

# *Haegler Ranch Basin*

## Drainage Basin Planning Study

May 2009



**URS**



# HAEGLER RANCH DRAINAGE BASIN PLANNING STUDY

**MAY 2009**

Prepared for:



El Paso County  
Department of Transportation  
3460 N. Marksheffel Road  
Colorado Springs, CO 80922

Prepared By:



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URS Project No. 21711039





AMENDMENT TO THE COUNTY PLAN (Approved)

**Approved  
El Paso County  
Planning Commission**

**This 2nd day of JUNE 2009**

Commissioner Bracken moved that the following Resolution be adopted:

**Chair**

BEFORE THE PLANNING COMMISSION

**Secretary**

OF THE COUNTY OF EL PASO

STATE OF COLORADO

RESOLUTION NO. MP-09-001

WHEREAS, the Department of Public Services, Transportation Division, URS Corporation and the El Paso County Planning Department requests approval of and amendment to the Master Plan by adoption of the Haegler Ranch Drainage Basin Planning Study within the designated areas of the unincorporated area of El Paso County; and

WHEREAS, a public hearing was held by this Commission on February 3, 2009 and May 5, 2009;

WHEREAS, based on the evidence, testimony, exhibits, study of the master plan for the unincorporated area of the county, comments of the El Paso County Planning Department, comments of public officials and agencies, and comments from all interested parties, this Commission finds as follows:

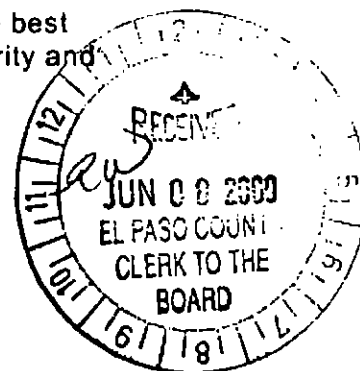
1. That proper posting, publication and public notice was provided as required by law for the hearing of the Planning Commission.
2. That the hearing before the Planning Commission was extensive and complete. that all pertinent facts, matters and issues were submitted and that all interested parties were heard at that meeting
3. That all data, surveys, analyses studies, plans, and designs as are required by the State of Colorado and El Paso County have been submitted, reviewed and found to meet all sound planning and engineering requirements of the El Paso County Subdivision Regulations.
4. That the proposal shall amend the Master Plan for El Paso County.
5. That for the above-stated and other reasons, the proposal is in the best interests of the health, safety, morals, convenience, order, prosperity and welfare of the citizens of El Paso County.

**RECEIVED**

JUN 11 2009

EPC DEVELOPMENT SERVICES

09-027





WHEREAS, Section 30-28-108 C.R.S. provides that a county planning commission may adopt, amend, extend, or add to the County Master Plan.

NOW, THEREFORE, BE IT RESOLVED that the amendment to the Master Plan for El Paso County be approved for the following described unincorporated area of El Paso County:

The Haegler Ranch (El Paso County Basin Number CHMS0200) flows to the southeast from north of Eastonville Road to McDaniels Road with a total of 16.6 sq mi in unincorporated El Paso County, Colorado.

BE IT FURTHER RESOLVED that the following conditions shall be placed upon this approval:

**CONDITIONS OF APPROVAL**

1. CRS 30-28-109 requires the Planning Commission to certify a copy of the Master Plan, or any adopted part or amendment thereof or addition thereto, to the Board of County Commissioners and to the Planning Commission of all municipalities in the County. The Planning Commission's action is to amend the Master Plan shall not be considered final until the applicant submits a minimum of ten (10) complete sets of the final documents to the Development Services Department and such documents are certified by the Chairman of the Planning Commission and distributed as required by law.

**NOTATIONS**

1. Certification of these documents to County municipalities pursuant to Condition 1 above is determined to be satisfied upon transmittal of summary information and maps along with a clear description of the locations where the complete documents are available for inspection, along with an offer to provide a given municipality a complete copy of the documents if requested. The transmittal may be in the form of digital copy.
2. Although this Drainage Basin Planning Study is adopted as a County Master Plan element pursuant to State Statute, the intent is not to use its land use assumptions as a justification for subsequent zoning decisions.
3. For currently undeveloped parcels without specific land use approvals, this Study bases assumptions for future land use on a generalized prediction for the year 2030. Because the timing of development and the ultimate density of this development are uncertain at this time, the overall land use assumptions for this basin will likely need to be comprehensively updated as patterns and trends emerge.

Commissioner Schanel seconded the adoption of the foregoing Resolution.

The roll having been called, the vote was as follows:



Commissioner Roulier	aye
Commissioner Schanel	aye
Commissioner Bracken	aye
Commissioner Powell	aye
Commissioner Vohland	aye
Commissioner Dickman	aye
Commissioner Hicks	aye
Commissioner Sery	aye
Commissioner Immel	aye

The Resolution was adopted by a unanimous vote of 8 to 0 by the Planning Commission of the County of El Paso, State of Colorado.

DATED: May 5, 2009



#### DISCLAIMER:

This report has been prepared based on certain key assumptions made by URS, which substantially affect the conclusions and recommendations of this report. These assumptions, although thought to be reasonable and appropriate, may not prove true in the future. URS' conclusions and recommendations are conditioned upon these assumptions.

Background information, design bases, and other data have been furnished to URS by third parties, which URS has used in preparing this report. URS has relied on this information as furnished, and is not responsible for and has not confirmed the accuracy of this information.

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Engineer's Statement:

The attached HAEGLER RANCH DRAINAGE BASIN PLANNING STUDY was prepared under my direction and supervision and is correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports. I accept responsibility for any liability caused by any negligent acts, errors, and omissions on my part in preparing this report.

URS, 9960 Federal Drive, Suite 300, Colorado Springs, CO 80921



John S. Griffith  
Registered Professional Engineer  
State of Colorado  
No. 16030

5/19/09  
Date



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## 1.0 EXECUTIVE SUMMARY

### 1.1. Purpose and Scope

The purpose of the drainage Basin Planning Study (DBPS) is to identify a stormwater management plan for the existing and future stormwater and infrastructure needs within the Haegler Ranch Drainage Basin (Haegler Ranch). The scope of work for this DBPS includes:

- Obtain existing relevant data and general information from participating entities.
- Obtain current information for land use and future growth in Haegler Ranch.
- Gather information about right-of-way, known drainage problems, and proposed stormwater projects.
- Utilize the County policies, criteria, and applicable information wherever possible.
- Perform hydrologic and hydraulic analyses within Haegler Ranch at 2-, 5-, 10-, and 100-year intervals.
- Identify existing and potential stormwater and/or flooding problems.
- Develop improvement alternatives to reduce existing and potential flooding problems.
- Recommend and prepare a preliminary design for a selected alternative plan.
- Conduct an economic analysis of the preferred alternative.
- Develop drainage and bridge fees for Haegler Ranch.
- Prepare a written report discussing all items examined in the DBPS.

### 1.2. Location and Description

The Haegler Ranch Drainage Basin (Haegler Ranch) encompasses 16.6 square miles in unincorporated El Paso County, Colorado, and is a tributary to Black Squirrel Creek (see Figure 1-1). Haegler Ranch Basin is located in Sections 29, 32 and 33 of Township 12 South Range 64 West and sections 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 22, 23, and 24 of Township 13 South, Range, 64 West and sections 18, 19, 20, 28, 29, 30, 31, 32, 33, and 34 of Township 13 South, Range 63 West and sections 2, 3, and 4 of Township 14 South, Range 63 West. Topography in the basin is rolling rangeland with poor vegetative cover associated with semi-arid climates. The Haegler Ranch consists of indistinct ephemeral streams that flow after storms for a short period of time, and the main stem of Haegler Ranch consists of dry natural grass swales with some poor quality riparian zones and small wetlands in the floodplains. The natural drainageways are generally shallow and wide, and flow paths are not well defined in many areas.

### 1.3. Land Use

As of July 2005, approximately 14 percent of the basin was developed. Much of this existing development consists of 2- to 5-acre lots and larger agricultural parcels south of US Hwy 24. Due to growth in the basin, land use is expected to change in the future with new low and medium density residential developments. Higher density residential developments such as Meridian Ranch, Santa Fe Springs, and Four Way Ranch are underway in the northwestern portions of the Haegler Ranch Basin. Meridian Ranch is in the north and Santa Fe Springs is in the central portion of the watershed. The area of Meridian Ranch within Haegler Ranch has high-density land uses of commercial and business,

residential lots of 0.25 acres, and new paved roads with curb and gutter. Santa Fe Springs has a larger area in Haegler Ranch and a wider range of land uses including high density development such as commercial and business, residential lots of 0.125 acres, residential lots of 0.25 acres, schools, and new paved roads with curb and gutter as well as low density development such as residential large lots with 2% imperviousness, parks, and open space.

Future developed condition hydrology was modeled using proposed 2030 land uses from Colorado Springs Utilities Land Use Coverages (CSU 2005). The developed condition land uses are reasonably consistent with the Falcon Small Area Master Plan dated August 2008.

### 1.4. Hydrologic Analysis

As part of this study, hydrologic analyses for existing and future land use conditions were computed for the Haegler Ranch for 2-, 5-, 10-, and 100-year recurrence interval events using the USACE Hydrologic Engineering Center – Hydrologic Modeling System Version 2.2.2 (HEC-HMS). During the analyses, a portion of the original Haegler Ranch as delineated by the County map was found to be part of the Geick Ranch Drainage Basin at Judge Orr Road, due to the lack of a roadway culvert at the crossing. This area is excluded from the Haegler Ranch DBPS and is included as part of the Geick Ranch DBPS, per the County. Resulting flow rates and volumes are compared at key locations throughout the Haegler Ranch for both existing and future models. Generally, the largest flow and volume increases due to future development occur in the middle portion of the basin, assuming no detention. Since the future land use scenario does not include development in the lower portion of the watershed, potential increases in peak flows are attenuated and less at the mouth of the basin. The results indicate the most profound increases in peak flows due to development are in the more frequent, 2- and 5-year events.

### 1.5. Hydraulic Analysis

Hydraulic analyses for existing conditions were then conducted for 8 channels within the Haegler Ranch Drainage Basin for the 2-, 5-, 10-, and 100-year recurrence interval floods using the USACE Hydrologic Engineering Center-River Analysis System Version 3.1.3 (HEC-RAS). The hydraulic analysis of Haegler Ranch main stem was performed by dividing the basin into several reaches covering approximately 31 miles from the headwaters near Eastonville Road to its confluence with the unnamed tributary of Geick Ranch Drainage Basin. As part of the field investigation, the size, type, and condition of bridges, culverts, channels, inlets, and pipes were recorded for the existing drainage facilities in the basin.

Using the results of the HEC-RAS modeling, floodplains for the 100-year existing condition flows were delineated. The approximate floodplain and profiles were used to assess where hydraulic inadequacies exist along the major drainageways. The approximate floodplain information was used primarily for the identification of flood prone areas along the major drainageways and to aid in the evaluation of alternative plans. The approximate floodplain data in this DBPS does not replace the information presented in the City of Colorado Springs and El Paso County Flood Insurance studies (FEMA 1999).

### 1.6. Flooding Problems

Results of the hydraulics analysis show that, of the 22 road crossings in the Haegler Ranch, only 2 crossings can safely pass the existing 100-year flow and 20 road crossings are overtopped. The floodplain areas include approximately 80 residential properties and additional structures.



1.7. Proposed Improvements

Channel improvements and sub-regional detention facilities (designed using “full-spectrum” detention) are proposed to mitigate increased flows due to development and existing erosion issues. The study is not in any way intended to address water rights or other legal issues which may exist with respect to existing private ponds.

Several types of channel improvements are recommended within the basin. In most cases, two alternatives have been called out on the preliminary design sheets. The cost estimate was prepared for the selected sub-regional detention alternative. The regional detention alternative provides optional channel treatments to be considered during final engineering depending upon specific land uses while still providing similar protection. In a few cases channelization is recommended to define and contain the flow where it is currently overland flow in poorly defined, broad, dry-grass swales. Drop structures and grade control are recommended for all channel designs. Hard linings are not recommended due to their expense, maintenance, environmental and hydraulic issues. Drops are preferred to be less than three feet high to enable wildlife to migrate upstream.

1.8. Cost Estimates and Fees

Cost estimates were based on recommended improvements as called out on the preliminary design drawings of the sub-regional detention alternative. They include 30% construction contingency and 15% engineering contingency. No estimation of costs for local or initial systems has been made.

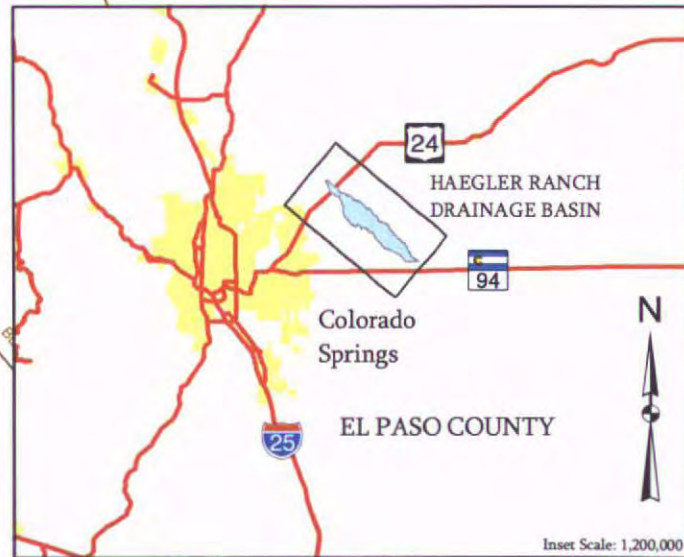
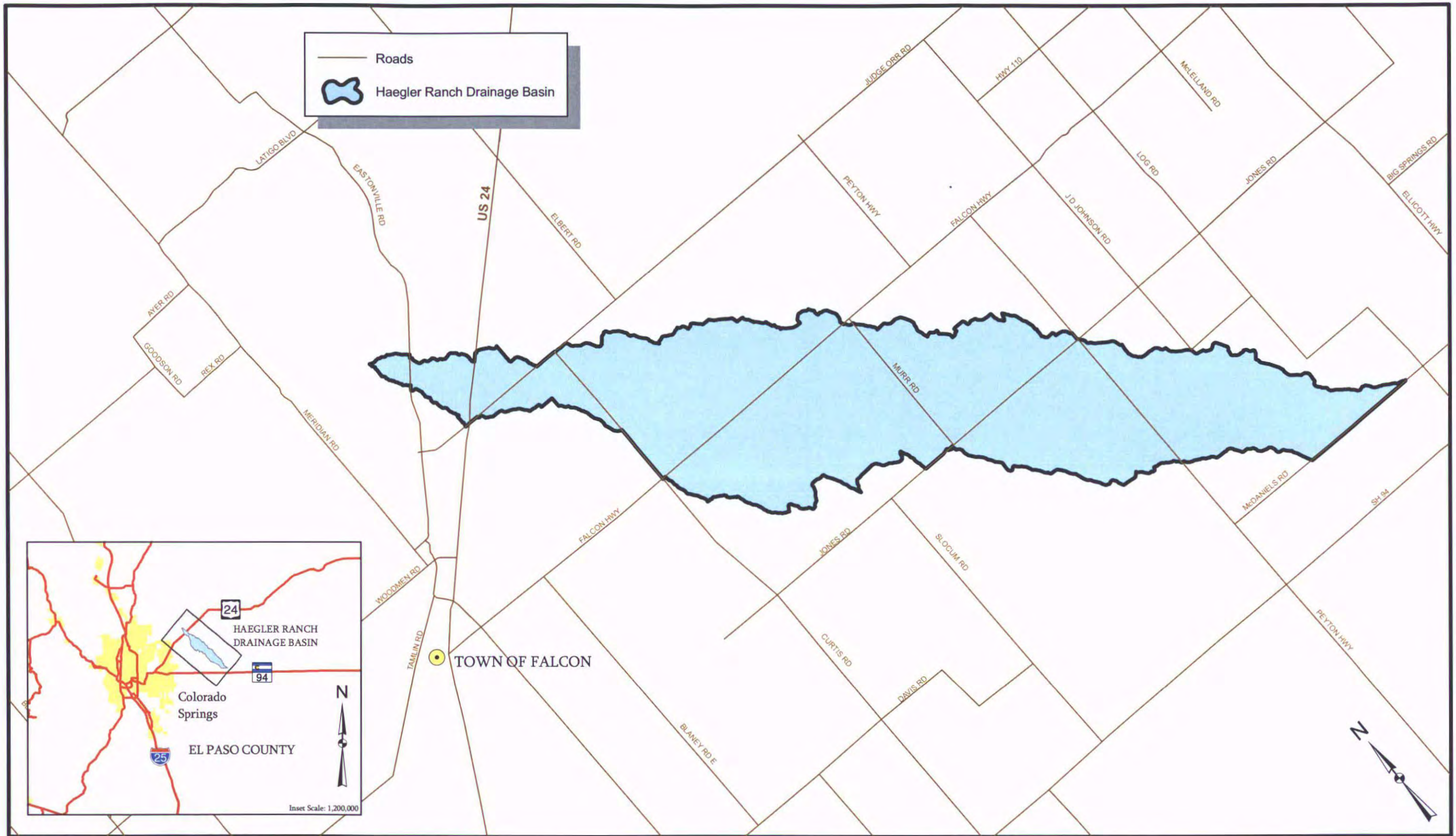
Fees were calculated on a per impervious acre basis according to the new fee structure adopted by the County September 13, 1999 (DCM 1994). A total of 8,953 acres is estimated to be currently unplatted and subject to future development. This unplatted land is projected to have an average imperviousness of approximately 15%, corresponding to approximately 1,343 unplatted impervious acres. All drainage and bridge fees are calculated per *impervious* acre.

The following table summarizes the total costs for improvements within the Haegler Ranch Basin and the associated fees.

Improvements	Total Cost	Fee per Impervious Acre
Bridges	\$1,512,022	\$1,126
General Drainage (Including ponds, channels, Falcon town center storm sewer, etc.)	\$10,251,636	\$7,633
Total	\$11,763,658	\$8,759

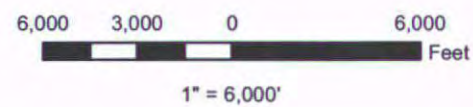
The fee calculation is based upon all ponds, channel improvements and most structures within the Haegler Ranch Basin being funded by drainage fee revenue (see Section 7 for details and calculations). Developers will be required to pay fees and/or construct Haegler Ranch Basin DBPS structures associated with their development. Reimbursement may be requested from the Drainage Board for the cost of DBPS facilities constructed in excess of fees owed by a development. El Paso County may also elect to construct improvements with Haegler Ranch Basin DBPS funds.





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DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**

**VICINITY MAP  
FIGURE 1-1**



## 2.0 INTRODUCTION

### 2.1. Purpose and Scope

The purpose of the drainage Basin Planning Study (DBPS) is to identify a stormwater management plan for the existing and future stormwater and infrastructure needs within the Haegler Ranch Drainage Basin (Haegler Ranch). The specific scope of work for this DBPS includes the following tasks:

- Obtain existing relevant data and general information from participating entities.
- Solicit participating entities and other interested agencies or groups regarding alternate plans.
- Obtain current information for land use and future growth in Haegler Ranch.
- Gather information about right-of-way, known drainage problems, and proposed stormwater projects.
- Contact the County, citizens, and other agencies that have knowledge and/or interest in Haegler Ranch.
- Utilize the County policies, criteria, and applicable information wherever possible.
- Perform hydrologic and hydraulic analyses within Haegler Ranch for the 2-, 5-, 10-, and 100-year recurrence interval storm events.
- Identify potential environmental impacts to the Haegler Ranch from growth.
- Identify existing and potential stormwater and/or flooding problems.
- Propose measures to mitigate the impact of stormwater runoff upon environmentally significant areas along the surface waterway(s).
- Develop improvement alternatives to reduce existing and potential flooding problems.
- Examine the operation and maintenance aspects of feasible alternatives.
- Recommend and prepare a preliminary design for a selected alternative plan.
- Conduct an economic analysis of the preferred alternative.
- Develop drainage and bridge fees for Haegler Ranch.
- Prepare a written report discussing all items examined in the DBPS.
- Conduct presentations to public and private entities in order to define project goals and involve entities with specific interest to help define feasible alternatives.

### 2.2. Summary of Data Obtained

Relevant data were collected as part of this project to construct and complete the required hydrologic and hydraulic models. Data collection included topography, soils, land use, aerial photography, rainfall, and field survey data, along with previous hydrology and floodplain studies. A majority of the data was collected and utilized in a Geographic Information Systems (GIS) format. Local sponsors and government agencies provided the necessary data. Table 2-1 lists the major data collected along with the source:

Table 2-1 Major Data Sources and Data Obtained

Data Source	Data Obtained
Aero-Metric	Digital Terrain Model (DTM) with 2-ft contour intervals, and aerial photographs,
El Paso County	Existing land use, Future land use, and Major Transportation Corridors Plan
Federal Emergency Management Agency (FEMA)	Flood Insurance Studies (FIS), Conditional Letters of Map Revision (CLOMR)
National Oceanic and Atmospheric Administration (NOAA)	Rainfall data
Natural Resources Conservation Service (NRCS)	Soil Survey Geographic (SSURGO) data

In addition to the listed data, reports such as U.S. Army Corps of Engineers (USACE) study of *Black Squirrel Creek, El Paso and Pueblo Counties, Colorado: Hydrologic Analysis* (USACE 2003), City of Colorado Springs, and the County DBPS's were utilized. A number of drainage reports, sketch plans, preliminary and final design drawings, development plans, and existing drainage facility maps were collected from the County and other local agencies. A complete list of reports cited is located in Section 8.0.

Bridges, culverts, and other drainage structures were surveyed in the Haegler Ranch for the hydraulic analysis. Site visits were also conducted at select locations throughout the basin, and photographs were taken documenting the key drainage features.

### 2.3. Mapping and Surveying

Mapping used in the analysis for Haegler Ranch consists of aerial topographic mapping compiled in April 2004 by Aero-Metric Inc. (AME), AME project number 3040402. The aerial topographic mapping included 2-ft contours and was used in the hydraulic structures inventory (See Section 5.3), hydrologic and hydraulic analyses, and in the alternative planning phases of this project. The vertical datum used is North American Datum 83 (NAD 83).

The following general conditions have been placed upon the use of the aerial topographic mapping:

- Use of these products is restricted to the project for which the Facility Information Management Systems (FIMS) products were provided.
- Only the body content found within the neatline of the borrowed maps may appear in any report/publication developed for the DBPS. Also, the labeling that appears on any photographs provided shall not appear in any such report/publication.
- All FIMS products provided to contractors involved in the subject DBPS shall be retrieved by said department upon conclusion of the DBPS and either returned or destroyed.
- The report(s) developed in which the FIMS products are used shall include the disclaimer statement that is on the Disclaimer page at the beginning of this report.

### 2.4. Project Coordination

Throughout the course of the DBPS preparation, meetings were held with representatives of the County, State, and Federal agencies as well as adjacent developers, public citizens with an interest in stormwater



planning. The primary reason for the coordination effort was to obtain technical information and to identify concerns with regard to the development of stormwater facilities within the Haegler Ranch. The County, State, and Federal agencies were involved in a series of meetings during the development of the alternative planning concepts and the preliminary design for the DBPS. The complete mailing list and project coordination is contained in Appendix E of this report.

**2.5. Acknowledgements**

During the preparation of the DBPS, several government agencies and interested individuals were routinely involved in the coordination activities. Representatives from the Regional Building Department, NRCS, USACE, and DOT provided valuable commentary during the development of the alternative plans. A list of the individuals and agencies involved on a regular basis during in the preparation of the DBPS is presented below:

<u>Name</u>	<u>Agency</u>
Andre Brackin	El Paso County Department of Transportation
Barbara Dellamand	El Paso County Department of Transportation
Michael Cartmell	El Paso County Department of Transportation
John Valentine	National Resource Conservation Service Colorado Department of Transportation
Kevin Stilson	Regional Building Department, FEMA Colorado Department of Wildlife
Diana Humphries	U.S. Army Corps of Engineers

Additional input was received from the following:

Karen Laden	Black Forest Trails Coalition
	Colorado Geological Survey
	El Paso County Parks Department
	Environmental Protection Agency
	Falcon Area Homeowners' Association
	Federal Emergency Management Agency
	RCI, Inc., Fort Collins, Colorado



### 3.0 AREA DESCRIPTION

The Haegler Ranch (El Paso County Basin Number CHMS0200) is an unnamed tributary to Ellicott Consolidated Drainage Basin unnamed tributary, which is a tributary of Black Squirrel Creek. Haegler Ranch lies in the central portion of El Paso County. Figure 1-1 shows the location of the Haegler Ranch in respect to El Paso County, Colorado. Haegler Ranch Basin is located in Sections 29, 32 and 33 of Township 12 South Range 64 West and sections 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 22, 23, and 24 of Township 13 South, Range, 64 West and sections 18, 19, 20, 28, 29, 30, 31, 32, 33, and 34 of Township 13 South, Range 63 West and sections 2, 3, and 4 of Township 14 South, Range 63 West.

#### 3.1. Basin Description

The Haegler Ranch flows to the southeast from north of Eastonville Road to McDaniels Road with a total of 16.6 sq mi in unincorporated El Paso County, Colorado. In 2005, approximately 14% of the basin was developed. Much of the existing development consists of 2- and 5-acre (ac) residential lots surrounded by open space range land used for agriculture and large parcels with homes south of U.S. Highway 24 (US 24). High-density residential developments are being planned in the northern portions of the basin.

The maximum basin elevation is approximately 7,054 ft in the headwaters and falls to approximately 6,085 ft at the downstream confluence of the basin. The basin is typified by rolling rangeland with poor vegetative cover associated with semi-arid climates.

#### 3.2. Climate

This area of El Paso County can be described as high plains with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry, while the springs and summer receive a majority of this precipitation in the form of rainfall. The average precipitation ranges from 14 to 16 in. per year. Thunderstorms are common during the summer months and are quick-moving low-pressure cells that draw moisture from the Gulf of Mexico into the region. The County has an average temperature ranging from a low of 14°F in the winter to a high of 81°F in the summer. The relative humidity ranges from 25% in the summer to 45% in the winter (SCS 1981).

#### 3.3. Soils and Geology

Soils within the Haegler Ranch are classified according to the NRCS soil classification system. The predominant soils are in the Blakeland soil series, which consist of deep, somewhat excessively drained soils that formed in sandy alluvium and sediment on uplands. The soil series has high infiltration rates, and are extremely susceptible to wind and water erosion where poor vegetation cover exists. Figure 3-1 shows the soil distribution map for the Haegler Ranch (SCS 1981). The bedrock geology is predominately flat lying sandstone and siltstone, some of which is covered with recent alluvium.

#### 3.4. Property Ownership and Land Use Information

Property ownership along the major drainageways within the Haegler Ranch varies from public to private. Along recent developments, drainage right-of-ways and greenbelts have been dedicated during the development of the adjacent residential and commercial land. A portion of Haegler Ranch has already been developed with 2- and 5-ac residential lots. The drainageways in the lower part of the basin remain under private ownership with no delineated drainage right-of-way or easements. A drainage easement or right-of-way must be granted to the County in order for DOT to perform any recommended improvements.

Roadway and utility easements abutting or crossing the major drainageways occur most frequently in the developed portions of the basin. The locations of roadways were obtained from the El Paso County Major Transportation Corridors Plan dated September 21, 2004 (EPC 2004). The El Paso County Rock Island Trail System runs parallel along the north side of US 24. The trail follows the abandoned Chicago and Rock Island Railroad between Falcon and Peyton, Colorado.

Land use information for the existing and future conditions models was obtained from El Paso County Planning Department in 2005. This information is used in the hydrologic analysis to predict runoff rates and volumes for the purposes of stormwater facility evaluation. The identification of land uses abutting the drainageways is also useful in the identification of feasible plans for stabilization and aesthetic treatment of the basin. Presented in Figure 3-2 and Figure 3-3 are the land use maps used for the evaluation of impervious land densities discussed in Section 4.0. These figures are not intended to reflect the future zoning or land use policies of the County.

#### 3.5. Environmental Analysis

An environmental analysis was conducted for this DBPS to assess the present condition of the biological and environmental resources in the Haegler Ranch. Site visits were conducted to study these elements of the basin. Particular attention was paid to the drainageways and spring/seep areas to determine biological resources in riparian zones and wetlands.

The Haegler Ranch consists of indistinct ephemeral streams that flow after storms for a short period of time. The main stem of Haegler Ranch consists of dry natural grass swales with some poor quality riparian zones and small wetlands in the floodplains. Most of the wetlands surround stock reservoirs and are heavily grazed in some of the rangeland pastures. As a result, the wetlands and riparian drainageways have been degraded in vegetative cover and ecological value. The existing wetlands are neither large nor extensive, and are mostly discontinuous. In their present condition, the wetlands are not a significant habitat resource within the basin. Figure 3-4 and Figure 4-4 show and potential wetlands that may require further study.

Most of the open space is used for agriculture or rangeland. Drainageways have been channelized principally only at roadway crossings. These areas of concentrated flow have defined channels that tend to become indistinct as they flow downstream. Vegetation in the Haegler Ranch in the open space does not vary dramatically. Vegetation patterns generally follow the physiographic region of the plains dominated by a short- to mid-height prairie grass with a few shrubs and sporadic trees such as cottonwoods. Wetlands consist of rushes and sedges such as little bluestem, grama grasses, needle and thread and western wheat grass.

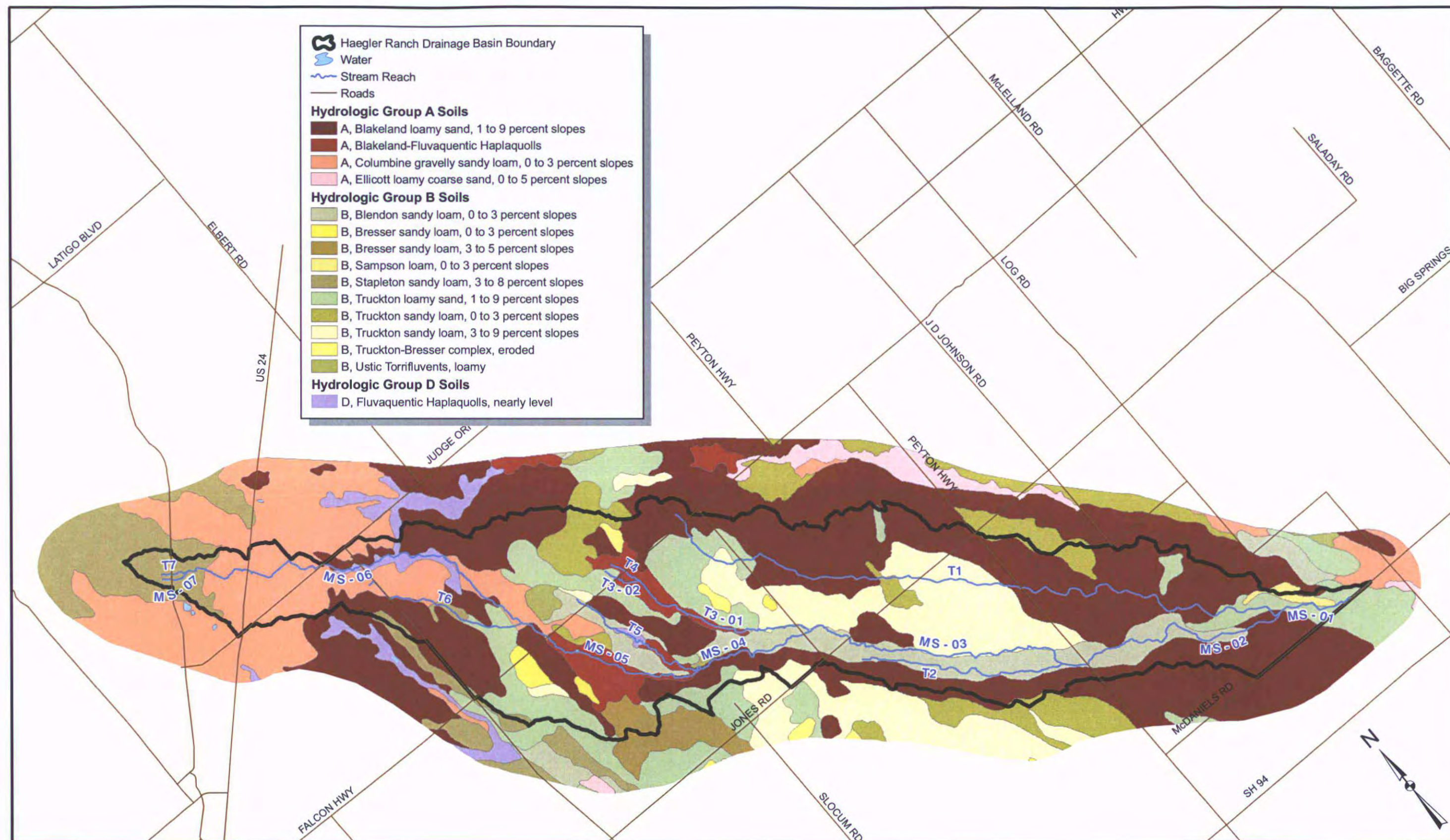
Wildlife and animal species common to the open plains inhabit the basin. They consist of animals that tolerate the presence of roads and people including large and small mammals such as deer, antelope, coyotes and rodents, and several species of birds such as killdeer and red-winged blackbirds. Preliminary review indicates that the DBPS will not affect any threatened or endangered species or critical habitat.

Because of the sensitivity of wetlands, riparian areas, and wildlife to stormwater runoff, sedimentation and erosion should be evaluated and planned for in the alternatives. Wetland and riparian areas provide a habitat resource that should be preserved during the alternative development. These areas can be protected and enhanced to improve ecological value.



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**URS**

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Colorado Springs, CO 80921  
719.531.0001



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Feet

1" = 5,000'

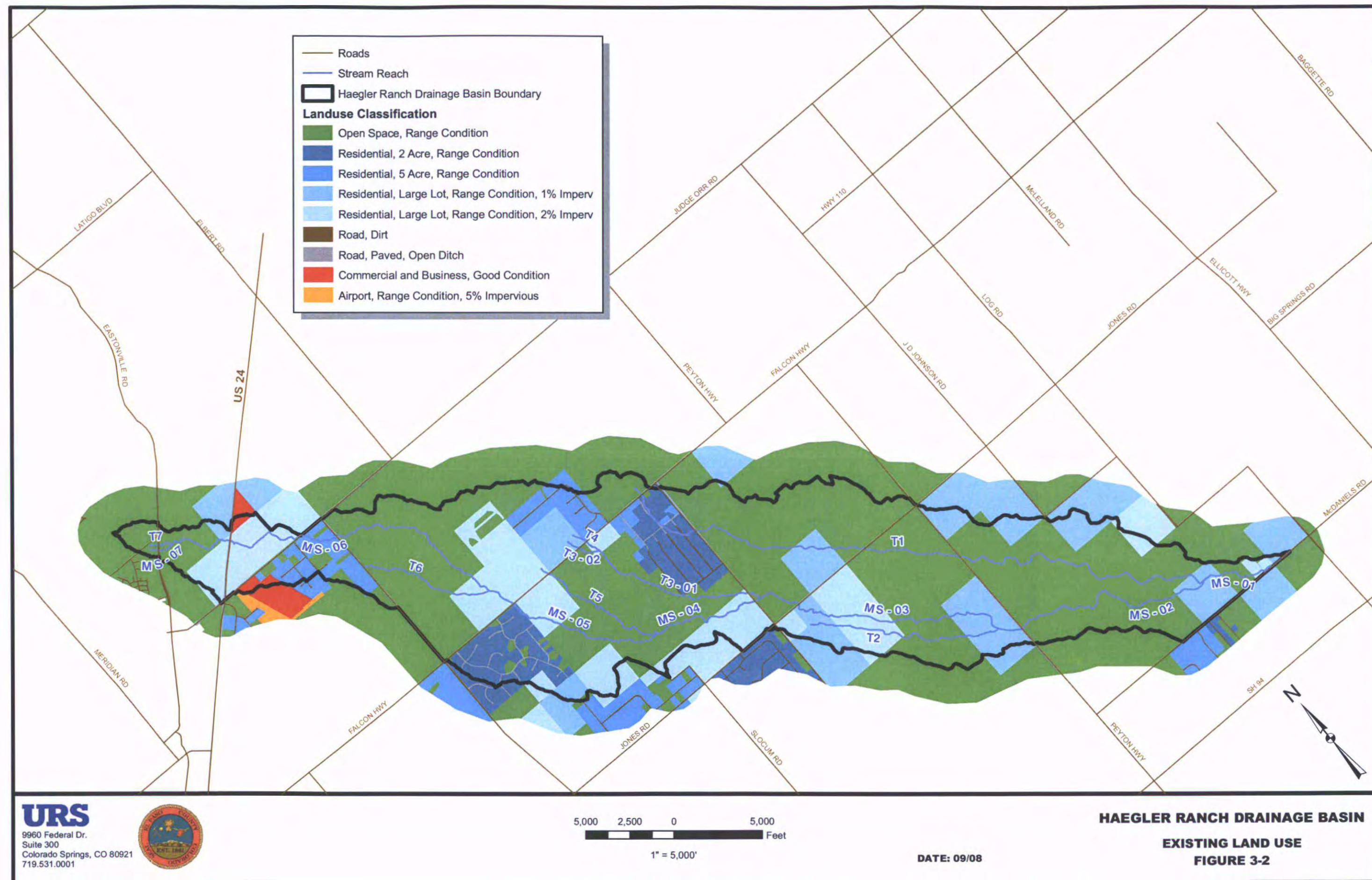
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**HAEGLER RANCH DRAINAGE BASIN**

**SOILS**  
**FIGURE 3-1**

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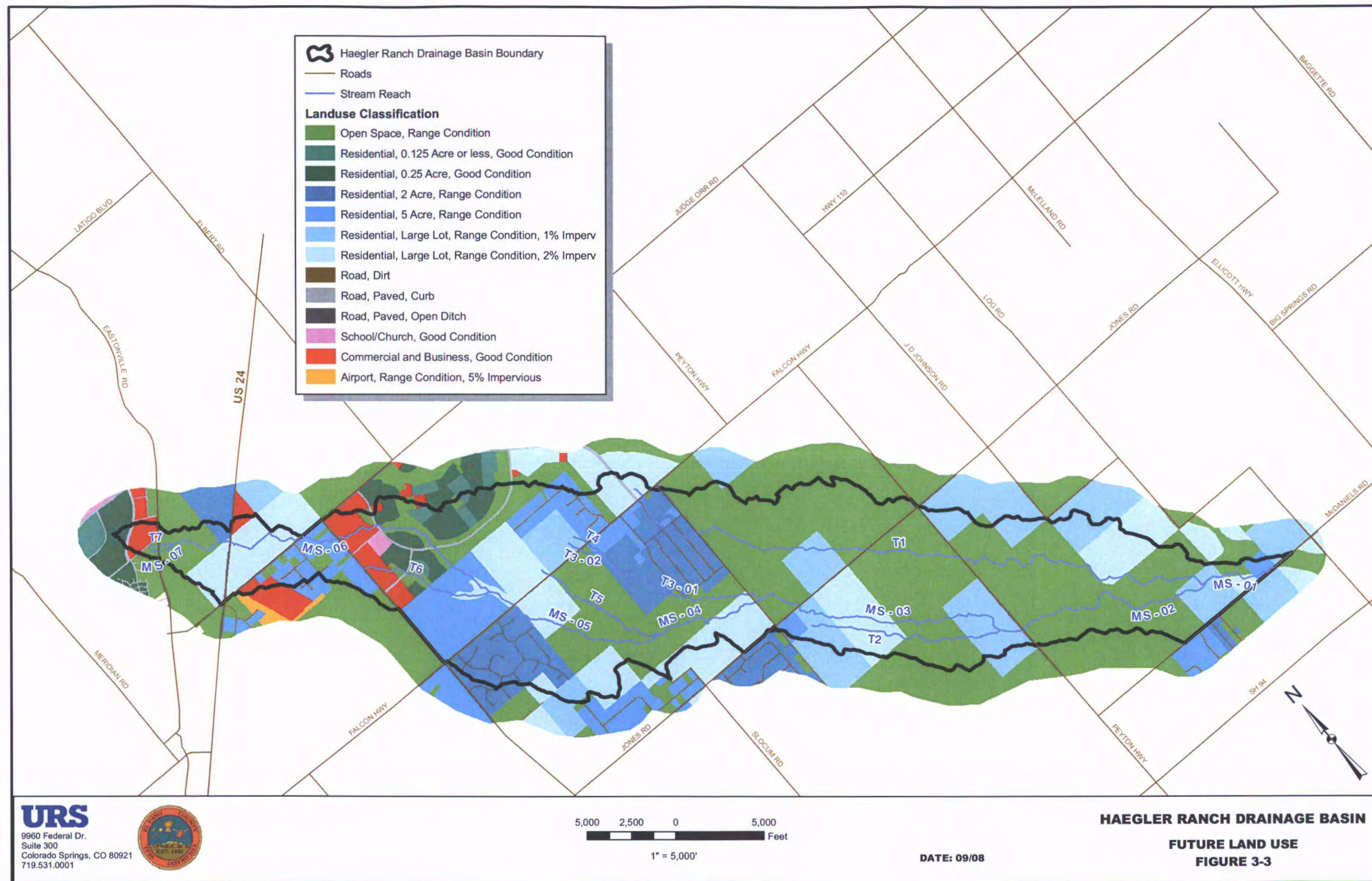


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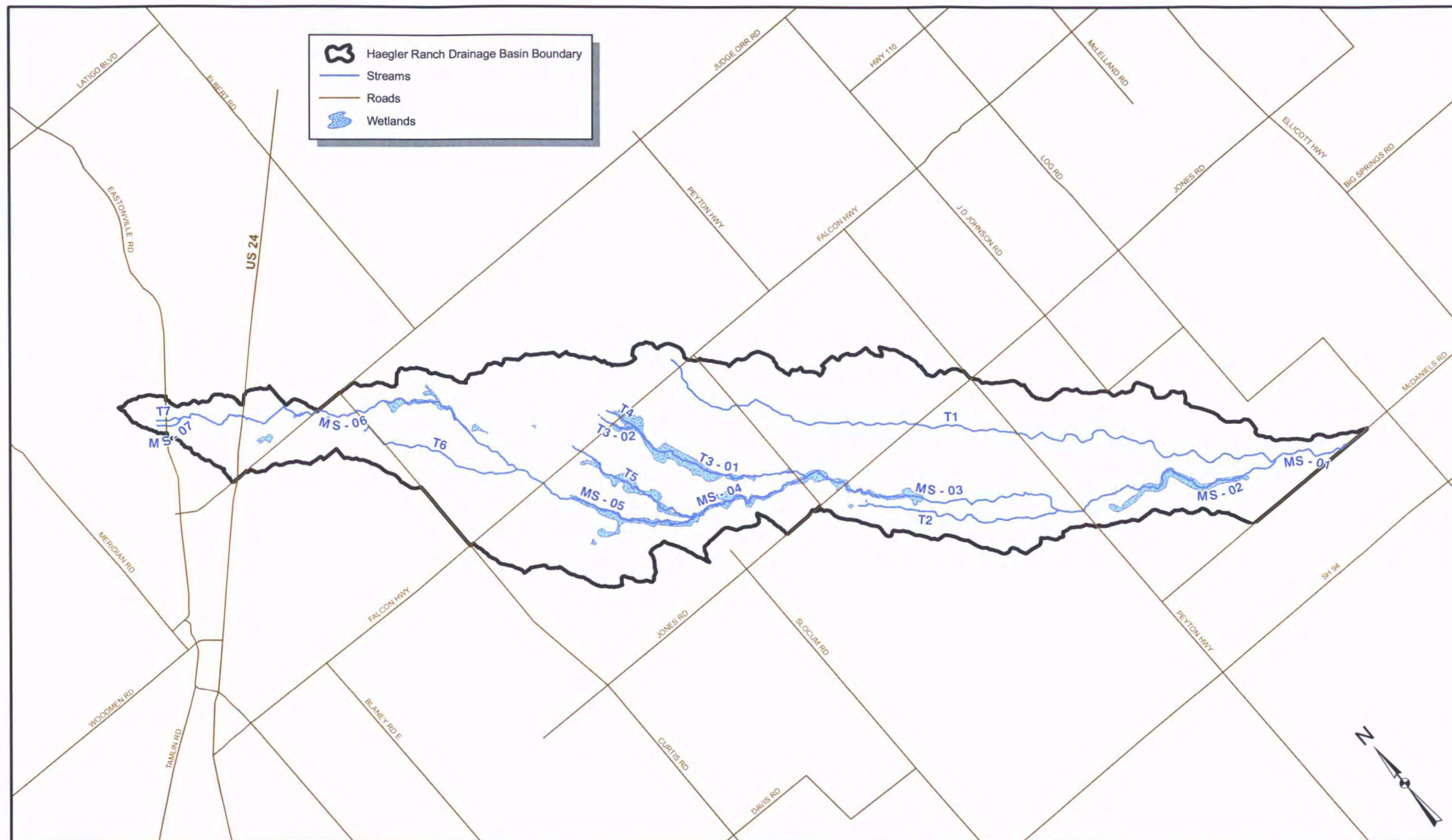
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**HAEGLER RANCH DRAINAGE BASIN**

**FUTURE LAND USE  
FIGURE 3-3**





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**HAEGLER RANCH DRAINAGE BASIN**

**WETLANDS  
 FIGURE 3-4**



4.0 HYDROLOGIC ANALYSIS

4.1. Project Basin

Hydrologic analyses for existing and future conditions were computed for the 68 subbasins within the Haegler Ranch for the 2-, 5-, 10-, and 100-year recurrence intervals. Sub-basin delineations and study reaches are shown in Figure 4-1.

The main stem in the Haegler Ranch is an unnamed tributary located within the Chico Creek basin in central El Paso County, Colorado. The Haegler Ranch’s headwaters are on the southeastern slope of the Black Forrest. The main stem flows to the southeast in the eastern plains of the County to the confluence with Geick Ranch Drainage Basin north of Ellicott. Bennet Ranch and Solberg Ranch Drainage Basins bound the Haegler Ranch to the west, Geick Ranch Drainage Basin to the east, and Telephone Exchange and Ellicott Consolidated Drainage Basins to the south. The Haegler Ranch has a contributing drainage area of approximately 16.6 sq mi at its confluence with the Geick Ranch Drainage Basin on the north side of McDaniels Road.

A portion of the original Haegler Ranch as delineated by the County map was found to be part of the Geick Ranch Drainage Basin at Judge Orr Road, due to the lack of a roadway culvert, as seen in Figure 4-1. This area is excluded from the Haegler Ranch DBPS and is included as part of the Geick Ranch DBPS, per the County.

4.2. HEC-HMS Modeling

Hydrologic modeling was completed using the USACE Hydrologic Engineering Center – Hydrologic Modeling System Version 2.2.2 (HEC-HMS). Each component of this model is described in detail following this section. A geospatially referenced basin model was generated in the USACE Hydrologic Engineering Center – Geospatial Hydrologic Modeling System Extension Version 1.1 (HEC-GeoHMS). Using HEC-GeoHMS, subbasin and stream reach physical characteristics including area, longest hydraulic flowpath, reach length, slope, and topological connectivity were extracted for calculation of hydraulic parameters such as time of concentration. Hydrologic parameters were calculated as outlined below and automatically populated to the basin and meteorological components of the HEC-HMS model. A summary of selected methodologies for each HEC-HMS model component is provided in Table 4-1.

Table 4-1 HEC-HMS Model Components

Model Component	Selected Methodology
Meteorological Model	User Gage Weighting Method
Infiltration Loss	SCS Runoff Curve Number Method
Runoff Transformation	SCS Unit Hydrograph Method
Channel Routing	Muskingum-Cunge Standard Method

Notes:  
HEC-HMS = U. S. Army Corps of Engineers Hydrologic Engineering Center – Hydrologic Modeling System  
SCS = Soil Conservation Service (since renamed NRCS)

The User Gage Weighting Method was chosen to model the Type IIa storm based on the City of Colorado Springs and El Paso County Drainage Criteria Manual (DCM) (1991). The Soil Conservation Service (SCS) Type IIa 24 hour hypothetical rainfall distribution was imported into the HEC-HMS

precipitation gage manager. Rainfall depths for each subbasin were then entered in the meteorological model. Rainfall was modeled with an areal reduced uniform spatial distribution based on the size of the basin.

Infiltration and runoff volumes were modeled using the SCS (now renamed NRCS) Runoff Curve Number (runoff CN) Loss Method. The composite runoff CN was calculated for each subbasin and imported into HEC-HMS. For modeling purposes, initial infiltration loss rates were automatically calculated as functions of composite runoff CNs by HEC-HMS.

The transformation of runoff volume to a runoff hydrograph was modeled using the SCS Unit Hydrograph Method. Subbasin lag times were calculated from the time of concentration as computed using the method outlined in the DCM.

The Muskingum-Cunge Method was selected to develop the channel routing component of the HEC-HMS model. This method was chosen to represent the travel time in the channel because it is based on channel physical measurements such as width, depth, and slope. Channel dimensions and Manning’s roughness coefficients (n values) were imported into HEC-HMS.

4.3. Basin Delineation

Basin delineation and stream network definition were completed in an ArcView® GIS environment using HEC-GeoHMS. The subbasin boundaries and stream network were refined using 2-ft contours, aerial photography, field survey, and site visit data.

The Haegler Ranch was divided into 68 subbasins with areas ranging from 0.02 sq mi up to 0.65 sq mi, as seen in Figure 4-1 and Figure 4-4. Subbasin slopes range from 0.16% to 8.0%. Subbasins were delineated at tributaries, major road crossings, changes in slope, and other drainage features. For the SCS Runoff CN Loss Method, the subbasins should be larger than 0.156 sq mi (100 ac) if possible. For some areas, the subbasins are smaller to accurately represent road crossings or detention. A schematic of the connectivity of the subbasins, junctions, and reaches can be seen in Figure 4-5.

4.4. Hydrologic Soil Group

Soils are classified into hydrologic soil group (HSG) by the NRCS for hydrologic modeling. HSG is a parameter assigned to each soil series by the NRCS to reflect the relative rate of infiltration of water into the soil profile. NRCS *Technical Release 55 (TR-55)* (1986) defines HSG into A, B, C, and D as follows:

**HSG A** - soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission.

**HSG B** - soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

**HSG C** - soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission.



**HSG D** - soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

The HSG was determined for each of the soil mapping units from the NRCS SSURGO for the County, as seen in Figure 3-1. Three HSGs are found within the Haegler Ranch. Group A soils, with moderate to high infiltration rates, dominate the basin at 56% coverage. Almost all of the soils in Haegler Ranch are in HSGs A and B with moderate to high infiltration and low runoff. In undeveloped areas, the predominance of HSG A and B soils give this basin a lower runoff per unit area as compared to basins with soils dominated by HSG C and D. Table 4-2 provides statistics for the HSGs within the basin.

**Table 4-2 HSGs within the Haegler Ranch Drainage Basin**

HSG	Basin Coverage (%)
A	56%
B	43%
C	0%
D	1%

Notes:  
HSG = Hydrologic Soil Group  
% = percent

### 4.5. Land Use

Land use information for the Haegler Ranch was obtained from the County. Both existing (circa 2005) and future (circa 2030) land use data were obtained from the County in GIS format. Each land use class was assigned a corresponding NRCS land use and condition class based on the *TR-55* and *Procedures for Determining Peak Flows in Colorado* (SCS 1984).

The Haegler Ranch reflects a variety of existing land uses including residential (high, medium, and low density), commercial and business, open space and rangeland, and roads. The predominate land use is open space with a mixture of vacant land, agriculture, and rangeland. Due to growth in the basin, land use is expected to change in the future conditions with new low and medium density residential developments.

Two major proposed developments in Haegler Ranch are Meridian Ranch in the north and Santa Fe Springs in the central portion of the watershed. The area of Meridian Ranch that is within Haegler Ranch has high density land uses of commercial and business, residential lots of 0.25 acres, and roads with curb and gutter. Santa Fe Springs has a larger area in Haegler Ranch and a wider range of land uses including high density development such as commercial and business, residential lots of 0.125 acres, residential lots of 0.25 acres, schools, and roads with curb and gutter as well as low density development such as residential large lots with 2% imperviousness, parks, and open space.

URS assigned 13 NRCS *TR-55* land use and condition classes within the Haegler Ranch for the existing and future conditions model, as seen in Figure 3-2 and Figure 3-3. Open Space, range condition was the dominant land use in the basin at 60% coverage in existing conditions and 46% coverage in the future conditions. In the future conditions model, the Haegler Ranch will have residential development in the upper and middle portions of the basin. A summary of land use classes is provided in Table 4-3.

**Table 4-3 Major Land Use Classes within the Haegler Ranch Drainage Basin**

Assigned NRCS Land Use and Condition	Existing Basin Coverage	Future Basin Coverage
Open Space, Range Condition	60%	46%
Residential, Large Lot, Range Condition, 2% Impervious	16%	16%
Residential, Large Lot, Range Condition, 1% Impervious	11%	10%
Residential, 2 ac, Range Condition	6.7%	9.1%
Residential, 5 ac, Range Condition	4.6%	9.5%
Road, Paved, Open Ditch	1.6%	1.7%
Road, Dirt	0.54%	0.48%
Commercial and Business, Good Condition	0.36%	2.7%
Airport, Range Condition, 5% Impervious	0.01%	0.01%
Residential, 0.25 ac, Good Condition	0%	2.8%
Residential, 0.125 ac or less, Good Condition	0%	0.59%
Road, Paved, Curb	0%	0.52%
School/Church, Good Condition	0%	0.22%

Notes:  
% = percent  
ac = acre

This report was presented to the El Paso County Planning Commission on February 3, 2009. The Planning Commission requested that the Falcon Small Area Master Plan (SAP) land use be compared with 2005 land use data used in this study. URS prepared an evaluation of the SAP and presented it to the Planning Commission at their meeting on May 7, 2009. The comparison of the SAP to the future land use assumptions used in this study is in Appendix G.

### 4.6. Runoff Curve Number Development

Runoff CN is a parameter developed by the NRCS to quantify the relationship between rainfall, infiltration, and runoff. It represents the combination of a HSG and a land use class and condition (McCuen 1998). Runoff CNs are estimated as a function of land use, HSG, and antecedent moisture condition (AMC). URS assigned runoff CNs for each class based on the *TR-55* land use/runoff CN table and *Procedures for Determining Peak Flows in Colorado* (SCS 1984) as seen in Figure 4-2 and Figure 4-3.



**Table 4-4 Runoff Curve Numbers for Haegler Ranch Drainage Basin**

Land Use and Hydrologic Condition	Average % Impervious Area	Use HSG B for Regraded HSG A	Runoff Curve Numbers for HSG			
			A	B	C	D
Impervious Area and Water	100%	No	98	98	98	98
Open space (lawns, parks, golf courses, etc.) <sup>1</sup> :						
Poor Condition (grass cover <50%)	0%	No	68	79	86	89
Range Condition (grass cover ≈ 40%)	0%	No	58	73	82	86
Fair Condition (grass cover 50% to 75%)	0%	No	49	69	79	84
Good Condition (grass cover >75%)	0%	No	39	61	74	80
Roads:						
Dirt	55%	Yes	72	82	87	89
Paved; Open Ditches	75%	Yes	83	89	92	93
Paved; Curb & Storm Sewer	100%	Yes	98	98	98	98
Good Condition <sup>2</sup> :						
Urban Districts:						
Commercial and Business	85%	Yes	89	92	94	95
School/Church	65%	No	77	85	90	92
Residential districts by average lot size:						
1/8 ac or less (multifamily)	65%	Yes	77	85	90	92
1/4 ac	38%	Yes	61	75	83	87
1/3 ac	30%	Yes	57	72	81	85
1/2 ac	25%	Yes	54	70	80	85
Range Condition <sup>2</sup> :						
Urban Districts:						
Airport	5%	Yes	60	74	83	87
Residential districts by average lot size:						
1 ac	20%	No	66	78	85	88
2 ac	12%	No	63	76	84	87
5 ac	5%	No	60	74	83	87
Large (160 ac, two or three structures)	2%	No	59	74	82	86
Large (160 ac, single structure)	1%	No	58	73	82	86

Notes:

% = percent

HSG = Hydrologic Soil Group

ac = acre

<sup>1</sup> Range Cover of 40% is based on field observations and discussions with the County. The selected curve numbers based on Figure S-3 from "Procedures for Determining Peak Flows in Colorado" by Soil Conservation Service, March 1984. Based on Figure S-3 and the TR-55 CN Table, poor condition is 15% cover, fair condition is 55% cover, and good condition is 85% cover.

<sup>2</sup> The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space with the respective hydrologic condition.

The runoff CN for urban residential developments smaller than 1 ac, multifamily homes, commercial and business sites with good conditions for the pervious area based on regrading, irrigation, and lawn maintenance was taken directly from the DCM. For residential areas 1 ac and larger, the pervious area was considered range condition based on large lots that will only have a small percentage of the lot irrigated. For the large residential lots with range condition pervious areas, the runoff CN was calculated based on Figure 2-3 from the TR-55 manual. The composite runoff CN is calculated as the percent pervious multiplied by a pervious runoff CN, plus the percent impervious multiplied by the pervious runoff CN for open space, range condition.

Runoff CNs were developed for both existing and future conditions within the Haegler Ranch. Any areas in HSG A that have been regraded as part of development were calculated as HSG B for runoff CNs.

Within an ArcMap® GIS environment, discrete combinations of soil mapping units and land uses were developed. Assuming average AMCs, runoff CNs were determined for each unique soil/land use combination using runoff CNs in Table 4-4. A runoff CN grid for the entire basin was then developed for both the existing and future conditions, as shown in Figure 4-2 and Figure 4-3. Using HEC-GeoHMS, composite runoff CNs were calculated and assigned to each subbasin.

The overall runoff CN for the basin is expected to increase between the existing and future conditions with an area-weighted average of 66 and 68, respectively. The changes in future land use are concentrated to two major developments, Meridian Ranch in the north and Santa Fe Springs in the central portion of the watershed. Runoff CNs for the basin are summarized in Table 4-5.

**Table 4-5 Runoff Curve Number Summary for the Haegler Ranch Drainage Basin**

	Existing Runoff CN	Future Runoff CN
Minimum	58	58
Maximum	98	98
Average	66	68

Notes:

Runoff CN = runoff curve number

#### 4.7. Time of Concentration

The time of concentration was calculated by summing the travel time for overland sheet flow, shallow concentrated flow, and channel flow segments along the longest flowpath as outlined in TR-55. The longest flow path was automatically delineated using HEC-GeoHMS, and then the longest flow paths were manually modified where appropriate to match the drainage patterns in the subbasins based on roads and culvert crossings. Overland flow was assumed to occur within the first 300 ft and may end before 300 ft if development is encountered, based on the TR-55. Shallow concentrated flow occurs after 300 feet of overland flow. Channel flow occurs after shallow concentrated flow when a channel is apparent in the aerial photo or contours, which transports runoff to the outlet of the subbasin.

Times of concentration calculations were completed for each of the 68 Haegler Ranch subbasins using sheet and channel flow segments. A summary of the time of concentration values for the Haegler Ranch is provided in Table 4-6.



Table 4-6 Time of Concentration Summary for the Haegler Ranch Drainage Basin

	Time of Concentration (min)	
	Existing	Future
Minimum	21	5
Maximum	119	119
Average	50	42

Notes:  
min = minutes

For the future conditions model, the time of concentration was adjusted for development. Overland flow was decreased in developed areas based on the type and density of future development. Shallow concentrated flow was shortened or eliminated based on the proposed development. Channel flow occurs after overland flow in a manmade channel. Future development typically decreases the time of concentration. However, future development can be planned to mimic current drainage patterns and employ methods to increase travel times to reduce peak flows.

4.8. Channel Routing

The Muskingum-Cunge method was used for hydrograph channel routing in 57 channel reaches in the Haegler Ranch. A shallow grass lined channel is dominant in the majority of the basin. Some portions of the basin have been channelized in developments or along roads. Table 4-7 lists the channel characteristics in the Haegler Ranch.

Table 4-7 Channel Characteristics in the Haegler Ranch Main Stem

	Slope (%)	Manning’s Roughness Coefficients
Minimum	0.58	0.025
Maximum	2.70	0.055
Average	1.20	0.049

Notes:  
% = percent

4.9. Climate and Precipitation

A hypothetical rainfall event was used to simulate precipitation for hydrologic analyses. The NRCS Type IIa 24-hour storm distribution is recommended for temporal distribution in the DCM. Storm events with 2-, 5-, 10-, and 100-year recurrence intervals were selected for hydrologic modeling. These storm events have an equivalent of a 50-, 20-, 10-, and 1-percent chance of exceedance, respectively.

Isopluvial maps published in *NOAA Atlas 2* (Miller et al. 1973) were used to estimate rainfall in the Haegler Ranch for each recurrence interval. Within an ArcMap® GIS environment, rainfall grids were developed for each recurrence interval from isopluvial contours. Using HEC-GeoHMS, rainfall depths for the 24-hour storm duration were calculated and assigned to each subbasin. Since the basin is greater than 10 sq mi, an areal reduction factor was applied as prescribed by *NOAA Atlas 2*.

The NRCS Type IIa 24-hour hypothetical rainfall event, with uniform spatial distribution, was used to simulate precipitation within the Haegler Ranch. Based on the basin area of 16.6 sq mi, an areal

reduction of 2% was applied to the *NOAA Atlas 2* rainfall depths for each recurrence interval modeled. Table 4-8 provides the 24-hour rainfall depths for each recurrence interval.

Table 4-8 Rainfall Depths within the Haegler Ranch Drainage Basin

Recurrence Interval	Rainfall Depth (in.) <sup>1</sup>
2-year	1.96
5-year	2.55
10-year	2.94
100-year	4.51

Notes:  
<sup>1</sup> Areal reduction of 2% applied to rainfall depths from the *NOAA Atlas 2*.  
in. = inches

4.10. Storage and Groundwater

In Haegler Ranch, some storage may occur in ponds and high groundwater can affect some storm events. For Haegler Ranch, storage occurs in stock ponds, low spots, and retention ponds. Based on field visits, these areas do not have an outlet structure or routine maintenance, so all these areas are considered full for hydrologic modeling in the DBPS.

Groundwater is a concern in this area of El Paso County based on flooding in previous storm events. The groundwater level can be high and can have a large affect on even a small storm event if the ground water table is saturated. Moisture conditions were taken as Antecedent Moisture Condition II from the *TR-55*. This is modeled as having a 5-year storm 5 days before the modeled storm event. This is standard engineering practice for the Front Range and the recommendation of the *DCM*. If multiple storm events occur in a short period of time, a minor rainfall event may produce a major runoff event. Studying the groundwater affects due to recent storms is typically done for specific rainfall events and not to model the typical flooding patterns of planning studies.

4.11. Validation

In the Haegler Ranch, no U.S. Geological Survey (USGS) gages are available for calibration. In order to validate the model, the DBPS hydrologic flows were compared to five methods including regional regression equations, a flow curve, a previous study, and a composite basin calculation. Results are listed in Table 4-9. The first regional regression equation was from the USGS in *Analysis of the Magnitude and Frequency of Floods in Colorado* (USGS 2000). The second regional regression equation was from the Colorado Water Conservation Board (CWCB) in *Guidelines for Determining 100-year Flood Flows for Approximate Floodplains in Colorado* (CWCB 2004). The third source is from the Urban Drainage and Flood Control District (UDFCD) in Denver and uses a flow curve based on 42 gaged sites in the Plains Region. The fourth source for comparison was from the USACE study of *Black Squirrel Creek El Paso and Pueblo Counties Colorado: Hydrologic Analysis* (USACE 2003). The fifth method was to make a composite basin of the entire Haegler Ranch using the weighted average runoff CN and a total time of concentration.



**Table 4-9 Flood Summary Comparison for the Haegler Ranch Drainage Basin**

Annual Percent Chance Flood Event	Recurrence Interval	Peak Flow (cfs)						
		Existing Conditions DBPS Model	Future Conditions DBPS Model	USGS Regression Analysis, Plains Region <sup>1</sup>	CWCB Regression Analysis, ARK - 5 <sup>2</sup>	FEMA / UDFCD Gages <sup>3</sup>	USACE Black Squirrel Creek Model <sup>4</sup>	Haegler Ranch Drainage Basin Composite Basin <sup>5</sup>
50%	2-year	190	550	150	---	---	360	96
20%	5-year	570	1,300	600	---	---	1,200	270
10%	10-year	950	2,000	1,100	---	---	1,900	420
1%	100-year	3,200	5,600	4,900	6,800	7,200	5,000	1,200

Notes:

cfs = cubic feet per second

% = percent

DBPS = Drainage Basin Planning Study

USGS = U.S. Geological Survey

CWCB = Colorado Water Conservation Board

FEMA = Federal Emergency management Agency

UDFCD = Urban Drainage Flood Control District

USACE = U.S. Army Corps of Engineers

<sup>1</sup> USGS Regression Analysis equations are from "Analysis of the Magnitude and Frequency of Floods in Colorado" Water-Resources Investigations Report 99-4190. The Plains Region covers the eastern plains below an elevation of about 9,000 ft. Drainage areas for the study ranged from 5 to 1,000 sq mi.

<sup>2</sup> CWCB Regression Analysis equations are from "Guidelines for Determining 100-Year Flood Flows for Approximate Floodplains in Colorado" by the Department of Natural Resources Colorado Water Conservation Board, June 2004. ARK-5 includes the Chico Creek basin with the boundary along the eastern boundary of the basin. Equations are only valid for tributaries between 4 and 75 sq mi.

<sup>3</sup> Tabulation of 42 stream gages in the Plains Region for the Urban Drainage and Flood Control District (UDFCD) in Denver that was provided by FEMA.

<sup>4</sup> "Black Squirrel Creek El Paso and Pueblo Counties Colorado: Hydrologic Analysis" study by USACE 2003.

<sup>5</sup> Composite Basin for in HEC-HMS using the area-weighted average runoff CN and total time of concentration.

The existing condition flows for the DBPS hydrologic model are lower than the USGS regression analysis, CWCB regression analysis, UDFCD gages, and USACE Black Squirrel Creek Model, but the flows are higher than the composite basin for Haegler Ranch. Assumptions and applicability of each method are as follows:

- USGS Regression Analysis, Plains Region
  - Uses area as only input parameter
  - Does not account for rainfall, basin slope, or soil type
  - Based on very limited gaging station in eastern plains and none within the Black Squirrel Creek basin
  - Margin of error is 300% for 100-year storm event
- CWCB Regression Analysis, ARK-5
  - Uses area as only input parameter
  - Does not account for rainfall, basin slope, or soil type
  - Based on study results and not gage data
- FEMA/UDFCD Gages
  - Uses rainfall, area, and basin shape

- Based on regional characteristics including Kansas
- Not specifically intended for Colorado

- USACE Black Squirrel Creek Model
  - Uses State Soil Geographic (STATSGO) database which is generalized soil data
  - Based on regression equation to calculate lag time
  - Employs SCS Type II storm
  - Obtained landuse from National Land Cover Dataset (NLCD) circa 1992
  - Uses higher imperviousness for existing low density development (20-30%)
  - Delineated basins and stream from 20-ft contours for a basin area of 18.8 sq mi
- Haegler Ranch Drainage Basin Composite Basin
  - Merges subbasins form DBPS into one large basin
  - Uses TR-55 to calculate lag time from the top of the basin along the river to confluence with Geick Ranch
  - Averages curve number from DBPS

The USGS regional regression equation flows are about 50% higher than the flows from the DBPS, but these regression equations have a large standard error. The CWCB regression equation flow is more than twice as high as the DBPS flow. Both regression equations have higher flows than the DBPS and neither regression analysis accounts for high rates of infiltration that occur in Haegler Ranch.

As part of a large basin study, the USACE Black Squirrel Creek Study (Black Squirrel) modeled the flow for the Haegler Ranch. The flows from the Black Squirrel model are higher than the flows for the DBPS. This is due to assumptions made in both models. Black Squirrel used 20-ft contours while the DBPS used 2-ft contours to delineate subbasins. Black Squirrel used National Land Cover Dataset (NLCD) data based on satellite imagery circa 1992 while the DBPS used existing data form the County. Black Squirrel used a regression equation to calculate the lag time while the DBPS used channel measurements. Black Squirrel used the initial abstraction for calibration of the large basin while the DBPS used uncalibrated flows with no gage data. The scale of the models also affects these flows. Black Squirrel is 724 sq mi while the DBPS is only 16.6 sq mi.

The Haegler Ranch composite basin was modeled using the average runoff CN of 66 and a total lag time of 376 minutes. The lag time was calculated based on 300 ft of overland flow, followed by shallow concentrated flow, and channel flow from the upper portions of the basin to the confluence. The channel slope and Manning's roughness coefficients for the channel are the average values for each, 1.20% and 0.49 respectively. All recurrence interval flows for the composite basin model are less than the existing conditions DBPS model. This is due to lack of detail since the subbasins and flows are not routed throughout the basin.

The existing condition DBPS modeled flows are higher than the regional regression equations, the flow curve from gage data, and the Black Squirrel Creek study. Due to existing development and the methodology used to develop the other methods, the flows vary. Due to differences and reliability of the comparisons, no action was taken to calibrate the DBPS model.

## 4.12. Results

Peak flows for all the subbasins, reaches, and junctions calculated throughout the Haegler Ranch are shown in Figure 4-4. HEC-HMS models for existing and future basin conditions are in Appendix A.



The existing flows were based on the existing routing, existing runoff CNs, and existing time of concentrations. For the future condition flows, the routing, runoff CNs, and times of concentrations were adjusted for future land use. The future conditions model does not currently take into account any proposed detention, channelization, or alternative configurations.

Summarized in Tables 4-10 and 4-11 are a comparison of peak flows and volumes at key locations throughout the Haegler Ranch for both existing and future models. The largest flow and volume

increases occur in the middle portion of the basin in response to development. These flows and volumes are based on no detention. There is planned detention upstream per the approved Master Development Drainage Plans (MDDPs) within this area that will be reevaluated during design.

The mainstem and southeast tributary experience an increase in flows throughout the watershed as a result of development. The change in peak flows decreases as water moves downstream because peak flows are attenuated and development does not occur in the lower portion of the watershed.

