drawings have been sized in accordance with the DCM. Bridges are defined as those structures conveying at least 1500 cubic feet per second, having a flow area of at least 200 square feet, or having a span of 20-feet or greater. Road crossings conveying flows less than 1500 cubic feet per second, smaller than 200 square feet in flow area, or less than 20-feet in span have been included in the drainage basin fee calculation. Structures defined as bridges have been included in the County Bridge fee calculations. Note that many structures have been classified as bridges due to their total span, and not because of the volume they convey.

7.3. Revegetation

Soils in the Haegler Ranch Basin vary widely and, because of this, drainageways are subject to varying degrees of hazard resulting from erosion and sediment transport. During the collection of field and drainage inventory data, numerous areas were noted which were being impacted by either erosion (of one form or another), or sediment deposition. The soils of the basin are generally highly erodible, and this is particularly the case where the channel has a sand bottom and the watersheds have poor to fair vegetative cover. The disturbance of the native vegetation and failure to properly revegetate areas impacted by site development, utility, roadway and landscape construction activities have in some cases negatively affected downstream areas.

El Paso County has enacted an erosion control ordinance to address these problems. In general, it is the responsibility of the entity conducting any land disturbance activity to properly control surface runoff, erosion and sedimentation during and after the activity. Technical criteria identifying measures which help mitigate the impacts of erosion and sedimentation are available and being used throughout the region. Minimum requirements must be developed to properly control erosion.

Erosion control is necessary to prevent environmental degradation caused by wind or water-borne soil. The following minimum criteria and standards are intended to prevent excessive erosion. El Paso County as well as other affected agencies will enforce the Clean Water Act standards if the planned erosion control measures fail to perform satisfactorily. Proper installation and maintenance is necessary to achieve the desired function of erosion control measures. By paying attention to quality, reinstallation can be avoided. General requirements for erosion control are as follows:

1. Any land disturbing activity shall be conducted so as to effectively reduce unacceptable erosion and resulting sedimentation.
2. All land disturbing activities shall be designed, constructed, and completed in such a manner that the exposure time of disturbed land shall be limited to the shortest possible period of time.
3. Sediment caused by accelerated soil erosion and runoff shall be intercepted by erosion control measures such as hay bales, silt fences and / or sediment ponds, and contained within the site.
4. Any facility designed and constructed to convey storm runoff shall be designed to be non-erosive.
5. Erosion control measures will be used prior to and during construction.

Temporary erosion control measures are required during construction, and permanent erosion control measures are required for all developments. Maintenance of erosion control measures is the responsibility of the property owner.

Various structures have been proposed in this plan to help control localized erosion and sedimentation problems. It is important that the erosion control plan for any land disturbing activity be strictly adhered to and maintained so that the above minimum criteria can be achieved in the Haegler Ranch Basin.

7.4. Operations and Maintenance

Maintenance of drainage way facilities is essential in preventing long term degradation of the creek and overbank areas. Along the drainageway, clearing of debris and dead vegetation should be considered within the low flow area of the creek and its tributaries. On the overbanks, limited maintenance of the existing vegetative cover is recommended. Semi-annual clearing of trash and debris at roadway crossings is also recommended to increase the effectiveness of the crossings. Sediments cleared from the channel or culvert should not be left on the overbank. This disturbs the native vegetation, creates a potential water quality concern if the dredgings are subsequently washed into the drainageway by natural erosion, and reduces the capacity of the overbank. In those reaches designated to be selectively lined and the floodplain preserved, maintenance activities should be carried out with the least disturbances to native vegetation that is practical.

Similar practices should be employed when removing sediment from detention basins. Although some channels degrade and others agrade, all detention basins will collect sediment and agrade. The use of an easily accessible concrete lined forebay in the final design of a detention facility can make the cleaning of the larger debris and trash more easily accomplished with motorized equipment. If forebays are provided, they will need clearing semi-annually and after major storm events. More frequent routine maintenance may be required depending on the type of development upstream and the access provided to the public. Plan for annual removal of sediment and debris from the detention area of a facility with a forebay.

Deposition in drainage facilities of wind-blown trash and debris, should be expected in this region. This means that regular maintenance, even without rainfall events, should be performed.

