RECLAMATION
Managing Water in the West

Technical Memorandum
Alternative B—Frenchman Hills Wasteway
(Note: The name of this alternative was changed to Alternative 3 in the Draft Environmental Assessment)

Potholes Reservoir Supplemental Feed Route Draft Environmental Assessment

Columbia Basin Project Grant County, Washington

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region

April 2007

Bureau of Reclamation – Supplemental Feed Route for Potholes Reservoir

Alternative B – Frenchman Hills Wasteway

PREPARED BY: Ed Thomas/KEN
Jason Lillywhite/SLC

REVIEWED BY Stan Schweissing/KEN

DATE: April 4, 2007

Introduction

The Bureau of Reclamation (BOR) is evaluating three alternatives for supplementing water supply to Potholes Reservoir. Performance of this work includes initial scoping and evaluation of alternatives, surveying, and conceptual design and development of estimated costs for each alternative. An evaluation of each alternative's feasibility of construction, impacts to property, capital costs, and operations and maintenance requirements and cost will be used to identify the best supply alternative to design, fund and construct.

This memorandum is focused on Alternative B which would supplement water supply to Potholes Reservoir by utilizing the existing West Canal and the Frenchman Hills Wasteway. Water would be diverted for a short time period early each year from the West Canal into the Frenchman Hills Wasteway and then flowing through the wasteway to the Potholes Reservoir.

This evaluation includes an assessment of the hydraulic capacity of two existing road crossings, conceptual road crossing modifications required for additional capacity at the two existing roads, development of inundation maps, determination of the extent of additional federal ownership or easements required to accommodate the proposed improvements based on inundation mapping, and a current estimate of costs associated with this alternative.

Data Collection

The BOR provided the necessary information to perform the evaluation. Information included BOR and Grant County drawings identifying the construction details for the Dodson Road and C SE Road crossings, 1930's era contour maps of the Frenchman Hills area at 2 ft. contour intervals, a draft *Hydrologic Analysis for Supplemental feed Route for Potholes Reservoir Study* developed by the BOR, and electronic GIS data identifying land ownership information. In addition, data was collected during site visits and field survey work was completed to create topography at each road crossing.

Alternative B – Facility Description

Radial gates in the West Canal, just upstream of the Frenchman Hills tunnel, control flow down the Frenchman Hills Spillway into the Frenchman Hills Wasteway. The Frenchman Hills Wasteway evaluated for this alternative is a meandering waterway approximately 19 miles long that varies from a relatively slow flowing creek at the upstream end to a series of wide marshy lake areas in the central reach to a narrow fast flowing creek as it drops in elevation to the

Potholes Reservoir. Existing road crossings at Dodson Road and C SE Road include large diameter culverts to pass the water under the road.

The majority of the wasteway flows through the Desert Wildlife Area managed by the Washington State Department of Fish and Wildlife (WSDFW), as such most of the surrounding land is federally owned, and therefore access is minimized. The area is generally used for hunting and fishing activities. However there is some privately owned land farmed adjacent to the wasteway as well.

Existing Facility and Supplemental Feed Capacities

The BOR has identified the existing capacities of the facilities associated with this alternative as follows:

Maximum capacity of Dodson Road crossing – 1100 cfs.

Maximum capacity of C SE Road crossing – 500 cfs.

Maximum typical spring return flow through Frenchman Hills Wasteway - 300 cfs.

Maximum supplemental feed through Frenchman Hills Wasteway – 700 cfs.

Maximum Short term emergency flow (includes typical return flows, the maximum diversion through the Royal Branch canal, and maximum supplemental feed) – 1500 cfs.

Existing Road Crossings Evaluation

The existing Dodson and C SE Road crossings evaluation included survey information, evaluation of structural alternatives, hydraulic analysis, and development of conceptual design drawings as discussed below.

Road Crossing Surveys

In August 2006 CH2M HILL and Knudsen Land Surveying generated survey data for the road crossings at Dodson and C SE Roads to provide topography sufficient to support conceptual design of structures capable of passing the flows identified by the BOR. Plan and sectional figures generated from the road crossings survey are included in Attachment 1.

Hydraulic Analysis of Existing Road Crossing Structures

The construction drawings for each road crossing were reviewed and compared to observations from the site visit. The construction drawings indicated that corrugated steel pipe (CSP) culverts were used at each crossing. Only a small portion of the culverts were visible during the site visit due to the depth of water flowing at that time, however it appeared that the location, size and shape of the culverts were consistent with the construction drawings provided by the BOR.

Dodson Road Crossing

The Dodson Road Crossing includes (2) 6 ft. diameter CMP culverts and a 13 ft. – 11 in. x 8 ft. – 7 in. (span x rise) structural steel plate pipe arch. The survey information indicates that approximately 2.9 ft. of freeboard exists between the top of the pipe arch and the road shoulder edge, approximately 1.3 ft. of additional freeboard is available above the (2) 6 ft. diameter culverts. Approximately 1.3 ft. of freeboard is available between the road shoulder edge and asphalt roadway. See Figure 1 depicting the upstream (West) side of the Dodson Road crossing.

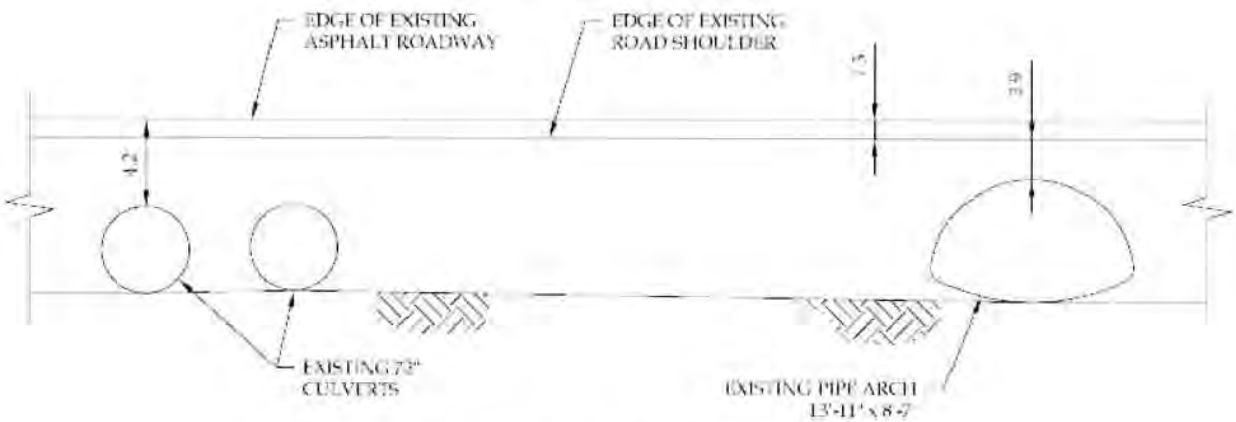


Figure 1 - Upstream Side of Dodson Road Crossing

Hydraulics evaluations of the three existing Dodson Road culverts indicate that the 1100 cfs capacity identified by the BOR for this crossing can be achieved when the pipe arch and 6 ft. CMP are flowing approximately 86% and 100% full respectively. Allowing a surcharge of water to rise to a level just under the gravel road shoulder (approximately 1.6 ft. of freeboard below asphalt roadway) will provide a capacity of approximately 1600 cfs under Dodson Road. See Figure 2 depicting water levels at design flows for the Dodson Road crossing.

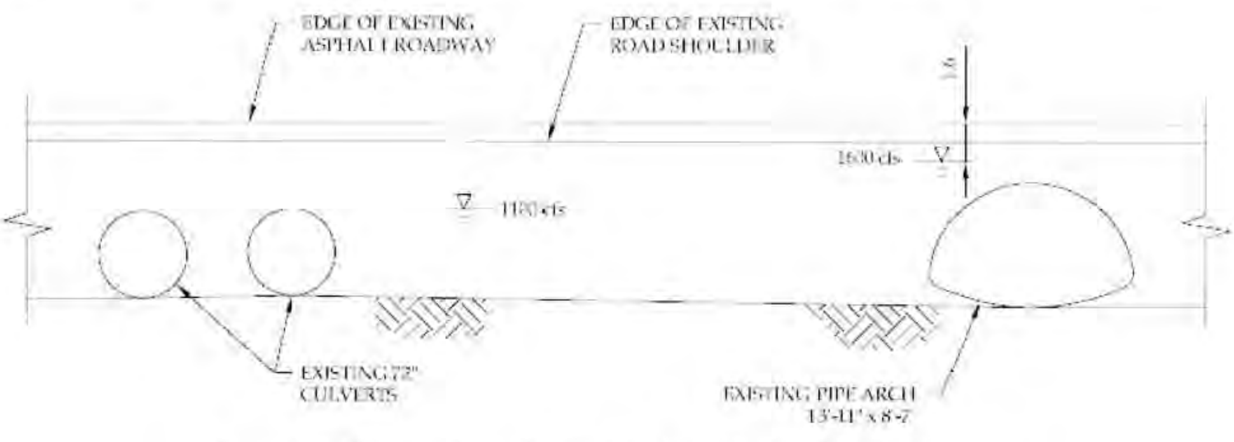


Figure 2 – Design Flow Water Levels at Dodson Road Crossing

C SE Crossing

The C SE Road crossing includes (8) 4 ft. diameter CMP culverts. The survey information indicates that approximately 3.5 ft. of freeboard is available above the culverts.

Hydraulics evaluations of the culverts at the C SE Road crossing indicate that the 500 cfs capacity identified by the BOR for this crossing can be achieved when the culverts are flowing approximately 100% full. A maximum flow of approximately 840 cfs could be achieved if the surcharge above the culverts was allowed to rise approximately 2.5 ft., leaving approximately 1 ft. of freeboard. The road is overtopped at a flow of approximately 960 cfs.

Hydraulic Analysis and Evaluation of New Road Crossing Structures

Dodson Road Crossing

The existing culverts have the capacity to pass the maximum typical flowrate of 1000 cfs (300 cfs wasteway return flow + 700 cfs supplemental flow) with no surcharge above culverts. In addition, the emergency flow can also be passed under Dodson Road with freeboard available before the water level reaches the asphalt road. Since the Dodson Road culverts have adequate capacity to pass the design flows, no further analysis of alternative culvert modifications were performed.

C SE Road Crossing

The C SE Road crossing has a maximum capacity of approximately 960 cfs before overtopping the gravel road. A major difference between the C SE crossing and the Dodson crossing is the lack of available freeboard above the culverts. Various alternatives were evaluated to provide more capacity for the proposed 1000 cfs maximum typical flowrate with minimal or no surcharge.

A bridge projects engineer at the Grant County Publics Works Department was contacted to discuss their experience and preference for bridge spans vs. culverts. Grant County prefers pre-stressed concrete spans for their bridge projects if it is determined that a bridge is needed. The pre-stressed concrete spans offer them reliability, and reduced maintenance costs. Grant County also noted that the cost of the concrete bridge spans eliminates them as an option in locations where cheaper CMP culverts meet design criteria and can be easily installed, such as at the C SE Road crossing.

The use of concrete box culverts were considered but eliminated when it became apparent that to install adequate capacity would be more expensive than the use of CMP.

CMP culverts and pipe arches were initially evaluated assuming that the existing road elevation would be maintained. Maintaining the existing road elevation and not allowing any significant surcharge required installation of so many new CMP or pipe arches, that extensive channel modification on the north and south side of the crossing would be necessary for their installation. The additional cost associated with this option eliminated it from further analysis.

CMP culverts and pipe arches with an approximate diameter or rise from 4 ft. to 6 ft. were then evaluated. Suppliers require at least 1.5 ft. of cover over the culverts but site conditions and long term maintenance concerns dictated that at least 2.5 ft. of cover be used for the analysis. The additional cover requires that the existing road elevation would increase 9 inches.

Hydraulic analysis indicates that the maximum typical flowrate of 1000 cfs could be achieved with (3) new 8′-2″ span x 5′-9″ rise pipe arches along with re-using (3) existing CMP culverts. In this configuration, the pipe arches would flow approximately 100% full, the existing CMP culverts would have a surcharge of approximately 1′-9″, and approximately 2′-6″ of freeboard would be available between the top of the pipe arch and the finished road grade. However, this configuration does not have the capacity to handle the 1500 cfs emergency flow even with additional surcharge reducing the freeboard to approximately 1 ft.

A design flow capacity of 1500 cfs could be achieved through C SE Road using (4) new 8′-2″ span x 5′-9″ rise pipe arches along with re-using (2) existing CMP culverts by allowing the water to surcharge to within 1 ft. of the finished road grade. The new culvert configuration would pass 1000 cfs with approximately 3.4 ft. of freeboard while the pipe arch and existing CMP flow approximately 85% and 123% full respectively. See Attachment 2 for a conceptual design sketch of this proposed C SE Road crossing modification.

Proposed Road Crossing Structures Cost Estimate

A cost estimate was developed for implementation of the proposed road crossing modifications for Dodson and C SE Road. Current unit cost information was collected for the materials, as opposed to relying strictly on historical information. The cost estimate excludes impacts from tasks that have not been performed such as soils investigations.

The estimate was prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering (AACE) International. According to the definitions of AACE International, the Class 5 Estimate is defined as the following:

> ***Class 5 Estimate:*** This estimate is prepared based on limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes include but are not limited to, market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, and long-range capital planning. Examples of estimating methods used would include cost/capacity curves and factors, scale-up factors, and parametric and modeling techniques. Typically, little time is expended in the development of this estimate. The expected accuracy ranges for this class estimate are –20 to –50 percent on the low side and +30 to +100 percent on the high side.

The cost estimates shown, which include any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final project costs will vary from the estimate presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Table 1

SUPPLEMENTAL FEED ROUTE FOR POTHOLES RESERVOIR - FRENCHMAN HILLS WASTEWAY

PROPOSED UPGRADES COST ESTIMATE

ITEM DESCRIPTION	ITEM QUANTITY	UNIT	UNIT COST	COST
C SE ROAD MODIFICATIONS				
Existing Culvert Extensions.	228	LF	$107	$24,396
Upstream Coffer Dam (including dewatering).	595	CY	$25	$14,875
Downstream Bypass Road / Coffer Dam (including dewatering).	955	CY	$25	$23,875
8'-2" x 5'-9" Structural Plate Pipe Arch Culvert and Installation.	208	LF	$300	$62,400
Crushed Surfacing Base Course and Installation for Pipe Arch Backfill and Finished Road Grade.	495	CY	$15	$7,425
Guard Rail and Installation	200	LF	$25	$5,000
Subtotal				$132,971
Contingency			25%	$33,243
Total Estimated Construction Cost				$166,214
Bonds/Insurance			2%	$3,324
Mobilization			2%	$3,324
WA state sales tax			8.0%	$13,297
Engineering, Legal and Administration Fees			20%	$33,243
Total Estimated Project Cost				$219,402

Inundation Mapping Development

This alternative for providing supplemental feed water to the Potholes Reservoir requires that the Frenchman Hills Wasteway convey 700 cfs of flow above normal spring return flows for a total flow of 1000 cfs. This necessitated an analysis to determine the extent of land inundation and identification of land ownership information associated with the increased inundation.

Hydraulics

A hydraulic model of the Frenchman Hills wasteway was generated using Hydraulic Engineering Center - River Analysis System (HEC-RAS) version 3.1.1 to evaluate the hydraulic profile of the wasteway when 1000 cfs is flowing to the Potholes Reservoir. The hydraulic profile was integrated with topographic information to show the approximate resultant inundated area along the Frenchman Hills wasteway.

Geometry

Existing ground elevations used to obtain cross sections for the model were obtained using a combination of 1930's era contour maps of the Frenchman Hills area at 2 ft. contour intervals, USGS topographic quad maps, and field survey data developed in August 2006 (for Dodson Road and C SE Road crossings). The land surveyor verified that the elevation datum of the survey data used was comparable to that of the BOR mapping data and the USGS quad map. The elevations used in this model are approximate and are dependent upon the accuracy of the mapping and other data provided. It is recommended that a field survey be conducted if more accurate information is required.

Cross sections were obtained using BOR 2 ft. contour interval maps supplemented with USGS quad map data. An alignment was developed by tracing the approximate centerline of the wasteway using recent aerial photography mapping as a background in AutoCAD. The mapping was scaled in AutoCAD using section lines and assuming the width of a section to be approximately 1 mile. The alignment was stationed so that cross sections could be positioned spatially and provides the proper downstream distances used in HEC-RAS.

Culvert and roadway information for Dodson and C SE Roads were obtained directly from plan and profile survey drawings. Culverts were assumed to be free of obstructions.

This information was entered into the HEC-RAS model to build the basic geometric structure.

The space between cross sections ranges from 400 to 15,000 feet depending on the change in terrain along the channel. For calculation of the hydraulic grade along the channel, additional cross sections were automatically interpolated every 1000 feet using the HEC-RAS interpolation function.

Insufficient measured flow vs. water surface data is available for calibration of the model. If more accuracy in inundation area is desired, it is recommended that flow and water level data be collected at a number of locations along the length of the wasteway so that the model can be calibrated. Manning's roughness factors were assumed based on references used for similar projects and by comparing photos of the site to documented sources such as Chow's Open Channel Flow text book and the HEC-RAS internal database. For the channel inside the banks, Manning's n of 0.04 is used. The Manning's n used for areas outside the banks is 0.06.

Flowrates

Steady flow simulation was used for this analysis, assuming a constant flow rate would occur over a significant period of time. The flow used for this model is 1000 cfs (sum of max spring return flow and peak supplemental feed flows). A mixed flow regime is used for calculation of water levels since flow through the culverts reaches supercritical flow velocities. The remaining channel appears to be within the sub critical flow regime.