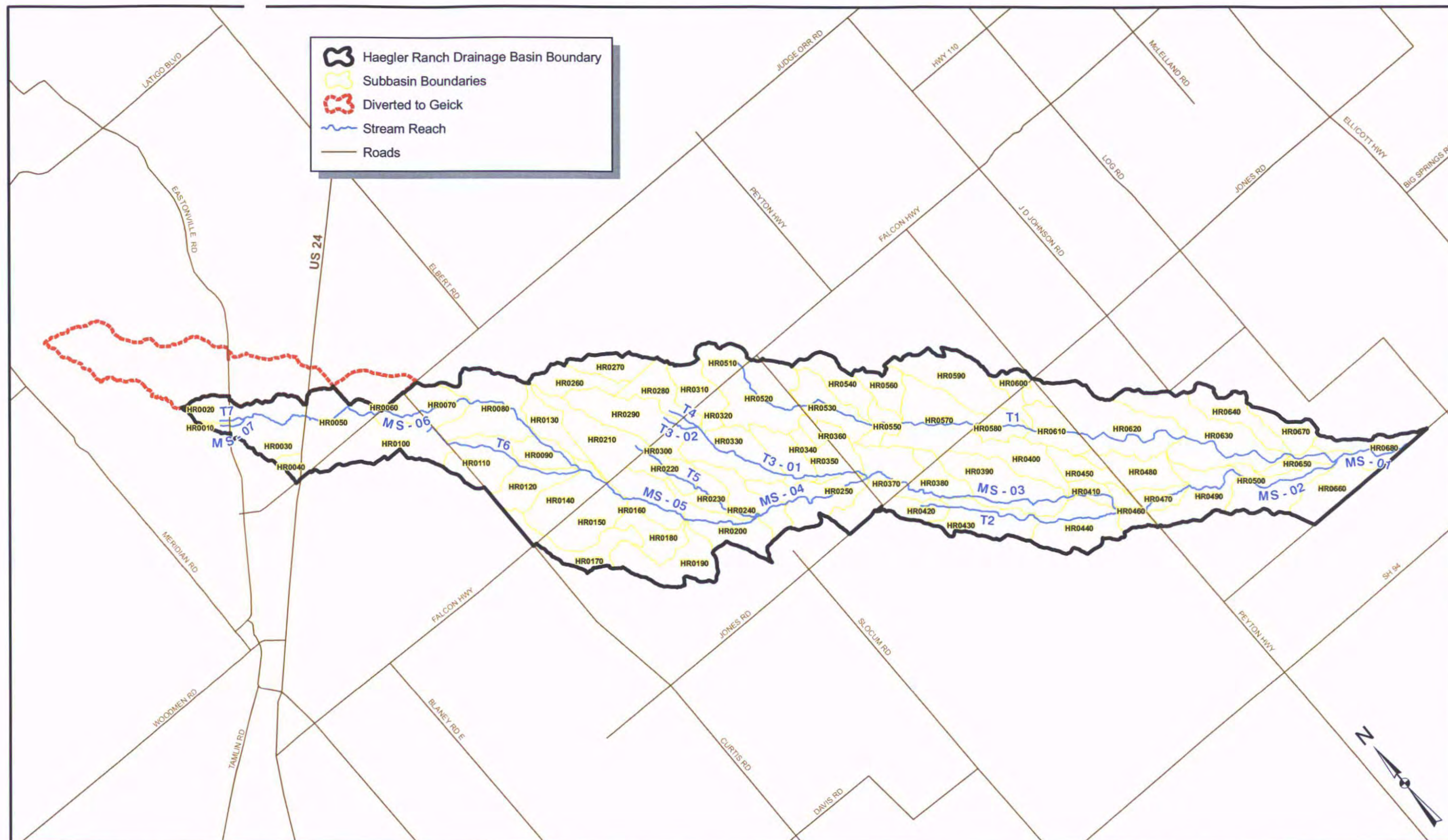
Table 4-10 Reach Flow Comparison for the Haegler Ranch Drainage Basin

Key Location	HEC-HMS Element	Area (sq mi)	Existing Flows (cfs)				Future Flows (cfs)				Future Flows Increase (%)			
			2-yr	5-yr	10-yr	100-yr	2-yr	5-yr	10-yr	100-yr	2-yr	5-yr	10-yr	100-yr
Main stem at US 24	JHR0030	0.5	21	65	110	350	120	210	280	630	471%	223%	155%	80%
Main stem at Judge Orr Road	JHR0056	0.9	24	85	150	540	120	230	330	830	400%	171%	120%	54%
Main stem at Falcon Highway	JHR0145	3.3	39	150	280	1,100	420	790	1,100	2,400	977%	427%	293%	118%
Main stem at Jones Road	JHR0370	8.6	150	420	670	2,300	600	1,300	1,900	5,000	300%	210%	184%	117%
Main stem at Peyton Highway	JHR0465	10.7	180	490	790	2,600	570	1,300	2,000	5,400	217%	165%	153%	108%
Southeast Tributary at Jones Road	JHR0570	1.8	29	75	120	370	48	120	180	520	66%	60%	50%	41%
Southeast Tributary at Peyton Highway	JHR0610	2.7	34	92	150	500	52	130	210	650	53%	41%	40%	30%
Southeast Tributary at Confluence with Main stem	JHR0650	4.3	38	110	180	670	54	150	230	790	42%	36%	28%	18%
At Confluence with Geick Basin	Haegler	16.6	190	570	950	3,200	550	1,300	2,000	5,600	189%	128%	111%	75%

Table 4-11 Volume Summary Comparison for the Haegler Ranch Drainage Basin

Key Location	HEC-HMS Element	Area (sq mi)	Existing Volume (ac-ft)				Future Volume (ac-ft)				Future Volume Increase (%)			
			2-yr	5-yr	10-yr	100-yr	2-yr	5-yr	10-yr	100-yr	2-yr	5-yr	10-yr	100-yr
Main stem at US 24	JHR0030	0.5	4.7	11	16	41	8.9	16	22	50	89%	45%	38%	22%
Main stem at Judge Orr Road	JHR0056	0.9	6.4	16	24	66	11	22	31	77	72%	38%	29%	17%
Main stem at Falcon Highway	JHR0145	3.3	17	46	72	210	54	100	140	310	218%	117%	94%	48%
Main stem at Jones Road	JHR0370	8.6	75	170	250	670	120	240	340	800	60%	41%	36%	19%
Main stem at Peyton Highway	JHR0465	10.7	95	220	320	840	140	290	400	970	47%	32%	25%	15%
Southeast Tributary at Jones Road	JHR0570	1.8	13	31	46	130	16	36	52	140	23%	16%	13%	8%
Southeast Tributary at Peyton Highway	JHR0610	2.7	18	45	68	190	21	50	73	200	17%	11%	7%	5%
Southeast Tributary at Confluence with Main stem	JHR0650	4.3	22	59	92	270	25	64	98	280	14%	8%	7%	4%
At Confluence with Geick Basin	Haegler	16.6	120	290	440	1,200	170	370	530	1,400	42%	28%	20%	17%





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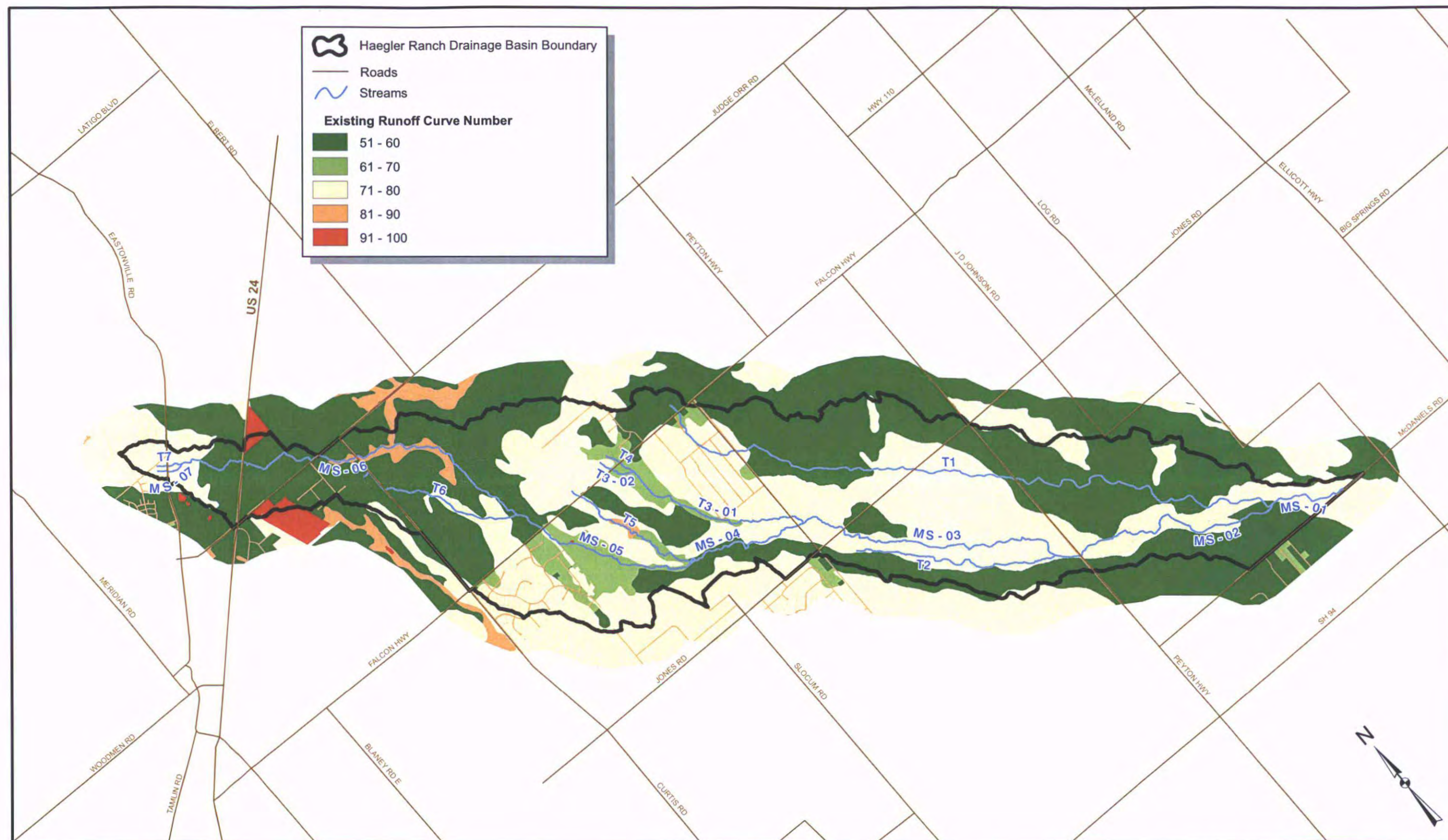
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**HAEGLER RANCH DRAINAGE BASIN**  
**SUBBASIN DELINEATION**  
**FIGURE 4-1**

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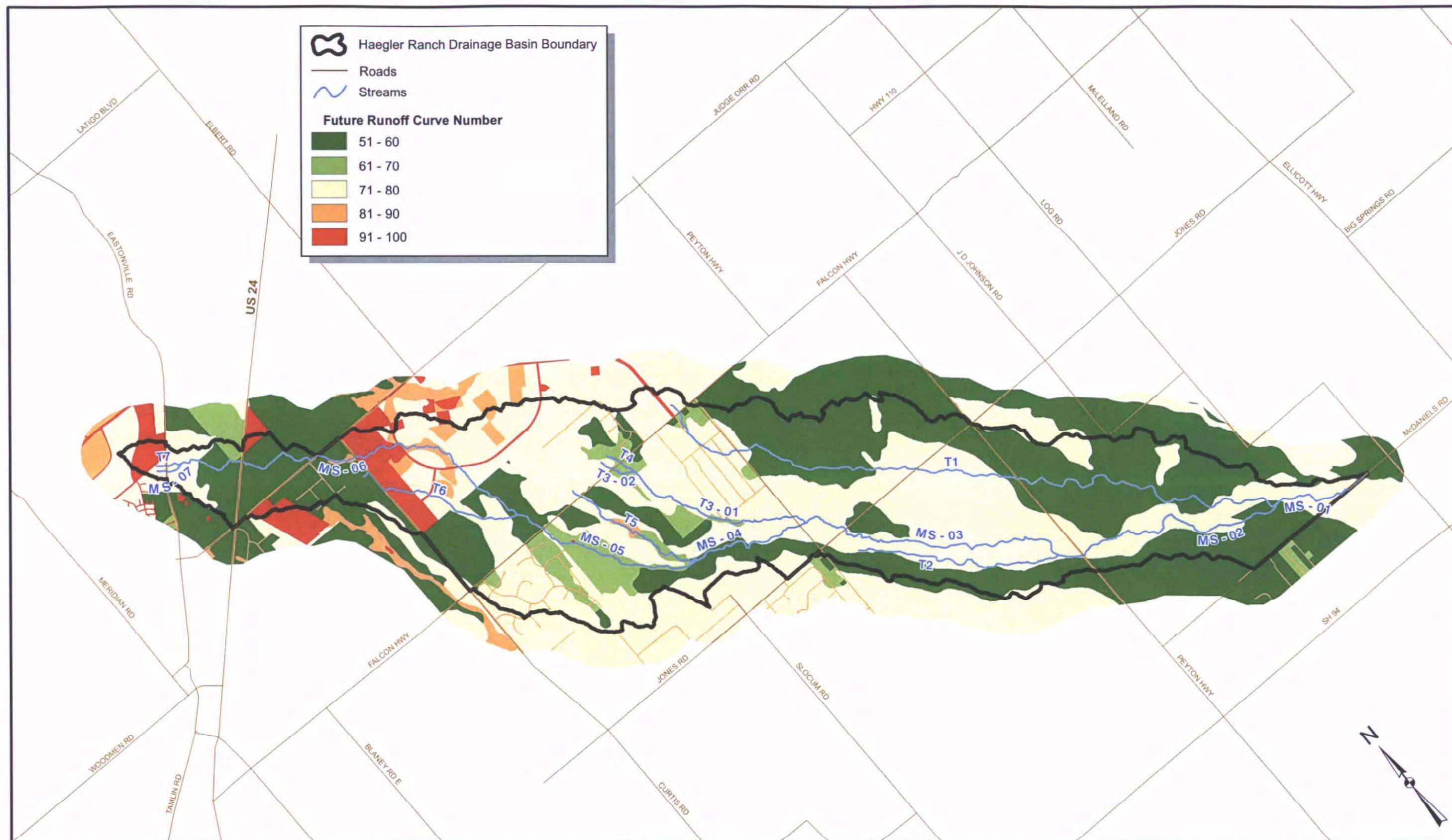


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**HAEGLER RANCH DRAINAGE BASIN**  
**EXISTING RUNOFF**  
**CURVE NUMBERS**  
**FIGURE 4-2**





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**HAEGLER RANCH DRAINAGE BASIN**  
**FUTURE RUNOFF**  
**CURVE NUMBERS**  
**FIGURE 4-3**

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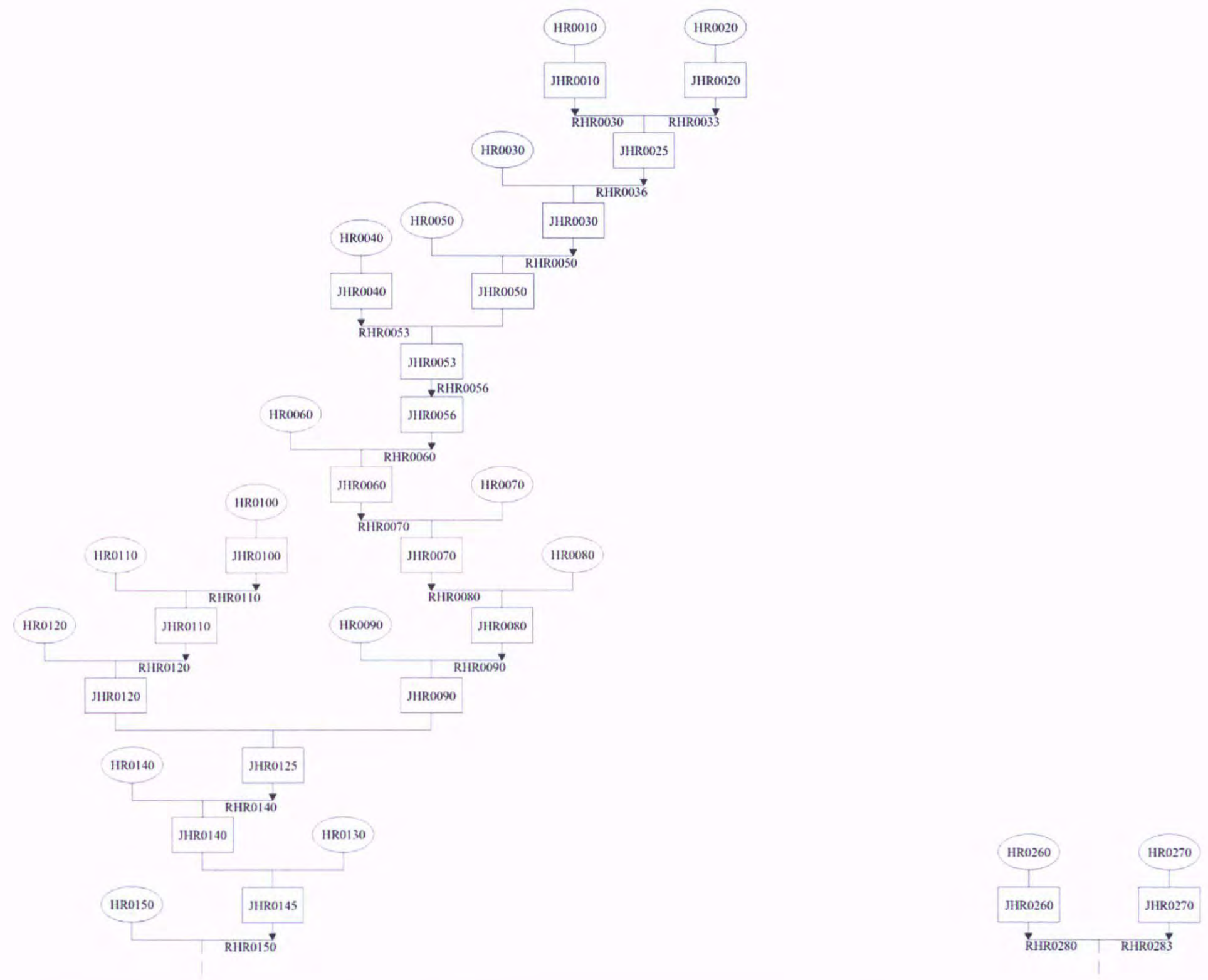
**Figure 4-4 Existing and Future Conditions Hydrologic Model**

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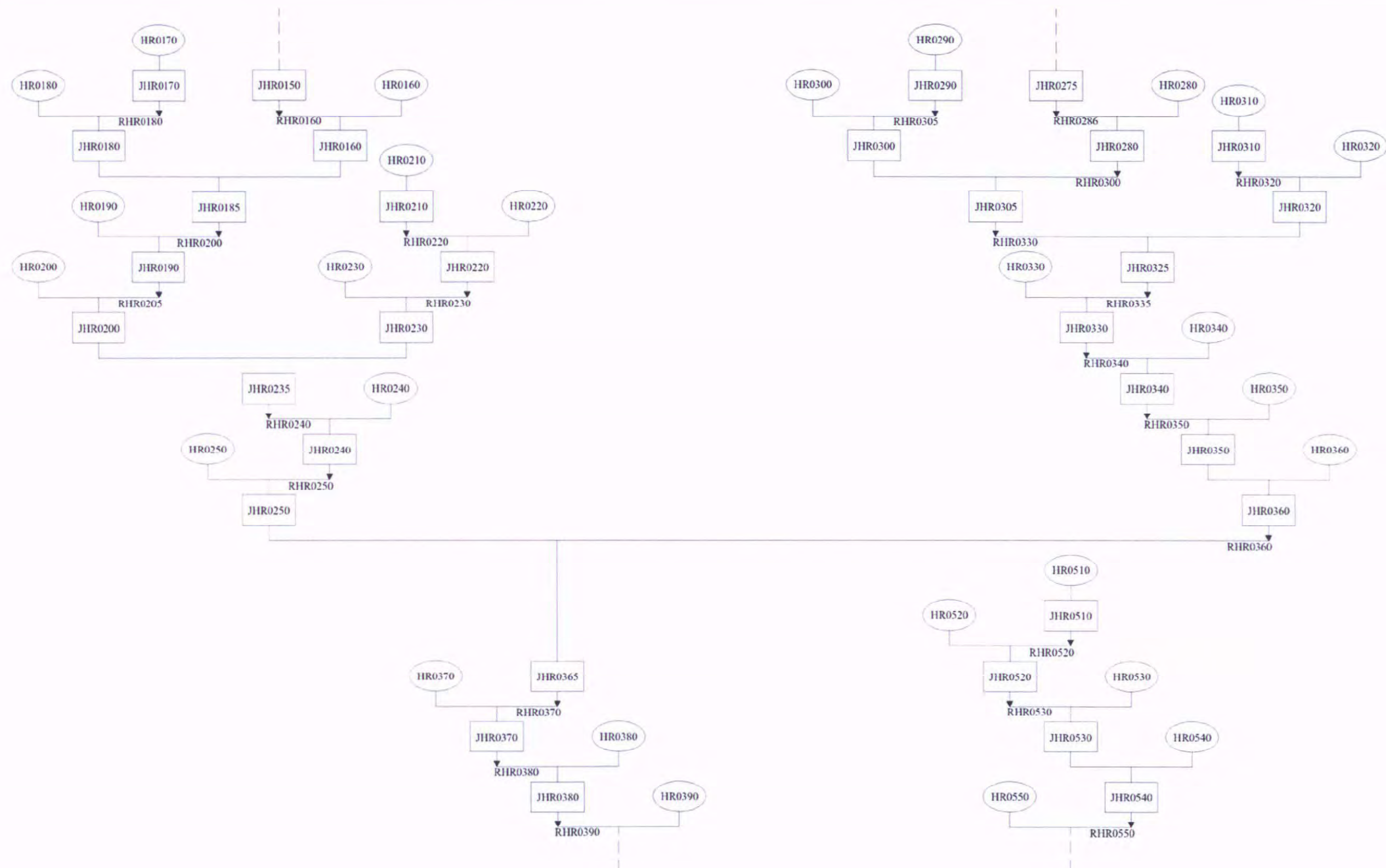
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**HAEGLER RANCH DRAINAGE BASIN**  
**HYDROLOGIC CONNECTIVITY**  
**SHEET 1**  
**FIGURE 4-5**





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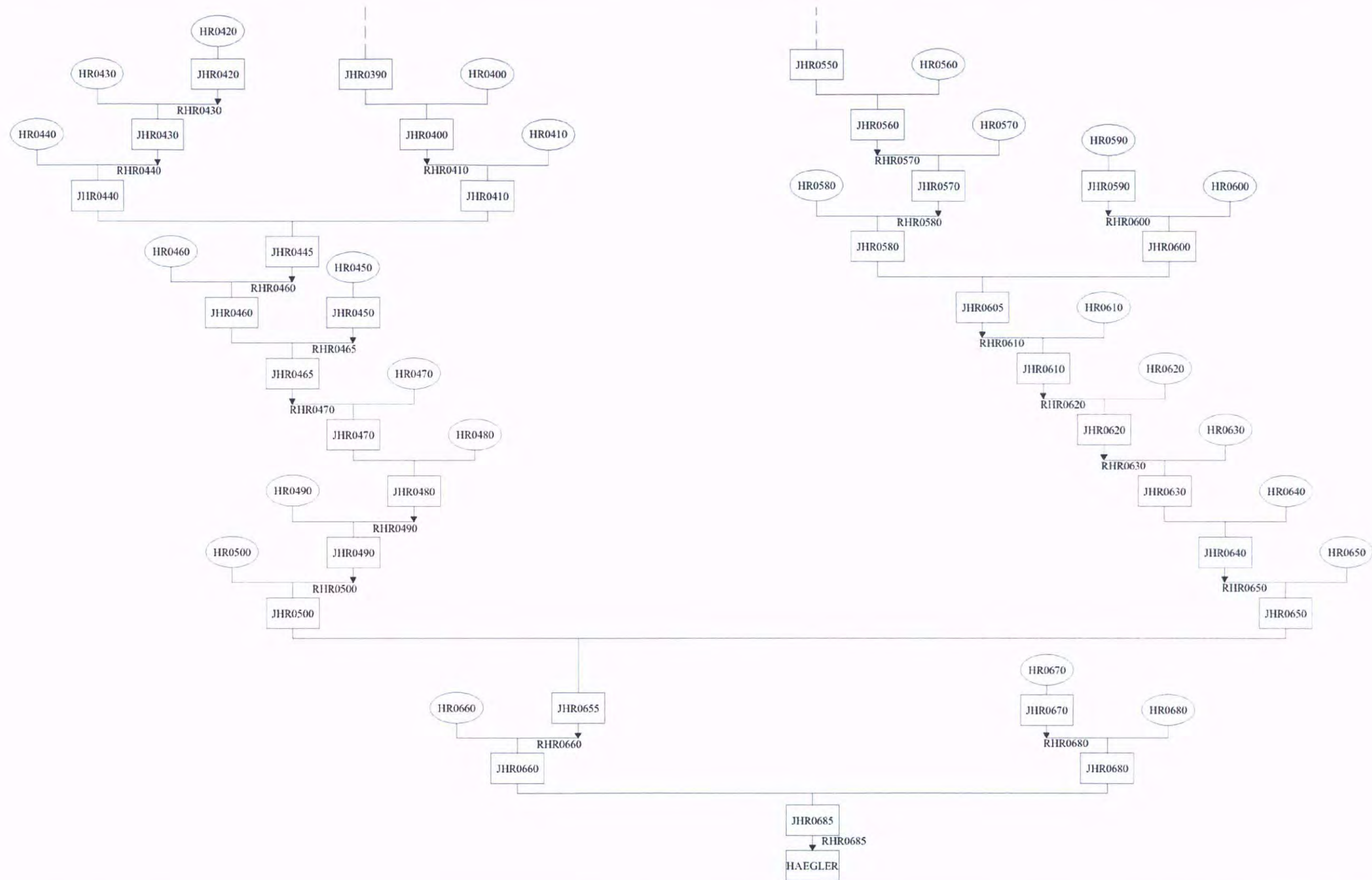
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**HAEGLER RANCH DRAINAGE BASIN**  
**HYDROLOGIC CONNECTIVITY**  
**SHEET 2**  
**FIGURE 4-5**





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**HAEGLER RANCH DRAINAGE BASIN**  
**HYDROLOGIC CONNECTIVITY**  
**SHEET 3**  
**FIGURE 4-5**

DATE: 05/08



## 5.0 HYDRAULIC ANALYSIS

### 5.1. Overview

Hydraulic analyses for existing conditions were computed for the 8 channel reaches within the Haegler Ranch Drainage Basin to model the flood events for the 2-, 5-, 10-, and 100-year recurrence interval flows. Hydraulic reaches studied are shown in Figure 5-1. Hydraulic analyses were conducted using the USACE Hydrologic Engineering Center-River Analysis System Version 3.1.3 (HEC-RAS). The employed methodology, models characteristics, and input data used in the hydraulics models are described in this section.

The hydraulic analysis of Haegler Ranch main stem was performed by dividing the basin into several reaches, which cover approximately 31 miles from the headwaters near Eastonville Road to its confluence with the unnamed tributary of Geick Ranch Drainage Basin. The Haegler Ranch main stem is primarily a grass-lined swale, with defined channels near road crossings that dissipate as the flow moves downstream.

### 5.2. Flood History

During the 1999 calendar year, a precipitation record was set for the Colorado Springs area. Haegler Ranch Drainage Basin also experienced this record precipitation. The 1999 flood event in Haegler Ranch Drainage Basin was caused by long periods of rainfall coupled with brief but intense storms. Several significant rainfall events occurred between March and August 1999 (FEMA 1999). The most pronounced event occurred April 28 to May 1 with a total of 5.59 in. (National Weather Service gauge, Colorado Springs Airport), only three days after a slightly smaller storm with a total of 1.79 in. At Meridian Road, Falcon Highway and East Blaney Road, culverts washed out and roadway embankments were damaged.

The spring of 1995 was extremely wet, with 7.8 in. of rain in June. Major flooding also occurred in spring 1965 when events very similar to the 1999 flood event took place. In 1965, 5.47 in. of rain was recorded at the Colorado Springs Airport in four days immediately after a series of ongoing, smaller events. Residents said that the 1965 storm centered more north and east of Falcon than the 1999 storm, and Ellicott Highway was completely washed out (FEMA 1999). These flood events clearly show the potential for severe flooding in the Haegler Ranch Drainage Basin.

### 5.3. Hydraulic Structure Inventory

As part of the field investigation, existing drainage facilities were inventoried. The size, type, and condition were recorded for the bridges, culverts, channels, inlets, pipes, and miscellaneous drainage features in the basin. An inventory of the major structures is presented in Figure 5-2 and Figure 5-3.

### 5.4. HEC-RAS Modeling

Hydraulic modeling was completed using HEC-RAS to perform one-dimensional, steady flow hydraulic calculations for each reach and a geospatially referenced river model in USACE Hydrologic Engineering Center – Geospatial River Analysis System Version 4.1 (HEC-GeoRAS).

In ArcMap®, the stream centerlines, banks, flow paths, cross-sections, and Manning's roughness coefficients were defined for the basin. The stream centerline follows the channel thalweg to define the reach network. The banks differentiate the 2-yr low flow channel from the floodplain channel. The

flowpaths identify the centroid of the flow in the left overbank, main channel, and right overbank in order to determine the respective reach lengths. The cross-sections use the topography to acquire information along the reach. The Manning's roughness coefficients are defined for the channel and floodplains for the cross-section data. Cross-section topography data was obtained by using the 2-ft contour referenced earlier in Section 2.3 (AME 2004). From the 2-ft contours, a triangulated irregular network (TIN) was created for the digital terrain model in HEC-GeoRAS. A HEC-GeoRAS import file that contained three-dimensional coordinates for the stream centerlines and cross-sections, as well as reach stations, bank stations, reach lengths, stream topology, and Manning's roughness coefficients was imported into HEC-RAS.

Bridges, culverts, levees, and ineffective flow were added to the HEC-RAS model after import from HEC-GeoRAS. For the culvert and bridge crossings, a field survey was conducted to get detailed cross-section data. Physical parameters for surveyed structures were incorporated into the hydraulic model using HEC-RAS bridge/culvert and cross-section data editors. Structures were modeled as if they were free of any major obstructions to reflect properly maintained conditions. However, many of the culverts have reduced capacities due to sedimentation, vegetation growth, and the accumulation of debris. Cleaning and maintenance of these culverts is required to restore their flood flow capacities. Levees were defined in the cross-sections to represent disconnected low lying areas using the HEC-RAS cross-section data editor. Ineffective flow areas were defined to represent areas that contain water in a flood event but do not effectively convey flow.

### 5.5. Reach Delineation

Reaches were delineated for channels of Haegler Ranch Drainage Basin for areas that drain at least 100 ac and channels that include stormwater improvement projects. The reaches were evaluated based upon the existing topography, physical condition of the channel, and the floodplains along the major drainageways. The delineated reaches shown in Figure 5-1 are described as follows:

- Main Stem (MS-01) – This channel extends from the confluence of the main stem and Tributary 1 in subbasin HR0660 to the outlet of the Haegler Ranch in subbasin HR0680 on the north side of McDaniels Road. The channel is a grass swale that flows into a grass-lined ditch on the north side of McDaniels Road.
- Main Stem (MS-02) – This channel extends from the confluence of the main stem with Tributary 2, just northwest of Peyton Highway in subbasin HR0460, to the confluence of the main stem and Tributary 1 in subbasin HR0660. The channel is a grass swale with one culvert crossing at Peyton Highway.
- Main Stem (MS-03) – This channel extends from the confluence of the main stem with Tributary 3, just east of Murr Road in subbasin HR0370, to the confluence of the main stem with Tributary 2, just northwest of Peyton Highway in subbasin HR0460. The channel is parallel to T2, and varies between a grass swale and an alluvial sand bed with one culvert crossing at Jones Road.
- Main Stem (MS-04) – This channel extends from the confluence of the main stem with Tributary 5 in subbasin HR0240 to the confluence of the main stem with Tributary 3, just east of Murr Road in subbasin HR0250. The channel is a grass swale with one culvert crossing at Murr Road.



- Main Stem (MS-05) – This channel extends from the confluence of the main stem with Tributary 6 north of Falcon Highway in subbasin HR0140 to the confluence of the main stem with Tributary 5 in subbasin HR0200. The channel is a grass swale with one culvert crossing at Falcon Highway.
- Main Stem (MS-06) – This channel extends from the confluence of the main stem with Tributary 7, southeast of Eastonville Road in subbasin HR0030, to the confluence of the main stem with Tributary 6, just north of Falcon Highway in subbasin HR0090. The channel is a grass swale with two culvert crossings, one bridge crossing, and one overtopped roadway at Judge Orr Road.
- Main Stem (MS-07) – This channel extends from subbasin HR0010 northwest of Eastonville Road to the confluence of the main stem with Tributary 7, southeast of Eastonville Road in subbasin HR0030. The channel is a grass swale with one culvert crossing at Eastonville Road.
- Tributary 1 (T1) – This channel extends from subbasin HR0510 just north of Falcon Highway to the confluence of the main stem at subbasin HR0650. The channel is long, dominated by a grass swale with low points along the channel, and has 4 culvert crossings.
- Tributary 2 (T2) – This channel extends from subbasin HR0420 just south of Jones Road to the confluence of the main stem at subbasin HR0440 to the northwest of Peyton Highway. The channel is parallel to MS-03, and varies between a grass swale and an alluvial sand bed channel with diversion structures such as pond embankments and berms.
- Tributary 3 (T3-01) – This channel extends from subbasin HR0330 at the confluence with Tributary 4, just south of Falcon Highway, to the confluence with the main stem east of Murr Road, at subbasin HR0360. The channel is a grass swale with two culvert crossings in a large lot residential development.
- Tributary 3 (T3-02) – This channel extends from subbasin HR0290 just north of Falcon Highway to the confluence with Tributary 4, just south of Falcon Highway, in subbasin HR0300. The channel is a grass swale with one culvert crossing at Falcon Highway.
- Tributary 4 (T4) – This channel extends from subbasin HR0280 north of Falcon Highway to the confluence with Tributary 3, just south of Falcon Highway, in subbasin HR0300. The channel is a grass swale with one culvert crossing at Falcon Highway.
- Tributary 5 (T5) – This channel extends from subbasin HR0210 just north of Falcon Highway to the confluence with the main stem in subbasin HR0230. The channel is a grass swale with one culvert crossing at Falcon Highway.
- Tributary 6 (T6) – This channel extends from subbasin HR0100 west of Curtis Road to the confluence of the main stem north of Falcon Highway in subbasin HR0120. The channel is a grass swale with one culvert crossing at Curtis Road.
- Tributary 7 (T7) – This channel extends from subbasin HR0020 northwest of Eastonville Road to the confluence of the main stem, southeast of Eastonville Road, in subbasin HR0030. The channel is a grass swale with one culvert crossing at Eastonville Road.

### 5.6. Manning’s Roughness Coefficients

Manning’s roughness coefficients for each cross-section were estimated based on site visits and aerial photographs. Multiple Manning’s roughness coefficients were used across the cross-section as necessary to accurately describe changes in vegetative cover between the main channel and overbank

areas. The values for the Manning’s roughness coefficients in the channel and the floodplains are taken from the Guide for Selecting Manning’s Roughness Coefficients for Natural Channels and Floodplains by the USGS (WSP 2339). This manual was used since the Manning’s roughness coefficients can be adjusted for surface irregularities, variation in cross-sections, obstructions, vegetation, and meandering. The Manning’s roughness coefficients for the channels and floodplains associated with different types of land cover are summarized in Table 5-1.

**Table 5-1 Manning’s Roughness Coefficients for the Haegler Ranch Drainage Basin**

Land Surface Type	Manning’s Roughness Coefficients
Channel	
Grass swale	0.055
Grass-lined ditch	0.032
Sand bed	0.025
Floodplain	
Grass	0.065
Trees	0.150
Light Brush	0.074
Brush	0.100
Earth	0.038
Asphalt / Concrete	0.020

Notes:  
<sup>1</sup>Source: Guide for Selecting Manning’s Roughness Coefficients for Natural Channels and Floodplains by the USGS (WSP 2339).

### 5.7. Cross-sections

Hydraulic cross-sections were initially placed approximately 500-ft apart along reaches, and additional cross-sections were added to represent confluences, road crossings and changes in channel form. Cross-sections were automatically stationed from downstream to upstream along the reach. Each cross-section was adjusted to extend across the entire floodplain and was placed perpendicular to the anticipated direction of flow in both the main channel and left/right overbanks. The cross-sections were bent in some locations to meet this requirement, as described in Chapter 3 of HEC-RAS Hydraulic Reference Manual (Version 3.1, November 2002).

Additional cross-sections were added at structures such as bridges and culverts. At each structure, four cross-sections were added to the HEC-RAS model. These four cross-sections included an upstream cross-section prior to flow contraction, a cross-section at the upstream face of the structure, a cross-section at the downstream face of the structure, and a downstream cross-section where flow is fully expanded. All bridge and culvert crossings were field surveyed to determine their size, inverts, and material.

Expansion and contraction coefficients were estimated based on the ratio of expansion and contraction of the effective flow area in the floodplain occurring at cross-sections and at roadway crossings. For subcritical flow conditions and where the change in the stream cross-section was gradual, contraction and expansion coefficients of 0.1 and 0.3, respectively, were used. Wherever the change in effective



cross section area was abrupt, such as at bridges and culverts, contraction and expansion coefficients of 0.3 and 0.5, respectively, were used.

### **5.8. Levees and Ineffective Flow**

Levees were used to describe portions of a cross-section in which water does not actively flow. Levees represent physical barriers, that may be either man-made or naturally occurring, that prevent the flow from reaching a low-lying area outside the channel. Once the levee is overtopped, the flow outside the levee is ineffective flow.

Ineffective flow areas are used to describe portions of a cross section in which water is not actively flowing. This ineffective flow can be in a side channel or on the upstream or downstream cross sections of a structure. All ineffective flow is considered as permanent, and will not flow once the levee or structure is overtopped.

### **5.9. Bridges and Culverts**

The field survey data and the TIN were combined to create upstream and downstream cross-sections for bridges and culverts along the reaches. The highest energy answer was selected for low flow methods. For bridges, the deck/roadway, pier, and sloping abutments were input where appropriate. For culverts, the shape and dimensions were input.

Entrance loss coefficients estimate the amount of energy lost as the flow enters into culverts and is used to determine the upstream headwater elevation for outlet control computations. Entrance loss coefficients for different types of culverts were selected from Tables 6.3, 6.4, and 6.5 of HEC-RAS Hydraulic Reference Manual (Version 3.1, November 2002). Exit losses are set to 1.0 for a typical culvert with sudden expansion as per the Reference Manual.

### **5.10. Steady Flow and Boundary Conditions**

Steady flow data were entered for all reaches based on the results of the hydrologic model as outlined in Section 4.0. Steady flow data corresponding to recurrence intervals of 2-, 5-, 10-, and 100-years for existing conditions for each reach were determined at different locations used in the HEC-RAS model.

Water surface elevation boundary conditions were determined using the normal depth method at the upstream end and downstream end of all reaches. This boundary condition requires input of the energy grade line slope, which is assumed to be bed slope, at the downstream and upstream boundaries for the mixed-flow regime and can be approximated from contour data. The upstream and downstream boundary conditions were entered into the HEC-RAS model.

### **5.11. Flow Regime**

The HEC-RAS model was run in a mixed flow regime to observe areas of subcritical flow, supercritical flow, hydraulic jumps, and draw downs. The model was then run using only subcritical flow, which was then used to delineate the 100-year floodplain.

### **5.12. Approximate Floodplains**

Approximate floodplains for the 100-year existing condition flow have been delineated for Haegler Ranch Drainage Basin using HEC-RAS and HEC-GeoRAS. Floodplain limits and profiles for the 100-

year storm event can be shown in Figure 5-4. The approximate floodplain limits and profiles were used to assess where hydraulic inadequacies exist along the major drainageways.

The approximate floodplain information shown on the plans can be used for identification of flood prone areas along the major drainageways and to aid in the evaluation of alternative plans. The approximate floodplain data contained herein is not intended to replace the information presented in the City of Colorado Springs and El Paso County Flood Insurance studies (FEMA 1999), but should be used as a planning tool for drainageway development projects.

The structures identified as being in the approximate floodplain shown in Figure 5-4 are listed in Table 5-2. This table has been prepared using available survey and aerial photo graphic data, but it has not been field verified.

### **5.13. Existing Deficiencies and Upgrades**

Hydraulic capacities were estimated for the 19 culverts, 1 bridge crossing, and 2 road crossings with no culvert or bridge along the 8 channels in the hydraulic models, to determine the existing deficiencies. The hydraulic capacity of a road crossing was assumed to be exceeded when the hydraulic grade line reached the road surface for the 100-year HEC-RAS model. A summary of the road crossings evaluated can be found in Table 5-3.

Of the 22 road crossings, 20 roads are overtopped and 2 crossings have existing 100-year flow capacities. For the 20 crossing that are currently insufficient, the facilities necessary to provide 100-year conveyance were determined, as listed in Table 5-3. These necessary facilities are based on approximate culvert capacity calculations in Appendix B.



Table 5-2 Structures in the Approximate Floodplain

Structure No.	Description	Location	Reach	Nearest Cross-Section	Approximate Flooding Depth, ft
1	home	HR0680	MS-01	1931	<1
2	lg. shed	HR0680	MS-01	1931	<1
3	garage	HR0680	MS-01	1931	<1
4	med. barn	HR0680	MS-01	1931	<1
5	shade str.	HR0680	MS-01	1931	<1
6	home	HR0680	MS-01	2426	<1
7	sm. shed	HR0680	MS-01	2426	<1
8	sm. barn	HR0680	MS-01	2426	<1
9	home	HR0680	MS-01	2426	<1
10	lg. barn	HR0660	MS-01	6205	<1
11	shop	HR0460	MS-02	19652	<1
12	sm. shed	HR0460	MS-02	19233	1.5
13	sm. shed	HR0460	MS-02	19233	1.7
14	sm. barn	HR0250	MS-04	36185	<1
15	mobile home	HR0250	T3-01	1009	<1
16	barn/stalls	HR0570	T1	24761	<1
17	shade str.	HR0570	T1	24761	<1
18	home	HR0520	T1	32854	<1
19	med. barn	HR0520	T1	33123	<1
20	home	HR0520	T1	33834	<1
21	sm. shed	HR0520	T1	33834	3.9
22	sm. shed	HR0520	T1	33985	2.7
23	lg. shed	HR0520	T1	34275	<1
24	home	HR0520	T1	34539	1.5
25	lg. shed	HR0520	T1	34539	<1
26	lg. shed	HR0520	T1	34539	<1
27	shop	HR0570	T1	35004	<1
28	home	HR0520	T1	35004	<1
29	home	HR0520	T1	35004	<1
30	home	HR0520	T1	35209	2.7
31	garage	HR0520	T1	35209	1.7
32	sm. shed	HR0520	T1	35540	1.7
33	home	HR0520	T1	35209	<1
34	garage	HR0520	T1	35540	<1
35	home	HR0520	T1	35540	<1
36	home	HR0520	T1	35540	<1
37	garage	HR0570	T1	35927	<1
38	sm. shed	HR0520	T1	35540	<1
39	home	HR0520	T1	35927	1.7
40	garage	HR0520	T1	35927	2.7
41	garage	HR0520	T1	36037	<1
42	home	HR0520	T1	36037	<1



**Table 5-2 Structures in the Approximate Floodplain**

Structure No.	Description	Location	Reach	Nearest Cross-Section	Approximate Flooding Depth, ft
43	home	HR0520	T1	36351	2.9
44	garage	HR0520	T1	36721	<1
45	home	HR0520	T1	36721	2.8
46	sm. barn	HR0520	T1	36721	<1
47	home	HR0570	T1	36721	<1
48	garage	HR0520	T1	36971	<1
49	home	HR0140	MS-05	52834	<1
50	shop	HR0140	MS-05	52834	<1
51	med. barn	HR0140	MS-05	53369	<1
52	med. shed	HR0140	MS-05	53369	<1
53	med. barn	HR0140	MS-05	53369	<1
54	lg. shed	HR0140	MS-05	53369	<1
55	sm. shed	HR0140	MS-05	53369	<1
56	sm. shed	HR0130	MS-06	55426	<1
57	home	HR0130	MS-06	54855	<1
58	shop	HR0130	MS-06	55883	<1
59	home	HR0100	T6	7733	<1
60	lg. shed	HR0100	T6	7994	<1
61	OMIT- NOT FLOODED				
62	med. barn	HR0060	MS-06	66759	<1
63	med. shed	HR0060	MS-06	66759	<1
64	mobile home	HR0220	T5	8074	<1
65	med. shed	HR0220	T5	8074	<1
66	med. shed	HR0220	T5	8074	<1
67	med. shed	HR0520	T1	36200	<1
<b>Propane Tanks</b>					
111	p.tank w.house1	HR0680	MS-01	1931	<1
112	p.tank w.house6	HR0680	MS-01	2426	1.1
113	p.tank w.house9	HR0680	MS-01	2426	<1
114	p.tank w.house19	HR0520	T1	33123	<1
115	p.tank w.house20	HR0520	T1	33985	2.1
116	p.tank w.house30	HR0520	T1	35209	1.7
117	p.tank w.house35	HR0520	T1	35540	<1
118	p.tank w.house36	HR0520	T1	35540	<1
119	p.tank w.house39	HR0520	T1	35927	1.7
120	p.tank w.house43	HR0520	T1	36721	2.9
121	p.tank w.house47	HR0520	T1	36721	<1
122	p.tank w.house49	HR0140	MS-05	52834	<1
123	p.tank w.house57	HR0130	MS-06	54855	<1
124	p.tank w.house59	HR0100	T6	7733	1.5
125	p.tank w.house64	HR0220	T5	8074	<1



**Table 5-3 Existing Hydraulic Deficiencies**

Facility Number	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency
301	Peyton Highway	Main Stem (MS-02)	2-33"X48" CMPs	2,500	Overtops
N/A	Peyton Highway	Tributary 1 (T1)	No Culvert	500	Overtops
401	Jones Road	Tributary 1 (T1)	2-24" CMPs	370	Overtops
402	Jones Road	N/A	15" RCP	N/A	N/A
403	Jones Road	Main Stem (MS-03)	3-60" CMPs	2,300	Overtops
404	Jones Road	N/A	18" CMP	N/A	N/A
405	Murr Road	Main Stem (MS-04)	66" RCP	1,700	Overtops
406	Jones Road	N/A	4.1' x 6.9' RCP	N/A	N/A
407	Murr Road	Tributary 3 (T3-01)	66" RCP	670	Overtops
501	Murr Road	N/A	2-14" RCP	N/A	N/A
502	Murr Road	N/A	2-18" CMP	N/A	N/A
503	Flat Creek Road	N/A	30" CMP	N/A	N/A
504	Flat Creek Road	N/A	18" CMP	N/A	N/A
505	Flat Creek Road	N/A	36" CMP	N/A	N/A
506	Flat Creek Road	N/A	60" CMP	N/A	N/A
507	Peerless Farms Road	Tributary 3 (T3-01)	60" CMP	600	Overtops
508	Whipsaw Road	N/A	30" CMP	N/A	N/A
509	Murr Road	Tributary 1 (T1)	2-15" RCPs	220	Overtops
510	Prospero Road	N/A	18" CMP	N/A	N/A
511	Southfork Dr	N/A	24" CMP	N/A	N/A
512	Falcon Grassy Hts	N/A	2-12" CMP	N/A	N/A
513	Southfork Dr	N/A	36" CMP	N/A	N/A
514	Oil Baron Dr	N/A	30" CMP	N/A	N/A
601	Whiting Way	Tributary 1 (T1)	24" CMP	220	Overtops
602	Whipsaw Road	N/A	24" CMP	N/A	N/A
603	Murr Road	N/A	24" CMP	N/A	N/A
604	Max Road	Tributary 1 (T1)	18" CMP	220	Overtops
605	Max Road	N/A	2-24" CMP	N/A	N/A



**Table 5-3 Existing Hydraulic Deficiencies**

Facility Number	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency
606	Prospero Road	N/A	2-24" CMP	N/A	N/A
N/A	Falcon Highway	Tributary 1 (T1)	No Culvert	33	Overtops
607	Falcon Highway	N/A	18" CMP	N/A	N/A
608	Falcon Highway	N/A	24" CMP	N/A	N/A
609	Falcon Highway	Tributary 3 (T3-02)	18" CMP	180	Overtops
610	Falcon Highway	Tributary 4 (T4)	24" CMP	200	Overtops
611	Falcon Highway	N/A	18" CMP	N/A	N/A
612	Falcon Highway	Tributary 5 (T5)	24" CMP	150	Overtops
613	Bobby Court	N/A	2-36" CMP	N/A	N/A
614	Southfork Dr	N/A	36" CMP	N/A	N/A
615	Southfork Dr	N/A	2-36" CMP	N/A	N/A
616	Southfork Dr	N/A	30" CMP	N/A	N/A
617	Clifford Dr	N/A	24" CMP	N/A	N/A
618	Southfork Dr	N/A	30" CMP	N/A	N/A
619	Southfork Dr	N/A	18" RCP	N/A	N/A
620	Oil Baron Dr	N/A	30" CMP	N/A	N/A
621	Sue Ellen Dr	N/A	36" CMP	N/A	N/A
622	Sue Ellen Dr	N/A	48" CMP	N/A	N/A
623	Sue Ellen Dr	N/A	24" CMP	N/A	N/A
624	Sue Ellen Dr	N/A	18" CMP	N/A	N/A
625	Pamela Way	N/A	30" CMP	N/A	N/A
626	Southfork Dr	N/A	24" CMP	N/A	N/A
627	Crebs Dr	N/A	3-30" CMP	N/A	N/A
628	Falcon Highway	Main Stem (MS-05)	2-60" CMPs	1,000	Overtops
629	Falcon Grassy Hts	N/A	24" CMP	N/A	N/A
630	Sagecreek Road	N/A	2-24" CMP	N/A	N/A
631	Sage Lake Court	N/A	18" CMP	N/A	N/A
632	Sagecreek Road	N/A	2-18" CMP	N/A	N/A



Table 5-3 Existing Hydraulic Deficiencies

Facility Number	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency
633	Sagecreek Road	N/A	24" CMP	N/A	N/A
634	Sagecreek Road	N/A	24" CMP	N/A	N/A
701	Curtis Road	N/A	18" CMP	N/A	N/A
702	Curtis Road	Tributary 6 (T6)	36" CMP	120	Overtops
703	Curtis Road	Main Stem (MS-06)	24" CMP	590	Overtops
704	Judge Orr Road	Main Stem (MS-06)	Blocked Culvert	540	Overtops
705	Judge Orr Road	N/A	18" CMP	N/A	N/A
706	US 24	N/A	20" Steel Pipe	N/A	N/A
707	US 24	N/A	24" CMP	N/A	N/A
801	Pedestrian Bridge	Main Stem (MS-06)	Bridge	350	Meets Capacity
802	US24	Main Stem (MS-06)	2-66" CMPs	350	Meets Capacity
803	Eastonville Road	Main Stem (MS-07)	27"X21" CMP	25	Overtops
804	Eastonville Road	Tributary 7 (T7)	18" CMP	99	Overtops

Note: 69 Structures were cataloged and located. N/A indicates that the structure was not analyzed because it was not on one of the main channels.

5.14. Results

Hydraulic conditions from the hydraulic model results are summarized in Table 5-4. This includes channel velocity, flow depth, and top width for existing conditions at key locations. Water surface profiles for Haegler Ranch Drainage Basin for the 100-year recurrence interval flood for the existing conditions are presented in Figure 5-4 the HEC-RAS model for Haegler Ranch Drainage Basin for the existing conditions is provided in Appendix B.

The approximate 100-year floodplain as seen in Figure 5-4 varies from a contained floodplain with in a defined channel to a wide floodplain with shallow flooding. Three areas were designated as flooding: 1) the approximate 100-year floodplain as delineated by HEC-RAS, 2) split flow flooding that was estimated from HEC-RAS elevation upstream and contours, and 3) shallow areas connected to the floodplain with less than 1 foot of flooding.



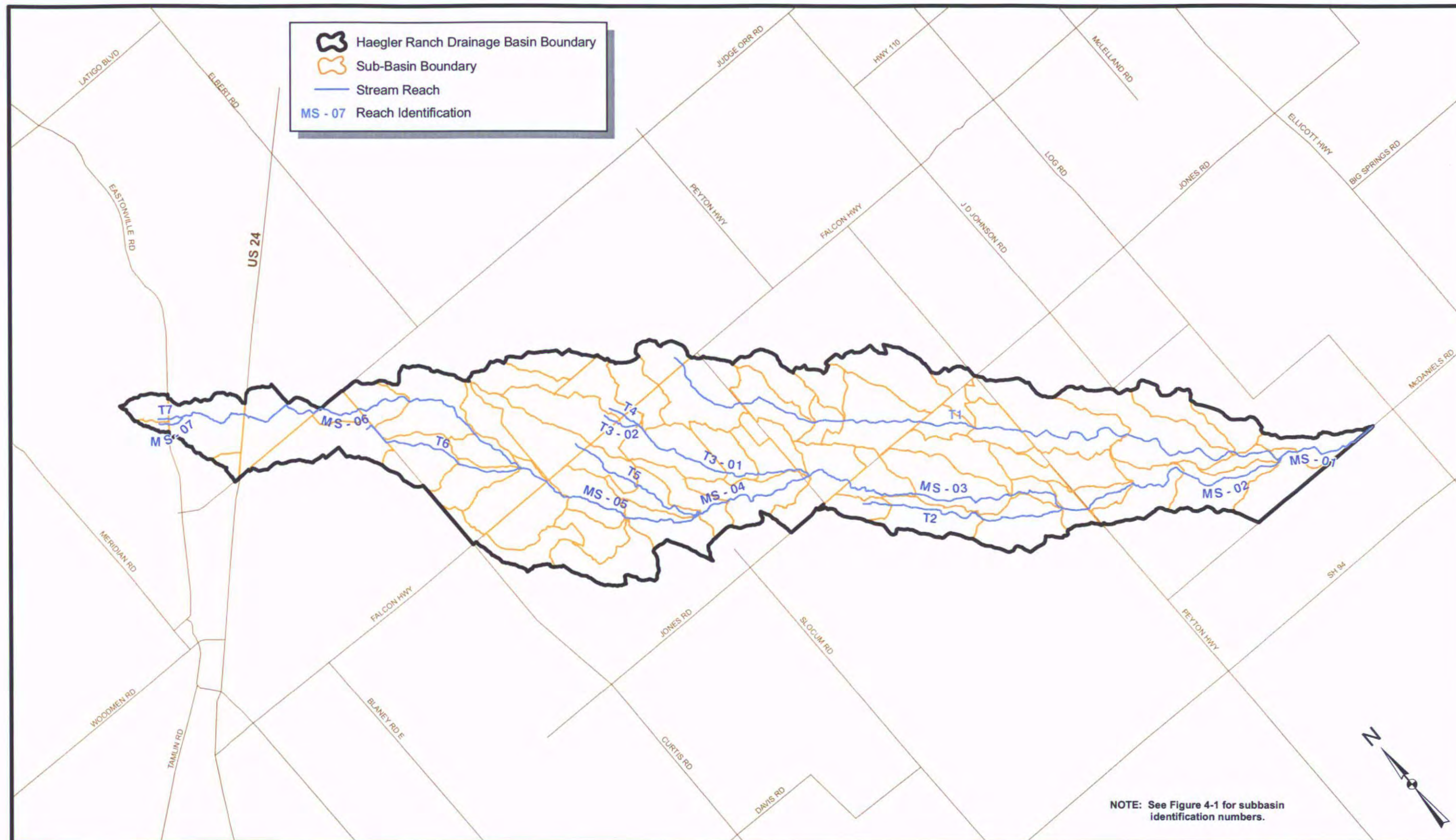
**Table 5-4 Existing Conditions HEC-RAS Model**

Key Location	Reach and Station	HEC-RAS Result	Recurrence Intervals			
			2-yr	5-yr	10-yr	100-yr
Main stem at US 24	MS-06 72276	Channel velocity (ft/sec)	1.1	1.63	1.98	2.92
		Water surface depth in channel (ft)	1.36	2.44	3.24	6.49
		Top width (ft)	18.23	24.85	29.7	255.62
Main stem at Judge Orr Road	MS-06 67666	Channel velocity (ft/sec)	3.33	4.09	1.76	3.48
		Water surface depth in channel (ft)	0.52	1.04	1.05	1.35
		Top width (ft)	174.53	534.34	535.52	569.34
Main stem at Falcon Highway	MS-05 52353	Channel velocity (ft/sec)	1.05	1.6	2.04	3.59
		Water surface depth in channel (ft)	1.79	3.69	4.96	5.74
		Top width (ft)	31.42	83.76	556.41	592.33
Main stem at Jones Road	MS-03 33189	Channel velocity (ft/sec)	2.45	3.7	1.27	2.51
		Water surface depth in channel (ft)	3.2	5.83	9.25	10.46
		Top width (ft)	47.98	105.51	580.28	667.17
Main stem at Peyton Highway	MS-02 18474	Channel velocity (ft/sec)	0.16	0.4	0.59	1.43
		Water surface depth in channel (ft)	4.14	4.35	4.51	5.15
		Top width (ft)	813.21	871.68	882.22	925.27
Southeast Tributary at Jones Road	T1 22297	Channel velocity (ft/sec)	0.62	1.02	1.47	3.2
		Water surface depth in channel (ft)	2.45	3.52	3.59	3.82
		Top width (ft)	197.35	345.68	351.74	372.17
Southeast Tributary at Peyton Highway	T1 16611	Channel velocity (ft/sec)	1.67	2.25	2.65	4.05
		Water surface depth in channel (ft)	0.08	0.17	0.24	0.51
		Top width (ft)	239.82	241.36	242.51	247.41
Southeast Tributary at Confluence with Main stem	T1 410	Channel velocity (ft/sec)	3.44	0.11	0.18	0.67
		Water surface depth in channel (ft)	1.69	2.01	2.01	2.01
		Top width (ft)	31.89	1169.3	1169.3	1169.3
At Confluence with Geick Basin	MS-01 82	Channel velocity (ft/sec)	2.68	3.85	19.89	17.33
		Water surface depth in channel (ft)	1.45	2.17	1.11	2.36
		Top width (ft)	75.88	255.32	60.67	262.84



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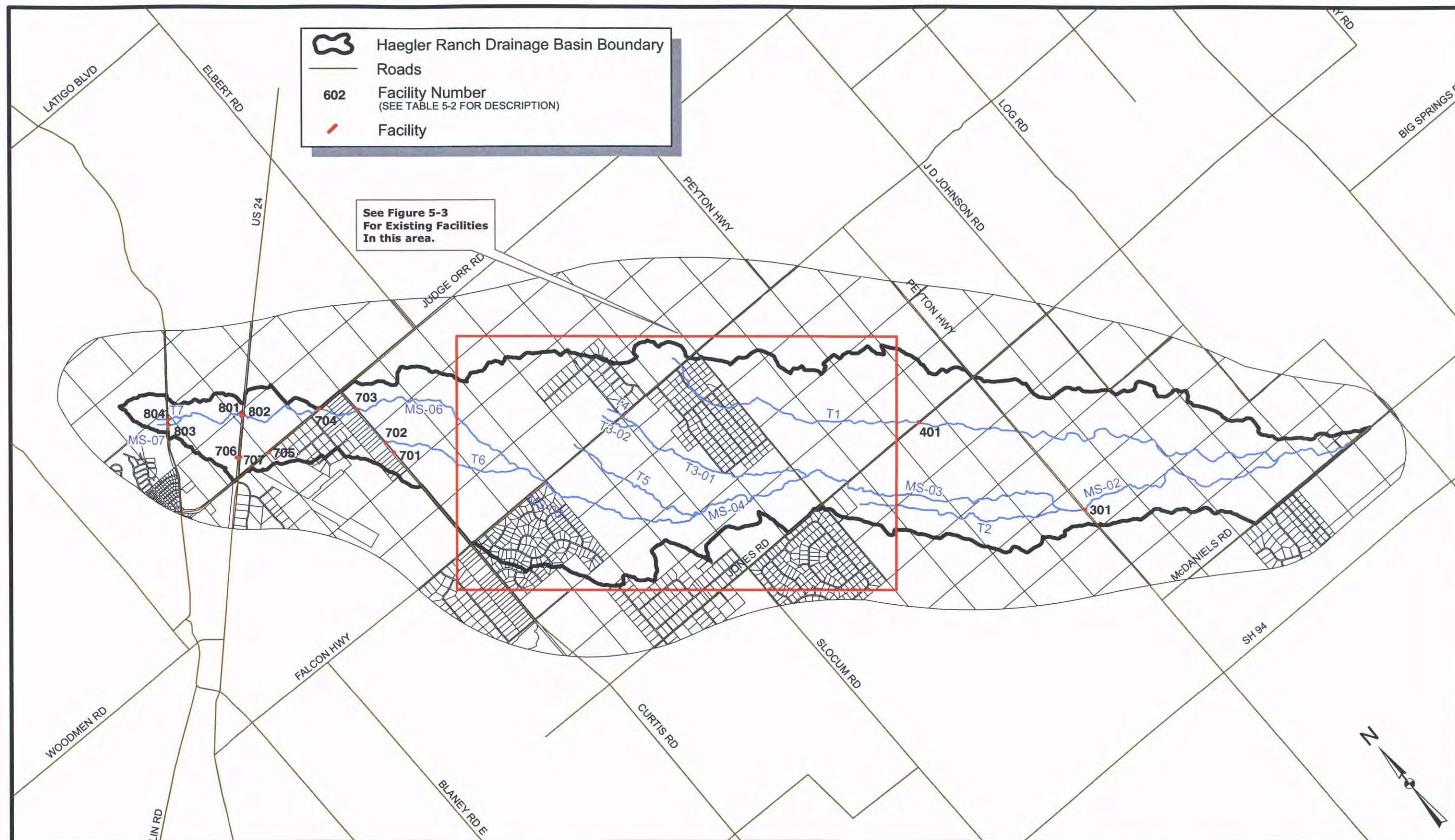
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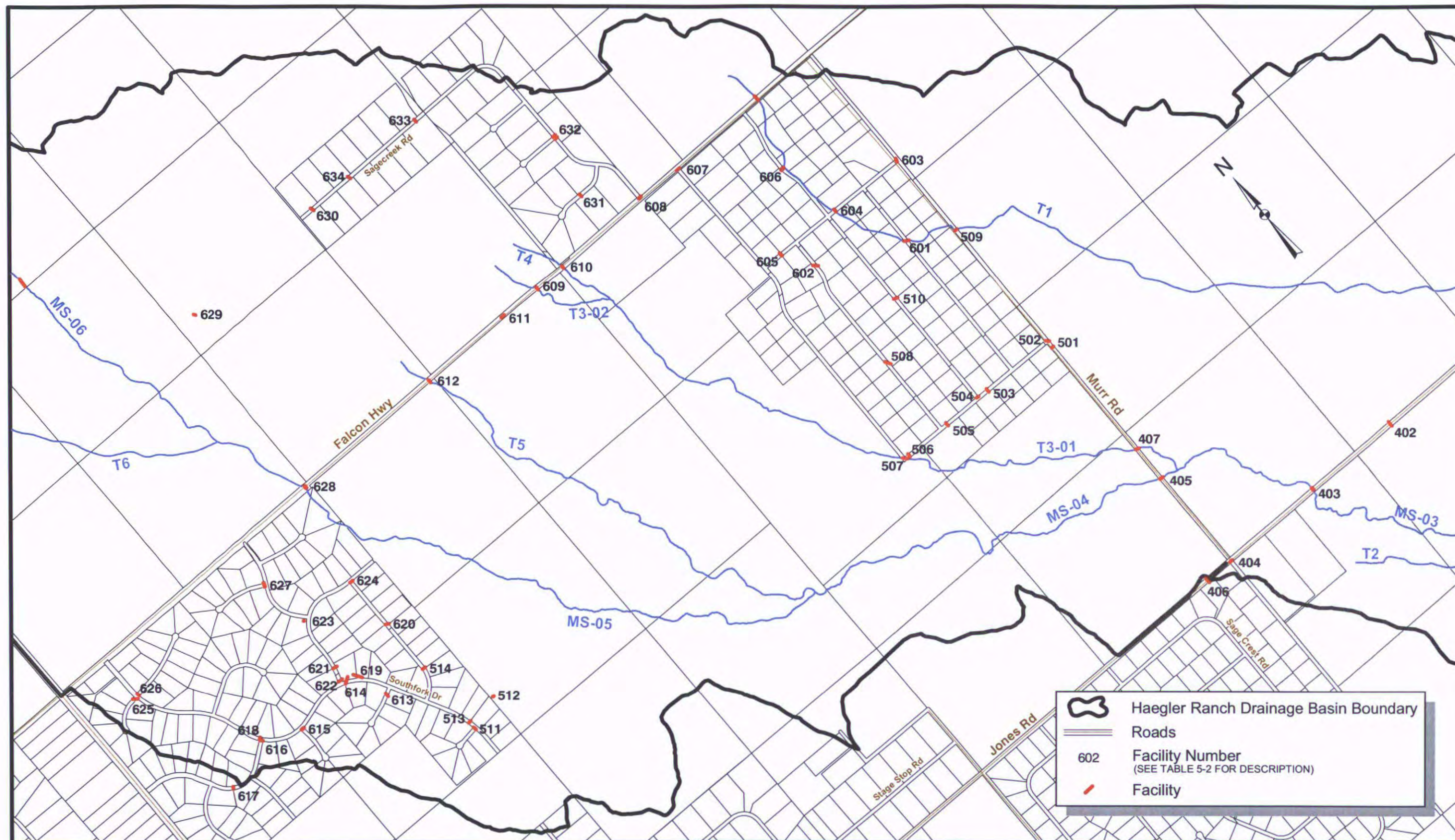
**HAEGLER RANCH DRAINAGE BASIN**

**HYDRAULIC REACHES  
FIGURE 5-1**









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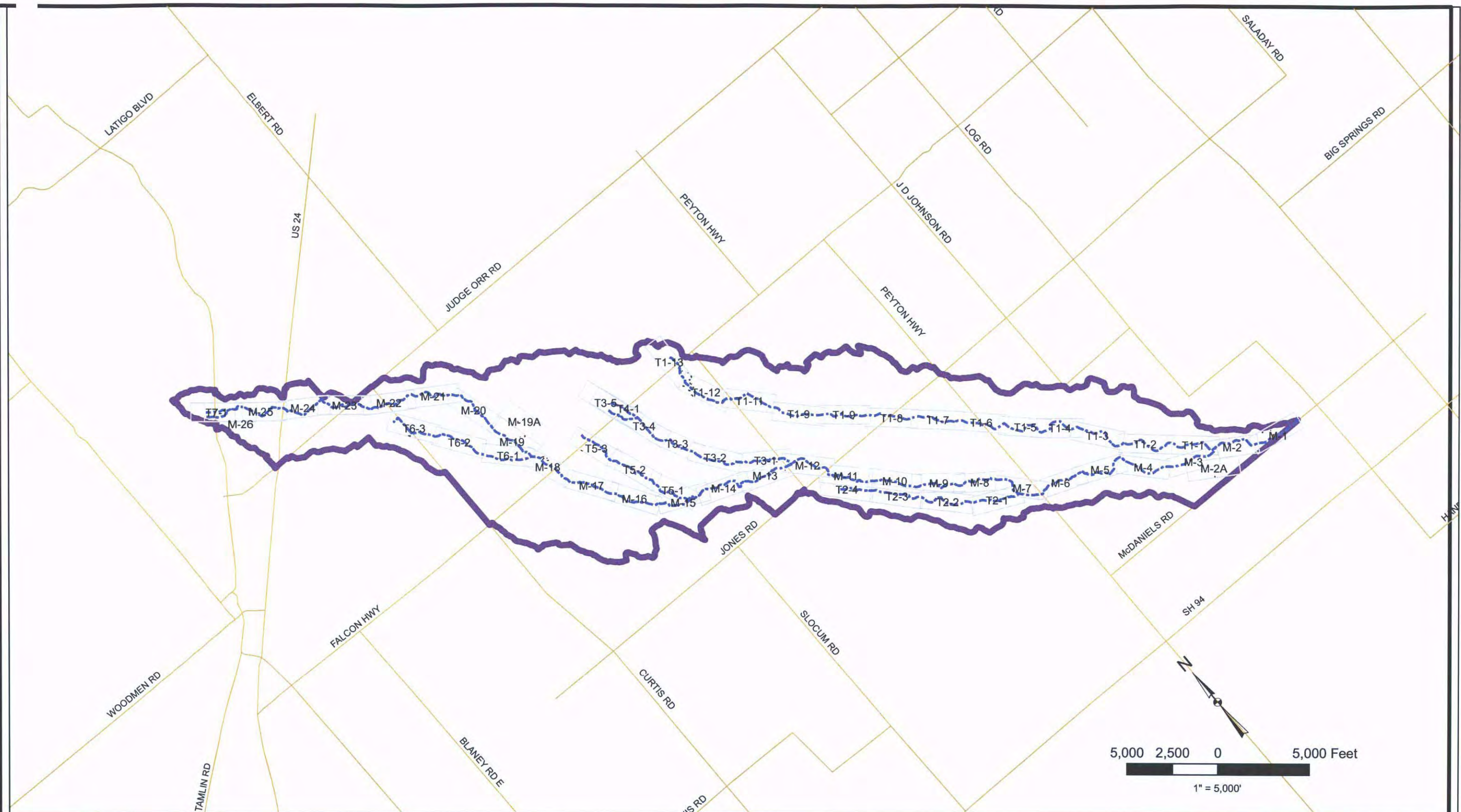


1,500 750 0 1,500  
 Feet  
 1" = 1,500'

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**HAEGLER RANCH DRAINAGE BASIN**  
**FACILITY INVENTORY B**  
**FIGURE 5-3**





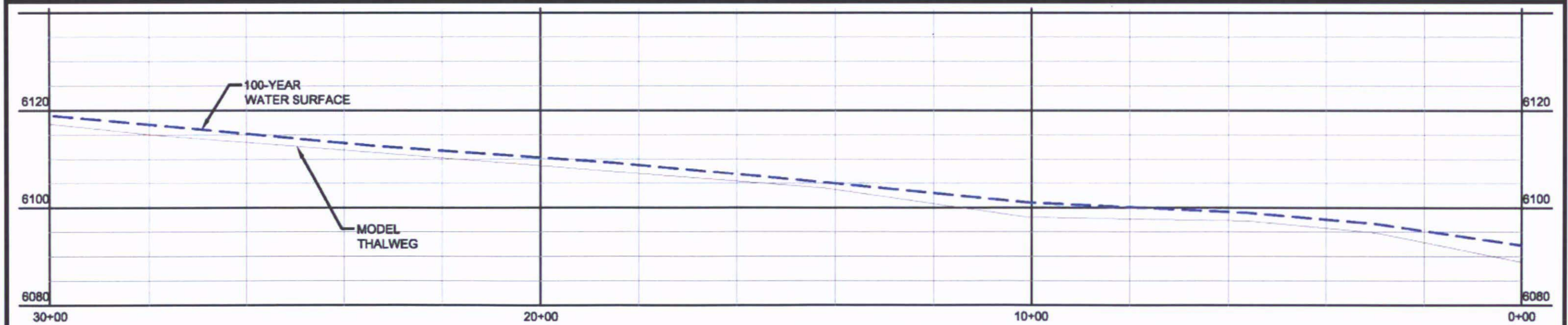
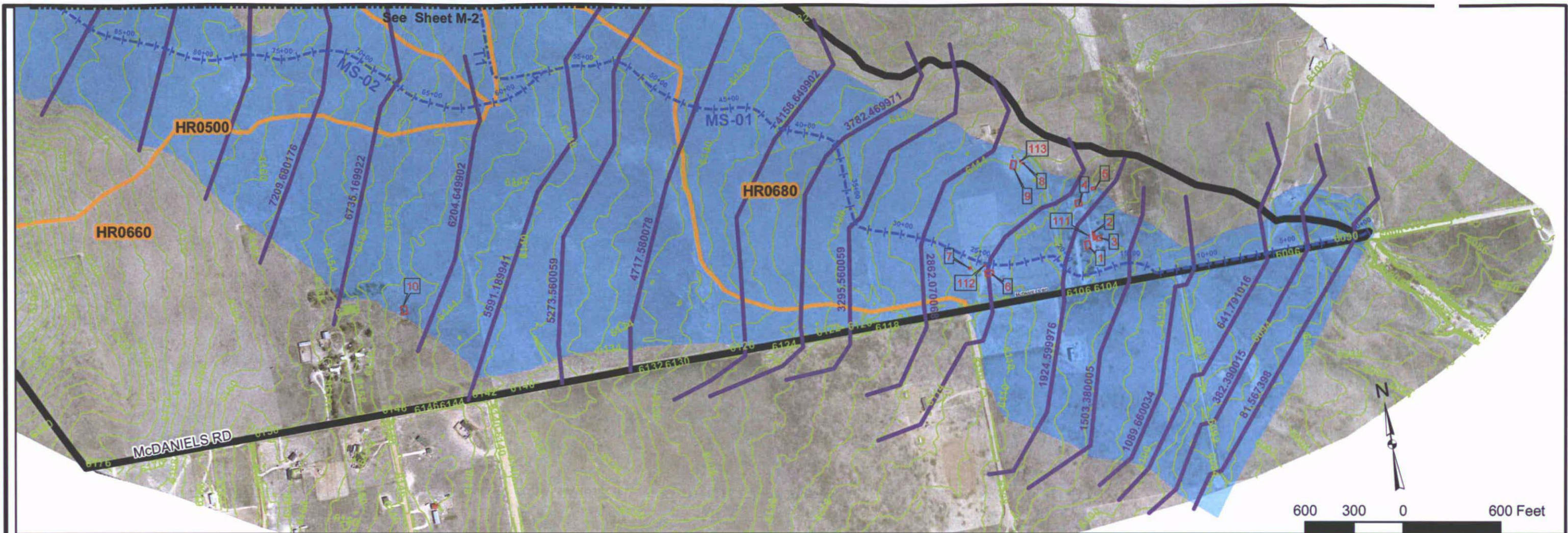
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**HAEGLER RANCH DRAINAGE BASIN**  
**100-YEAR FLOOD LIMITS**  
**SHEET INDEX**  
**FIGURE 5-4**





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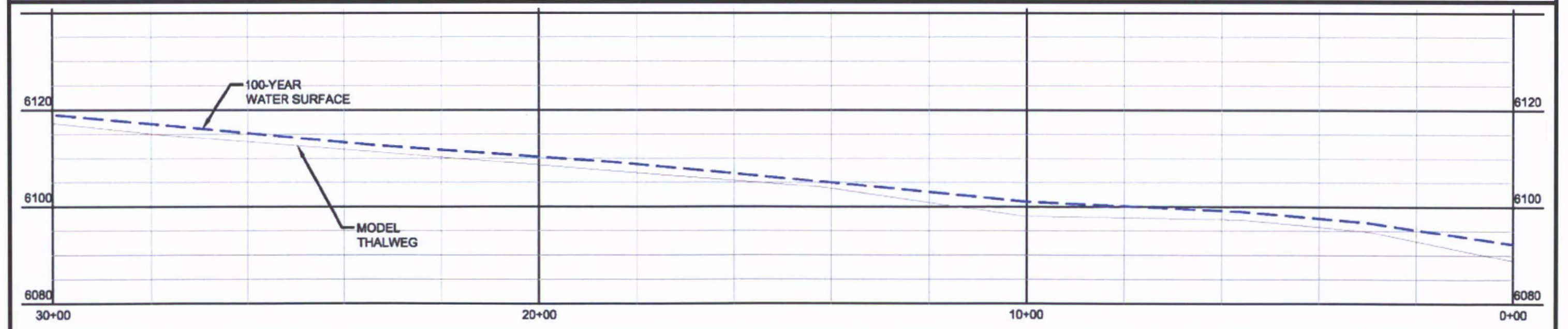
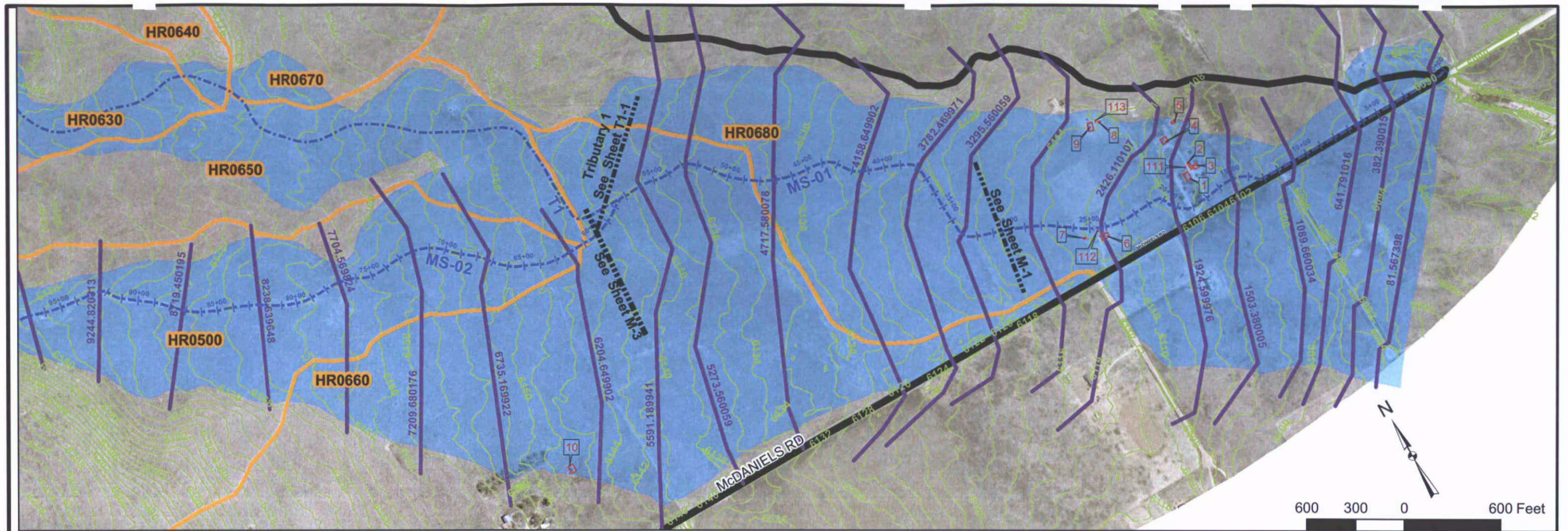


- |                                 |                |
|---------------------------------|----------------|
| Haegler Basin Boundary          | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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





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Haegler Basin Boundary

Thalweg

Subbasin Boundaries

Cross Sections

Approximate 100-Year Floodplain

2' Contours

**HAEGLER RANCH DRAINAGE BASIN**

**APPROXIMATE 100-YEAR FLOOD LIMITS**

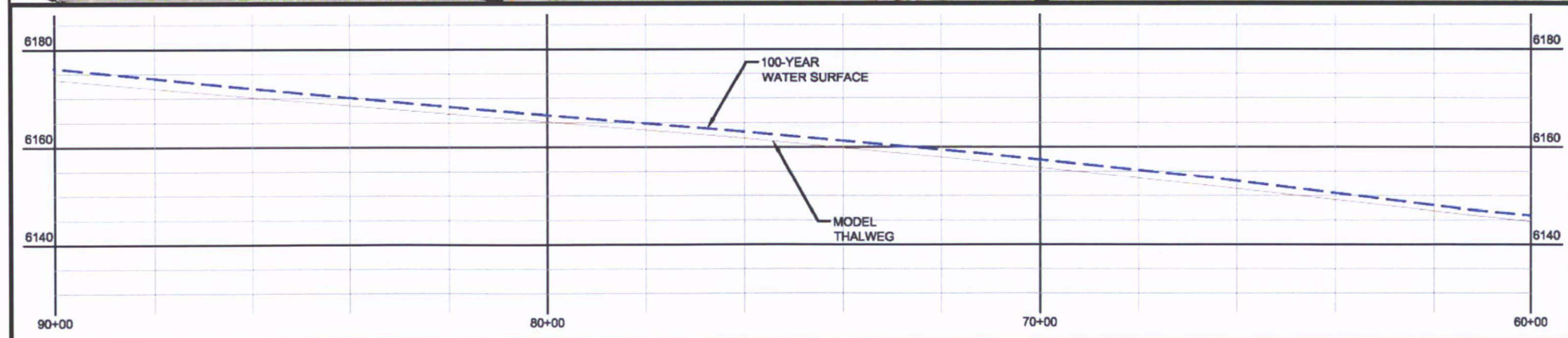
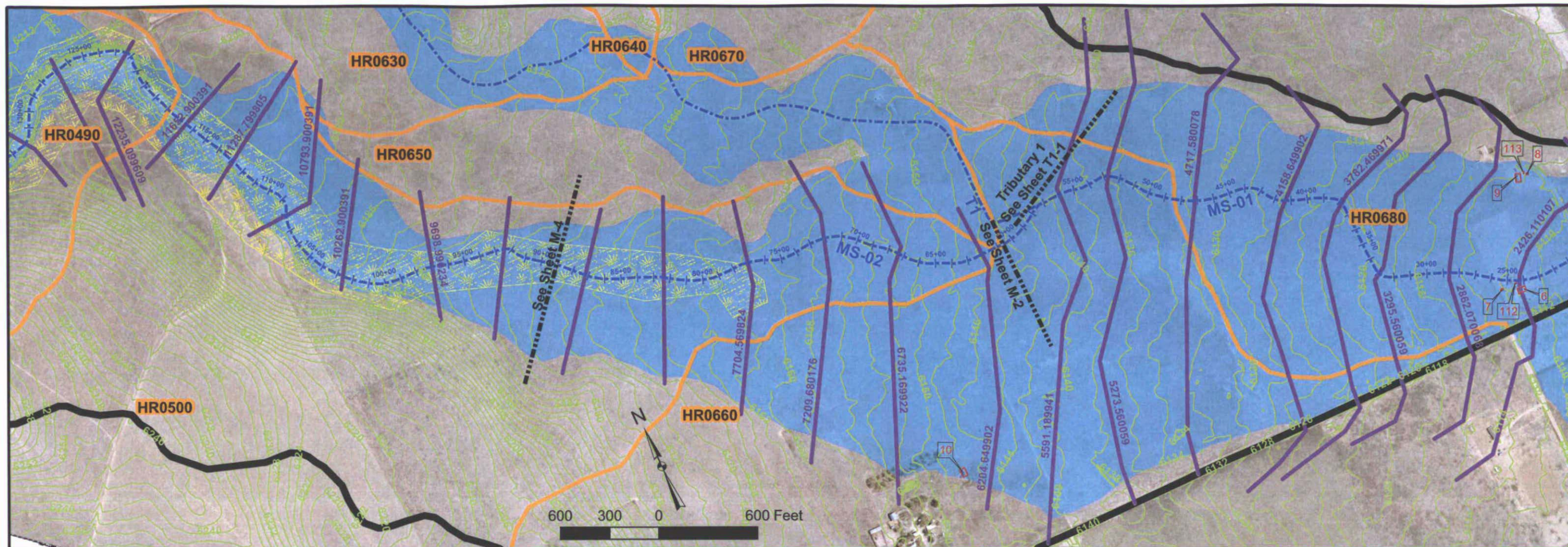
**SHEET M-2**

