Final Addendum to Dambreak Study for Apache Junction FRS and Signal Butte FRS

Buckhorn-Mesa Structures

Prepared for:

Flood Control District of Maricopa County
And LTM Engineering, Inc.
(FCD No. 2005C016 PCN 300.01.26)

LTM Engineering, Inc.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
24767
ROBERT A.
EICHINGER
Date Signed 5/31/06
ARIZONA, U.S.A.

KHA Project No. 091725006

© Kimley-Horn and Associates, Inc. May 2006

Kimley-Horn and Associates, Inc.

FINAL ADDENDUM TO DAMBREAK STUDY FOR APACHE JUNCTION FRS AND SIGNAL BUTTE FRS BUCKHORN-MESA STRUCTURES

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
FCD 2005C016 PCN 300.01.26

KIMLEY-HORN AND ASSOCIATES, INC.
7878 NORTH 16TH STREET, SUITE 300
PHOENIX, ARIZONA 85020
(602) 944-5500

MAY 2006

Registered Professional Engineer (Civil)
CERTIFICATE NO.
24767
ROBERT A.
EICHINGER
Date Signed 5/31/06
ARIZONA U.S.A.

This document, together with the concepts and designs presented herein, as an instrument of service, is intended only for the specific purpose and client for which it was prepared. Reuse of and improper reliance on this document without written authorization and adaptation by Kimley-Horn and Associates, Inc., shall be without liability to Kimley-Horn and Associates, Inc.

FINAL ADDENDUM TO DAMBREAK STUDY FOR APACHE JUNCTION FRS AND SIGNAL BUTTE FRS

Table of Contents

Section No. **Page No.**

1.0 Introduction 1

2.0 Authority and Purpose 1

3.0 Scope of Work 2

4.0 Data Collection 2

5.0 Mapping and Aerial Photography 3

6.0 Inflow Design Flood 3

7.0 Description of Downstream Inundation Area 3

8.0 Dambreak/Hydraulic Analysis and Methodology 4

- 8.1 CAP Embankment 4
- 8.2 CAP Embankment In-Line Gates 5
- 8.3 Model Scenario No. 1 - Empty Pool 6
  - 8.3.1 Boundary and Initial Conditions 6
- 8.4 Model Scenario No. 2 – Full Pool 7
- 8.5 Model Scenario No. 3 – Sunny Day 7

9.0 Dambreak Results 7

10.0 Discussion of Assumptions 23

- 10.1 Downstream Flood Inundation Delineation 23
- 10.2 Central Arizona Project 23

11.0 Discussion and Comparison of Results 24

- 11.1 Depths of Flow 26
- 11.2 Routed Flows 26
- 11.3 Times to Peak 27
- 11.4 Flood Elevations 27

12.0 Recommendations for Local Flood Response 27

13.0 Conclusions 28

Registered Professional Engineer (Civil) CERTIFICATE NO. 24767 ROBERT A. EICHINGER Date Signed 5/31/06 ARIZONA U.S.A.

List of Tables

Table No.

1. Dambreak Summary Table for Apache Junction FRS (Empty Pool) 9
2. Dambreak Summary Table for Apache Junction FRS (Full Pool) 10
3. Dambreak Summary Table for Apache Junction FRS (Sunny Day) 11
4. Dambreak Summary Table for Signal Butte FRS (Empty Pool) 12
5. Dambreak Summary Table for Signal Butte FRS (Full Pool) 13
6. Dambreak Summary Table for Signal Butte FRS (Sunny Day) 14

List of Figures

Figure No.

1. Breach Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS 15

2. Flow Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Full Pool) 16

3. Flow Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Empty Pool) 17

4. Flow Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Sunny Day) 18

5. Breach Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS ... 19

6. Flow Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Full Pool) 20

7. Flow Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Empty Pool) 21

8. Flow Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Sunny Day) 22

List of Appendices

Appendix

A. Data Collection and References
B. Central Arizona Project Canal Study Data
C. Inundation Map Exhibits
D. Comparison Tables and Cross Section Plots

1.0 Introduction

Kimley-Horn and Associates, Inc. (KHA) prepared an updated dambreak study for the Apache Junction Flood Retarding Structure (FRS) and the Signal Butte FRS in November 2005 (KHA Nov 2005). The updated dambreak study used revised 6-hour Probable Maximum Flood (PMF) hydrology for each dam (KHA Sept 2005). The dambreak study used the U.S. Army Corps of Engineers unsteady flow HEC-RAS model to simulate the breach of each dam and route the resulting dambreak floodwave through each downstream inundation area. The dambreak report provided inflow hydrographs to each dam, breach parameters, hydraulic results, and dambreak hydrographs, and summarized the results of the modeling scenarios (sunny day breach, empty pool breach, and full pool breach). The full KHA updated dambreak report and electronic models are on file with the Flood Control District of Maricopa County.

2.0 Authority and Purpose

The District has retained LTM Engineering, Inc. to develop emergency action plans (EAPs) for the Buckhorn-Mesa FRSs (Apache Junction, Signal Butte, and Spook Hill) under FCD Contract 2005C016 - Work Assignment No 1. KHA is assisting LTM Engineering by preparing updated dambreak studies and analyses for the Apache Junction FRS and Signal Butte FRS.

Development downstream of each structure has significantly increased since construction of the dams. The original dambreak analyses for each dam were prepared using simplified technical methods and United States Geological Survey (USGS) 7.5 minute topographic quadrangle mapping. The updated dambreak analyses conducted by KHA is based on new two-foot contour mapping, new stage-storage-discharge rating curves for each dam, use of the dynamic hydraulic model capability (USACE May 2005; HEC-RAS Version 3.1.3), and updated Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) for each structure (KHA, Sept 2005). Kimley-Horn evaluated potential dambreak scenarios for these two structures and developed downstream inundation mapping resulting from the routed dambreak floodwave from each dambreak scenario (empty pool, full pool, and sunny day pool).

Kimley-Horn has prepared this addendum report to the November 2005 updated dambreak study and report. The purpose of this addendum is to add the Central Arizona Project (CAP) canal embankment to the downstream inundation area and examine the effects of the canal embankment on the routed dambreak floodwave. The CAP canal is located downstream of the Signal Butte FRS approximately mid-way in the downstream inundation area and approximately two-thirds of the way in the downstream inundation area for Apache Junction FRS. The CAP canal embankment is anticipated to provide attenuation of the dambreak floodwave for the area downstream of the CAP canal. The upstream embankment of the CAP canal will impound floodwater and this study will estimate the level of impoundment during the routing of the dambreak floodwave.