The upstream boundary condition used in the model is the normal depth of a 1000 cfs flowrate calculated using the slope of the first few hundred feet of the channel (S=0.0028). The downstream boundary condition is a constant water level of 1034.0 ft in Potholes Reservoir.

Table 2 is a summary of criteria and assumptions used for estimating the hydraulic profile of the existing channel.

Table 2

Criteria for Analysis of Existing Channel

Parameter	Value
Peak Flow Rate (cfs)	1000
Upstream slope assumption for normal flow boundary	0.0028
Manning's roughness coefficient for channel	0.04
Manning's roughness coefficient for over-bank	0.06
Manning's roughness coefficient for existing culverts	0.02
Entrance loss coefficient for existing culverts	0.9
Exit loss coefficient for existing culverts	1.0
Contraction and expansion coefficients for regular channel	0.1 and 0.13
Contraction and expansion coefficients for existing culverts	0.3 and 0.5
Downstream boundary condition (feet elevation)	1034.0
Flow regime	Mixed (sub and super critical flow)

Inundation Analysis Results

Attachment 3 includes the hydraulic profile of the Frenchman Hills wasteway at peak flow along with the associated cross sectional results of the hydraulic analysis. The cross sectional results were used to illustrate the approximate inundated areas along the Frenchman Hills wasteway as shown in Attachment 4. The hydraulic analysis results indicate the most significant areas of flooding will likely occur around station 400+00 and 800+00 where the land is relatively flat and dominated by swamp lands in the vicinity of the main channel. Some flooding appears to occur at both Dodson and C SE Road culverts, but the water surface does not exceed the top of road elevation in either case. Both culvert crossings appear to cause backwater upstream and are inlet controlled.

Land Ownership Evaluation

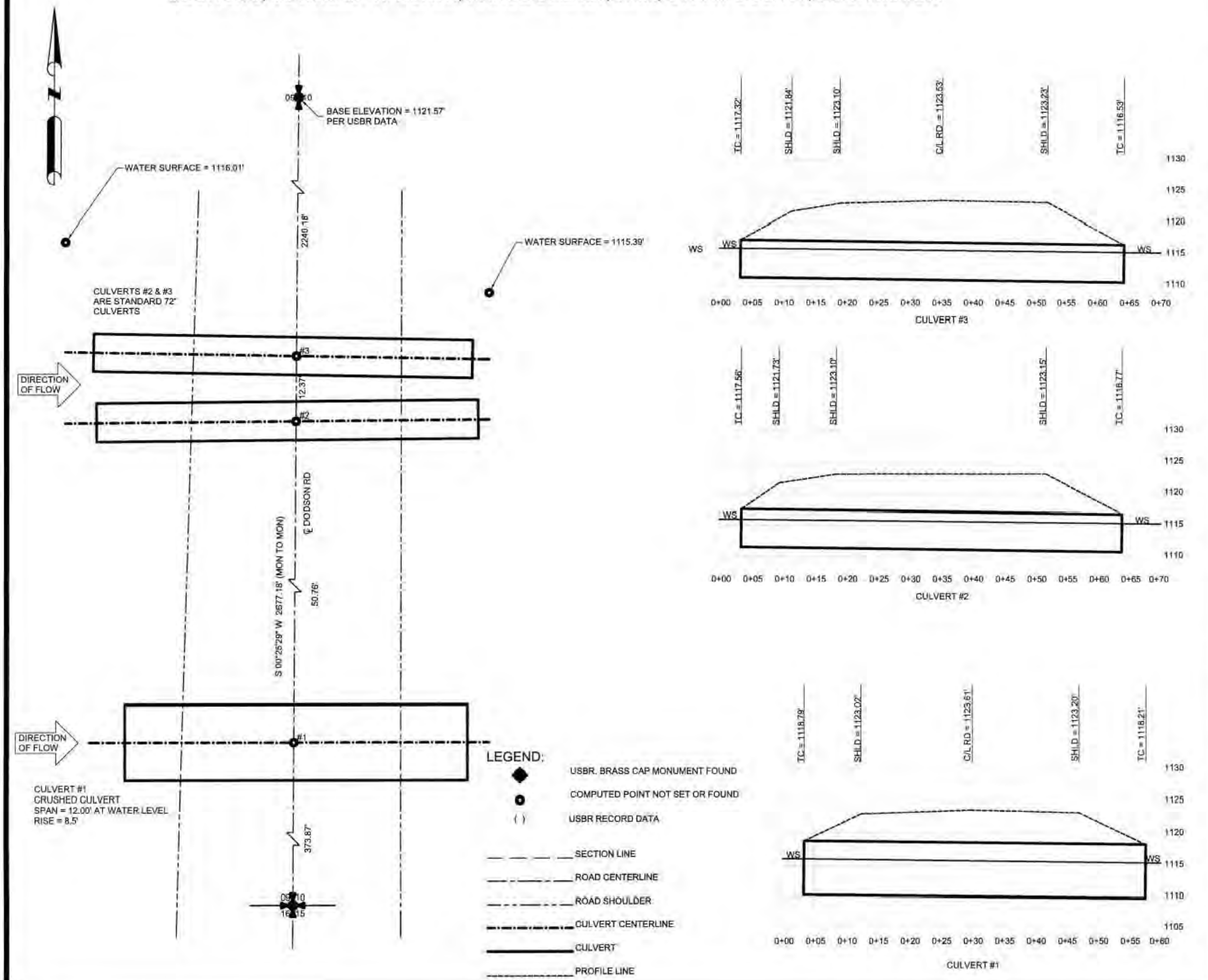
The BOR supplied a parcel map identifying land ownership in the Frenchman Hills wasteway. The parcel map identifies the parcel ownership by indicating if the parcel is federal, state, county, public utility, or privately owned. The parcel map was overlaid on the aerial photography map along with the approximate inundation area as shown in Attachment 4. Land within the inundation area was then summed into either public or private land ownership. The majority of approximate inundation occurs on federal, state, or county land totaling 2,100 acres. Private land ownership within the approximate inundated area totals 537 acres.

Measurement of acreage is restricted to acres shown to be inundated. No analysis or consideration was given to acres that a particular land owner may feel is impacted beyond practical use despite not being directly inundated.

Attachment 1
Dodson Road Survey - Plan & Profiles
C SE Road Survey - Plan
C SE Road Survey – Profiles

CH2M HILL - DODSON CROSSING PROFILES

SECTION 9, TOWNSHIP 17 NORTH, RANGE 26 EAST, W.M., GRANT COUNTY, WASHINGTON.



KNUDSEN LAND SURVEYING L.L.C.

A Complete Land Development Service

16 Basin St. SW
P.O. Box 505
Ephrata, Wa 98823
Phone: (509) 754-4376 Fax: (509) 754-3403
URL: www.knudsen-surveying.com
Email: knudsen@knudsen-surveying.com

KNUD S. KNUDSEN — STATE OF WASHINGTON — 8588 — REGISTERED PROFESSIONAL LAND SURVEYOR — EXPIRES: 8-02-06

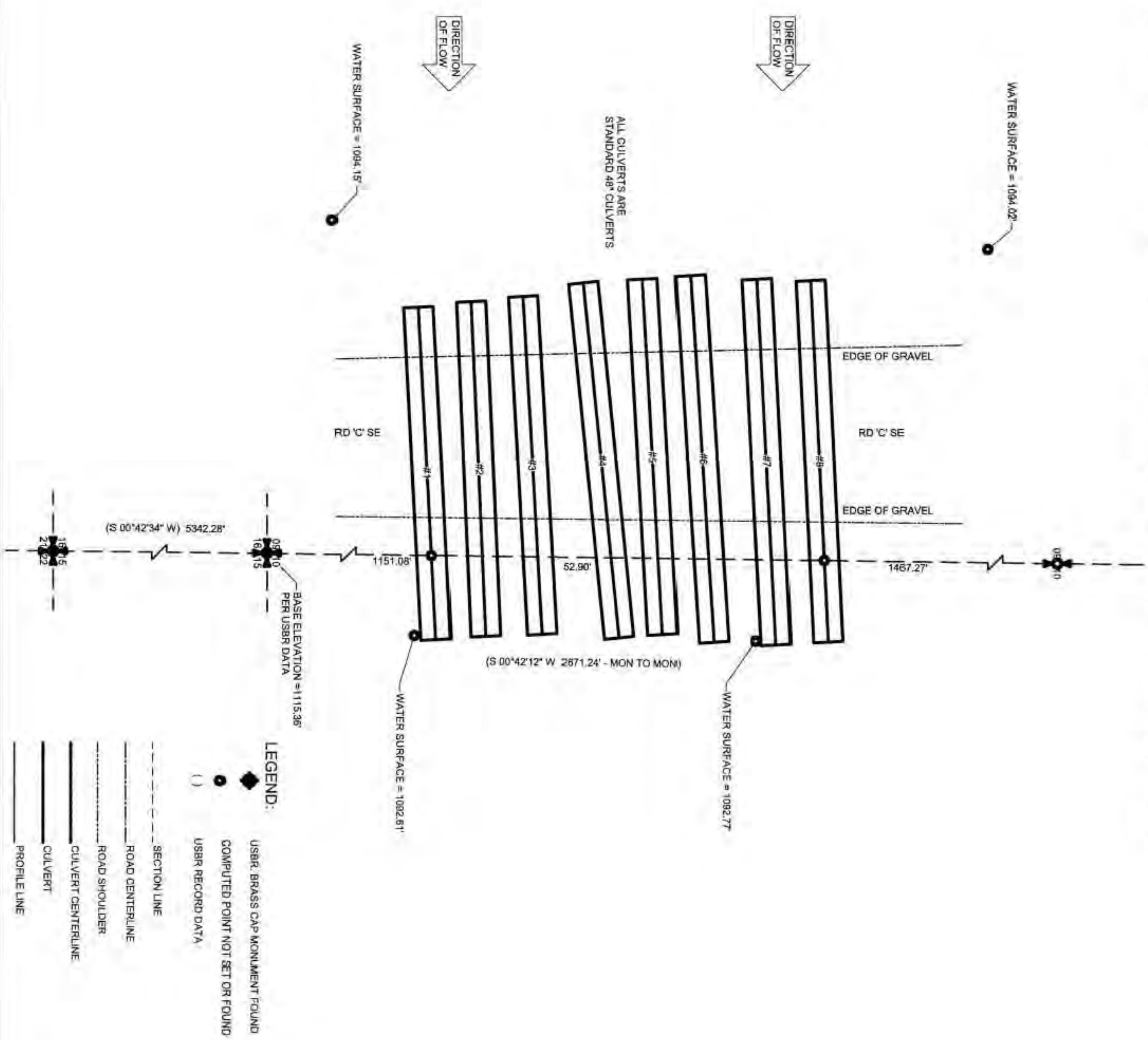
CH2M HILL
DODSON ROAD
CROSSING PROFILES

DRAWN BY:		SURVEY TECH.:	CHECKED BY:	
MICHAEL A. BUDD		MICHAEL A. BUDD		
DATE:	SHEET NO.:	PROJECT NO.:	FILE NAME:	SCALE:
06-17-06	1 OF 1	06-261	06-261-B	1" = 10'

REV.	REV. PER.	DESCRIPTION	CHK'D BY:	DATE:

CH2M HILL - 'C' SE CROSSING PROFILES

SECTION 10, TOWNSHIP 17 NORTH, RANGE 27 EAST, W.M., GRANT COUNTY, WASHINGTON.



KNUDSEN LAND SURVEYING L.L.C.
A Complete Land Development Service

16 Basin St. SW
P.O. Box 505
Ephrata, Wa 98823
Phone: (509) 754-4376 Fax: (509) 754-3403
URL: www.knudsen-surveying.com
Email: knudsen@knudsen-surveying.com

KNUD S. KNUDSEN — STATE OF WASHINGTON — 8588 — REGISTERED PROFESSIONAL LAND SURVEYORS — EXPIRES: 8-02-06

CH2M HILL
ROAD 'C' SE
CROSSING PROFILES

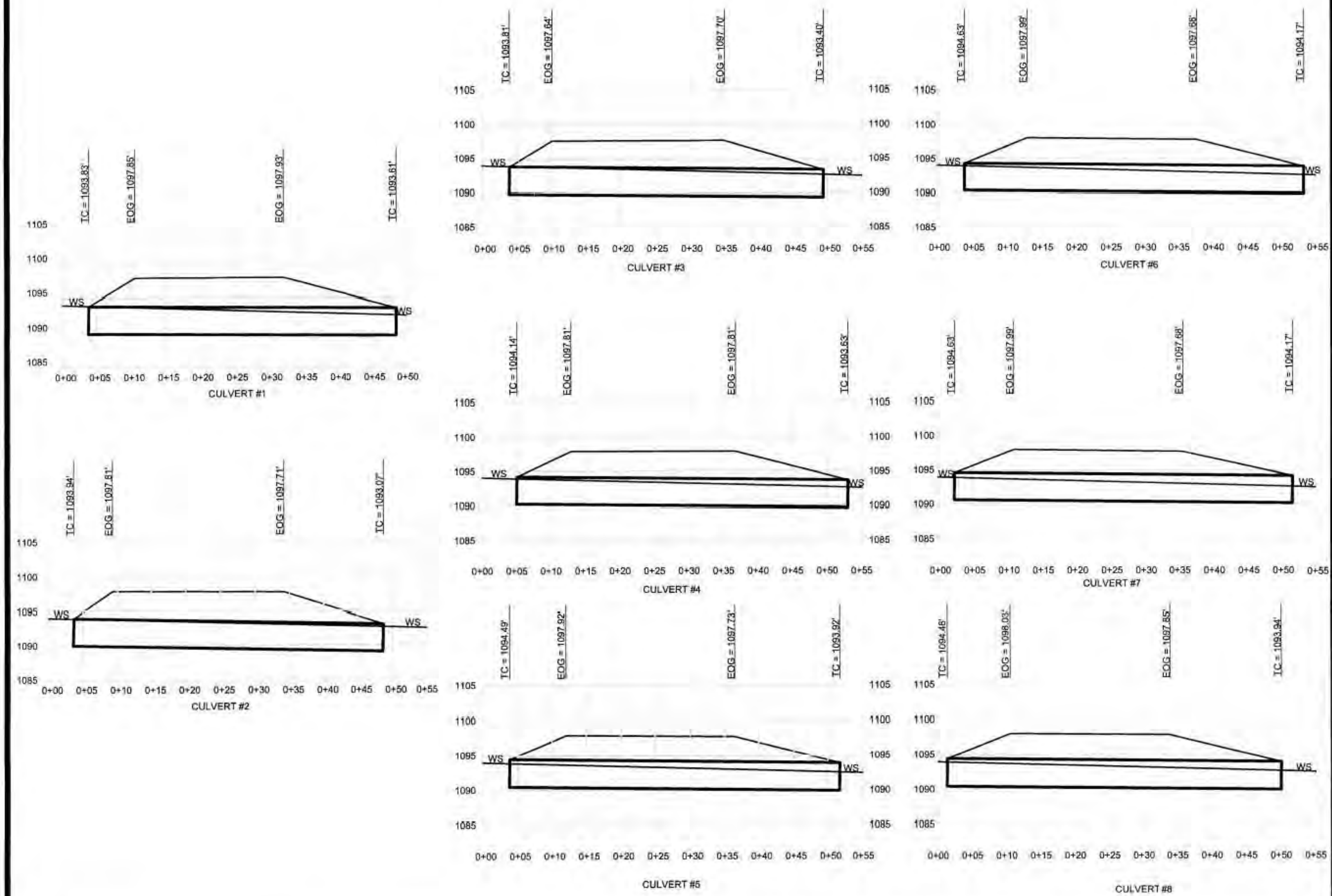
DRAWN BY:	SURVEY TECH.:	CHECKED BY:
Michael A. Budd	Michael A. Budd	

DATE:	SHEET NO.:	PROJECT NO.:	FILE NAME:	SCALE:
08-14-06	1 OF 2	06-261	06-261-A	1:10

REV.	REV. PER.:	DESCRIPTION	CHK'D BY:	DATE:

CH2M HILL - 'C' SE CROSSING PROFILES

SECTION 10, TOWNSHIP 17 NORTH, RANGE 27 EAST, W.M., GRANT COUNTY, WASHINGTON.