**FIGURE 5-4**

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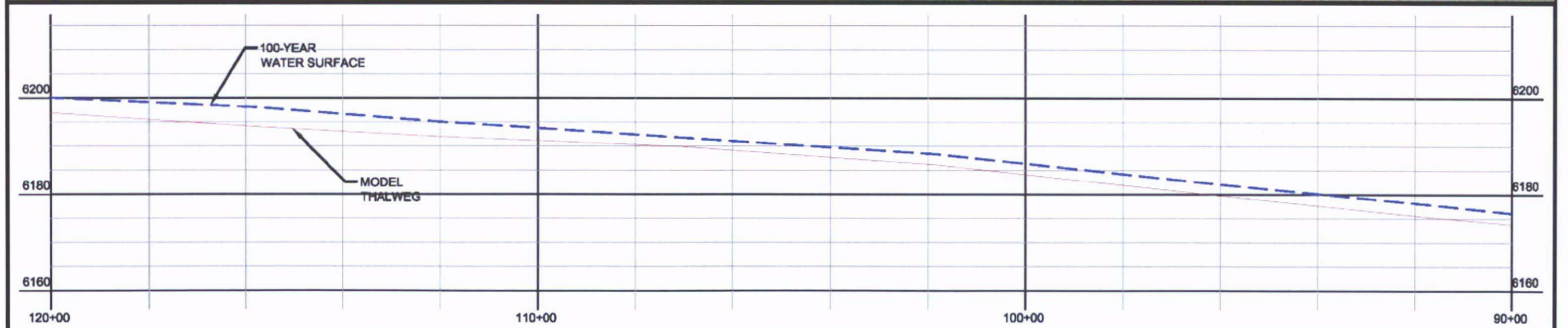
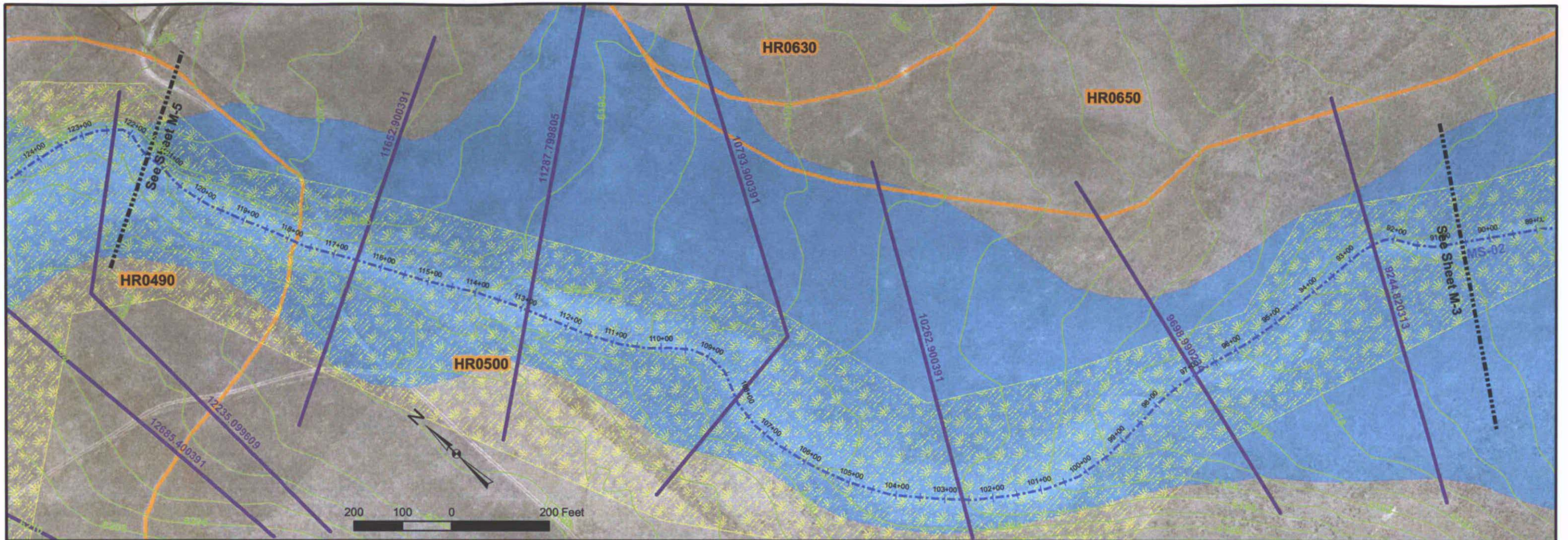
Haegler Basin Boundary	Thalweg
Subbasin Boundaries	Cross Sections
Approximate 100-Year Floodplain	2' Contours

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

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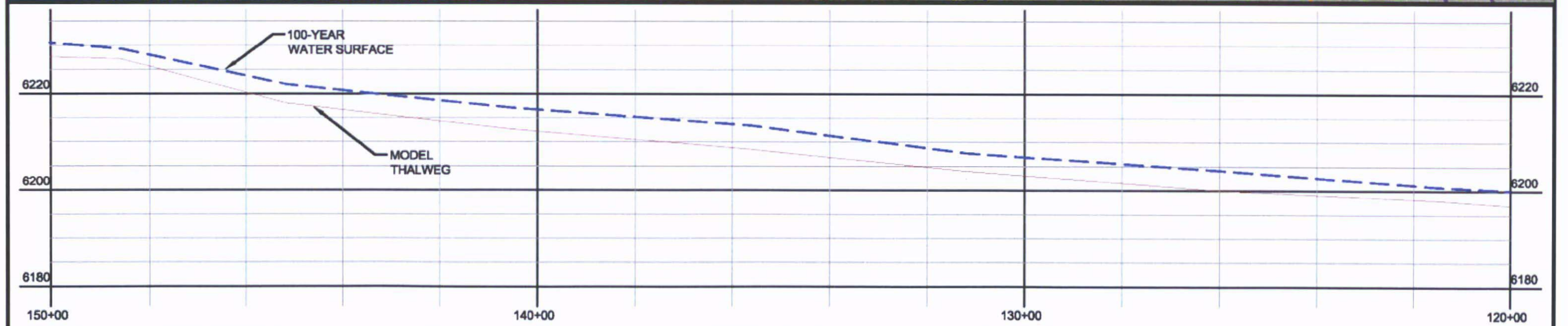
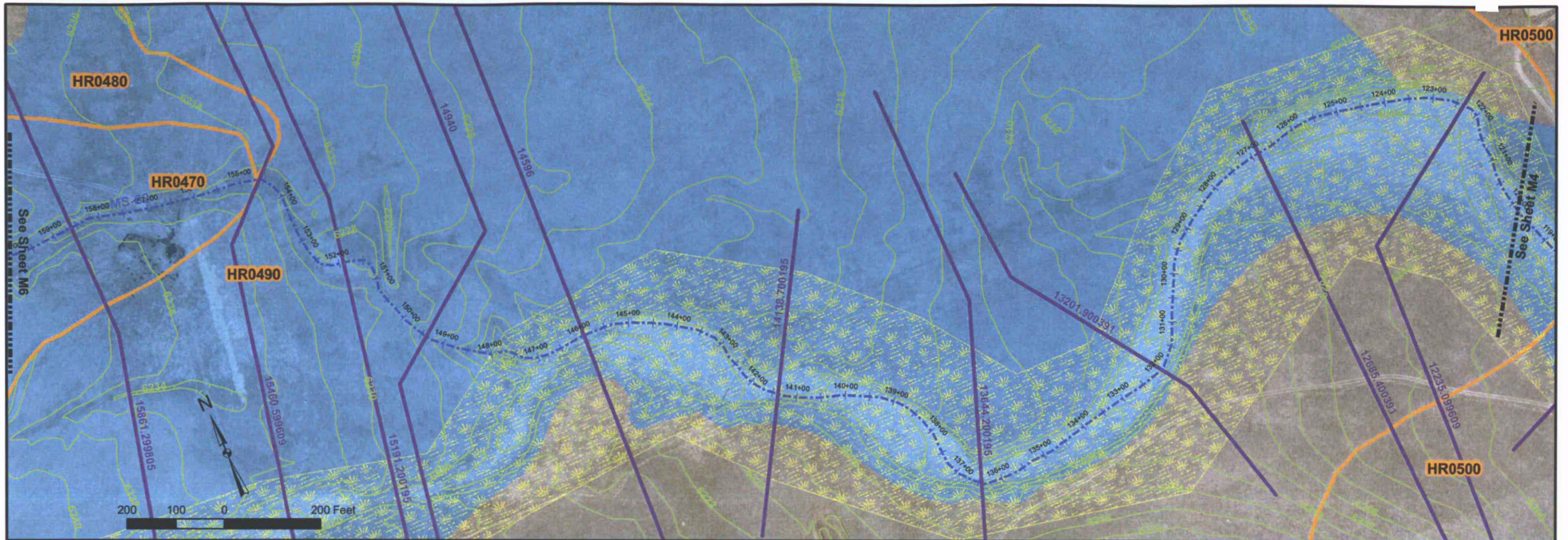
Potential Wetlands	Thalweg
Subbasin Boundaries	Cross Sections
Approximate 100-Year Floodplain	2' Contours

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-4**  
**FIGURE 5-4**

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Potential Wetlands

Subbasin Boundaries

Approximate 100-Year Floodplain

Thalweg

Cross Sections

2' Contours

**HAEGLER RANCH DRAINAGE BASIN**

**APPROXIMATE 100-YEAR FLOOD LIMITS**

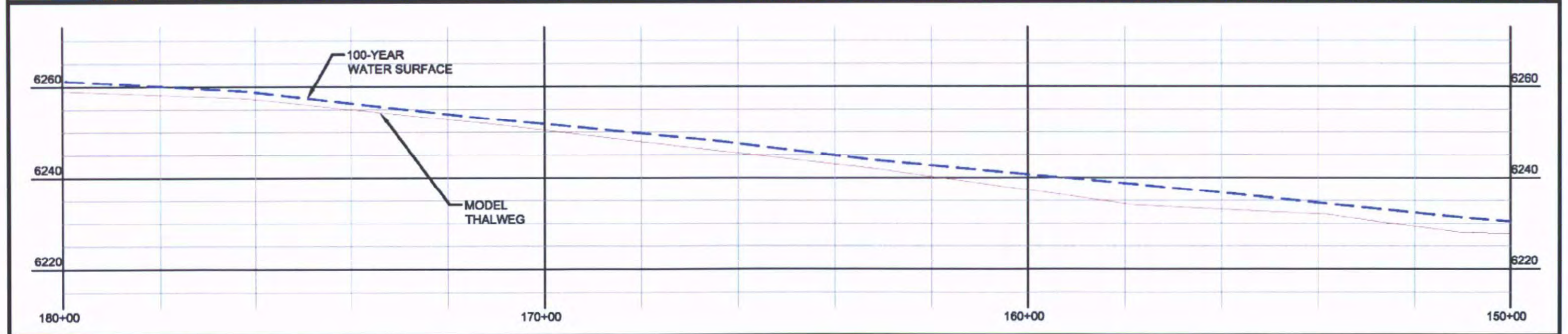
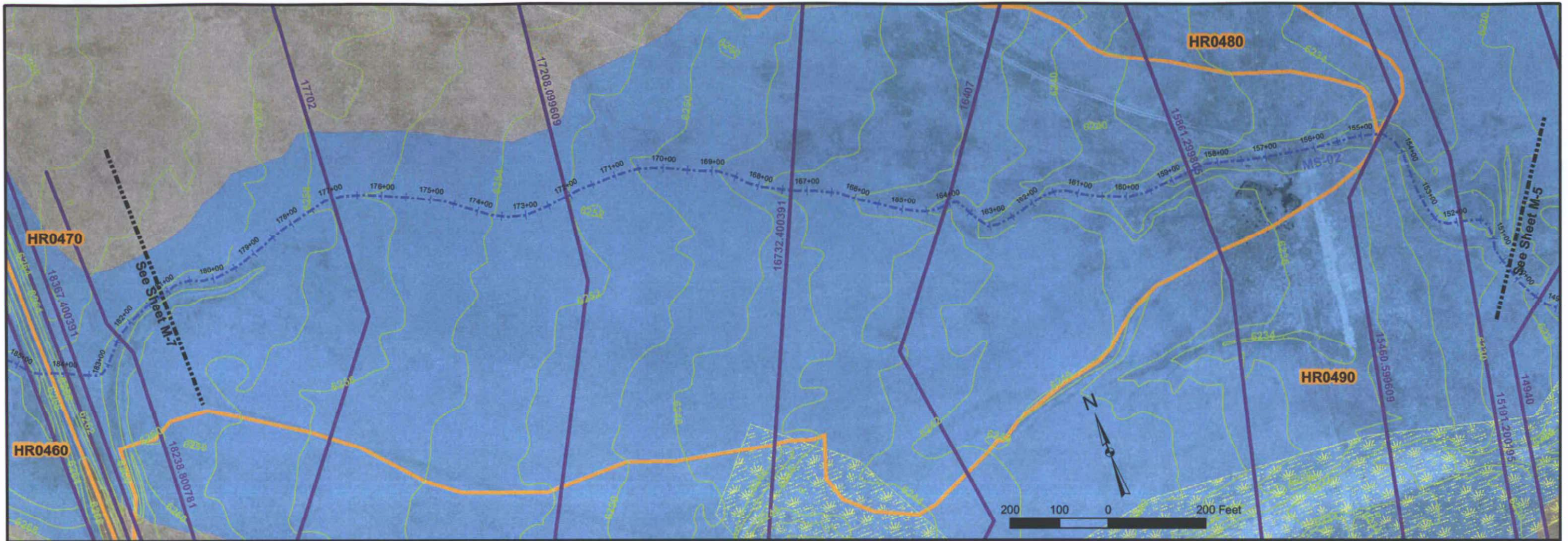
**SHEET M-5**

**FIGURE 5-4**

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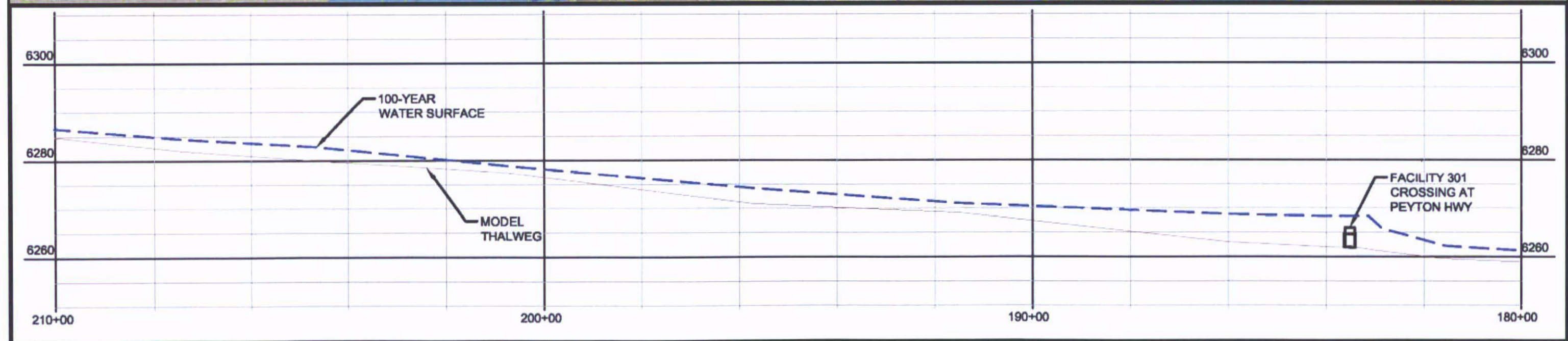
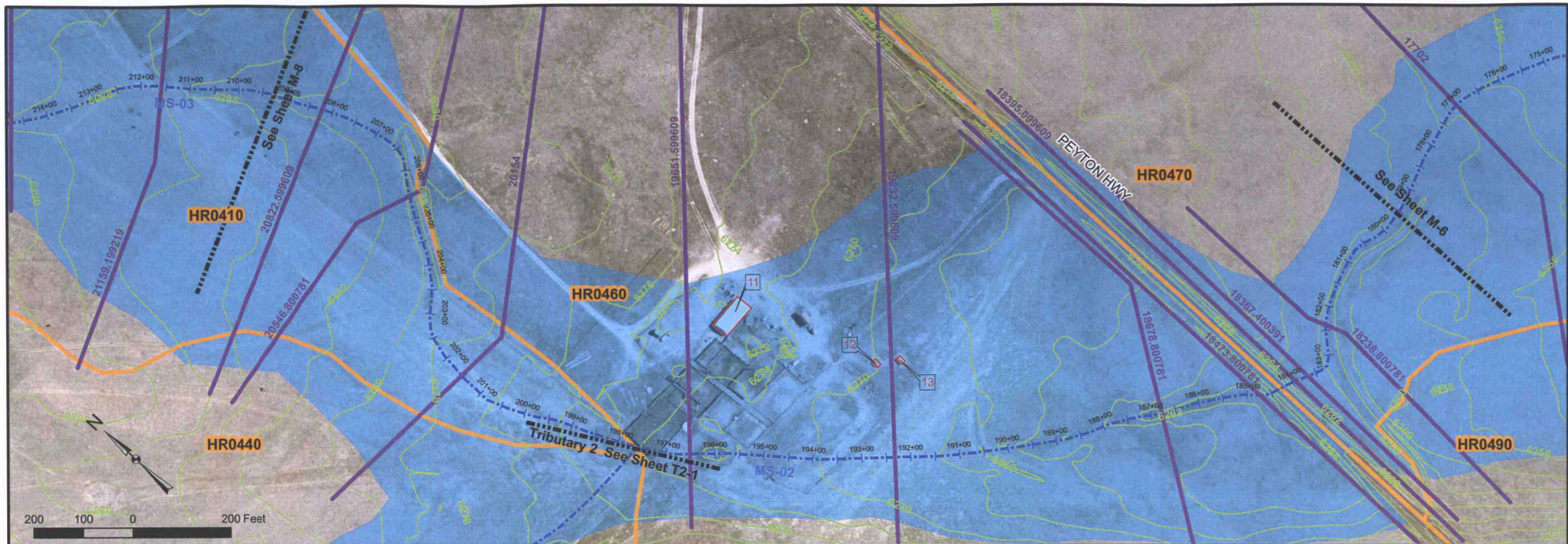


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-6**  
**FIGURE 5-4**





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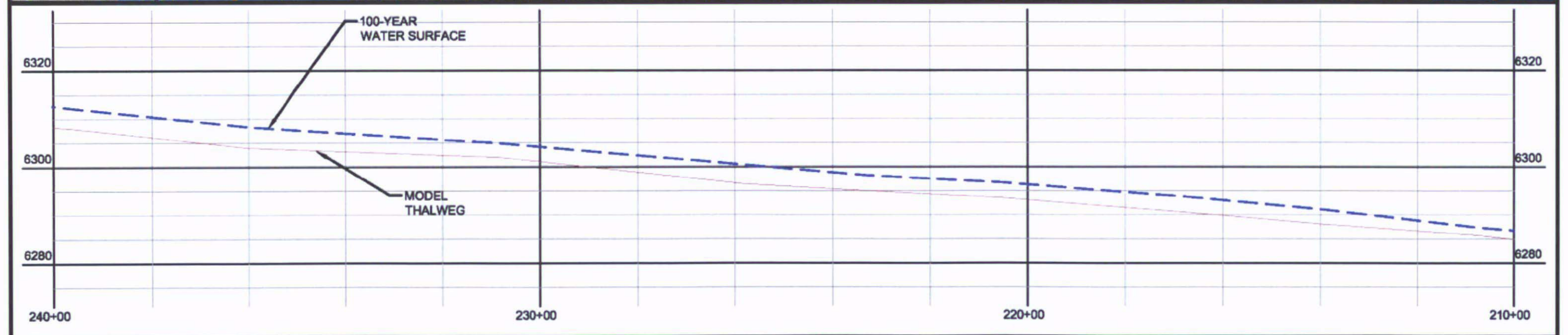
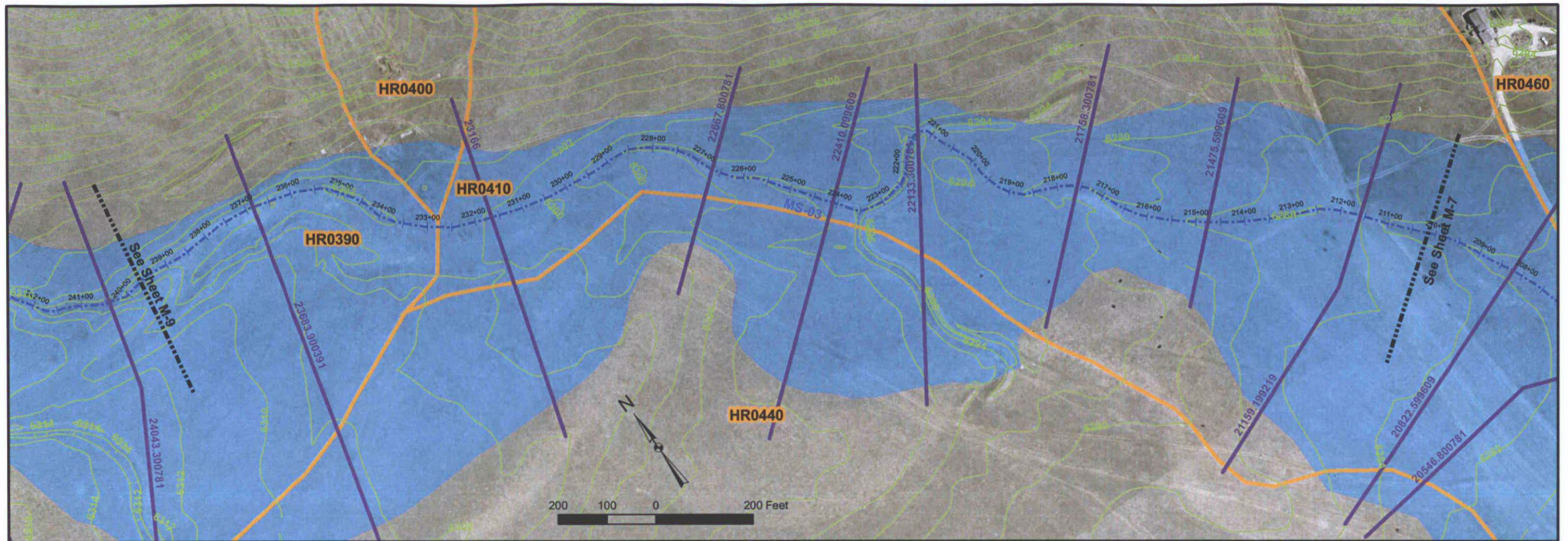


- Subbasin Boundaries
- Thalweg
- Approximate 100-Year Floodplain
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-7**  
**FIGURE 5-4**





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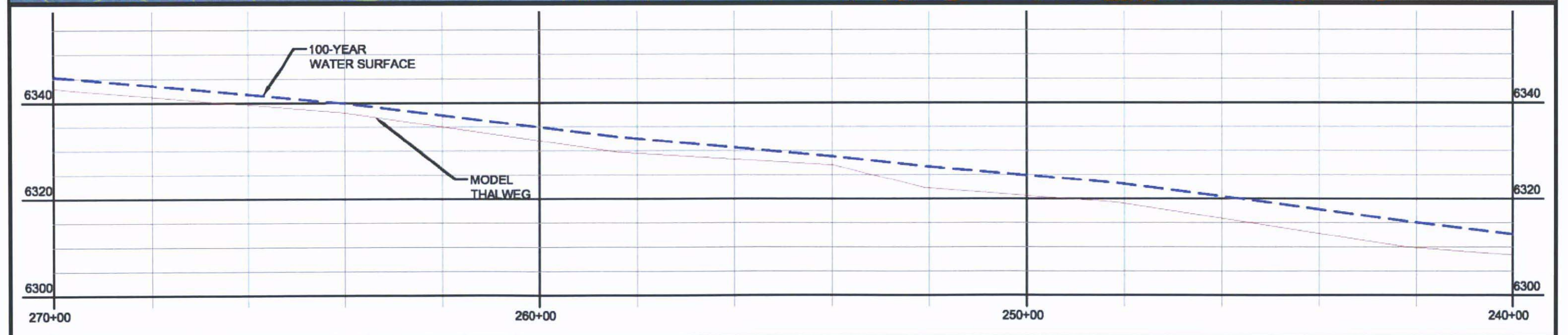
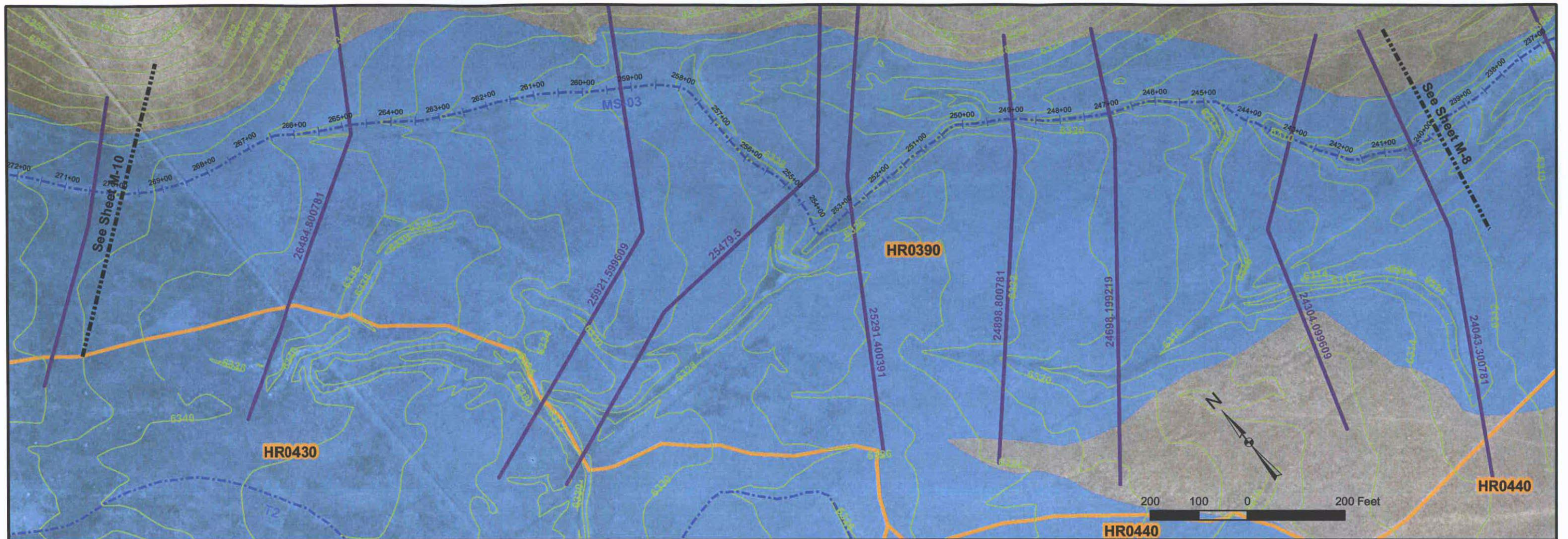


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-8**  
**FIGURE 5-4**





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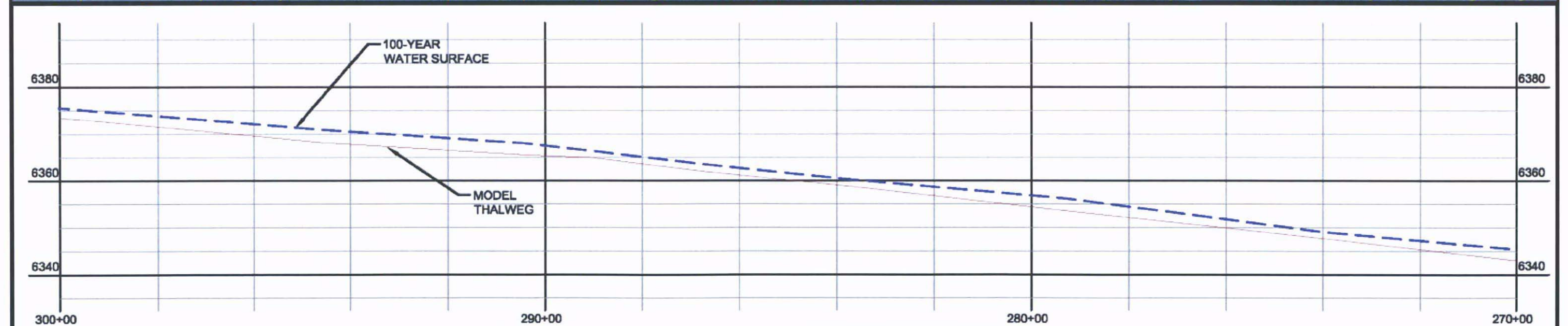
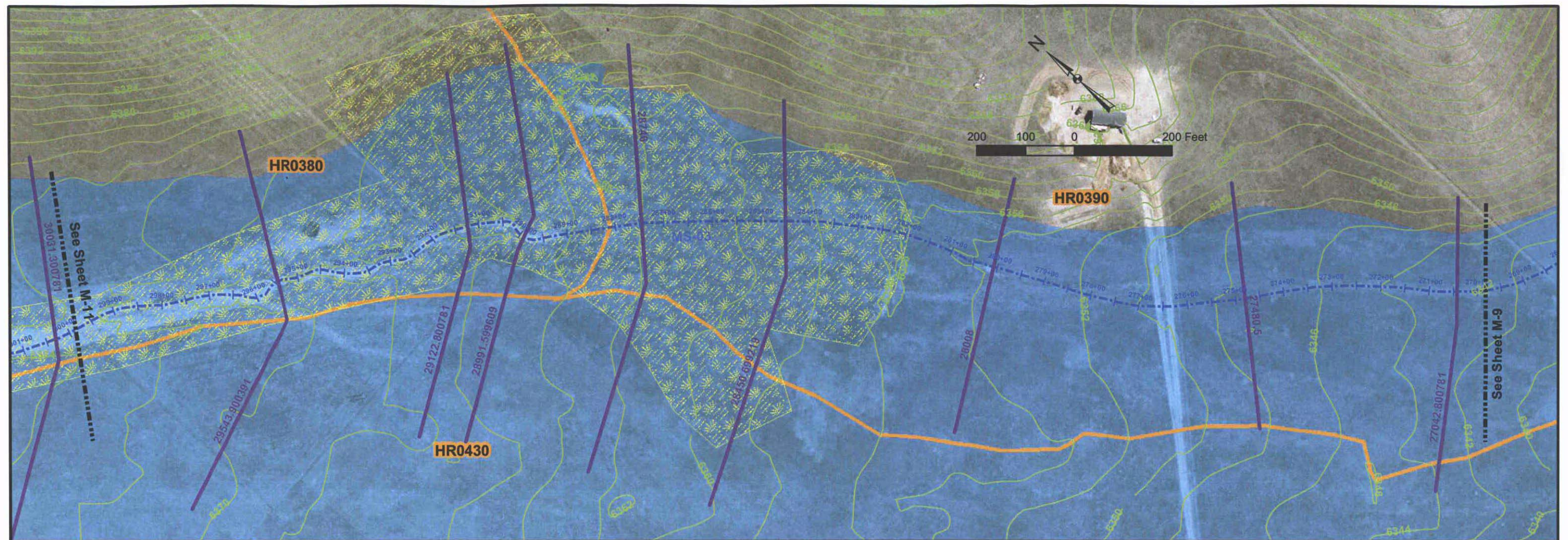


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-9**  
**FIGURE 5-4**





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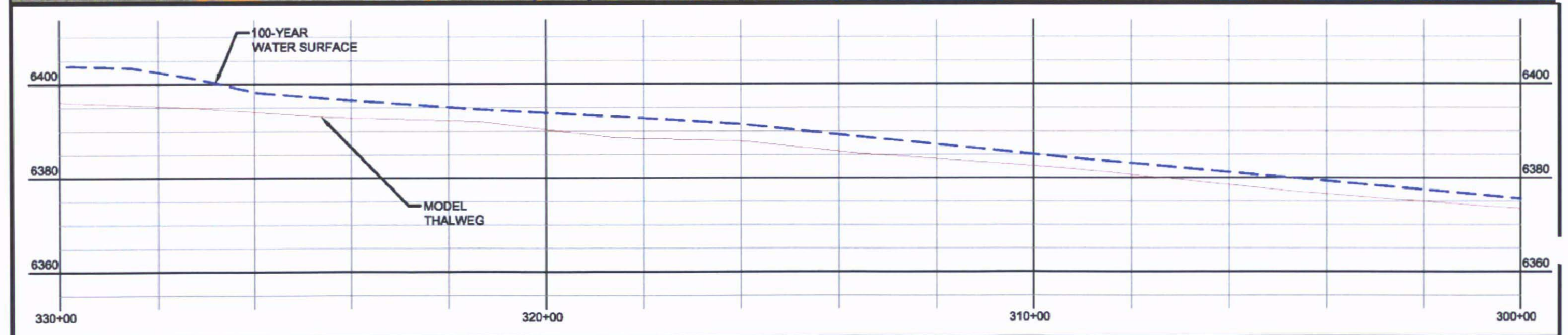
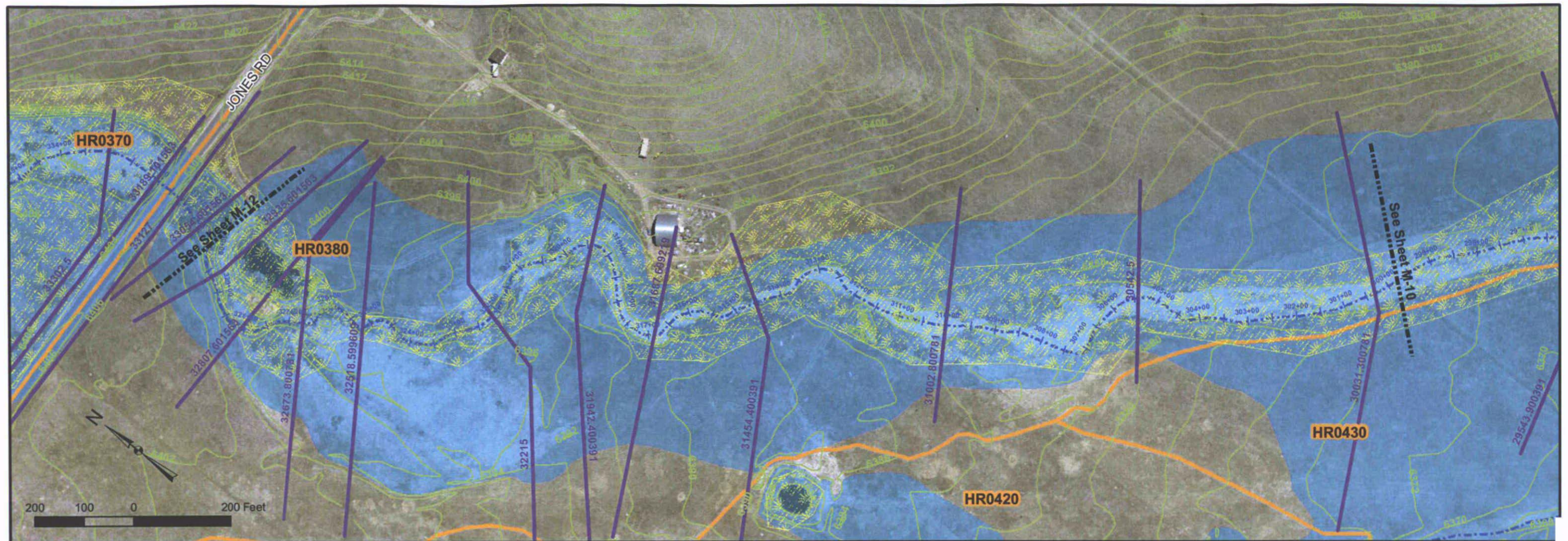


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-10**  
**FIGURE 5-4**





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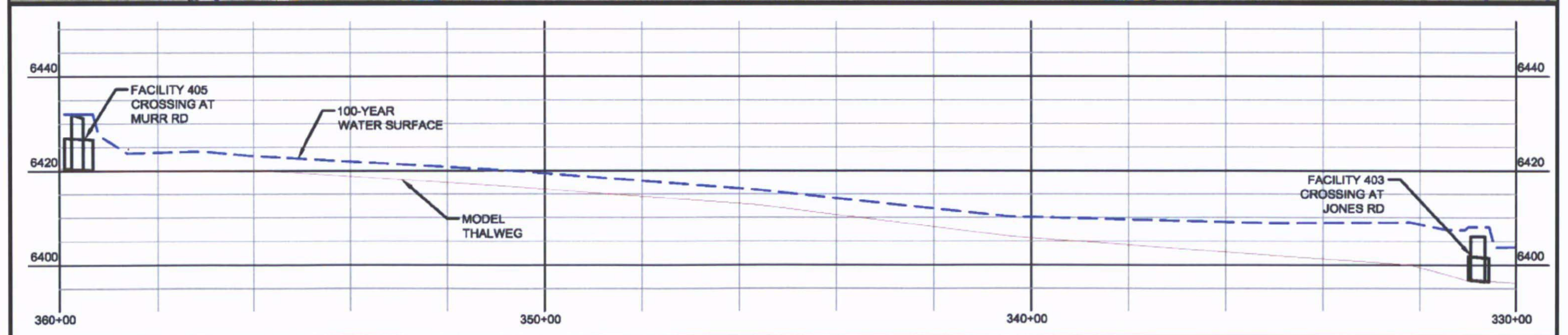
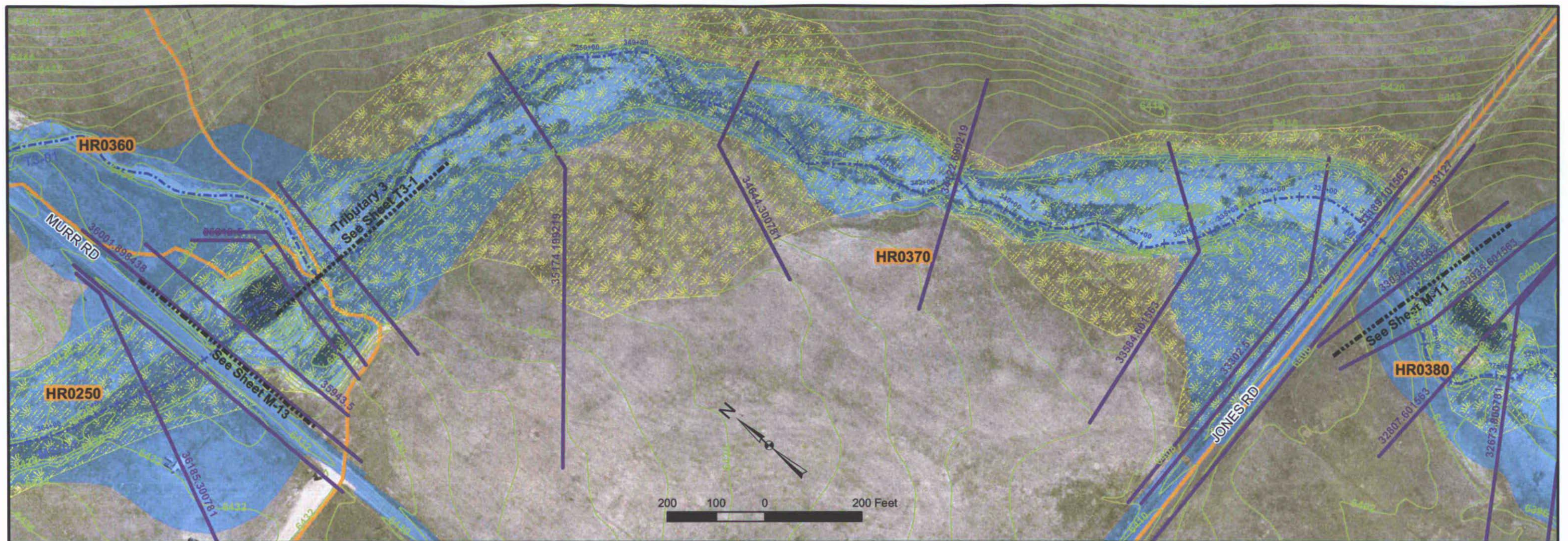


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-11**  
**FIGURE 5-4**





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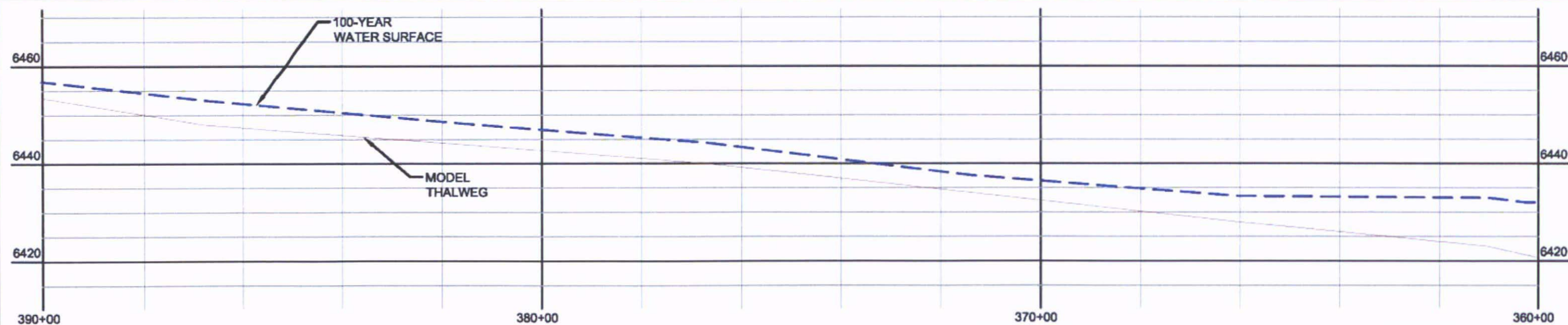
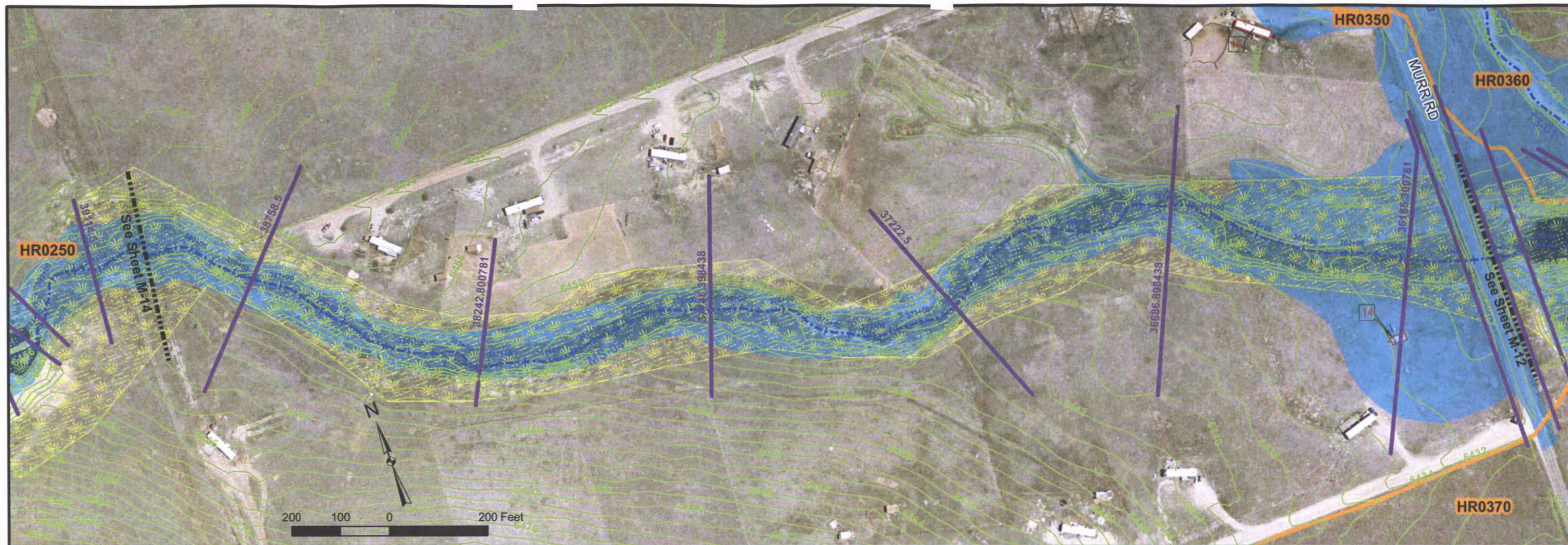


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-12**  
**FIGURE 5-4**





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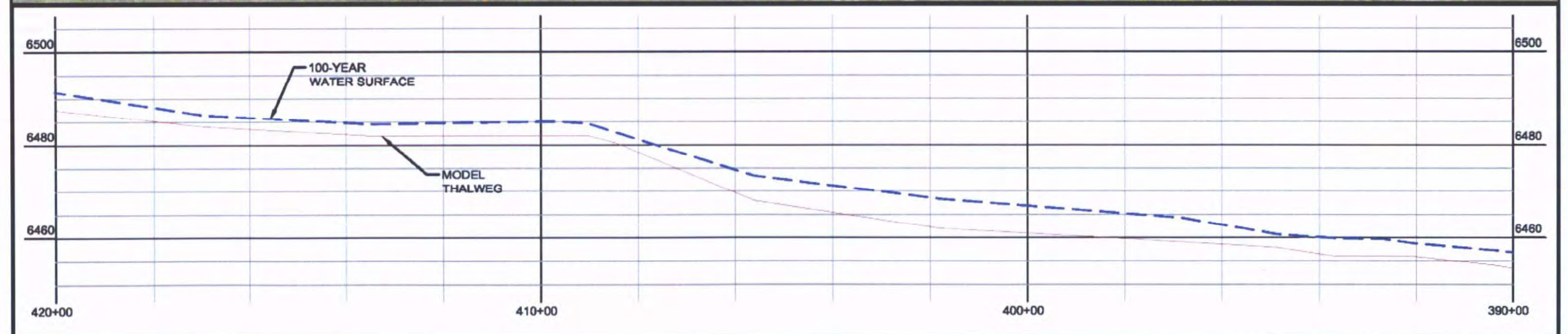
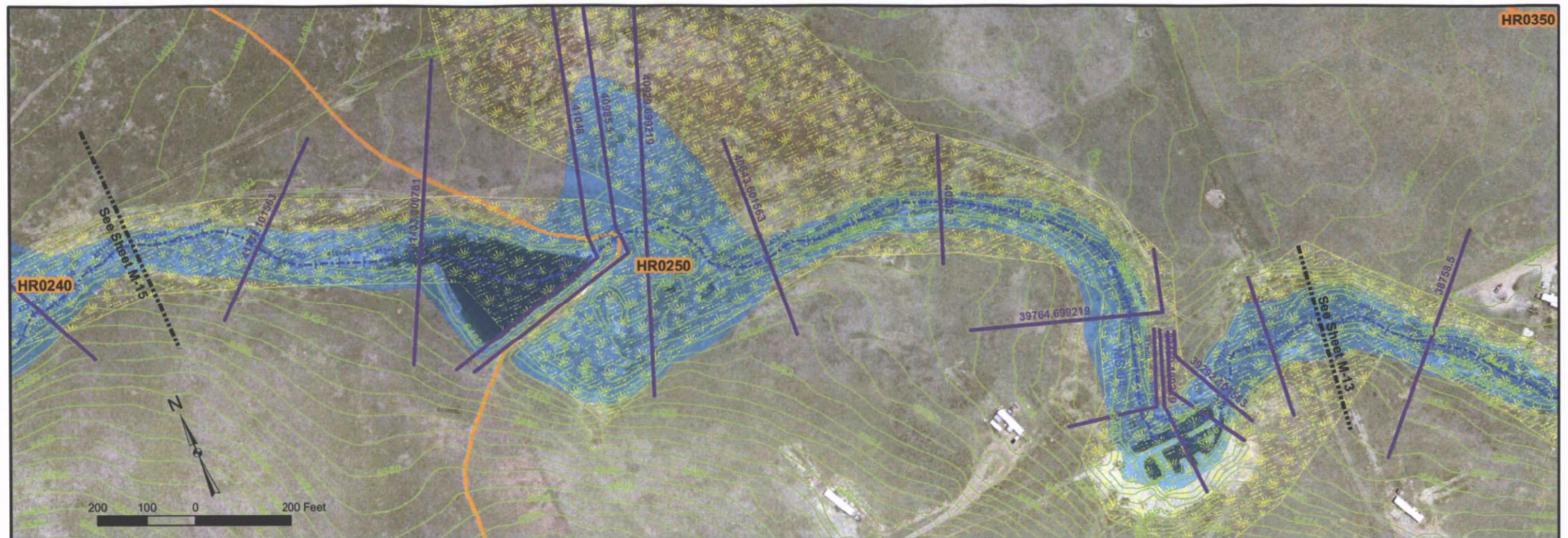


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-13**  
**FIGURE 5-4**





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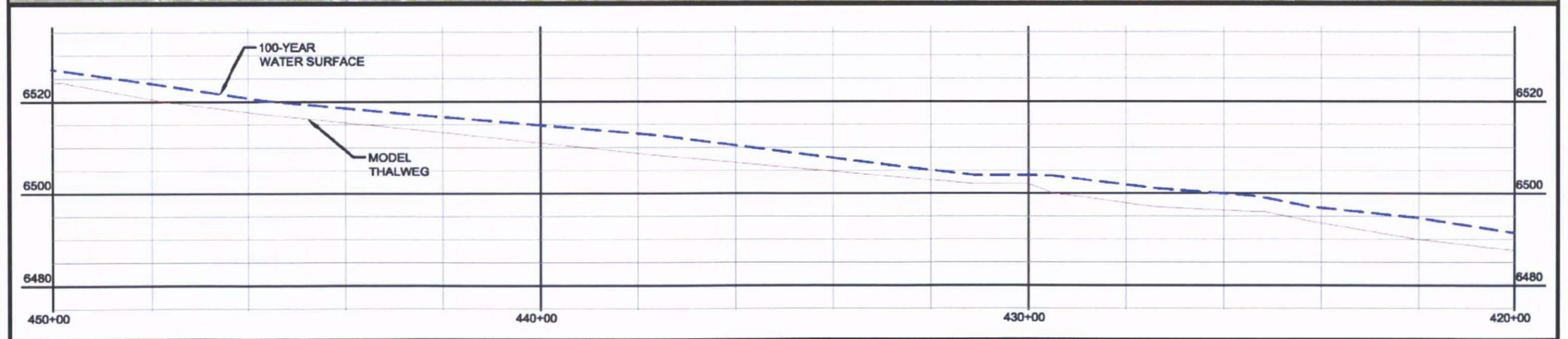
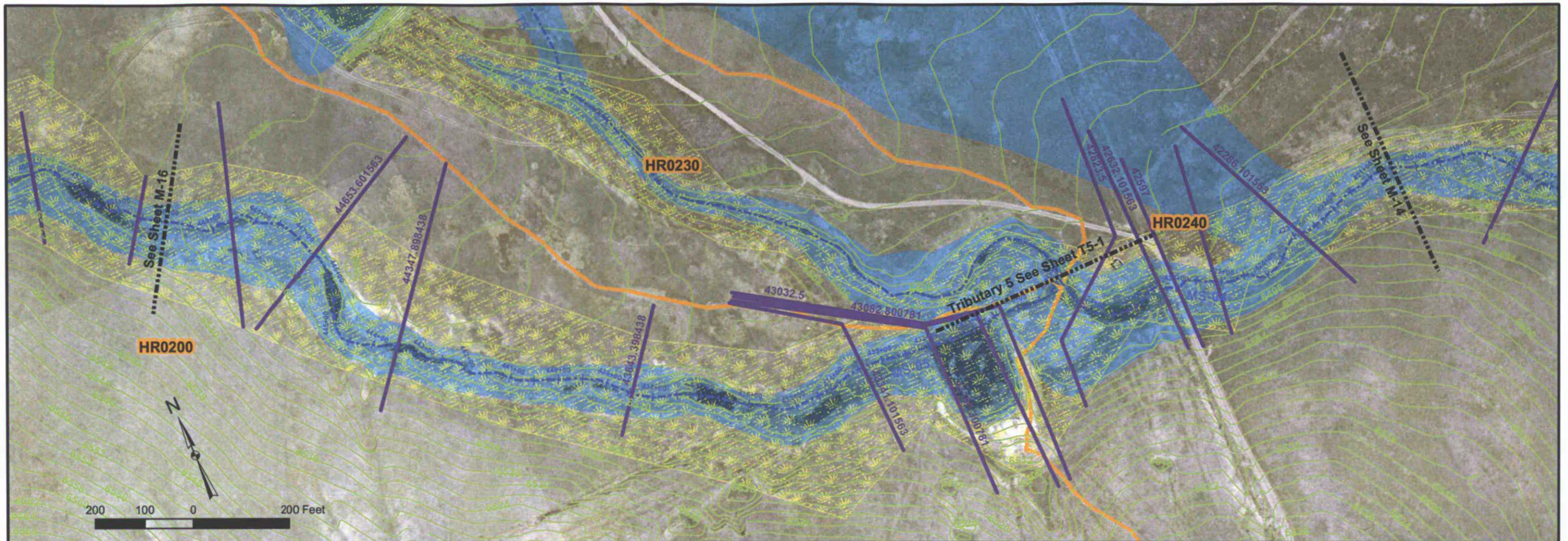


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-14**  
**FIGURE 5-4**





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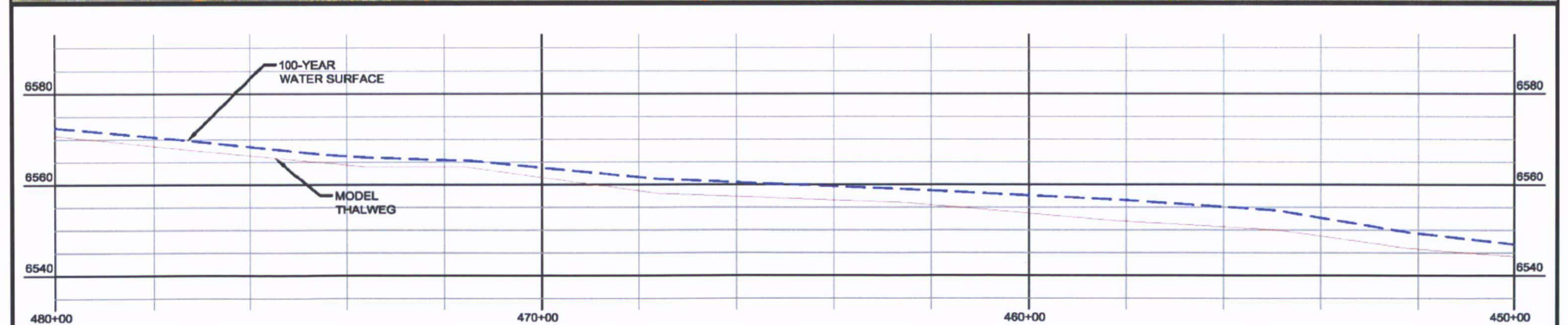
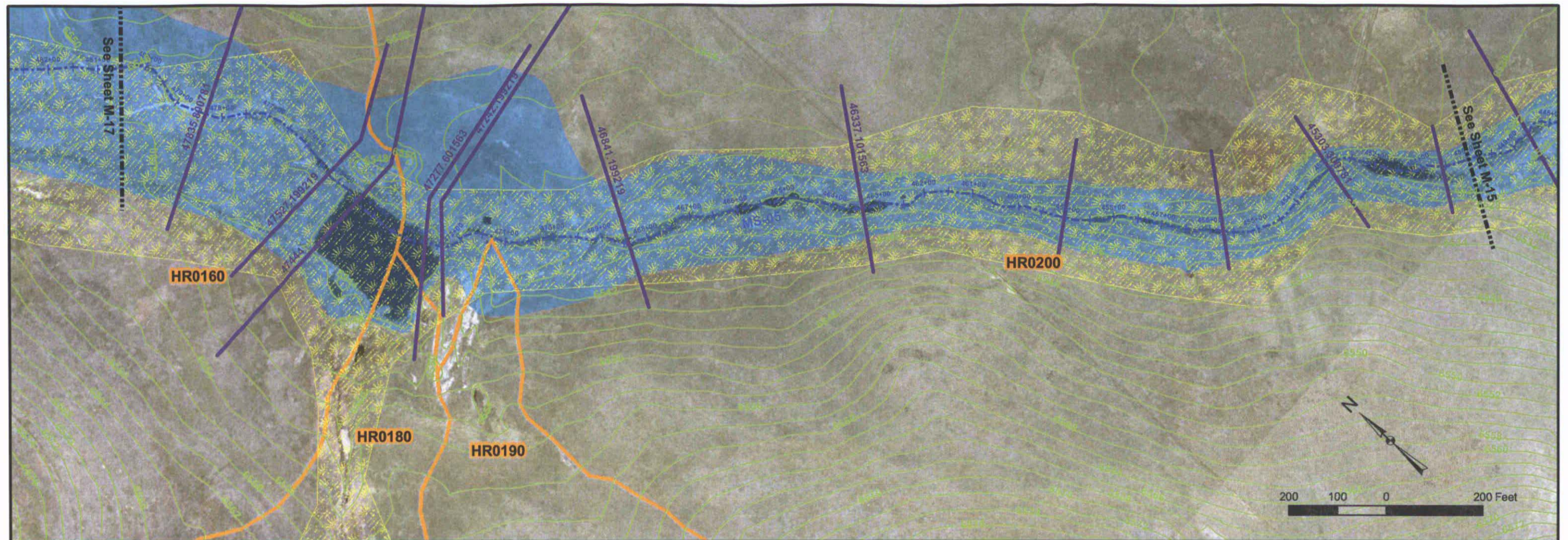


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-15**  
**FIGURE 5-4**





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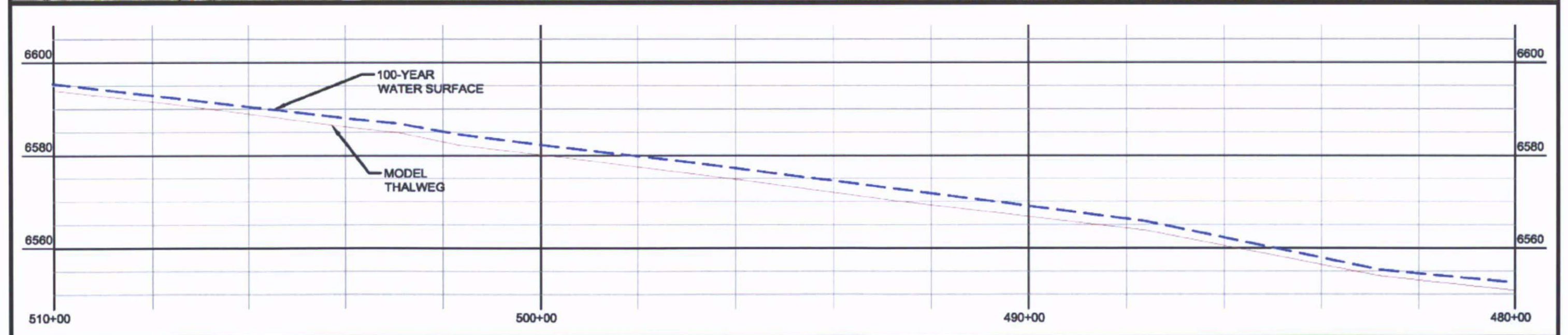
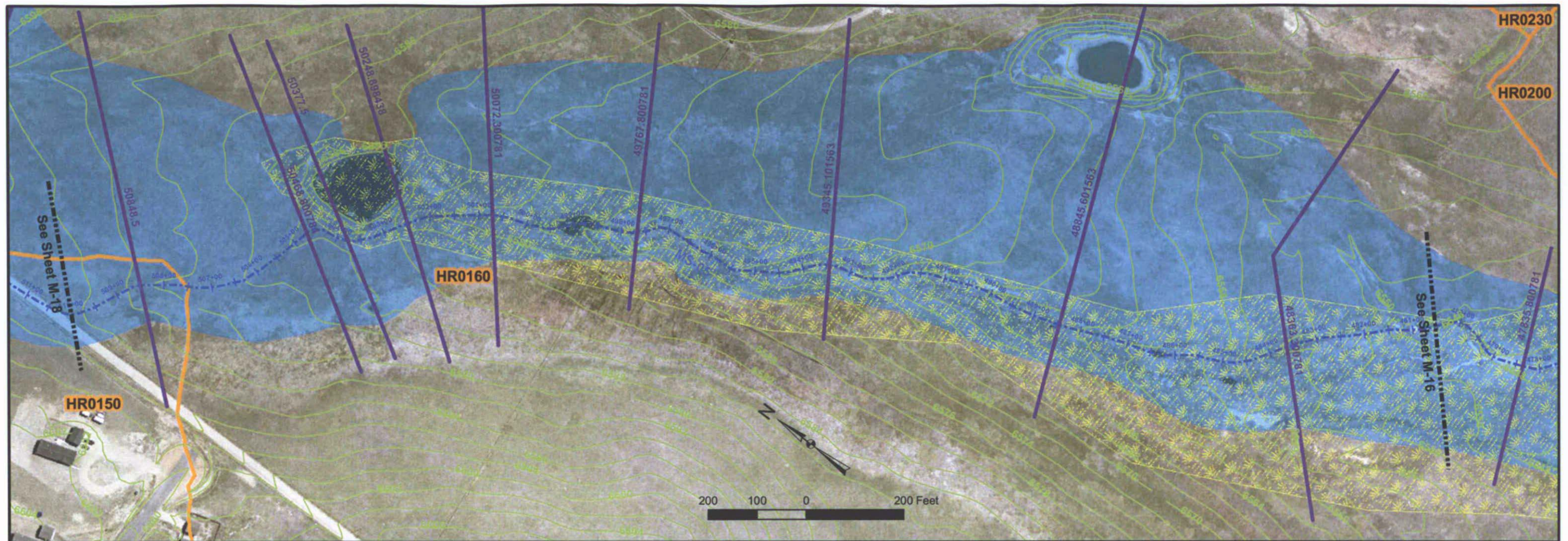


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-16**  
**FIGURE 5-4**





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Potential Wetlands



Subbasin Boundaries



Approximate 100-Year Floodplain

--- Thalweg

— Cross Sections

— 2' Contours

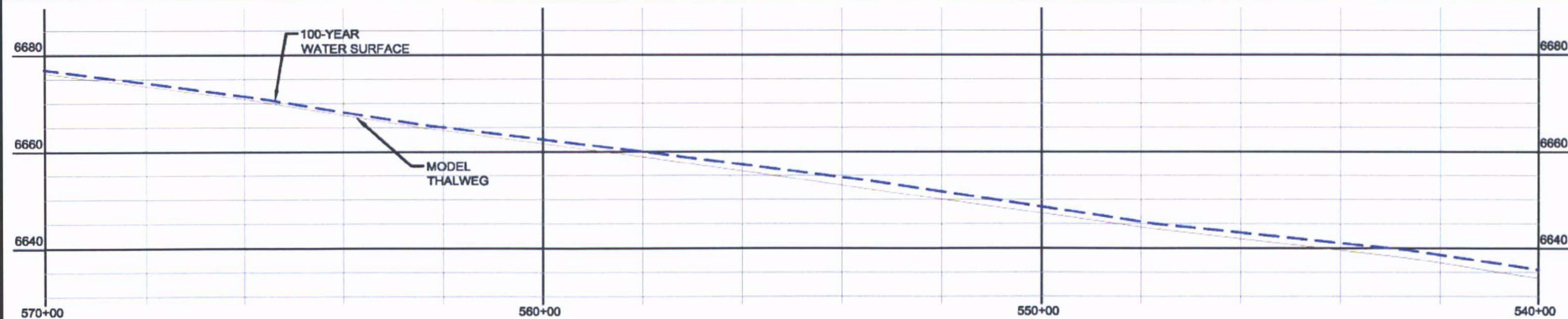
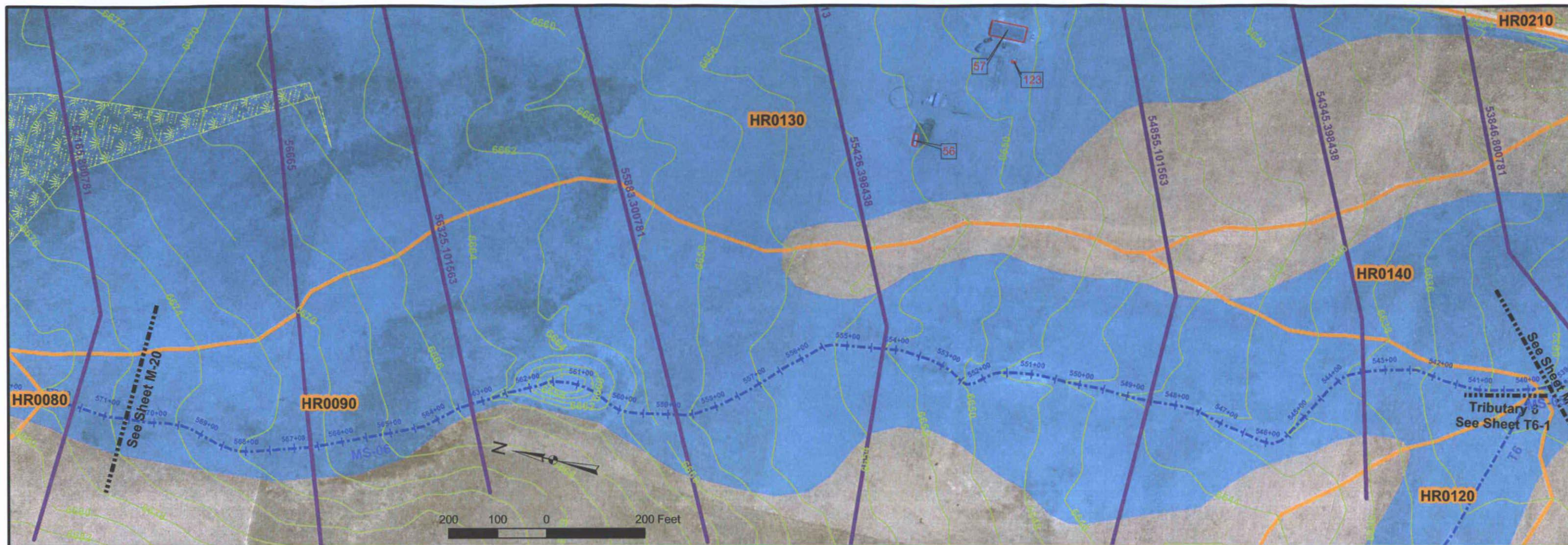
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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-17**  
**FIGURE 5-4**









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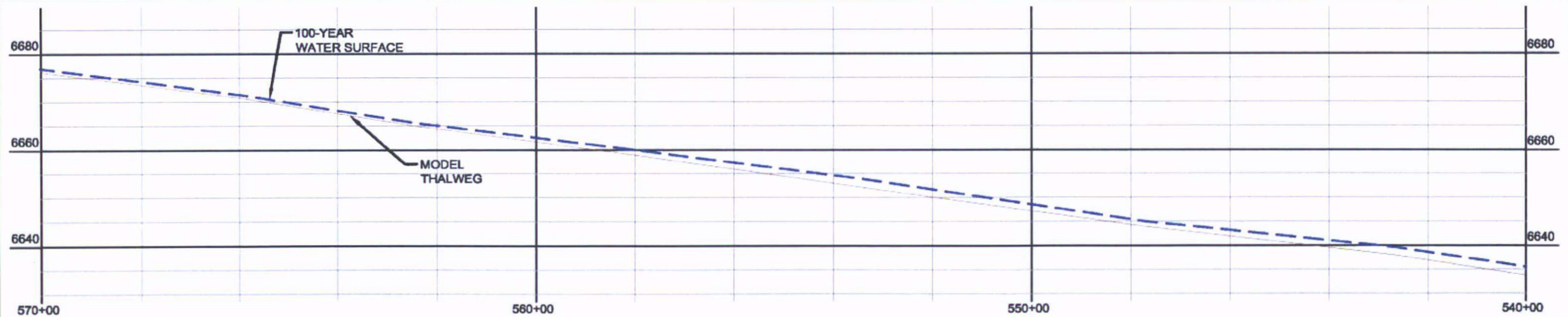
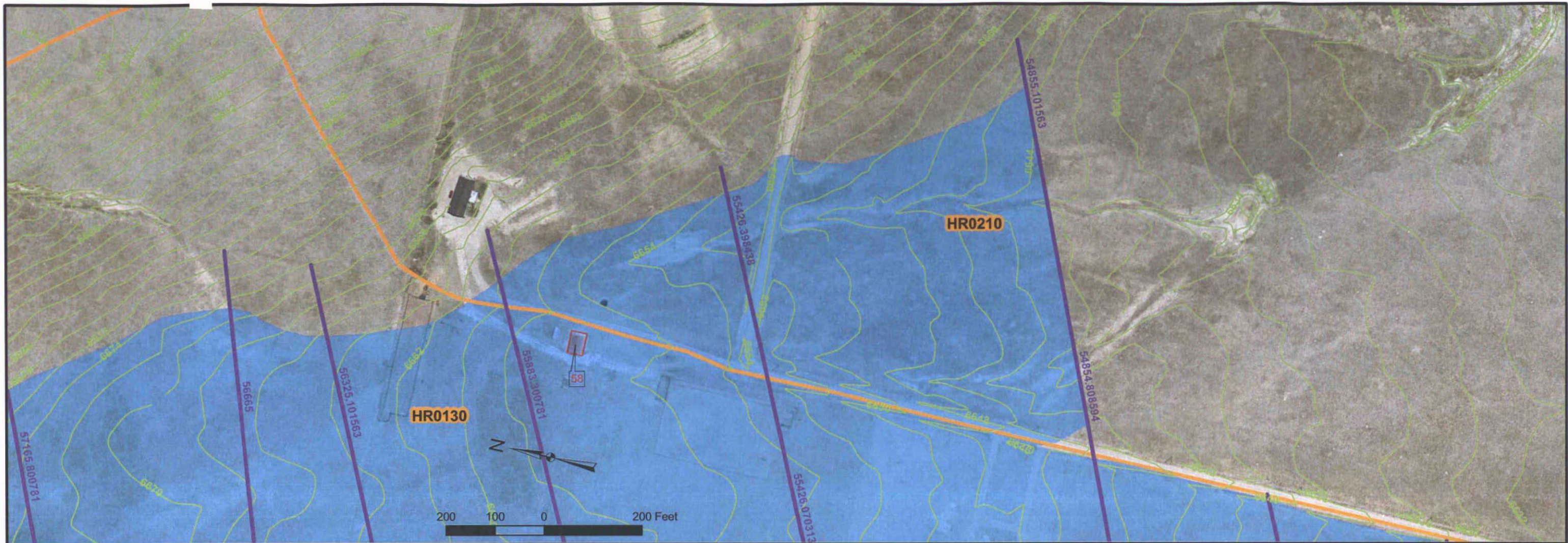


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-19**  
**FIGURE 5-4**





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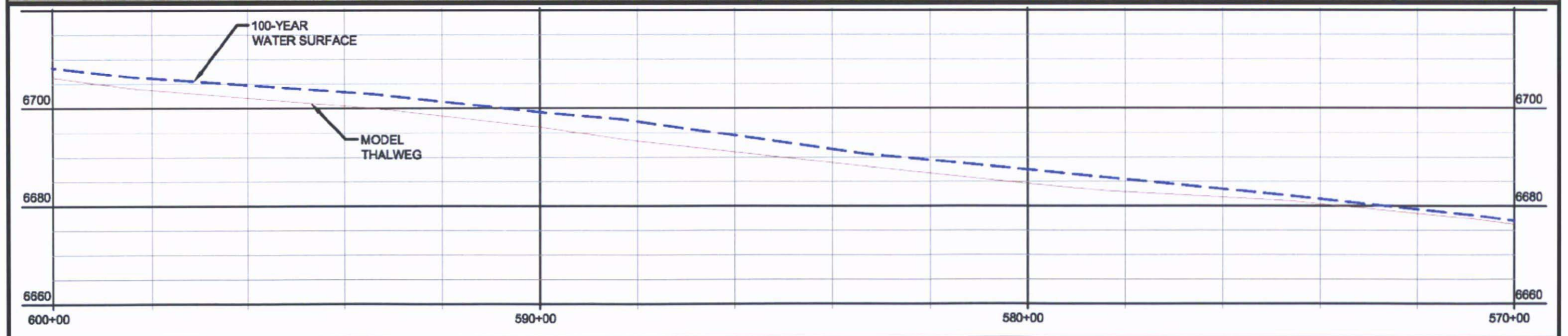
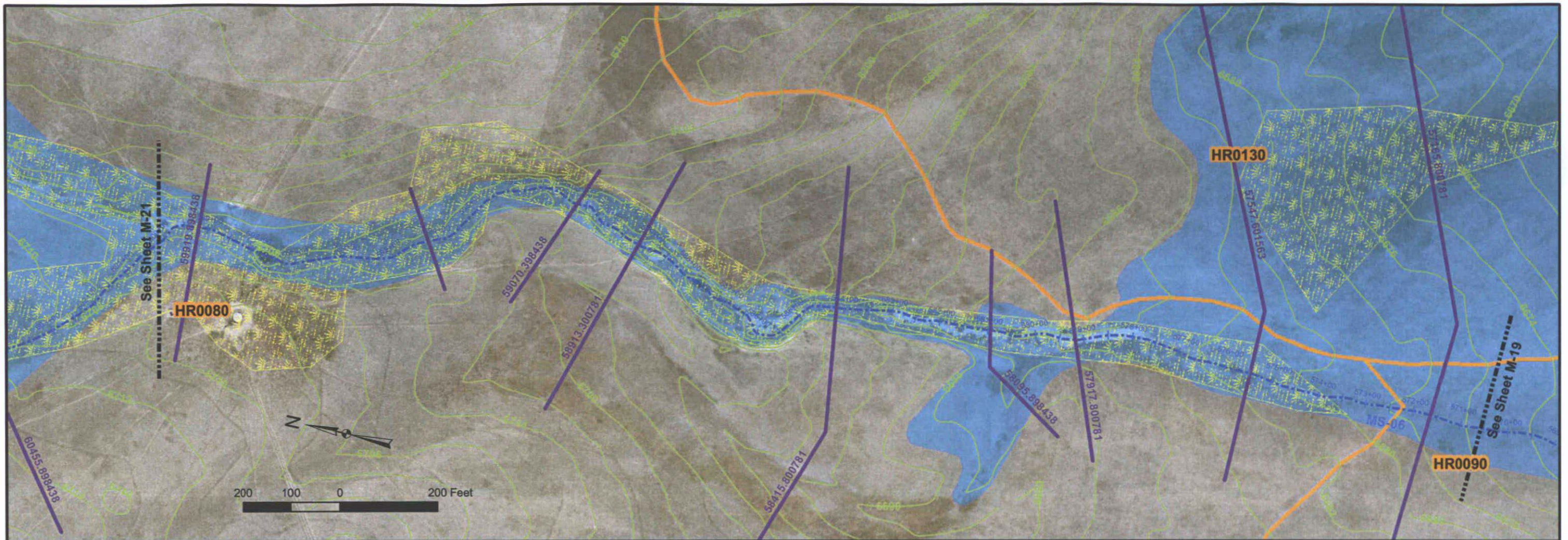


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-19A**  
**FIGURE 5-4**





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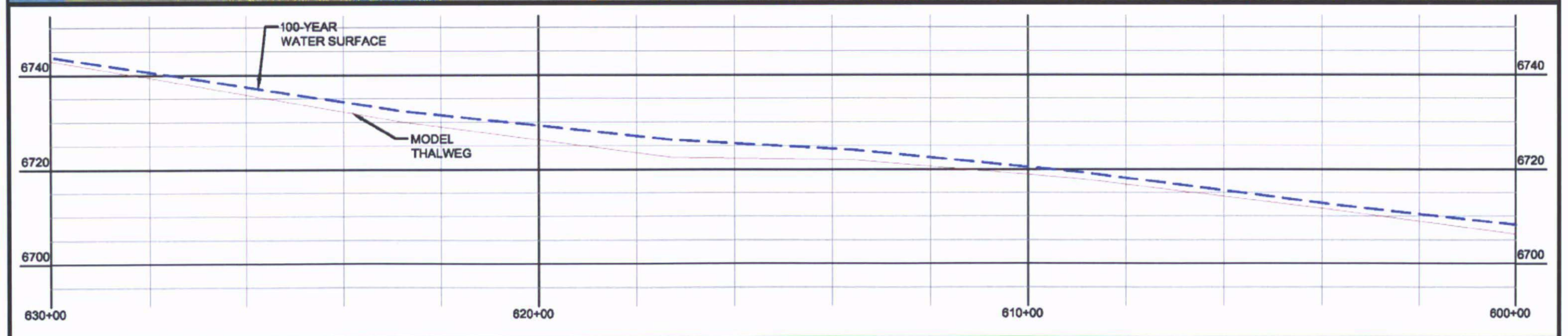
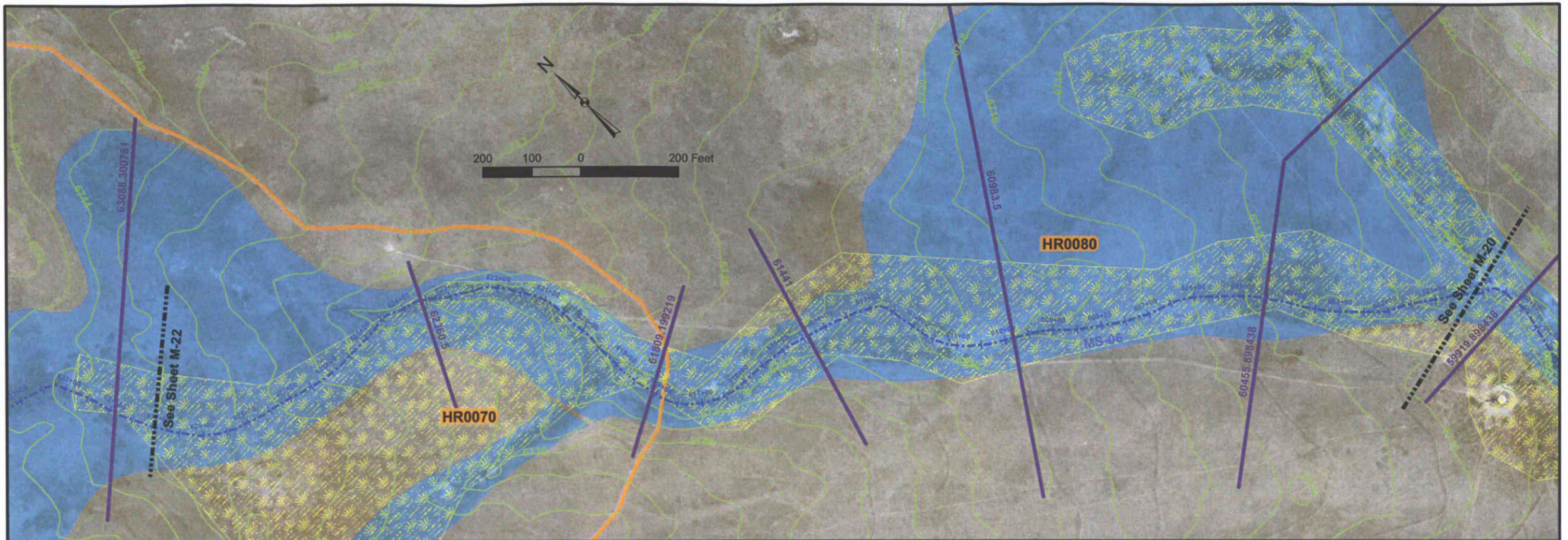
Potential Wetlands	Thalweg
Subbasin Boundaries	Cross Sections
Approximate 100-Year Floodplain	2' Contours