7.5. Drainage and Bridge Fee Calculations

The cost estimates and basin fee calculation for the major drainageways, tributary drainageways, roadway culverts, regional detention basins, and related improvements for the Sub-Regional Detention Facilities are presented in Table 7-2. The sub-regional detention capital construction cost estimates include the cost for the construction of the embankment, water quality, and outlet structures. Bridges in the Sub-Regional Detention Alternative are presented in Table 7-3. The cost estimates include engineering and construction costs for the entire Haegler Ranch Basin as presented on the Conceptual Design Drawings in Appendix D. These estimates do not include costs for local or initial systems, and therefore no costs attributable to local or minor drainage systems have been computed in the estimation of the drainage basin fee. These systems are expected to be provided with proposed development. Costs associated with utility relocations have not been estimated but would be included in construction contingencies. A review of utility maps indicates that the majority of the potential relocations occur at the roadway crossings. Land acquisition costs for the detention facilities were not included for calculation of fees per Appendix L of the El Paso County Criteria Manual.

Unplatted acreage within Haegler Ranch was obtained from El Paso County, and is shown in Figure 7-1. A total of 8,953 acres is estimated to be currently unplatted and subject to future development. This unplatted land is projected to have an average imperviousness of approximately 15%, corresponding to approximately 1,343 unplatted impervious acres. All drainage and bridge fees are calculated per *impervious* acre. (See Appendix D for an unplatted area breakdown by subbasin and average imperviousness calculations.)

Reimbursable costs calculated for the Haegler Ranch Basin are listed in Table 7-4. These costs are based on improvements required under existing conditions. The term "reimbursable costs" used on Table 7-4 means those costs that have been used in estimation of drainage basin fees. Costs considered "non-reimbursable" are costs for the replacement of existing, undersized culverts, or costs to rehabilitate or maintain an existing lined segment of drainageway. For the most part, all of the drainageway costs for Haegler Ranch Basin are considered reimbursable.

The calculated drainage basin fee presented in Table 7-2 is $ 7,633 per impervious acre, and the bridge fee is $1,126 per impervious acre, as shown in Table 7-3.

Table 7-2 Drainage Basin Fee Calculations

Channel Improvements					
Channel	Basins	Channel Construction Cost	Drop Structure Construction Cost	Contingency Cost	Total Cost
Main Stem (MS-05)	HR0200	$224,000	$363,600	$264,420	$852,020
Main Stem (MS-06)	HR0070	$162,000	$295,400	$205,830	$633,230
Main Stem (MS-06)	HR0080	$331,000	$374,500	$317,475	$1,022,975
Main Stem (MS-06)	HR0090	$188,000	$368,000	$250,200	$806,200
Tributary 3 (T3-01)	HR0330	$259,000	$422,000	$306,450	$987,450
Tributary 3 (T3-02)	HR0300	$18,000	$37,000	$24,750	$79,750
Tributary 4 (T4)	HR0300	$40,000	$74,000	$51,300	$165,300
Tributary 6 (T6)	HR0110	$179,000	$333,000	$230,400	$742,400
Tributary 6 (T6)	HR0120	$55,000	$106,500	$72,675	$234,175
Subtotal Channel Costs					$5,553,500
Culvert Improvements					
Culvert	Road Crossing	Channel	Culvert Construction Cost	Contingency Cost	Total Cost
609	Falcon Highway	Tributary 3 (T3-02)	$106,301	$47,836	$154,137
N/A	Falcon Highway	Tributary 1 (T1)	$19,500	$8,775	$28,275
1001	Future Pastura Street	Main Stem (MS-06)	$106,301	$47,836	$154,137
1002	Future Arroyo Hondo Blvd. N.	Main Stem (MS-06)	$87,301	$39,286	$126,587
1003	Future Arroyo Hondo Blvd. N.	Main Stem (MS-06)	$87,301	$39,286	$126,587
1004	Future Pasture Street	Tributary 6 (T6)	$51,000	$22,950	$73,950
1005	Future El Vado Road	Tributary 6 (T6)	$19,500	$8,775	$28,275
1006	Future Socorro Trail	Tributary 6 (T6)	$42,800	$19,260	$62,060
Subtotal Culvert Costs					$754,007
Detention Improvements					
Facility	Storage (AF)	Construction Cost		Contingency Cost	Total Cost
SR-01	10	$296,701		$133,516	$430,217
SR-02	5	$207,949		$93,577	$301,525
SR-03	16	$186,252		$83,814	$270,066
SR-04	25	$390,182		$175,582	$565,764
SR-05	24	$455,235		$204,856	$660,091
SR-06	9	$140,670		$63,301	$203,971
SR-07	5	$162,046		$72,921	$234,967
SR-08	5	$87,489		$39,370	$126,860
SR-09	20	$188,250		$84,713	$272,963
SR-10	23	$331,635		$149,236	$480,871
SR-11	2	$56,880		$25,596	$82,476
SR-12	9	$108,987		$49,044	$158,031
SR-13	3	$107,812		$48,515	$156,327
Subtotal Detention Costs					$3,944,129
Total Cost					**$10,251,636**
Total Unplatted Impervious Acres					**1,343**
Fee Per Impervious Acre					**$7,633**