KNUDSEN LAND SURVEYING L.L.C.
A Complete Land Development Service
16 Basin St. SW
P.O. Box 505
Ephrata, Wa 98823
Phone: (509) 754-4376 Fax: (509) 754-3403
URL: www.knudsen-surveying.com
Email: knudsen@knudsen-surveying.com

KNUD S. KNUDSEN, STATE OF WASHINGTON, 8588, REGISTERED PROFESSIONAL LAND SURVEYOR, EXPIRES: 8-02-06

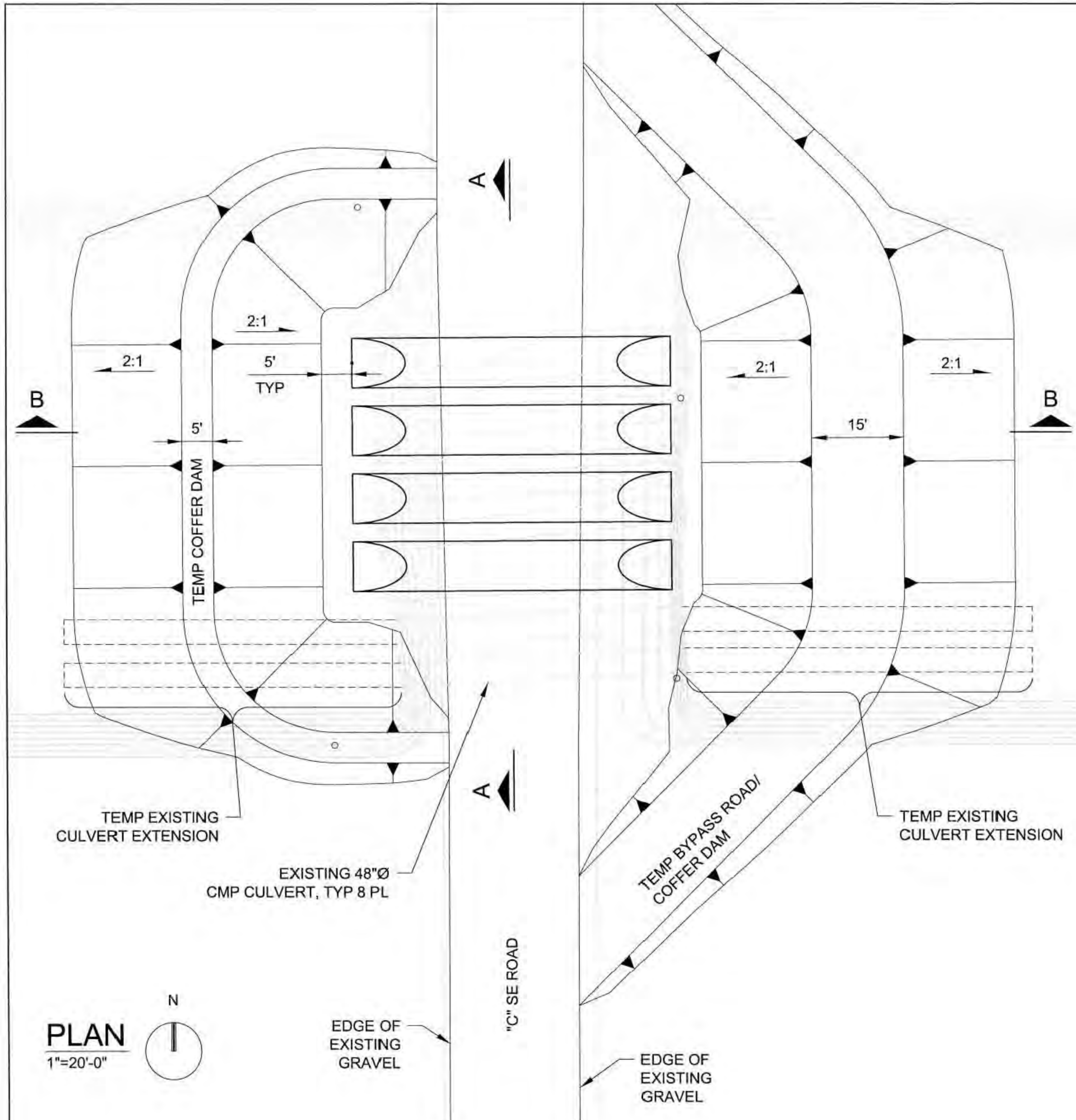
CH2M HILL
ROAD 'C' SE
CROSSING PROFILES

DRAWN BY:	SURVEY TECH.:	CHECKED BY:
Michael A. Budd	Michael A. Budd	

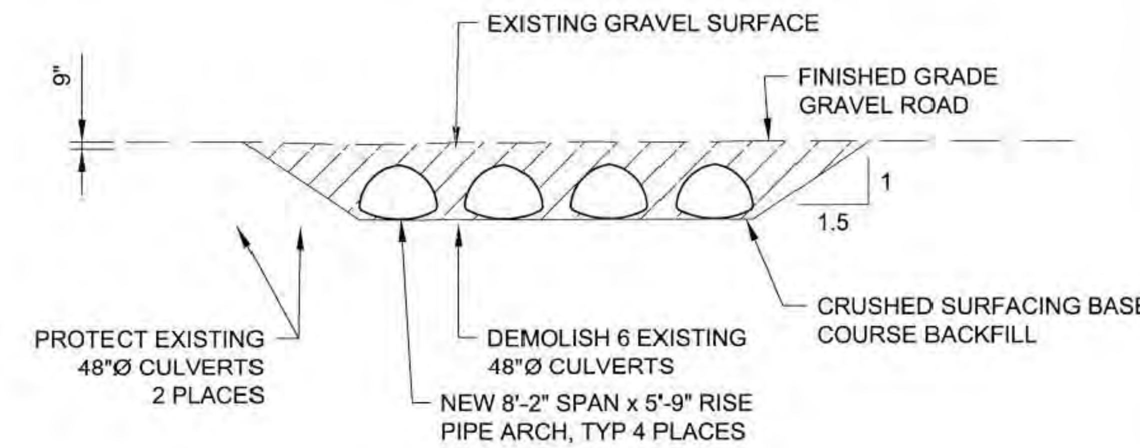
DATE:	SHEET NO.:	PROJECT NO.:	FILE NAME:	SCALE:
08-14-06	2 OF 2	06-261	06-261-A	1:10

REV.	REV. PER.:	DESCRIPTION	CHK'D BY:	DATE:

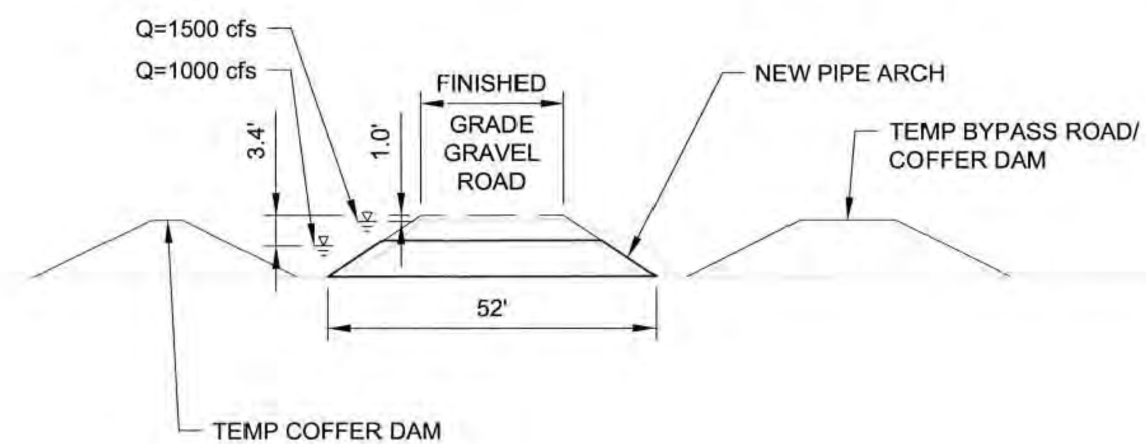
Attachment 2
C SE Road Proposed Modification



PLAN
1"=20'-0"



SECTION A
1"=20'-0"



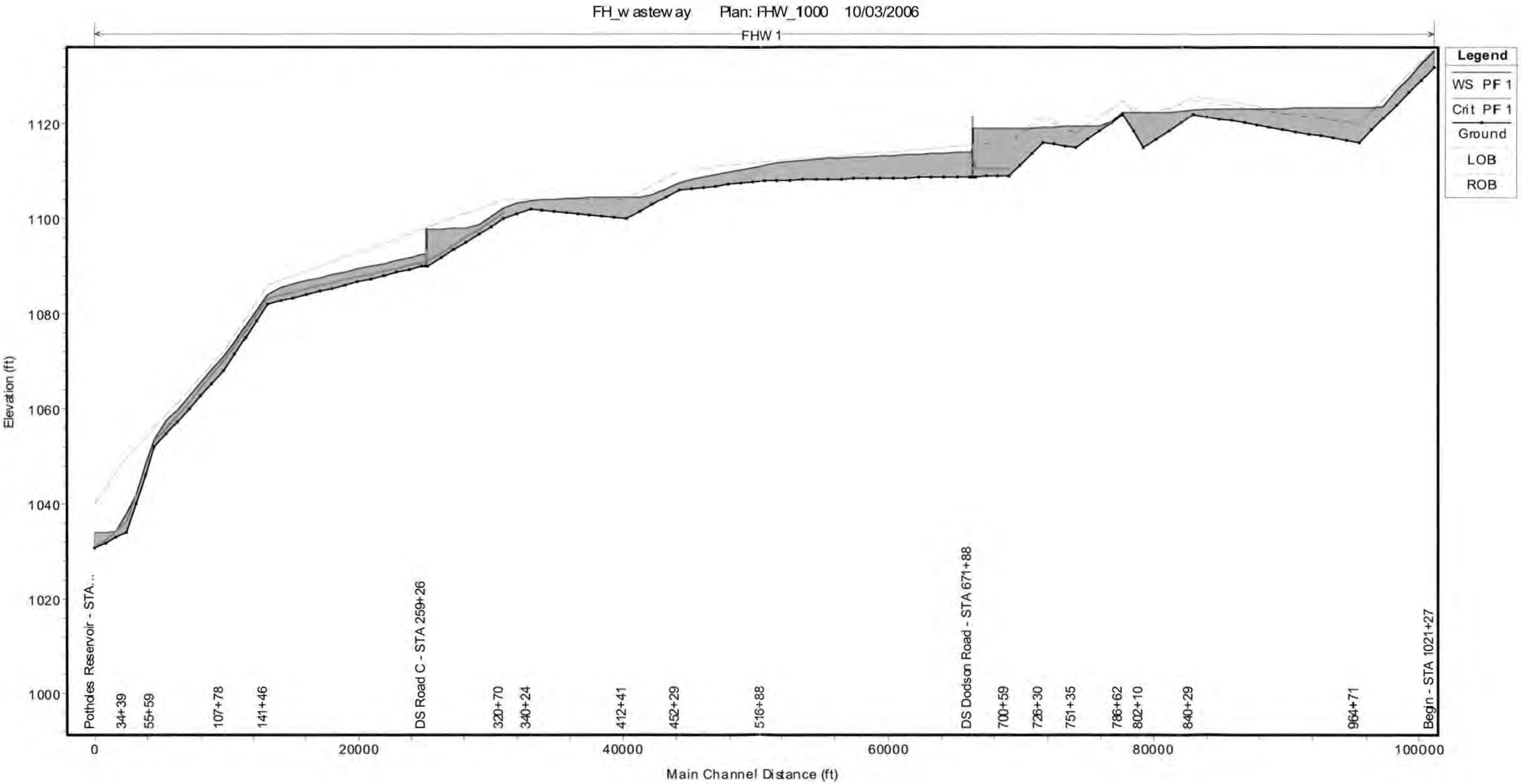
SECTION B
1"=30'-0"

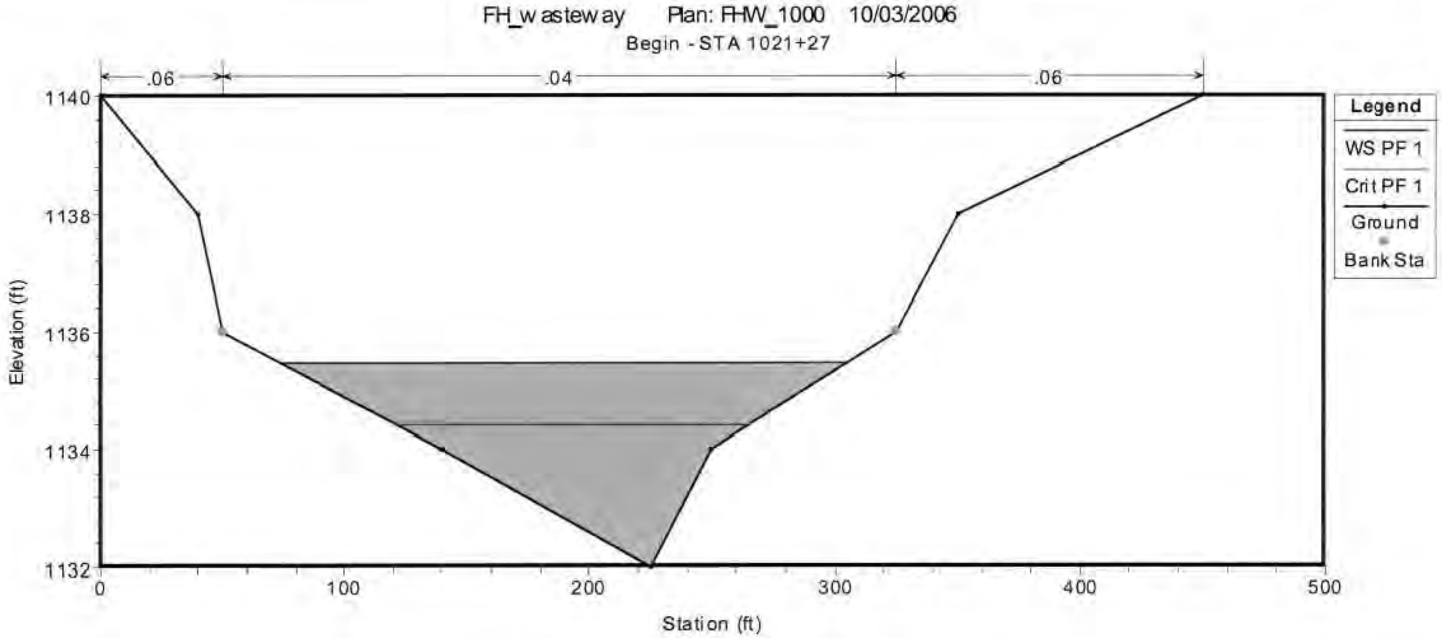
348226

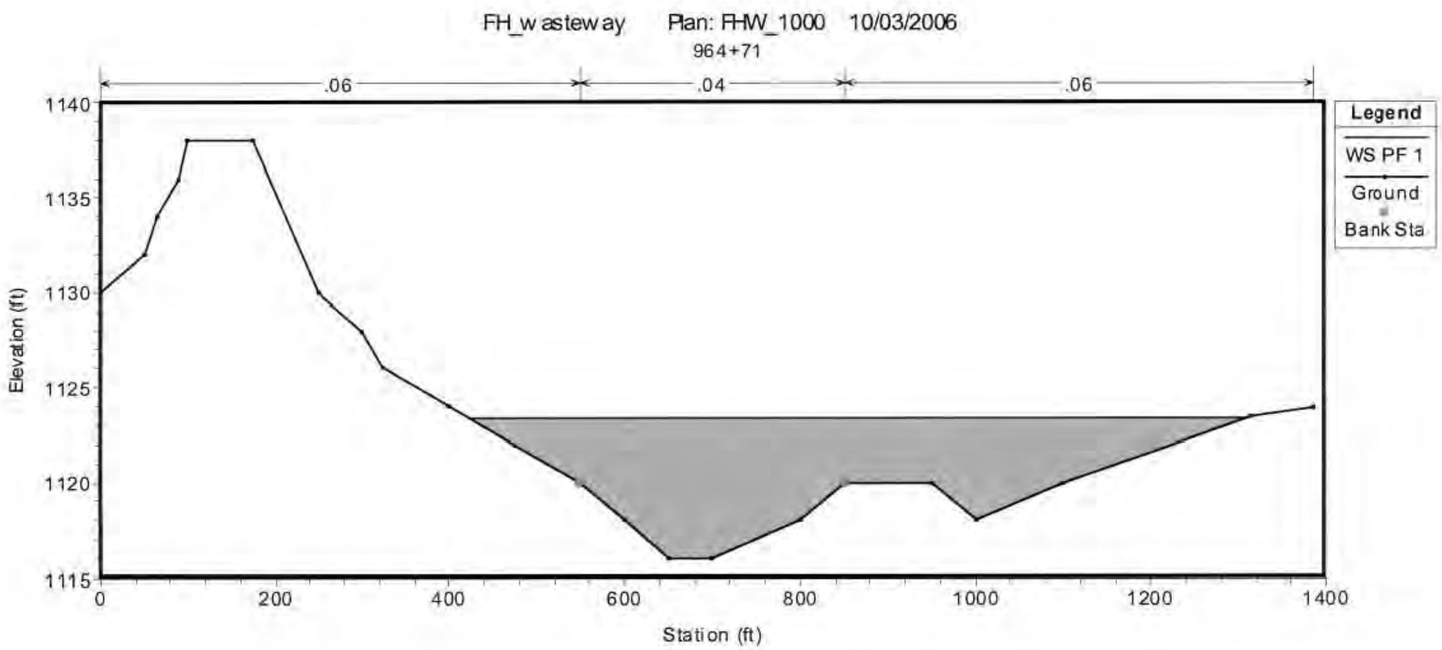
BUREAU OF RECLAMATION
SUPPLEMENTAL FEED ROUTE
FOR POTHOLES RESERVOIR
ALTERNATIVE B - FRENCHMAN HILLS WASTEWAY
C SE RD PROPOSED MODIFICATIONS