This addendum to the dambreak report documents Kimley-Horn's analyses for Apache Junction and Signal Butte FRS. This report documents the approach, methodology, assumptions, results, conclusions, and provides recommendations for flood response as a result of the findings of this addendum.

This addendum to the dambreak study provides information that is required for emergency action planning. This data includes information on flood depths, flow velocities, and travel time for the discharge hydrographs associated with the dam breach and boundary conditions evaluated for Apache Junction FRS and Signal Butte FRS. The data will provide planning information for emergency management purposes, flood warning, and floodplain management.

3.0 Scope of Work

The objective of this addendum study is to revise the November 2005 dambreak study by adding the CAP canal embankment to the downstream inundation area in the unsteady flow hydraulic models for each dam. This addendum report will revise the downstream inundation mapping for inclusion to the updated emergency action plans for Apache Junction FRS and Signal Butte FRS. The scope of work included these elements and dambreak scenarios:

Collection of CAP as-built plans within the study area.
The study analysis flood is the inflow design flood (IDF) for the dams which is the Probable Maximum Flood.
Add the CAP canal embankment profile as an in-line weir using the lateral structure option of the HEC-RAS computer program.
Model Scenario No. 1 (Empty Pool): Route the IDF through each dam with initial conditions of an empty pool and breach the dams.
Model Scenario No. 2 (Full Pool): Route the IDF through each dam with initial conditions of a full pool elevation at the emergency spillway crest and breach the dams.
Model Scenario No. 3 (Sunny Day): This scenario does not route the IDF through each dam. Instead the dams are breached with initial pool elevations at the emergency spillway crests (this scenario is referred to as the "sunny day failure").
Evaluate the inundation (i.e., flow depths, flow velocity) downstream for each dam from the breaches for each of the three model scenarios.
Revise the November 2005 flood inundation area maps.

4.0 Data Collection

Existing studies and reports for each dam were collected by Kimley-Horn in previous works tasks (KHA, March 2005 and April 2005) as part of the updated dambreak studies (KHA November 2005). Kimley-Horn collected the as-built CAP canal plans from the Central Arizona Project as part of this addendum study. The as-built plans included a typical cross section of the CAP canal as well as the plan and profile of the canal within the study area.

A record of the data collected by Kimley-Horn for this addendum report and the updated dambreak study is compiled in **Appendix A**. **Appendix A** also serves as the reference listing. **Appendix B** includes the CAP as-built plan and profile sheets.

5.0 Mapping and Aerial Photography

The District provided aerial photography and topographic mapping for the updated dambreak study (NAVD88). The mapping was prepared by others under separate contract. The base mapping was flown in April 2005.

6.0 Inflow Design Flood

The Arizona Department of Water Resources has determined that the inflow design flood for the Apache Junction FRS and Signal Butte FRS is the probable maximum flood (PMF). Kimley-Horn developed updated PMF hydrology for each watershed for both the 6-hour and 72-hour duration events (KHA September 2005). The 6-hour storm was used for these dambreak studies. The peak inflow for the PMF for Apache Junction FRS and Signal Butte FRS was determined to be 23,400 cfs and 26,222 cfs, respectively in the KHA study.

7.0 Description of Downstream Inundation Area

The dambreak study limits are defined as beginning at the dams and traversing downstream to approximately US 60 (Superstition Freeway), a distance of approximately 6.8 miles for Apache Junction FRS and 5.5 miles for Signal Butte FRS. The downstream limits of the study area include the future alignment location of the Arizona Department of Transportation's (ADOT) Red Mountain Freeway (Loop 202).

The downstream inundation study areas for both dams have the same land use type and characteristics. Within the pool area and immediately downstream of each dam the land use is primarily upland Sonoran desert. In less than ½ mile downstream from each dam the land use changes from desert to rural medium residential. Residential development consists of medium density mobile home trailers, trailer parks, and commercial activities. The density of mobile homes and trailer parks increases moving in the downstream direction. The spillway inundation delineation studies for Apache Junction FRS (July 2000) and Signal Butte FRS (August 1999) provide a discussion of this downstream study area and correlates the Manning's roughness coefficients with land use type.

The downstream study area includes local and residential drainage improvements as well as ADOT freeway drainage improvements. The local improvements include trailer park retention/detention basins, roadside drainage channels and minor improved drainage channels. The ADOT freeway drainage facilities includes large regional detention basins located between the Central Arizona Project (CAP) canal and the future Red Mountain Freeway on the north side of US 60 (Superstition Freeway).

The Central Arizona Project canal is a large water supply canal that delivers Colorado River water from the Colorado River near the confluence with the Bill Williams River to the central Arizona municipalities including the City of Phoenix, Scottsdale, Tempe, Mesa, and City of Tucson. The canal through the study area is a concrete lined open channel that has a bottom width of 24-feet and an invert constructed at a mild slope of 0.00008 feet/foot. The depth of the

canal ranges from 26-feet to 30-feet within the study area (from canal invert to top of canal bank). According to the as-built plans the hydraulic capacity of the canal is 2,750 cfs. The upstream CAP canal embankment ranges in height above existing adjacent ground approximately 8 to 10 feet.

The CAP canal within the study reach includes eleven cross drainage structures. Each cross drainage structure is a group of multiple barrel culverts that convey local drainage over the canal from the upstream side (east side) to the downstream side (west side). The cross drainage structures, according to the Bureau of Reclamation drainage analysis, were designed to convey the 100-year storm event. **Appendix B** includes the as-built plans of the CAP canal and data regarding the CAP canal cross drainage structures.

8.0 Dambreak/Hydraulic Analysis and Methodology

The November 2005 KHA dambreak report provides a detailed discussion of the dambreak hydraulic analyses and methodology used to prepare the dambreak study. The report discusses the model requirements including cross section geometry, Manning's roughness coefficients, reach lengths, boundary conditions, and dam breach parameters. Cross section location maps were provided in the November 2005 report as well as a discussion of the determination of roughness coefficients based on land use type.

The November 2005 hydraulics models for each dam were used as the base models for this addendum study. No changes were made to the hydraulic models from the November 2005 study regarding the physical representation of the dam embankments and cross section geometry. Changes were made to the base models by adding the CAP embankment in the geometry files through the use of the in-line structure editor. The CAP embankment was located between cross sections 8.391 and 8.292 in the Apache Junction FRS models and between cross sections 8.965 and 8.90 in the Signal Butte FRS models. Further discussion of the approach for modeling the CAP embankment is provided in Sections 8.1 and 8.2 below.