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-20**  
**FIGURE 5-4**

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Potential Wetlands

Subbasin Boundaries

Approximate 100-Year Floodplain

Thalweg

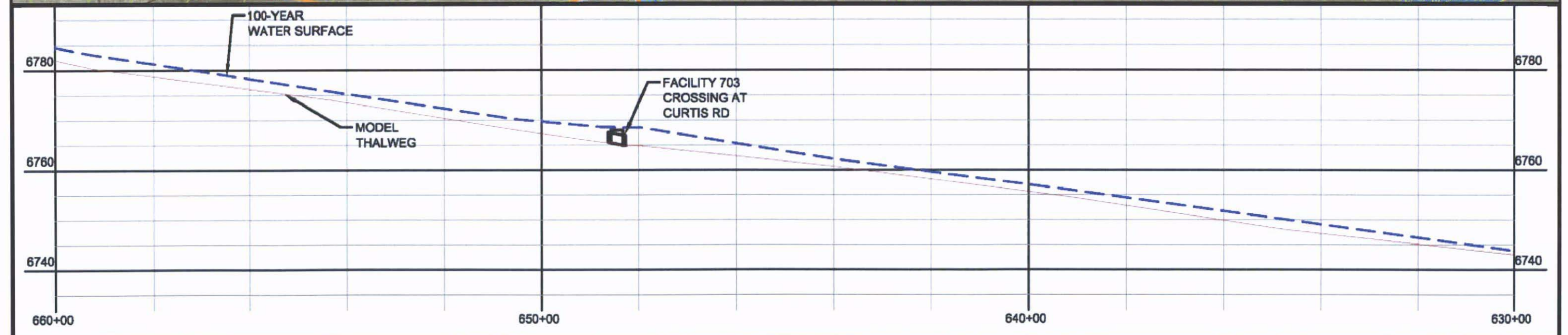
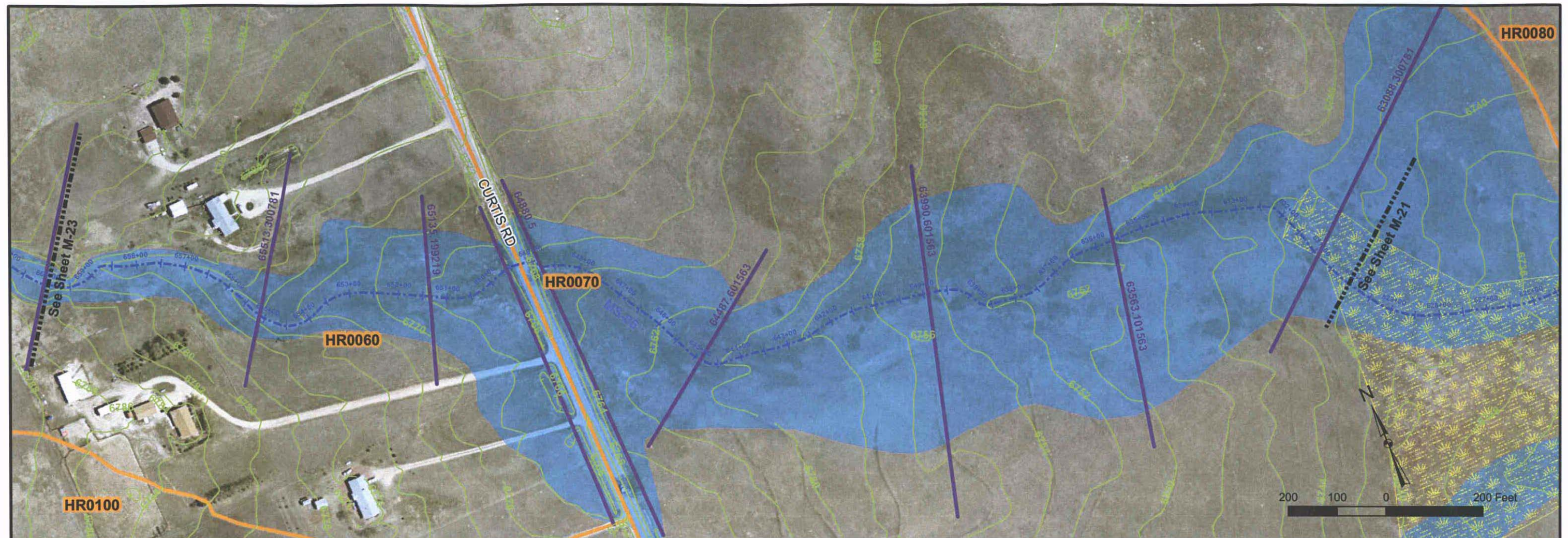
Cross Sections

2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-21**  
**FIGURE 5-4**





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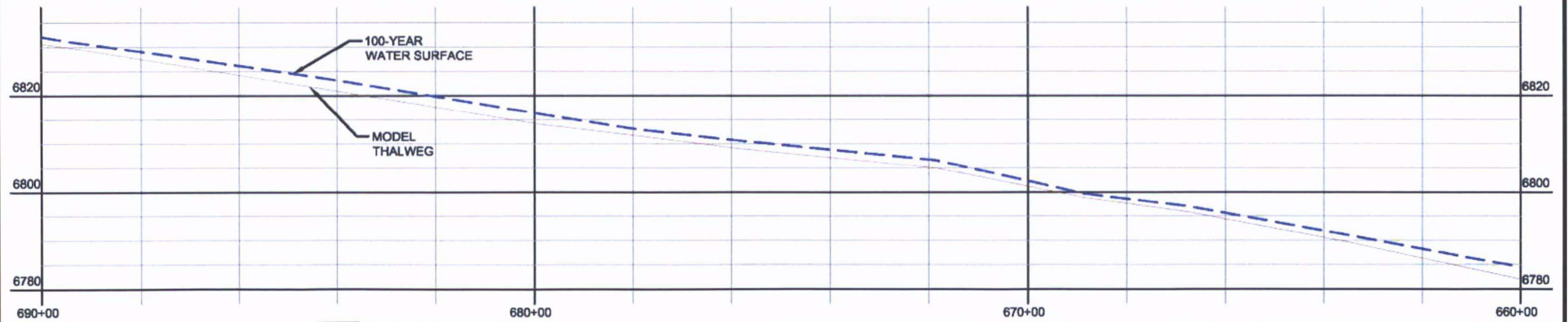
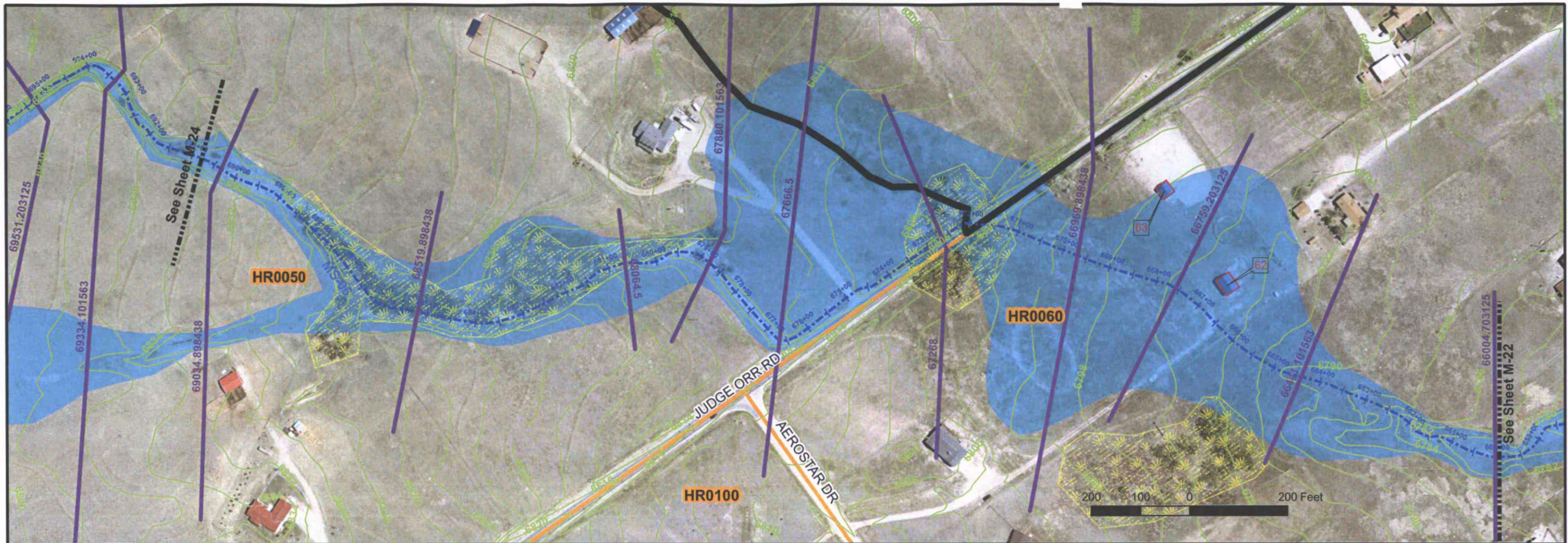


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-22**  
**FIGURE 5-4**





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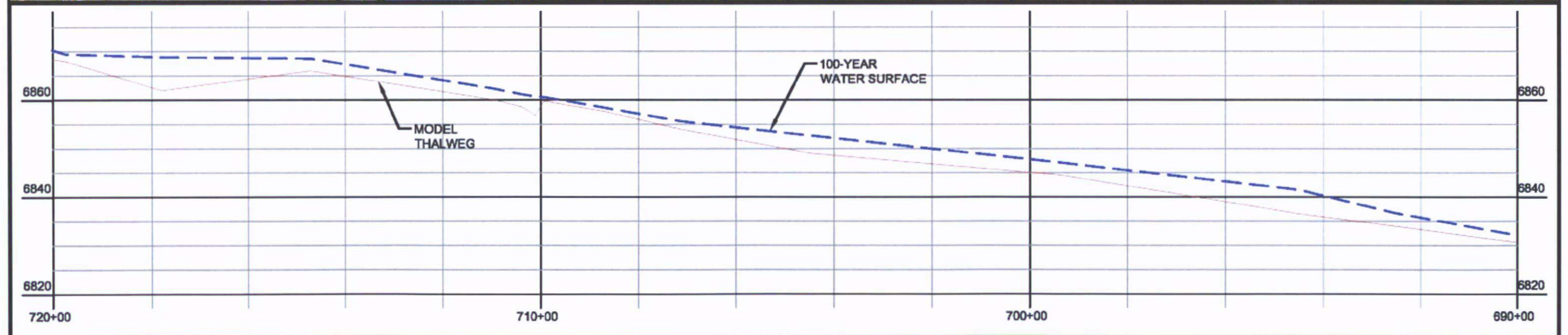
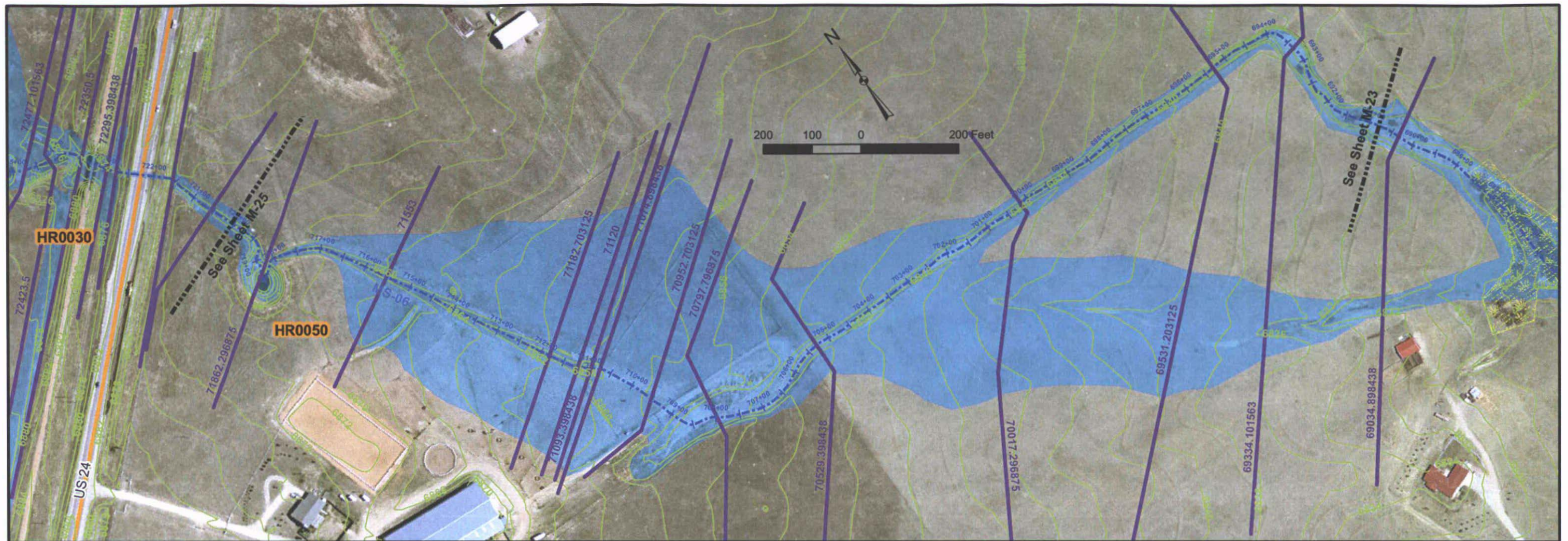


- Haegler Basin Boundary
- 2' Contours
- Potential Wetlands
- Subbasin Boundaries

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-23**  
**FIGURE 5-4**





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Potential Wetlands



Subbasin Boundaries



Approximate 100-Year Floodplain



Thalweg



Cross Sections

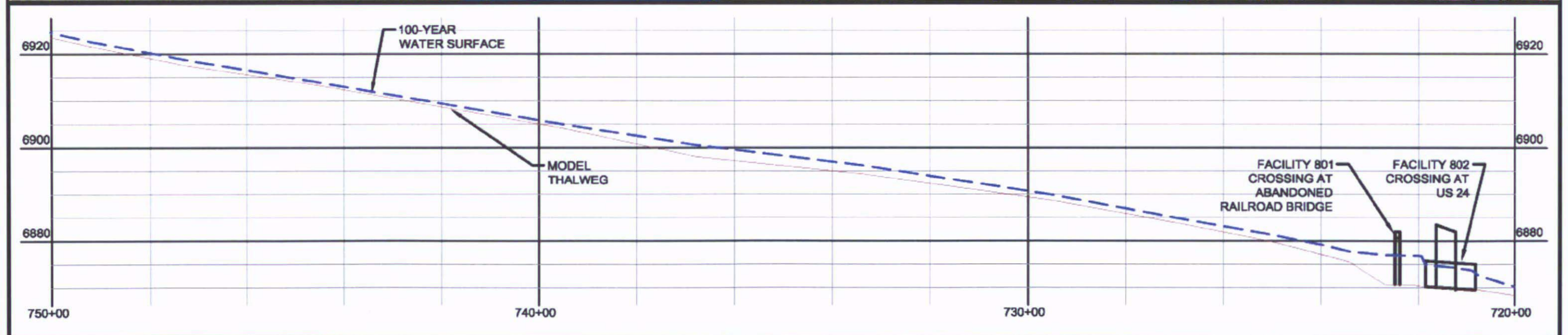
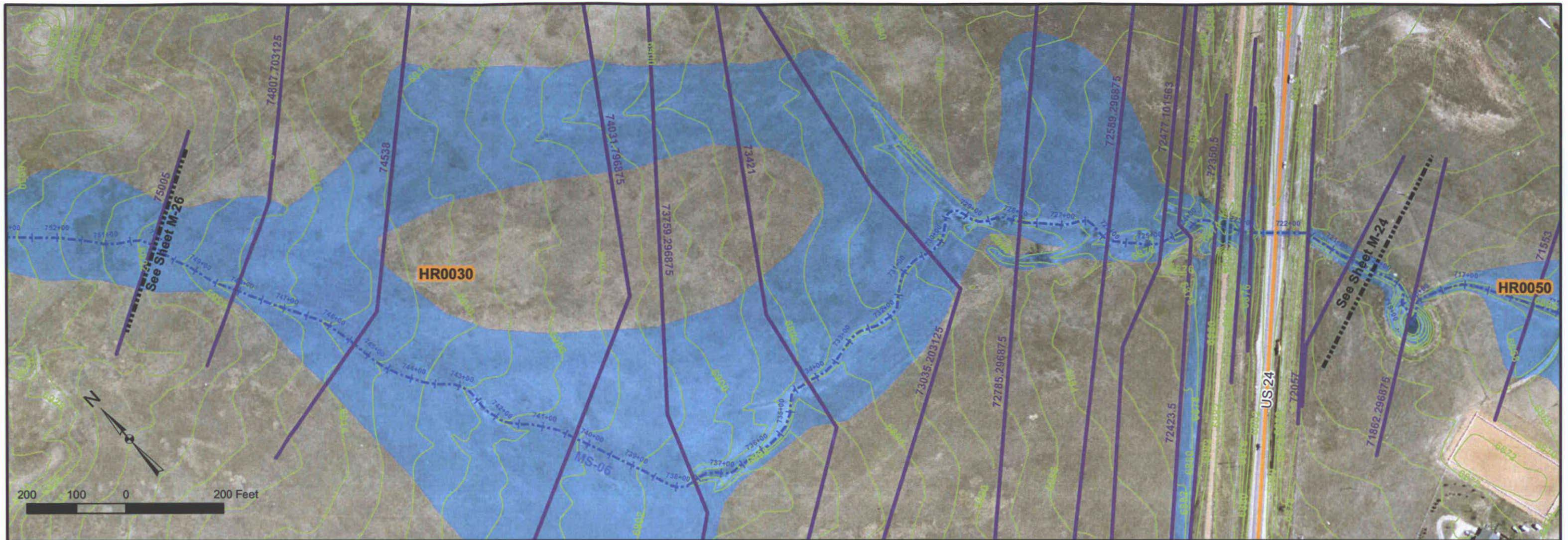


2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-24**  
**FIGURE 5-4**





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Subbasin Boundaries

Approximate 100-Year Floodplain

Thalweg

Cross Sections

2' Contours

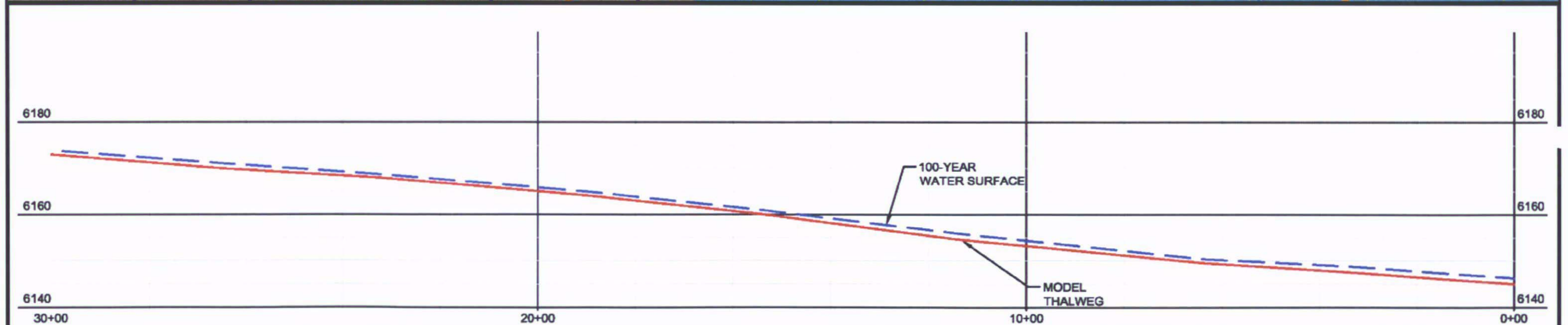
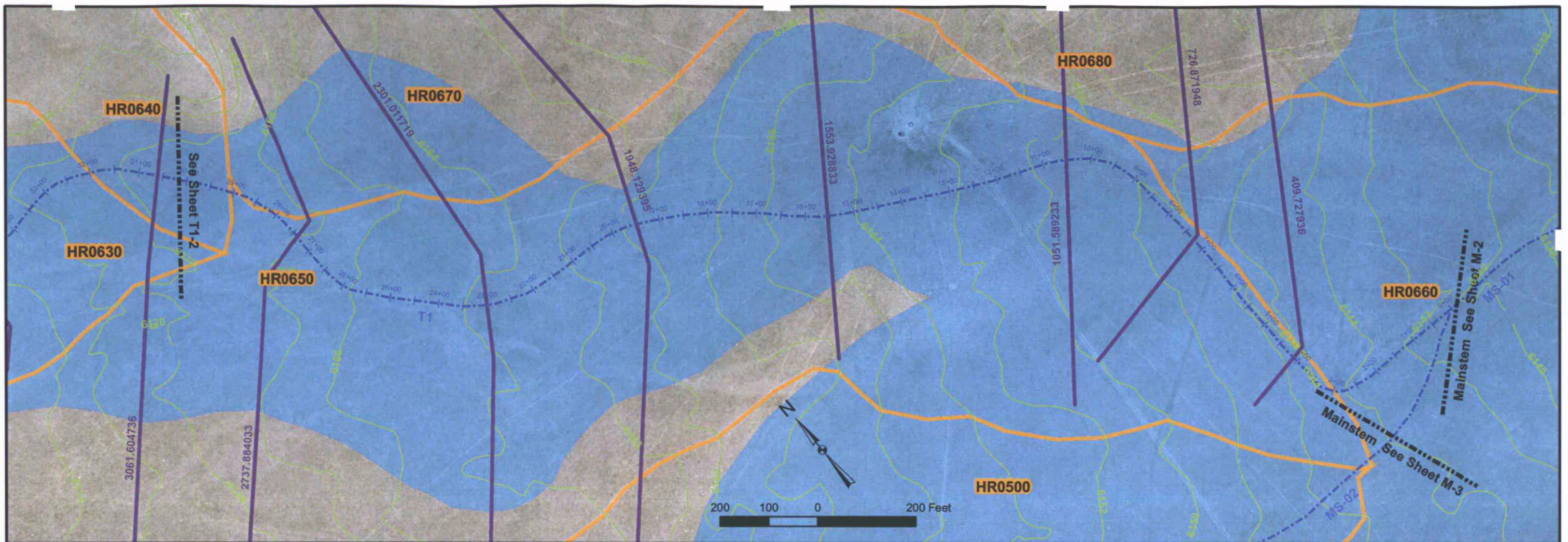
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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET M-25**  
**FIGURE 5-4**












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Subbasin Boundaries

Thalweg

Approximate 100-Year Floodplain

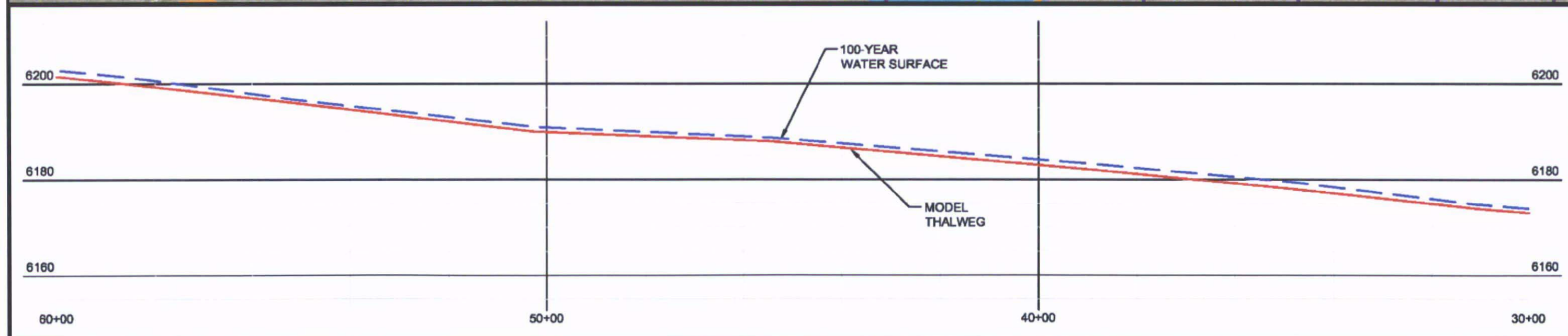
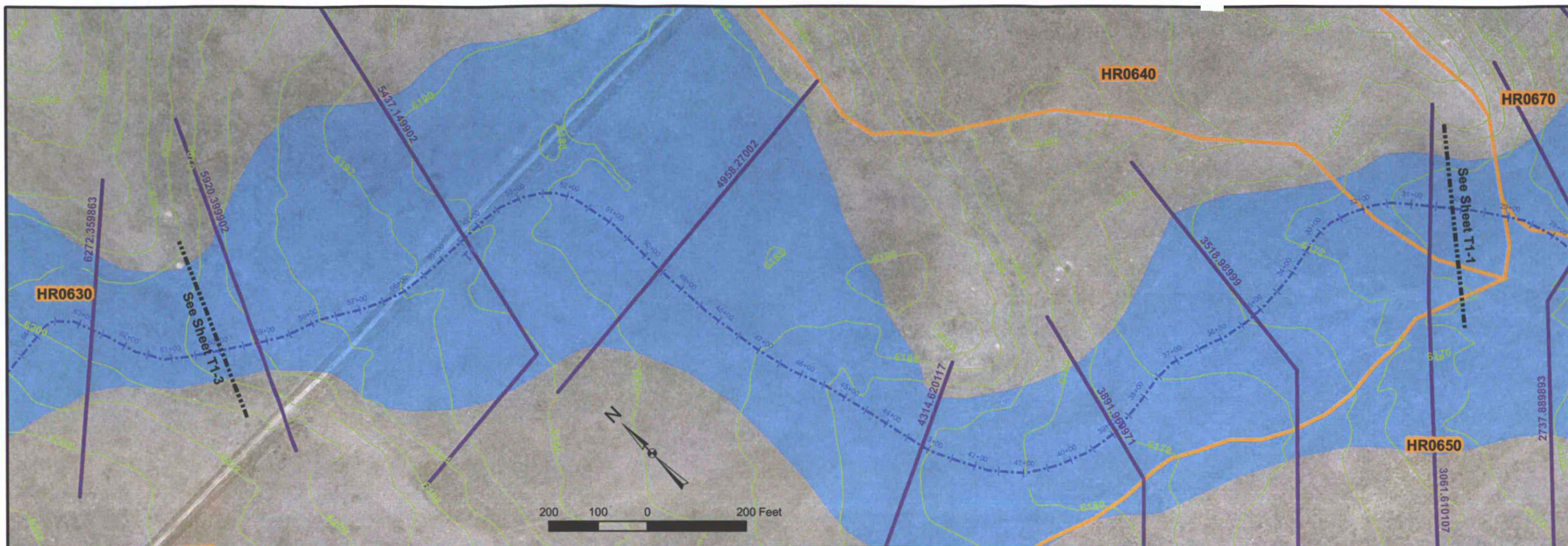
Cross Sections

2' Contours

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-1**  
**FIGURE 5-4**

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Subbasin Boundaries



Approximate 100-Year Floodplain



Thalweg

Cross Sections

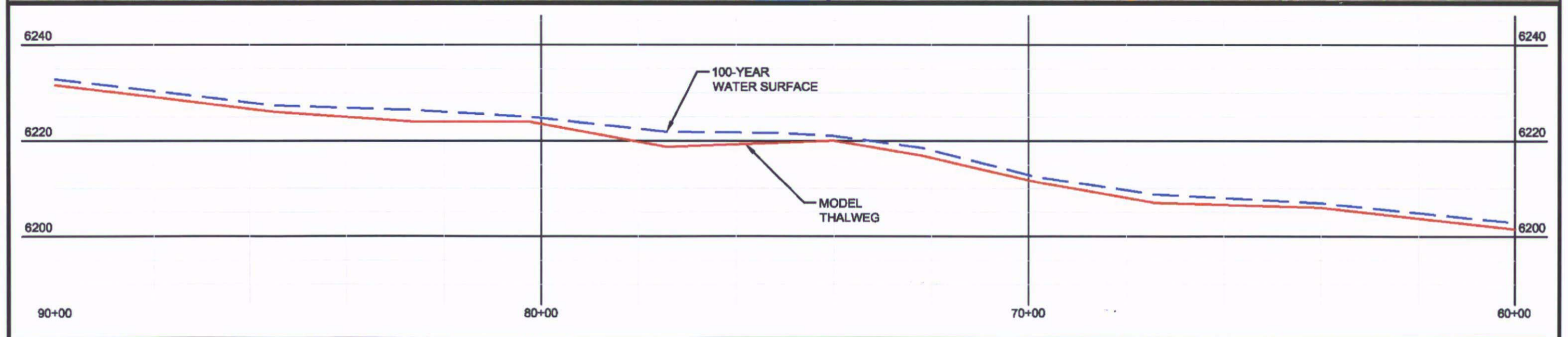
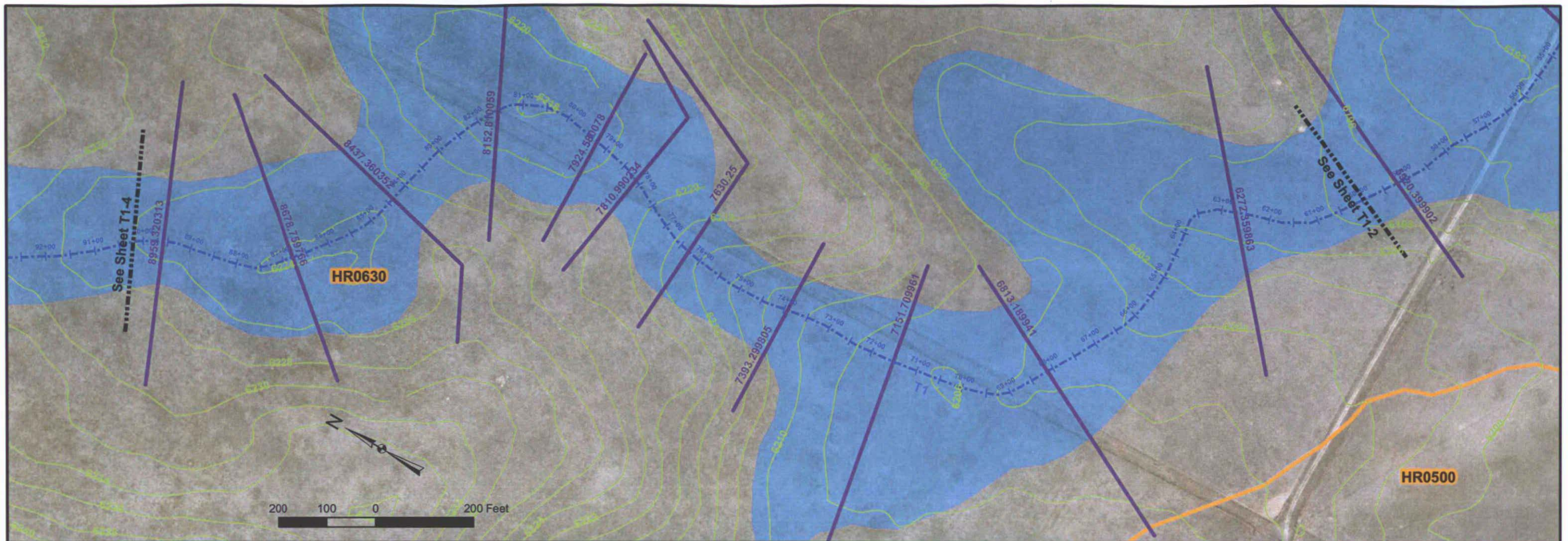


2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-2**  
**FIGURE 5-4**





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Subbasin Boundaries

Thalweg

Approximate 100-Year Floodplain

Cross Sections

2' Contours

**HAEGLER RANCH DRAINAGE BASIN**

**APPROXIMATE 100-YEAR FLOOD LIMITS**

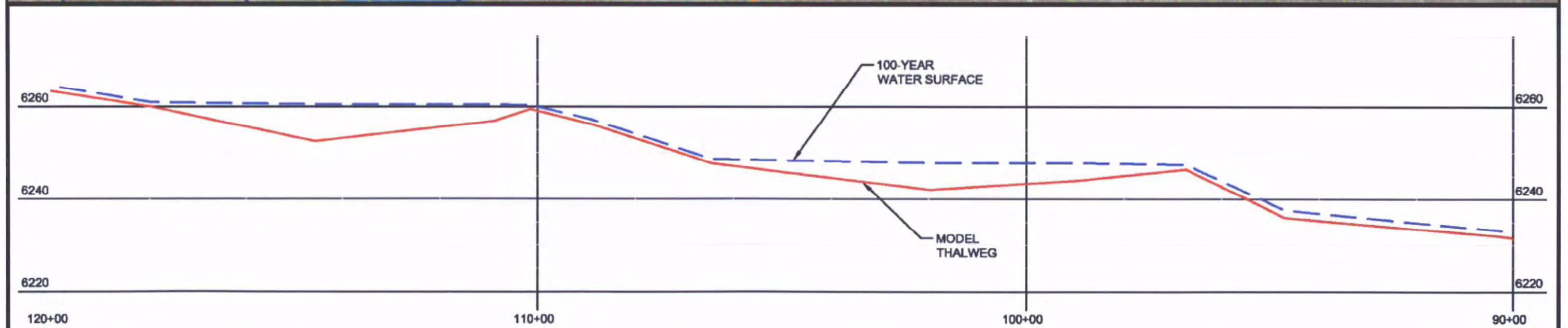
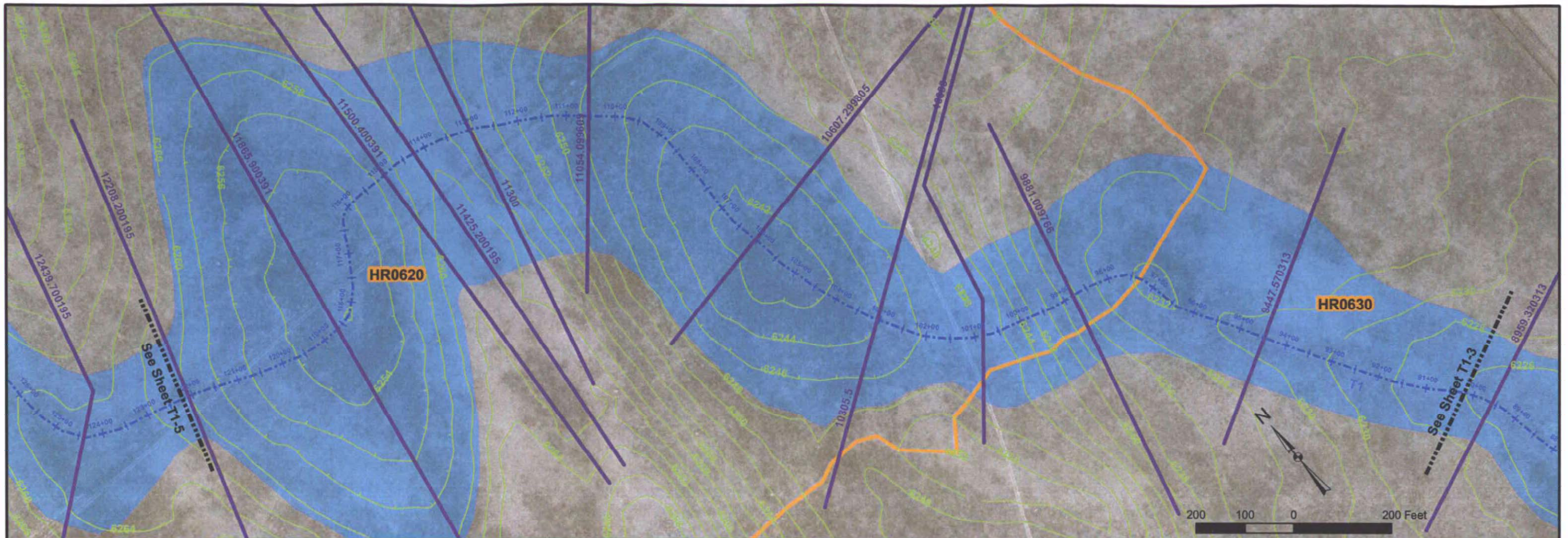
**SHEET T1-3**

**FIGURE 5-4**

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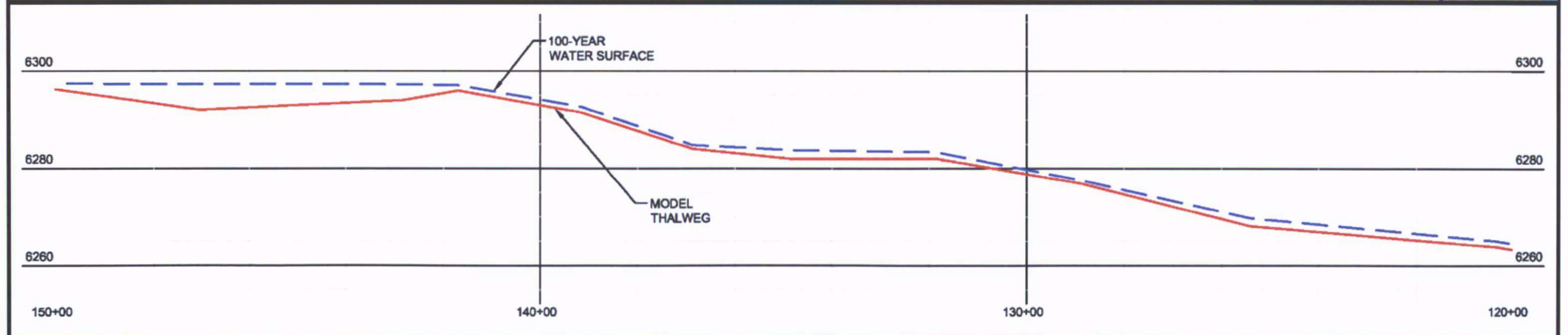
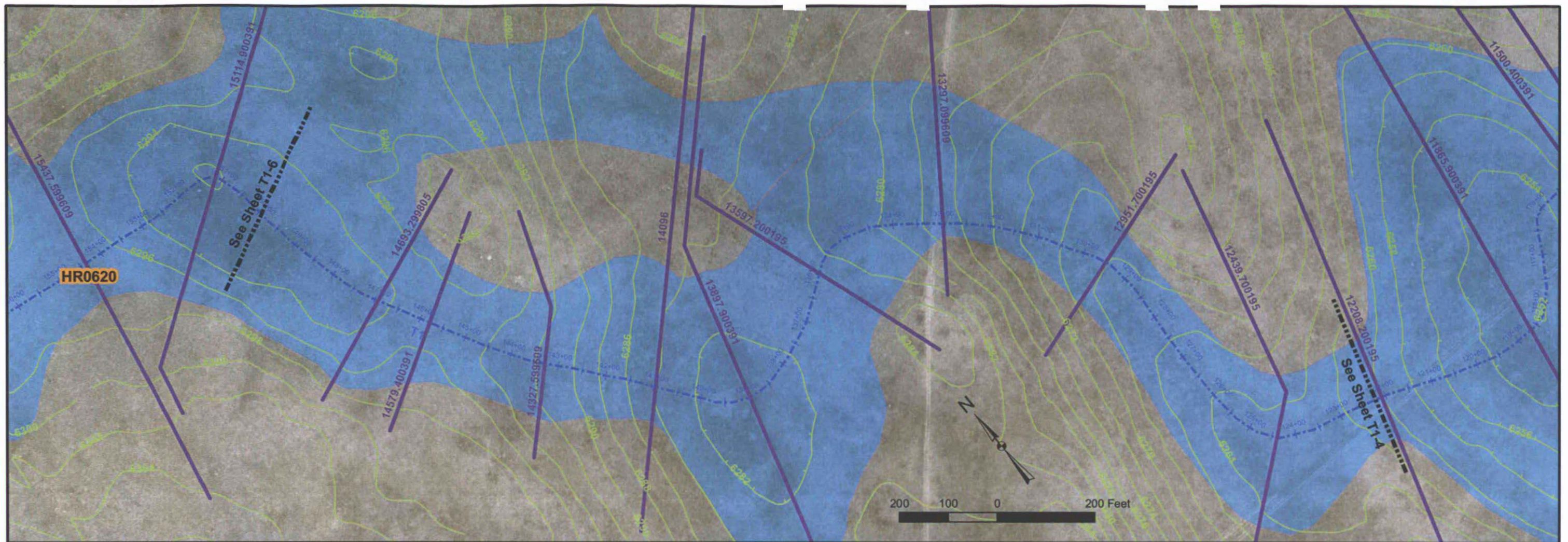


- |                                 |                |
|---------------------------------|----------------|
| Subbasin Boundaries             | Thalweg        |
| Approximate 100-Year Floodplain | Cross Sections |
|                                 | 2' Contours    |

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-4**  
**FIGURE 5-4**





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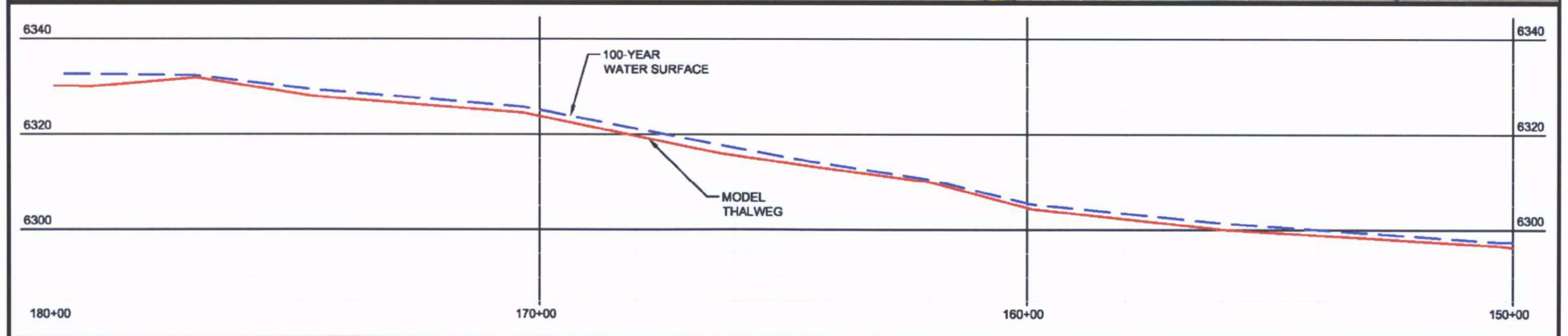
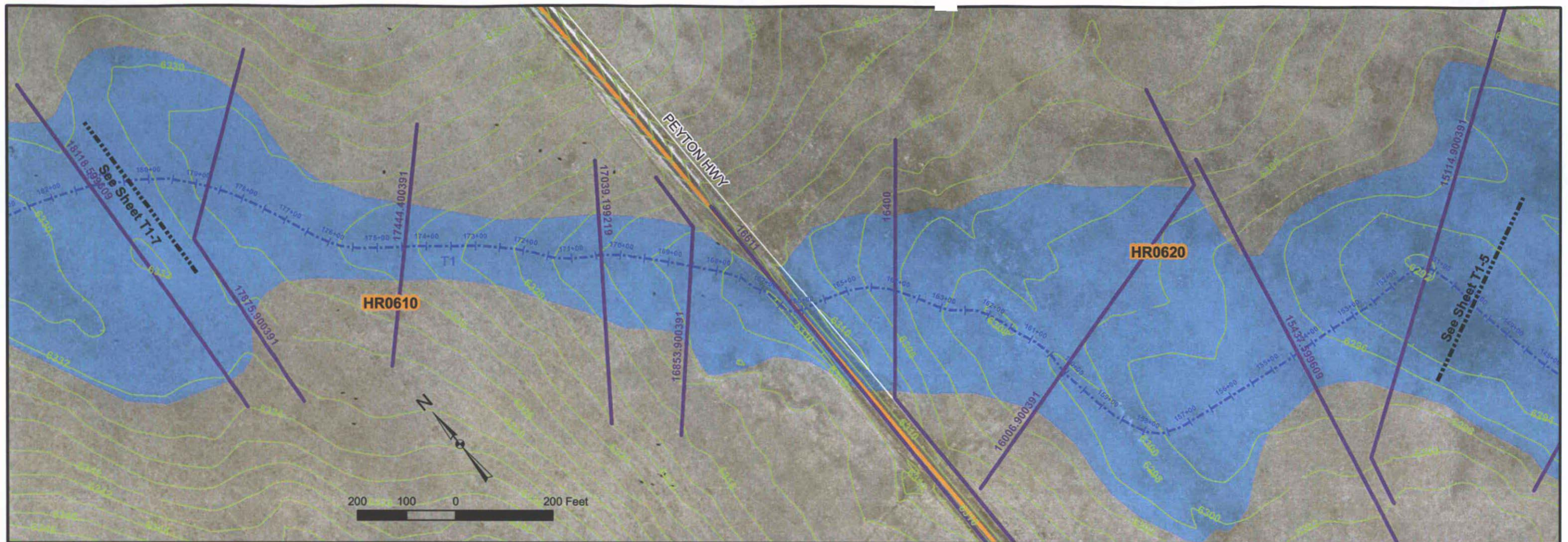


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-5**  
**FIGURE 5-4**





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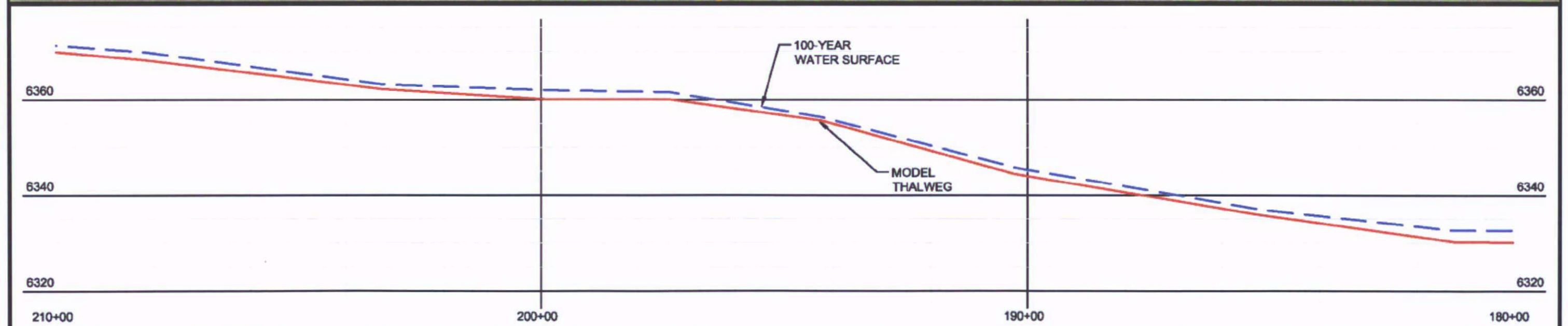
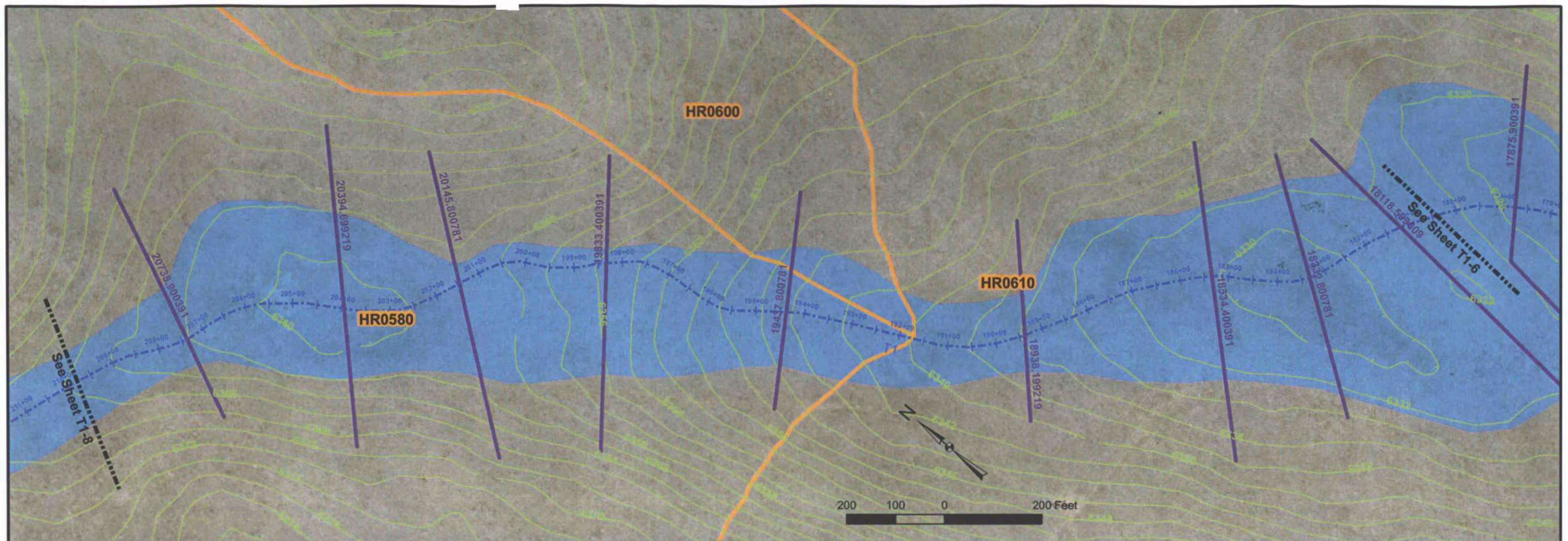


- |                                 |                |
|---------------------------------|----------------|
| Subbasin Boundaries             | Thalweg        |
| Approximate 100-Year Floodplain | Cross Sections |
|                                 | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-6**  
**FIGURE 5-4**





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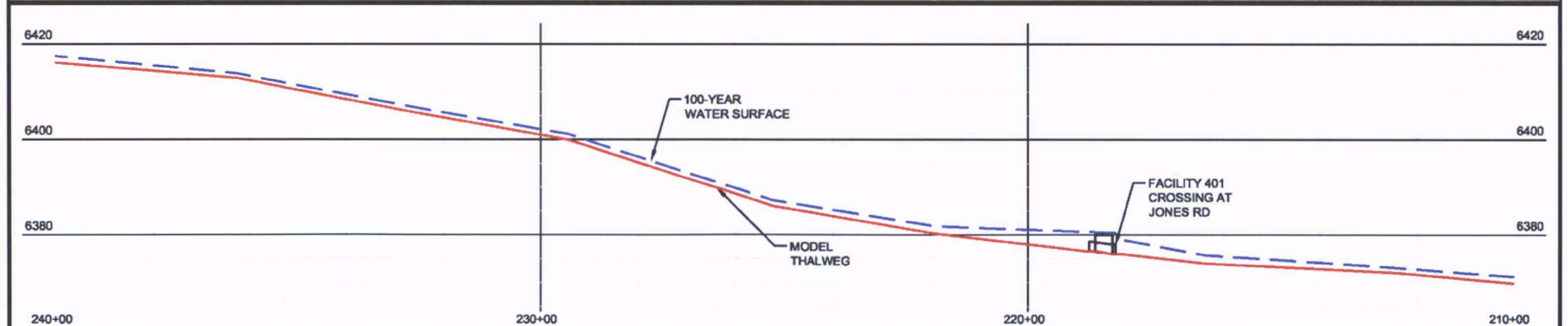
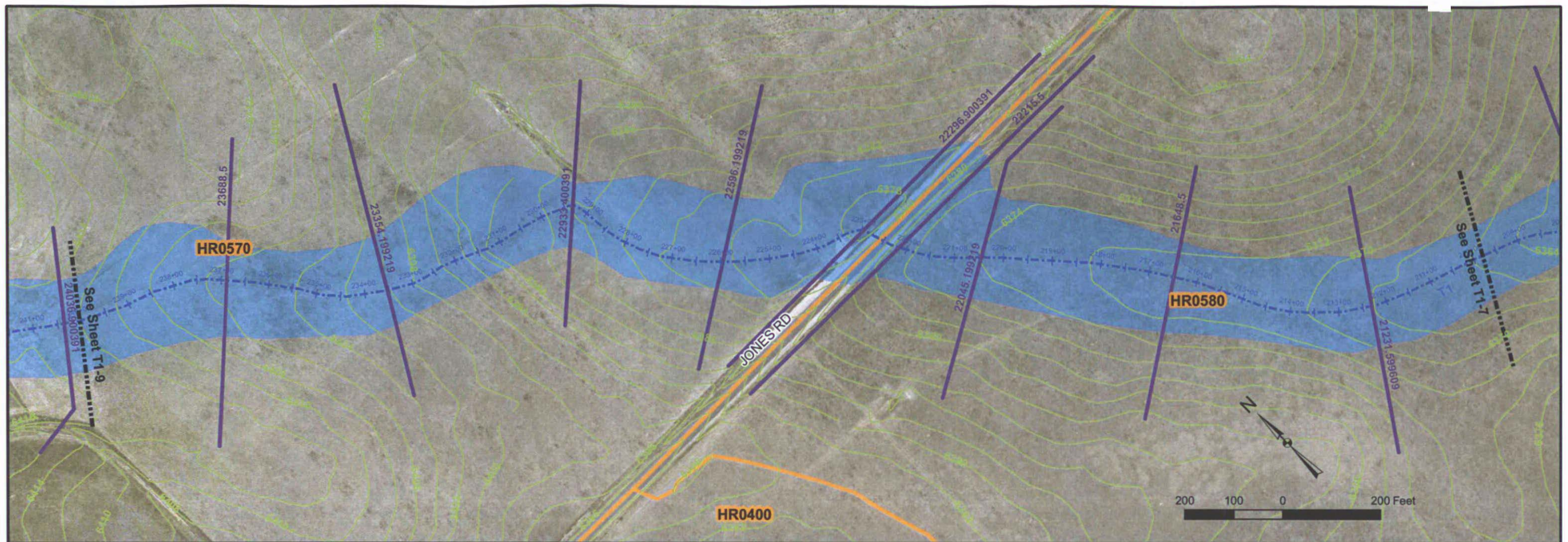


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-7**  
**FIGURE 5-4**





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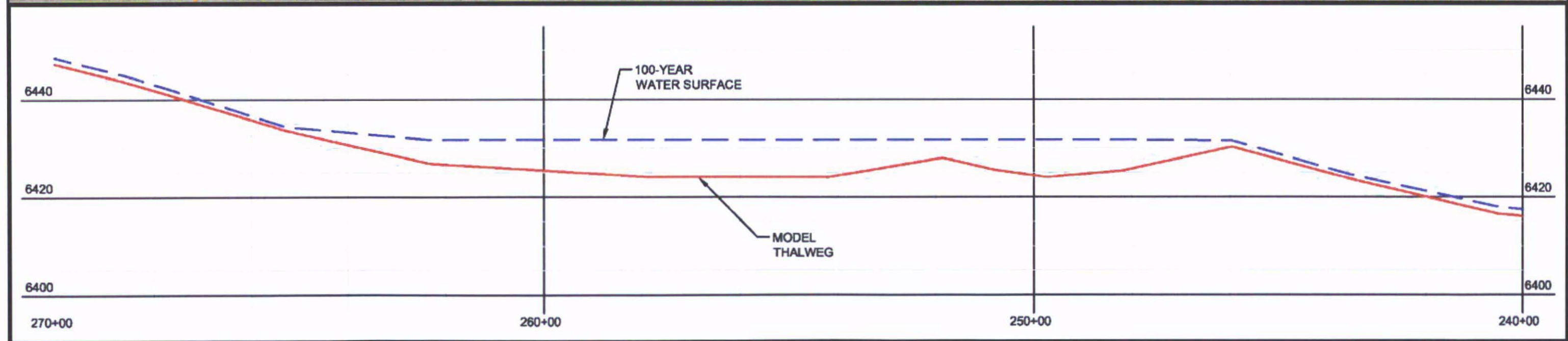
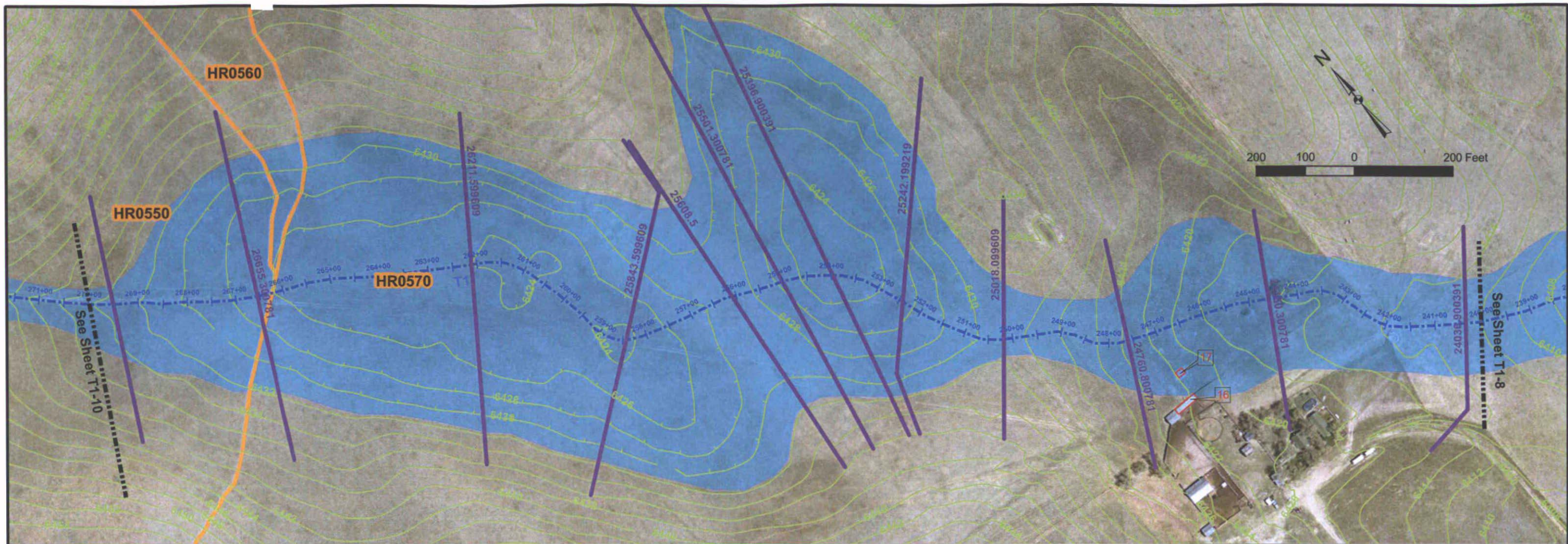


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-8**  
**FIGURE 5-4**





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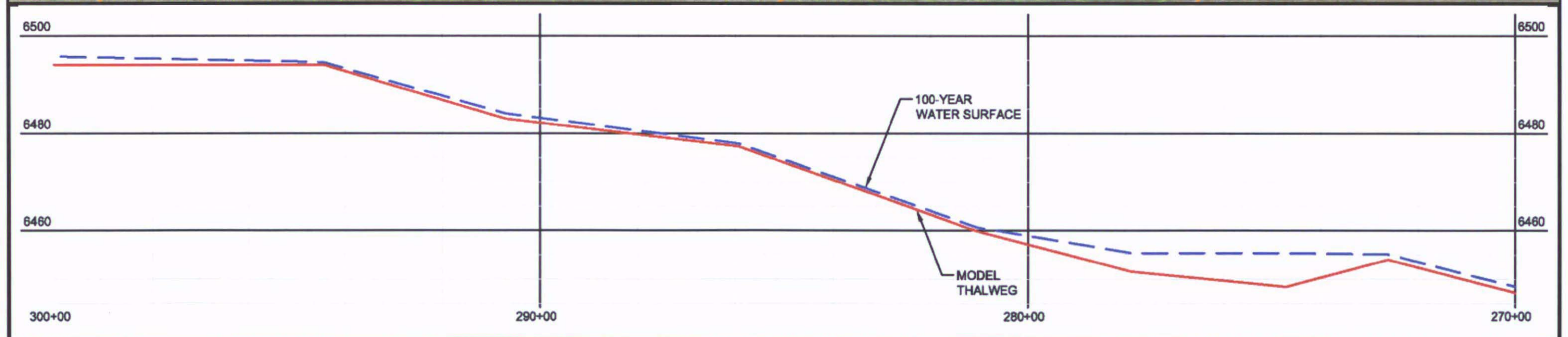
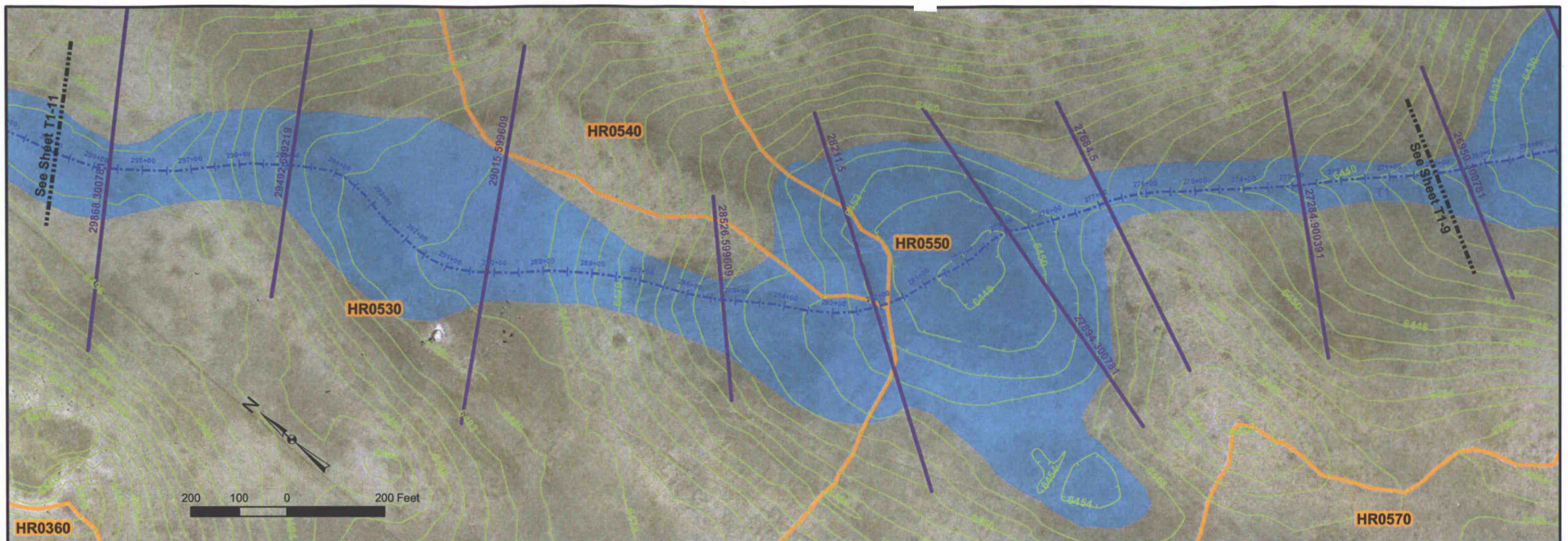


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|---------------------------------|----------------|
| Subbasin Boundaries             | Thalweg        |
| Approximate 100-Year Floodplain | Cross Sections |
|                                 | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-9**  
**FIGURE 5-4**





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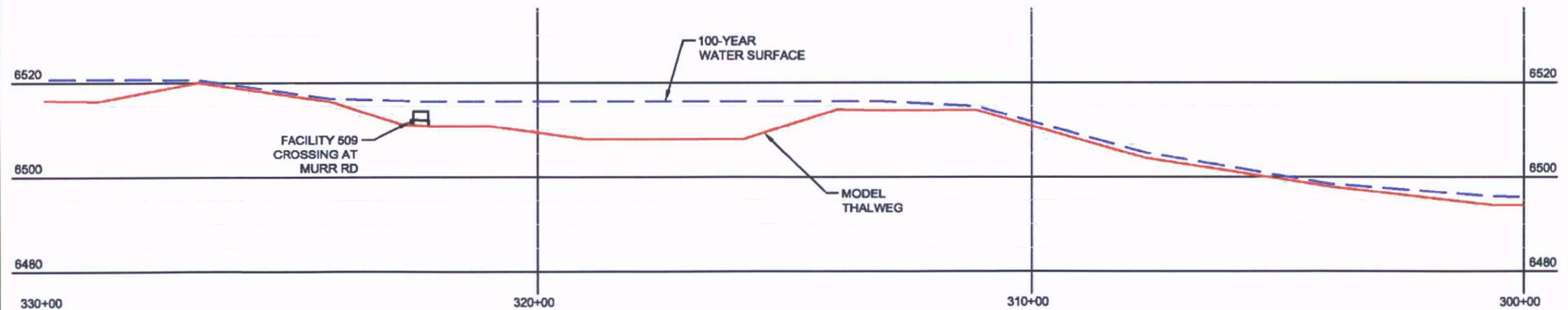
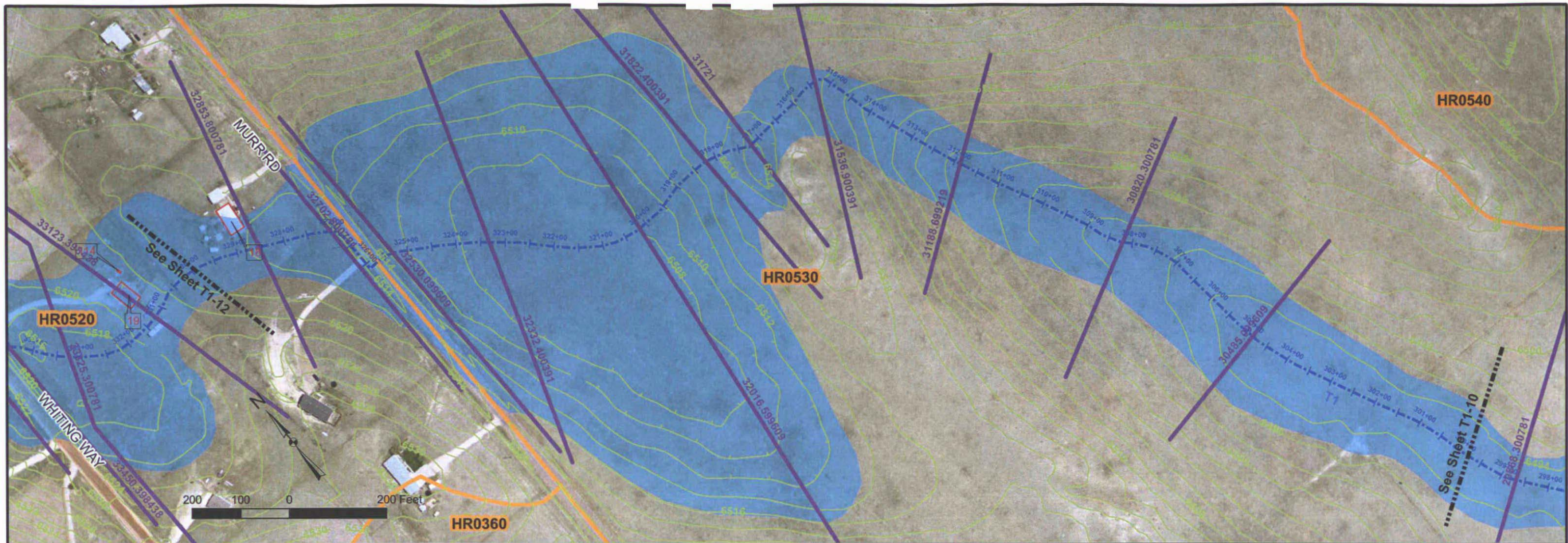


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

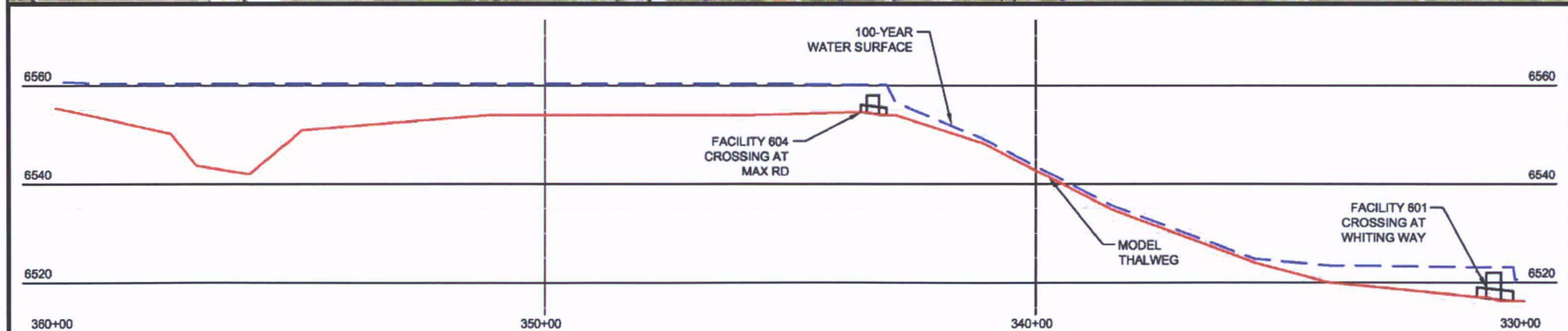
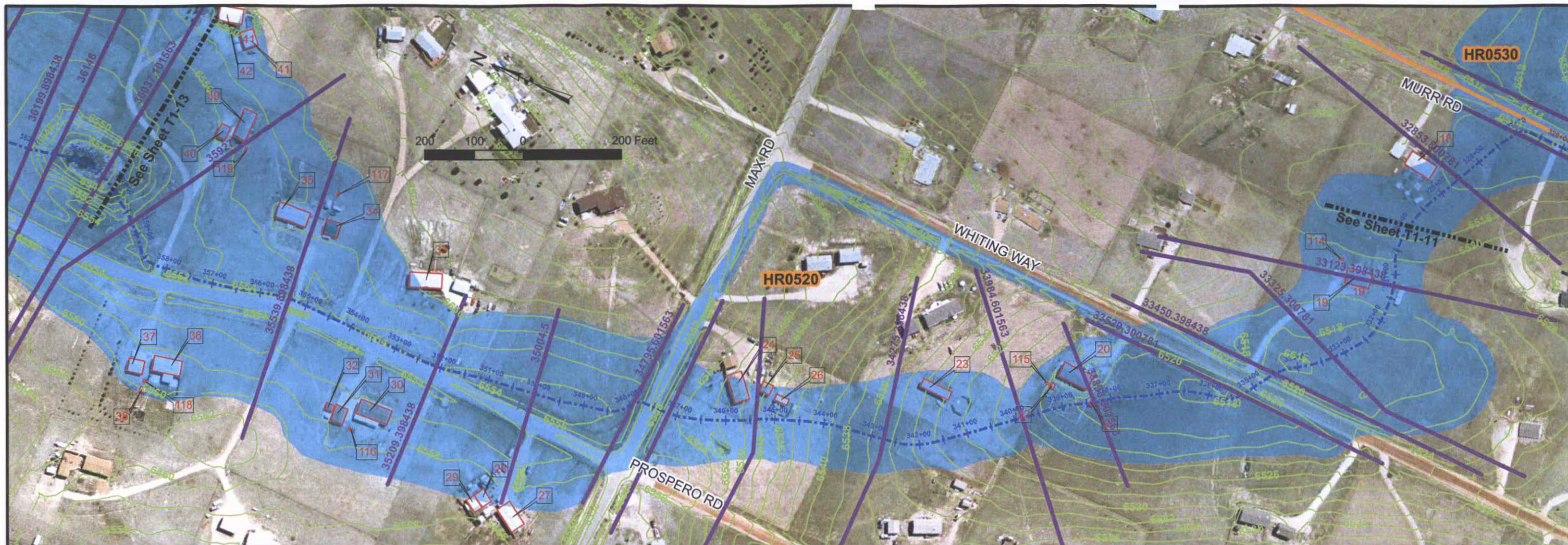
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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-10**  
**FIGURE 5-4**









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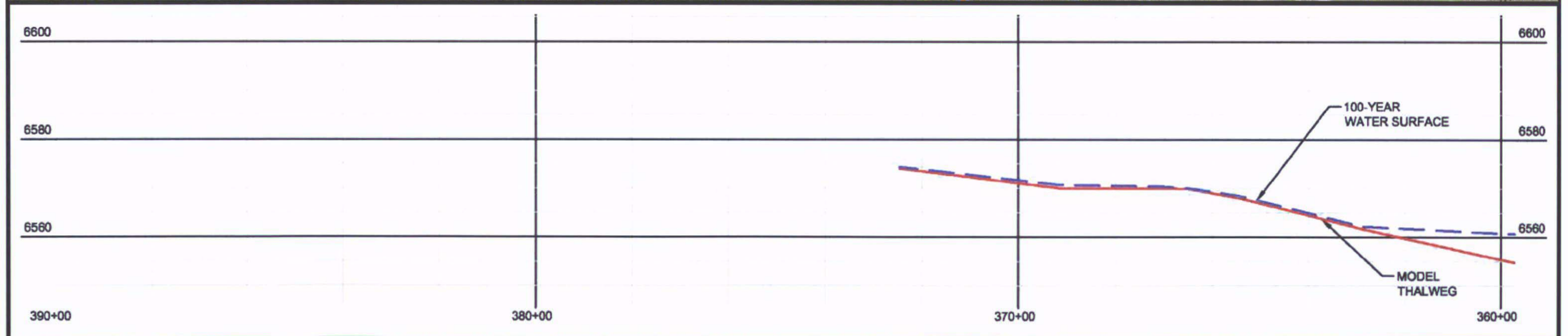
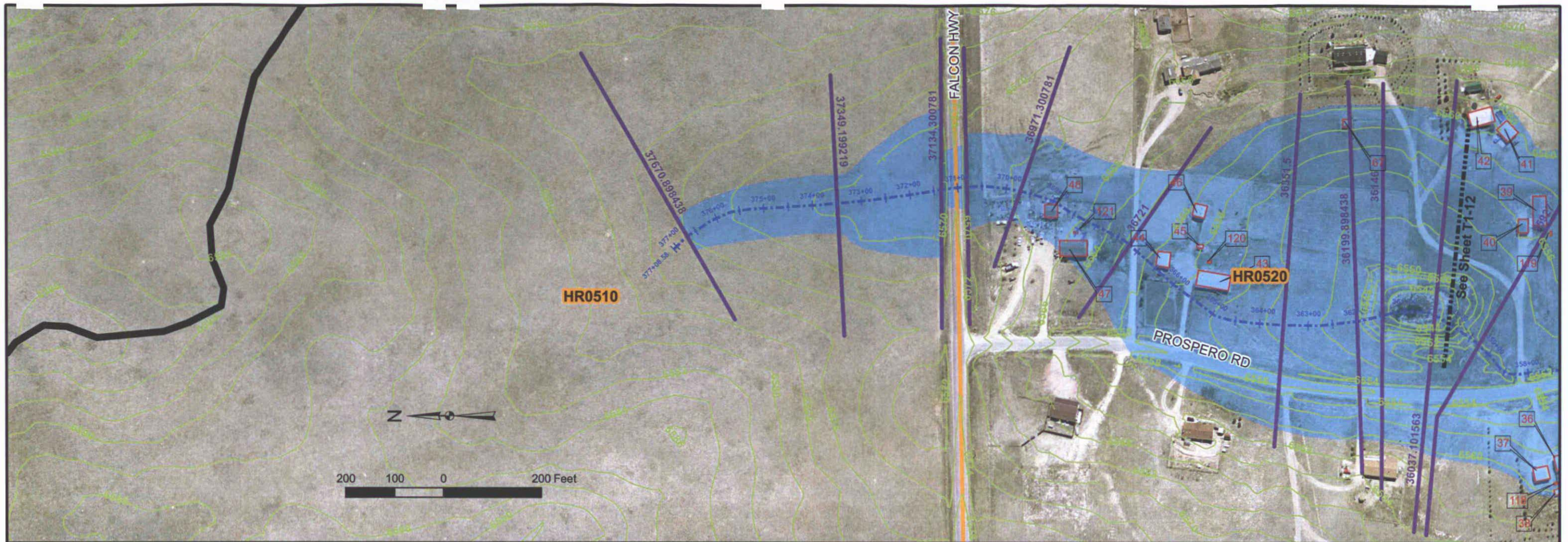