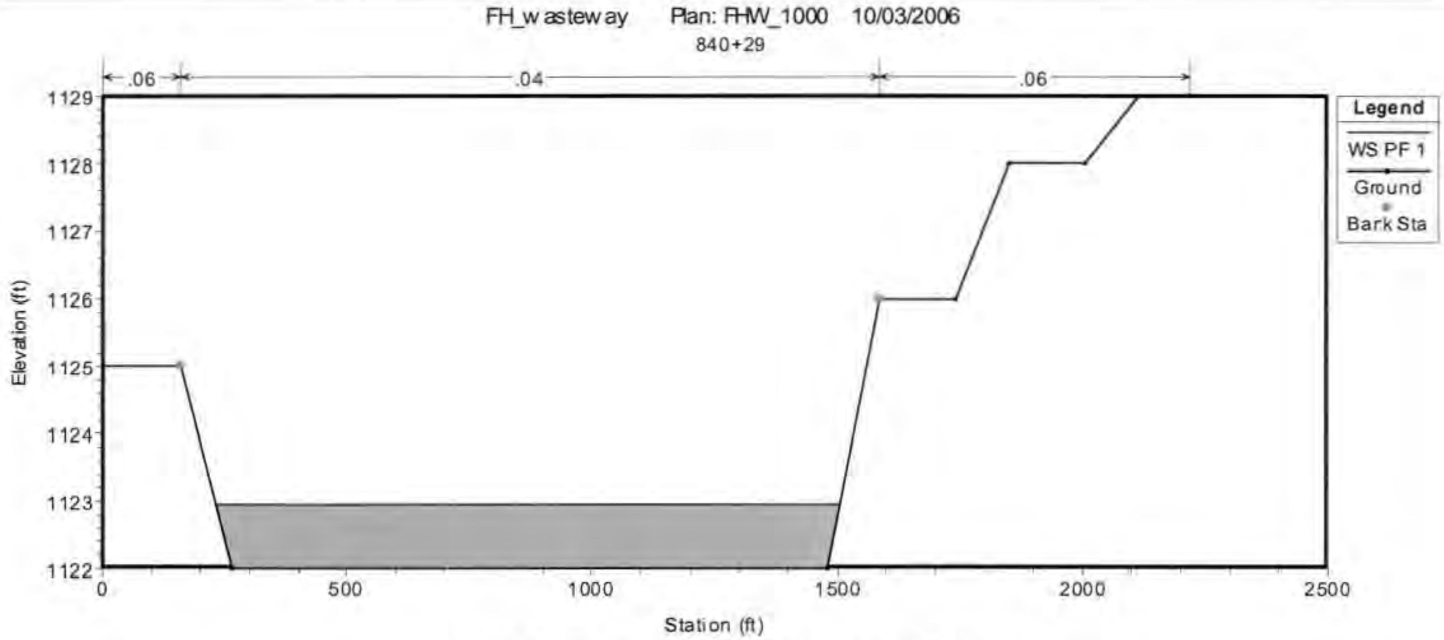
CH2MHILL

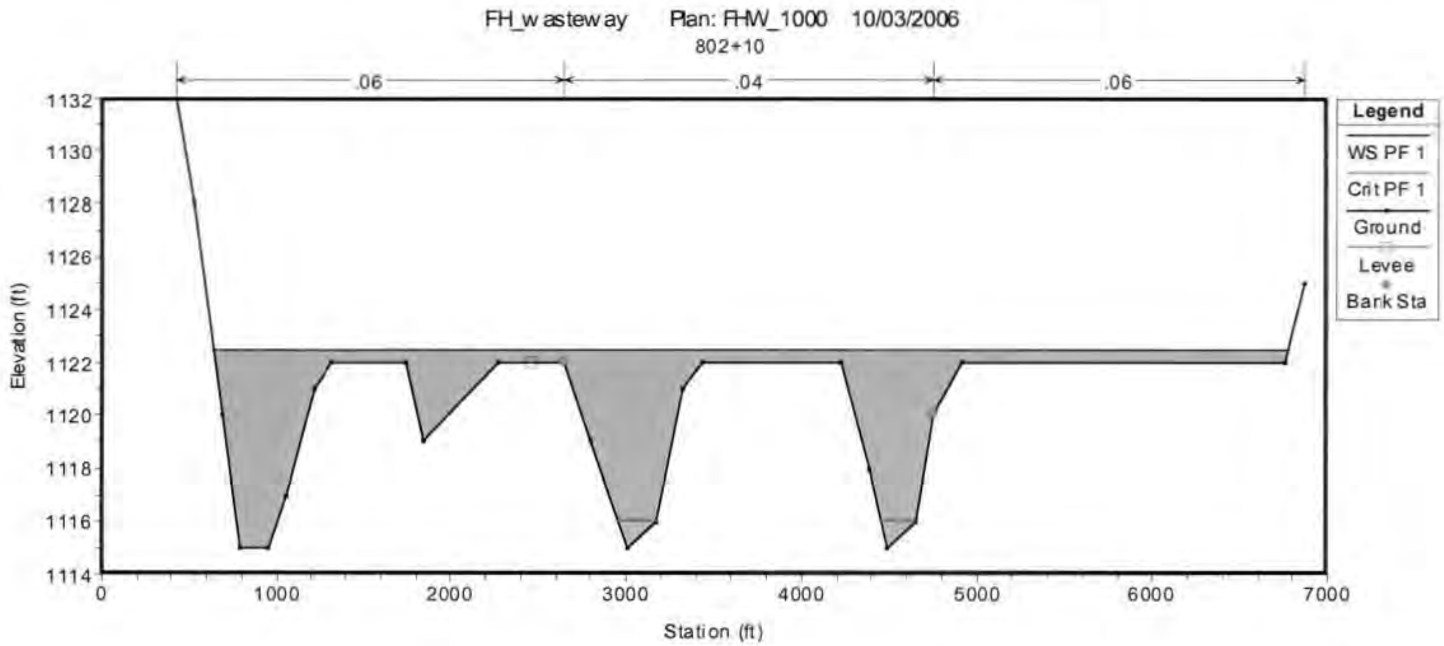
Attachment 3
Inundation Hydraulic Analysis Results

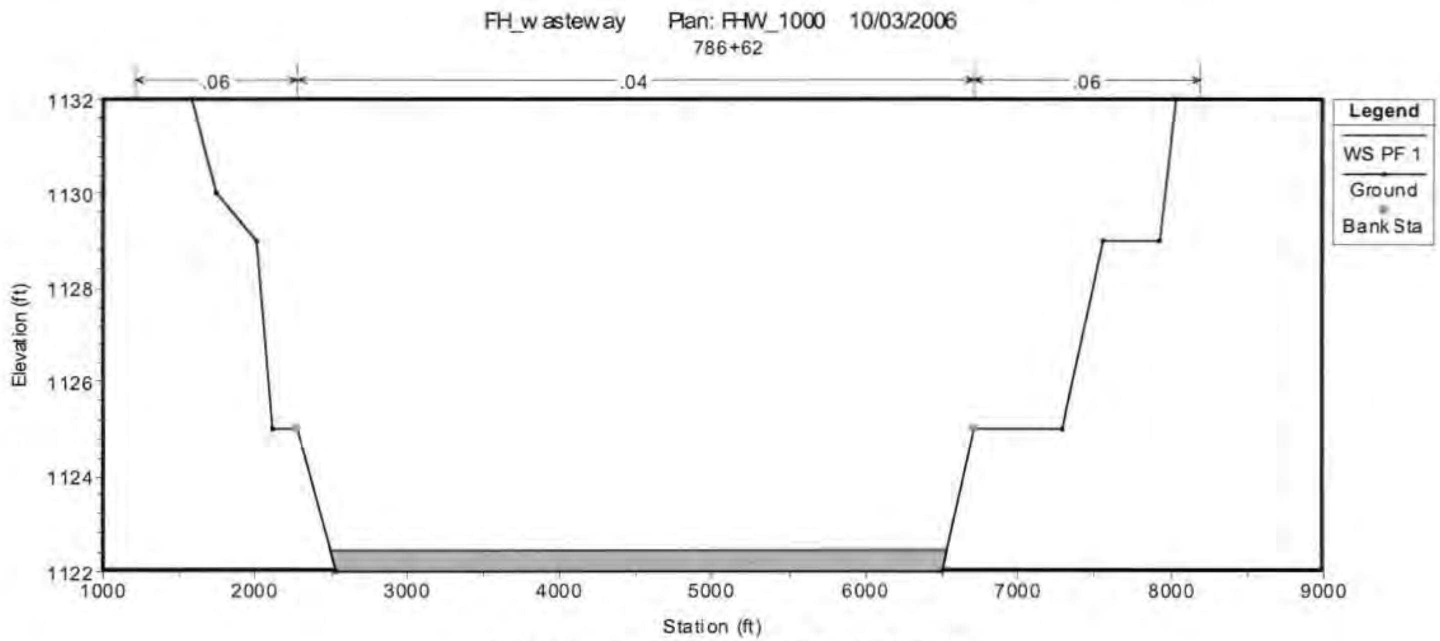

FH_w astew ay Plan: FHW_1000 10/03/2006
FHW 1
Legend
WS PF 1
Crit PF 1
Ground
LOB
ROB
Elevation (ft)
1120
1100
1080
1060
1040
1020
1000
Potholes Reservoir - STA...
34+39
55+59
107+78
141+46
DS Road C - STA 259+26
320+70
340+24
412+41
452+29
516+88
DS Dodson Road - STA 671+88
700+59
726+30
751+35
786+62
802+10
840+29
964+71
Begin - STA 1021+27
0
20000
40000
60000
80000
100000
Main Channel Distance (ft)

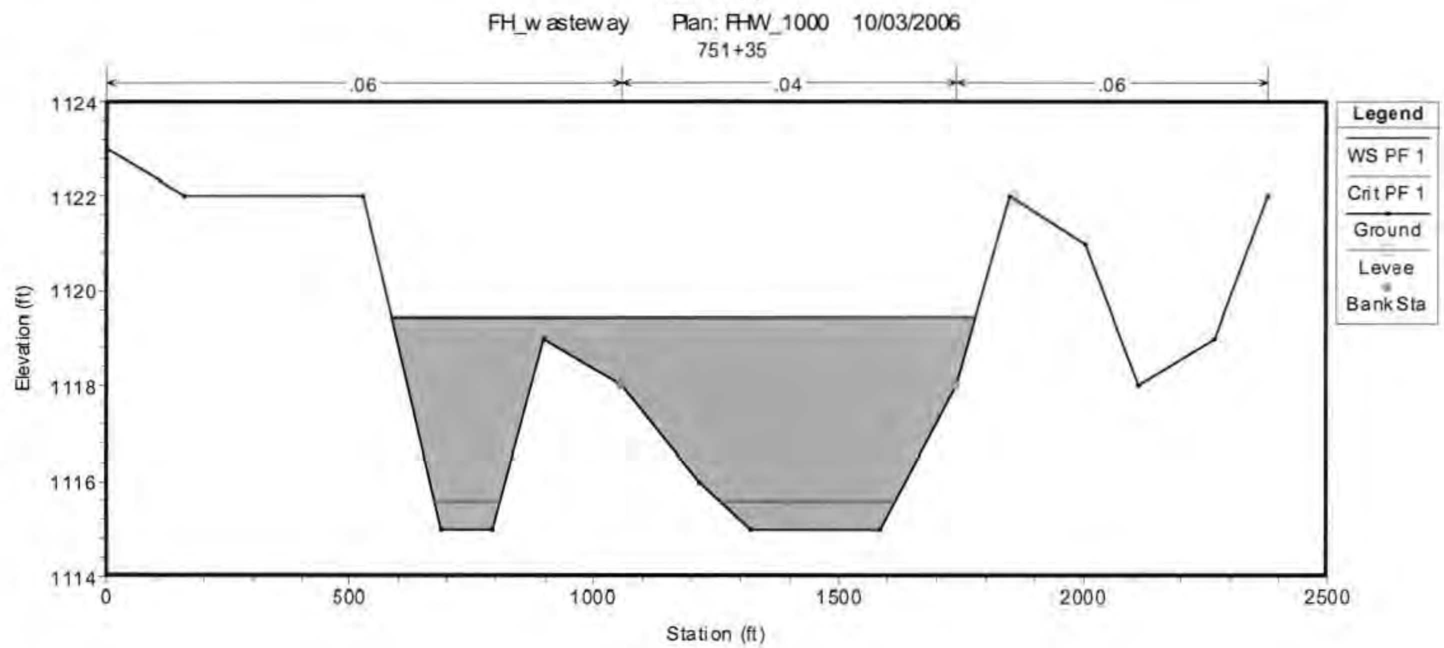

FH_wasteway Plan: FHW_1000 10/03/2006
Begin - STA 1021+27
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
1140
1138
1136
1134
1132
0
100
200
300
400
500
Station (ft)

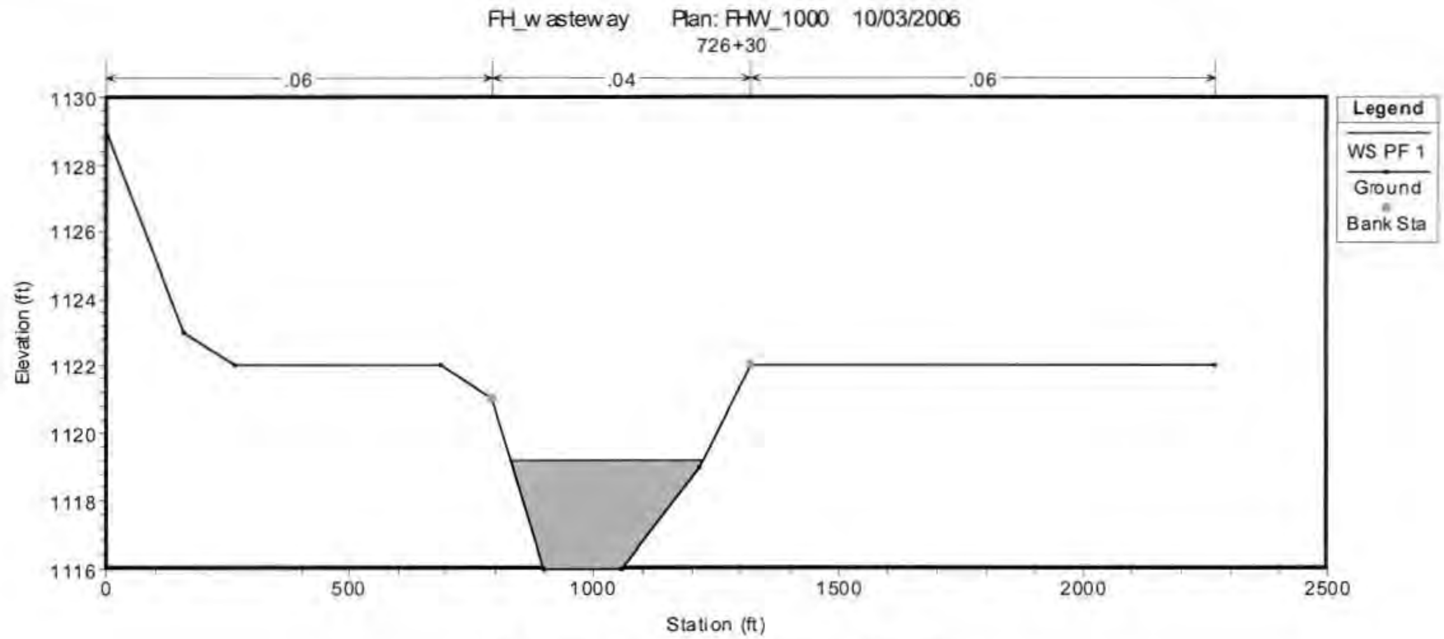

FH_wasteway Plan: FHW_1000 10/03/2006
964+71
.06
.04
.06
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
1140
1135
1130
1125
1120
1115
0
200
400
600
800
1000
1200
1400
Station (ft)

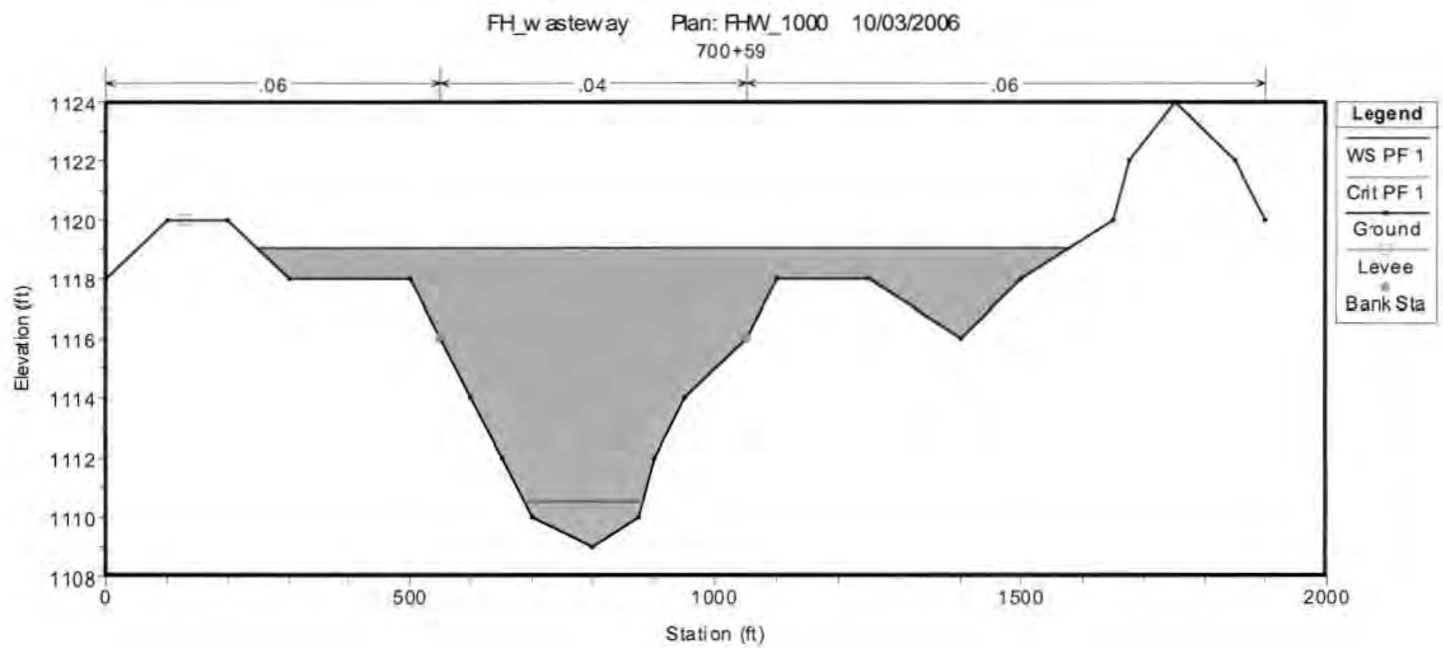

FH_wasteway Plan: FHW_1000 10/03/2006
840+29
.06
.04
.06
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
1129
1128
1127
1126
1125
1124
1123
1122
0
500
1000
1500
2000
2500
Station (ft)