8.1 CAP Embankment

Kimley-Horn collected the as-built plans of the CAP canal for Reach 1B of the canal. For this addendum study this portion of the CAP system extends from University Drive to US 60 in the City of Mesa. The as-built plans were provided in the form of Tiff images by the CAP. Due to the nature of the quality of the images it could not be determined if a canal bank profile was included on the plan and profile sheets. Therefore, KHA computed the canal embankment profile and elevations using the canal inverts, canal slope, canal lining height, and freeboard. A profile of the computed canal bank is provided in **Appendix B**.

KHA also used the BOSS River Mechanics System (RMS) software to cut a profile of the crest of the upstream embankment to the canal. This profile is also plotted in **Appendix B**. Note that profile is oriented looking upstream from north to south (left to right). The plot also includes the canal invert profile from the as-built plans. The crest profiles from the as-built plans and the cut profile (using the two-foot contour mapping developed for this dambreak study) appear to generally be in agreement.

The CAP canal profile used in this addendum study was based on the RMS cut profile and smoothed by KHA to represent a gradual transition in elevations. **Appendix B** also includes the smoothed profile. The CAP embankment profile was added to the dambreak models for each dam using the in-line structure option of the geometry editor. The in-line structure editor requires designating a river mile where the canal embankment is located plus embankment geometry and weir coefficient data. The geometry data includes the weir profile as well as the top of weir width and embankment side slopes. The top of weir (or embankment) and embankment side slopes are used by the HEC-RAS program for graphical plotting purposes.

A. Embankment Weir Coefficient. Kimley-Horn reviewed the "Handbook of Hydraulics" by Brater and King which provides a discussion of weir coefficients for broad-crested weirs. Weir coefficients have been developed based on laboratory data which is used to relate the discharge over the weir to the hydraulic head acting on the weir. Laboratory results indicate that the weir coefficient ranges from 3.07 to 2.63 for broad-crested weirs. Brater and King provide a weir coefficient table which is based on the breadth of the weir crest and head acting over the weir. The breadth of the upstream CAP canal embankment from as-built drawings is on the order of 12 – 15 feet. The results for the addendum for Apache Junction indicate the hydraulic head over the upstream CAP canal embankment to be on the order of 0.4 feet, 1.2 feet, and 1.5 feet for the sunny day, empty pool, and full pool scenarios (for a weir coefficient of 2.65). The hydraulic head over the upstream CAP canal embankment for Signal Butte is on the order of 1.7 feet, 2.1 feet, and 2.5 feet for the sunny day, empty pool, and full pool scenarios. The Brater and King table indicates that a weir coefficient on the order of 2.63 to 2.67 is appropriate for a weir breadth of 15 feet and the above hydraulic heads. A review of ADWR discussion of weir coefficients in an unpublished paper prepared by John Linkswiler supports the use of this range of weir coefficients for the CAP embankment. KHA also reviewed the HEC-RAS hydraulics and user's manual for weir coefficients for broad-crested weirs. The manuals recommend a range of weir coefficients of 2.6 to 4.0 depending on the type of weir. The manual recommends a 2.6 coefficient for flow over bridge decks and 3.0 for flow over elevated roadway approach embankments. From review of the above literature a value of 3.0 would over estimate the hydraulic efficiency of the CAP canal embankment compared to a paved roadway embankment. The value used in the addendum study is 2.65 which is within the range of the 2.63 to 2.67 recommended by Brater and King.

Kimley-Horn also conducted a limited sensitivity analysis for the CAP embankment weir coefficient. Model runs were conducted for weir coefficients of 2.60, 2.65, and 3.0 for each dam and for each modeling scenario (full pool, empty pool, and sunny day). The 2005 dambreak and 2006 dambreak addendum used a weir coefficient of 2.60. The results of the sensitivity analysis indicated that the change in flow over the CAP embankment increased approximately by 100 cfs or less in all cases. Therefore, the results indicate that the change in weir coefficient was not very sensitive. In order to be within the range recommended by Brater and King, KHA used for the addendum a weir coefficient of 2.65.

8.2 CAP Embankment In-Line Gates

An in-line flood gate was provided by KHA as part of the geometric description and modeling operations for the CAP embankment. The unsteady flow option of HEC-RAS requires flow at

all cross sections during the initial warm-up conditions. A structure, such as a dam or in-line structure, blocks channel flow and thus the requirement for maintaining a "wet" model in the initial condition cannot be met. HEC-RAS provides an option to allow flow "through" the embankment with very minor impact on the outcome of the study. An approach to satisfy this requirement is to add a gate in the canal embankment. An in-line gate was entered into the geometric description of the CAP embankment (in-line structure) using the geometric editor.

The in-line gate for the CAP embankment was modeled as a 4-foot high by 150-foot wide rectangular gate for both the Apache Junction FRS and Signal Butte FRS HEC-RAS unsteady flow models. The gate was allowed to remain open during model initialization. The geometry (size) of the gate was determined initially to pass the initial condition flow without hydraulic impacts. The final gate size was determined through multiple iterations of the model and assurance of flow downstream of the CAP canal for model requirements.

The unsteady flow option of HEC-RAS requires a time series in the unsteady flow editor to define the operating conditions for the gate. The time series entered for the gate was to assume that the gate was open initially and closed over time as the dambreak floodwave approached the CAP canal embankment and began to fill the "impoundment" area upstream of the canal. The gate was gradually closed so that flow would continue in the downstream inundation area to satisfy the modeling conditions. The gate was closed at a time before the peak of the dambreak floodwave approached the CAP canal. The time series for the gate was dependent on the modeling scenario for each dambreak model. **Appendix B** provides a graph of the time series of the gate for each dam for each modeling scenario.

8.3 Model Scenario No. 1 – Empty Pool

The Empty Pool Model Scenario routes the 6-hour PMF through each dam under the conditions of an empty impoundment (no pool). This scenario follows the guidelines published by ADWR (ADWR, March 2004) which allow the analysis to start with initial conditions of an empty pool.

8.3.1 Boundary and Initial Conditions

The dynamic routing option of HEC-RAS requires the input of unsteady flow data (inflow hydrographs). The unsteady flow data may be entered as upstream and downstream boundary conditions as well as lateral inflow hydrographs. The model requires boundary conditions at all the external boundaries of the model system, as well as any desired internal locations, and setting the initial flow and storage area conditions at the beginning of simulation.