Table 7-3 Bridge Fee Calculation

301	Peyton Highway	Main Stem (MS-02)	401,710	$180,770	$582,480
403	Jones Road	Main Stem (MS-03)	358,123	$161,155	$519,278
405	Murr Road	Main Stem (MS-04)	282,941	$127,323	$410,264
Subtotal Bridge Costs					$1,512,022
Total Cost					**$1,512,022**
Total Unplatted Impervious Acres					**1,343**
Bridge Fee Per Impervious Acre					**$1,126**

Table 7-4 Reimbursable Costs

Reimbursable Culvert Improvements					
Culvert	Road Crossing	Channel	Culvert Construction Cost	Contingency Cost	Total Cost
N/A	Peyton Highway	Tributary 1 (T1)	$51,000	$22,950	$73,950
N/A	Falcon Highway	Tributary 1 (T1)	$9,7580	$4,388	$14,138
301	Peyton Highway	Main Stem (MS-02)	$314,535	$141,541	$456,076
401	Jones Road	Tributary 1 (T1)	$53,111	$23,900	$77,011
403	Jones Road	Main Stem (MS-03)	$270,947	$121,926	$392,874
405	Murr Road	Main Stem (MS-04)	$180,371	$81,167	$261,538
407	Murr Road	Tributary 3 (T3-01)	$77,801	$35,011	$112,812
507	Peerless Farms Road	Tributary 3 (T3-01)	$115,801	$52,111	$167,912
509	Murr Road	Tributary 1 (T1)	$19,300	$8,685	$27,985
601	Whiting Way	Tributary 1 (T1)	$23,500	$10,575	$34,075
604	Max Road	Tributary 1 (T1)	$19,300	$8,685	$27,985
609	Falcon Highway	Tributary 3 (T3-02)	$25,600	$11,520	$37,120
610	Falcon Highway	Tributary 4 (T4)	$23,500	$10,575	$34,075
612	Falcon Highway	Tributary 5 (T5)	$21,200	$9,540	$30,740
628	Falcon Highway	Main Stem (MS-05)	$154,741	$69,633	$224,375
702	Curtis Road	Tributary 6 (T6)	$23,150	$10,418	$33,568
703	Curtis Road	Main Stem (MS-06)	$125,301	$56,386	$181,687
704	Judge Orr Road	Main Stem (MS-06)	$83,200	$37,440	$120,640
803	Eastonville Road	Main Stem (MS-07)	$9,680	$4,356	$14,036
804	Eastonville Road	Tributary 7 (T7)	$14,980	$6,741	$21,721
Subtotal Channel Costs					$2,344,315

Reimbursable Detention Improvements					
Facility	Storage (AF)	Construction Cost		Contingency Cost	Total Cost
SR-01	10	$296,701		$133,516	$430,217
SR-02	5	$207,949		$93,577	$301,525
SR-03	16	$186,252		$83,814	$270,066
SR-04	25	$390,182		$175,582	$565,764
SR-05	24	$455,235		$204,856	$660,091
SR-06	9	$140,670		$63,301	$203,971
SR-07	5	$162,046		$72,921	$234,967
SR-08	5	$87,489		$39,370	$126,860
SR-09	20	$188,250		$84,713	$272,963
SR-10	23	$331,635		$149,236	$480,871
SR-11	2	$56,880		$25,596	$82,476
SR-12	9	$108,987		$49,044	$158,031
SR-13	3	$107,812		$48,515	$156,327
Subtotal Detention Costs					$3,944,129
Total Reimbursable Cost					**$6,288,444**