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-12**  
**FIGURE 5-4**





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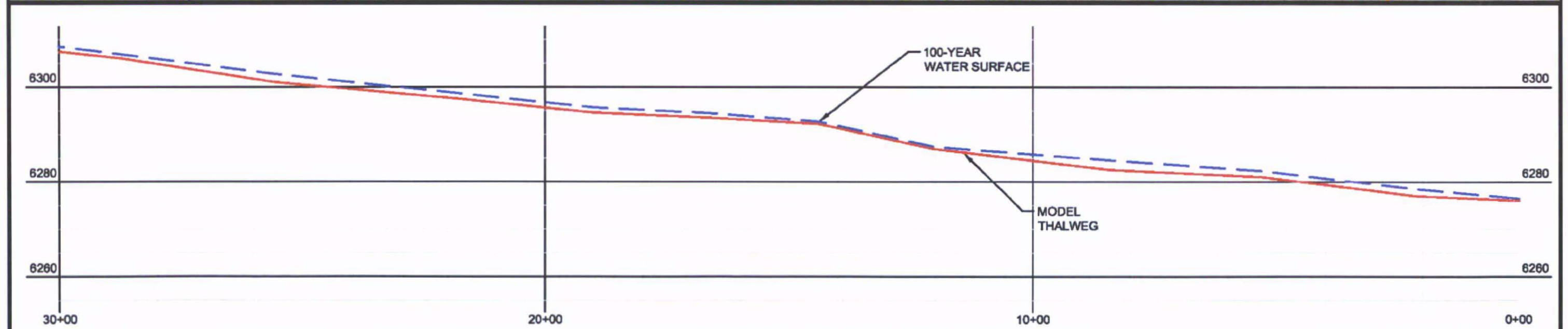
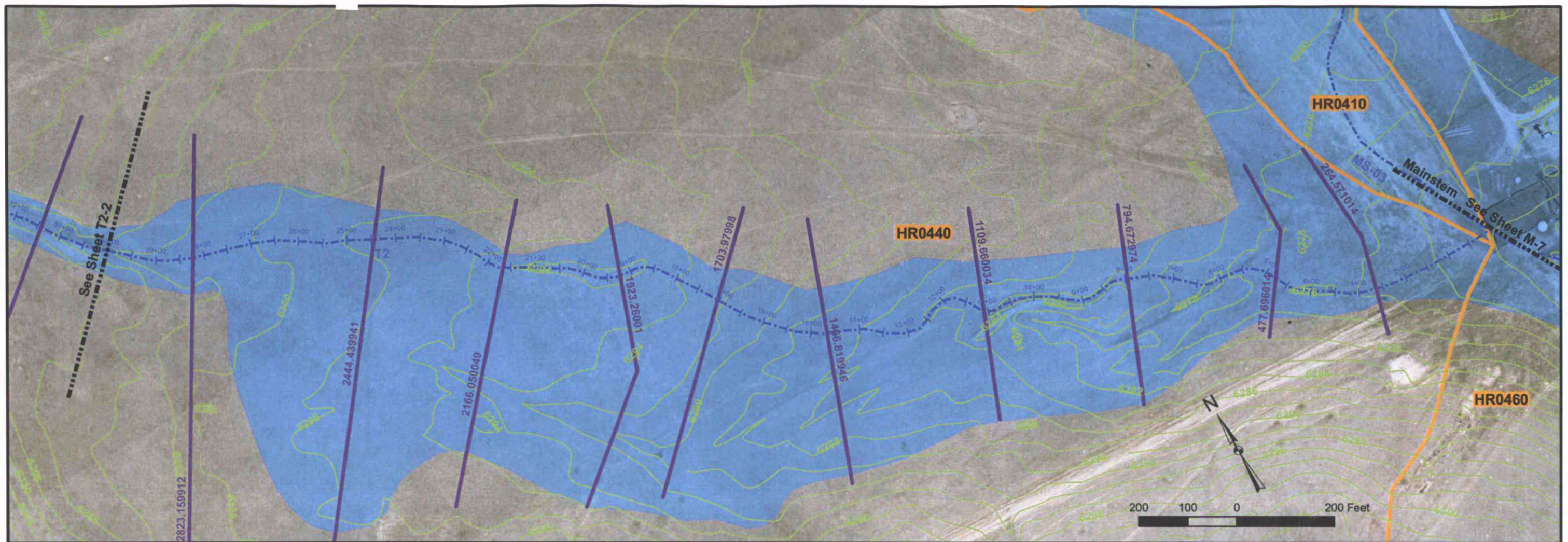


- |                                 |                |
|---------------------------------|----------------|
| Haegler Basin Boundary          | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T1-13**  
**FIGURE 5-4**





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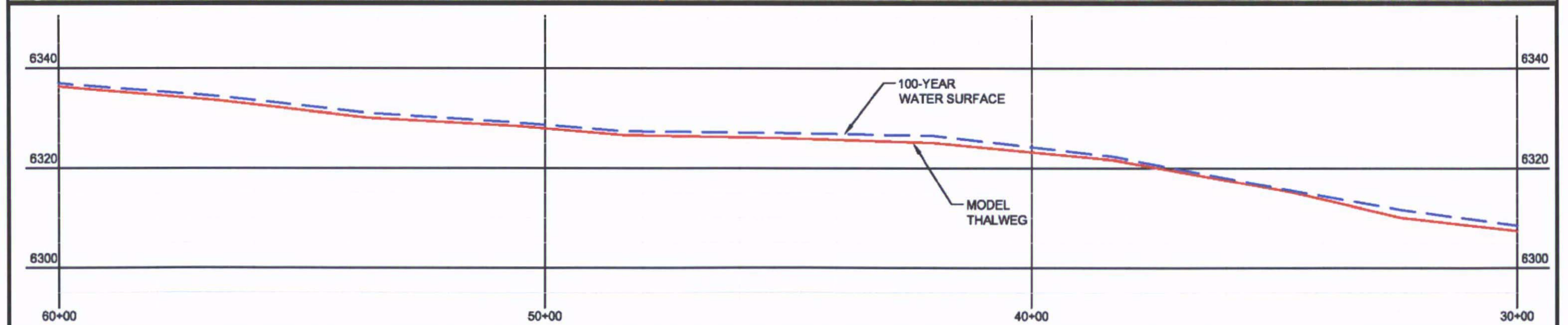
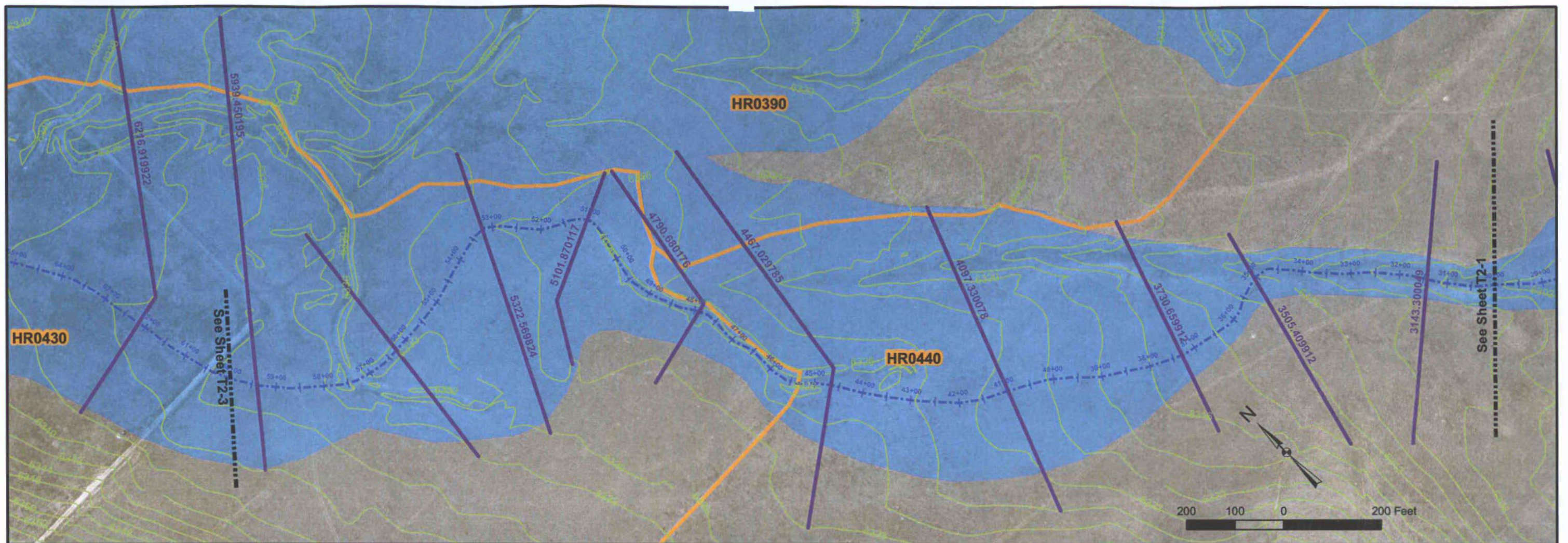


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T2-1**  
**FIGURE 5-4**





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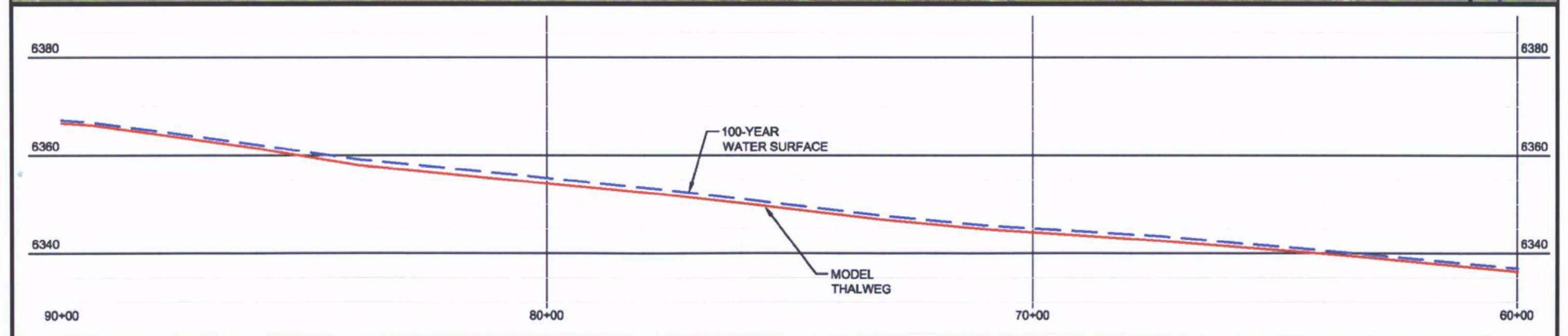
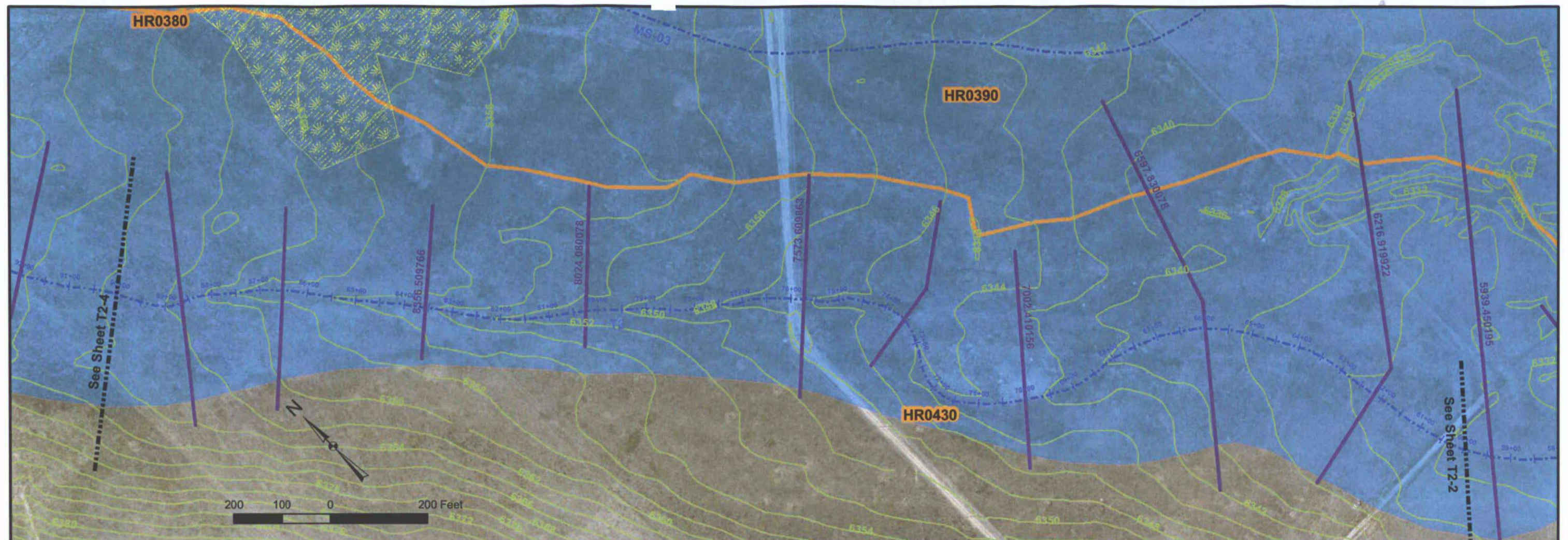


- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

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**HAEGLER RANCH DRAINAGE BASIN  
APPROXIMATE 100-YEAR FLOOD LIMITS  
SHEET T2-2  
FIGURE 5-4**





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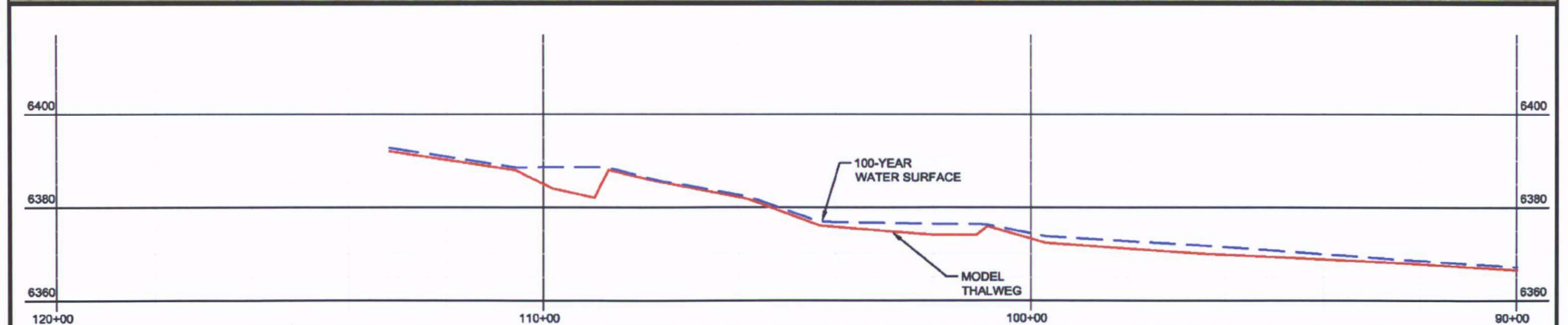
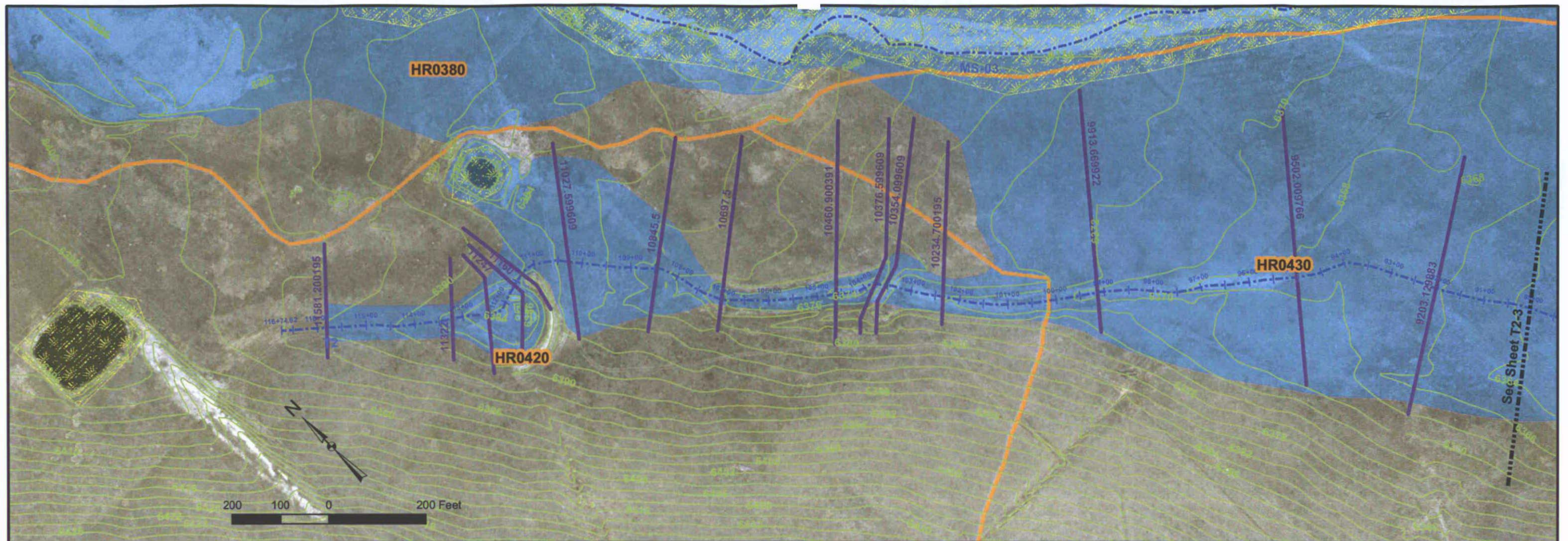


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T2-3**  
**FIGURE 5-4**





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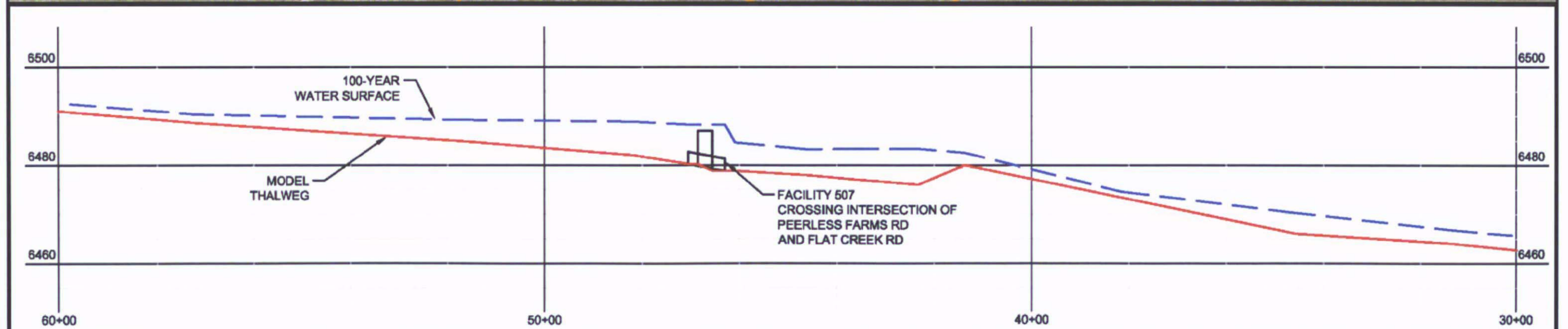
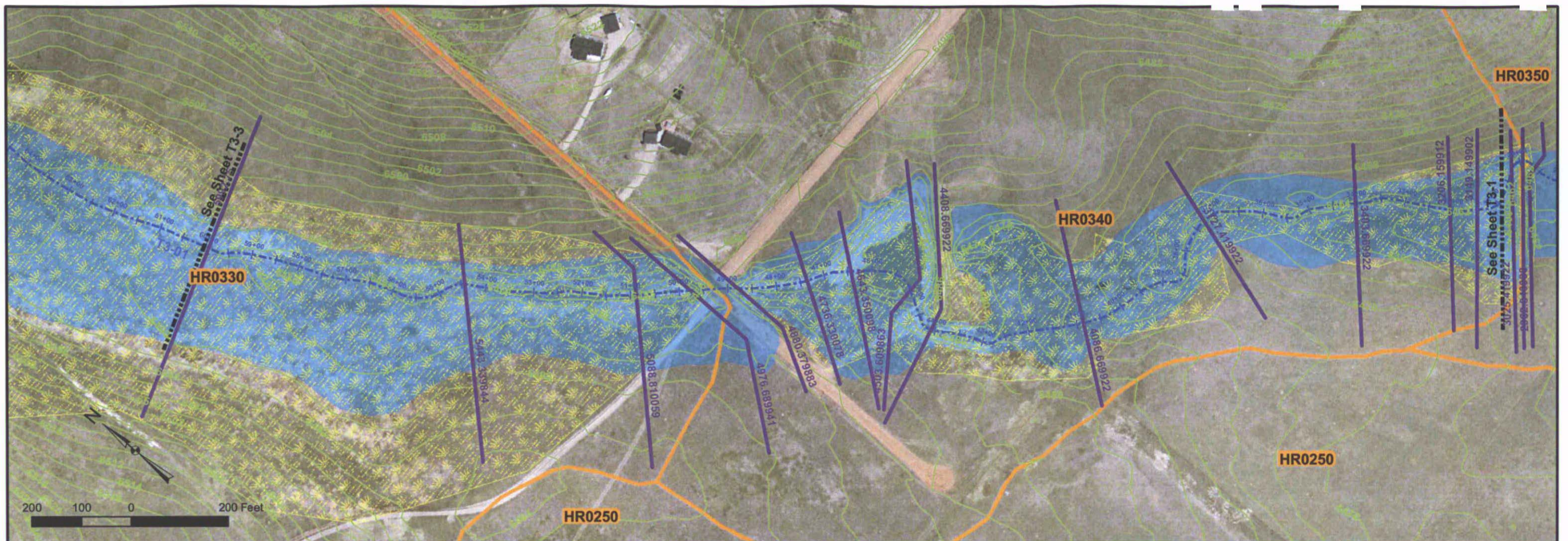


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T2-4**  
**FIGURE 5-4**





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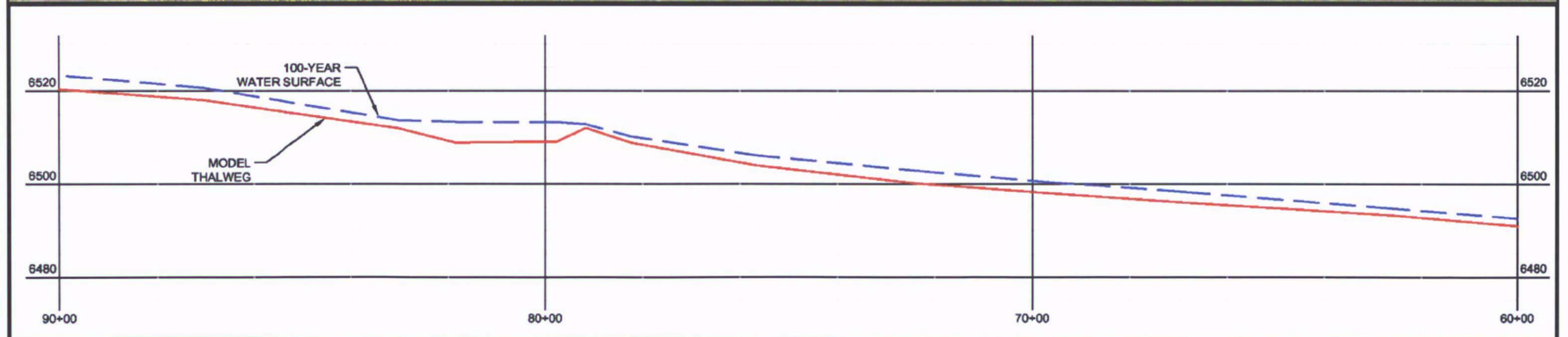
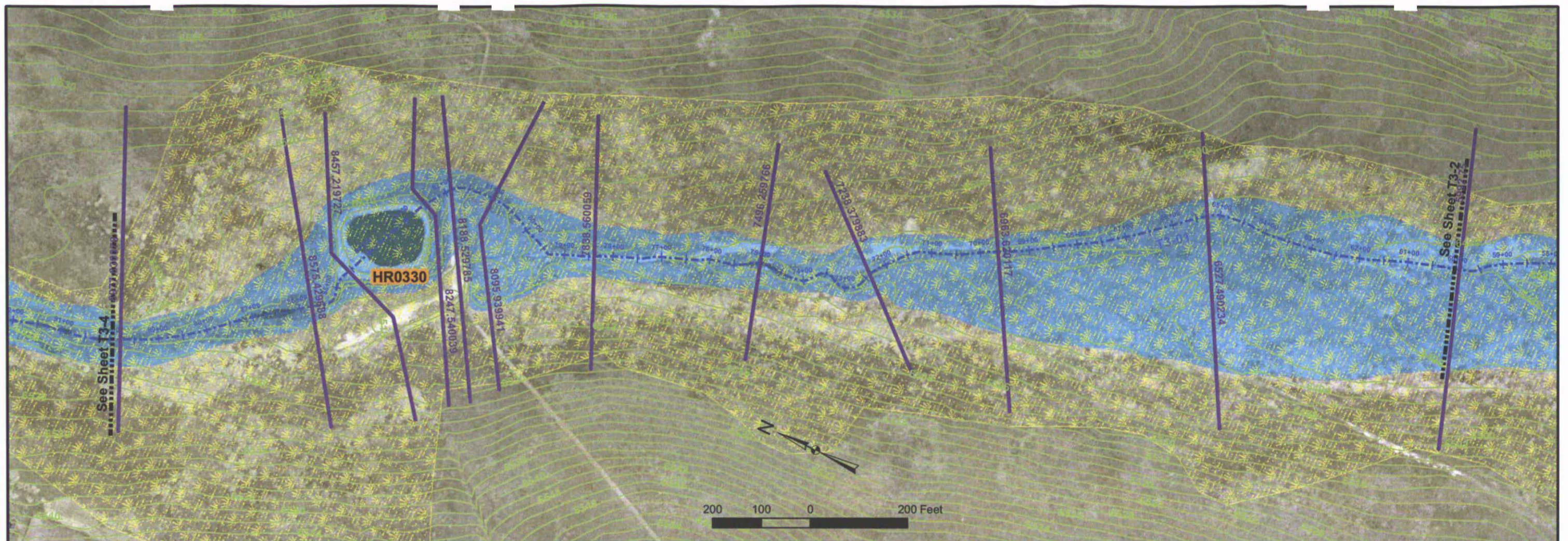


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T3-2**  
**FIGURE 5-4**





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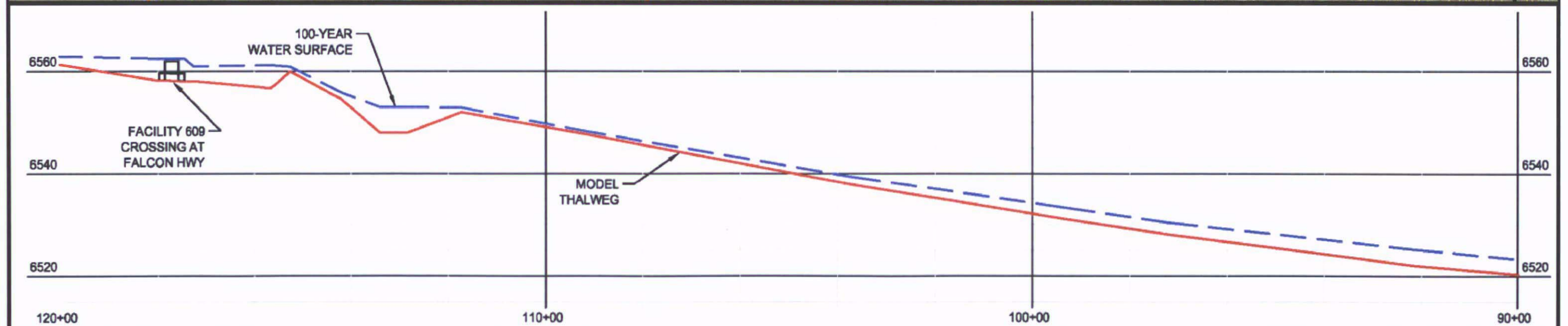
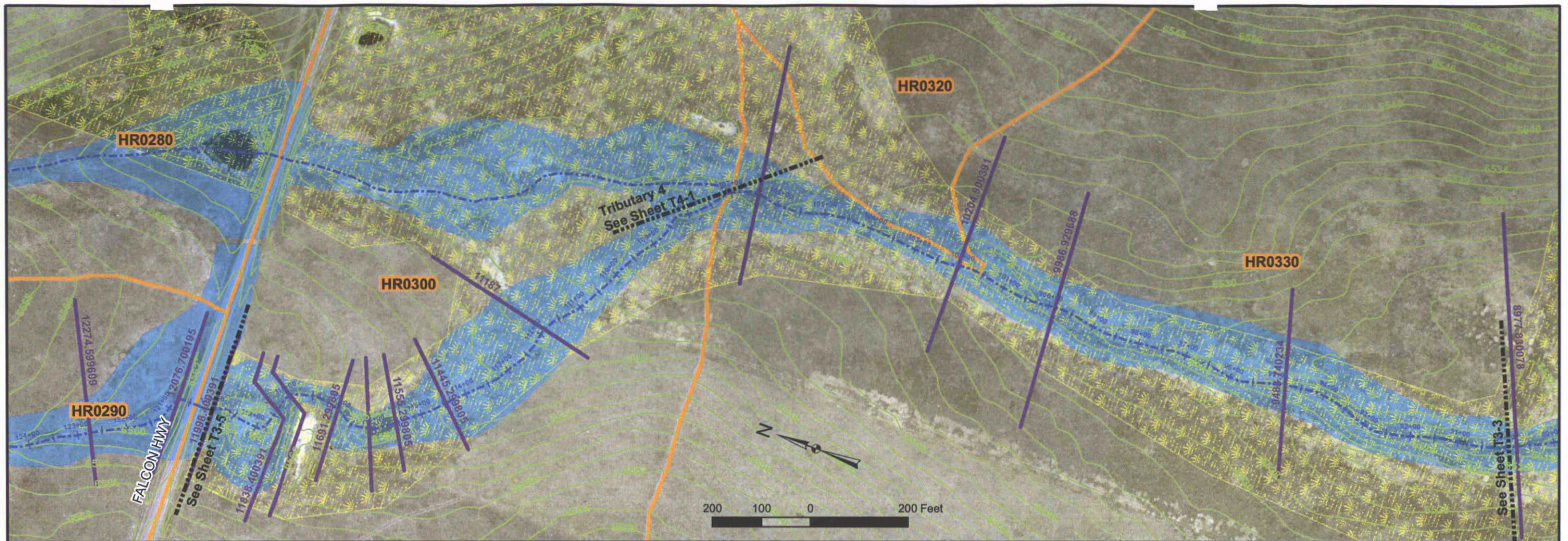


- |                                 |                |
|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T3-3**  
**FIGURE 5-4**





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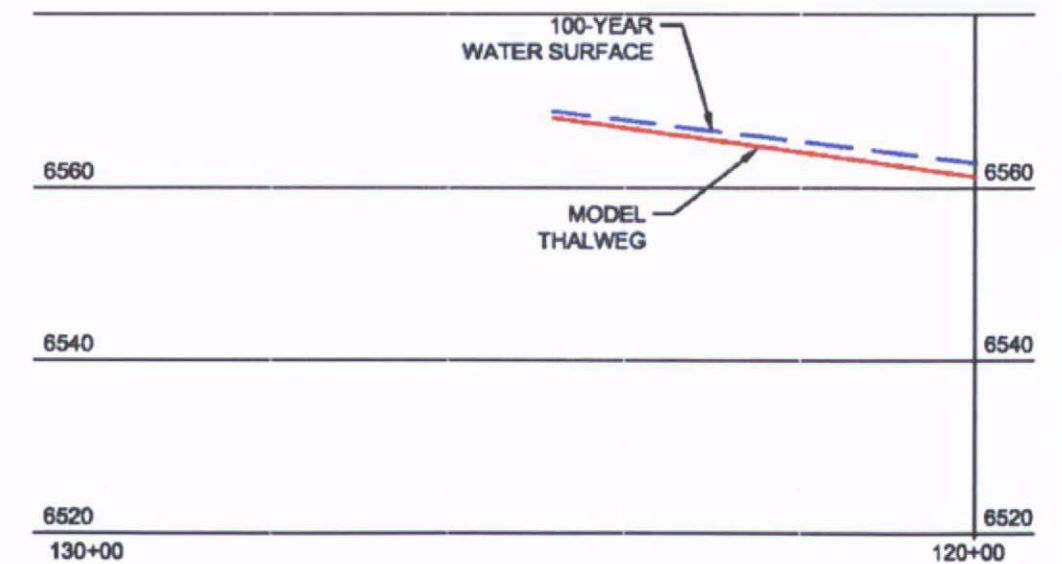
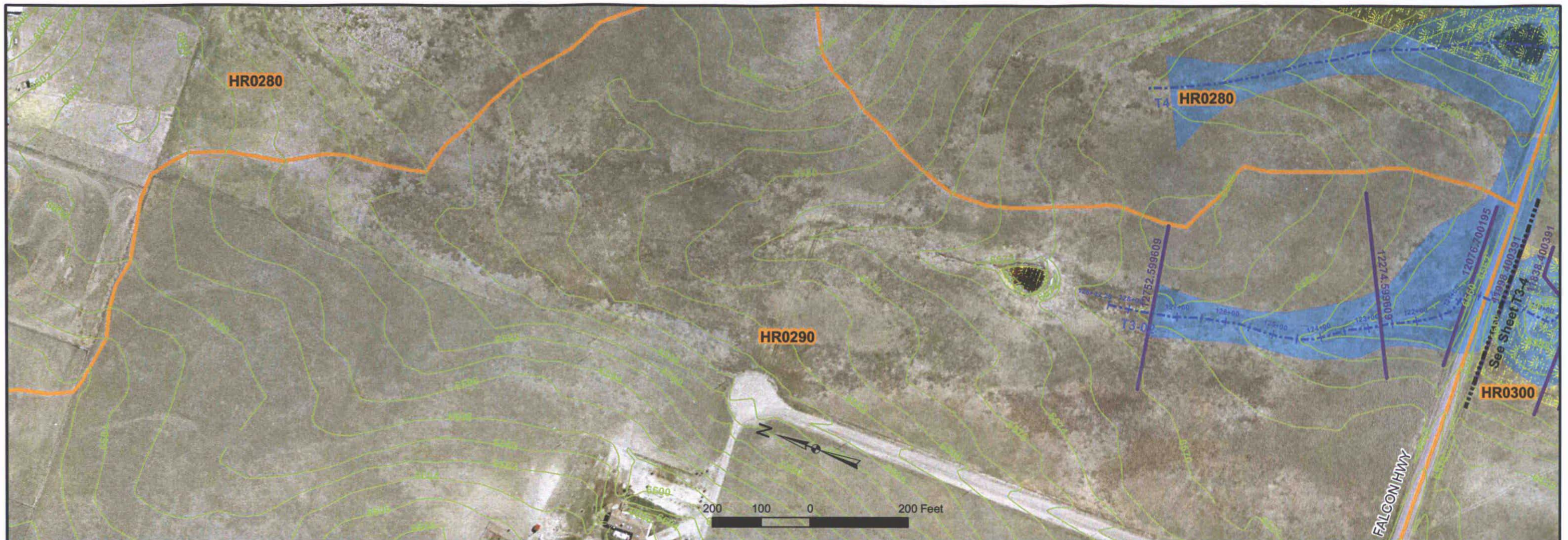


- Potential Wetlands
- Subbasin Boundaries
- Approximate 100-Year Floodplain
- Thalweg
- Cross Sections
- 2' Contours

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T3-4**  
**FIGURE 5-4**





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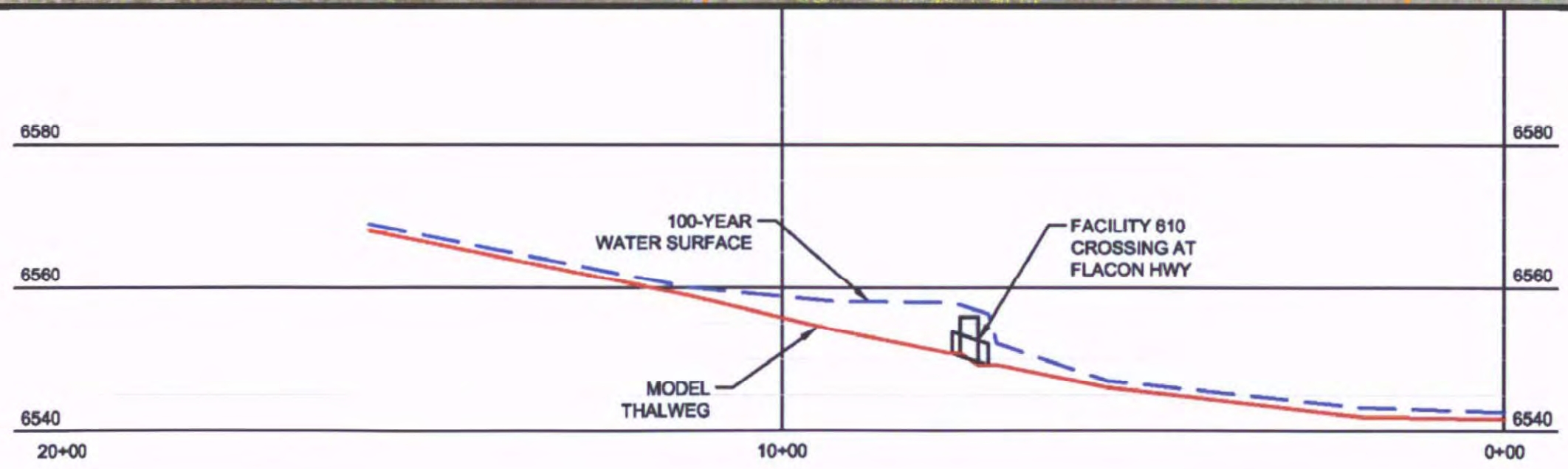
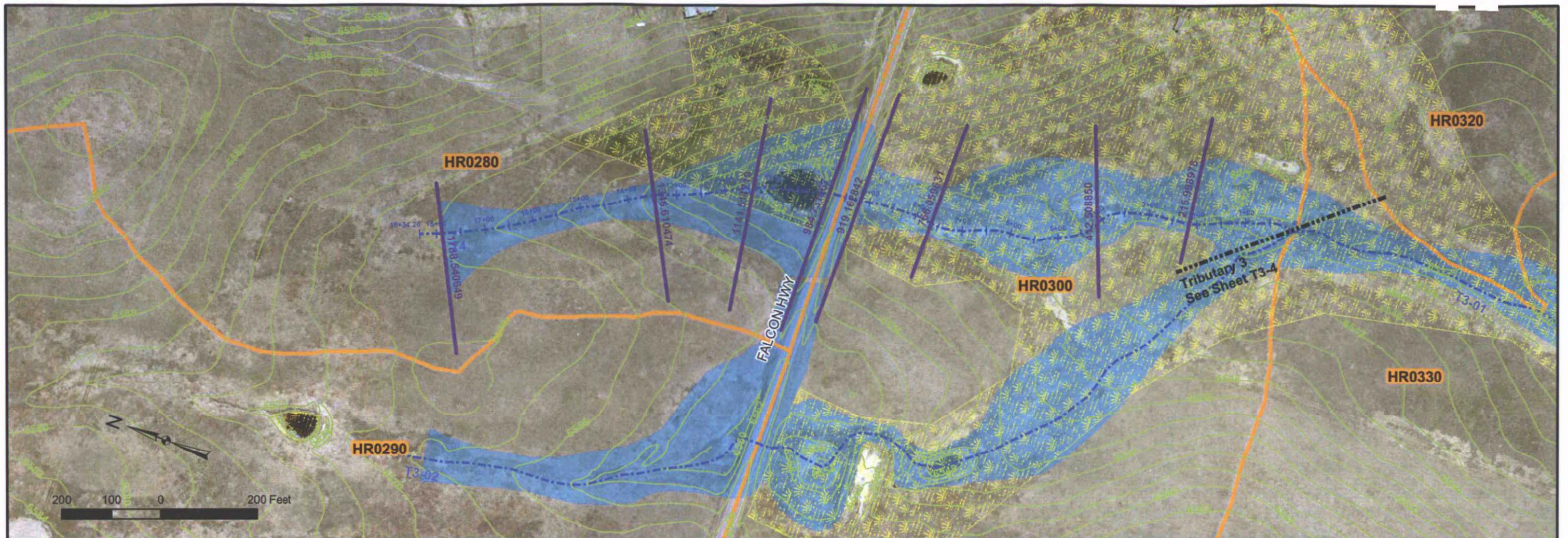


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|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T3-5**  
**FIGURE 5-4**





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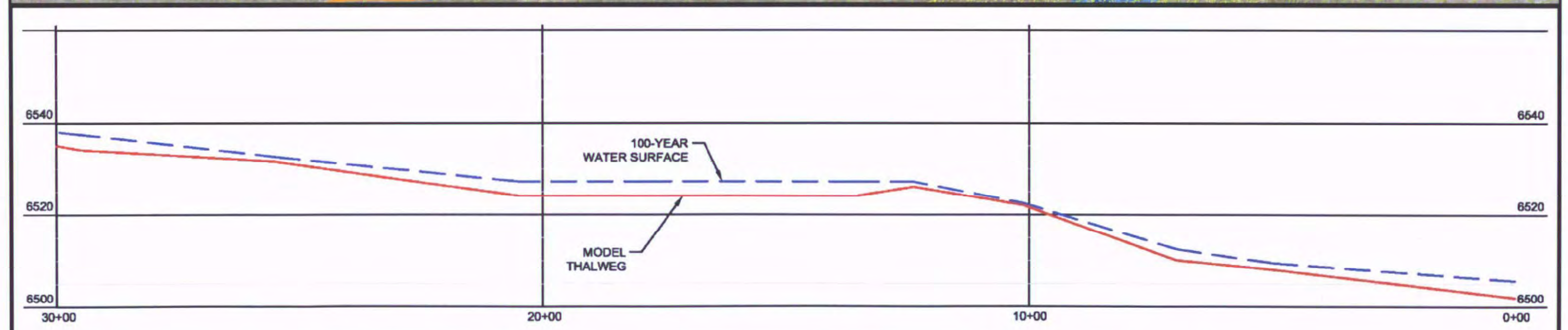
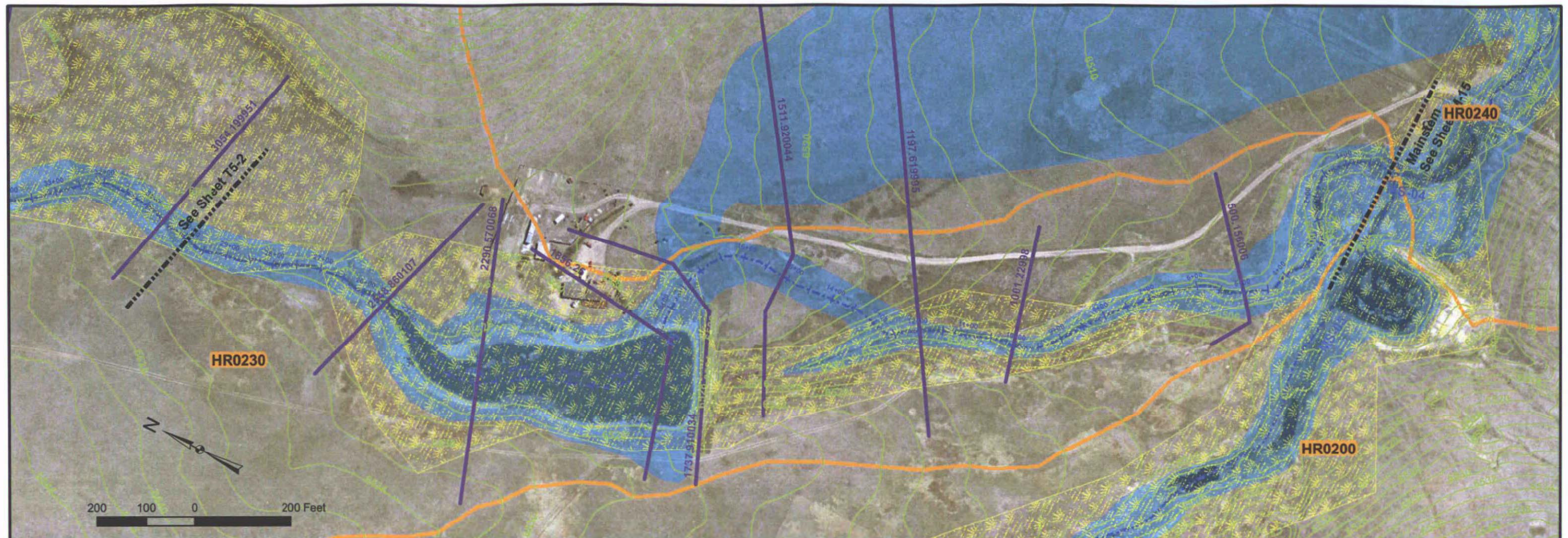


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|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T4-1**  
**FIGURE 5-4**





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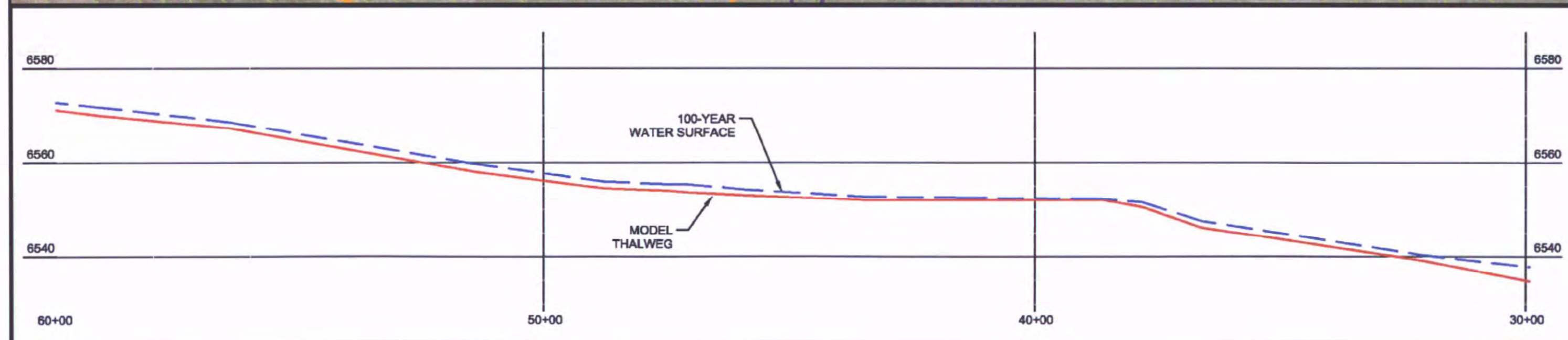
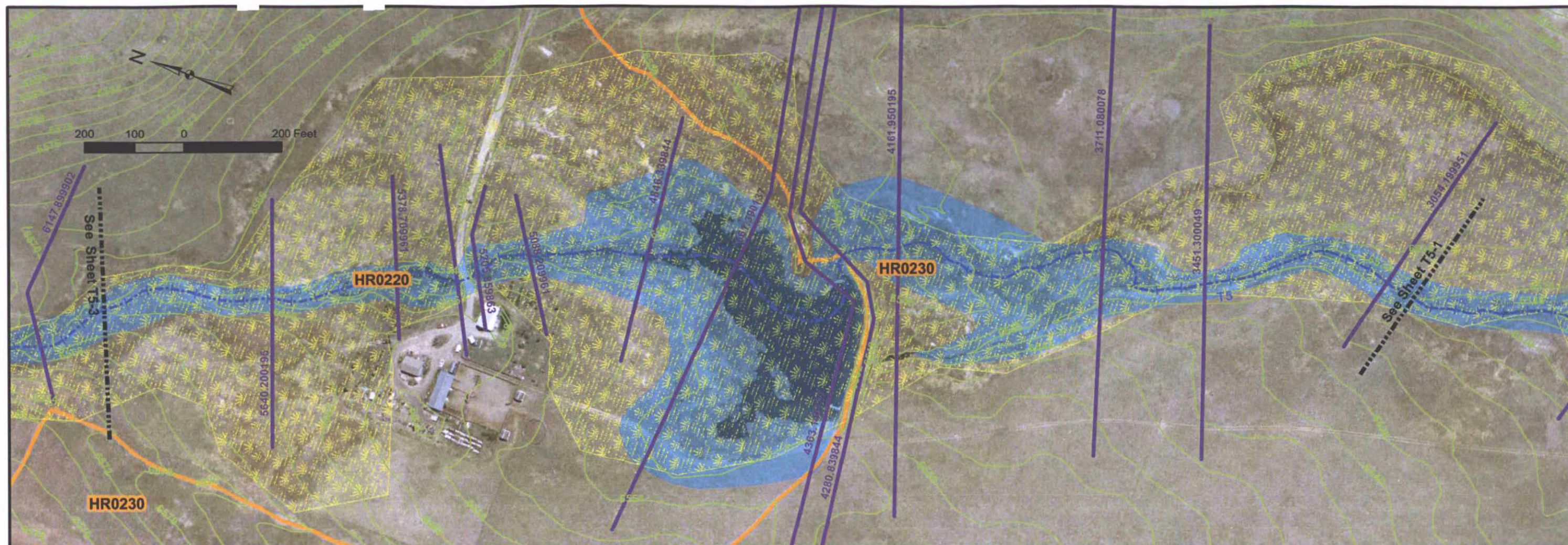


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|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

DATE: 05/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T5-1**  
**FIGURE 5-4**





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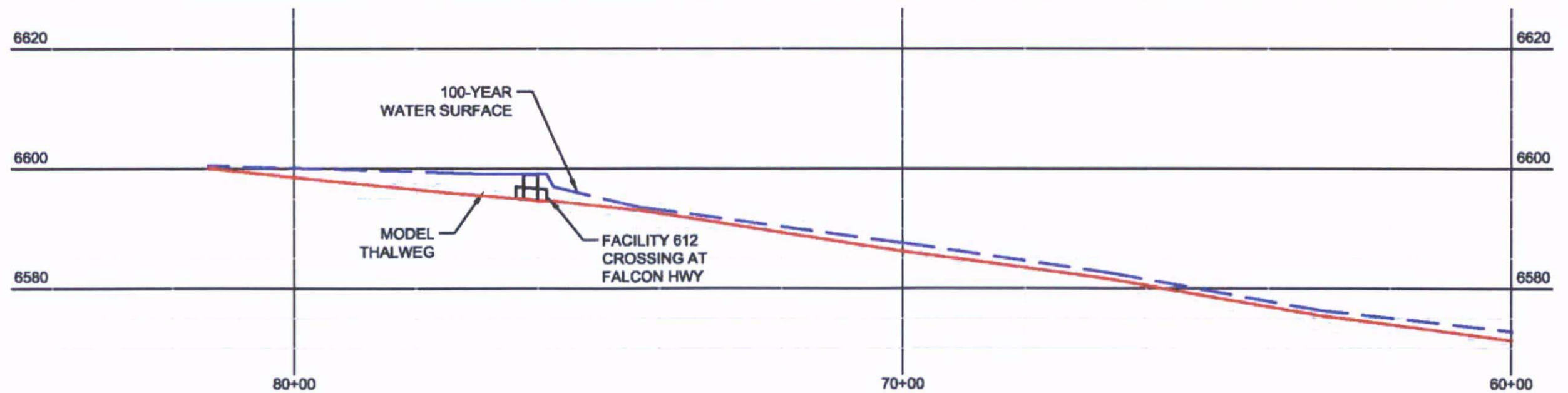
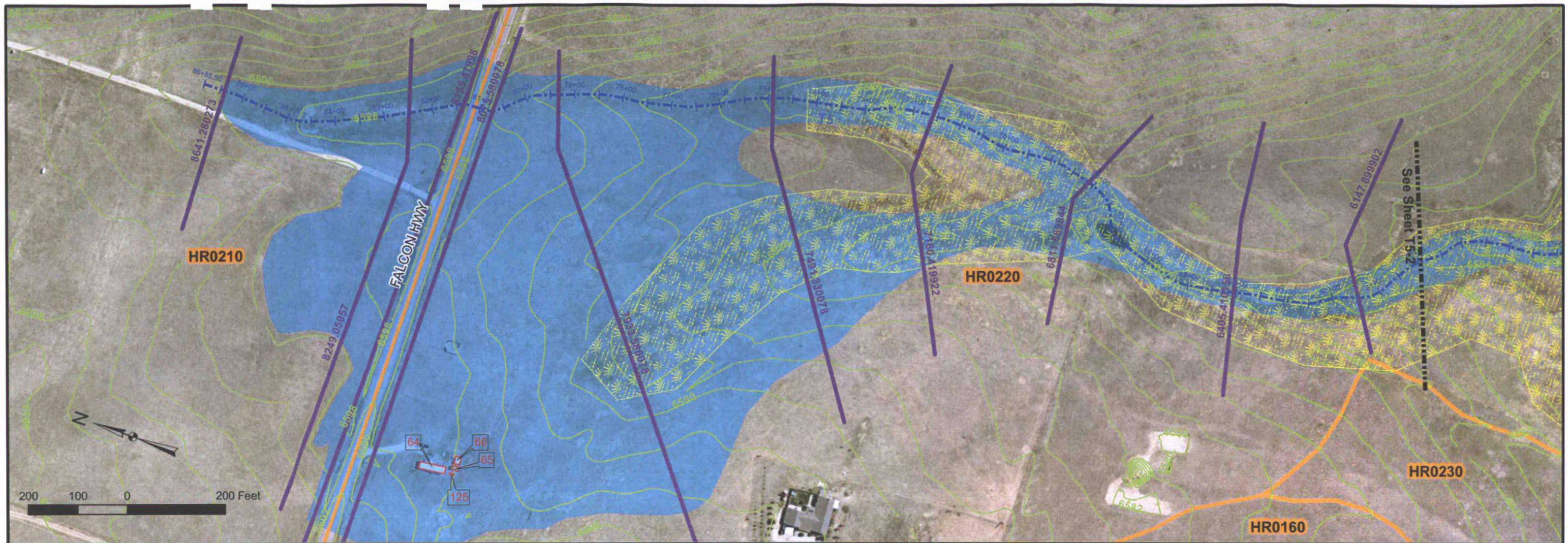


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|---------------------------------|----------------|
| Potential Wetlands              | Thalweg        |
| Subbasin Boundaries             | Cross Sections |
| Approximate 100-Year Floodplain | 2' Contours    |

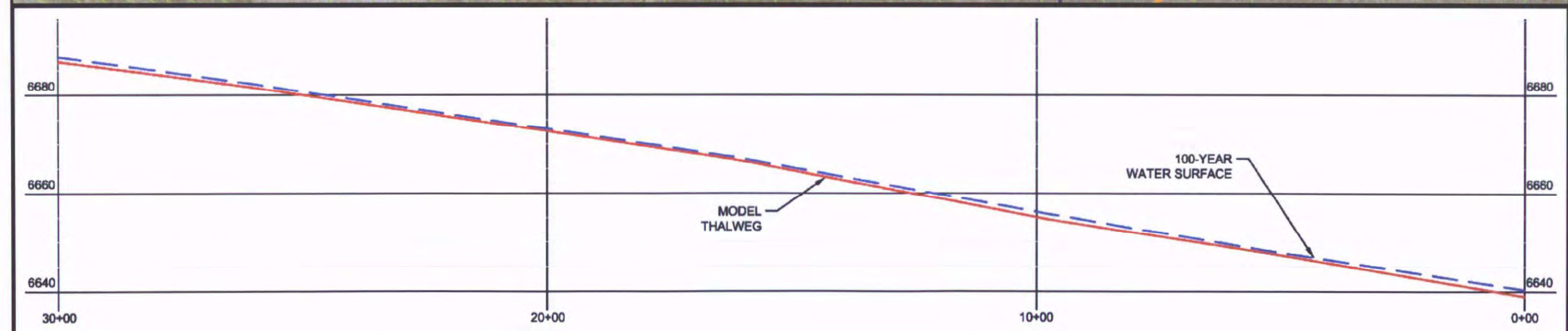
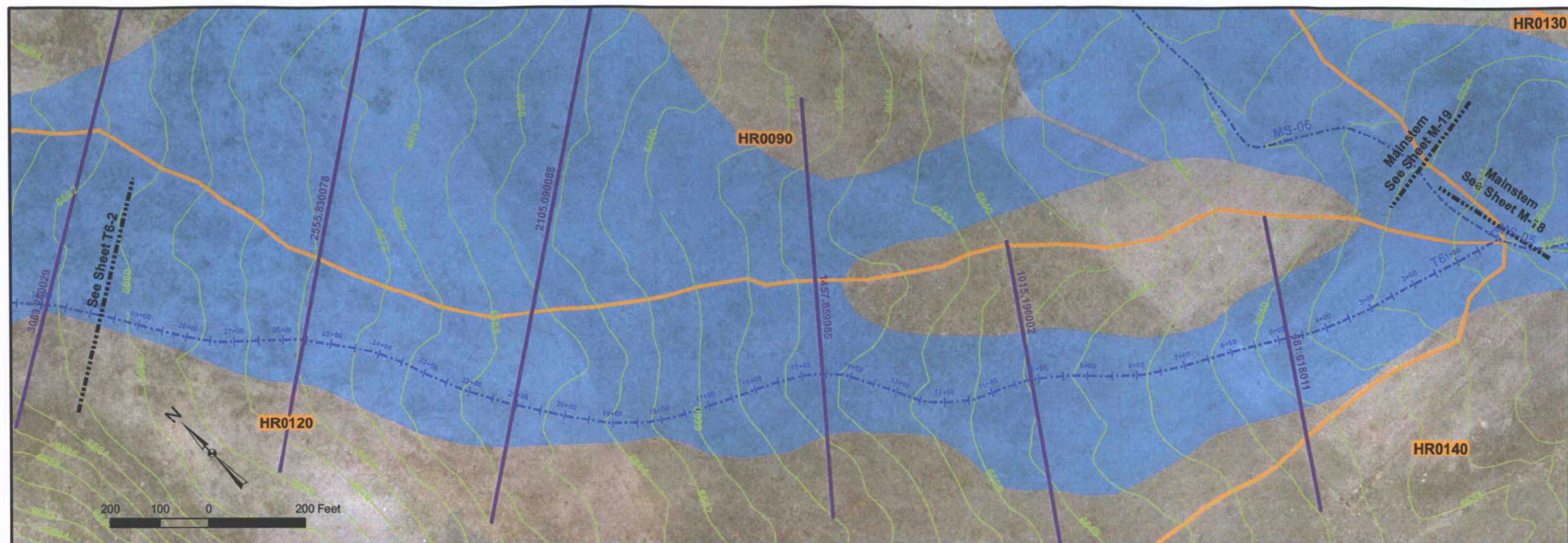
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**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T5-2**  
**FIGURE 5-4**












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Subbasin Boundaries

Approximate 100-Year Floodplain

Thalweg

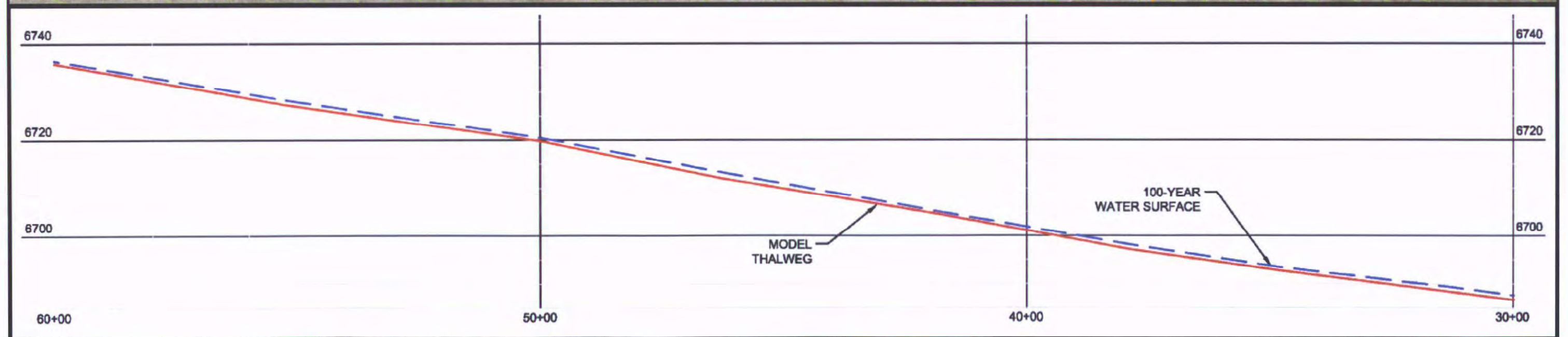
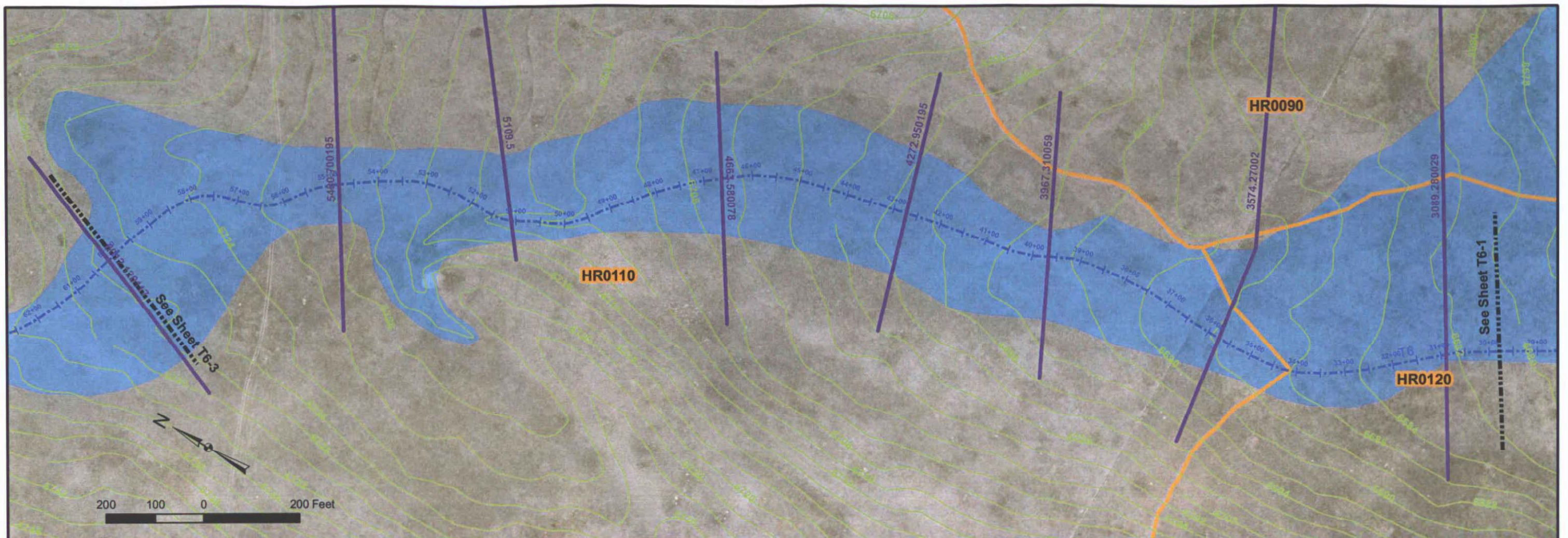
Cross Sections

2' Contours

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


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Subbasin Boundaries
 

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 Thalweg
  Cross Sections
 

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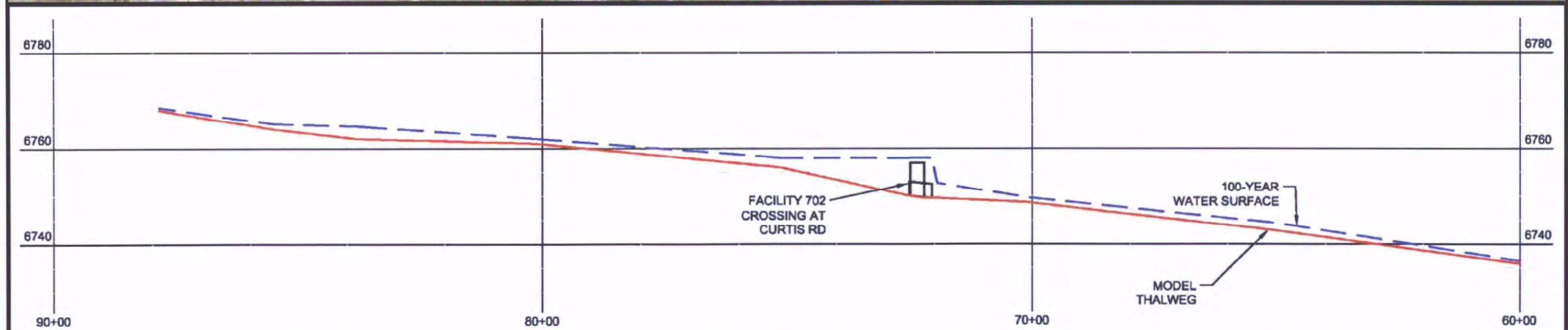
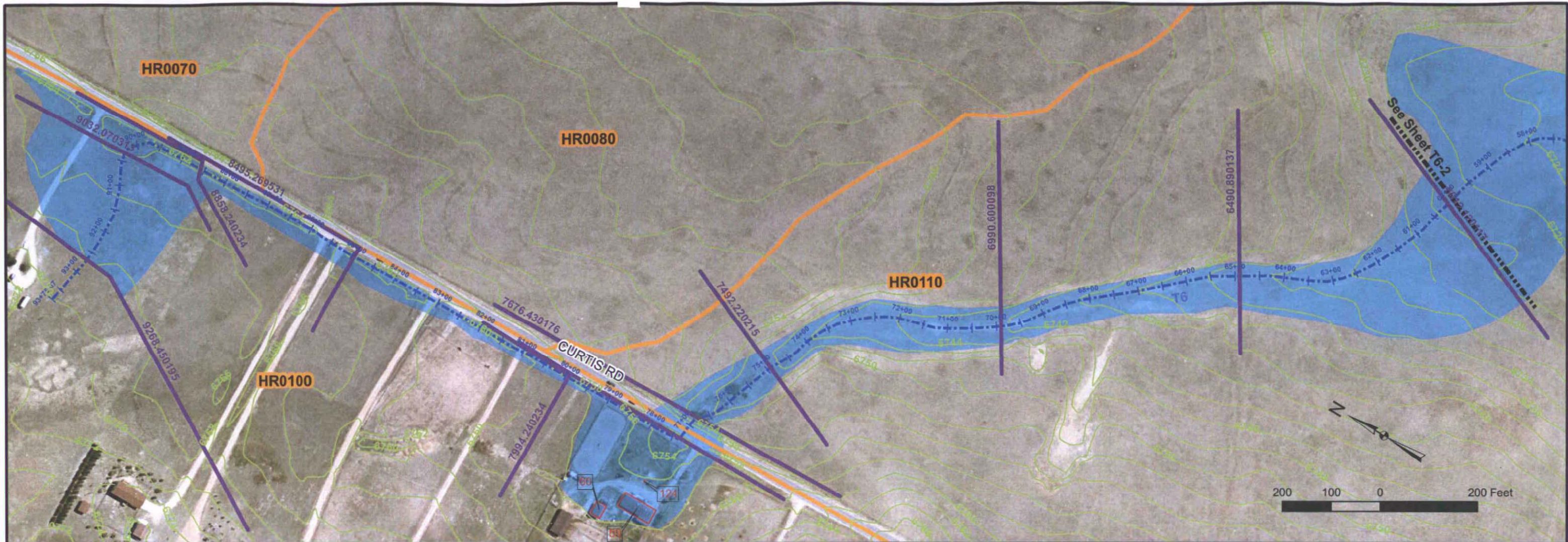
 2' Contours

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

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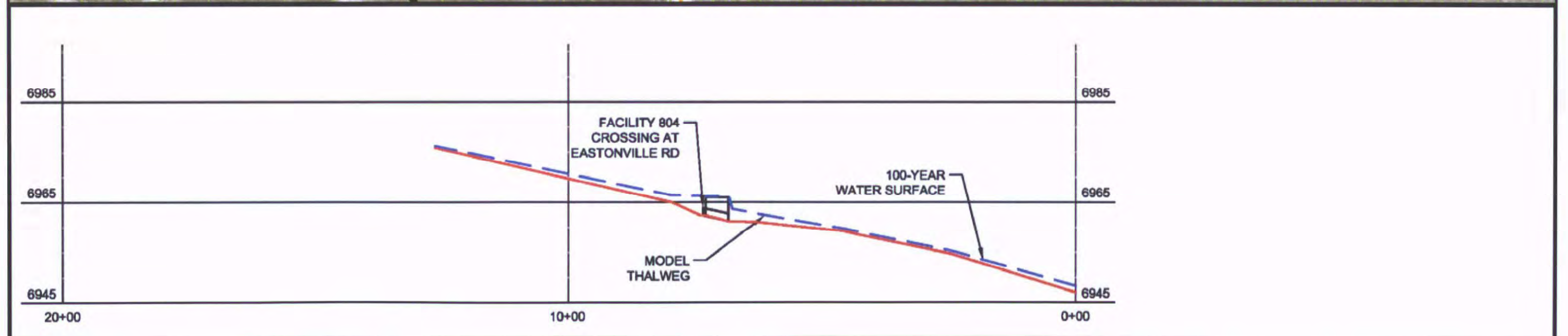
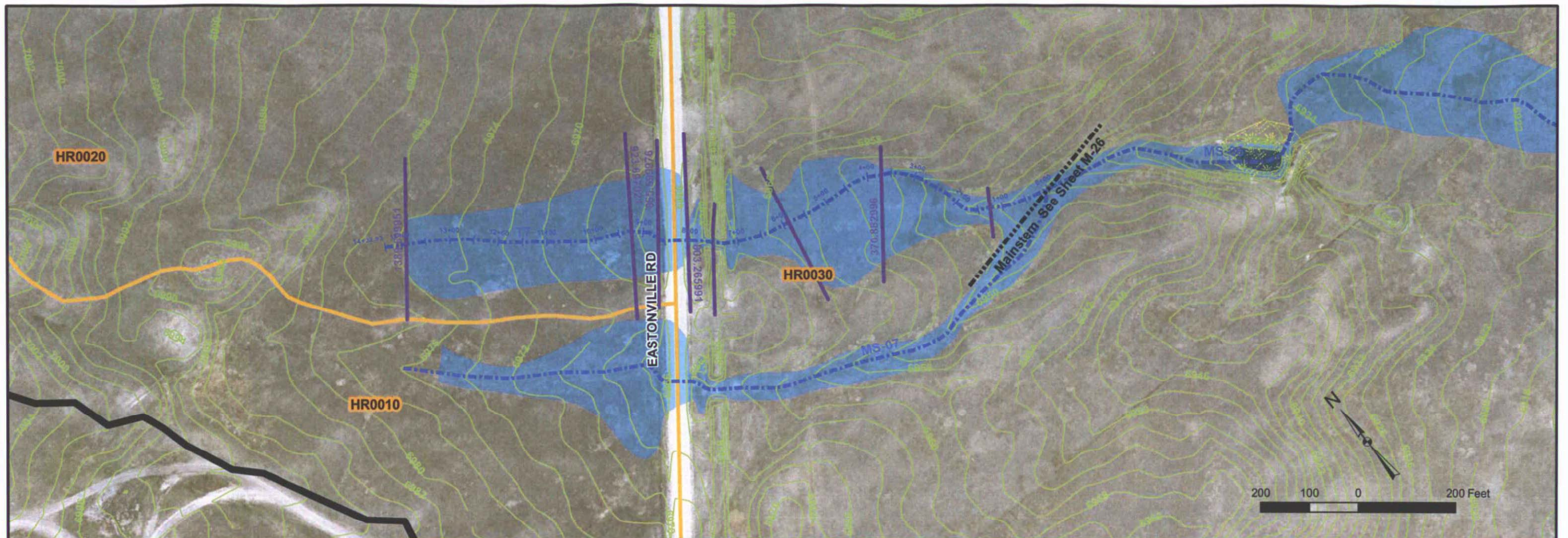


- Subbasin Boundaries
- Thalweg
- Approximate 100-Year Floodplain
- Cross Sections
- 2' Contours

DATE: 09/08

**HAEGLER RANCH DRAINAGE BASIN**  
**APPROXIMATE 100-YEAR FLOOD LIMITS**  
**SHEET T6-3**  
**FIGURE 5-4**





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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**



## 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 alternative 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

Facility Number	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency	Necessary Facility
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	Pedestrian 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

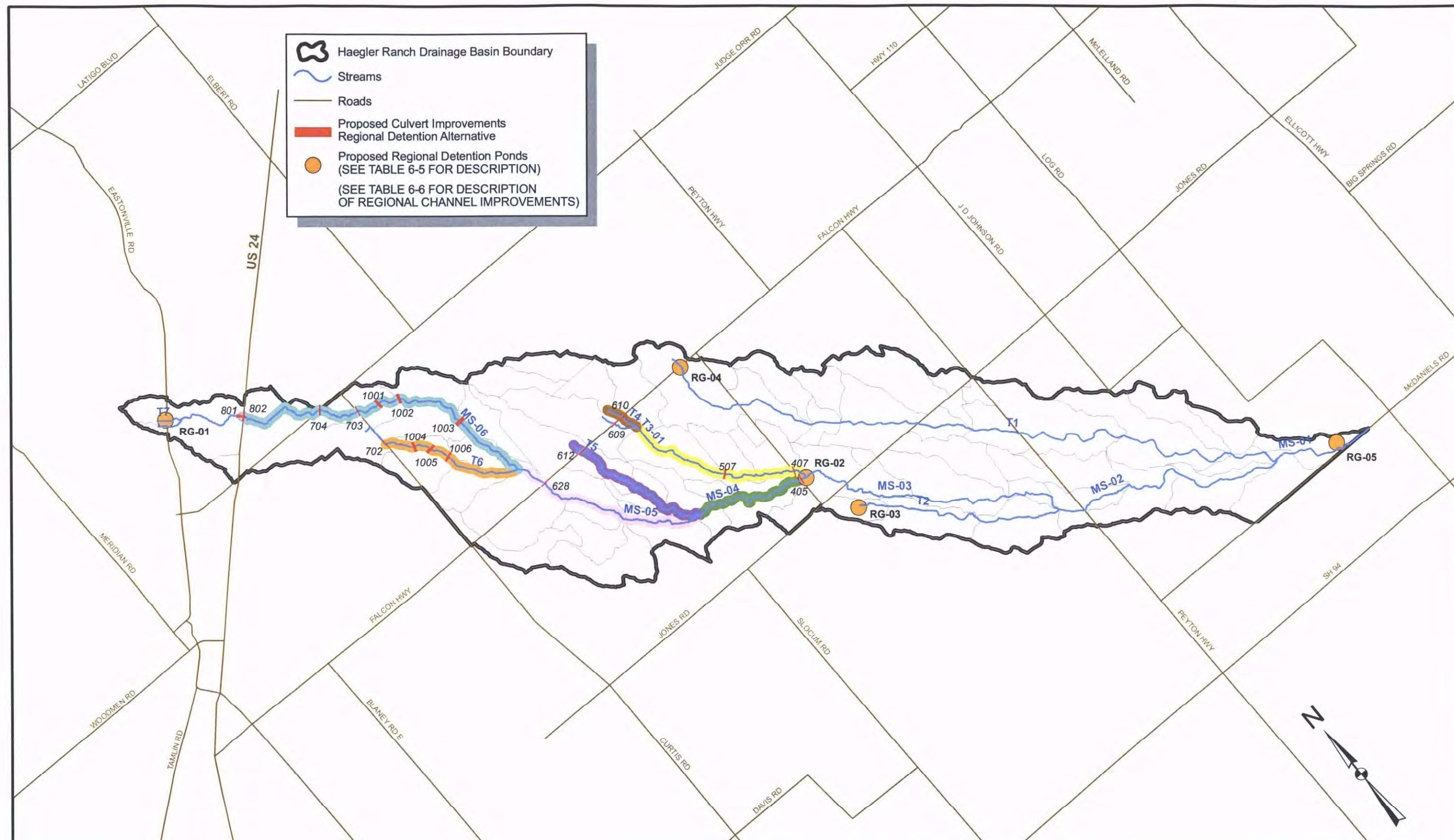
#### 6.3.1. Regional Detention

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.