A flow hydrograph was selected as the upstream boundary condition for both dams. The upstream hydrograph boundary condition for the dambreak analysis for the empty pool and full pool model scenarios was the 6-hr PMF hydrograph. For the sunny day model scenario, it is assumed that no inflow occurs into the reservoir pool; however, the pool is initially full to an elevation of the emergency spillway crest elevation. HEC-RAS requires an upstream boundary condition, thus a small low-flow steady hydrograph was selected for the sunny day scenario to satisfy model requirements and model stability. The upstream hydrographs for Apache Junction FRS was a steady 1000 cfs and for Signal Butte FRS was a steady 2000 cfs. In the 2005

dambreak study the upstream hydrograph for the sunny day scenario for Apache Junction FRS was 500 cfs. The flow was increased in this addendum study to 1000 cfs as the 1000 cfs appears to provide better model stability compared to the 500 cfs.

The unsteady flow option of HEC-RAS requires that initial conditions also be specified. Initial conditions establish the flow and stage at all nodes in the model system at the beginning of the simulation. Initial conditions are used to "warm up" the model and to have the program perform a steady flow backwater run to compute corresponding stages at each cross section. The initial condition flow for Apache Junction FRS was increased from 500 cfs (in the 2005 dambreak study) to 1000 cfs for the same reasoning provided in the previous paragraph for the upstream boundary condition. For the Signal Butte FRS, the initial condition flow was reduced to 2000 cfs from 2031 cfs (in the 2005 dambreak study) for the empty pool and full pool scenario. The drop was completed to round down the initial flow used and as a result the reduction in initial flow did not appear to cause any model instability. No other changes were made to the 2005 dambreak models regarding initial water surface elevations, water surface elevation for initiation of breach formation, and other breach parameters.

8.4 Model Scenario No. 2 – Full Pool

The Full Pool Model Scenario routes the 6-hour PMF through both dams under the conditions of an assumed initial conditions of a full impoundment. This scenario simulates "back-to-back" storm events. The same model conditions described for the Empty Pool were applied to the Full Pool Model Scenario except for the condition of an initial full impoundment.

8.5 Model Scenario No. 3 - Sunny Day

In the sunny day model scenario the initial pool elevation is set approximately at the emergency spillway crest for Signal Butte FRS and Apache Junction FRS. Breach parameters are the same as in the first two model scenarios except the water surface elevation at the initiation of breach was set just above the emergency spillway elevations. This scenario assumes a full pool resulting from a previous flood event but no subsequent inflow event. There is no flood inflow, only a "static" full pool. This model scenario is known as the sunny day failure. The sunny day failure assumes a breach of the dam under non-hydrologic inflow conditions or after the hydrologic event has occurred.

There was one minor change in the addendum model from the 2005 dambreak model for Apache Junction sunny day scenario. The time for triggering the breach initiation was changed from 2 minutes into the simulation to 15 minutes into the simulation.

9.0 Dambreak Results

The cross section water surface elevations in the downstream inundation reach were computed and well as channel velocities and hydraulic depths for each modeling scenario for each dam. Arrival times were derived for the maximum stage based on time zero being the peak flow through the breach. Flow arrival times are included on the inundation exhibit maps in **Appendix C**. The time in hours for the peak of the floodwave to reach the downstream end of the

inundation reach for the Apache Junction FRS dambreak is 4.7 hours, 4.3 hours, and 8.1 hours for the Empty Pool, Full Pool, and Sunny Day scenarios, respectively. The time in hours for the peak of the floodwave to reach the downstream end of the inundation reach for the Signal Butte FRS dambreak is 3.1 hours, 2.4 hours, and 3.2 hours for the Empty Pool, Full Pool, and Sunny Day scenarios, respectively.

The Apache Junction FRS dambreak flood elevations, flow velocities, and depths of channel flow are summarized in **Tables 1, 2,** and **3** for the Empty Pool, Full Pool, and Sunny Day scenario, respectively. The Signal Butte FRS dambreak flood elevations, flow velocities, and depths of channel flow are summarized in **Tables 4, 5,** and **6** for the Empty Pool, Full Pool, and Sunny Day scenario, respectively. Results are not reported in the following tables for interpolated cross sections. Detailed model output is provided as electronic format in the enclosed compact disk as part of this report (see pocket in back of report). A series of dambreak and downstream routing hydrographs are provided in **Figures 1** through **4** for Apache Junction FRS and **Figures 5** through **6** for Signal Butte FRS.

Kimley-Horn and Associates, Inc.

Table 1. Dambreak Summary Table Apache Junction FRS (Empty Pool – NAVD88).

(CAP canal is located between section 8.391 and section 8.292; yellow highlight indicates maximum value for parameter in downstream reach)