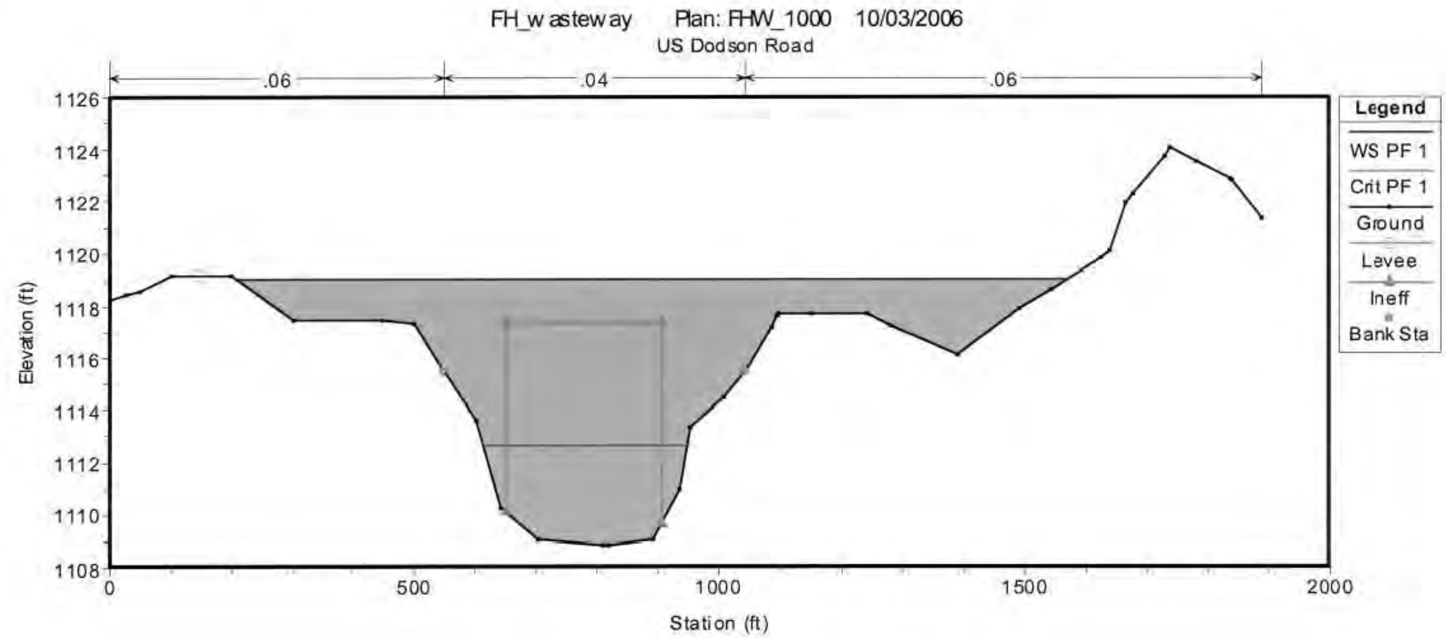

FH_wasteway Plan: FHW_1000 10/03/2006
802+10
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
1132
1130
1128
1126
1124
1122
1120
1118
1116
1114
0
1000
2000
3000
4000
5000
6000
7000
Station (ft)

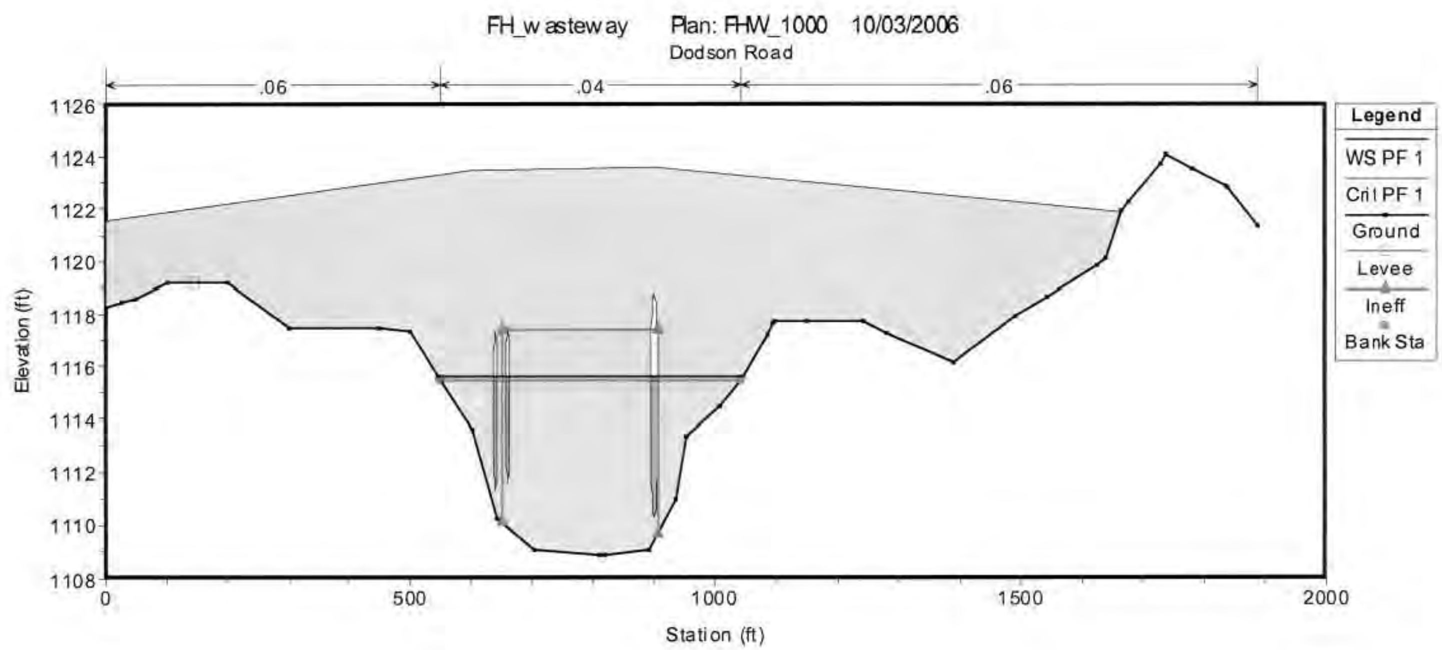

FH_wasteway Plan: FHW_1000 10/03/2006
786+62
.06
.04
.06
Elevation (ft)
1132
1130
1128
1126
1124
1122
1000
2000
3000
4000
5000
6000
7000
8000
9000
Station (ft)
Legend
WS PF 1
Ground
Bank Sta

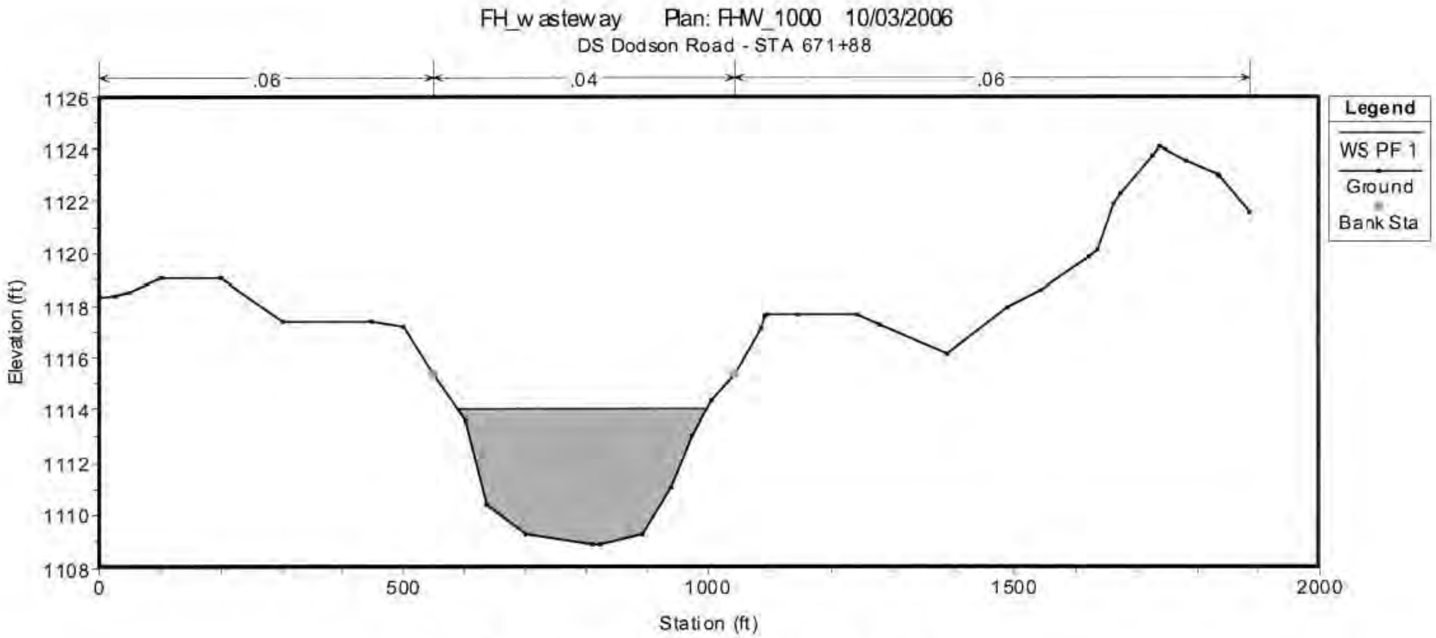

FH_wasteway Plan: FHW_1000 10/03/2006
751+35
.06
.04
.06
Elevation (ft)
1124
1122
1120
1118
1116
1114
0
500
1000
1500
2000
2500
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

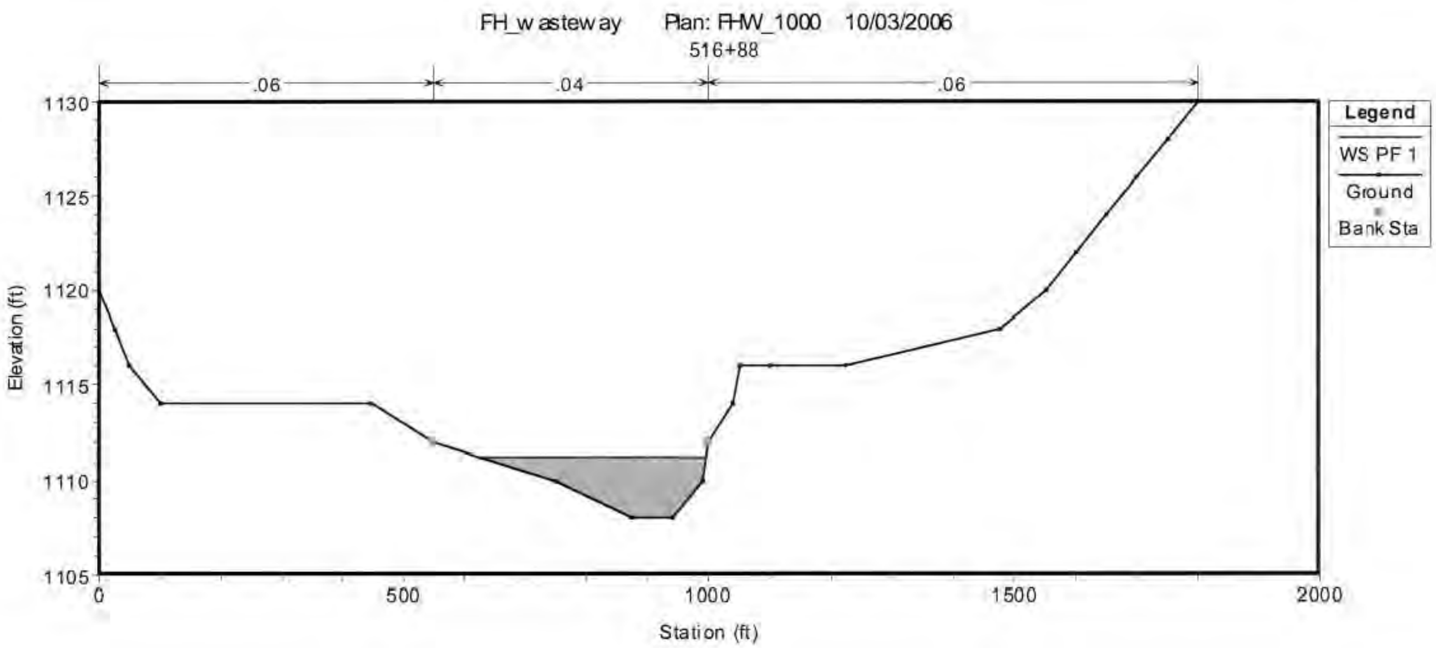

FH_wasteway Plan: FHW_1000 10/03/2006
726+30
.06
.04
.06
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

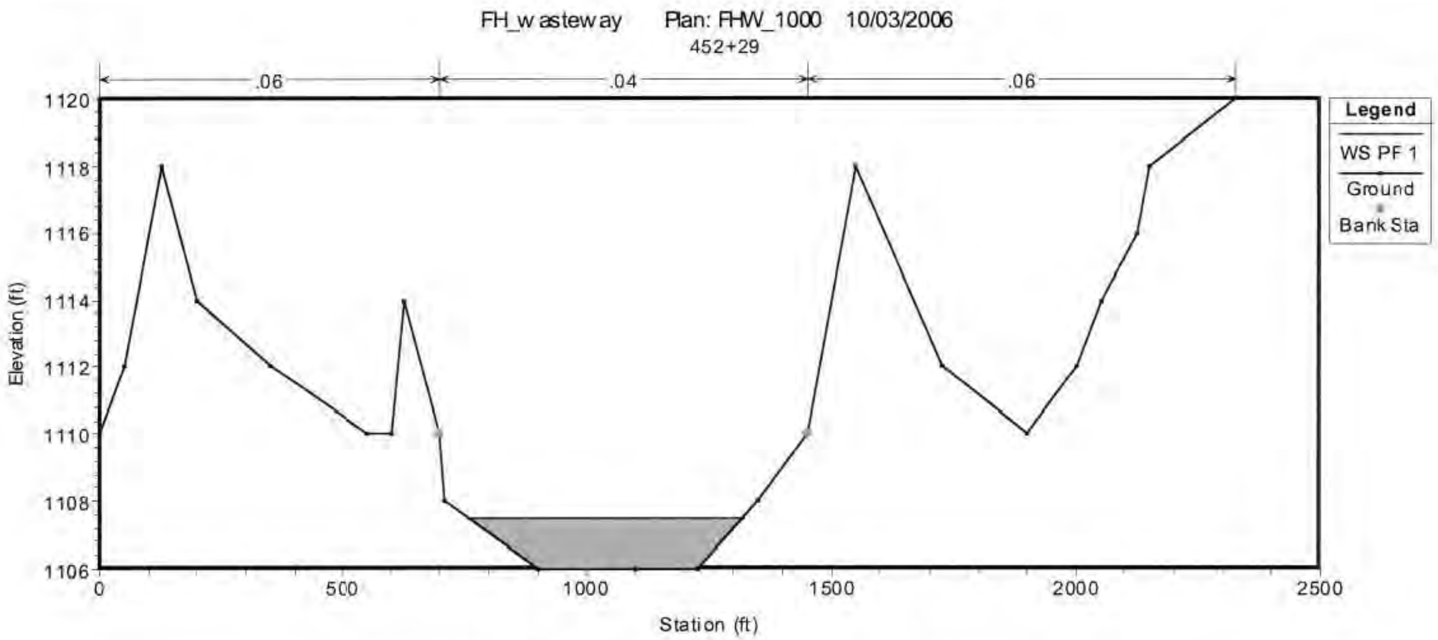

FH_wasteway Plan: FHW_1000 10/03/2006
700+59
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

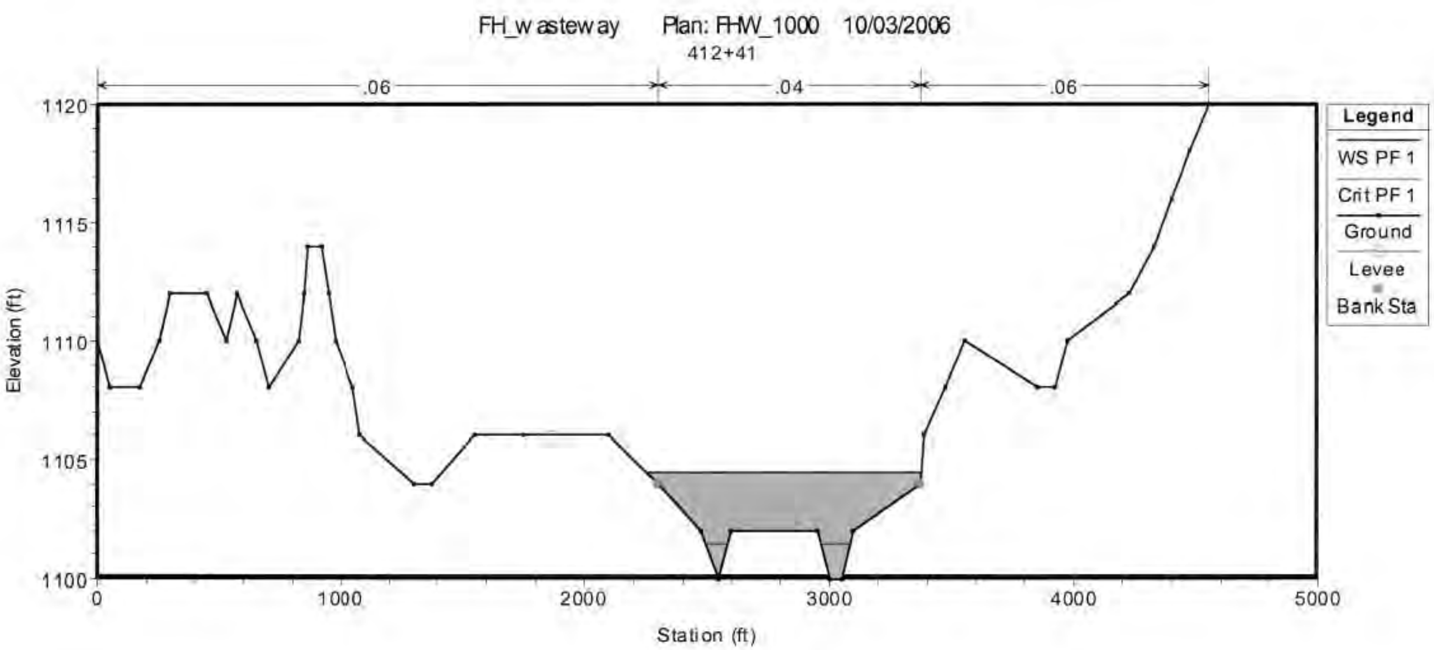

FH_wasteway Plan: FHW_1000 10/03/2006
US Dodson Road
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta

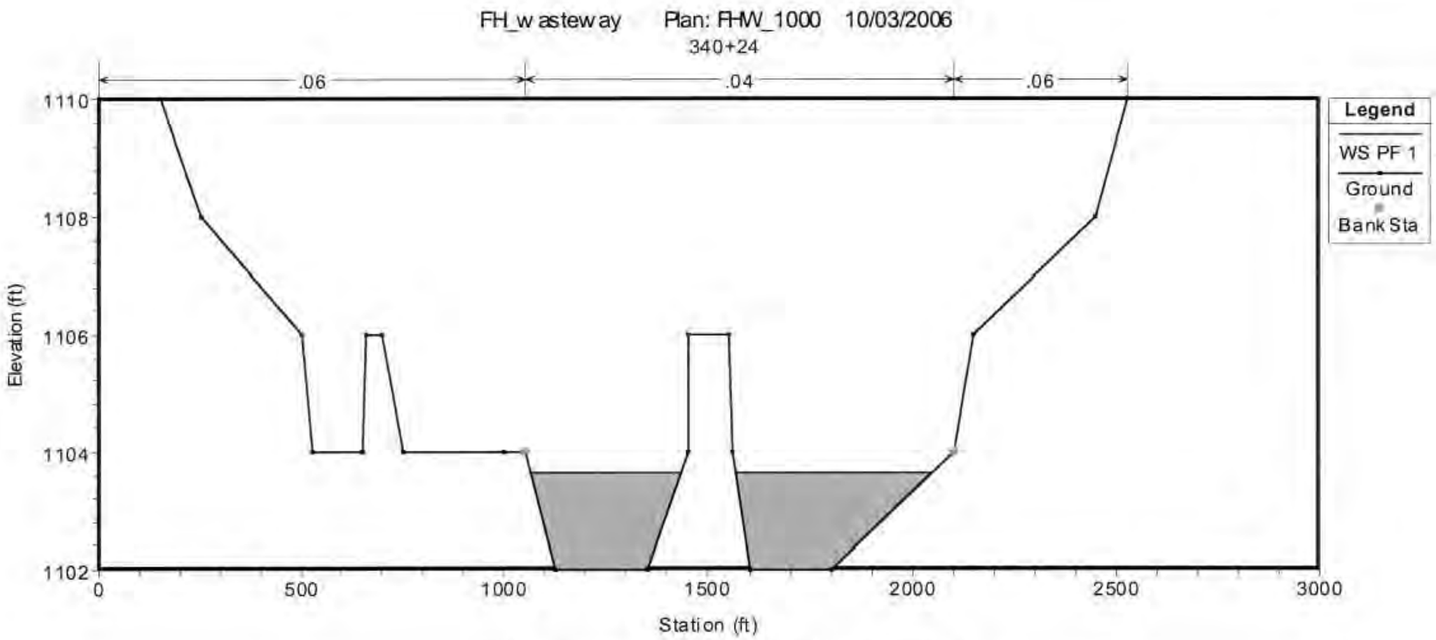

FH_wasteway Plan: FHW_1000 10/03/2006
Dodson Road
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta

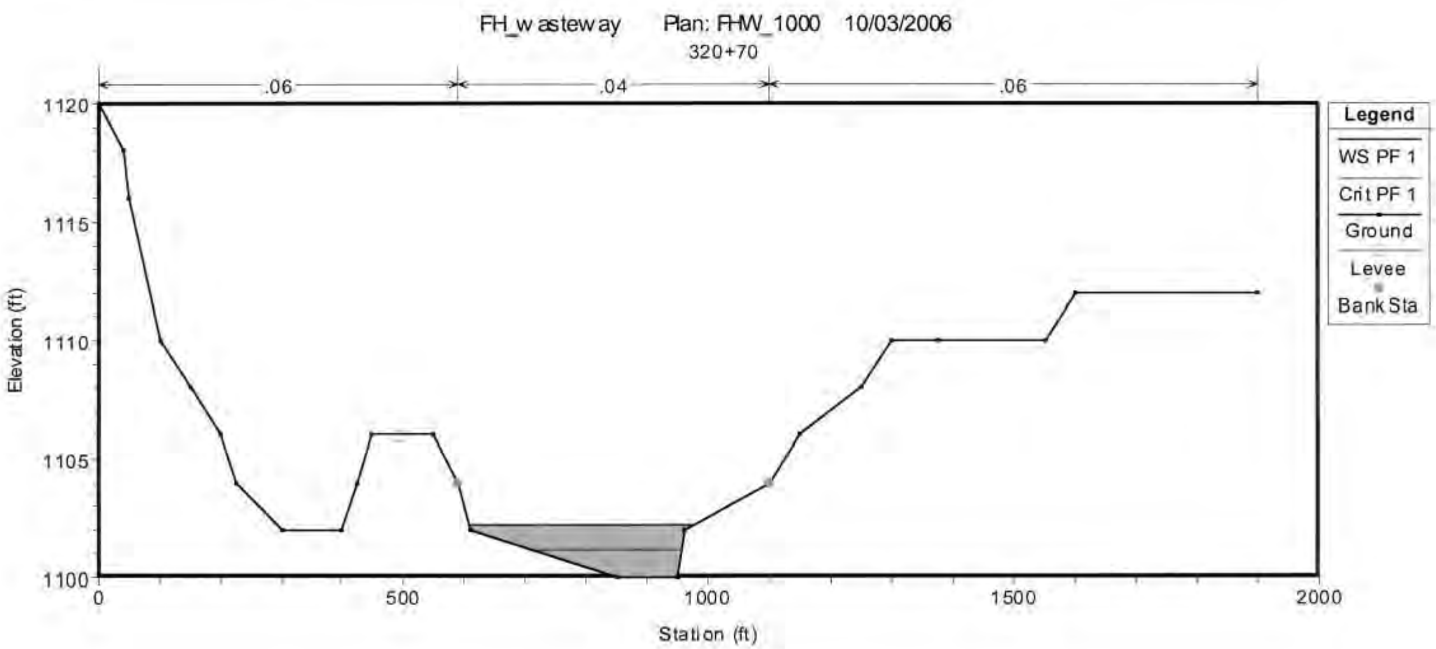

FH_wasteway Plan: FHW_1000 10/03/2006
DS Dodson Road - STA 671+88
.06
.04
.06
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
1126
1124
1122
1120
1118
1116
1114
1112
1110
1108
0
500
1000
1500
2000
Station (ft)

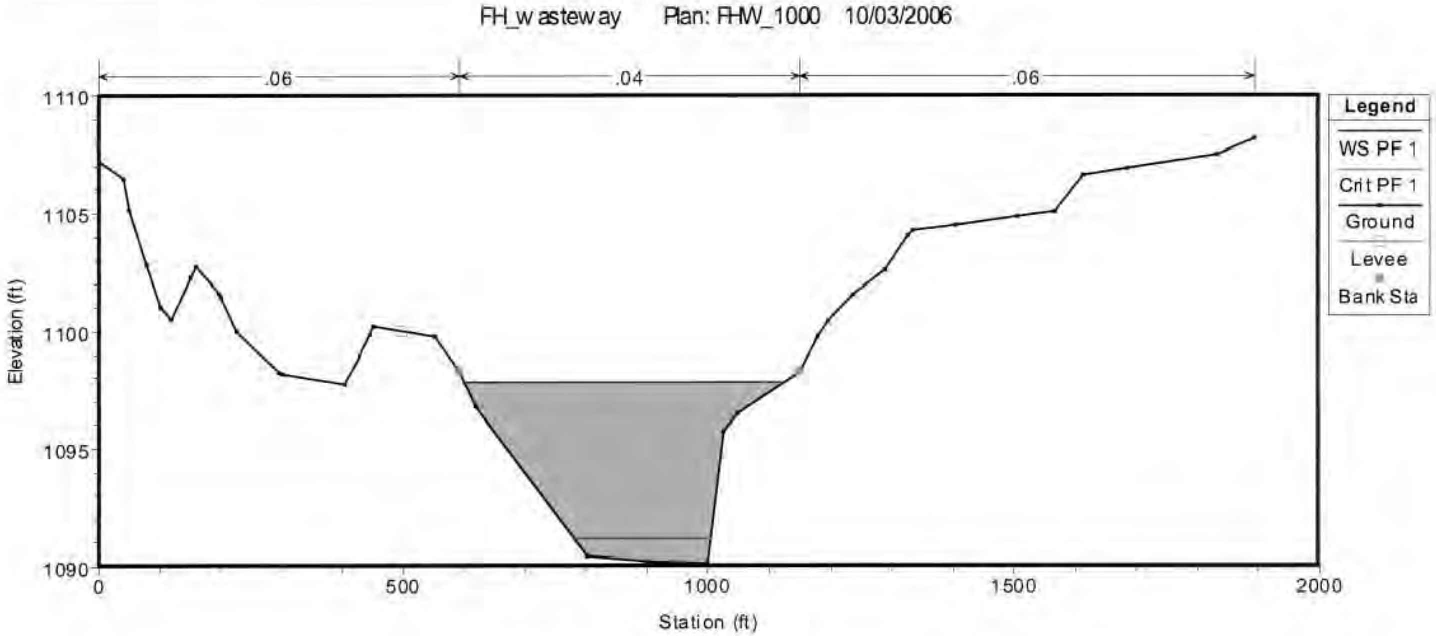

FH_wasteway Plan: FHW_1000 10/03/2006
516+88
.06
.04
.06
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
1130
1125
1120
1115
1110
1105
0
500
1000
1500
2000
Station (ft)

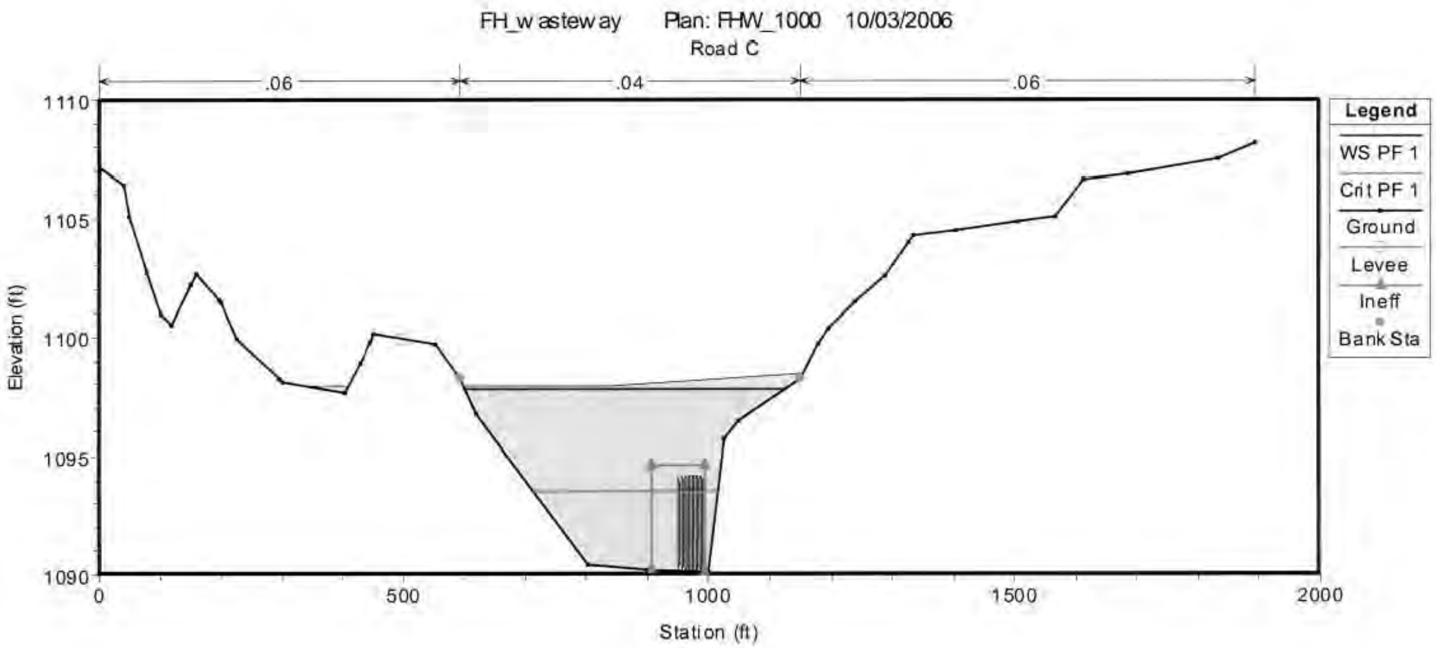

FH_wasteway Plan: FHW_1000 10/03/2006
452+29
.06
.04
.06
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
1120
1118
1116
1114
1112
1110
1108
1106
0
500
1000
1500
2000
2500
Station (ft)

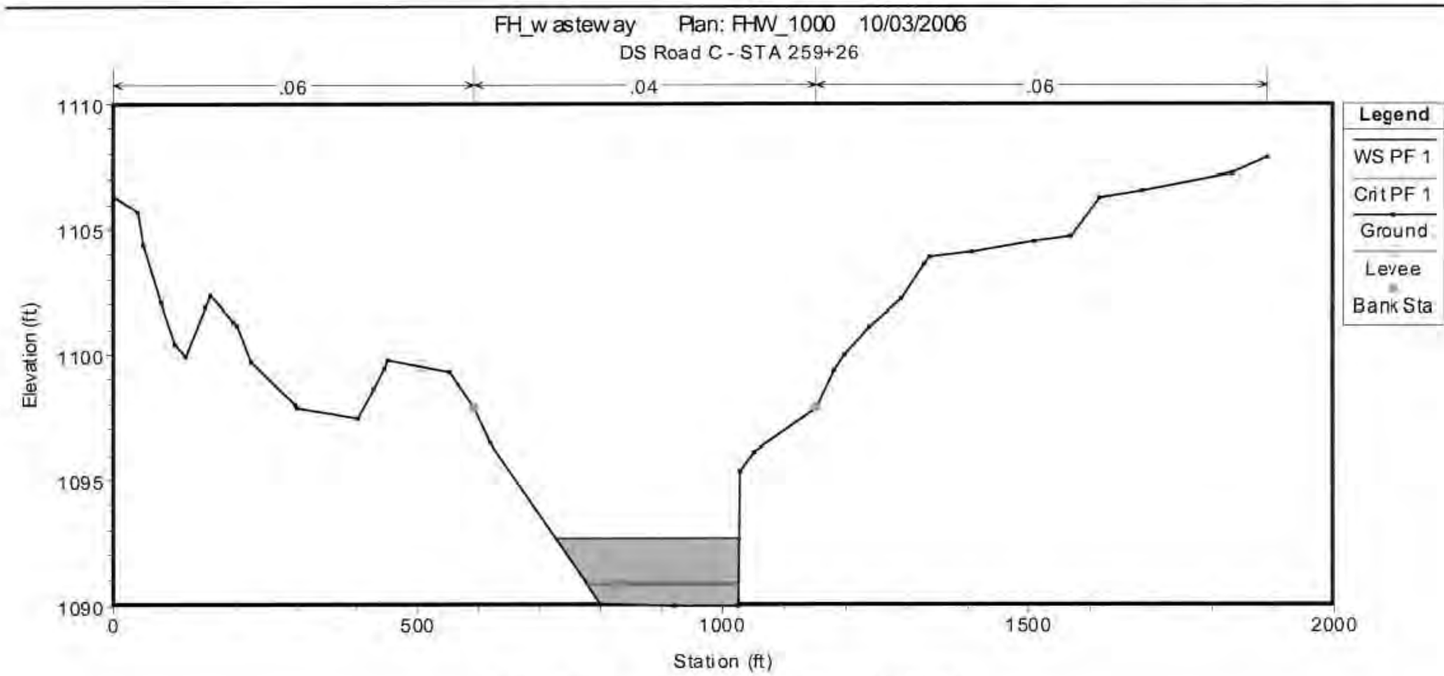

FH_wasteway Plan: FHW_1000 10/03/2006
412+41
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
1120
1115
1110
1105
1100
0
1000
2000
3000
4000
5000
Station (ft)