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**HAEGLER RANCH DRAINAGE BASIN  
 REGIONAL DETENTION  
 ALTERNATIVES  
 FIGURE 6-1**



**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

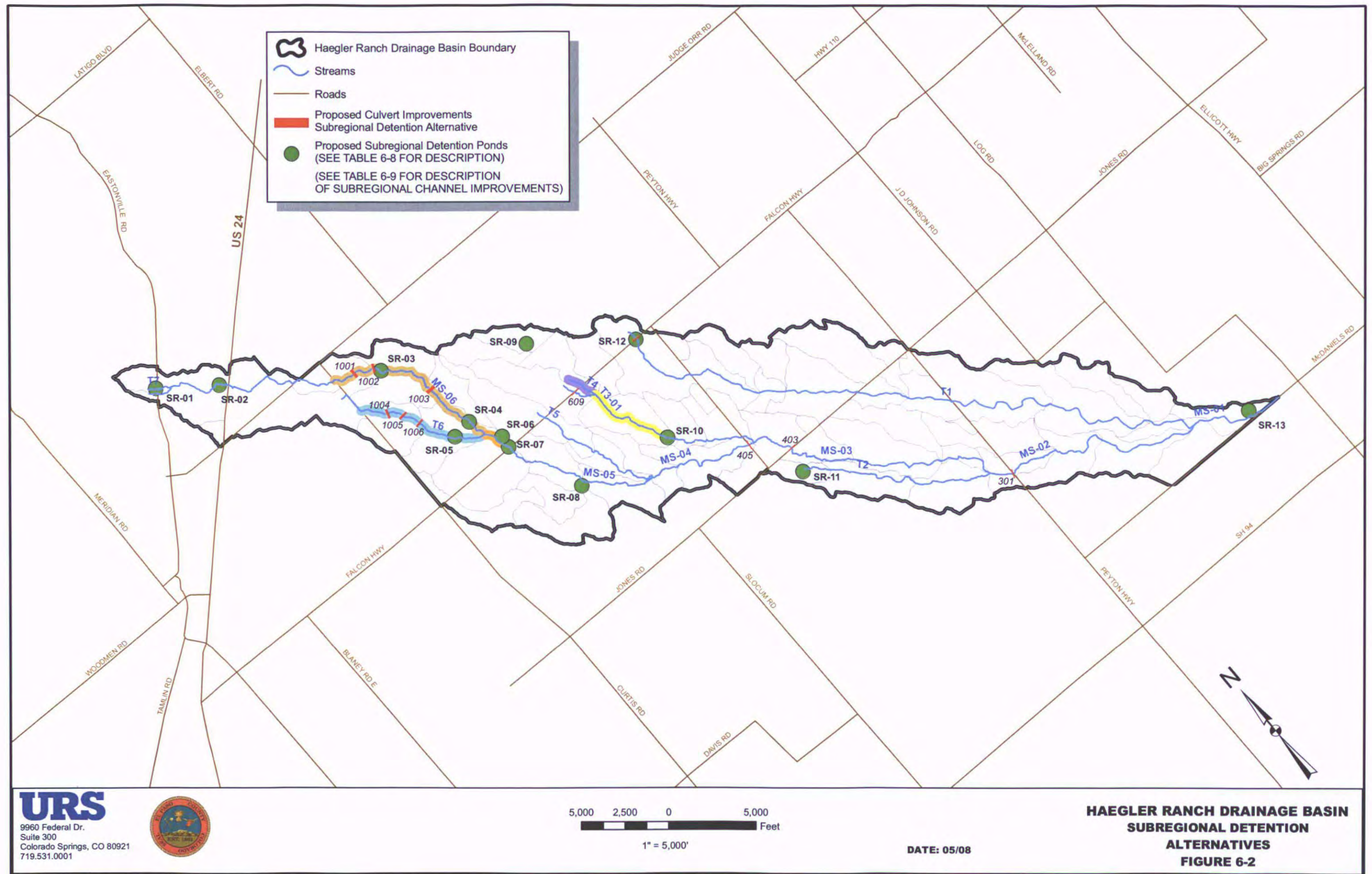
#### 6.3.2.2. Culverts

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.

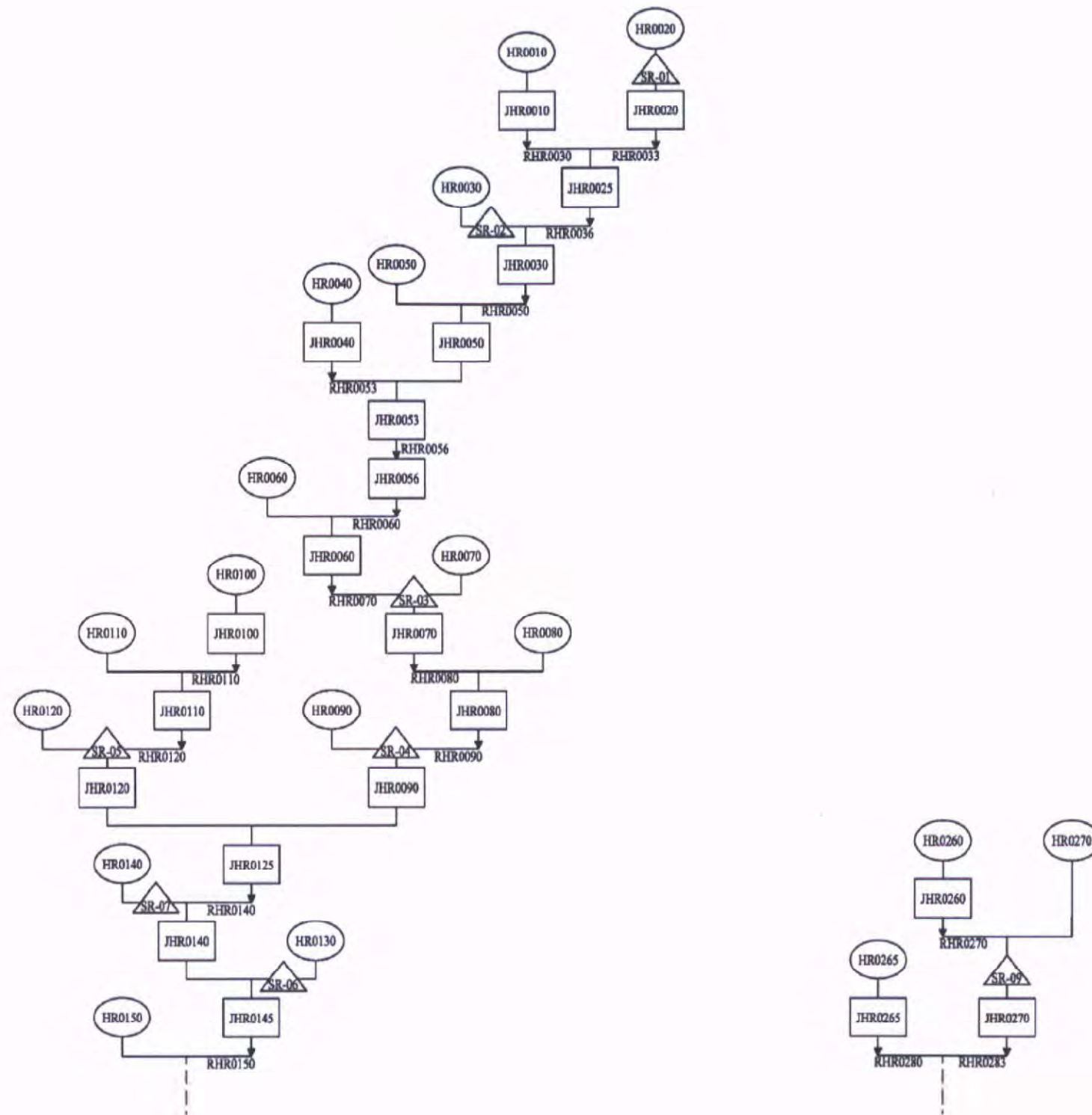
**Table 6-10 Culvert Design for Subregional Detention Alternative**

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









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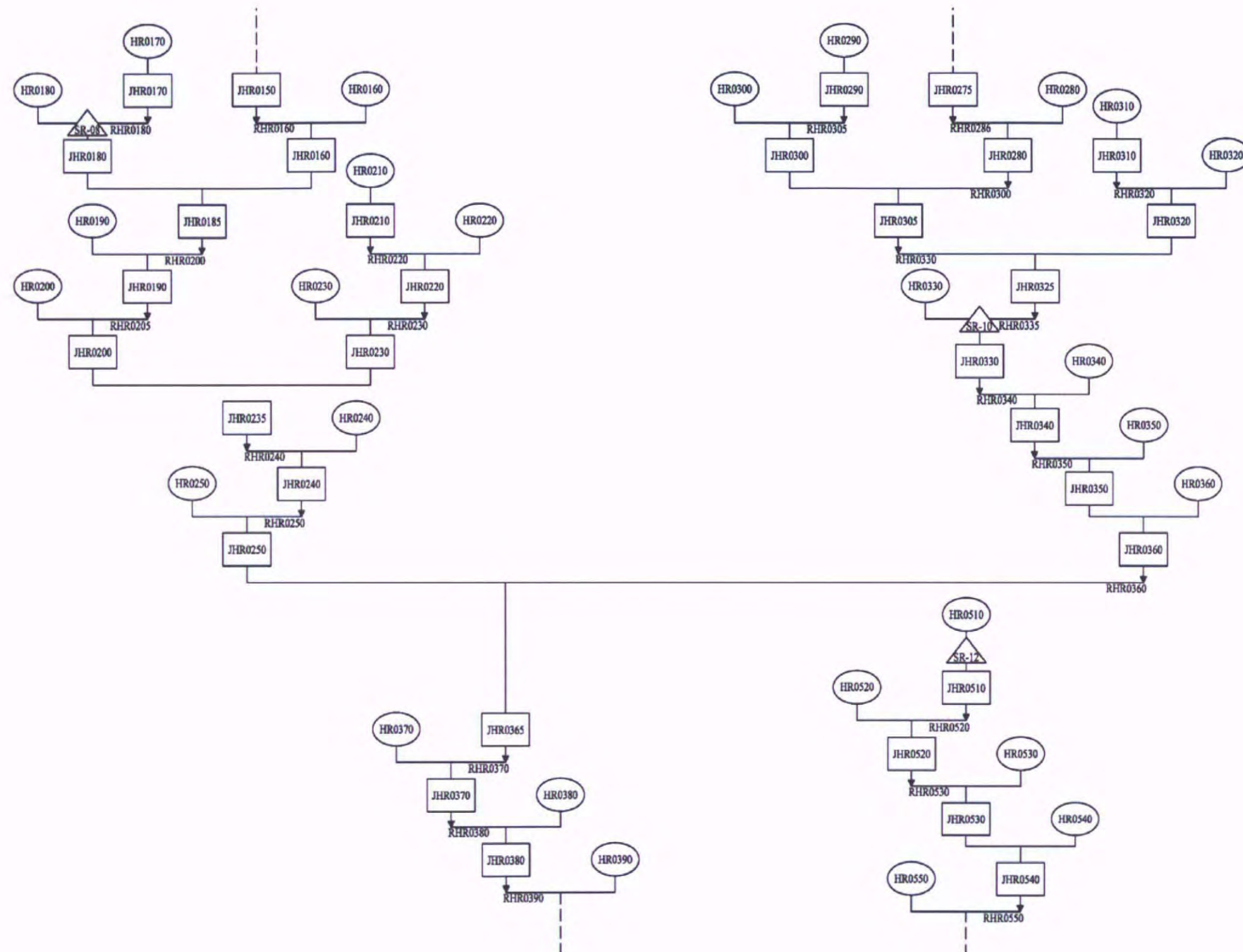


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**HAEGLER RANCH DRAINAGE BASIN  
SUBREGIONAL DETENTION ALTERNATIVE  
SHEET 1  
FIGURE 6-3**

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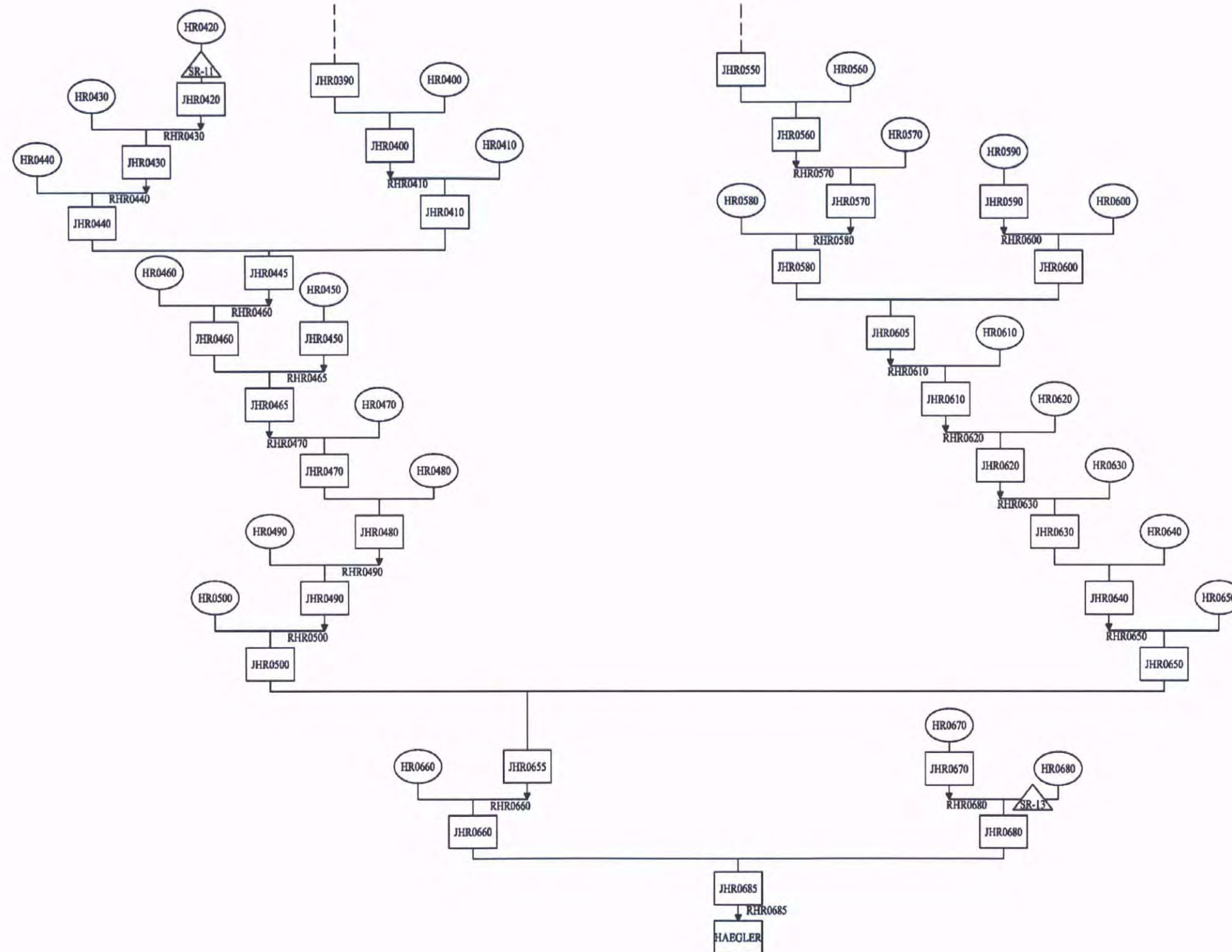
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**HAEGLER RANCH DRAINAGE BASIN  
SUBREGIONAL DETENTION ALTERNATIVE  
SHEET 2  
FIGURE 6-3**

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**HAEGLER RANCH DRAINAGE BASIN  
SUBREGIONAL DETENTION ALTERNATIVE  
SHEET 3  
FIGURE 6-3**

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## 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

Item Number	Description	Units	URS Estimated Unit Price
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 Summary

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 DCM 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 <sub>E</sub> (acres)= 1814		A <sub>E</sub> (acres)= 3692	
	Q <sub>100</sub> (cfs)	Q <sub>100</sub> (cfs/acre)	Q <sub>100</sub> (cfs)	Q <sub>100</sub> (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 <sub>E</sub> (acres)= 10198		A <sub>E</sub> (acres)= 10491	
	Q <sub>100</sub> (cfs)	Q <sub>100</sub> (cfs/acre)	Q <sub>100</sub> (cfs)	Q <sub>100</sub> (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 aggrade, all detention basins will collect sediment and aggrade. 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	\$663,230
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
<b>Total Cost</b>					<b>\$10,251,636</b>
<b>Total Unplatted Impervious Acres</b>					<b>1,343</b>
<b>Fee Per Impervious Acre</b>					<b>\$7,633</b>

**Table 7-3 Bridge Fee Calculation**

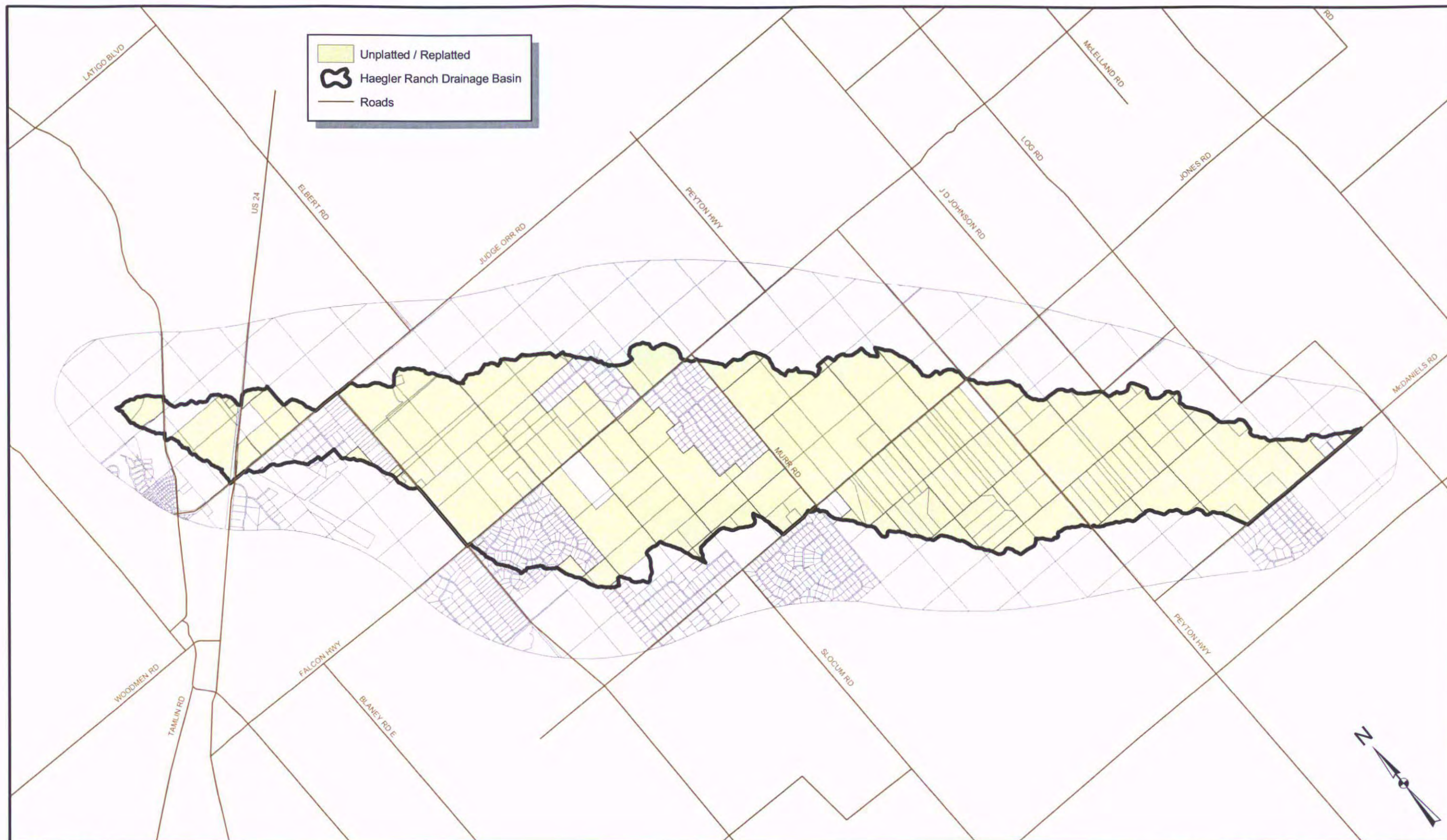
301	Peyton Highway	Main Stem (MS-02)	401,710	\$180,770	\$582,480
403	Jones Road	Main Stem (MS-03)	358,123	\$161,155	\$519,278
405	Murr Road	Main Stem (MS-04)	282,941	\$127,323	\$410,264
Subtotal Bridge Costs					\$1,512,022
<b>Total Cost</b>					<b>\$1,512,022</b>
<b>Total Unplatted Impervious Acres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



**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
<b>Total Reimbursable Cost</b>					<b>\$6,288,444</b>





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

DATE: 02/09

**HAEGLER RANCH DRAINAGE BASIN**  
**AREAS CALCULATED**  
**AS UNPLATTED ACREAGE**  
**FIGURE 7-1**



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## 9.0 APPENDICES



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## **Appendix A HYDROLOGY**

**Reference Attached CD**



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## **Appendix B HYDRAULICS**

**Reference Attached CD**



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## **Appendix C ALTERNATIVES AND COST ESTIMATES**



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Table C1

**Regional Ponds**

Note: Total Costs in Bold have used a minimum expected cost instead of QTY \* COST/UNIT

Pond RG-01				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	14,552	\$15	\$218,284
Seeding	Acres	2	\$505	\$2,608
Topsoil	CY	970	\$8	\$7,761
Land Costs	Acres	2	\$53,000	\$124,025
Outlet Culvert	EACH	1	\$14,150	\$14,150
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$374,000</b>
			30% Construction Contingency	\$112,200
			15% Engineering Contingency	\$56,100
			<b>Total</b>	<b>\$542,300</b>
Pond RG-02				
Detention Reservoir Excavation	CY	104,092	\$15	\$1,561,384
Seeding	Acres	13	\$505	\$7,484
Topsoil	CY	6,934	\$8	\$55,472
Land Costs	Acres	14	\$55,000	\$770,000
Outlet Culvert	EACH	1	\$352,950	\$352,950
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$2,795,306</b>
			30% Construction Contingency	\$838,592
			15% Engineering Contingency	\$419,296
			<b>Total</b>	<b>\$4,053,194</b>
Pond RG-03				
Detention Reservoir Excavation	CY	85	\$7	\$5,950
Seeding	Acres	1	\$505	\$2,505
Topsoil	CY	538	\$8	\$5,904
Land Costs	Acres	1	\$55,000	\$55,000
Outlet Culvert	EACH	1	\$12,500	\$12,500
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$101,030</b>
			30% Construction Contingency	\$30,309
			15% Engineering Contingency	\$15,155
			<b>Total</b>	<b>\$146,494</b>
Pond RG-04				
Detention Reservoir Excavation	CY	1,726	\$7	\$12,084
Seeding	Acres	1	\$505	\$2,505
Topsoil	CY	538	\$8	\$5,904
Land Costs	Acres	1	\$55,000	\$55,000
Outlet Culvert	EACH	1	\$14,400	\$14,400
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$110,014</b>
			30% Construction Contingency	\$33,004
			15% Engineering Contingency	\$16,502
			<b>Total</b>	<b>\$159,520</b>
Pond RG-05				
Detention Reservoir Excavation	CY	46	\$7	\$3,220
Seeding	Acres	1	\$505	\$2,505
Topsoil	CY	538	\$8	\$5,904
Land Costs	Acres	1	\$55,000	\$55,000
Outlet Culvert	EACH	1	\$12,475	\$12,475
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$101,005</b>
			30% Construction Contingency	\$30,302
			15% Engineering Contingency	\$15,151
			<b>Total</b>	<b>\$146,457</b>
			<b>Subtotal Regional Ponds</b>	<b>\$5,047,885</b>

**Sub-Regional Ponds**

Note: Total Costs in Bold have used a minimum expected cost instead of QTY \* COST/UNIT

Pond SR-01				
Detention Reservoir Excavation	CY	26,000	\$8	\$208,000
Seeding	Acres	5	\$505	\$2,525
Topsoil	CY	2,326	\$8	\$18,608
Land Costs	Acres	8	\$55,000	\$440,000
Outlet Culvert	EACH	1	\$25,275	\$25,275
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$679,626</b>
			30% Construction Contingency	\$203,888
			15% Engineering Contingency	\$101,943
			<b>Total</b>	<b>\$985,457</b>
Pond SR-02				
Detention Reservoir Excavation	CY	18,330	\$8	\$146,640
Seeding	Acres	3	\$505	\$1,515
Topsoil	CY	1,508	\$8	\$12,064
Land Costs	Acres	4	\$55,000	\$220,000
Outlet Culvert	EACH	1	\$18,490	\$18,490
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$411,690</b>
			30% Construction Contingency	\$123,507
			15% Engineering Contingency	\$61,755
			<b>Total</b>	<b>\$596,952</b>
Pond SR-03				
Detention Reservoir Excavation	CY	14,141	\$8	\$113,128
Seeding	Acres	4	\$505	\$2,020
Topsoil	CY	3,227	\$8	\$25,816
Land Costs	Acres	8	\$55,000	\$440,000
Outlet Culvert	EACH	1	\$22,410	\$22,410
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$598,752</b>
			30% Construction Contingency	\$179,626
			15% Engineering Contingency	\$89,813
			<b>Total</b>	<b>\$868,191</b>
Pond SR-04				
Detention Reservoir Excavation	CY	29,798	\$8	\$238,384
Seeding	Acres	5	\$505	\$2,525
Topsoil	CY	4,798	\$8	\$38,384
Land Costs	Acres	11	\$55,000	\$605,000
Outlet Culvert	EACH	3	\$23,960	\$71,880
Outlet Structure	EACH	1	\$7,280	\$7,280
			<b>Subtotal</b>	<b>\$1,002,057</b>
			30% Construction Contingency	\$300,617
			15% Engineering Contingency	\$150,309
			<b>Total</b>	<b>\$1,452,983</b>



Pond SR-05					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	42,235	\$2	\$84,470	
Seeding	Acres	8	\$580	\$4,640	
Topsoil	CY	4,847	\$5	\$24,235	
Land Costs	Acres	11	\$55,000	\$605,000	
Outlet Culvert	EAACH	1	\$23,500	\$23,500	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$1,073,985	
30% Construction Contingency				\$322,196	
15% Engineering Contingency				\$161,098	
Total				\$1,557,278	
Pond SR-06					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	11,480	\$2	\$22,960	
Seeding	Acres	4	\$580	\$2,320	
Topsoil	CY	2,312	\$5	\$11,560	
Land Costs	Acres	4	\$55,000	\$220,000	
Outlet Culvert	EAACH	1	\$5,250	\$5,250	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$377,170	
30% Construction Contingency				\$113,151	
15% Engineering Contingency				\$56,575	
Total				\$546,896	
Pond SR-07					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	13,880	\$2	\$27,760	
Seeding	Acres	3	\$580	\$1,740	
Topsoil	CY	1,560	\$5	\$7,800	
Land Costs	Acres	4	\$55,000	\$220,000	
Outlet Culvert	EAACH	1	\$15,000	\$15,000	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$301,421	
30% Construction Contingency				\$90,426	
15% Engineering Contingency				\$45,213	
Total				\$436,860	
Pond SR-08					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	8,730	\$2	\$17,460	
Seeding	Acres	2	\$580	\$1,160	
Topsoil	CY	1,078	\$5	\$5,390	
Land Costs	Acres	3	\$55,000	\$165,000	
Outlet Culvert	EAACH	1	\$12,880	\$12,880	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$224,960	
30% Construction Contingency				\$67,488	
15% Engineering Contingency				\$33,744	
Total				\$326,192	
Pond SR-09					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	11,210	\$2	\$22,420	
Seeding	Acres	6	\$580	\$3,480	
Topsoil	CY	3,173	\$5	\$15,865	
Land Costs	Acres	7	\$55,000	\$385,000	
Outlet Culvert	EAACH	1	\$15,275	\$15,275	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$453,875	
30% Construction Contingency				\$136,163	
15% Engineering Contingency				\$68,081	
Total				\$658,119	
Pond SR-10					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	20,000	\$2	\$40,000	
Seeding	Acres	10	\$580	\$5,800	
Topsoil	CY	3,173	\$5	\$15,865	
Land Costs	Acres	7	\$55,000	\$385,000	
Outlet Culvert	EAACH	1	\$15,550	\$15,550	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$511,775	
30% Construction Contingency				\$153,533	
15% Engineering Contingency				\$76,767	
Total				\$742,075	
Pond SR-11					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	3,800	\$2	\$7,600	
Seeding	Acres	1	\$580	\$580	
Topsoil	CY	1,560	\$5	\$7,800	
Land Costs	Acres	1	\$55,000	\$55,000	
Outlet Culvert	EAACH	1	\$7,900	\$7,900	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$86,460	
30% Construction Contingency				\$25,938	
15% Engineering Contingency				\$12,969	
Total				\$125,367	
Pond SR-12					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	7,890	\$2	\$15,780	
Seeding	Acres	3	\$580	\$1,740	
Topsoil	CY	1,221	\$5	\$6,105	
Land Costs	Acres	4	\$55,000	\$220,000	
Outlet Culvert	EAACH	1	\$14,700	\$14,700	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$271,605	
30% Construction Contingency				\$81,482	
15% Engineering Contingency				\$40,741	
Total				\$393,828	
Pond SR-13					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	5,953	\$2	\$11,906	
Seeding	Acres	2	\$580	\$1,160	
Topsoil	CY	1,333	\$5	\$6,665	
Land Costs	Acres	3	\$55,000	\$165,000	
Outlet Culvert	EAACH	1	\$24,500	\$24,500	
Outlet Structure	EAACH	1	\$7,280	\$7,280	
Subtotal				\$226,516	
30% Construction Contingency				\$67,955	
15% Engineering Contingency				\$34,028	
Total				\$328,499	
Land Acquisition Subtotal				\$3,785,725	
Subtotal SubRegional Ponds				\$8,779,835	



Table C2  
Outlet Pipe Cost Estimates

Detention	Pipe Size (in)	Number of Barrels	Pipe Length (ft)	Slope (ft/ft)	Pipe Cost	End Section Cost	Total Cost
SR-01	36	1	300	0.02	\$24,000	\$1,275	\$25,275
SR-02	48	1	150	0.03	\$16,500	\$1,990	\$18,490
SR-03	72	1	87	0.02	\$20,010	\$2,400	\$22,410
SR-04	54	3	150	0.02	\$65,250	\$6,450	\$71,700
SR-05	54	1	150	0.02	\$21,750	\$2,150	\$23,900
SR-06	24	1	150	0.02	\$8,400	\$850	\$9,250
SR-07	42	1	135	0.02	\$13,500	\$1,550	\$15,050
SR-08	48	1	100	0.02	\$11,000	\$1,990	\$12,990
SR-09	36	1	175	0.01	\$14,000	\$1,275	\$15,275
SR-10	60	2	300	0.01	\$111,000	\$4,550	\$115,550
SR-11	30	1	100	0.03	\$6,800	\$1,100	\$7,900
SR-12	30	1	200	0.01	\$13,600	\$1,100	\$14,700
SR-13	48	1	300	0.01	\$33,000	\$1,990	\$34,990
RG-01	36	1	150	0.01	\$12,000	\$2,150	\$14,150
RG-02	6x6	6	300	0.01	\$333,000	\$49,950	\$382,950
RG-03	30	1	150	0.01	\$10,200	\$2,300	\$12,500
RG-04	36	1	150	0.01	\$12,000	\$2,400	\$14,400
RG-05	30	1	150	0.01	\$12,000	\$475	\$12,475



Table C3  
Existing Condition Culvert Improvements Cost Estimate

Facility Number	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency	Necessary Facility for Existing 100-year Flow	Number of Culverts	Assumed Length (LF) <sup>1</sup>	Unit Cost	End Section Unit Cost	Headwall Concrete (LF/HW)	Headwall Steel (LB/HW)	Wingwall Concrete (CY)	Wingwall Steel (tons)	Concrete Unit Cost \$/CY	Steel Unit Cost \$/ton	Total Cost
301	Peyton Highway	Main Stem (MS-02)	2-33"X48" CMPs	2,500	Overtops	7-6'X6' RCBs	7	90	\$475		0.581	151	19.7	774.4	\$435	\$1.1	\$314,535
401	Jones Road	Tributary 1 (T1)	2-24" CMPs	370	Overtops	6'X6' RCB	1	90	\$475		0.652	169.4	19.7	774.4	\$435	\$1.1	\$53,111
403	Jones Road	Main Stem (MS-03)	3-60" CMPs	2,300	Overtops	6-6'X6' RCBs	6	90	\$475		0.581	151	19.7	774.4	\$435	\$1.1	\$270,947
405	Murr Road	Main Stem (MS-04)	66" RCP	1,700	Overtops	5-6'X6' RCBs	5	70	\$475		0.652	169.4	19.7	774.4	\$435	\$1.1	\$180,371
407	Murr Road	Tributary 3 (T3-01)	66" RCP	670	Overtops	2-6'X6' RCBs	2	70	\$475		0.652	169.4	19.7	774.4	\$435	\$1.1	\$77,801
507	Peerless Farms Road	Tributary 3 (T3-01)	60" CMP	600	Overtops	2-6'X6' RCBs	2	110	\$475		0.652	169.4	19.7	774.4	\$435	\$1.1	\$115,801
509	Murr Road	Tributary 1 (T1)	2-15" RCPs	220	Overtops	66" RCP	1	70	\$210	\$2,300							\$19,300
601	Whiting Way	Tributary 1 (T1)	24" CMP	220	Overtops	66" RCP	1	90	\$210	\$2,300							\$23,500
604	Max Road	Tributary 1 (T1)	18" CMP	220	Overtops	66" RCP	1	70	\$210	\$2,300							\$19,300
609	Falcon Highway	Tributary 3 (T3-02)	18" CMP	180	Overtops	66" RCP	1	100	\$210	\$2,300							\$25,600
610	Falcon Highway	Tributary 4 (T4)	24" CMP	200	Overtops	66" RCP	1	90	\$210	\$2,300							\$23,500
612	Falcon Highway	Tributary 5 (T5)	24" CMP	150	Overtops	60" RCP	1	90	\$185	\$2,275							\$21,200
628	Falcon Highway	Main Stem (MS-05)	2-60" CMPs	1,000	Overtops	3-6'X6' RCBs	3	100	\$475		0.652	169.4	19.7	774.4	\$435	\$1.1	\$154,741
702	Curtis Road	Tributary 6 (T6)	36" CMP	120	Overtops	54" RCP	1	130	\$145	\$2,150							\$23,150
703	Curtis Road	Main Stem (MS-06)	24" CMP	590	Overtops	2-6'X6' RCBs	2	120	\$475		0.652	169.4	19.7	774.4	\$435	\$1.1	\$125,301
704	Judge Orr Road	Main Stem (MS-06)	Blocked Culvert	540	Overtops	2-72" RCPs	2	160	\$230	\$2,400							\$83,200
801	Pedestrian Bridge	Main Stem (MS-06)	Bridge	350	Meets Capacity	Existing Bridge											\$0
802	US24	Main Stem (MS-06)	2-66" CMPs	350	Meets Capacity	Existing Culvert											\$0
803	Eastonville Road	Main Stem (MS-07)	27"X21" CMP	25	Overtops	30" RCP	1	110	\$68	\$1,100							\$9,680
804	Eastonville Road	Tributary 7 (T7)	18" CMP	99	Overtops	48" RCP	1	100	\$110	\$1,990							\$14,980
N/A	Peyton Highway	Tributary 1 (T1)	No Culvert	500	Overtops	2-72" RCPs	2	90	\$230	\$2,400							\$51,000
N/A	Falcon Highway	Tributary 1 (T1)	No Culvert	33	Overtops	36" RCP	1	90	\$80	\$1,275							\$9,750

<sup>1</sup> Length is based on Future Land Use Road widths

<sup>2</sup> Wingwalls assumed 15' long for calculations. Calculations based on CDOT cross sections.

Sub-Total	\$1,616,769
30% Construction Contingency	\$485,031
15% Engineering Contingency	\$242,515
Total	\$2,344,315



Table C4

Regional Detention Alternative Culvert Cost Calculation

Facility Number	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency	Necessary Facility for Existing 100-year Flow	Proposed 100-yr Flow (cfs)	Deficiency	Necessary Facility for Proposed 100-year Flow	Number of Culverts	Assumed Length (LF) <sup>1</sup>	Unit Cost	End Section Unit Cost	Headwall Concrete (LF/HW)	Headwall Steel (LB/HW)	Wingwall <sup>2</sup> Concrete (CY)	Wingwall <sup>2</sup> Steel (tons)	Concrete Unit Cost \$/CY	Steel Unit Cost \$/ton	Total Cost
405	Murr Road	Main Stem (MS-04)	66" RCP	2,200	Overtops	5-6'X6' RCBs	3,400	Overtops	6-10x6 Box	6	70	\$570		0.581	151	24.42	1144	\$435	\$1.10	\$256,307
507	Peerless Farms Road	Tributary 3 (T3-01)	60" CMP	600	Overtops	2-6'X6' RCBs	1200	Overtops	2-10x6 Box	2	110	\$570		0.581	151	24.42	1144	\$435	\$1.10	\$138,956
609	Falcon Highway	Tributary 3 (T3-02)	18" CMP	180	Overtops	66" RCP	460	Overtops	2-66" RCPs	2	100	\$210	\$2,300							\$51,200
610	Falcon Highway	Tributary 4 (T4)	24" CMP	200	Overtops	66" RCP	570	Overtops	2-72" RCPs	2	90	\$230	\$2,400							\$51,000
612	Falcon Highway	Tributary 5 (T5)	24" CMP	150	Overtops	60" RCP	240	Overtops	72" RCP	1	90	\$230	\$2,400							\$25,500
628	Falcon Highway	Main Stem (MS-05)	2-60" CMPs	1,100	Overtops	3-6'X6' RCBs	2,400	Overtops	4-10x6 Box	4	100	\$570		0.581	151	24.42	1144	\$435	\$1.10	\$243,232
702	Curtis Road	Tributary 6 (T6)	36" CMP	120	Overtops	54" RCP	140	Overtops	60" RCP	1	130	\$185	\$2,275							\$28,600
703	Curtis Road	Main Stem (MS-06)	24" CMP	590	Overtops	2-6'X6' RCBs	890	Overtops	2-8x6 Box	2	120	\$535		0.581	151	24.42	1144	\$435	\$1.10	\$141,956
704	Judge Orr Road	Main Stem (MS-06)	Blocked Culvert	540	Overtops	2-72" RCPs	830	Overtops	2-8x6 Box	2	160	\$535		0.581	151	24.42	1144	\$435	\$1.10	\$184,756
N/A	New Santa Fe Springs 1	Main Stem (MS-06)	N/A	660	N/A	No Culvert	930	New Road	2-8x6 Box	2	80	\$535		0.581	151	24.42	1144	\$435	\$1.10	\$99,156
N/A	New Santa Fe Springs 3	Main Stem (MS-06)	N/A	660	N/A	No Culvert	930	New Road	2-8x6 Box	2	80	\$535		0.581	151	24.42	1144	\$435	\$1.10	\$99,156
N/A	New Santa Fe Springs 3	Main Stem (MS-06)	N/A	720	N/A	No Culvert	1500	New Road	3-8x6 Box	3	80	\$535		0.581	151	24.42	1144	\$435	\$1.10	\$142,794
N/A	New Santa Fe Springs 1	Tributary 6 (T6)	N/A	200	N/A	No Culvert	440	New Road	2-66" RCPs	2	80	\$210	\$2,300							\$42,800
N/A	New Santa Fe Springs 2	Tributary 6 (T6)	N/A	200	N/A	No Culvert	440	New Road	2-66" RCPs	2	80	\$210	\$2,300							\$42,800
N/A	New Santa Fe Springs 3	Tributary 6 (T6)	N/A	200	N/A	No Culvert	440	New Road	2-66" RCPs	2	80	\$210	\$2,300							\$42,800

<sup>1</sup> Length is based on Future Land Use Road widths

<sup>2</sup> Wingwalls assumed 15' long for calculations. Calculations based on CDOT cross sections.

Sub-Total	\$1,591,015
30% Construction Contingency	\$477,305
15% Engineering Contingency	\$238,652
Total	\$2,306,972



Table C5

Sub Regional Detention Alternative Culvert Cost Calculation

Facility Number	HMS Design Point	Road Crossing	Channel	Existing Size	Existing 100-yr Flow (cfs)	Deficiency	Necessary Facility for Existing 100-year Flow	Proposed 100-yr Flow (cfs)	Deficiency	Necessary Facility for Proposed 100-year Flow	Number of Culverts	Assumed Length (LF) <sup>1</sup>	Unit Cost	End Section Unit Cost	Headwall Concrete (LF/HW)	Headwall Steel (LB/HW)	Wingwall <sup>2</sup> Concrete (CY)	Wingwall <sup>2</sup> Steel (tons)	Concrete Unit Cost \$/CY	Steel Unit Cost \$/ton	Total Cost
301	JHR0465	Peyton Highway	Main Stem (MS-02)	2-33"X48" CMPs	2,500	3,370	35	Overtops	9-6'X6' RCBs	7-6'X6' RCBs	9	90	\$475		0.581	151	19.7	774.4	\$435	\$1.10	\$401,710
401	JHR0570	Jones Road	Tributary 1 (T1)	2-24" CMPs	370	390	5	Overtops	6'X6' RCB	6'X6' RCB	1	90	\$475		0.652	169.4	19.7	774.4	\$435	\$1.10	\$53,111
601	JHR0520	Whiting Way	Tributary 1 (T1)	24" CMP	220	210	-5	Overtops	66" RCP	66" RCP	1	90	\$210	\$2,300	0.652	169.4	19.7	774.4	\$435	\$1.10	\$33,861
803	JHR0010	Eastonville Road	Main Stem (MS-07)	27"X21" CMP	25	50	100	Overtops	24" RCP	30" RCP	1	110	\$56	\$850	0.652	169.4	19.7	774.4	\$435	\$1.10	\$18,221
804	JHR0020	Eastonville Road	Tributary 7 (T7)	18" CMP	99	90	-9	Overtops	48" RCP	48" RCP	1	100	\$110	\$1,990	0.652	169.4	19.7	774.4	\$435	\$1.10	\$25,341
N/A	JHR0060	Santa Fe Springs 1	Main Stem (MS-06)	N/A	660	610	-8	N/A	2-6'X6' RCB's	No Culvert	2	100	\$475		0.652	169.4	19.7	774.4	\$435	\$1.10	\$106,301
N/A	JHR0070	Santa Fe Springs 3	Main Stem (MS-06)	N/A	720	530	-26	N/A	2-6'X6' RCB's	No Culvert	2	80	\$475		0.652	169.4	19.7	774.4	\$435	\$1.10	\$87,301
N/A	JHR0610	Peyton Highway	Tributary 1 (T1)	No Culvert	500	520	4	Overtops	2-72" RCPs	2-72" RCPs	2	90	\$230	\$2,400							\$51,000
N/A	JHR0310	Falcon Highway	Tributary 1 (T1)	No Culvert	33	110	233	Overtops	2 - 36" RCP	36" RCP	2	90	\$80	\$1,275							\$19,500
N/A	JHR0110	Santa Fe Springs 1	Tributary 6 (T6)	N/A	200	440	120	N/A	2 - 66" RCP	No Culvert	2	80	\$210	\$2,300							\$42,800
N/A	JHR0110	Santa Fe Springs 2	Tributary 6 (T6)	N/A	200	440	120	N/A	2 - 66" RCP	No Culvert	2	80	\$210	\$2,300							\$42,800
N/A	JHR0110	Santa Fe Springs 3	Tributary 6 (T6)	N/A	200	440	120	N/A	2 - 66" RCP	No Culvert	2	80	\$210	\$2,300							\$47,000

<sup>1</sup> Length is based on Future Land Use Road widths

<sup>2</sup> Wingwalls assumed 15' long for calculations. Calculations based on CDOT cross sections.

Sub-Total	\$1,582,078
30% Construction Contingency	\$474,624
15% Engineering Contingency	\$237,312
Total	\$2,294,014





Job: Haegler DBPS  
Description: Channelization

Project No: 21711039  
Computed by: KAP  
Checked by:

Table C6  
General Channel Design

Sheet:  
Date: 6/18/08  
Date:

			Unit Cost	
Assumptions:			Common Excavation	\$7.00 /CY
4' bottom width minimum.			Structure Excavation	\$18.00 /CY
Bottom width is at least twice the flow depth			Topsoil	\$8.00 /CY
Allowable Shear Stress			Seeding	\$580.00 /Acre
t <sub>d</sub> =	1.00 psf	Grass	6" Riprap	\$80.00 /CY
	2.00 psf	6" Riprap	12" Riprap	\$76.00 /CY
	4.00 psf	12" Riprap	18" Riprap	\$64.00 /CY
	6.00 psf	18" Riprap	24" Riprap	\$75.00 /CY
	8.00 psf	24" Riprap	Grouted Riprap	\$90.00 /CY
			Slope Paving	\$300.00 /CY
Limit slope to 0.30% minimum			Concrete Class B	\$500.00 /CY *This includes steel reinforcing cost
Limit Velocity of flow to 20 fps for concrete channels.			Geotextile	\$3.00 /yd <sup>2</sup>
Limit Constructed Depth to 5 ft. or less.				

Channel Dimensions													Channel Costs									
Q (cfs)	n	Slope	Side Sopes	Bottom Width (ft)	Normal Depth (ft)	Froude Number	Constructed Depth (ft)	Velocity (fps)	Flow Area (sf)	Wetted Perimeter (ft)	R (ft)	t <sub>d</sub> (psf)	Excavation Area (ft <sup>2</sup> /lin. ft)	Excavation (cy/lin. ft)	Excavation Cost (\$/lin. ft)	Surface Area (ft/lin. ft)	4" Topsoil (cy/ lin. ft)	4" Topsoil Cost (\$/lin. ft)	Seeding (acre)	Seeding Cost (\$/lin. ft)	TOTAL COST (\$/LF)	
GRASS																						
300	0.035	0.90%	4	6	2.93	0.77	5	5.79	51.92	30.16	1.721	Sub	0.97	130	4.8	\$33.70	47.23	0.58	\$4.66	0.00108	\$0.63	\$39.00
500	0.035	0.70%	4	8	3.68	0.70	5	5.97	83.61	38.35	2.180	Sub	0.95	140	5.2	\$36.30	49.23	0.61	\$4.86	0.0011	\$0.66	\$41.81
600	0.035	0.60%	4	15	3.55	0.66	5	5.80	103.66	44.27	2.341	Sub	0.88	175	6.5	\$45.37	56.23	0.69	\$5.55	0.0013	\$0.75	\$51.67
800	0.035	0.60%	4	20	3.72	0.67	5	6.16	129.75	50.68	2.560	Sub	0.96	200	7.4	\$51.85	61.23	0.76	\$6.05	0.0014	\$0.82	\$58.71
900	0.035	0.60%	4	25	3.64	0.68	5	6.25	144.00	55.02	2.617	Sub	0.98	225	8.3	\$58.33	66.23	0.82	\$6.54	0.0015	\$0.88	\$65.76
1000	0.035	0.60%	4	30	3.57	0.68	5	6.31	158.08	59.44	2.660	Sub	1.00	250	9.3	\$64.81	71.23	0.88	\$7.04	0.0016	\$0.95	\$72.80
1500	0.035	0.50%	4	50	3.71	0.63	5	6.22	240.56	80.59	2.985	Sub	0.93	350	13.0	\$90.74	91.23	1.13	\$9.01	0.0021	\$1.21	\$100.97
2000	0.035	0.40%	4	80	3.66	0.57	5	5.76	346.38	110.18	3.144	Sub	0.78	500	18.5	\$129.63	121.23	1.50	\$11.97	0.0028	\$1.61	\$143.22
3000	0.035	0.45%	4	120	3.59	0.61	5	6.22	482.35	149.60	3.224	Sub	0.91	700	25.9	\$181.48	161.23	1.99	\$15.92	0.0037	\$2.15	\$199.55
3500	0.035	0.45%	4	140	3.61	0.61	5	6.29	557.53	169.77	3.284	Sub	0.92	800	29.6	\$207.41	181.23	2.24	\$17.90	0.0042	\$2.41	\$227.72

Channel Dimensions			Drop Structures & Costs																				
Q (cfs)	n	Slope	Constructed Depth (ft)	Length Perp. To Channel (ft/lin. ft)	Drop Depth (ft)	Height of Concrete Cutoff Wall (1' thick) (ft)	Volume of Concrete (cy)	Concrete Cost (\$/Str)	Structure Excavation (cy)	Structure Excavation Cost (\$/Str)	Approach Armoring Length (ft)	Approach Armoring Bed Thickness (ft)	Approach Armoring Volume of Riprap (cy)	Approach Armoring Cost - 12" Riprap (\$/Str)	Approach Armoring Geotextile (yd²)	Approach Armoring Geotextile Cost (\$/Str)	Exit Armoring Length (ft)	Exit Armoring Bed Thickness (ft)	Exit Armoring Volume of Riprap (cy)	Exit Armoring Cost - 24" Riprap (\$/Str)	Exit Armoring Geotextile (yd²)	Exit Armoring Geotextile Cost (\$/Str)	TOTAL COST (\$/STR)
GRASS																							
300	0.035	0.90%	5	47.23	4	12	21.0	\$10,496	13.99	\$251.90	20	3	104.96	\$7,976.80	104.96	\$314.87	40	3	209.92	\$15,743.69	209.92	\$629.75	\$35,500
500	0.035	0.70%	5	49.23	4	12	21.9	\$10,940	14.59	\$262.57	20	3	109.40	\$8,314.58	109.40	\$328.21	40	3	218.80	\$16,410.35	218.80	\$656.41	\$37,000
600	0.035	0.60%	5	56.23	4	12	25.0	\$12,496	16.66	\$299.90	20	3	124.96	\$9,496.80	124.96	\$374.87	40	3	249.92	\$18,743.69	249.92	\$749.75	\$42,200
800	0.035	0.60%	5	61.23	4	12	27.2	\$13,607	18.14	\$326.57	20	3	136.07	\$10,341.25	136.07	\$408.21	40	3	272.14	\$20,410.35	272.14	\$816.41	\$46,000
900	0.035	0.60%	5	66.23	4	12	29.4	\$14,718	19.62	\$353.23	20	3	147.18	\$11,185.69	147.18	\$441.54	40	3	294.36	\$22,077.02	294.36	\$883.08	\$49,700
1000	0.035	0.60%	5	71.23	4	12	31.7	\$15,829	21.11	\$379.90	20	3	158.29	\$12,030.13	158.29	\$474.87	40	3	316.58	\$23,743.69	316.58	\$949.75	\$53,500
1500	0.035	0.50%	5	91.23	4	12	40.5	\$20,274	27.03	\$486.57	20	3	202.74	\$15,407.91	202.74	\$608.21	40	3	405.47	\$30,410.35	405.47	\$1,216.41	\$68,500
2000	0.035	0.40%	5	121.23	4	12	53.9	\$26,940	35.92	\$646.57	20	3	269.40	\$20,474.58	269.40	\$808.21	40	3	538.80	\$40,410.35	538.80	\$1,616.41	\$90,900
3000	0.035	0.45%	5	161.23	4	12	71.7	\$35,829	47.77	\$859.90	20	3	358.29	\$27,230.13	358.29	\$1,074.87	40	3	716.58	\$53,743.69	716.58	\$2,149.75	\$120,900
3500	0.035	0.45%	5	181.23	4	12	80.5	\$40,274	53.70	\$966.57	20	3	402.74	\$30,607.91	402.74	\$1,208.21	40	3	805.47	\$60,410.35	805.47	\$2,416.41	\$135,900



**Table C7**  
**Regional Detention Alternative Channel Design**

Regional Channel Improvements								
Channel	Basins	Existing 100-yr Flow (cfs)	Proposed 100-yr Flow (cfs)	Design Flow (cfs)	Channel Length	Material	Unit Cost	Total Cost
Main Stem (MS-04)	HR0250	1,700	3,400	3,500	7,140	Grass	\$227.72	\$1,626,000
Main Stem (MS-05)	HR0200	1,500	3,000	3,000	11,100	Grass	\$199.55	\$2,216,000
Main Stem (MS-06)	HR0060	590	890	900	7,330	Grass	\$65.76	\$482,000
Main Stem (MS-06)	HR0070	660	930	1,000	3,170	Grass	\$72.80	\$231,000
Main Stem (MS-06)	HR0080	720	1,500	1,500	4,450	Grass	\$100.97	\$450,000
Main Stem (MS-06)	HR0090	750	1,600	2,000	3,330	Grass	\$143.22	\$477,000
Tributary 3 (T3-01)	HR0360	720	1,500	1,500	10,710	Grass	\$100.97	\$1,082,000
Tributary 4 (T4)	HR0300	200	570	600	1,840	Grass	\$51.67	\$96,000
Tributary 5 (T5)	HR0210	150	240	300	930	Grass	\$39.00	\$37,000
Tributary 5 (T5)	HR0230	270	410	500	7,770	Grass	\$41.81	\$325,000
Tributary 6 (T6)	HR0110	200	440	500	4,270	Grass	\$41.81	\$179,000
Tributary 6 (T6)	HR0120	240	570	600	3,940	Grass	\$51.67	\$204,000

Sub-Total	\$7,405,000
30% Construction Contingency	\$2,221,500
15% Engineering Contingency	\$1,110,750
<b>Total</b>	<b>\$10,737,250</b>

Regional Drop Structures											
Channel	Basins	Existing 100-yr Flow (cfs)	Proposed 100-yr Flow (cfs)	Design Flow (cfs)	Channel Length	Existing Slope	Proposed Slope	Elevation Change	No. of Drops	Unit Cost	Total Cost
Main Stem (MS-05)	HR0200	1,500	3,000	3,000	11,100	1.20%	0.45%	83.25	21	\$120,900	\$2,538,900
Main Stem (MS-06)	HR0060	590	890	1,000	7,330	1.20%	0.60%	44.0	11	\$53,500	\$588,500
Main Stem (MS-06)	HR0070	660	930	1,000	3,170	1.20%	0.60%	19.0	5	\$53,500	\$267,500
Main Stem (MS-06)	HR0080	720	1,500	1,500	4,450	1.20%	0.50%	31.2	8	\$68,500	\$548,000
Main Stem (MS-06)	HR0090	750	1,600	2,000	3,330	1.20%	0.40%	26.6	7	\$90,900	\$636,300
Tributary 3 (T3-01)	HR0360	720	1,500	1,500	10,710	1.20%	0.50%	75.0	19	\$68,500	\$1,301,500
Tributary 4 (T4)	HR0300	200	570	600	1,840	1.20%	0.60%	11.0	3	\$42,200	\$126,600
Tributary 5 (T5)	HR0210	150	240	300	930	1.20%	0.90%	2.8	1	\$35,500	\$35,500
Tributary 5 (T5)	HR0230	270	410	500	7,770	1.20%	0.70%	38.9	10	\$37,000	\$370,000
Tributary 6 (T6)	HR0110	200	440	500	4,270	1.20%	0.70%	21.4	6	\$37,000	\$222,000
Tributary 6 (T6)	HR0120	240	570	600	3,940	1.20%	0.60%	23.6	6	\$42,200	\$253,200

Sub-Total	\$6,888,000
30% Construction Contingency	\$2,066,400
15% Engineering Contingency	\$1,033,200
<b>Total</b>	<b>\$9,987,600</b>



**Table C8**  
**Sub-Regional Detention Alternative Channel Design**

Subregional Channel Improvements								
Channel	Basins	Existing 100-yr Flow (cfs)	Proposed 100-yr Flow (cfs)	Design Flow (cfs)	Channel Length (ft)	Lining Material	Unit Cost	Total Cost
Main Stem (MS-05)	HR0200	1,460	1,680	2,000	1,560	Grass	\$143.22	\$224,000
Main Stem (MS-06)	HR0070	660	530	600	3,120	Grass	\$51.67	\$162,000
Main Stem (MS-06)	HR0080	720	970	1,000	4,535	Grass	\$72.80	\$331,000
Main Stem (MS-06)	HR0090	750	740	800	3,190	Grass	\$58.71	\$188,000
Tributary 3 (T3-01)	HR0330	600	600	600	5,000	Grass	\$51.67	\$259,000
Tributary 3 (T3-02)	HR0300	220	500	500	420	Grass	\$41.81	\$18,000
Tributary 4 (T4)	HR0300	220	500	500	940	Grass	\$41.81	\$40,000
Tributary 6 (T6)	HR0110	200	440	500	4,280	Grass	\$41.81	\$179,000
Tributary 6 (T6)	HR0120	240	250	300	1,400	Grass	\$39.00	\$55,000

Sub-Total	\$1,456,000
30% Construction Contingency	\$436,800
15% Engineering Contingency	\$218,400
<b>Total</b>	<b>\$2,111,200</b>

Subregional Drop Structures											
Channel	Basins	Existing 100-yr Flow (cfs)	Proposed 100-yr Flow (cfs)	Design Flow (cfs)	Channel Length (ft)	Existing Slope (%)	Proposed Slope	Elevation Change	No. of Drops	Unit Cost	Total Cost
Main Stem (MS-05)	HR0200	1,460	1,680	2,000	1,560	1.40%	0.40%	15.6	4	\$90,900	\$363,600
Main Stem (MS-06)	HR0070	660	530	600	3,120	1.40%	0.60%	25.3	7	\$42,200	\$295,400
Main Stem (MS-06)	HR0080	720	970	1,000	4,535	1.03%	0.60%	24.6	7	\$53,500	\$374,500
Main Stem (MS-06)	HR0090	750	740	800	3,190	1.40%	0.60%	31.8	8	\$46,000	\$368,000
Tributary 3 (T3-01)	HR0330	600	600	600	4,725	1.30%	0.60%	37.9	10	\$42,200	\$422,000
Tributary 3 (T3-02)	HR0300	220	500	500	420	1.30%	0.70%	2.5	1	\$37,000	\$37,000
Tributary 4 (T4)	HR0300	220	500	500	940	1.33%	0.70%	5.0	2	\$37,000	\$74,000
Tributary 6 (T6)	HR0110	200	440	500	4,280	1.32%	0.70%	33.6	9	\$37,000	\$333,000
Tributary 6 (T6)	HR0120	240	250	300	1,400	1.40%	0.90%	10.7	3	\$35,500	\$106,500

Sub-Total	\$2,374,000
30% Construction Contingency	\$712,200
15% Engineering Contingency	\$356,100
<b>Total</b>	<b>\$3,442,300</b>



Table C9

Regional Ponds					
Note: Total Costs in Bold have used a minimum expected cost instead of QTY * COST/UNIT					
Pond RG-01					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	14,552	\$15		\$218,284
Seeding	Acres	3	\$580		\$1,740
Topsoil	CY	979	\$8		\$7,832
Outlet Culvert	EACH	1	\$14,150		\$14,150
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$249,375</b>
			30% Construction Contingency		\$74,883
			15% Engineering Contingency		\$37,496
			<b>Total</b>		<b>\$361,754</b>
Pond RG-02					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	11,542,002	\$15		\$173,130,034
Seeding	Acres	113	\$580		\$65,940
Topsoil	CY	6,939	\$8		\$55,512
Outlet Culvert	EACH	1	\$182,950		\$182,950
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$2,014,614</b>
			30% Construction Contingency		\$604,384
			15% Engineering Contingency		\$302,192
			<b>Total</b>		<b>\$2,921,191</b>
Pond RG-03					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	23	\$7		\$161,999
Seeding	Acres	1	\$580		\$580
Topsoil	CY	1,538	\$8		\$12,304
Outlet Culvert	EACH	1	\$12,500		\$12,500
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$132,280</b>
			30% Construction Contingency		\$39,684
			15% Engineering Contingency		\$19,842
			<b>Total</b>		<b>\$191,806</b>
Pond RG-04					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	1,753	\$7		\$12,271
Seeding	Acres	1	\$580		\$580
Topsoil	CY	1,538	\$8		\$12,304
Outlet Culvert	EACH	1	\$14,400		\$14,400
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$41,264</b>
			30% Construction Contingency		\$12,379
			15% Engineering Contingency		\$6,190
			<b>Total</b>		<b>\$59,833</b>
Pond RG-05					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	148	\$7		\$1,036
Seeding	Acres	1	\$580		\$580
Topsoil	CY	1,336	\$8		\$10,688
Outlet Culvert	EACH	1	\$12,475		\$12,475
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$32,255</b>
			30% Construction Contingency		\$9,677
			15% Engineering Contingency		\$4,838
			<b>Total</b>		<b>\$46,770</b>
			<b>Subtotal Regional Ponds</b>		<b>\$5,437,863</b>
Sub-Regional Ponds					
Note: Total Costs in Bold have used a minimum expected cost instead of QTY * COST/UNIT					
Pond SR-01					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	335,000	\$15		\$5,025,000
Seeding	Acres	35	\$580		\$20,300
Topsoil	CY	2,628	\$8		\$21,024
Outlet Culvert	EACH	1	\$25,475		\$25,475
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$5,079,079</b>
			30% Construction Contingency		\$1,523,724
			15% Engineering Contingency		\$761,862
			<b>Total</b>		<b>\$7,364,665</b>
Pond SR-02					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	18,329	\$5		\$91,645
Seeding	Acres	3	\$580		\$1,740
Topsoil	CY	1,828	\$8		\$14,624
Outlet Culvert	EACH	1	\$18,492		\$18,492
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$129,781</b>
			30% Construction Contingency		\$38,934
			15% Engineering Contingency		\$19,467
			<b>Total</b>		<b>\$188,182</b>
Pond SR-03					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	16,141	\$5		\$80,705
Seeding	Acres	3	\$580		\$1,740
Topsoil	CY	1,227	\$8		\$9,816
Outlet Culvert	EACH	1	\$22,410		\$22,410
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$119,951</b>
			30% Construction Contingency		\$35,985
			15% Engineering Contingency		\$17,993
			<b>Total</b>		<b>\$173,929</b>
Pond SR-04					
Item	UNIT	QTY	COST/UNIT	TOTAL COST	
Detention Reservoir Excavation	CY	28,795	\$5		\$143,975
Seeding	Acres	3	\$580		\$1,740
Topsoil	CY	1,798	\$8		\$14,384
Outlet Culvert	EACH	1	\$23,900		\$23,900
Outlet Structure	EACH	1	\$7,280		\$7,280
			<b>Subtotal</b>		<b>\$189,279</b>
			30% Construction Contingency		\$56,784
			15% Engineering Contingency		\$28,392
			<b>Total</b>		<b>\$274,455</b>



Pond SR-05				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	42,235	\$9	\$380,115
Seeding	Acres	3	\$580	\$1,740
Topsoil	CY	4,840	\$8	\$38,720
Outlet Culvert	FEACH	1	\$23,900	\$23,900
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$455,235
			30% Construction Contingency	\$136,571
			15% Engineering Contingency	\$68,285
			Total	\$660,091
Pond SR-06				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	11,480	\$9	\$103,320
Seeding	Acres	4	\$580	\$2,320
Topsoil	CY	2,312	\$8	\$18,500
Outlet Culvert	FEACH	1	\$9,250	\$9,250
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$140,670
			30% Construction Contingency	\$42,201
			15% Engineering Contingency	\$21,100
			Total	\$203,971
Pond SR-07				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	13,880	\$9	\$124,920
Seeding	Acres	3	\$580	\$1,740
Topsoil	CY	1,560	\$8	\$12,480
Outlet Culvert	FEACH	1	\$15,050	\$15,050
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$162,046
			30% Construction Contingency	\$48,614
			15% Engineering Contingency	\$24,307
			Total	\$234,967
Pond SR-08				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	5,235	\$9	\$47,115
Seeding	Acres	2	\$580	\$1,160
Topsoil	CY	1,076	\$8	\$8,608
Outlet Culvert	FEACH	1	\$12,880	\$12,880
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$87,489
			30% Construction Contingency	\$26,247
			15% Engineering Contingency	\$13,123
			Total	\$126,860
Pond SR-09				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	19,210	\$9	\$172,890
Seeding	Acres	6	\$580	\$3,480
Topsoil	CY	3,173	\$8	\$25,383
Outlet Culvert	FEACH	1	\$15,275	\$15,275
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$188,250
			30% Construction Contingency	\$56,475
			15% Engineering Contingency	\$28,238
			Total	\$272,963
Pond SR-10				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	25,000	\$9	\$225,000
Seeding	Acres	4	\$580	\$2,320
Topsoil	CY	3,173	\$8	\$25,383
Outlet Culvert	FEACH	1	\$115,550	\$115,550
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$331,635
			30% Construction Contingency	\$99,491
			15% Engineering Contingency	\$49,745
			Total	\$480,871
Pond SR-11				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	3,800	\$9	\$34,200
Seeding	Acres	1	\$580	\$580
Topsoil	CY	1,56	\$8	\$12,480
Outlet Culvert	FEACH	1	\$7,950	\$7,950
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$66,890
			30% Construction Contingency	\$17,854
			15% Engineering Contingency	\$8,532
			Total	\$93,276
Pond SR-12				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	7,860	\$9	\$70,740
Seeding	Acres	3	\$580	\$1,740
Topsoil	CY	1,721	\$8	\$13,767
Outlet Culvert	FEACH	1	\$14,700	\$14,700
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$108,987
			30% Construction Contingency	\$32,696
			15% Engineering Contingency	\$16,348
			Total	\$158,031
Pond SR-13				
Item	UNIT	QTY	COST/UNIT	TOTAL COST
Detention Reservoir Excavation	CY	5,901	\$9	\$53,109
Seeding	Acres	2	\$580	\$1,160
Topsoil	CY	1,183	\$8	\$9,464
Outlet Culvert	FEACH	1	\$34,990	\$34,990
Outlet Structure	FEACH	1	\$7,280	\$7,280
			Subtotal	\$107,812
			30% Construction Contingency	\$32,344
			15% Engineering Contingency	\$16,172
			Total	\$156,327
			Subtotal SubRegional Ponds	\$3,844,139

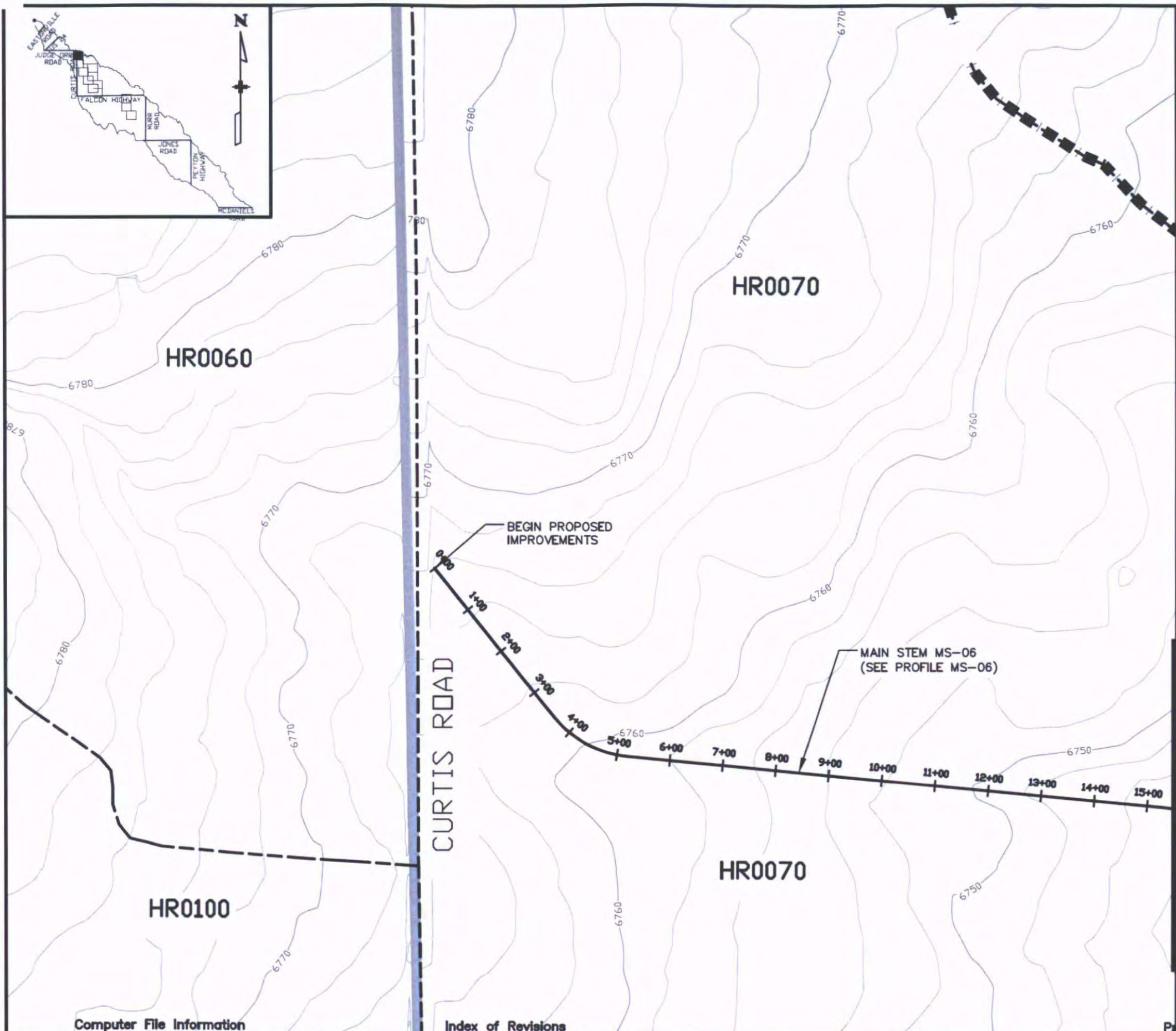


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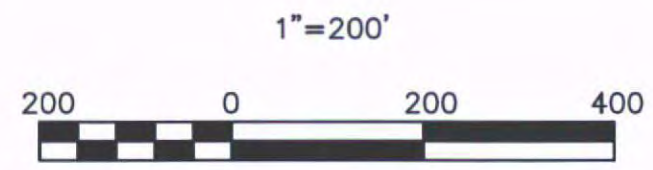
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**LEGEND**

- 6630 — CONTOURS — MAJOR ELEVATION
- CONTOURS — MINOR ELEVATION
- WATERSHED BOUNDARY
- BASIN BOUNDARY
- ROADS
- RIVER AND ALIGNMENT



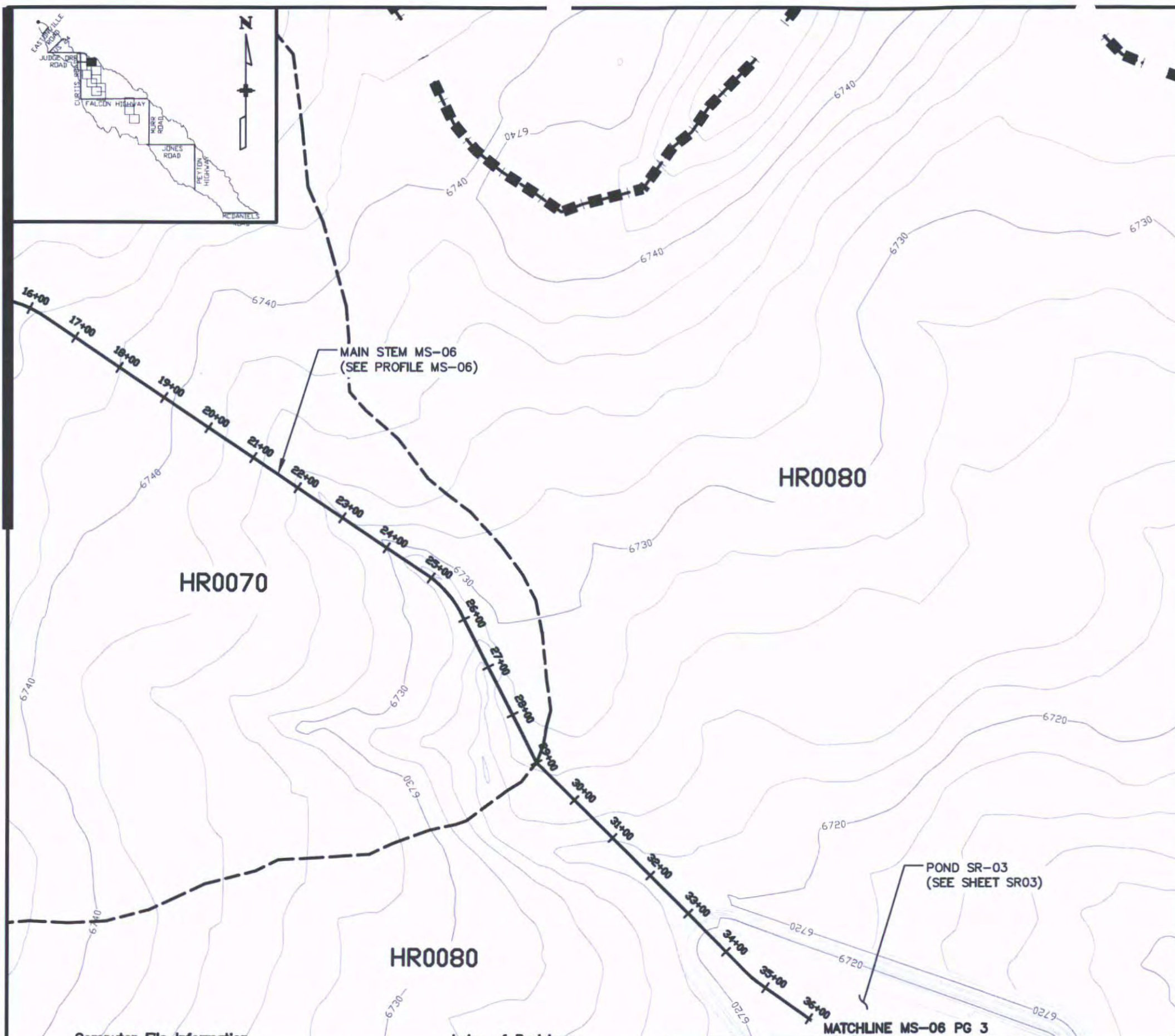
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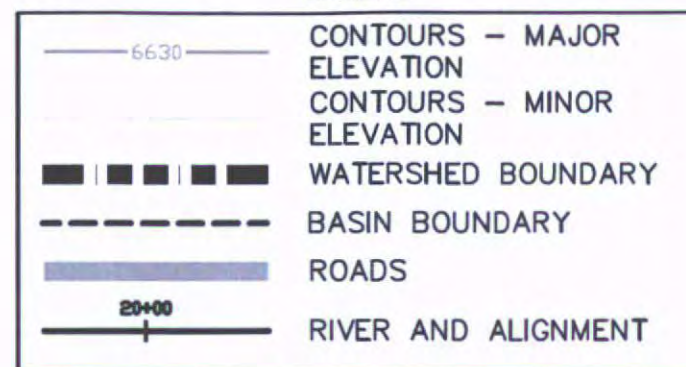
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MATCHLINE MS-06 PG 1



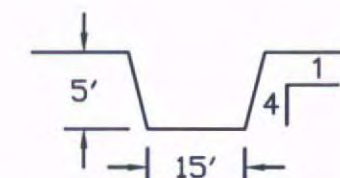
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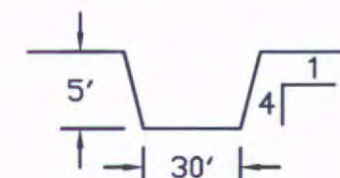
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BASIN: HR0070



STA: 0+00 TO STA: 31+34

Q: 600 CFS

CHANNEL: MAIN STEM (MS-06)  
BASIN: HR0080



STA: 31+34 TO STA: 74+61

Q: 1000 CFS

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MATCHLINE MS-06 PG 3

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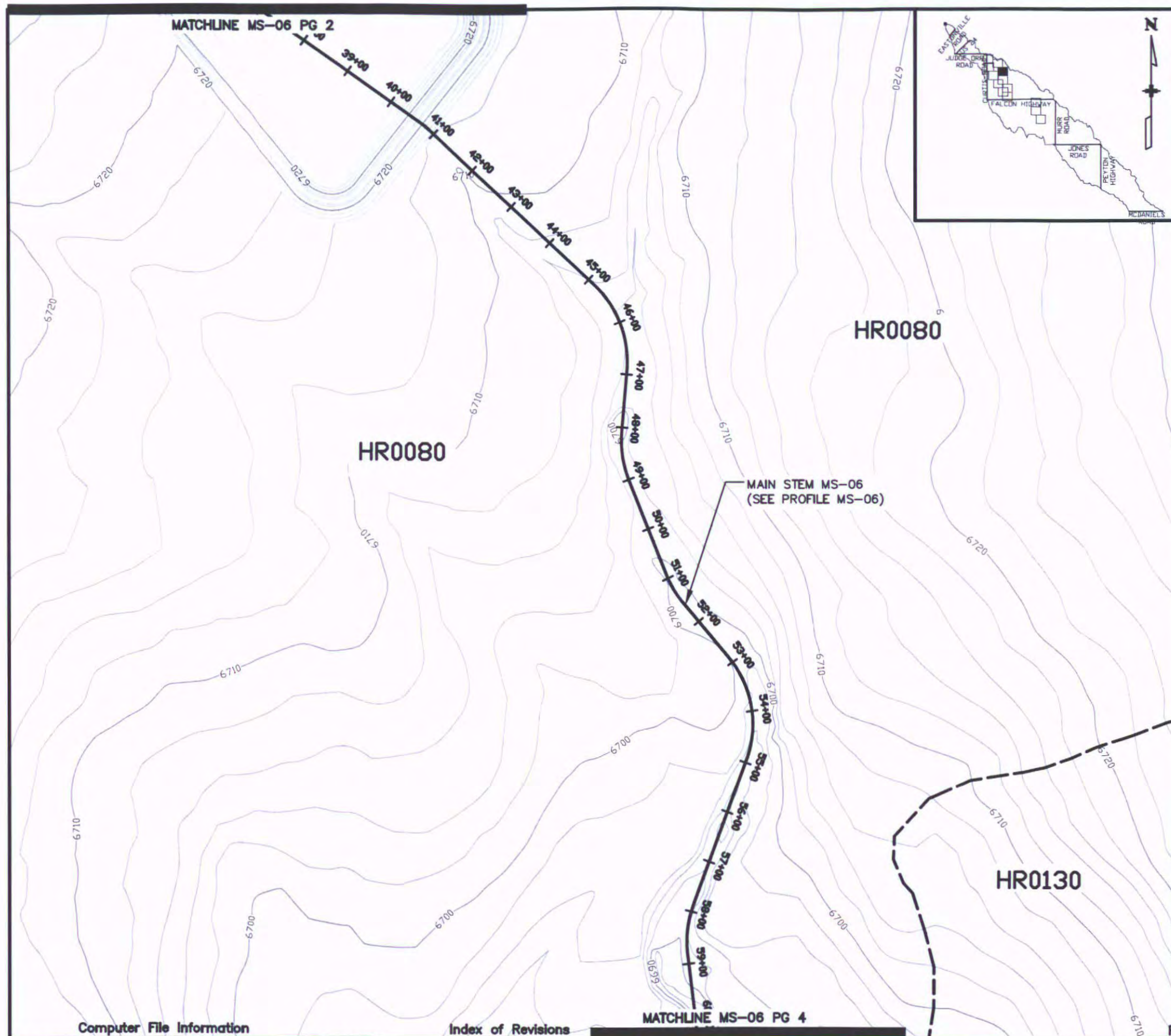
5000 Federal Drive, Suite 300  
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(719) 531-0001  
Fax (719) 531-0007