HEC-RAS Section No.	Total Flow (cfs)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Cross Section Velocity (ft/s)	Top Width (ft)	Hydraulic Depth (ft)
13.580	23,401	1840.77	9.6	3.5	5,171	1.3
13.459	23,381	1830.72	9.7	4.0	4,468	1.3
13.365	23,369	1821.77	6.4	3.4	4,671	1.5
13.286	23,355	1815.66	6.8	3.7	4,713	1.4
13.232	23,343	1810.57	5.3	3.4	6,570	1.1
13.163	8,695	1810.05	0.3	0.2	6,405	6.2
13.123	8,667	1810.05	0.2	0.1	6,401	10.6
13.092	8,625	1810.05	0.1	0.1	6,190	13.4
13.054	8,598	1810.05	0.1	0.1	5,940	16.4
12.998	8,566	1810.05	0.1	0.1	5,274	17.3
12.967	15,098	1790.04	10.4	10.1	1,430	1.0
12.932	21,796	1788.77	5.5	4.1	2,536	2.1
12.904	21,746	1786.83	8.6	4.7	2,386	2.0
12.866	21,681	1783.18	13.0	6.1	2,270	1.8
12.827	21,611	1780.61	5.0	3.3	5,455	1.2
12.743	21,503	1774.86	5.6	3.1	5,892	1.2
12.677	21,405	1769.44	5.5	3.1	4,528	1.5
12.550	21,247	1758.98	3.0	2.6	3,849	2.1
12.406	21,173	1750.81	4.4	2.9	5,199	1.4
12.270	21,098	1741.29	1.9	2.6	4,964	1.7
12.131	21,016	1732.64	4.1	2.9	6,225	1.2
12.019	20,949	1725.40	6.0	2.4	5,790	1.5
11.889	20,858	1718.91	7.4	2.7	5,695	1.4
11.723	20,731	1709.76	5.9	3.2	4,201	1.6
11.600	20,639	1702.30	4.3	3.0	6,072	1.1
11.466	20,533	1695.31	4.9	2.4	5,827	1.5
11.406	20,452	1691.55	5.3	2.0	6,922	1.5
11.270	20,323	1680.81	4.7	2.3	5,703	1.7
11.127	20,226	1671.19	4.9	2.4	6,267	1.3
10.817	20,005	1662.43	7.2	1.8	8,240	1.4
10.569	19,714	1652.30	7.6	1.7	7,391	1.5
10.392	19,443	1645.46	5.2	1.6	8,049	1.5
10.112	19,128	1635.55	7.9	1.9	6,728	1.5
9.944	18,860	1626.72	3.3	1.5	6,672	1.9
9.760	18,629	1618.66	7.1	2.1	5,809	1.5
9.528	18,508	1608.45	3.6	3.1	5,498	1.1
9.313	18,381	1600.89	4.0	3.0	4,239	1.4
8.967	17,937	1591.14	4.7	1.5	9,194	1.3
8.648	17,592	1579.54	7.1	1.5	8,351	1.5
8.391	12,342	1573.21	1.4	0.4	10,703	2.7
8.292	12,325	1566.04	5.9	1.6	5,726	1.4
8.206	12,212	1560.98	6.4	1.5	7,706	1.7
8.072	12,067	1554.36	6.7	1.8	8,373	0.9
7.940	11,997	1548.73	6.3	1.9	7,188	0.9
7.711	11,940	1539.26	4.4	2.3	4,351	1.3
7.431	11,842	1529.02	4.3	2.0	5,838	1.0
7.134	11,702	1520.86	4.9	2.4	4,359	1.1
6.959	11,575	1515.12	5.8	2.3	4,486	1.1
6.684	11,463	1506.63	6.1	2.8	2,707	1.5
6.443	11,320	1499.33	8.1	2.6	3,685	1.2
6.278	11,227	1493.37	5.3	2.4	3,315	1.4
6.121	11,110	1488.96	6.5	2.8	3,561	1.1
5.957	10,947	1483.06	7.3	2.5	3,904	1.1
5.783	10,761	1477.83	3.2	1.9	3,353	1.7
5.642	10,644	1473.69	4.1	1.8	3,331	1.8
5.471	10,425	1469.35	5.9	1.7	4,494	1.4
5.322	10,272	1463.71	7.2	2.2	3,082	1.5
5.000	9,827	1454.67	8.5	2.5	2,625	1.5

Table 2. Dambreak Summary Table for Apache Junction FRS (Full Pool – NAVD88).

(CAP canal is located between section 8.391 and section 8.292; yellow highlight indicates maximum value for parameter in downstream reach)

HEC-RAS Section No.	Total Flow (cfs)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Cross Section Velocity (ft/s)	Top Width (ft)	Hydraulic Depth (ft)
13.580	23,399	1840.77	9.6	3.5	5,171	1.3
13.459	23,380	1830.72	9.7	4.0	4,468	1.3
13.365	23,367	1821.77	6.4	3.4	4,671	1.5
13.286	23,352	1815.66	6.8	3.7	4,712	1.4
13.232	13,089	1812.12	1.1	0.7	7,283	2.4
13.163	13,009	1812.11	0.3	0.2	6,674	8.0
13.123	12,942	1812.11	0.2	0.2	6,421	12.6
13.092	12,870	1812.11	0.2	0.1	6,211	15.4
13.054	12,862	1812.11	0.2	0.1	5,978	18.4
12.998	12,737	1812.11	0.2	0.1	5,674	18.0
12.967	15,386	1790.04	10.6	10.3	1,431	1.1
12.932	28,569	1789.17	6.0	4.5	2,592	2.5
12.904	28,518	1787.21	9.2	5.1	2,472	2.3
12.866	28,452	1783.43	14.6	7.0	2,319	2.0
12.827	28,346	1780.87	5.4	3.6	5,601	1.4
12.743	28,138	1775.09	5.9	3.4	5,952	1.4
12.677	27,888	1769.73	5.8	3.4	4,686	1.8
12.550	27,463	1759.35	3.4	2.9	4,096	2.4
12.406	27,289	1751.05	4.8	3.2	5,275	1.6
12.270	27,159	1741.59	2.1	2.8	5,218	1.9
12.131	27,085	1732.89	4.4	3.1	6,561	1.4
12.019	26,995	1725.70	6.4	2.5	6,032	1.8
11.889	26,861	1719.23	7.8	2.8	5,939	1.6
11.723	26,562	1710.14	7.0	3.0	8,479	1.0
11.600	26,459	1702.55	4.6	3.1	6,244	1.4
11.466	26,320	1695.61	5.3	2.5	6,044	1.7
11.406	26,244	1691.82	5.7	2.2	7,220	1.7
11.270	26,110	1681.10	5.2	2.5	5,886	2.0
11.127	26,011	1671.47	5.3	2.6	6,395	1.6
10.817	25,817	1662.69	7.5	1.9	8,342	1.6
10.569	25,583	1652.60	7.9	1.9	7,419	1.8
10.392	25,326	1645.75	5.5	1.7	8,147	1.8
10.112	24,896	1635.86	8.2	2.0	6,973	1.8
9.944	24,637	1627.08	3.6	1.6	6,754	2.3
9.760	24,403	1618.99	7.5	2.3	6,274	1.7
9.528	24,255	1608.72	4.0	3.2	5,778	1.3
9.313	24,094	1601.25	4.4	3.2	4,476	1.7
8.967	23,532	1591.40	5.0	1.7	9,532	1.5
8.648	23,062	1579.83	7.4	1.6	8,796	1.7
8.391	17,262	1573.51	1.8	0.5	10,734	3.0
8.292	17,223	1566.46	6.3	1.7	6,099	1.8
8.206	17,042	1561.40	6.8	1.6	8,080	2.0
8.072	16,945	1554.63	7.0	1.9	8,544	1.2
7.940	16,855	1548.99	6.5	2.0	7,352	1.1
7.711	14,554	1539.64	3.8	2.1	4,472	1.7
7.431	16,589	1529.25	4.6	2.3	5,885	1.3
7.134	16,320	1521.20	5.3	2.6	4,796	1.3
6.959	16,118	1515.43	6.1	2.5	4,720	1.4
6.684	15,924	1507.03	6.5	3.1	3,052	1.7
6.443	15,723	1499.67	8.4	2.8	4,004	1.4
6.278	15,593	1493.75	5.6	2.6	3,460	1.7
6.121	15,463	1489.28	7.1	3.0	3,741	1.4
5.957	15,314	1483.41	7.7	2.6	4,228	1.4
5.783	15,063	1478.21	3.8	2.1	4,841	1.5
5.642	14,993	1474.12	4.8	2.0	4,787	1.6
5.471	14,635	1469.69	6.3	1.9	4,548	1.7
5.322	14,454	1464.18	8.0	2.3	3,936	1.6
5.000	13,779	1455.30	9.0	2.5	2,667	2.1

Kimley-Horn and Associates, Inc.