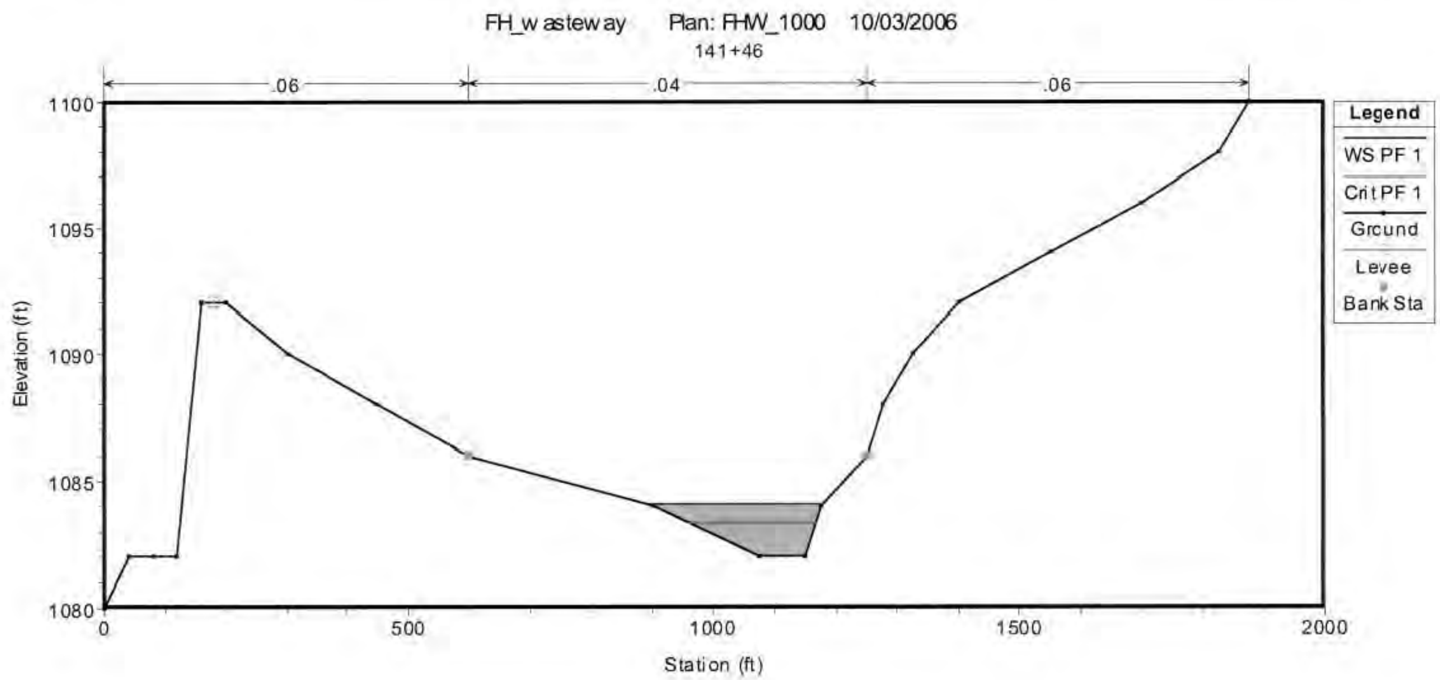

FH_wasteway Plan: FHW_1000 10/03/2006
340+24
.06
.04
.06
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
1110
1108
1106
1104
1102
0
500
1000
1500
2000
2500
3000

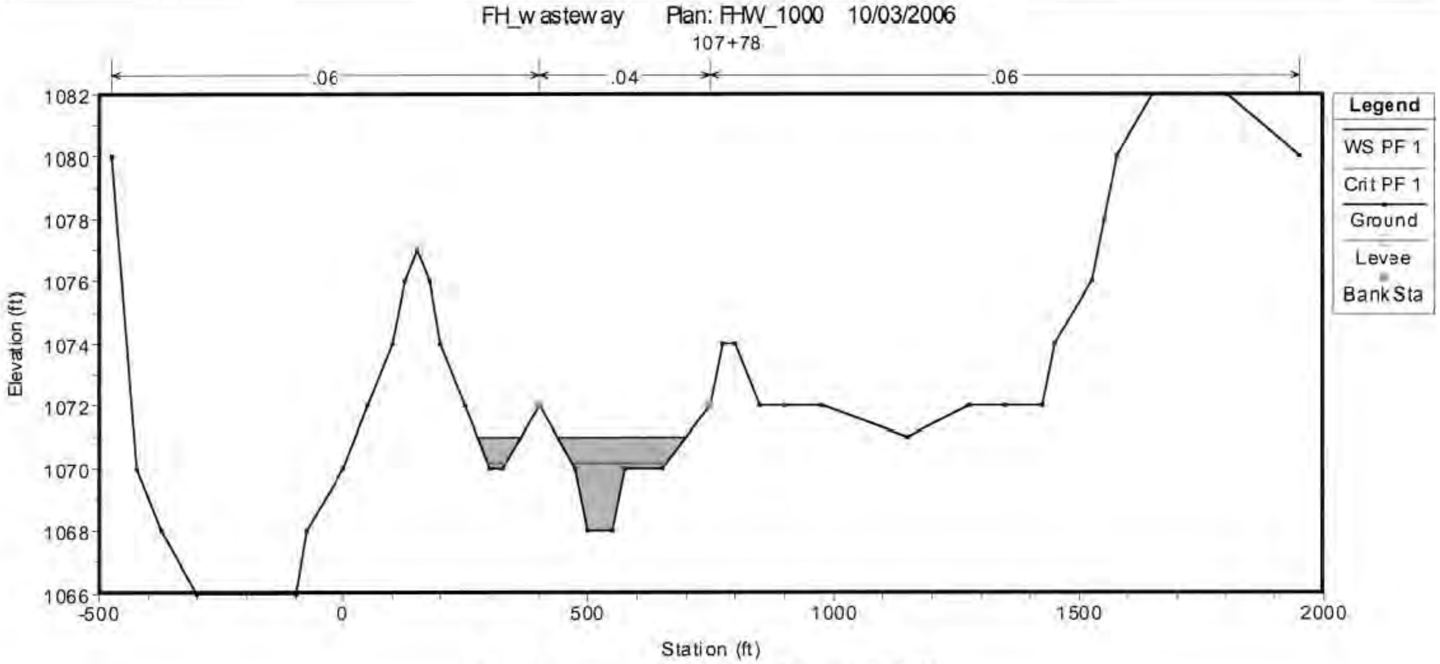

FH_wasteway Plan: FHW_1000 10/03/2006
320+70
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1120
1115
1110
1105
1100
0
500
1000
1500
2000

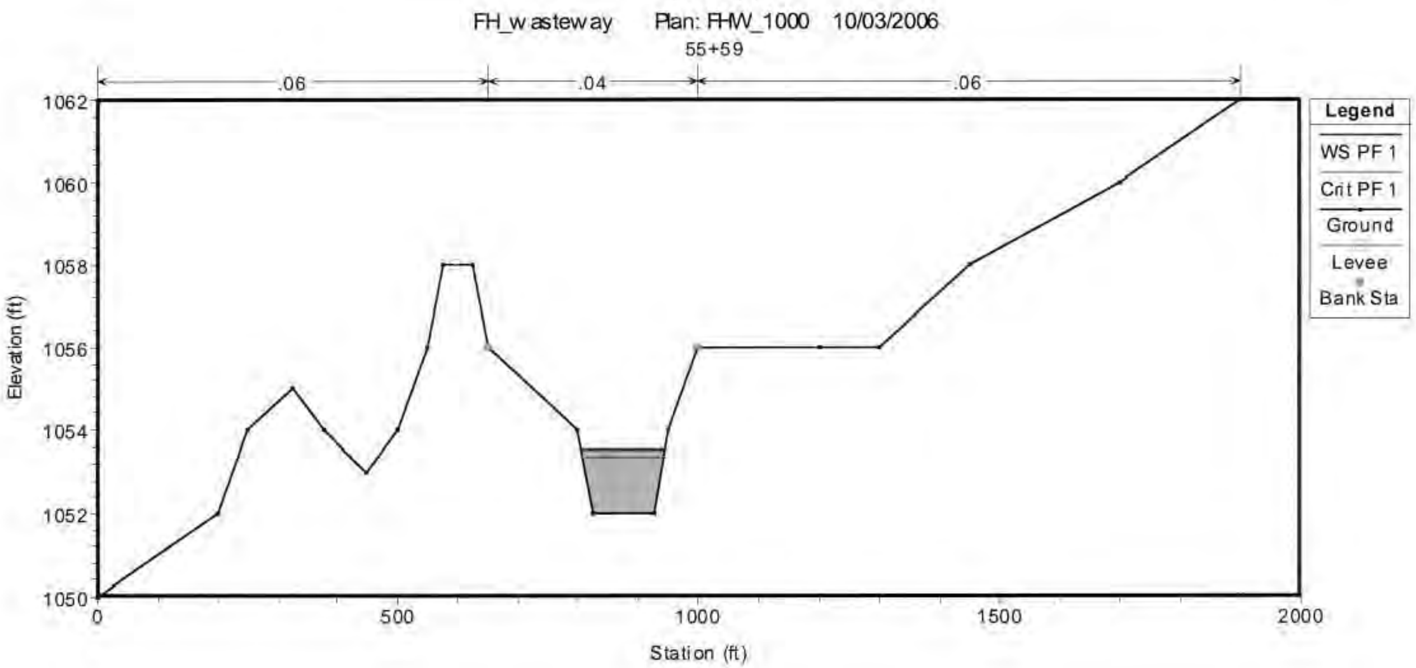

FH_wasteway Plan: FHW_1000 10/03/2006
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1110
1105
1100
1095
1090
0
500
1000
1500
2000

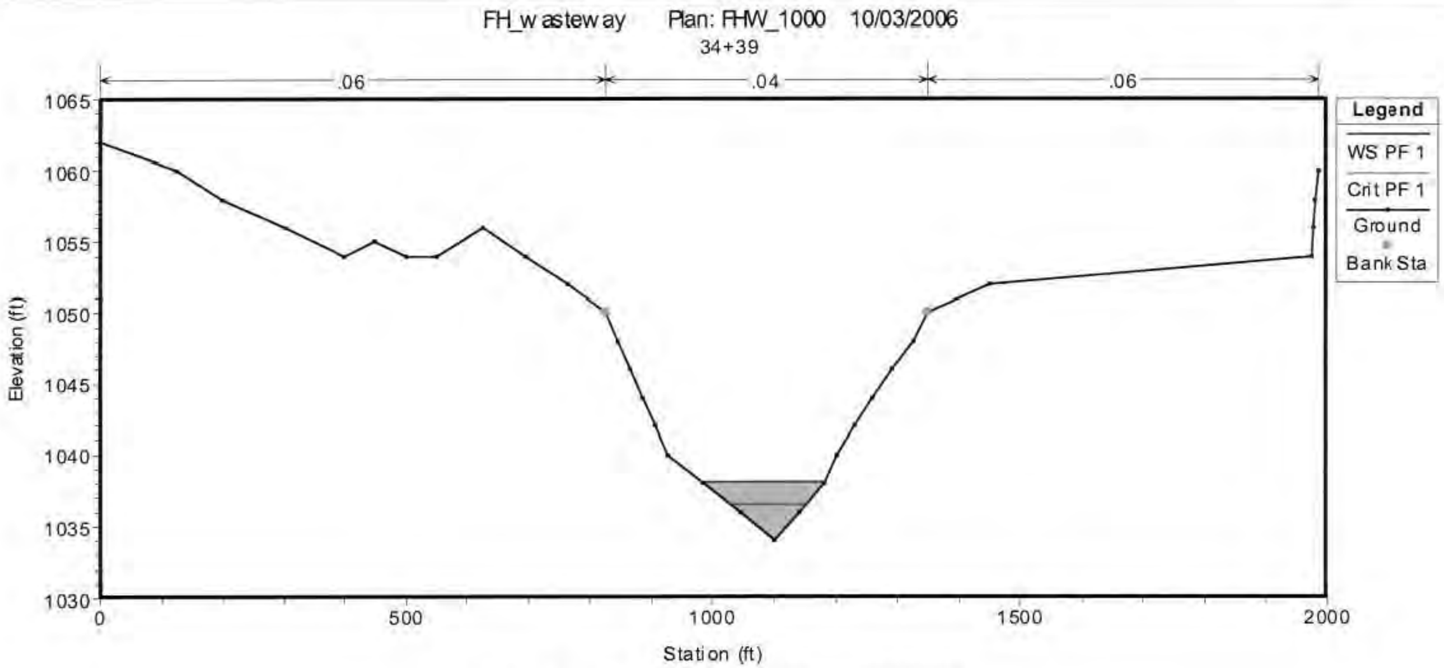

FH_wasteway Plan: FHW_1000 10/03/2006
Road C
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1110
1105
1100
1095
1090
0
500
1000
1500
2000

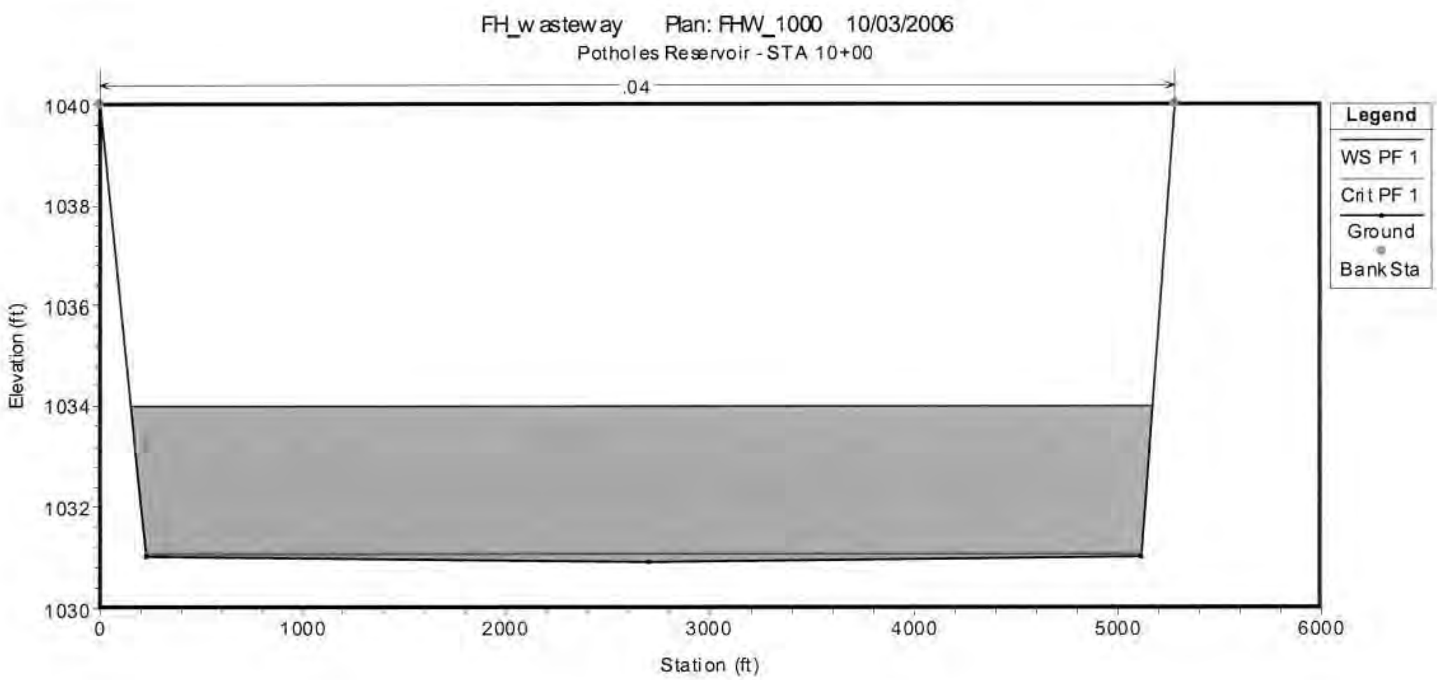

FH_wasteway Plan: FHW_1000 10/03/2006
DS Road C - STA 259+26
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1110
1105
1100
1095
1090
0
500
1000
1500
2000


FH_wasteway Plan: FHW_1000 10/03/2006
141+46
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1100
1095
1090
1085
1080
0
500
1000
1500
2000


FH_wasteway Plan: FHW_1000 10/03/2006
107+78
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


FH_wasteway Plan: FHW_1000 10/03/2006
55+59
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta


FH_wasteway Plan: FHW_1000 10/03/2006
34+39
.06
.04
.06
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
1065
1060
1055
1050
1045
1040
1035
1030
0
500
1000
1500
2000
Station (ft)