Designed by: KAP  
Detailed by: DRM  
Checked by: JAJ

Structure  
Numbers

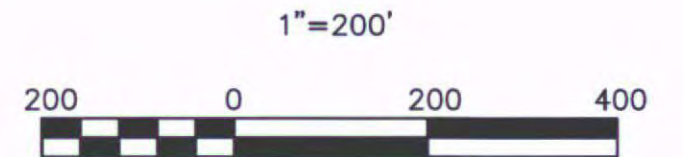
HAEGLER RANCH SUB-REGIONAL DETENTION  
ALTERNATIVE CONCEPTUAL CHANNELS  
Sheet Number MAIN STEM PG 2





**LEGEND**

- 6630 — CONTOURS — MAJOR ELEVATION
- CONTOURS — MINOR ELEVATION
- WATERSHED BOUNDARY
- - - - - BASIN BOUNDARY
- ROADS
- 20+00 — RIVER AND ALIGNMENT

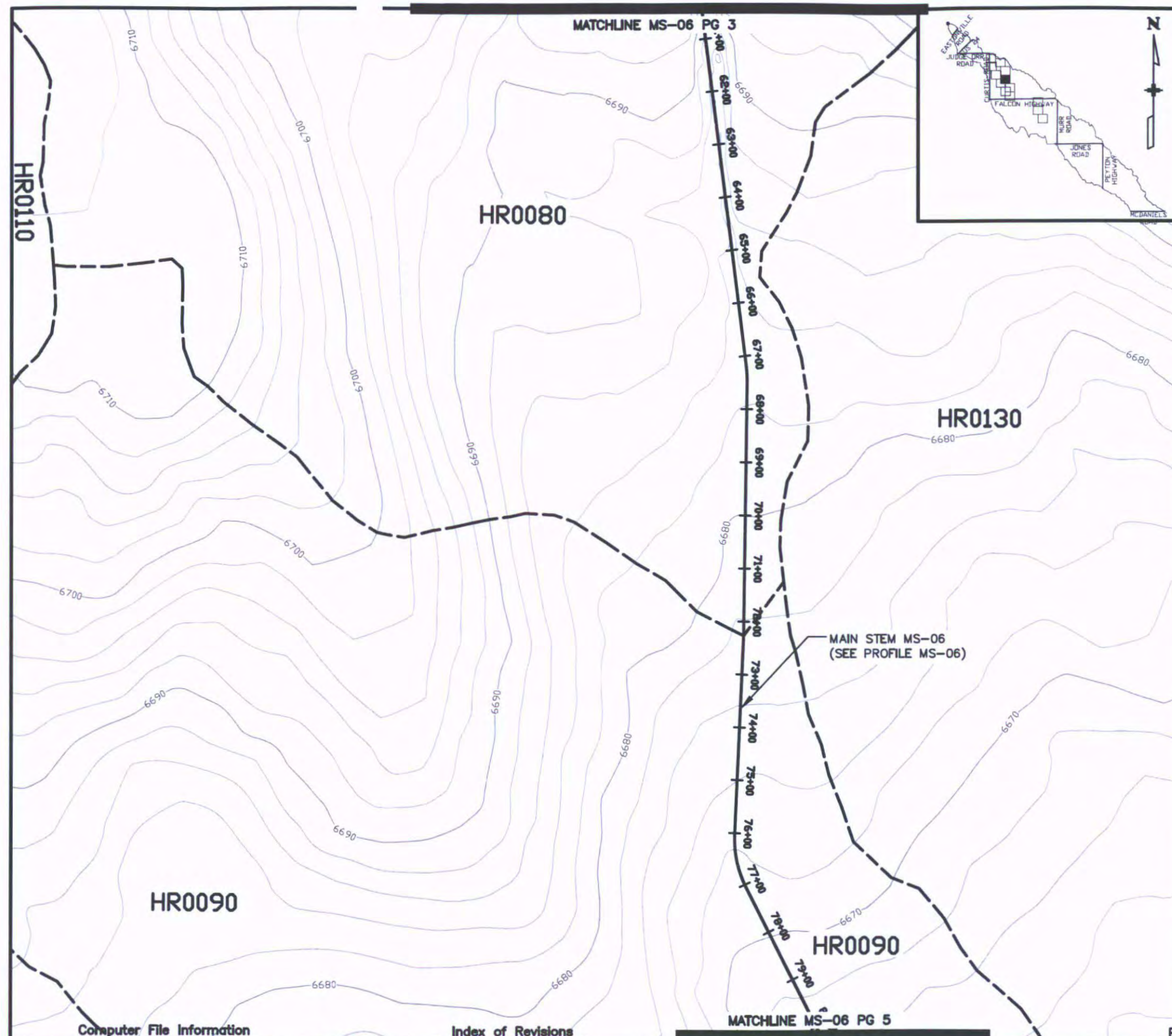


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STA: 31+34 TO STA: 74+61

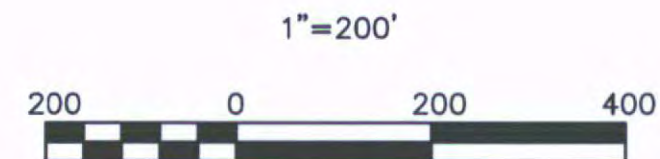
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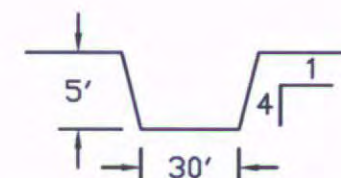


**LEGEND**

- 6630 ——— CONTOURS — MAJOR ELEVATION
- CONTOURS — MINOR ELEVATION
- WATERSHED BOUNDARY
- - - - - BASIN BOUNDARY
- ROADS
- 20+00 ——— RIVER AND ALIGNMENT



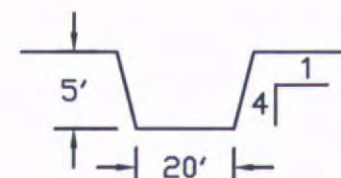
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STA: 31+34 TO STA: 74+61

Q: 1000 CFS

CHANNEL: MAIN STEM (MS-06)  
BASIN: HR0090



STA: 74+61 TO STA: 103+62

Q: 800 CFS

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Acad. Ver. 2006 Scale: 1"=200' Units: Feet

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Checked by: JAJ

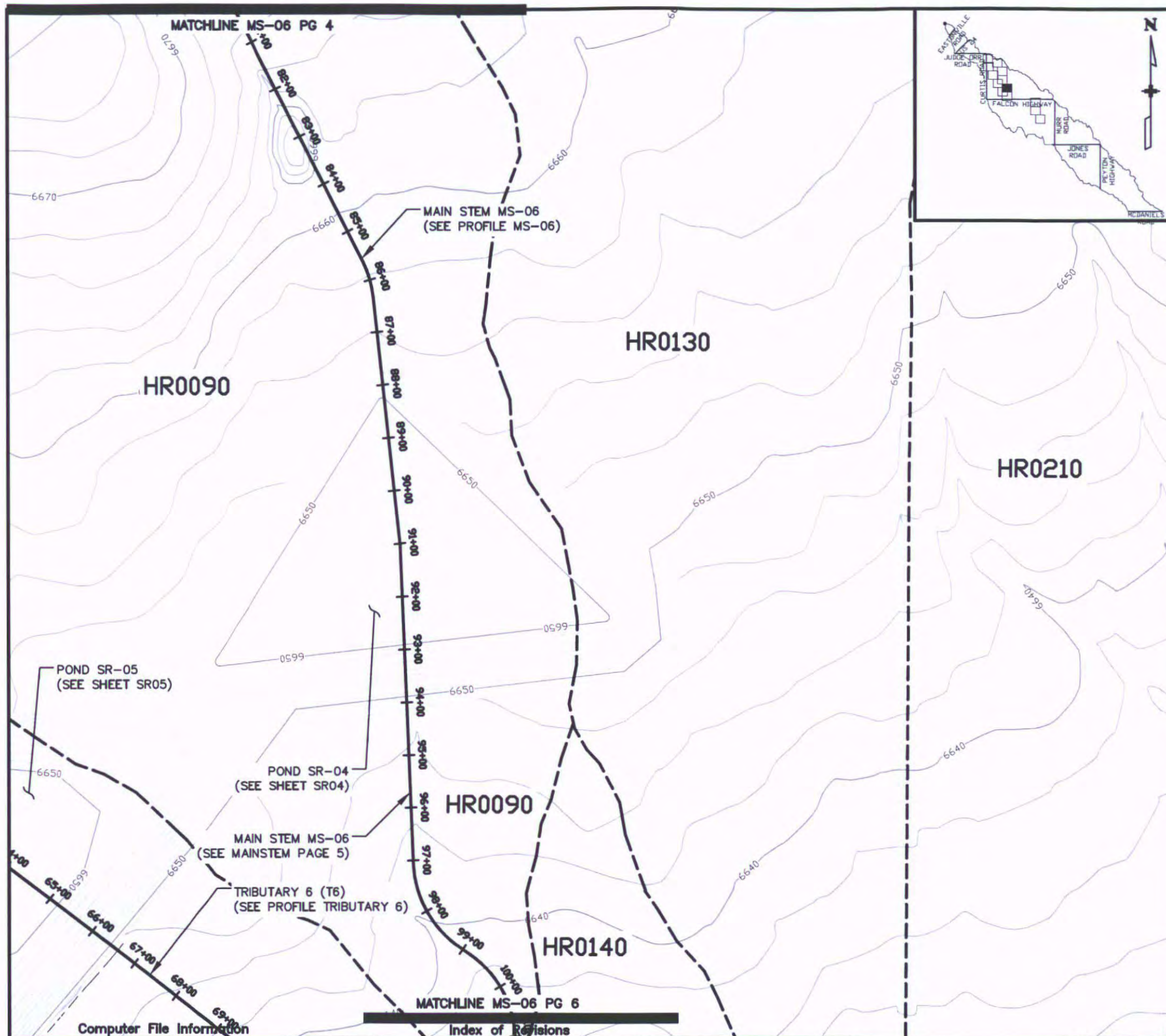
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Numbers

HAEGLER RANCH SUB-REGIONAL DETENTION  
ALTERNATIVE CONCEPTUAL CHANNELS

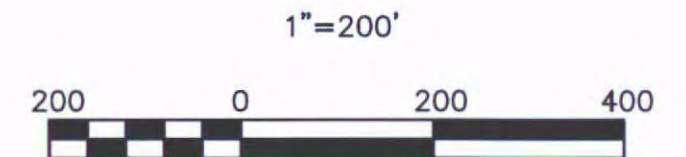
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**LEGEND**

- 6630 — CONTOURS — MAJOR ELEVATION
- CONTOURS — MINOR ELEVATION
- WATERSHED BOUNDARY
- BASIN BOUNDARY
- ROADS
- 20+00 — RIVER AND ALIGNMENT



CHANNEL: MAIN STEM (MS-06)  
 BASIN: HR0090

STA: 74+61 TO STA: 103+62

Q: 800 CFS

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Drawing File Name: CHANNEL.DWG

Acad. Ver. 2006 Scale: 1"=200' Units: Feet

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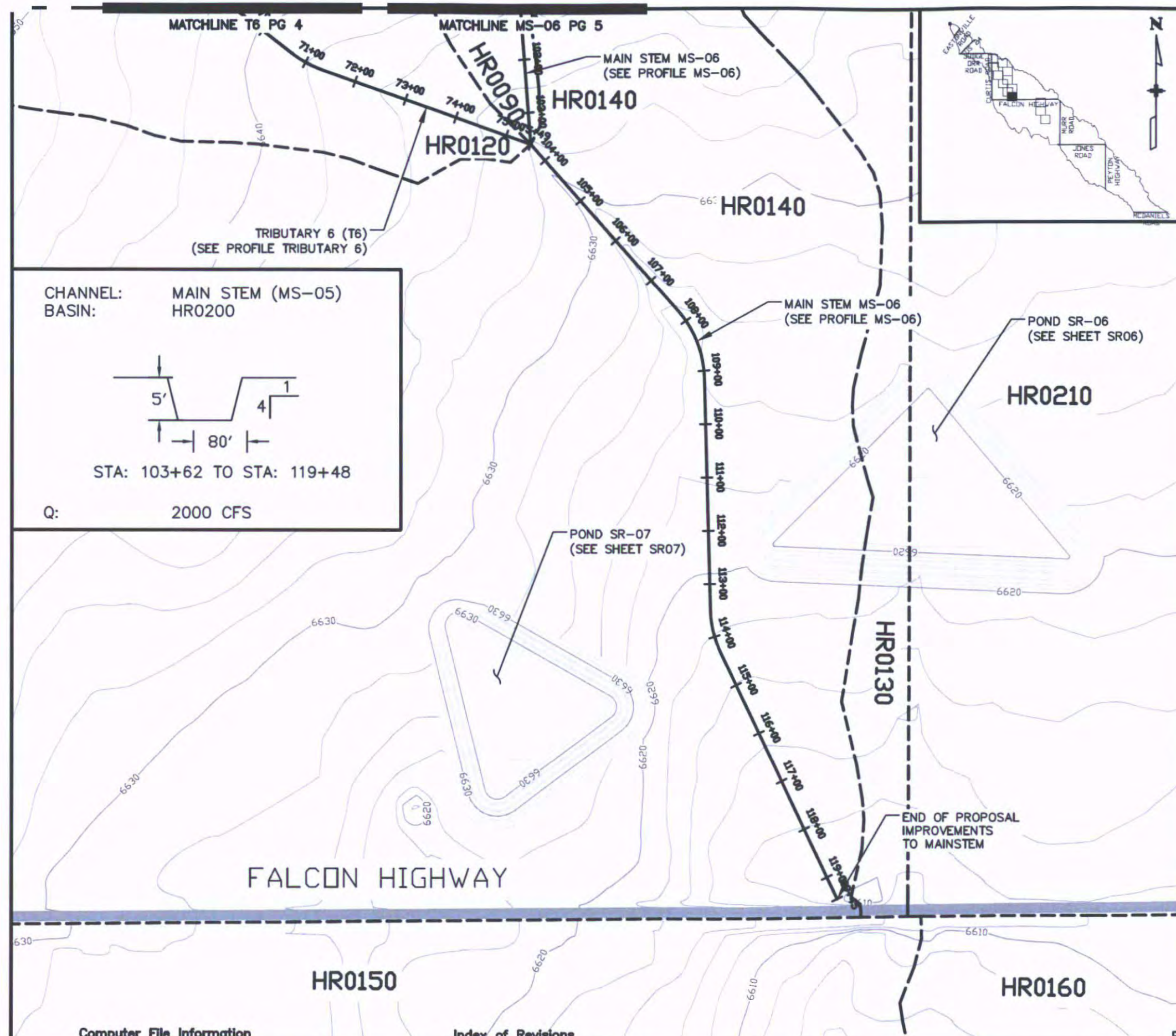
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 Detailed by: DRM  
 Checked by: JAJ

Structure  
 Numbers

HAEGLER RANCH SUB-REGIONAL DETENTION  
 ALTERNATIVE CONCEPTUAL CHANNELS

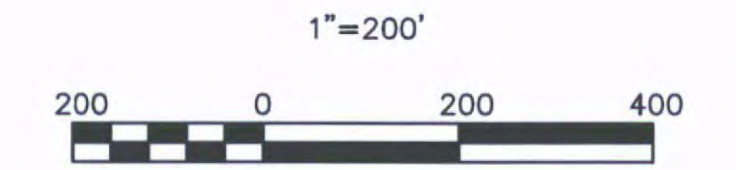
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**LEGEND**

- 6630 — CONTOURS — MAJOR ELEVATION
- CONTOURS — MINOR ELEVATION
- WATERSHED BOUNDARY
- - - - - BASIN BOUNDARY
- ROADS
- 20+00 RIVER AND ALIGNMENT



CHANNEL: MAIN STEM (MS-05)  
BASIN: HR0200

STA: 103+62 TO STA: 119+48

Q: 2000 CFS

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BASIN: HR0090

STA: 74+61 TO STA: 103+62

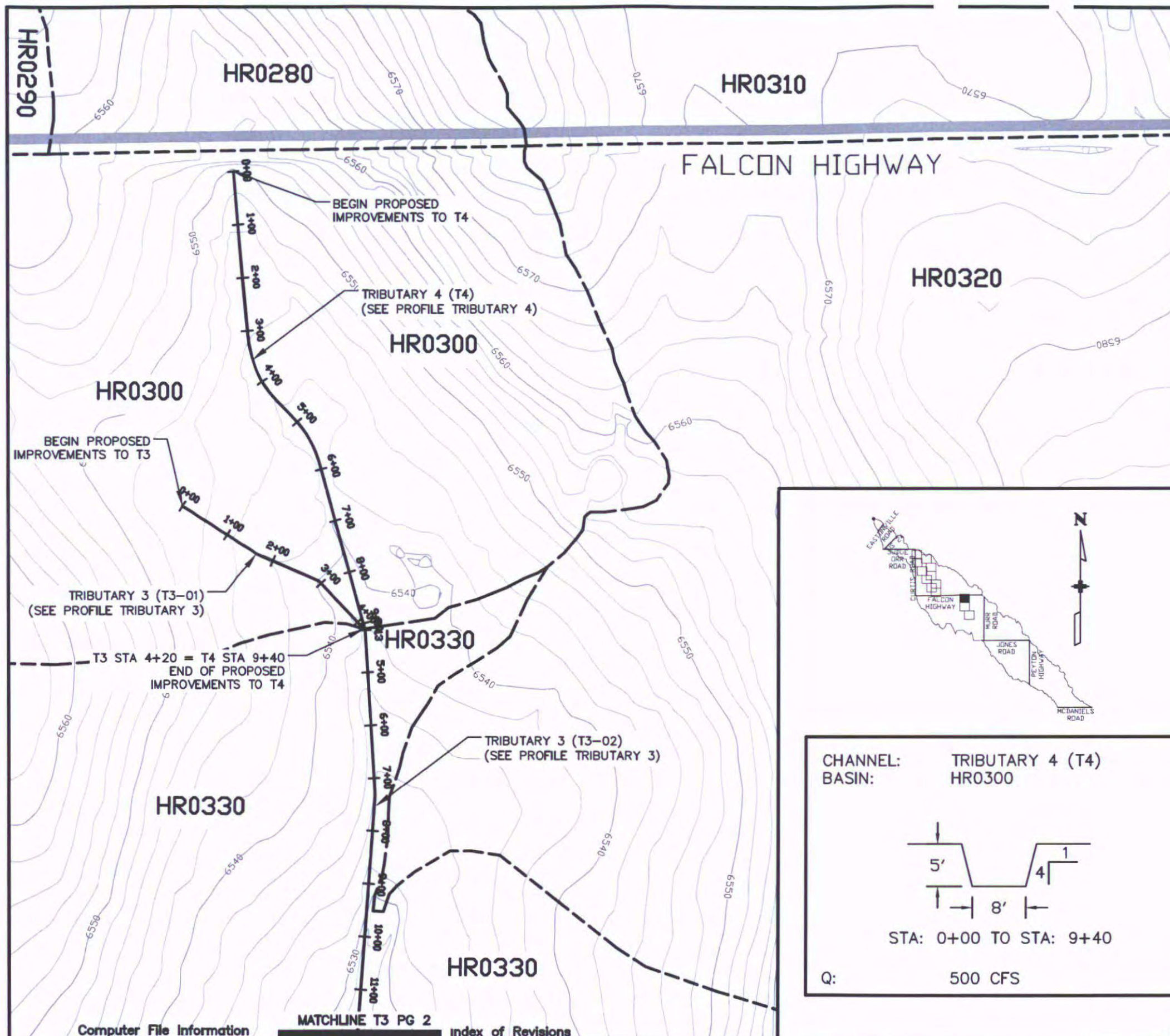
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BASIN: HR0120

STA: 41+73 TO STA: 75+50

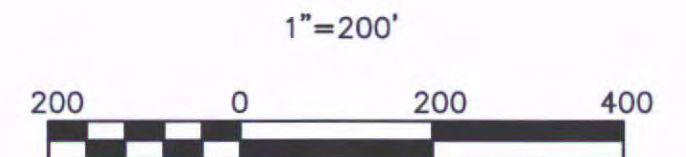
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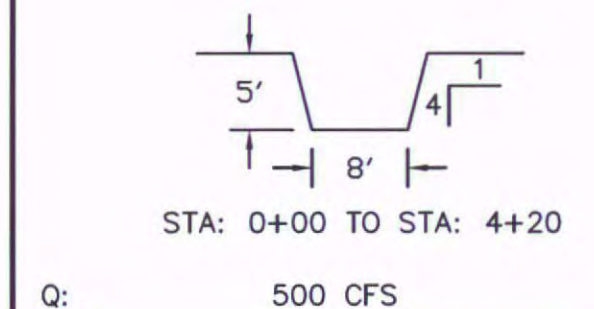


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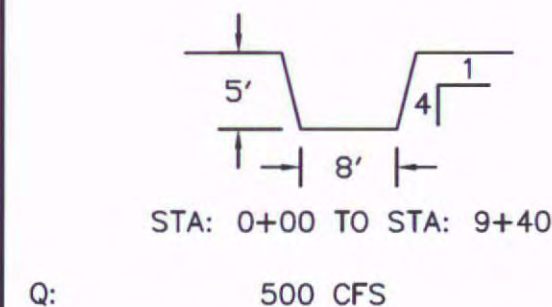
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- CONTOURS — MINOR ELEVATION
- WATERSHED BOUNDARY
- - - - - BASIN BOUNDARY
- ROADS
- 20+00 RIVER AND ALIGNMENT



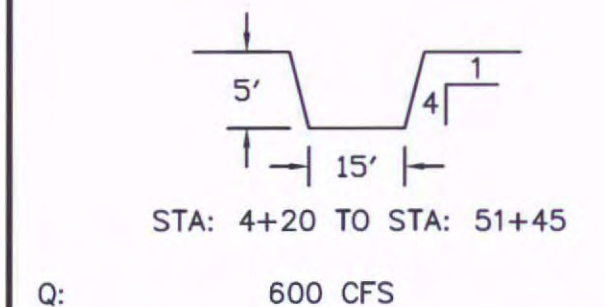
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BASIN: HR0300



CHANNEL: TRIBUTARY 4 (T4)  
BASIN: HR0300



CHANNEL: TRIBUTARY 3 (T3-02)  
BASIN: HR0330



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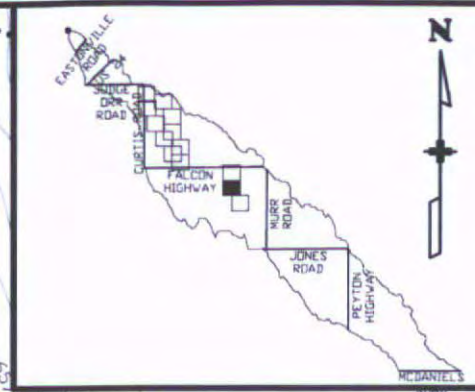
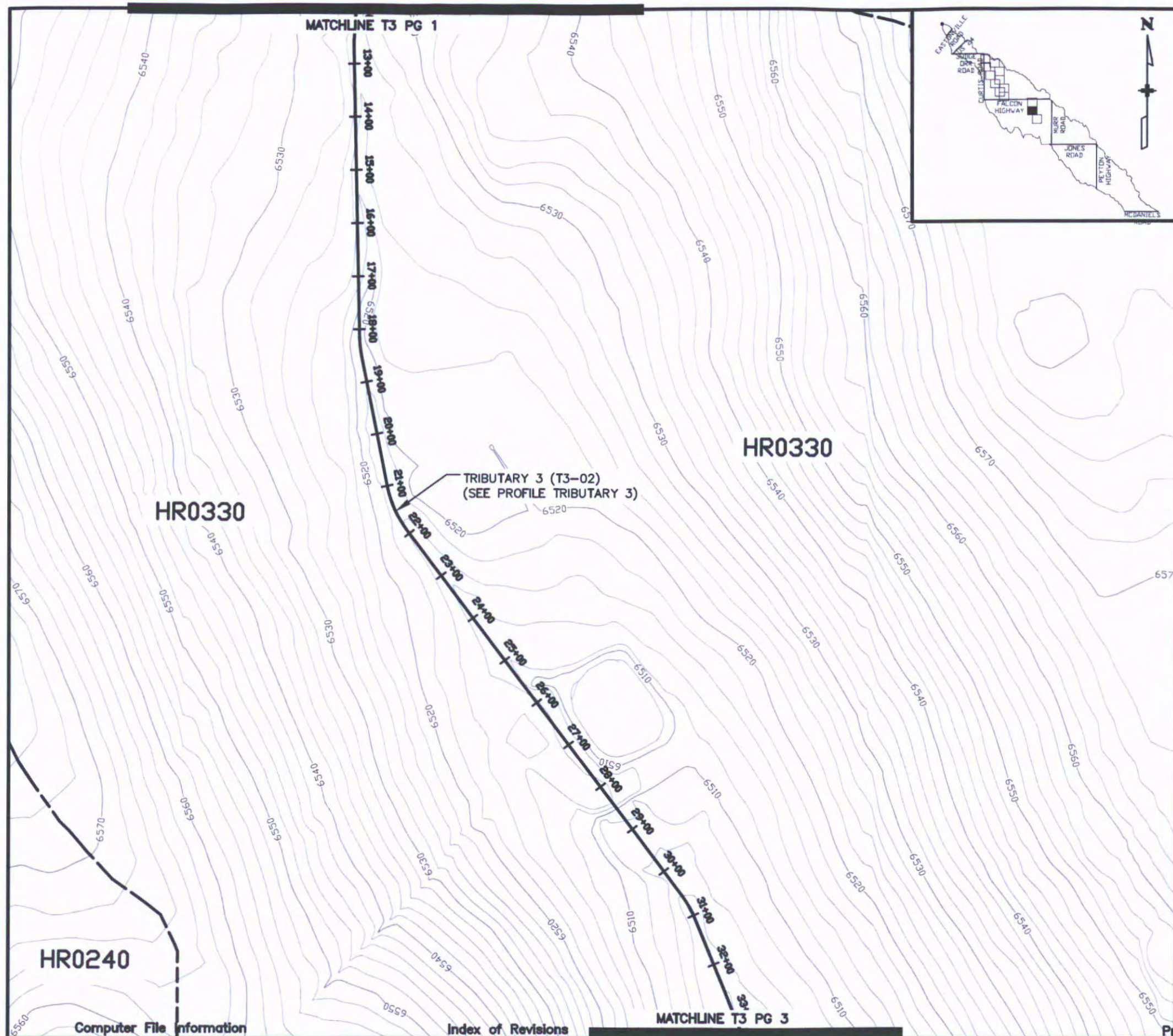
8000 Federal Drive, Suite 200  
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HAEGLER RANCH SUB-REGIONAL DETENTION  
ALTERNATIVE CONCEPTUAL CHANNELS  
Sheet Number TRIBUTARY 3 PG 1





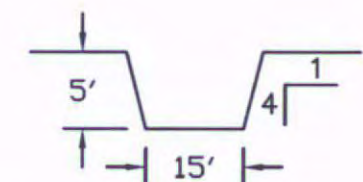
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	CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	BASIN BOUNDARY
	ROADS
20+00	RIVER AND ALIGNMENT

1"=200'



CHANNEL: TRIBUTARY 3 (T3-02)  
BASIN: HR0330



STA: 4+20 TO STA: 51+45

Q: 600 CFS

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MATCHLINE T3 PG 3

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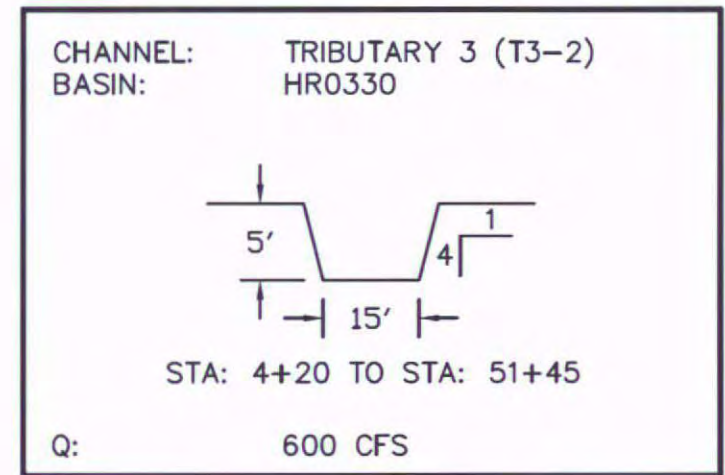
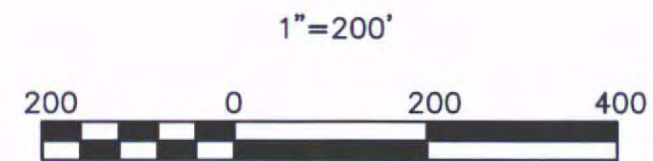
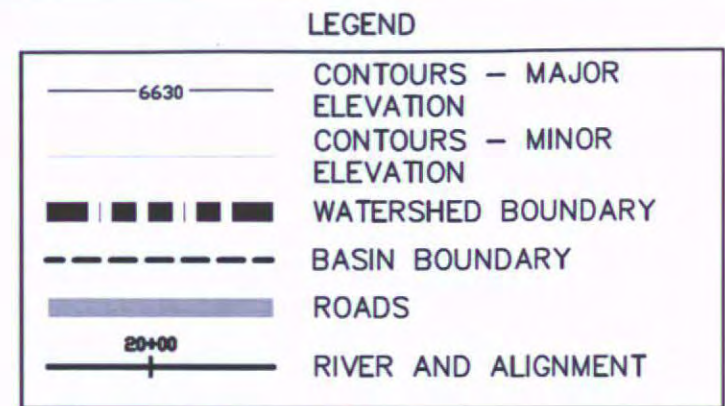
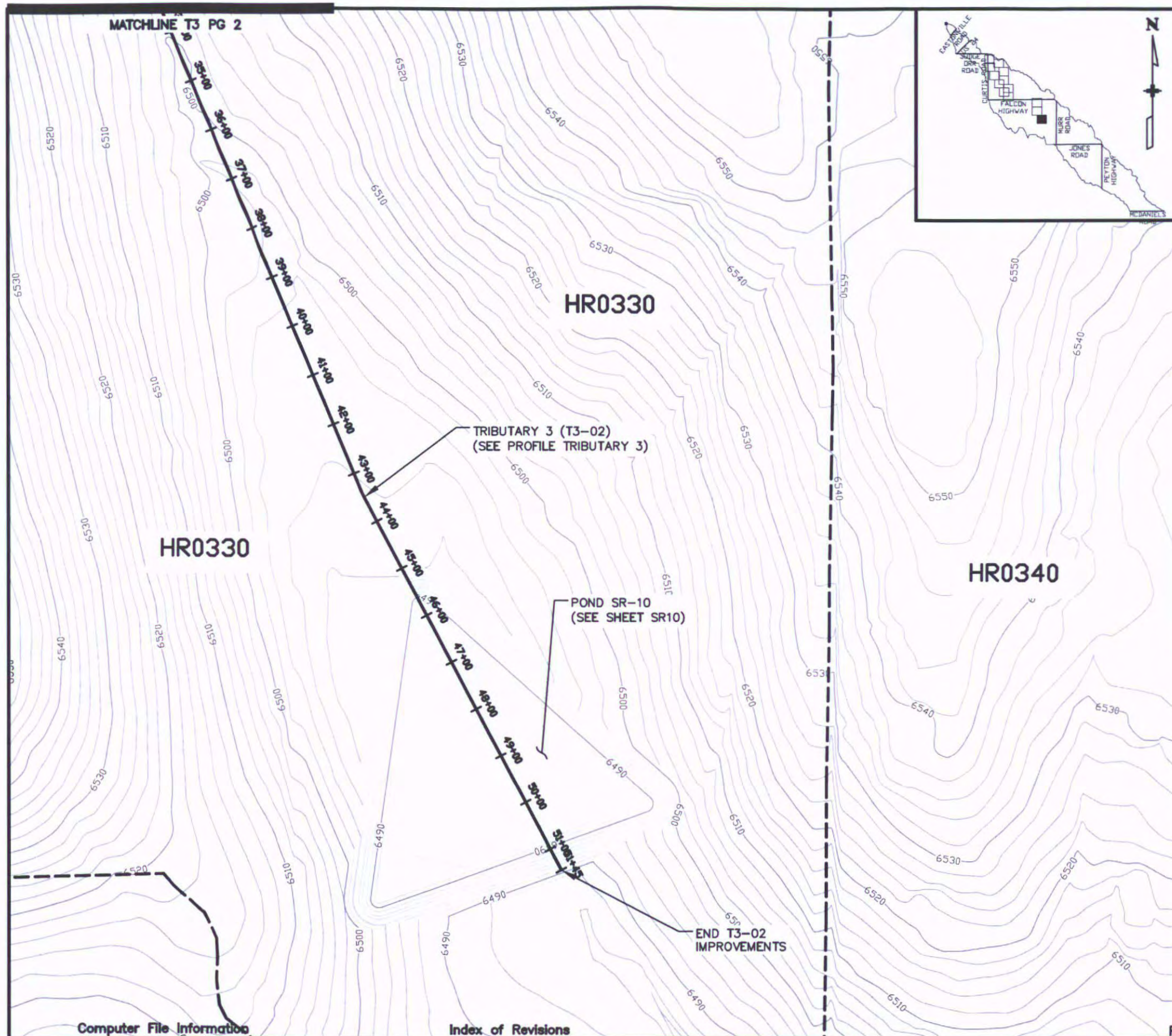
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HAEGLER RANCH SUB-REGIONAL DETENTION  
ALTERNATIVE CONCEPTUAL CHANNELS

Sheet Number TRIBUTARY 3 PG 2





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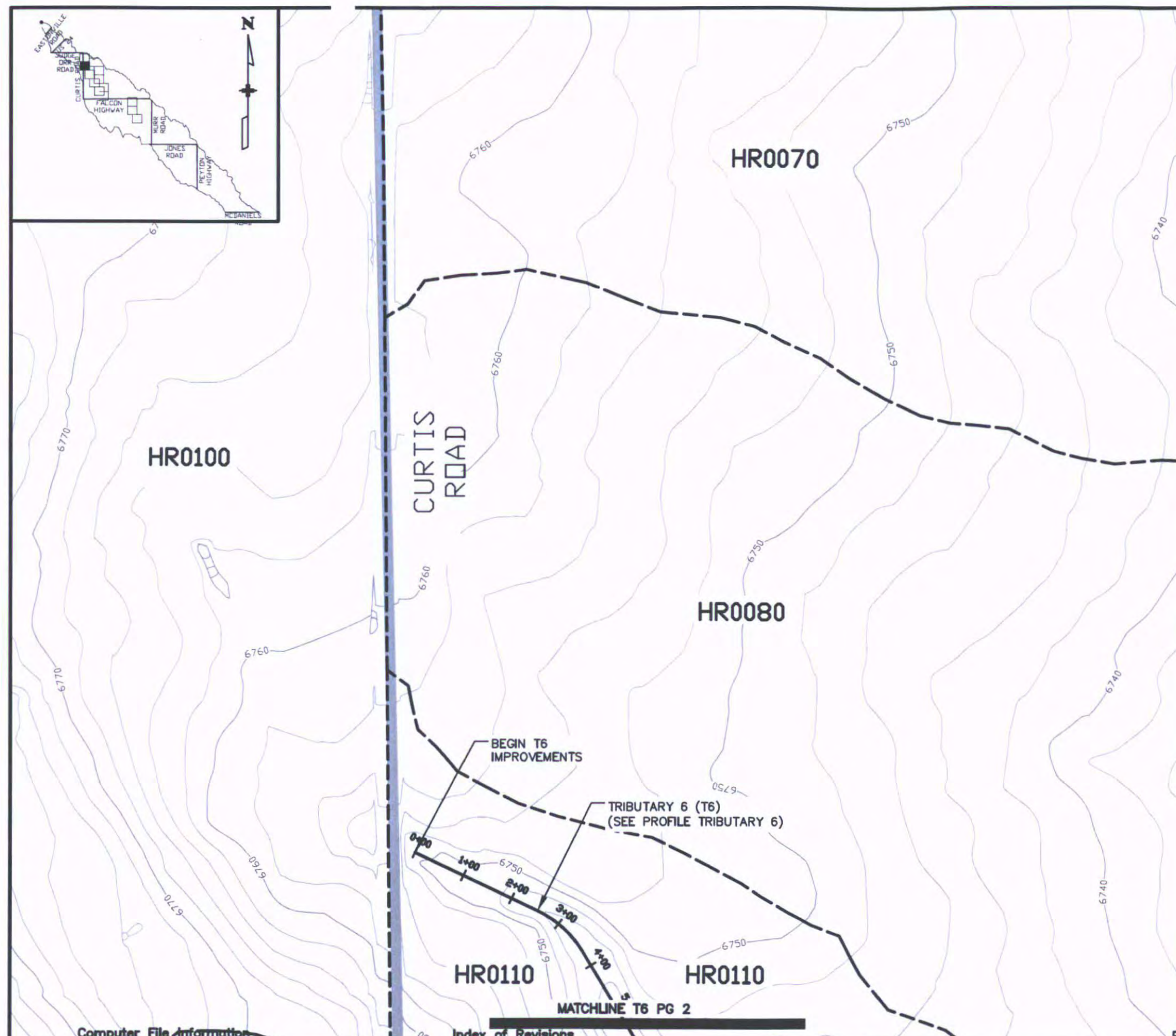
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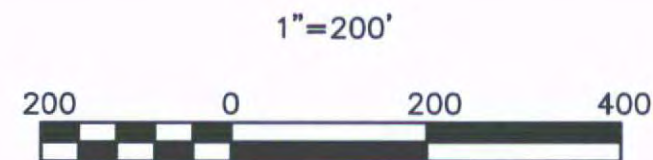
HAEGLER RANCH SUB-REGIONAL DETENTION  
ALTERNATIVE CONCEPTUAL CHANNELS  
Sheet Number TRIBUTARY 3 PG 3





**LEGEND**

- 6630 CONTOURS - MAJOR ELEVATION
- CONTOURS - MINOR ELEVATION
- WATERSHED BOUNDARY
- BASIN BOUNDARY
- ROADS
- 20+00 RIVER AND ALIGNMENT



CHANNEL: TRIBUTARY 6 (T6)

BASIN: HR0110

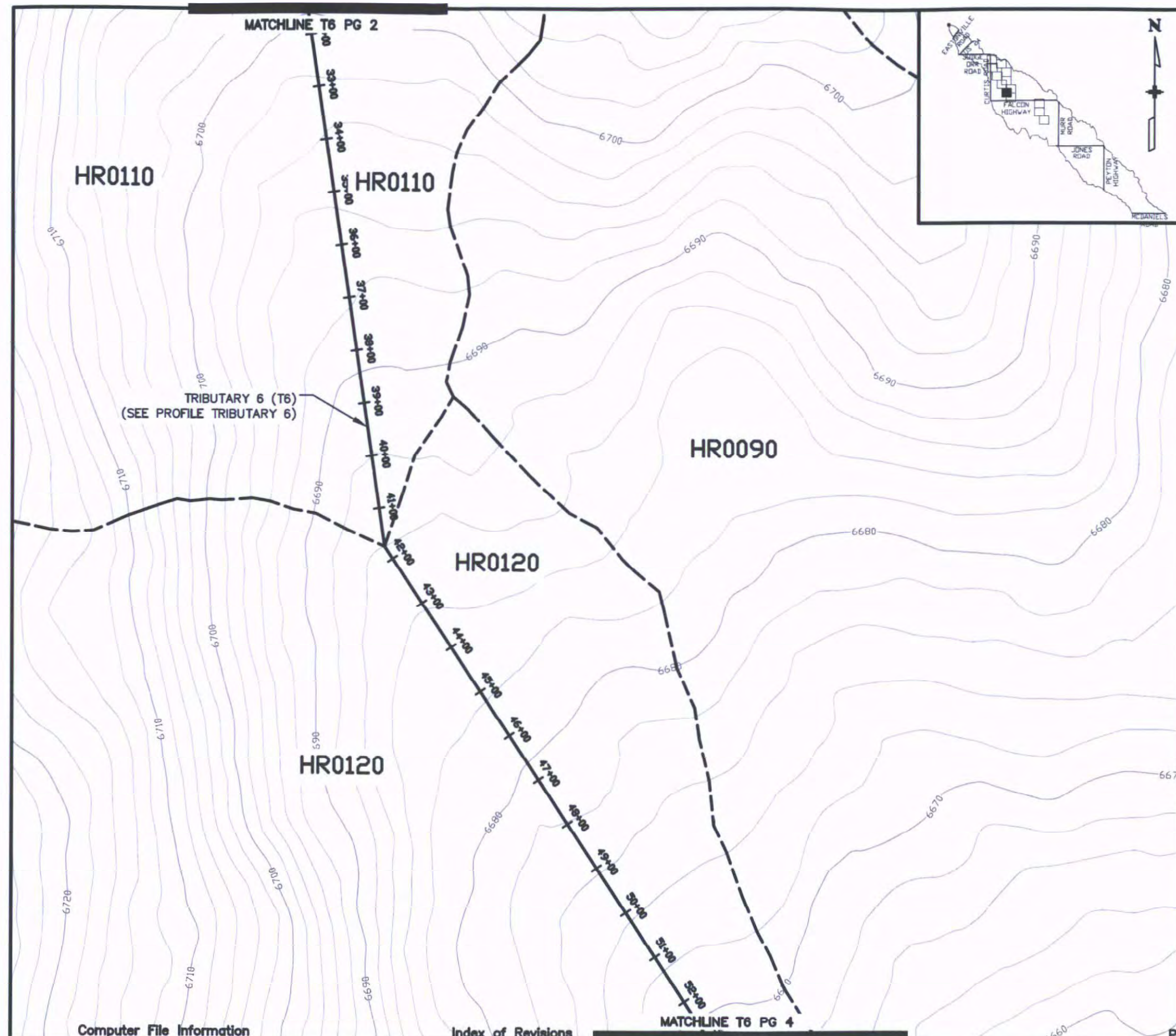
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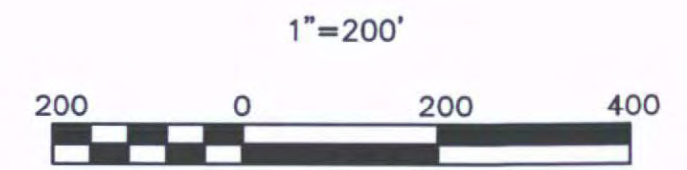






**LEGEND**

- 6630 — CONTOURS — MAJOR ELEVATION
- CONTOURS — MINOR ELEVATION
- WATERSHED BOUNDARY
- BASIN BOUNDARY
- ROADS
- 20+00 — RIVER AND ALIGNMENT



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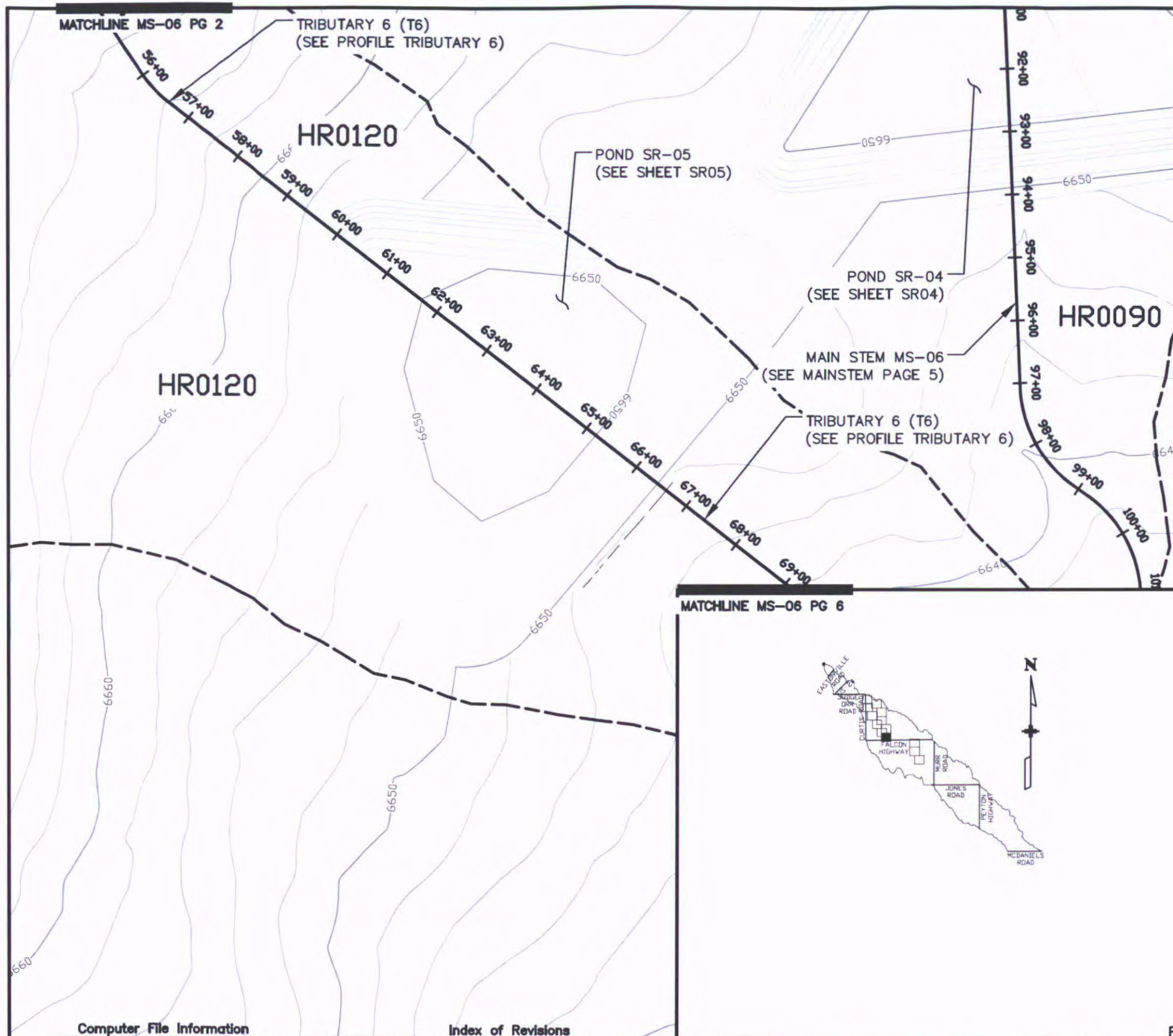
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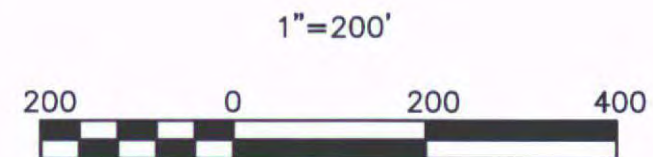
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**LEGEND**

- 6630 ——— CONTOURS — MAJOR ELEVATION
- CONTOURS — MINOR ELEVATION
- ||||| WATERSHED BOUNDARY
- - - - - BASIN BOUNDARY
- ROADS
- 20+00 ——— RIVER AND ALIGNMENT



CHANNEL: TRIBUTARY 6 (T6)  
BASIN: HR0120

STA: 41+73 TO STA: 75+50

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Profiles

Designed by:	KAP
Detailed by:	DRM
Checked by:	JAJ

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Fax (719) 531-0007

Structure Numbers

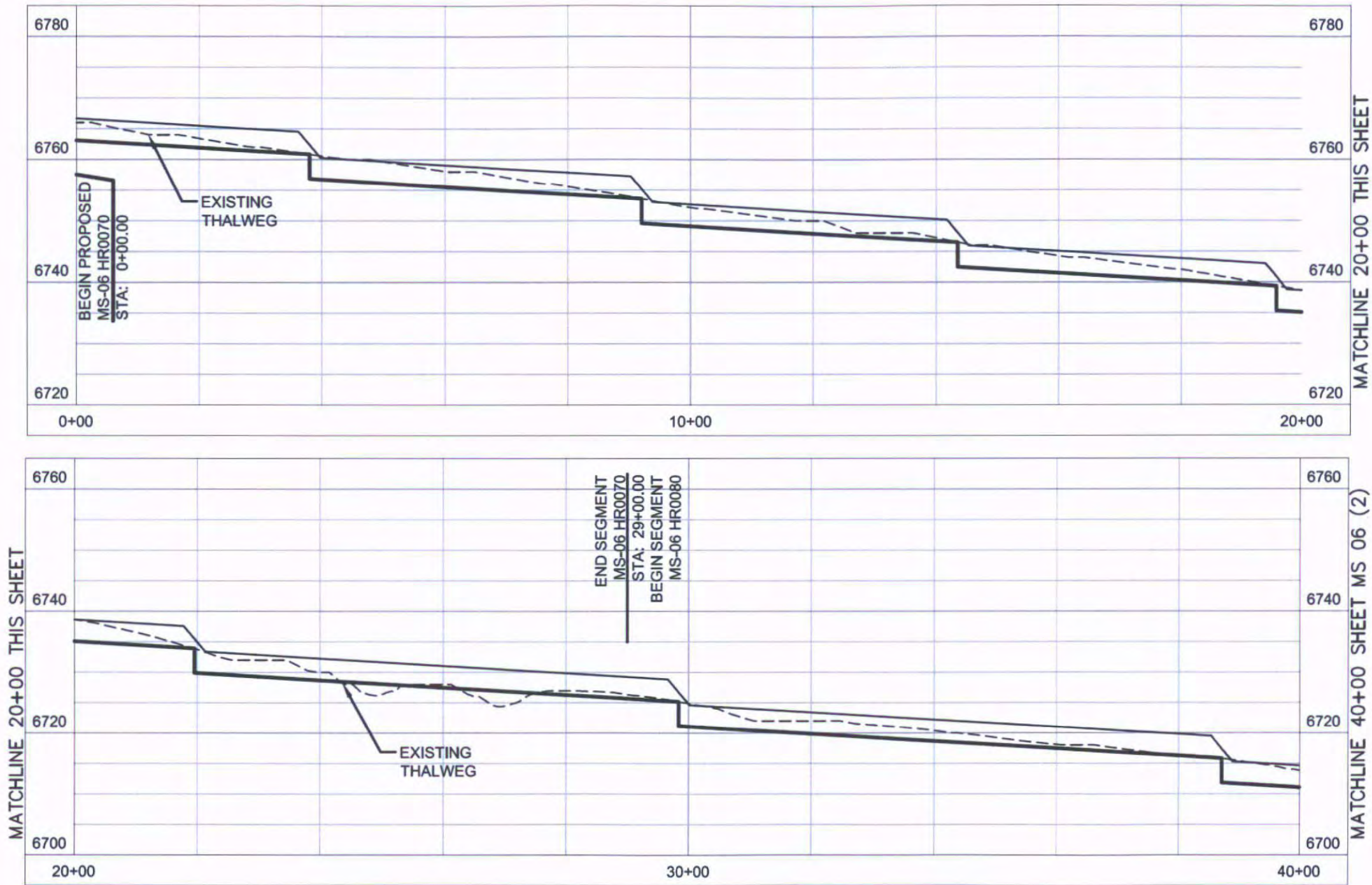
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MS-06 HR0070  
SLOPE = 0.60%  
(7) 4' DROPS

MS-06 HR0080  
SLOPE = 0.60%  
(7) 4' DROPS

PROFILE MAIN STEM (MS-06 & MS-05)



LEGEND

- PROPOSED DROP STRUCTURE
- - - EXISTING THALWEG
- HYDRAULIC GRADE LINE



MS-06 HR0080

SLOPE = 0.60%

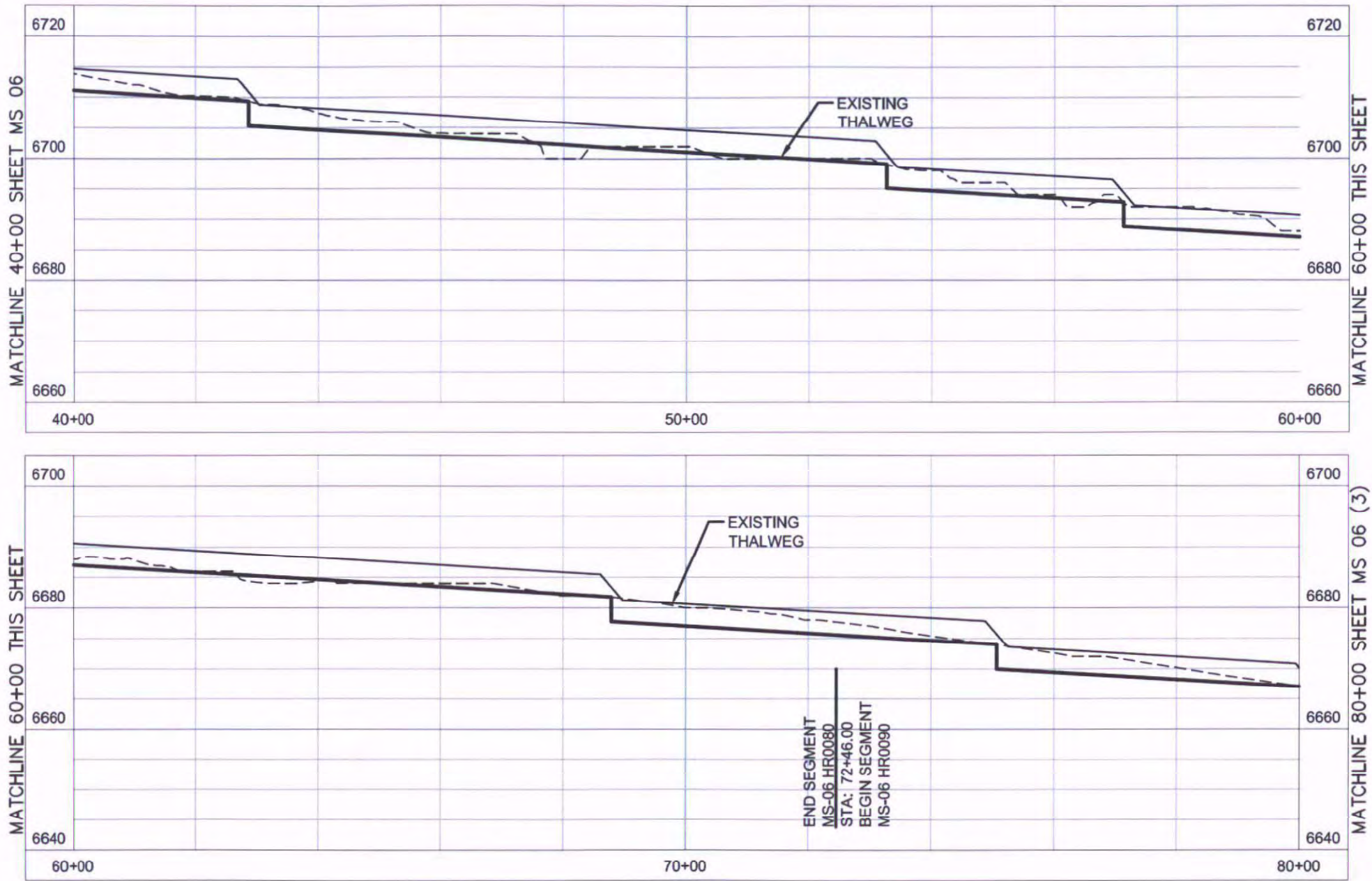
(7) 4' DROPS

MS-06 HR0090

SLOPE = 0.60%

(8) 4' DROPS

PROFILE MAIN STEM (MS-06 & MS-05)



LEGEND

- PROPOSED DROP STRUCTURE
- - - EXISTING THALWEG
- HYDRAULIC GRADE LINE

Computer File Information

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Profiles

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MS-06 HR0090

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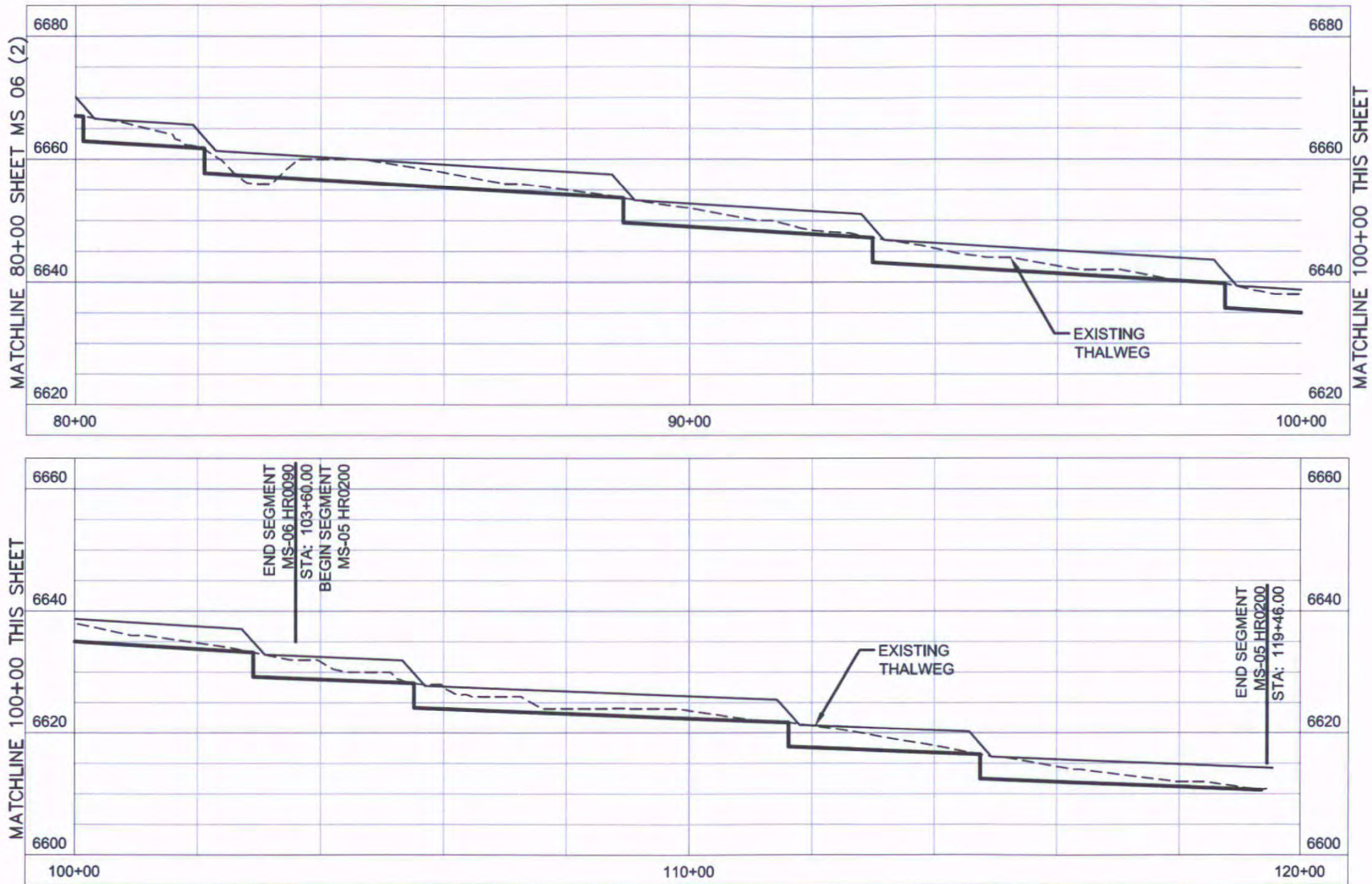
(8) 4' DROPS

MS-05 HR0200

SLOPE = 0.40%

(4) 4' DROPS

PROFILE MAIN STEM (MS-06 & MS-05)

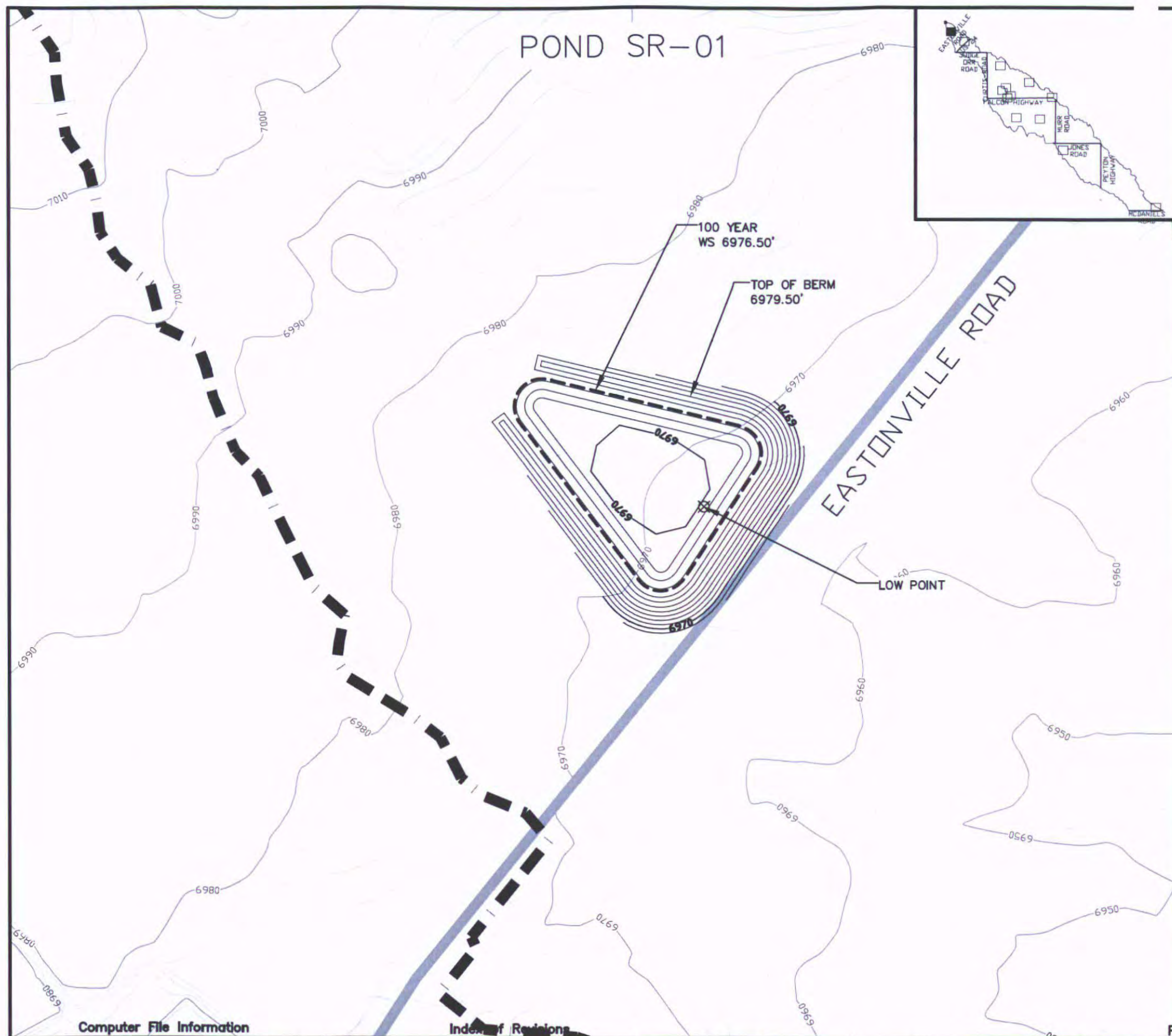


LEGEND

—	PROPOSED DROP STRUCTURE
- - -	EXISTING THALWEG
—	HYDRAULIC GRADE LINE

Computer File Information				Index of Revisions				Profiles				HAEGLER RANCH SUB-REGIONAL DETENTION ALTERNATIVE CONCEPTUAL PROFILES			
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Acad. Ver.	2006	Scale:	1"=20'	Units:	Feet			Checked by:							





LEGEND

6630

PROPOSED CONTOURS - MAJOR ELEVATION

PROPOSED CONTOURS - MINOR ELEVATION

6630

EXISTING CONTOURS - MAJOR ELEVATION

EXISTING CONTOURS - MINOR ELEVATION

WATERSHED BOUNDARY

ROADS

RIVER

100 YEAR WATER SURFACE ELEVATION

OUTLET

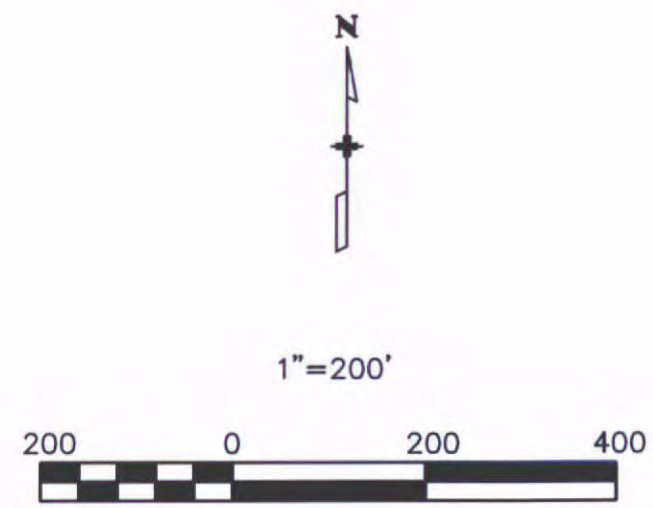
POND SR-01  
DISCHARGE

Q100	90 CFS
Q2	8 CFS

POND VOLUME AC FT    10

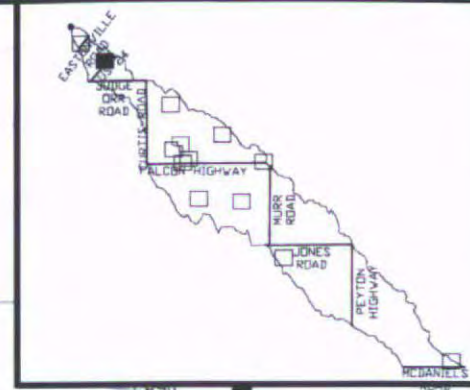
BERM WIDTH            10'

SIDESLOPE             8:1





# POND SR-02



**LEGEND**

6630

6630

6630

PROPOSED CONTOURS -  
MAJOR ELEVATION

PROPOSED CONTOURS -  
MINOR ELEVATION

EXISTING CONTOURS -  
MAJOR ELEVATION

EXISTING CONTOURS -  
MINOR ELEVATION

WATERSHED BOUNDARY

ROADS

RIVER

100 YEAR WATER  
SURFACE ELEVATION

OUTLET

## POND SR-02 DISCHARGE

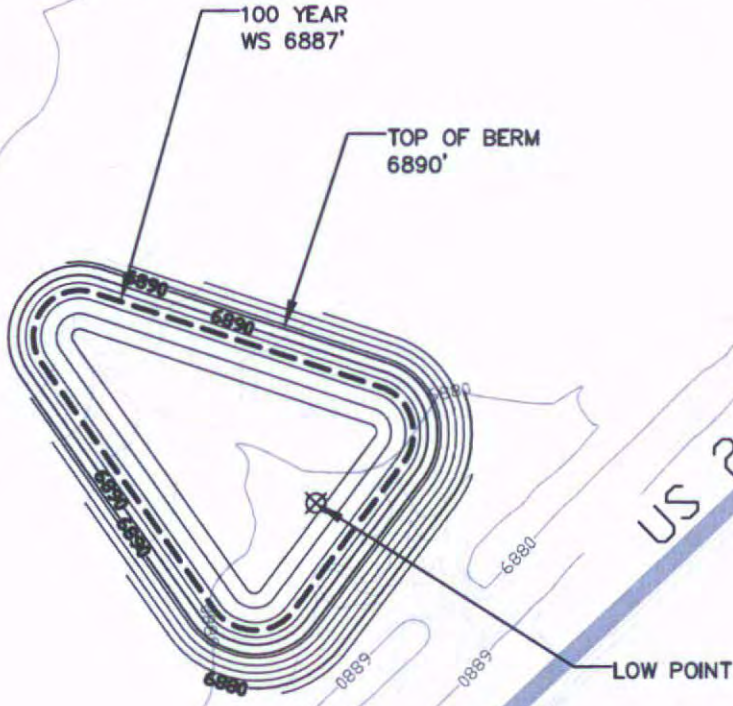
Q100                      250 CFS  
Q2                         3 CFS

POND VOLUME AC FT                      5

BERM WIDTH                      10'  
SIDESLOPES                         8:1



1"=200'



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Drawing File Name: PONDS.DWG  
Acad. Ver. 2006 Scale: 1"=200' Units: Feet

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Checked by: JAJ

### Profiles

Structure  
Numbers

HAEGLER RANCH DRAINAGE BASIN  
Sheet Number SR02



# POND SR-03

MAIN STEM MS-06  
(SEE MAINSTEM PG 2 & 3)  
(SEE PROFILE MS-06)

TOP OF BERM  
6724'

100 YEAR  
WS 6721'

LOW POINT

## LEGEND

	PROPOSED CONTOURS - MAJOR ELEVATION
	PROPOSED CONTOURS - MINOR ELEVATION
	EXISTING CONTOURS - MAJOR ELEVATION
	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

POND SR-03  
DISCHARGE

Q100 530 CFS  
Q2 29 CFS

POND VOLUME AC FT 16

BERM WIDTH 10'  
SIDESLOPES 8:1



1"=200'



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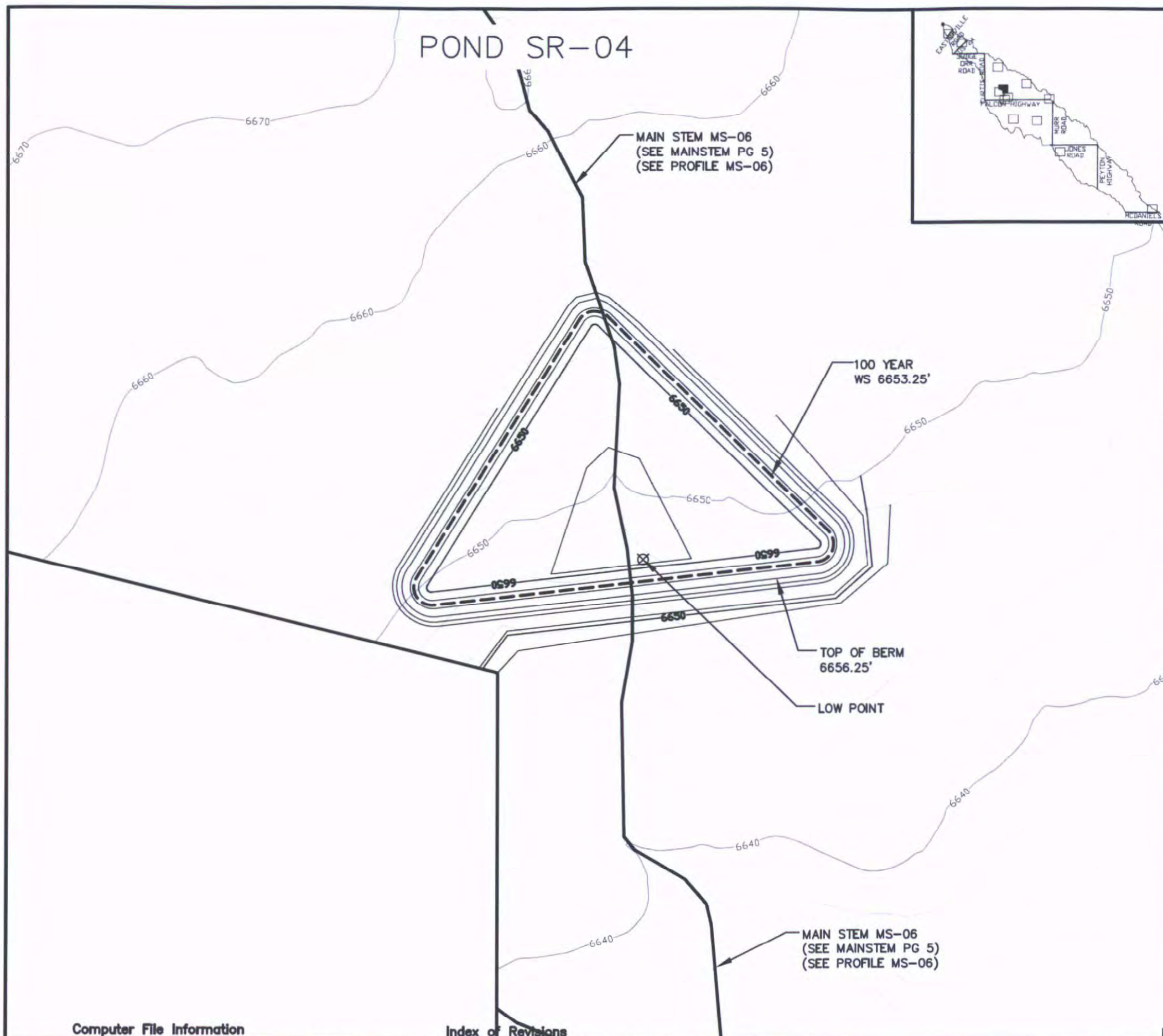
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Detailed by: DRM  
Checked by: JAJ

## Profiles

Structure  
Numbers

HAEGLER RANCH DRAINAGE BASIN  
Sheet Number SR03





LEGEND	
	PROPOSED CONTOURS - MAJOR ELEVATION
	PROPOSED CONTOURS - MINOR ELEVATION
	EXISTING CONTOURS - MAJOR ELEVATION
	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

# POND SR-04 DISCHARGE

Q100	740 CFS
Q2	33 CFS

POND VOLUME AC FT	25
-------------------	----

BERM WIDTH	10'
SIDESLOPES	8:1



1"=200'



## Computer File Information

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Acad. Ver.	2006
Scale:	1"=200'
Units:	Feet

## Index of Revisions

1				
2				
3				



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## Profiles

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Structure  
Numbers

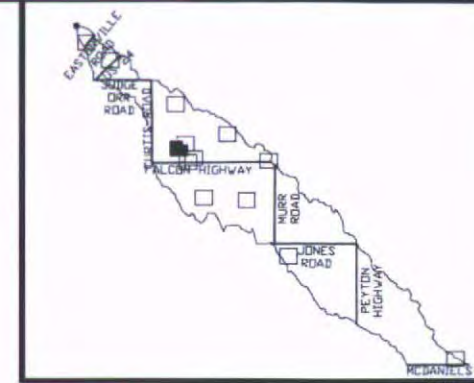
HAEGLER RANCH DRAINAGE BASIN

Sheet Number

SR04



# POND SR-05



## LEGEND

	PROPOSED CONTOURS - MAJOR ELEVATION
	PROPOSED CONTOURS - MINOR ELEVATION
	EXISTING CONTOURS - MAJOR ELEVATION
	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

## POND SR-05 DISCHARGE

Q100	250 CFS
Q2	9 CFS

POND VOLUME AC FT 24

BERM WIDTH 10'  
SIDESLOPES 8:1

TRIBUTARY 6 (T6)  
(SEE TRIBUTARY 6 PG 4)  
(SEE PROFILE TRIBUTARY 6)

100 YEAR  
WS 6655.50'

LOW POINT

TOP OF BERM  
6658.50'

TRIBUTARY 6 (T6)  
(SEE TRIBUTARY 6 PG 4)  
(SEE PROFILE TRIBUTARY 6)



1"=200'



## Computer File Information

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Drawing File Name: PONDS.DWG  
Acad. Ver. 2006 Scale: 1"=200' Units: Feet

## Index of Revisions






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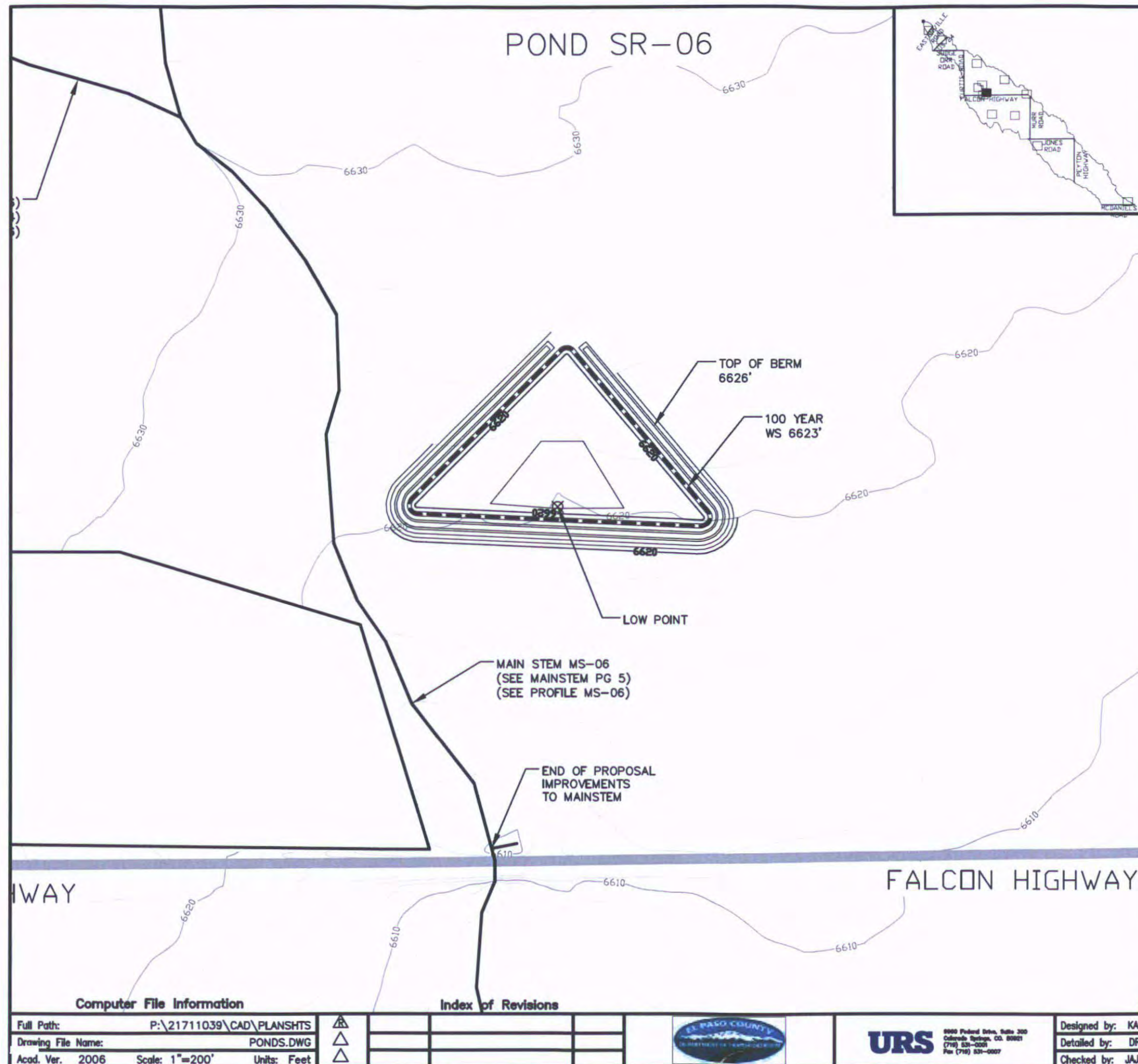
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Detailed by: DRM  
Checked by: JAJ