Table 3. Dambreak Summary Table for Apache Junction (Sunny Day – NAVD88).

(CAP canal is located between section 8.391 and section 8.292; yellow highlight indicates maximum value for parameter in downstream reach)

HEC-RAS Section No.	Total Flow (cfs)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Cross Section Velocity (ft/s)	Top Width (ft)	Hydraulic Depth (ft)
13.580	1,000	1837.45	4.9	2.8	378	1.0
13.459	1,010	1828.16	4.9	2.9	1,140	0.3
13.365	1,088	1820.15	4.2	1.8	3,099	0.2
13.286	1,140	1813.99	4.2	4.2	360	1.2
13.232	1,154	1808.37	2.3	2.3	1,157	0.4
13.163	1,012	1803.15	0.2	0.3	1,946	2.1
13.123	996	1803.15	0.1	0.0	6,223	3.8
13.092	992	1803.15	0.0	0.0	6,129	6.6
13.054	970	1803.15	0.0	0.0	5,881	9.7
12.998	931	1803.15	0.0	0.0	5,104	10.9
12.967	7,780	1789.43	5.9	5.9	367	6.6
12.932	7,729	1787.56	3.7	3.0	1,900	1.4
12.904	7,701	1785.71	6.8	3.5	1,856	1.2
12.866	7,680	1782.35	9.5	4.0	2,103	1.0
12.827	7,653	1779.48	3.3	3.3	1,665	1.4
12.743	7,480	1774.09	6.0	3.1	5,692	0.4
12.677	7,451	1768.64	4.4	2.2	4,093	0.8
12.550	7,417	1757.78	1.7	1.8	2,552	1.6
12.406	7,372	1749.94	2.8	2.5	2,446	1.2
12.270	7,323	1740.36	1.5	1.9	4,189	0.9
12.131	7,273	1731.76	2.5	2.5	2,700	1.2
12.019	7,231	1724.47	4.8	1.9	5,052	0.8
11.889	7,167	1717.78	5.9	2.9	1,738	1.4
11.723	7,131	1708.71	4.3	2.7	3,161	0.8
11.600	7,108	1701.30	3.0	2.5	2,861	1.0
11.466	7,073	1694.37	3.7	2.0	5,151	0.7
11.406	7,044	1690.69	4.1	1.6	5,995	0.8
11.270	7,000	1679.75	2.9	1.8	3,183	1.3
11.127	6,951	1670.33	3.7	2.2	5,873	0.6
10.817	6,877	1661.30	5.2	1.5	4,247	1.1
10.569	6,802	1651.22	6.2	1.3	4,699	1.1
10.392	6,699	1644.65	4.2	1.1	7,775	0.8
10.112	6,552	1634.63	6.8	1.5	6,001	0.7
9.944	6,357	1625.58	2.1	1.0	4,478	1.4
9.760	6,238	1617.36	5.2	1.8	2,794	1.2
9.528	6,204	1607.54	2.6	2.6	2,441	1.0
9.313	6,179	1599.77	2.8	2.8	1,708	1.3
8.967	5,990	1590.41	3.6	1.1	8,220	0.7
8.648	5,837	1578.74	5.9	1.0	7,190	0.8
8.391	2,660	1572.45	0.4	0.1	10,621	1.9
8.292	2,637	1564.55	3.8	1.2	3,161	0.7
8.206	2,575	1559.18	3.9	1.1	4,516	1.3
8.072	2,409	1552.75	4.3	1.9	2,498	0.8
7.940	2,359	1547.15	4.0	2.5	637	2.7
7.711	2,310	1538.36	3.9	1.3	4,064	0.5
7.431	2,282	1528.33	3.4	1.1	5,688	0.4
7.134	2,260	1519.12	3.8	2.9	871	1.2
6.959	2,239	1514.01	5.1	3.6	3,403	0.2
6.684	2,228	1504.81	4.6	2.1	1,151	0.9
6.443	2,204	1498.27	5.6	2.2	2,723	0.4
6.278	2,198	1491.94	4.4	4.4	190	2.6
6.121	2,189	1487.11	4.8	4.4	377	1.8
5.957	2,139	1481.44	4.0	3.5	1,386	2.8
5.783	2,126	1476.68	2.4	1.1	2,903	0.7
5.642	2,117	1472.20	3.3	1.3	2,436	0.7
5.471	2,108	1468.38	4.7	1.1	4,339	0.4
5.322	2,103	1461.81	5.5	5.5	99	3.8
5.000	2,102	1451.38	6.2	4.1	239	2.1

Kimley-Horn and Associates, Inc.

Table 4. Dambreak Summary Table Signal Butte FRS (Empty Pool – NAVD88).

(CAP canal is located between section 8.965 and section 8.90; yellow highlight indicates maximum value for parameter in downstream reach)