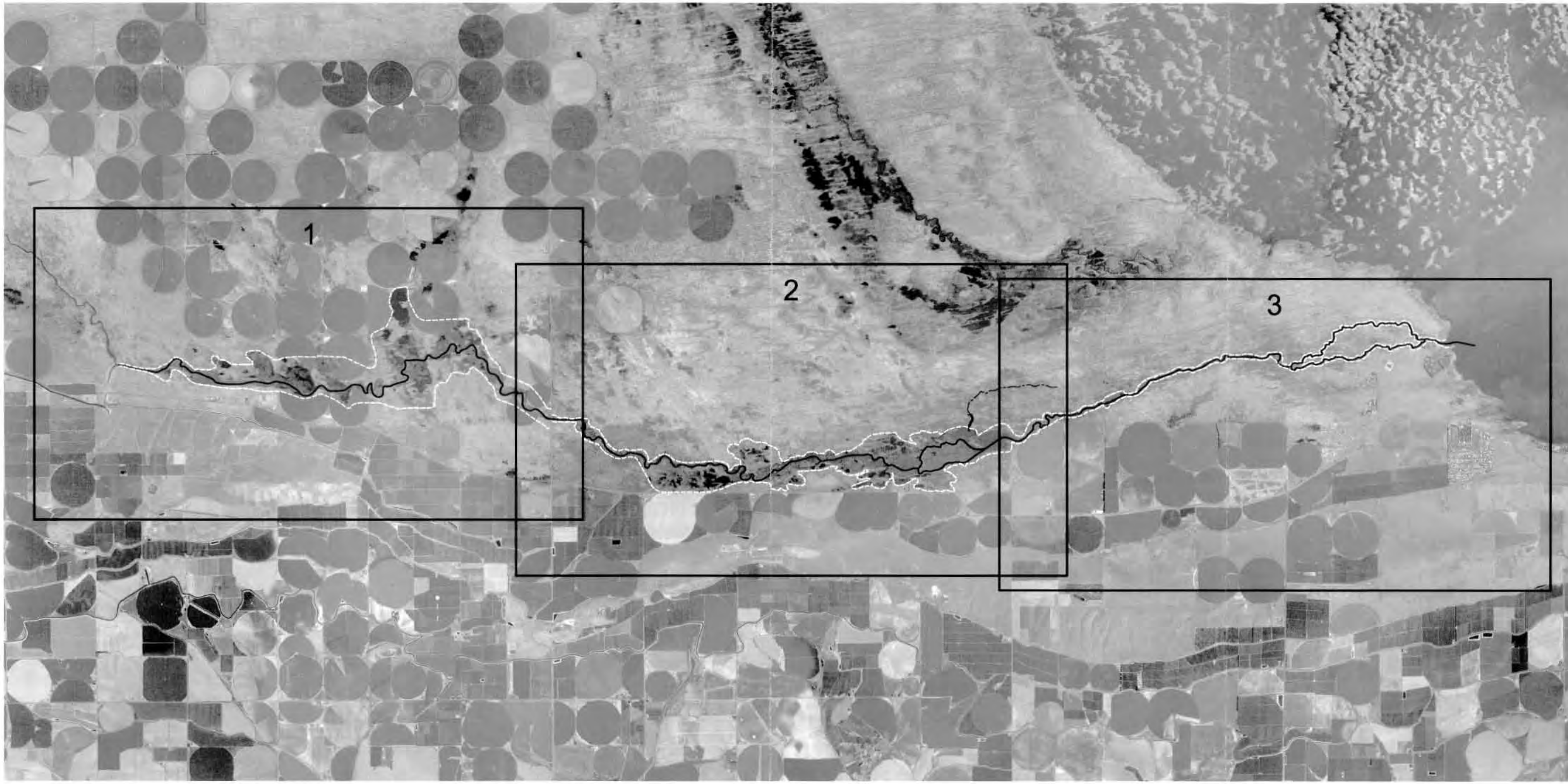

FH_wasteway Plan: FHW_1000 10/03/2006
Potholes Reservoir - STA 10+00
.04
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
1040
1038
1036
1034
1032
1030
0
1000
2000
3000
4000
5000
6000
Station (ft)

348226.03.06

HECRAS Output Table

HEC-RAS Plan: FHW1 River: FHW Reach: 1 Profile: PF 1

River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
102127	1000	1132	1135.5	1134.4	1135.6	0.00311	2.8	359	231	0.39
96471	1000	1116	1123.4		1123.4	0.00001	0.4	3339	890	0.03
84029	1000	1122	1123		1123	0.00055	0.8	1196	1273	0.15
80210	1000	1115	1122.5	1116.1	1122.5	0	0.1	12042	6139	0.01
78662	1000	1122	1122.4		1122.4	0.0007	0.6	1766	4030	0.15
75135	1000	1115	1119.4	1115.6	1119.4	0.00002	0.3	3549	1194	0.03
72630	1000	1116	1119.2		1119.2	0.00033	1.1	872	389	0.13
70059	1000	1109	1119.1	1110.5	1119.1	0	0.3	4672	1334	0.02
67584	1000	1108.9	1119.1	1110.4	1119.1	0	0.3	5069	1366	0.02
67544	1000	1108.9	1119.1	1112.7	1119.1	0	0.2	5375	1366	0.01
67300	Culvert									
67187	1000	1108.8	1114		1114	0.00005	0.6	1555	406	0.06
67147	1000	1108.8	1114		1114	0.00011	0.8	1227	398	0.08
51688	1000	1108	1111.3		1111.3	0.00067	1.4	691	372	0.19
45229	1000	1106	1107.5		1107.5	0.00126	1.5	673	564	0.24
41241	1000	1100	1104.5	1101.4	1104.5	0.00003	0.4	2575	1129	0.04
34024	1000	1102	1103.6		1103.7	0.0005	1	1045	848	0.15
32070	1000	1100	1102.2	1101.1	1102.2	0.00171	1.9	516	365	0.29
26335	1000	1090.1	1097.8	1091.2	1097.8	0.00001	0.4	2492	524	0.03
26295	1000	1090.1	1097.8	1091.6	1097.8	0.00001	0.4	2492	526	0.03
26000	Culvert									
25926	1000	1090	1092.6	1090.8	1092.6	0.00052	1.5	684	300	0.17
25886	1000	1090	1092.5	1090.8	1092.5	0.00063	1.6	641	296	0.19
14146	1000	1082	1084.1	1083.3	1084.2	0.00377	2.7	371	289	0.42
10778	1000	1068	1071	1070.2	1071.1	0.00311	2.6	420	348	0.39
5559	1000	1052	1053.6	1053.4	1054	0.01416	5.4	186	139	0.82
3439	1000	1034	1038.1	1036.6	1038.2	0.00174	2.5	403	199	0.31
1000	1000	1030.9	1034	1031.1	1034	0	0.1	15070	5016	0.01



0 6000 12000 18000

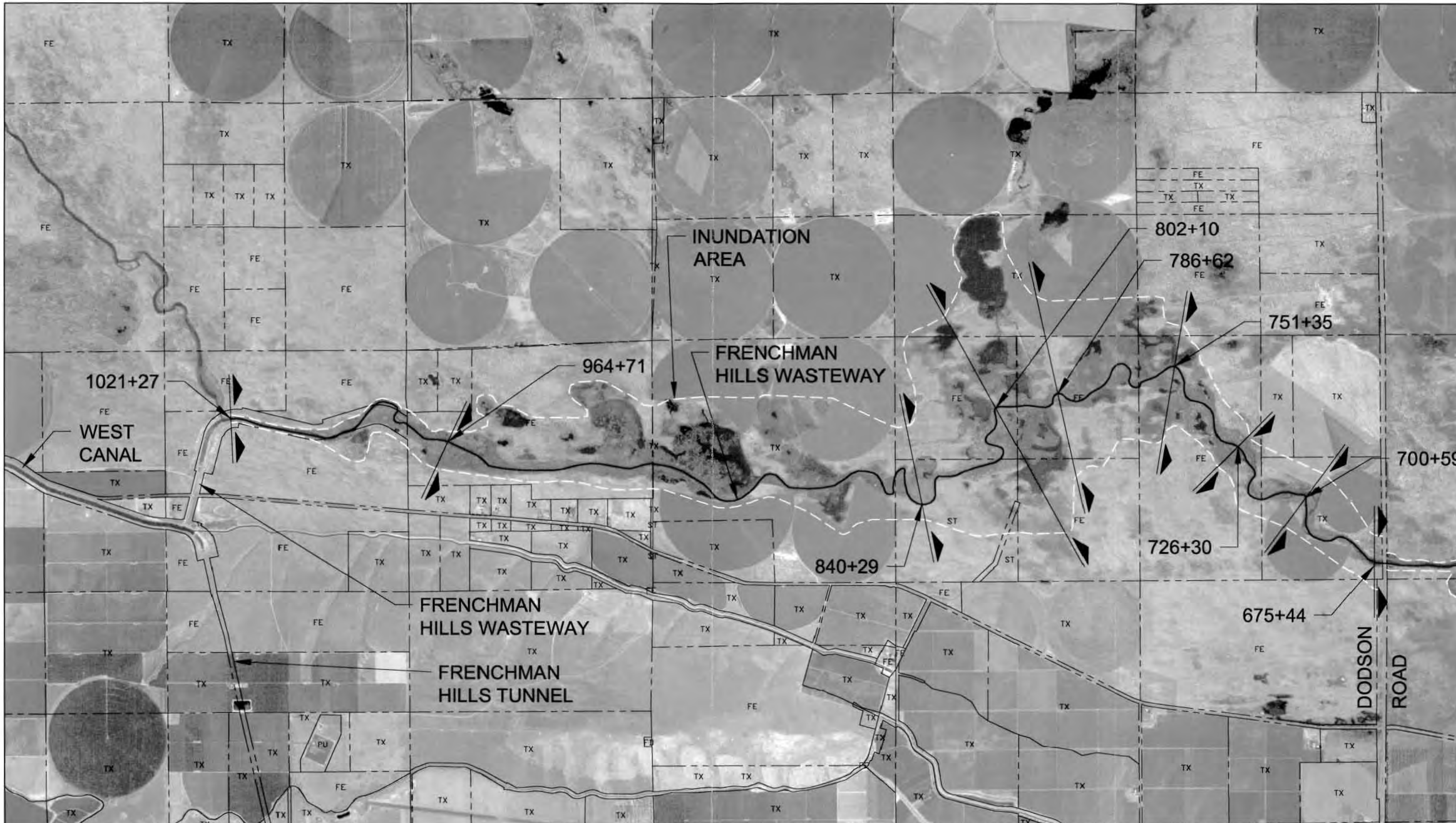
1"=6000'

N

INDEX MAP
FRENCHMAN HILLS WASTEWAY

348226

CH2MHILL



0 2000 3000 4000
1"=2000'

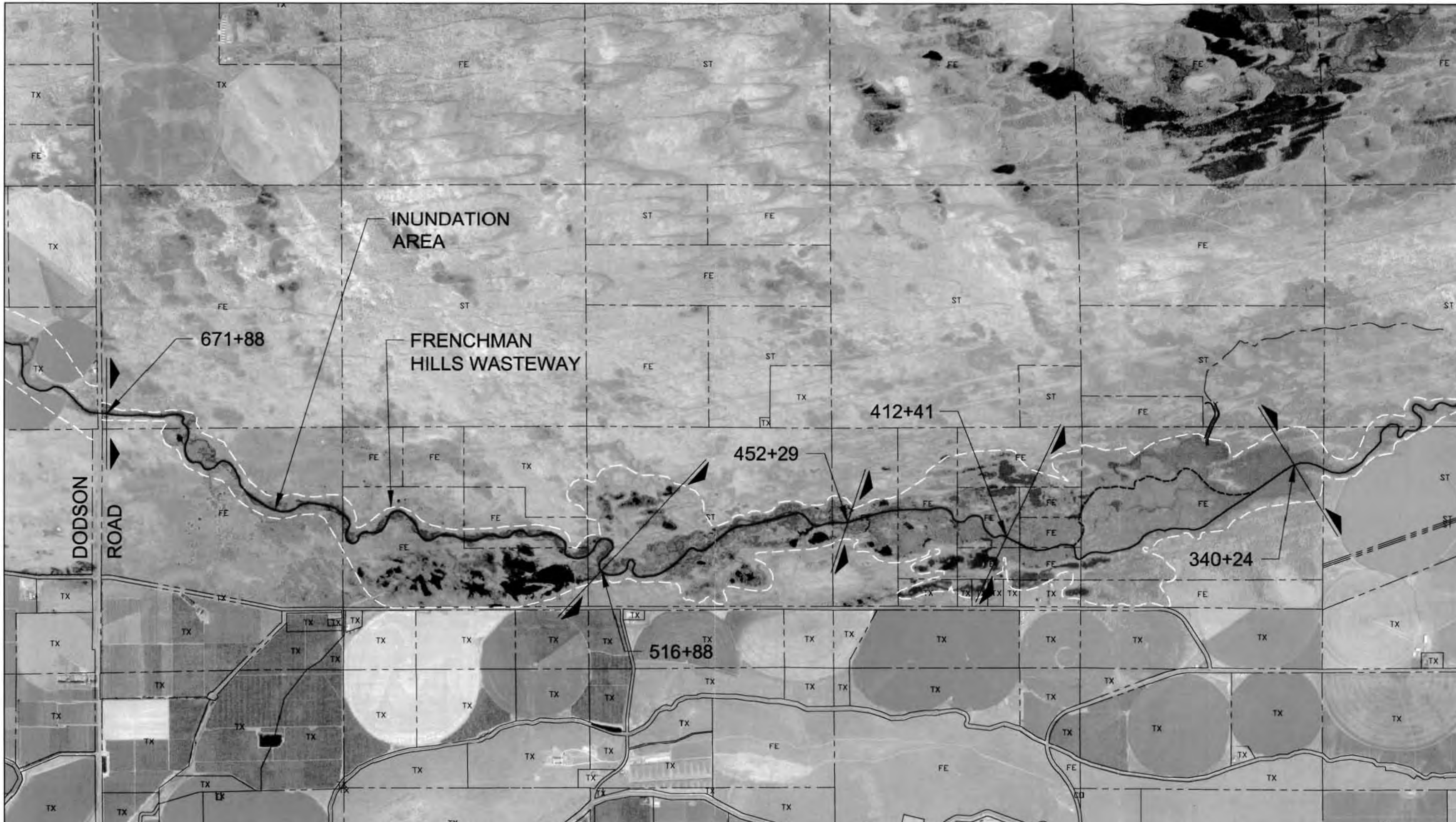
N

LEGEND
TX = PRIVATE LAND
FE = FEDERAL LAND
ST = STATE LAND

INUNDATION MAP - #1
FRENCHMAN HILLS WASTEWAY

348226

CH2MHILL



0 2000 3000 4000

1"=2000'

N

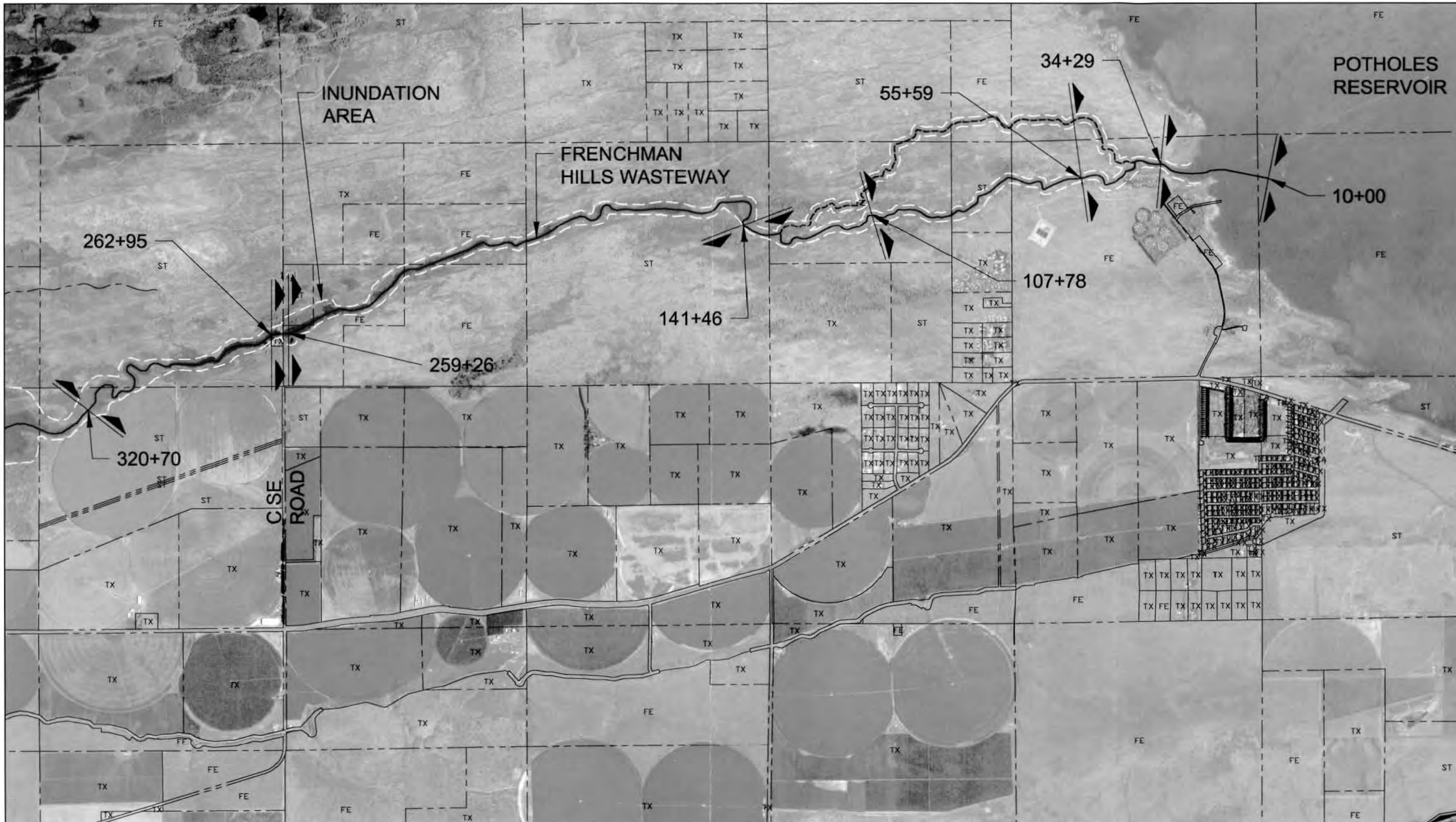
LEGEND

TX = PRIVATE LAND
FE = FEDERAL LAND
ST = STATE LAND

INUNDATION MAP - #2
FRENCHMAN HILLS WASTEWAY

348226

CH2MHILL



0 2000 3000 4000
1"=2000'

N

LEGEND
TX = PRIVATE LAND
FE = FEDERAL LAND
ST = STATE LAND

INUNDATION MAP - #3
FRENCHMAN HILLS WASTEWAY

348226

CH2MHILL