Structure  
Numbers

HAEGLER RANCH DRAINAGE BASIN  
Sheet Number SR05

## Profiles





LEGEND	
	PROPOSED CONTOURS - MAJOR ELEVATION
	PROPOSED CONTOURS - MINOR ELEVATION
	EXISTING CONTOURS - MAJOR ELEVATION
	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

POND SR-06  
DISCHARGE

Q100	20 CFS
Q2	1 CFS

POND VOLUME AC FT	9
-------------------	---

BERM WIDTH	10'
SIDESLOPES	4:1

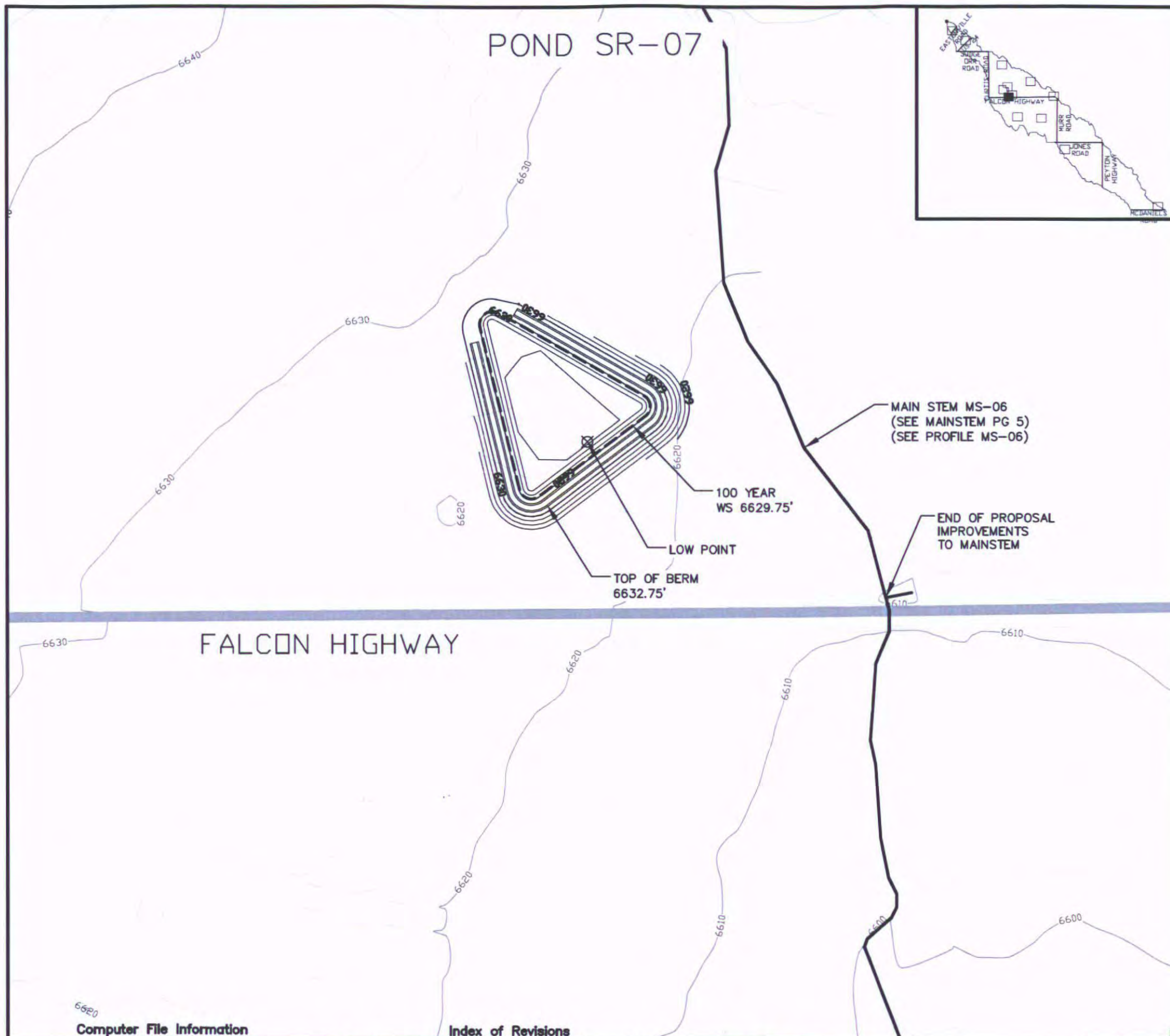


1"=200'



Designed by: KAP	Structure Numbers	HAEGLER RANCH DRAINAGE BASIN	
Detailed by: DRM		Sheet Number	
Checked by: JAJ		SR06	





LEGEND	
	PROPOSED CONTOURS - MAJOR ELEVATION
	PROPOSED CONTOURS - MINOR ELEVATION
	EXISTING CONTOURS - MAJOR ELEVATION
	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

POND SR-07  
DISCHARGE

Q100	88 CFS
Q2	1 CFS

POND VOLUME AC FT	5
-------------------	---

BERM WIDTH	10'
SIDESLOPES	4:1



1"=200'



#### Computer File Information

Full Path:	P:\21711039\CAD\PLANSHTS
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Units:	Feet

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#### Profiles

Structure Numbers	
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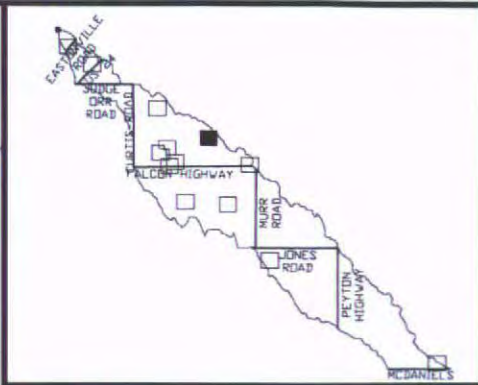
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Sheet Number	SR07







POND SR-09



LEGEND

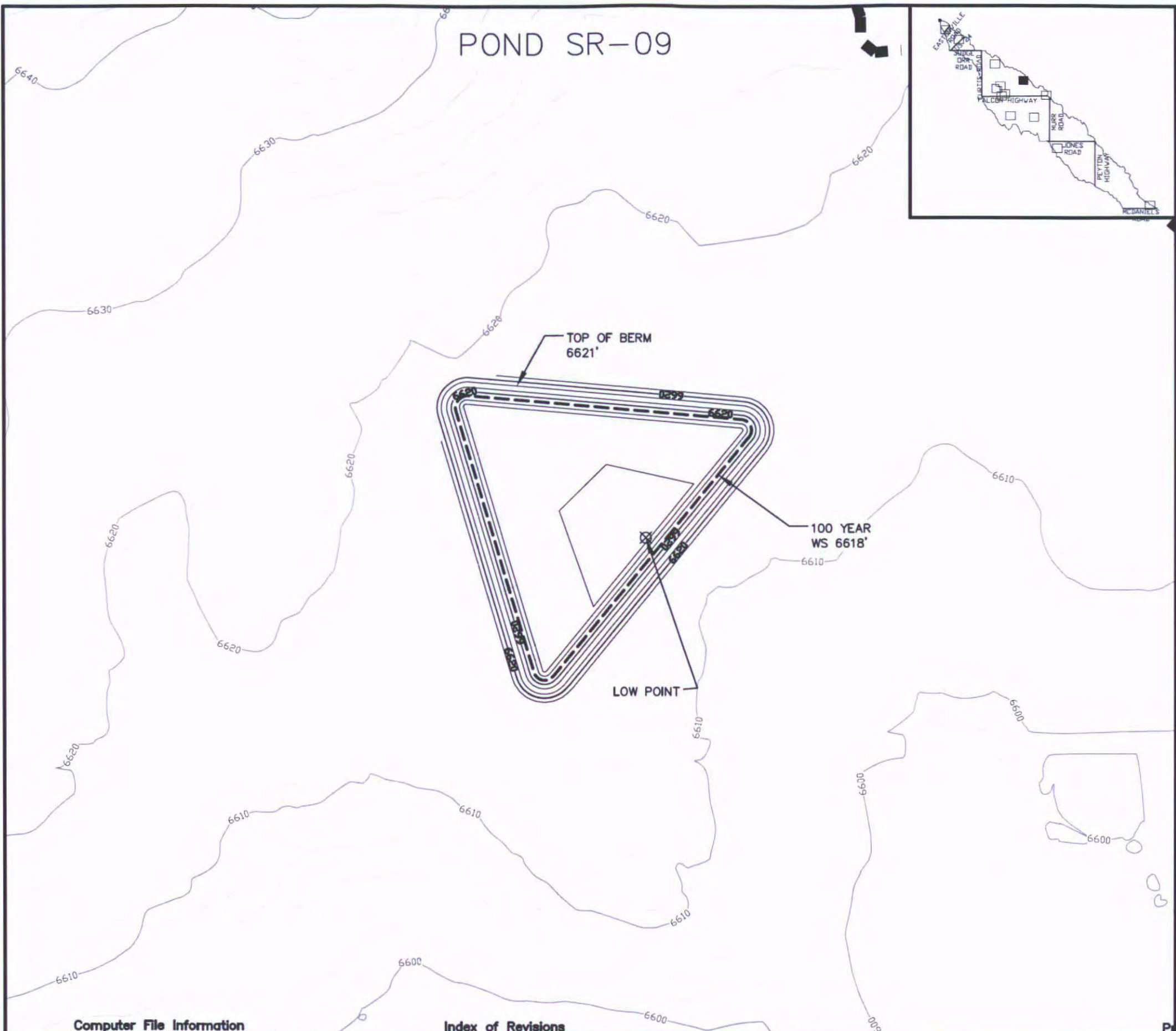
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	EXISTING CONTOURS - MAJOR ELEVATION
	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

POND SR-09  
DISCHARGE

Q100	66 CFS
Q2	3 CFS

POND VOLUME AC FT 20

BERM WIDTH 10'  
SIDESLOPES 4:1



1"=200'



Computer File Information

Full Path:	P:\21711039\CAD\PLANSHTS
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Acad. Ver.	2006
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Units:	Feet

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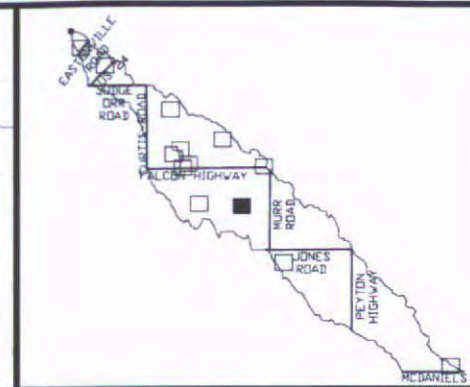
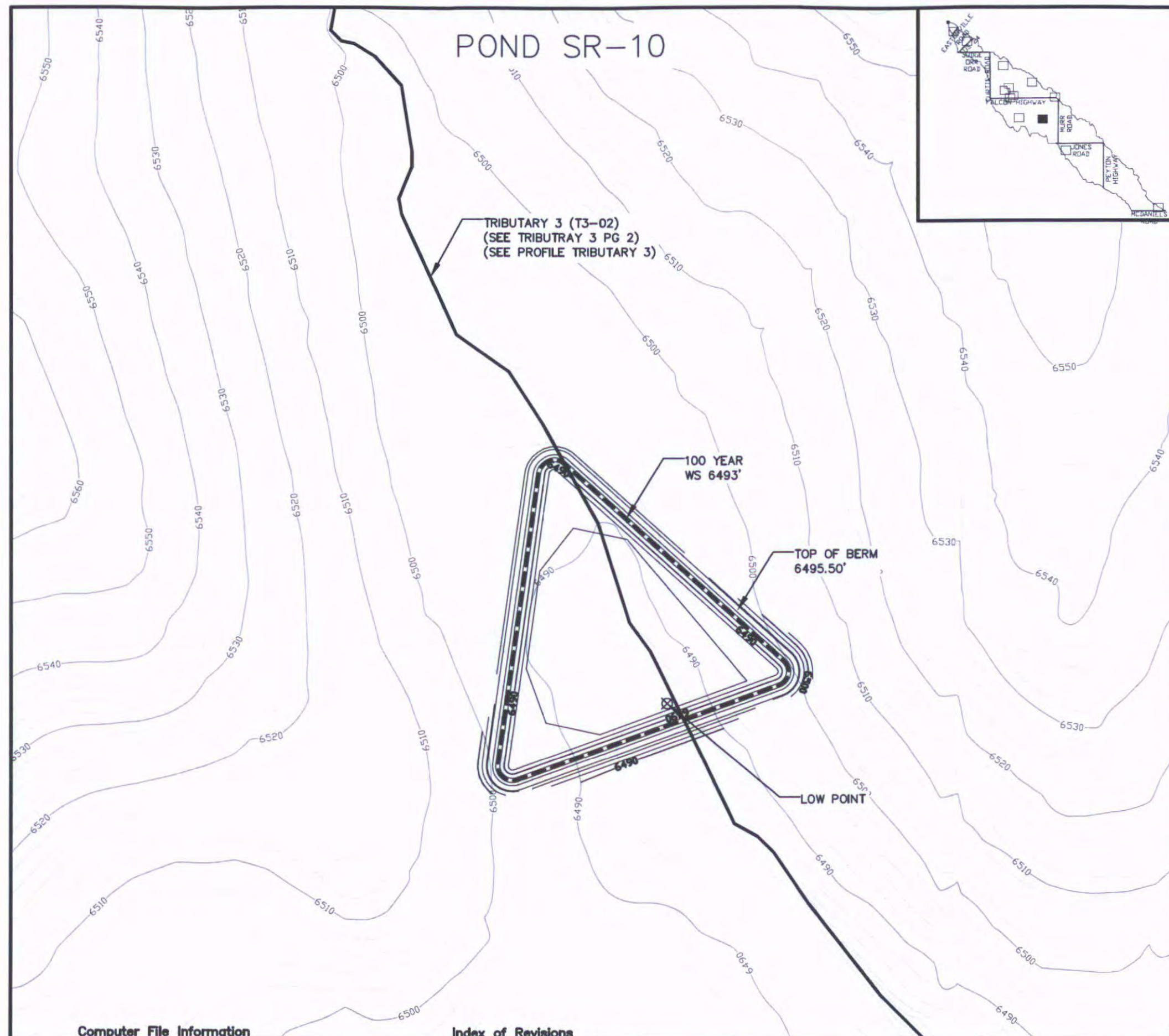

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Structure  
Numbers

HAEGLER RANCH DRAINAGE BASIN
Sheet Number SR09





# LEGEND

6630	PROPOSED CONTOURS - MAJOR ELEVATION
	PROPOSED CONTOURS - MINOR ELEVATION
6630	EXISTING CONTOURS - MAJOR ELEVATION
	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

POND SR-10

DISCHARGE

Q100	600 CFS
Q2	23 CFS

POND VOLUME AC FT 23

BERM WIDTH 10'  
SIDESLOPES 4:1



1"=200'



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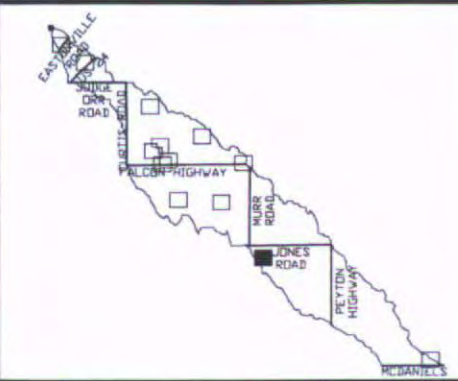
Structure  
Numbers

HAEGLER RANCH DRAINAGE BASIN

Sheet Number SR10



POND SR-11



LEGEND

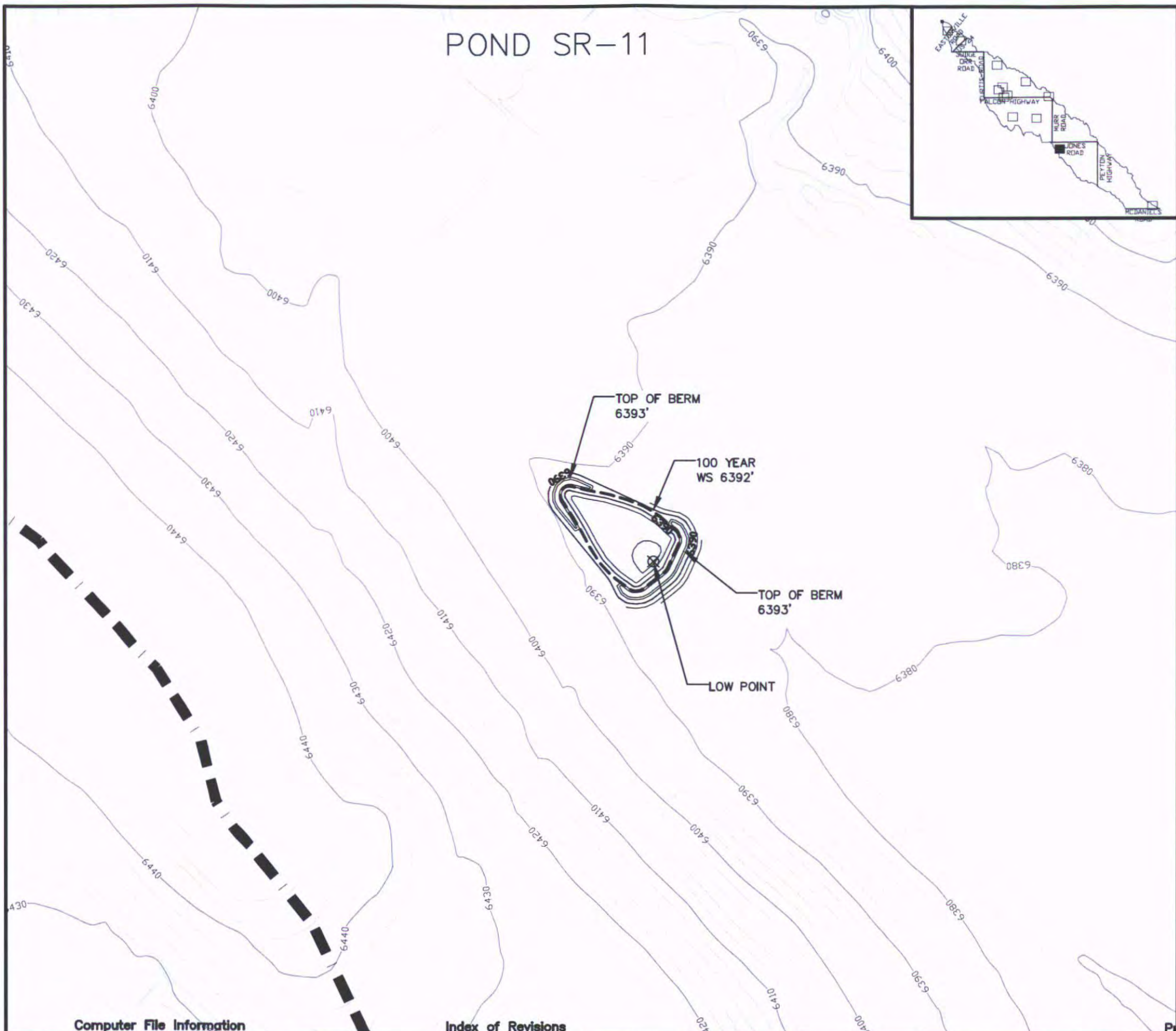
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	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

POND SR-11  
DISCHARGE

Q100	61 CFS
Q2	1 CFS

POND VOLUME AC FT 2

BERM WIDTH 10'  
SIDESLOPES 4:1



1"=200'



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Acad. Ver.	2006
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Units:	Feet

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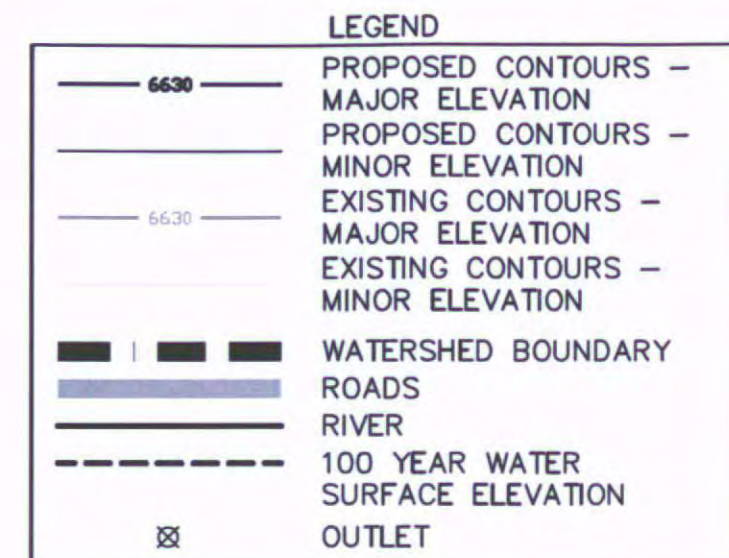
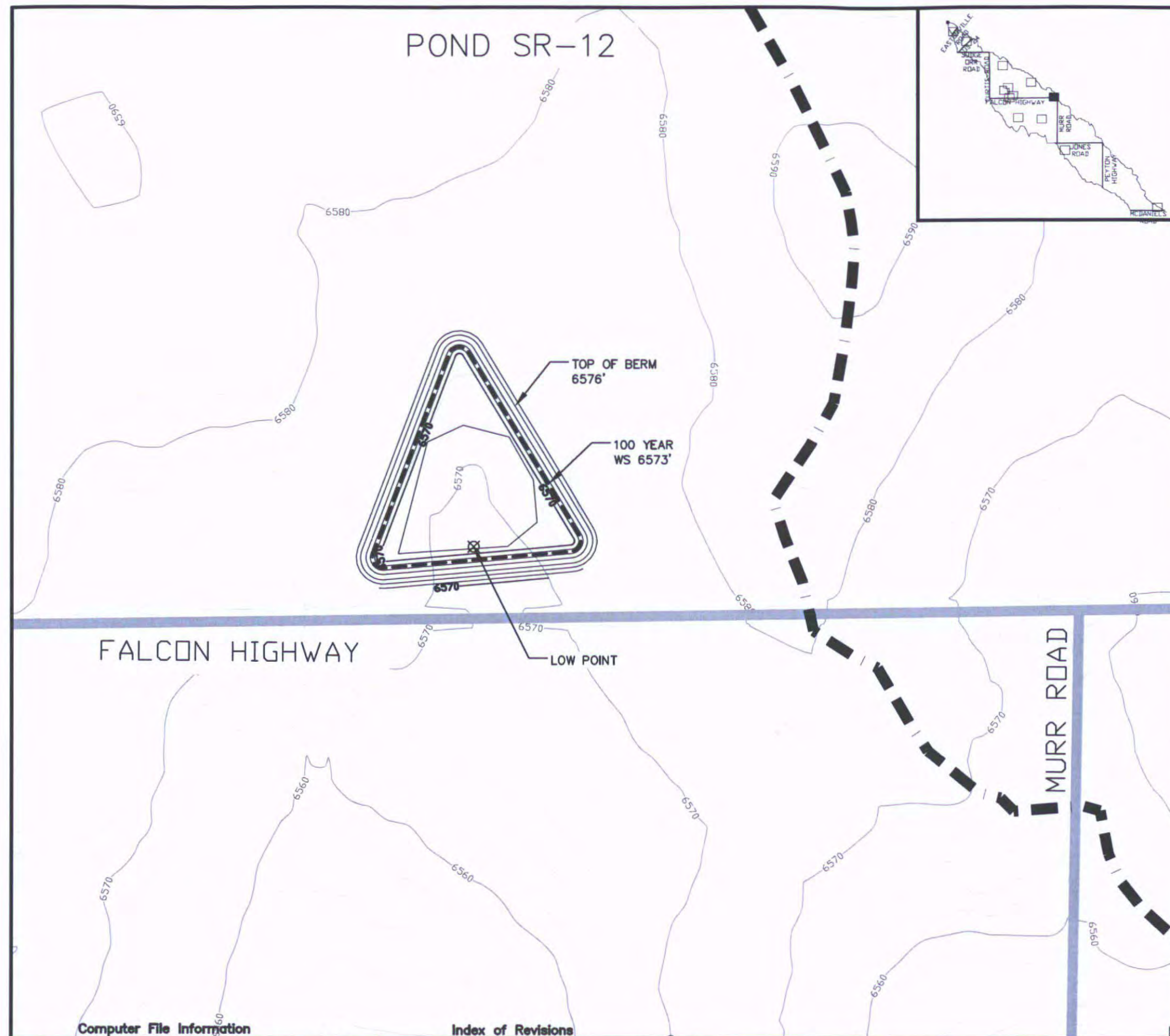
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Structure  
Numbers

HAEGLER RANCH DRAINAGE BASIN
Sheet Number SR11





POND SR-12

DISCHARGE

Q100	35 CFS
Q2	1 CFS

POND VOLUME AC FT	9
-------------------	---

BERM WIDTH	10'
SIDESLOPES	4:1



1"=200'



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Profiles

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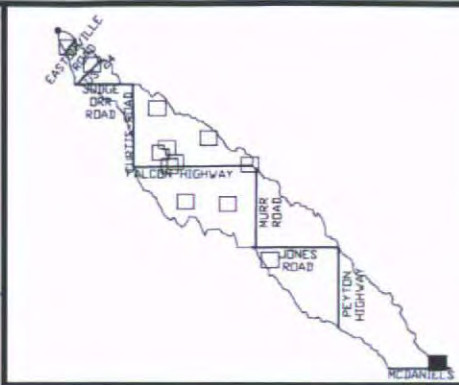
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Structure  
 Numbers

HAEGLER RANCH DRAINAGE BASIN  
 Sheet Number SR12



POND SR-13



LEGEND

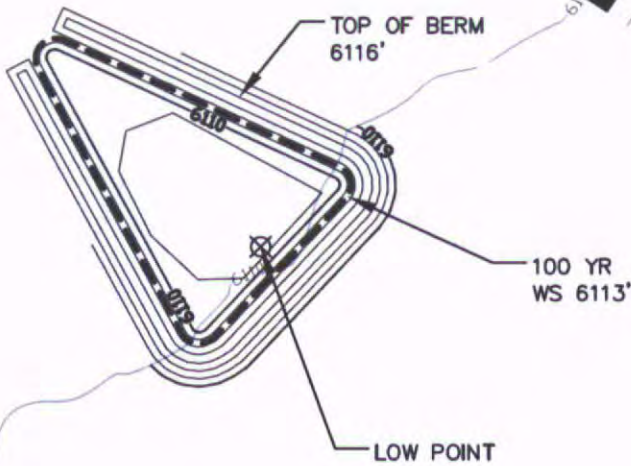
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	EXISTING CONTOURS - MINOR ELEVATION
	WATERSHED BOUNDARY
	ROADS
	RIVER
	100 YEAR WATER SURFACE ELEVATION
	OUTLET

POND SR-13  
DISCHARGE

Q100	110 CFS
Q2	6 CFS

POND VOLUME AC FT      3

BERM WIDTH      10'  
SIDESLOPES      4:1



McDANIELS ROAD



1"=200'



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Units:	Feet

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Structure Numbers		HAEGLER RANCH DRAINAGE BASIN
Sheet Number		SR13



T3-02 HR0300

SLOPE = 0.70%

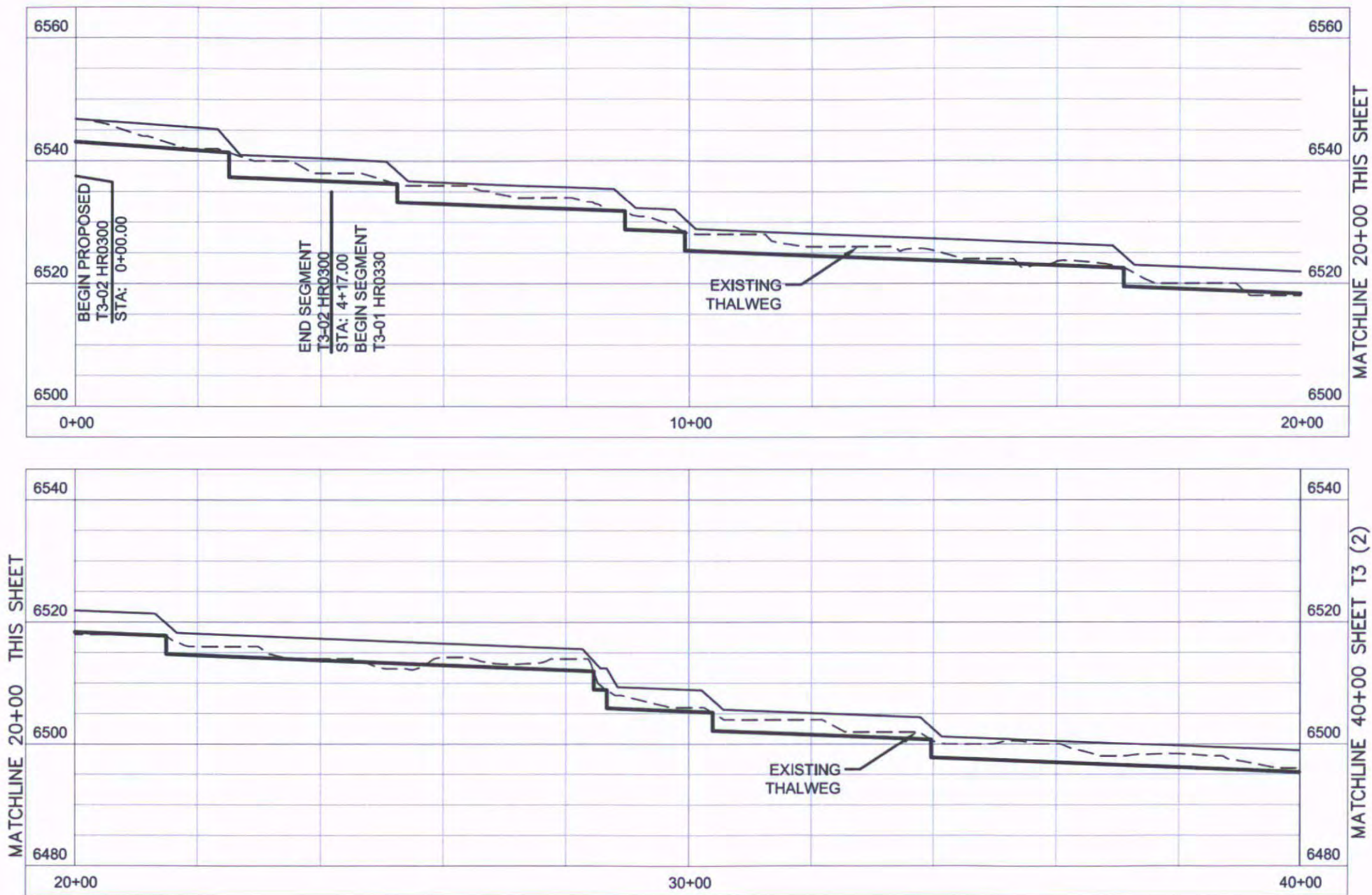
(2) 4' DROPS

T3-01 HR0330

SLOPE = 0.40%

(8) 4' DROPS

PROFILE TRIBUTARY 3 (T3)



LEGEND

- PROPOSED DROP STRUCTURE
- - - EXISTING THALWEG
- HYDRAULIC GRADE LINE

Computer File Information				Index of Revisions				Profiles				Structure Numbers		HAEGLER RANCH SUB-REGIONAL DETENTION ALTERNATIVE CONCEPTUAL PROFILES	
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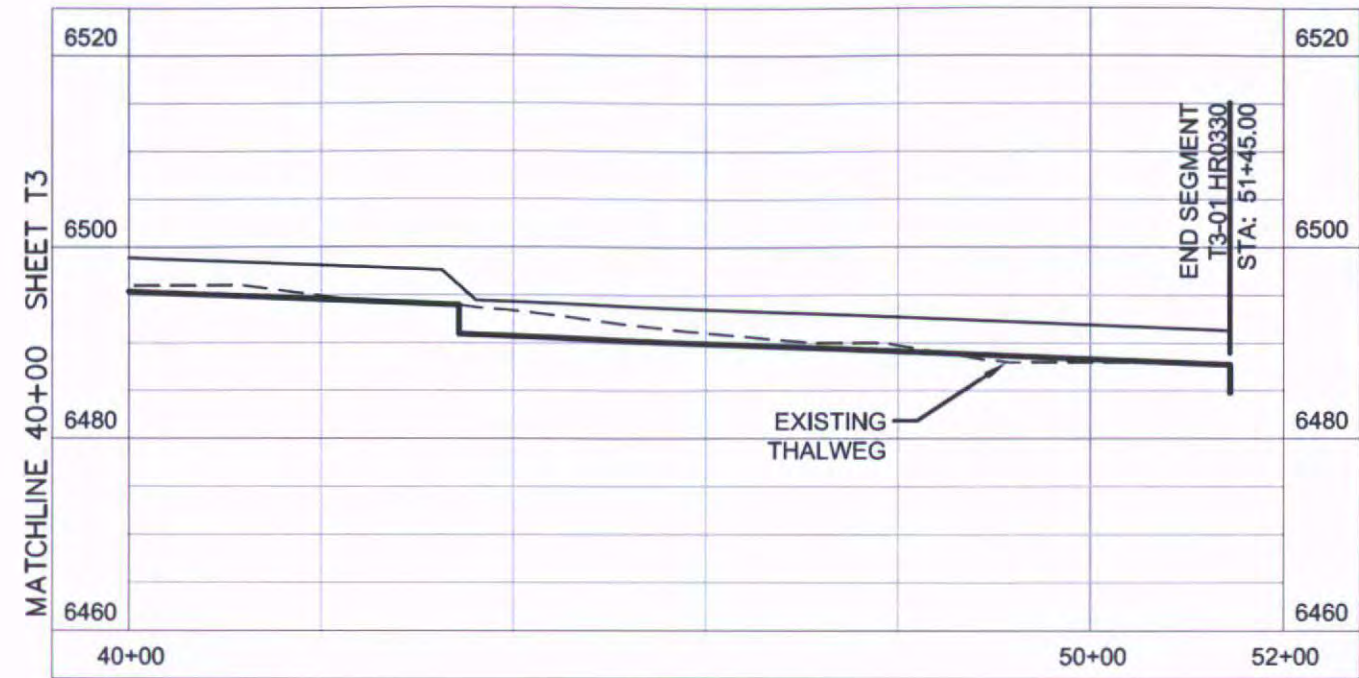


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T3-01    HR0330  
SLOPE = 0.40%  
(8) 4' DROPS

PROFILE TRIBUTARY 3 (T3)



LEGEND

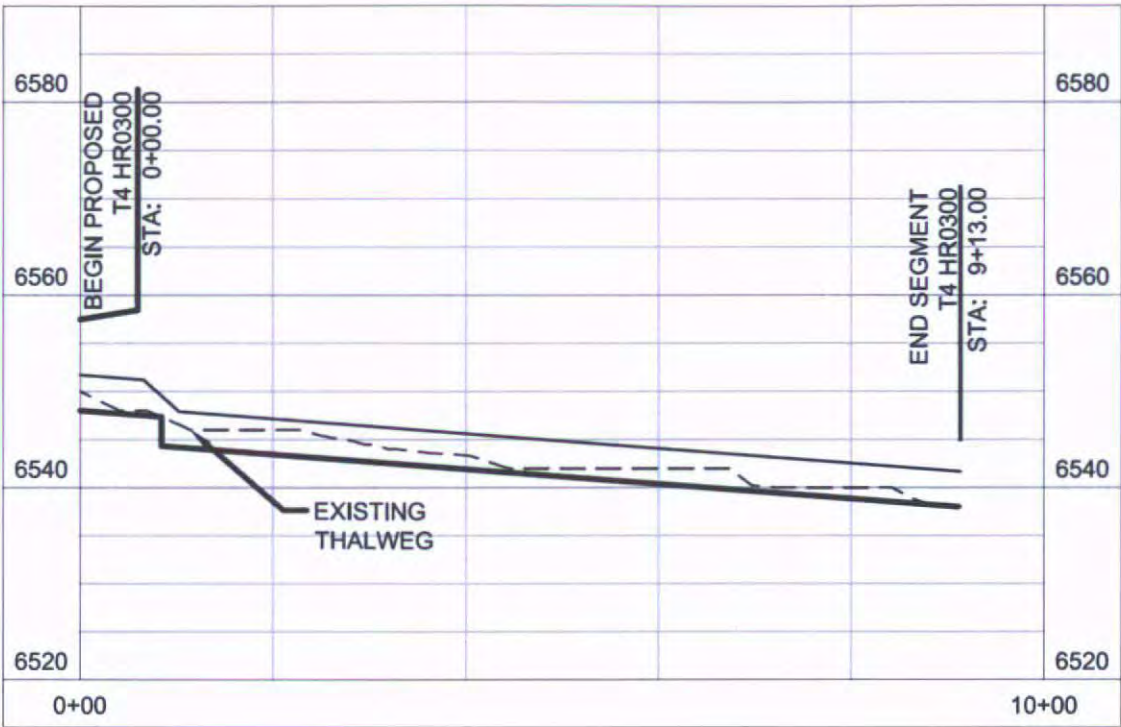
- PROPOSED DROP STRUCTURE
- - - EXISTING THALWEG
- HYDRAULIC GRADE LINE

Computer File Information				Index of Revisions				Profiles								
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Acad. Ver.	2006	Scale:	1"=20'		Units:	Feet					Checked by:					



T4 HR0300  
SLOPE = 0.70%  
(2) 3' DROPS

PROFILE TRIBUTARY 4 (T4)



LEGEND

- PROPOSED DROP STRUCTURE
- - - EXISTING THALWEG
- HYDRAULIC GRADE LINE

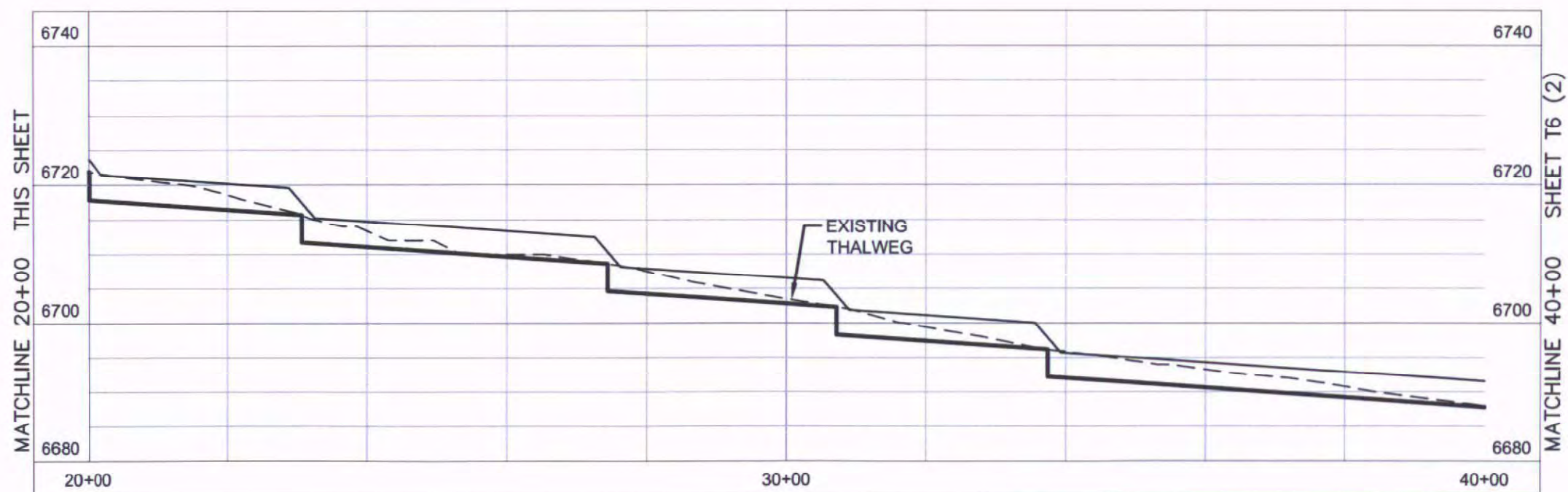
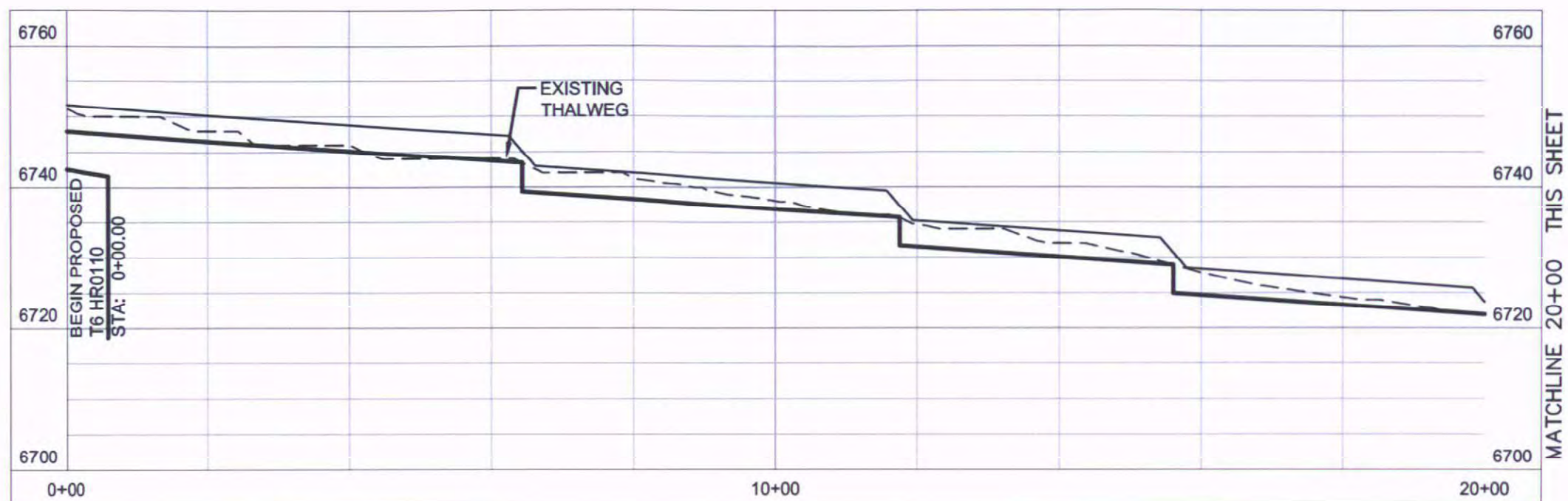
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(9) 4' DROPS



- PROPOSED DROP STRUCTURE  
 - - - EXISTING THALWEG  
 — HYDRAULIC GRADE LINE

Full Path: P:\21711039\CAD\PLANSHTS  
Drawing File Name: T PROFILE SHEETS 6\_PROPOSED.DWG  
Acad. Ver. 2006 Scale: 1"=20' Units: Feet






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Structure  
NumbersHAEGLER RANCH SUB-REGIONAL DETENTION  
ALTERNATIVE CONCEPTUAL PROFILES

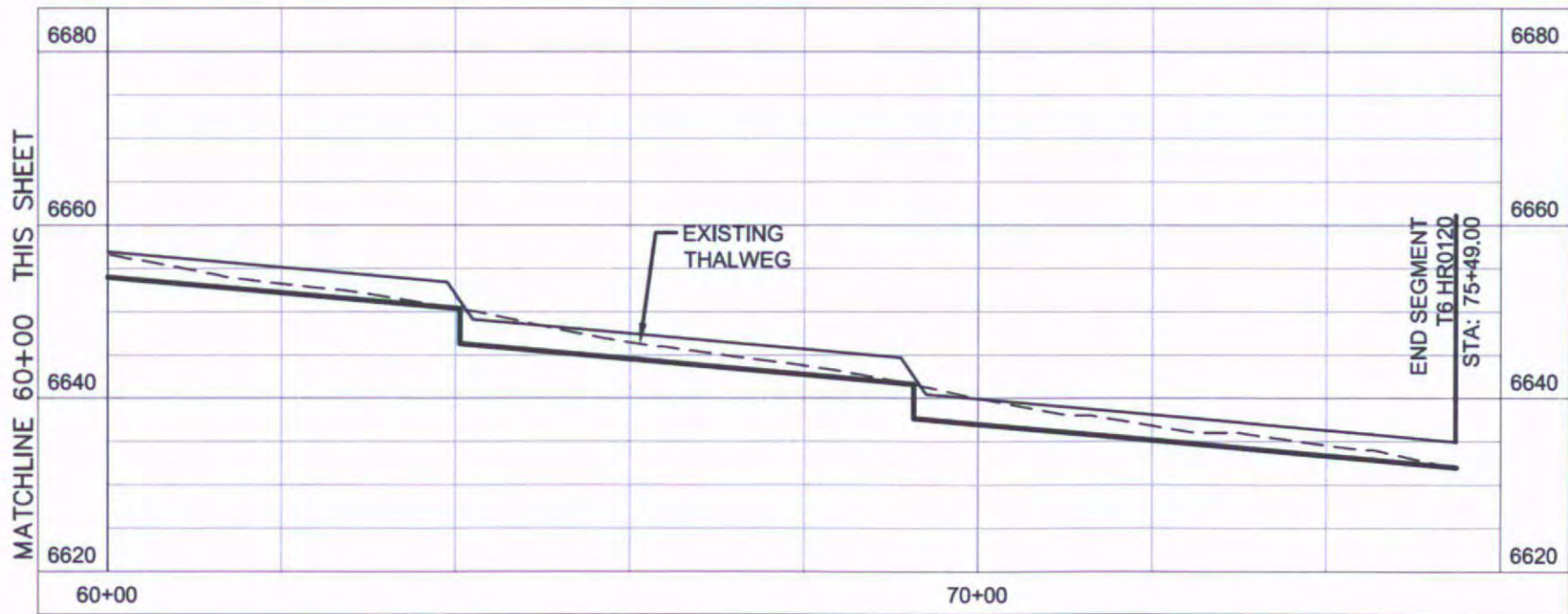
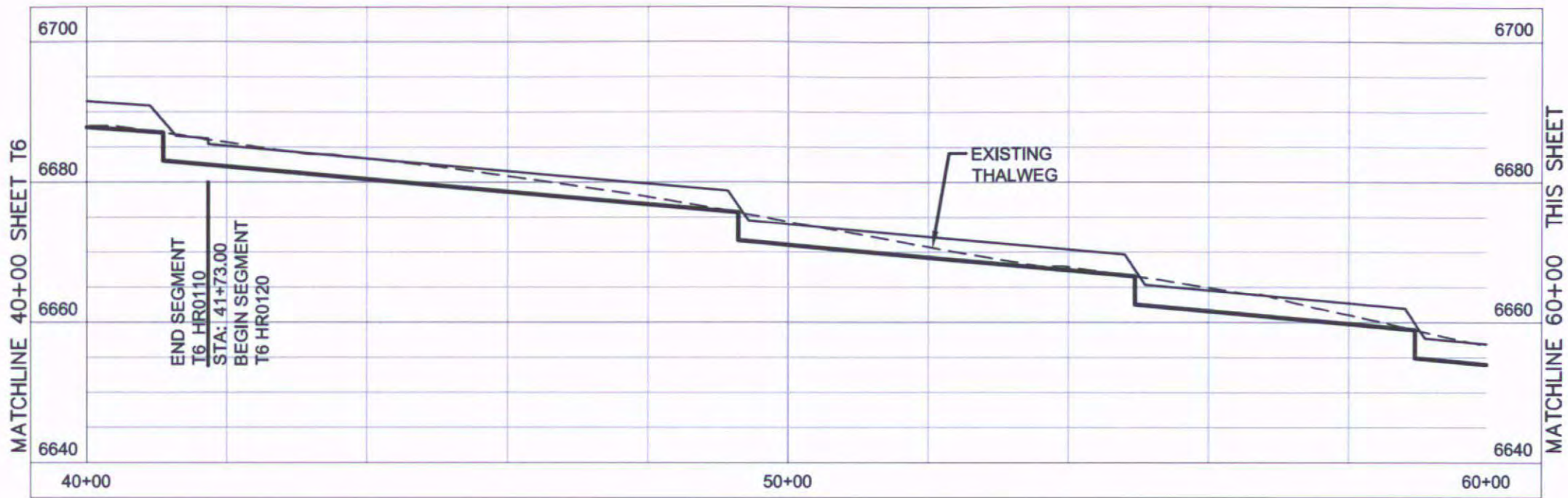
Sheet Number

T6



T6 HR0110  
SLOPE = 0.70%  
(9) 4' DROPS  
  
T6 HR0120  
SLOPE = 0.90%  
(6) 4' DROPS

PROFILE TRIBUTARY 6 (T6)



LEGEND

- PROPOSED DROP STRUCTURE
- - - EXISTING THALWEG
- HYDRAULIC GRADE LINE



## Appendix E CONTACTS

The following is a mailing list of those involved in the preparation and review of the Haegler Ranch DBPS

U. S. Army Corps of Engineers  
Van Truan  
200 South Santa Fe Ave. #301  
Pueblo, CO 81003  
719-543-6915

John Valentine  
Soils Conservation District  
1826 E. Platte Avenue  
Suite 114  
Colorado Springs, CO 80909  
719-473-7104

Colorado Department of Transportation  
16 E. Arvada Street  
Colorado Springs, CO 80906  
719-634-2323

Colorado Division of Wildlife  
2126 N. Weber Street  
Colorado Springs, CO 80907  
719-227-5283

Colorado Division of Wildlife  
Shaun Deeney  
4255 Sinton Road  
Colorado Springs, CO 80307  
719-227-5200

Regional Floodplain Administrator  
101 W. Costilla  
Colorado Springs, CO 80903  
719-327-2906

Andre Brackin  
El Paso Department of Transportation  
3460 N. Marksheffel Road  
Colorado Springs, CO 80922  
719-520-6845

Falcon Homeowners' Association  
7685 Mustang Rd  
Colorado Springs, CO 80908  
719-495-4213



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## **Appendix F HAEGLER DOW COMMENTS**



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STATE OF COLORADO

Bill Ritter, Jr., Governor  
DEPARTMENT OF NATURAL RESOURCES  
**DIVISION OF WILDLIFE**  
AN EQUAL OPPORTUNITY EMPLOYER

Thomas E. Remington, Director  
Southeast Region  
4255 Sinton Road  
Colorado Springs, Colorado 80907  
Telephone: (719)227-5200



December 11<sup>th</sup>, 2008

Joel Jones  
URS Corporation  
8181 East Tufts Avenue  
Denver, CO 80237

Re: Haegler Ranch Drainage Basin Planning Study Job Number: 21711039

Dear Mr. Jones:

The Division of Wildlife (DOW) has reviewed the preliminary plans for Haegler Ranch Drainage Basin generally located near Judge Orr Road and Eastonville Road to Peyton Highway and McDaniels Road in El Paso County. DOW staff offers the following comments for your consideration.

The local vegetative community is considered rangeland and is comprised of short grass prairie species and deciduous trees with wetland areas. This habitat type will sustain numerous wildlife species including deer, pronghorn, elk, coyote, red fox, swift fox, raptors, ground nesting birds, migratory waterfowl and numerous small mammals.

Haegler Ranch and Gieck Ranch Basin are important corridors and habitat for fish and wildlife. The environmental analysis portion of your basin planning study states that on-site wetlands are not a significant habitat resource within the basin. While we agree those wetlands may not be in their original state, these riparian areas still remain important for local and migratory wildlife use. At this time, it is unclear how the water detention ponds, channel design and culverts will be established in relation to the Haegler Ranch Drainage basin and future development. The DOW is concerned about the quantity and quality of runoff from the development into the Black Squirrel Creek, which is a tributary to Chico Creek prior to it flowing into the Arkansas River. The native fish community within the basin primarily consists of small bodied fishes. We would be interested in sampling for native fish on the project site within the Basin prior to work being done. We would also like to meet with the developer to discuss water flows within the Basin and evaluate potential impacts to native fishes and amphibian species. Native fish, including the Arkansas Darter (a state threatened species), are known to exist in Black Squirrel Creek and Chico Creek downstream of the proposed development. Increased flows upstream could impact Arkansas Darter populations downstream.

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DEPARTMENT OF NATURAL RESOURCES, Harris D. Sherman, Executive Director  
WILDLIFE COMMISSION, Robert Bray, Chair • Brad Coors, Vice Chair • Tim Glenn, Secretary  
Members, Dennis Buechler • Jeffrey Crawford • Dorothea Farris • Roy McAnally • Richard Ray • Robert Streeter  
Ex Officio Members, Harris Sherman and John Stulp

December 11, 2008  
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The DOW suggests keeping the channel width and stream sinuosity similar to the width and natural sinuosity of the existing stream. If changes to the channel are necessary to accommodate for any flow increase, DOW recommends maximizing the use of natural stream sinuosity, wetland improvements and soft engineering techniques. DOW recommends off channel detention or retention of water as much as possible to reduce water flows thus minimizing the need for channel and culvert improvements. Wildlife will likely be attracted to ponds. Ponds should not be fenced and have shallow slopes to promote aquatic and wetland vegetation growth. A gradual slope will also allow wildlife access to water regardless of water levels in the pond, and will decrease chances of entrapment.

The DOW is concerned about possible channel stabilization along the sides of the creek. DOW suggests maintaining the natural floodplain to promote riparian vegetation growth, channel stability, and natural stream sinuosity. If materials are used to make flat, steep, tall banks then pronghorn, deer and other animals can get trapped in the creek while retrieving water. We recommend leaving the stream in its natural state when possible. This not only benefits wildlife but makes the construction more aesthetically pleasing and less invasive.

The DOW recommends utilizing natural vegetation to control the grade. Should rip-rap be utilized we recommend non-grouted rip-rap. Vegetation and tree roots are more stable in non-grouted rip-rap. Small body fish have a difficult time moving up through large drop structures. We recommend using several drop structures with minimal drop height over fewer drop structures with a maximum drop height. We also recommend incorporating a low flow channel that would allow small bodied fishes to move through each drop structure.

The DOW is concerned about possible sedimentation in the stream during project construction and post construction. The sediment in the stream could have detrimental impacts on avian, fish and terrestrial species. We recommend placing sediment traps in areas of high sediment accumulation. This trap should be designed to allow fish species to move upstream and downstream without allowing the sediment to seep and compile downstream. The DOW recommends monitoring the sediment level in the stream for 3-5 years after the project is completed to ensure appropriate function of the sediment traps.

In reference to the roadway culverts, the DOW recommends bridges over drainages capable of seasonal flow that are likely to support native fishes and amphibians. This allows for native fish and amphibian passage, helps to maintain stream integrity, and promotes healthy wildlife permeability at road ways. Bridges will reduce wildlife mortality from vehicles by providing alternative roadway crossings. In places where culverts are used, we recommend a three sided concrete box culvert (CBC) with a natural bottom.

The DOW recommends using on-site clean fill material but if off-site fill material will be used, the DOW recommends using a clean fill material that would be conducive to growing native vegetation. Non-native vegetation can outcompete native vegetation and become problematic. Coyote Willow is a native willow that is great at bank stabilization and in reducing erosion. A seed mixture of native grasses is also recommended to provide a good support system in the soil. The DOW also recommends adoption of a noxious weed management plan and active control of noxious weeds in disturbed areas until reclaimed vegetation has become appropriately established.

-continued-



The DOW is aware of the wetland areas on Haegler Ranch and we recommend leaving as many wetland areas in their natural state as possible. The DOW recommends contacting the United States Army Corps of Engineers to verify if a 404 permit is needed for the project. Should mitigation be required, DOW recommends a 1:1 mitigation on-site to replace the wetlands altered, damaged or destroyed by the project. The DOW recommends monitoring the wetland mitigation area for 3-5 years after the project is completed to ensure appropriate hydrology and adequate wetland mitigation acreage to replace those acres impacted.

Trails throughout Haegler Ranch would provide excellent opportunities for wildlife viewing. However, if trails are placed too close to areas utilized by wildlife it creates disturbances resulting in reduced wildlife viewing opportunities. The DOW recommends constructing trails on the outer edges of open space areas. This minimizes wildlife disturbance and creates increased wildlife viewing opportunities. Trails near creeks and drainage areas should cross perpendicular rather than run parallel to these critical wildlife habitat areas. Crossings should occur in areas that have the least usage by wildlife in order to have minimal impacts on wildlife.

Care should be taken to avoid the destruction of active dens and nests while constructing structures, ponds, and trails. Possible dens or nests should be monitored for species activity. The DOW is concerned about the number of trees and snags that will be removed for the development. The DOW would like to see similar tree densities on the new development. The main concern with removal of trees is that these trees may be currently occupied or historic nest sites. Please take care to avoid removal of trees with occupied nests. An active nest is any nest that is frequented or occupied by a raptor during the breeding season or which has been active in any of the five previous breeding seasons. Many raptors use alternate nests in various years; therefore, a nest may be active even if it is not occupied in a given year. We would request leaving as many native healthy trees on site as possible and replacing trees that are removed with comparable native species on a 3:1 basis. The following site recommendations from the DOW should be followed regarding raptors:

#### DEFINITIONS

**Surface occupancy:** Any physical object that is intended to remain on the landscape permanently or for a significant amount of time. Examples include houses, oil and gas wells, tanks, wind turbines, roads, tracks, etc.

**Human encroachment:** Any activity that brings humans in the area. Examples include facilities maintenance, boating, trail access (e.g., hiking, biking), etc.

#### FERRUGINOUS HAWK

**Nest site:** No surface occupancy (beyond what has occurred historically) within ½ mile of active nest sites. Seasonal restriction to human encroachment within ½ mile of active nest sites between February 1 and July 15. This species is especially prone to nest abandonment during incubation if disturbed.

#### PRAIRIE FALCON

**Nest Site:** No surface occupancy (beyond what has occurred historically) within ½ mile of active nest sites. Seasonal restriction to human encroachment within ½ mile of active nest sites between March 15 and July 15.

#### RED-TAILED HAWK

**Nest Site:** No surface occupancy (beyond what has occurred historically) within 1/3 mile of active nest sites. Seasonal restriction to human encroachment within 1/3 mile of active nest sites between February 15 and July 15. Some birds have adapted to urbanization and will tolerate human habitation to within 200 yards of a nest. Development that encroaches in rural areas is likely to cause abandonment.

#### SWAINSON'S HAWK

**Nest Site:** No surface occupancy (beyond what has occurred historically) within 1/4 mile of active nest sites. Seasonal restriction to human encroachment within 1/4 mile of active nest sites between April 1 and July 15. Some birds have adapted to urbanization and will tolerate human habitation to within 100 yards of a nest.

If Black Tail Prairie Dogs are found on the site we recommend surveying for Burrowing Owls. The following site recommendations from the DOW should be followed regarding Burrowing Owls:

#### BURROWING OWL

**Nest Site:** No human encroachment within 150 feet of the nest site from March 15 through October 31. Although Burrowing Owls may not be actively nesting during this entire period, they may be present at burrows up to a month before egg laying and several months after the young have fledged. Therefore, it is recommended that efforts to eradicate prairie dogs or destroy abandoned towns not occur between March 15 and October 31 when owls may be present. The DOW would be involved with any prairie dog relocation effort through our permitting process. Since burrowing owls (a federally protected species) can occupy prairie dog towns during the spring and summer and may not be easily visible, we recommend their presence be determined with a target survey. If discovered, dirt moving should only be done from November 1 through February 28, after these birds have migrated. More detailed recommendations are available in a document entitled "Recommended Survey Protocol and Actions to Protect Nesting Burrowing Owls" which is available from the DOW (<http://wildlife.state.co.us/wildlifespecies/profiles/birds/burrowingowl.htm>).

Wildlife species may utilize the streambed as a water source and/or habitat. This habitat falls within potential Preble's Meadow Jumping Mouse (PMJM) range, which is currently on both the Federal and State threatened species list. Temporary and permanent construction impacts in this area may permanently impact resident wildlife. The DOW recommends contacting the United States Fish and Wildlife Service for information regarding developing in potential PMJM habitat.

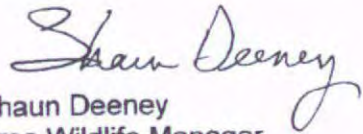


December 11, 2008

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Thank you for the opportunity to comment on this preliminary plan approval. In an effort to assist with planning with wildlife in mind, we hope that we can meet with you and the project proponent prior to any earthmoving. If you have any questions or require additional information please contact District Wildlife Manager Jeromy Huntington at 719-227-5283 or via e-mail [Jeromy.Huntington@state.co.us](mailto:Jeromy.Huntington@state.co.us).

Sincerely,



Shaun Deeney  
Area Wildlife Manager



xc: File  
SE Regional Office  
Jeromy Huntington



## **Appendix G FALCON SMALL AREA MASTER PLAN MEMO**





## Memorandum

To: Mike Cartmell  
El Paso County

From: John Griffith  
Date: April 21, 2009

Subject: Haegler Ranch DBPS Land Use Considerations

This memo addresses the consideration given to the new Falcon/Peyton Small Area Master Plan (SAP) recommendations and compatibility with respect to the land use assumptions used in the Haegler Ranch Drainage Basin Planning Study (DBPS).

The new Falcon/Peyton Small Area Master Plan (Attachment 1) was approved on August 5, 2008. To address the question raised by the El Paso County Planning Commission on February 3, 2009, we overlaid the Haegler Ranch Drainage Basin boundary on the Falcon/Peyton Small Area Master Plan (Attachment 2). Proposed land use types are identified in the legend. The SAP encompasses most of the area in the upper portion of the basin, which is proposed for development within the 2030 planning horizon.

As of July 2005, when work on the Haegler Ranch DBPS hydrologic analysis began, approximately 14 percent of the Haegler Ranch drainage basin was developed. Much of the existing development consists of 2- to 5-acre lots and larger agricultural parcels south of US Hwy 24. Higher density residential developments such as Meridian Ranch, Santa Fe Springs, and Four Way Ranch were underway in the northwestern portions of the Haegler Ranch Basin.

The land use data for the Haegler DBPS was completed sometime during 2006. Future, fully developed conditions hydrology for the DBPS was modeled using proposed 2030 land uses obtained from El Paso County, which were based on Land Use Coverages from Colorado Springs Utilities (CSU 2005). The future land uses used in the Haegler DBPS are shown in Figure 3-3 in the report (Attachment 3). We modified this figure such that the color codes for land use types are similar to the color codes used for the SAP to make visual comparison easier (Attachment 4).

Meridian Ranch is in the north and Santa Fe Springs is in the central portion of the watershed. The area of Meridian Ranch within Haegler Ranch has high-density land uses of commercial and business, residential lots of 0.25 acres, and new paved roads with curb and gutter. Santa Fe Springs has a larger area in Haegler Ranch and a wider range of land uses including high density development such as commercial and business, residential lots of 0.125 acres, residential lots of 0.25 acres, schools, and new paved roads with curb and gutter as well as low density development such as residential large lots with 2% imperviousness, parks, and open space. The Sketch Plan for Santa Fe Springs (Attachment 5) shows these various types of proposed land use.



Haegler Ranch DBPS Land Use Considerations  
April 21, 2009  
Page 2

In addition to the more general land use plans received from El Paso County, URS used approved land uses in the Sketch plans of Meridian Ranch and Santa Fe Springs in the development of the DBPS hydrologic study.

The land use types used in the Haegler Ranch DBPS include more discreet categories, such as: open space, 3 categories of residential less than 2.5 acres per site, and 3 categories of residential larger than 5 acres per dwelling. The areas identified in the SAP are broader, and do not include open space. This can be seen by comparing the area being developed by Santa Fe Springs with the Haegler Ranch DBPS future land use map (Attachment 4) and the SAP (Attachment 2)

There are some differences in proposed future land uses between the 2005 plan and the current SAP, however, the DBPS is not meant to be used as a zoning document. This information is used in the DBPS for the hydrologic analysis to predict runoff rates and volumes for the purposes of stormwater facility evaluation. The identification of land uses abutting the drainageways is also useful in the identification of feasible plans for stabilization and aesthetic treatment of the basin's drainageways. It is used to assess drainage/bridge fees and to provide a guideline for drainage structures as development occurs. These land use figures are not intended to reflect the future zoning or land use policies of the County, but to document assumptions used in the engineering analysis.

In order to answer the question of whether or not the preferred alternative and conceptual design recommendations still make sense with the newer land use plan, we have overlaid the proposed subregional detention pond locations on the future land use map, using the SAP data (Attachment 2). Several types of channel improvements are also recommended within the basin by this plan. In most cases, two alternatives have been called out on the preliminary design sheets. The cost estimate was prepared for the selected sub-regional detention alternative. The plan provides optional channel treatments to be considered during final engineering depending upon the specific land uses, while still providing similar protection. In a few cases channelization is recommended to define and contain the flow where it is currently overland flow in poorly defined, broad, dry-grass swales.

The Falcon/Peyton SAP land use data is two years fresher and a more credible data source from a planning perspective, but the SAP does not identify the location of the drainage channels in the Haegler Ranch Basin. Our conclusion is that there do not appear to be any significant inconsistencies with the location of proposed improvements and the proposed future land uses. The actual size and location of the proposed facilities will be based on actual development plans, which will have a variety of land uses not shown specifically on the SAP including open space.

The land use plan shown in the DBPS is the basis for the engineering analysis and should remain in the report. We can mention the SAP in the document and include it in the





Haegler Ranch DBPS Land Use Considerations

April 21, 2009












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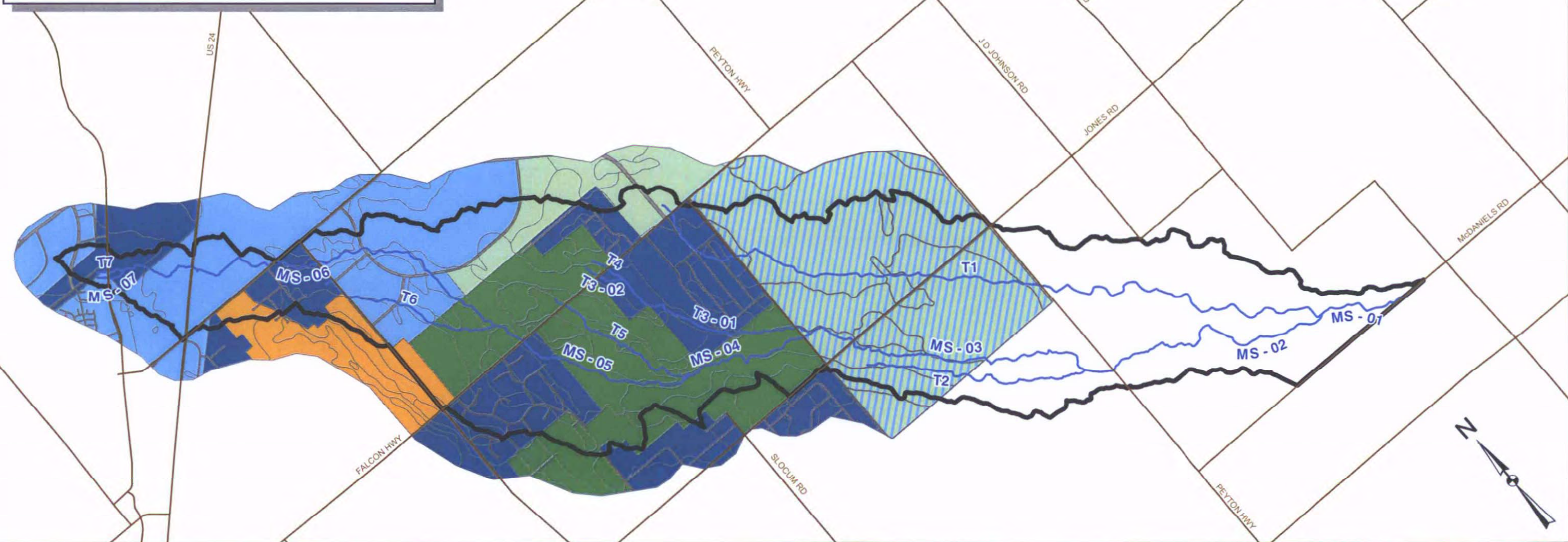
Appendix for reference, but we do not believe it is necessary to revise the hydrologic analysis or study recommendations based on this information. The Haegler Ranch DBPS can be used as intended by El Paso County as presented.



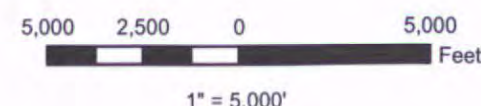




— Roads  
 — Stream Reach  
 Haepler Ranch Drainage Basin Boundary  
**LANDUSE**  
 Existing Airport Development  
 Existing Rural Density, >5 acres per dwelling  
 Existing Rural Residential Density, 2.5-5 acres per dwelling  
 Existing Urban Density, <2.5 acres per dwelling  
 Proposed Rural Development with Future Development Potential  
 Proposed Rural Residential Development  
 Proposed Urban Density Development  
 Road, Dirt  
 Road, Paved, Curb  
 Road, Paved, Open Ditch



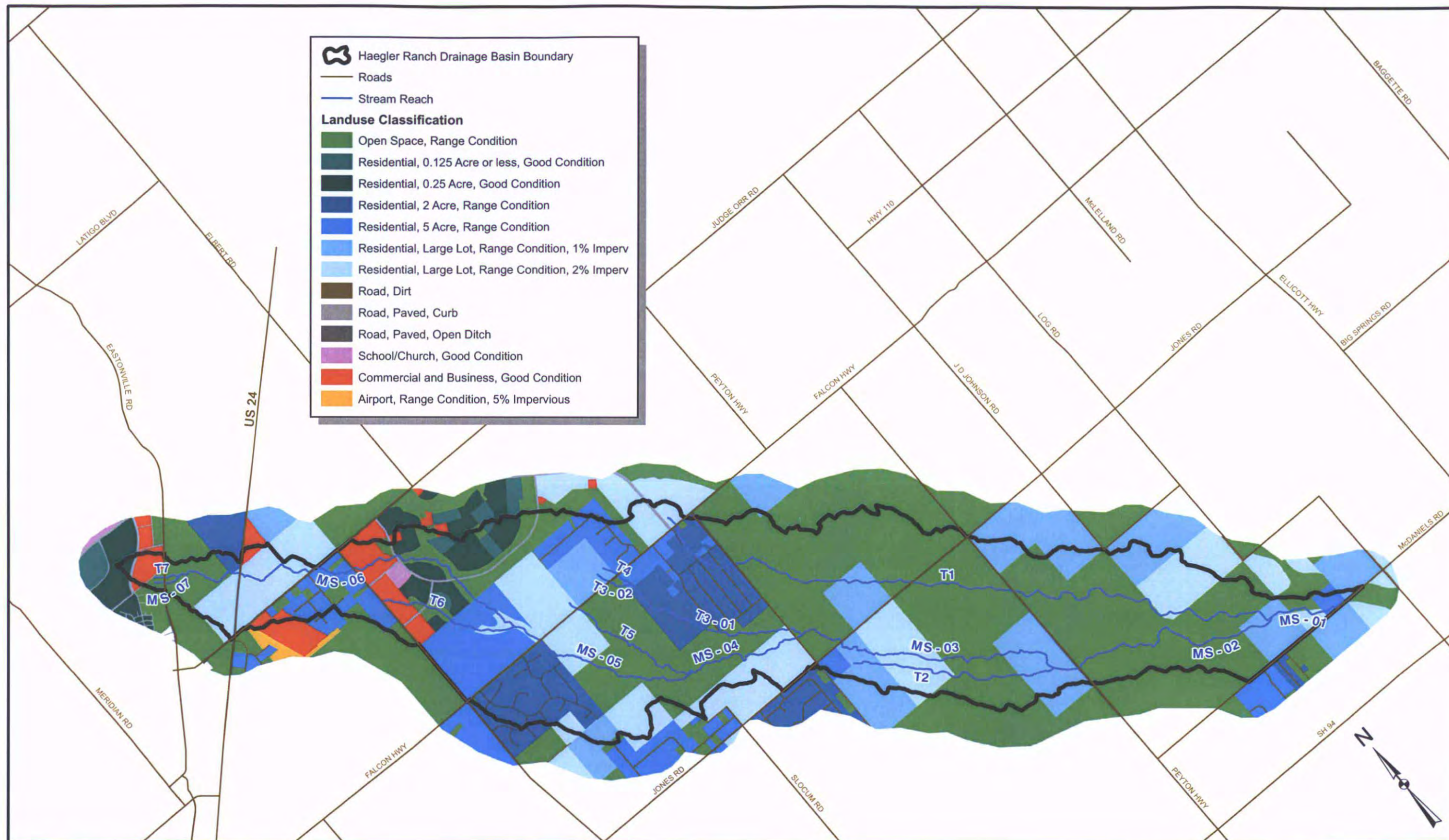
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 Suite 300  
 Colorado Springs, CO 80921  
 719.531.0001

DATE: 04/07/09

**HAEGLER RANCH DRAINAGE BASIN**  
**FUTURE LAND USE FROM**  
**EL PASO COUNTY SAMP**  
**ATTACHMENT 2**







Roads

Stream Reach

Haegler Ranch Drainage Basin Boundary

Future Land Use

Airport, Range Condition, 5% Impervious

Commercial and Business, Good Condition

Industrial, Good Condition

School/Church, Good Condition

Residential, 0.125 Acre or less, Good Condition

Residential, 0.25 Acre, Good Condition

Residential, 0.5 Acre, Good Condition

Residential, 2 Acre, Range Condition

Residential, 5 Acre, Range Condition

Residential, Large Lot, Range Condition, 1% Imperv

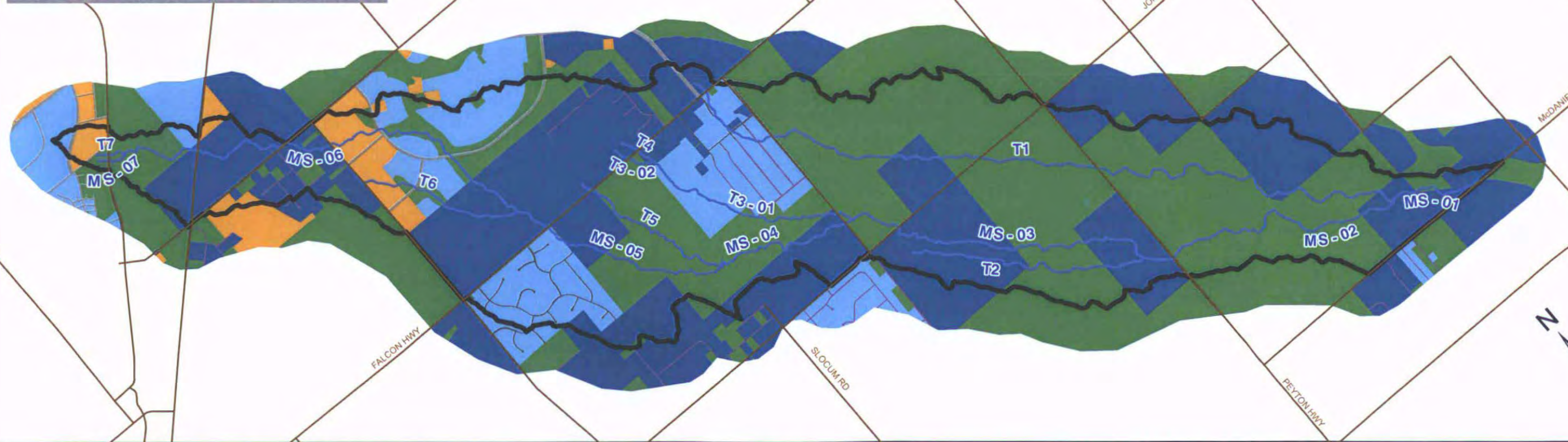
Residential, Large Lot, Range Condition, 2% Imperv

Open Space, Range Condition

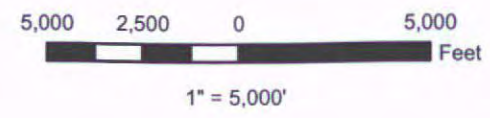
Road, Dirt

Road, Paved, Curb

Road, Paved, Open Ditch



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DATE: 04/07/09

**HAEGLER RANCH DRAINAGE BASIN  
FUTURE LAND USE**

**ATTACHMENT 4**