HEC-RAS Section No.	Total Flow (cfs)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Cross Section Velocity (ft/s)	Top Width (ft)	Hydraulic Depth (ft)
11.804	8,355	1721.05	1.6	0.7	2,944	3.9
11.803	8,354	1721.05	1.6	0.7	2,944	3.9
11.753	8,363	1721.05	0.8	0.4	3,683	6.5
11.693	8,333	1721.05	0.5	0.2	4,571	8.3
11.653	8,322	1721.05	0.3	0.2	4,361	12.0
11.585	8,261	1721.05	0.2	0.1	4,722	15.7
11.561	8,250	1721.05	0.2	0.1	4,717	17.2
11.506	8,227	1721.05	0.1	0.1	4,808	21.3
11.417	8,215	1721.05	0.1	0.1	4,840	21.3
11.401	8,212	1721.05	0.1	0.1	4,852	20.7
11.353	43,581	1692.75	9.2	5.5	3,284	2.4
11.332	43,167	1691.21	8.3	4.8	3,377	2.7
11.313	42,890	1689.88	8.7	5.2	2,833	2.9
11.265	42,495	1687.13	7.5	4.9	3,076	2.8
11.231	42,133	1685.27	7.3	4.7	3,214	2.8
11.178	41,236	1682.46	7.1	4.1	3,786	2.7
11.048	39,963	1676.42	6.8	4.9	2,836	2.9
10.966	38,851	1672.56	9.2	5.0	4,695	1.7
10.821	37,649	1663.44	5.7	3.2	5,686	2.1
10.708	37,073	1657.51	6.1	3.5	4,816	2.2
10.629	36,639	1653.33	4.1	2.6	5,237	2.7
10.483	36,098	1647.12	6.1	2.3	7,466	2.1
10.360	35,986	1642.68	8.6	2.8	6,378	2.0
10.170	35,863	1634.66	5.2	2.6	5,421	2.5
10.083	35,839	1631.06	4.8	2.5	6,507	2.2
9.983	35,728	1626.67	4.9	2.2	6,218	2.6
9.901	35,591	1623.34	6.1	2.1	6,394	2.7
9.810	35,488	1619.10	7.7	2.2	6,415	2.5
9.659	35,341	1611.99	6.2	2.6	5,343	2.5
9.599	35,210	1607.80	6.6	1.9	7,037	2.6
9.466	34,733	1602.22	6.3	1.9	7,994	2.2
9.280	34,450	1592.57	7.7	2.0	8,499	2.1
9.154	34,273	1585.33	5.7	2.3	8,639	1.7
9.076	33,970	1579.52	5.8	2.6	5,895	2.2
8.996	33,706	1575.94	6.3	2.8	4,339	2.7
8.965	32,935	1574.14	1.1	0.7	9,812	5.2
8.900	32,711	1565.19	4.5	4.4	3,275	3.7
8.612	32,367	1559.67	5.5	2.1	8,364	1.9
8.417	31,897	1551.27	5.7	1.9	9,079	1.8
8.201	31,338	1540.58	4.8	2.0	10,466	1.5
8.069	30,635	1534.08	6.7	2.6	9,035	1.3
7.983	30,530	1529.45	5.6	2.4	7,783	1.7
7.811	30,355	1520.67	5.3	2.3	10,806	1.2
7.602	30,109	1510.79	5.3	2.4	8,525	1.5
7.223	29,735	1501.91	5.8	2.4	8,025	1.6
6.847	29,256	1490.08	4.8	2.2	8,106	1.7
6.715	29,044	1482.49	3.7	2.7	6,824	1.6
6.586	28,713	1477.07	3.7	2.1	6,689	2.0
6.391	28,484	1472.69	6.0	2.2	5,999	2.2
6.276	28,279	1468.32	7.8	2.3	5,773	2.1
6.168	28,087	1463.36	5.9	2.3	5,604	2.2
6.064	27,881	1458.31	2.7	3.6	4,873	1.6
5.954	27,558	1455.15	5.1	2.2	5,236	2.4
5.836	27,359	1451.70	7.1	2.7	4,721	2.1
5.716	27,121	1446.01	7.6	2.8	4,983	1.9
5.505	26,083	1442.53	5.1	1.8	5,261	2.8
5.291	25,227	1436.29	9.4	1.9	4,751	2.8
5.205	24,860	1432.77	8.8	2.2	4,370	2.6
5.072	24,545	1428.29	10.4	2.8	3,620	2.4
5.000	24,424	1425.73	8.0	2.5	3,569	2.8

Kimley-Horn and Associates, Inc.

Table 5. Dambreak Summary Table Signal Butte FRS (Full Pool – NAVD88)

(CAP canal is located between section 8.965 and section 8.90; yellow highlight indicates maximum value for parameter in downstream reach)

HEC-RAS Section No.	Total Flow (cfs)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Cross Section Velocity (ft/s)	Top Width (ft)	Hydraulic Depth (ft)
11.804	15,275	1725.06	1.4	0.6	3,727	6.7
11.803	15,285	1725.06	1.4	0.6	3,727	6.7
11.753	15,268	1725.06	0.8	0.4	4,534	8.8
11.693	15,224	1725.06	0.5	0.3	4,930	11.5
11.653	15,176	1725.06	0.4	0.2	4,888	14.5
11.585	15,145	1725.06	0.3	0.2	4,886	19.1
11.561	15,137	1725.06	0.3	0.2	4,801	20.8
11.506	15,047	1725.06	0.2	0.1	4,911	24.8
11.417	15,024	1725.06	0.2	0.1	5,049	24.4
11.401	15,018	1725.06	0.2	0.1	5,252	23.0
11.353	62,833	1693.43	10.0	6.2	3,405	3.0
11.332	62,478	1691.96	9.1	5.4	3,668	3.2
11.313	62,196	1690.58	10.2	5.9	3,483	3.0
11.265	61,527	1687.95	8.4	5.5	3,340	3.4
11.231	61,065	1686.16	8.5	5.1	3,796	3.2
11.178	60,547	1683.23	7.7	4.7	3,851	3.4
11.048	58,993	1677.43	7.4	5.3	3,005	3.7
10.966	57,508	1673.27	9.8	5.1	5,018	2.3
10.821	56,093	1664.09	6.7	3.6	6,731	2.3
10.708	55,345	1658.26	7.1	3.8	5,684	2.5
10.629	54,591	1654.14	5.4	3.0	6,409	2.9
10.483	53,692	1647.69	7.0	2.7	7,608	2.6
10.360	53,481	1643.35	9.2	3.1	6,580	2.6
10.170	52,845	1635.37	6.1	3.0	5,725	3.1
10.083	52,579	1631.69	5.6	2.8	6,678	2.8
9.983	52,006	1627.41	5.7	2.5	6,494	3.2
9.901	51,511	1624.09	7.1	2.4	7,309	3.0
9.810	51,232	1619.75	8.3	2.6	6,558	3.1
9.659	50,921	1612.53	6.9	2.8	6,614	2.8
9.599	50,605	1608.46	7.4	2.2	7,585	3.1
9.466	50,126	1602.79	6.9	2.2	8,066	2.8
9.280	49,540	1593.11	8.3	2.2	8,710	2.6
9.154	49,234	1585.81	6.4	2.6	8,955	2.1
9.076	48,729	1580.26	6.4	2.7	8,262	2.2
8.996	48,446	1576.58	7.6	3.2	5,602	2.7
8.965	47,682	1574.53	1.5	0.9	10,087	5.4
8.900	47,355	1565.94	5.5	5.3	3,924	4.3
8.612	46,925	1560.25	6.3	2.2	10,434	2.0
8.417	46,127	1551.79	6.3	2.1	9,345	2.3
8.201	45,769	1541.04	5.5	2.2	10,574	2.0
8.069	45,435	1534.69	6.9	2.6	9,609	1.8
7.983	45,230	1529.96	6.2	2.7	8,258	2.0
7.811	44,901	1521.20	5.3	2.4	10,998	1.7
7.602	44,417	1511.28	5.8	2.7	9,156	1.8
7.223	43,976	1502.37	6.5	2.5	11,364	1.6
6.847	43,275	1490.60	5.3	2.4	8,425	2.1
6.715	42,811	1483.03	4.3	2.9	7,133	2.0
6.586	42,206	1477.65	4.4	2.4	7,074	2.5
6.391	41,814	1473.31	6.6	2.5	6,330	2.7
6.276	41,540	1468.90	8.5	2.6	5,910	2.7
6.168	41,291	1463.93	6.9	2.6	5,670	2.8
6.064	41,026	1458.89	3.0	3.9	5,069	2.1
5.954	40,686	1455.84	6.1	2.5	5,283	3.1
5.836	40,467	1452.32	7.9	3.1	5,464	2.4
5.716	39,979	1446.64	7.8	3.1	5,185	2.5
5.505	38,655	1443.32	5.8	2.1	5,261	3.6
5.291	37,745	1437.18	9.9	2.2	4,751	3.7
5.205	37,244	1433.66	9.4	2.4	4,397	3.5
5.072	36,766	1429.33	11.0	2.9	3,921	3.3
5.000	36,665	1426.78	8.7	2.7	3,691	3.7

Kimley-Horn and Associates, Inc.

Table 6. Dambreak Summary Table Signal Butte FRS (Sunny Day – NAVD88).

(CAP canal is located between section 8.965 and section 8.90; yellow highlight indicates maximum value for parameter in downstream reach)

HEC-RAS Section No.	Total Flow (cfs)	Water Surface Elevation (ft)	Channel Velocity (ft/s)	Cross Section Velocity (ft/s)	Top Width (ft)	Hydraulic Depth (ft)
11.804	2,000	1717.51	0.7	0.6	841	4.4
11.803	1,941	1717.50	0.7	0.5	839	4.4
11.753	2,186	1717.44	0.4	0.2	2,808	4.3
11.693	2,129	1717.44	0.2	0.1	3,784	6.0
11.653	2,198	1717.43	0.1	0.1	3,895	9.6
11.585	2,000	1717.43	0.1	0.0	4,232	13.6
11.561	2,000	1717.43	0.1	0.0	4,471	14.3
11.506	2,000	1717.43	0.0	0.0	4,619	18.4
11.417	2,000	1717.43	0.0	0.0	4,697	18.3
11.401	1,999	1717.43	0.0	0.0	4,658	17.9
11.353	28,596	1692.00	7.9	5.2	2,233	2.5
11.332	28,368	1690.48	7.7	4.3	3,095	2.1
11.313	28,111	1689.02	8.1	4.8	2,540	2.3
11.265	27,712	1686.34	6.6	4.4	2,822	2.2
11.231	27,357	1684.52	6.5	4.1	2,973	2.2
11.178	27,251	1681.60	6.2	3.8	2,949	2.4
11.048	26,981	1675.52	6.1	4.6	2,303	2.6
10.966	26,647	1671.85	7.8	5.3	1,839	2.7
10.821	26,393	1662.97	5.1	2.9	5,514	1.6
10.708	26,271	1657.01	5.6	3.2	4,659	1.8
10.629	26,167	1652.77	3.4	2.3	4,916	2.3
10.483	25,983	1646.74	5.5	2.0	7,372	1.7
10.360	25,912	1642.16	8.4	2.7	6,219	1.6
10.170	25,657	1634.10	4.5	2.4	5,176	2.0
10.083	25,595	1630.59	4.2	2.2	6,380	1.8
9.983	25,480	1626.07	4.2	2.0	6,042	2.1
9.901	25,369	1622.76	5.5	1.9	6,068	2.2
9.810	25,273	1618.60	7.2	2.0	6,306	2.0
9.659	25,140	1611.50	5.4	2.3	5,267	2.1
9.599	25,067	1607.27	6.1	1.7	6,891	2.1
9.466	24,761	1601.61	5.5	1.8	6,474	2.1
9.280	24,450	1592.12	7.3	1.8	8,323	1.7
9.154	24,290	1584.87	5.5	2.2	8,305	1.3
9.076	24,057	1578.87	5.6	2.6	5,467	1.7
8.996	23,895	1575.37	5.6	2.5	4,096	2.3
8.965	23,095	1573.75	0.8	0.5	8,876	5.3
8.900	22,966	1564.51	3.8	3.8	2,685	3.1
8.612	22,777	1559.22	5.0	1.9	7,991	1.5
8.417	22,488	1550.87	5.2	1.7	8,876	1.5
8.201	21,704	1540.10	4.7	2.0	10,352	1.1
8.069	21,574	1533.54	4.9	2.5	4,386	2.0
7.983	21,517	1529.09	5.1	2.2	7,434	1.4
7.811	21,445	1520.07	7.1	3.2	10,586	0.6
7.602	21,232	1510.42	4.9	2.3	8,050	1.2
7.223	20,944	1501.56	5.3	2.1	7,486	1.3
6.847	20,628	1489.66	3.9	1.9	6,175	1.8
6.715	20,452	1482.06	3.2	2.6	6,580	1.2
6.586	20,241	1476.64	3.2	1.9	6,336	1.7
6.391	20,081	1472.22	5.5	2.0	5,750	1.8
6.276	19,943	1467.87	7.2	2.0	5,302	1.9
6.168	19,812	1462.93	5.2	2.0	5,559	1.8
6.064	19,701	1457.89	2.4	3.4	3,764	1.5
5.954	19,428	1454.63	4.2	2.0	5,112	1.9
5.836	19,279	1451.23	6.7	2.5	4,628	1.7
5.716	19,137	1445.57	7.4	2.6	4,837	1.6
5.505	18,300	1441.94	4.5	1.6	4,930	2.4
5.291	17,645	1435.51	8.3	1.8	3,937	2.5
5.205	17,348	1432.11	8.4	2.0	4,349	2.0
5.072	17,073	1427.51	9.8	2.8	3,424	1.8
5.000	16,919	1424.88	7.4	2.4	3,274	2.1

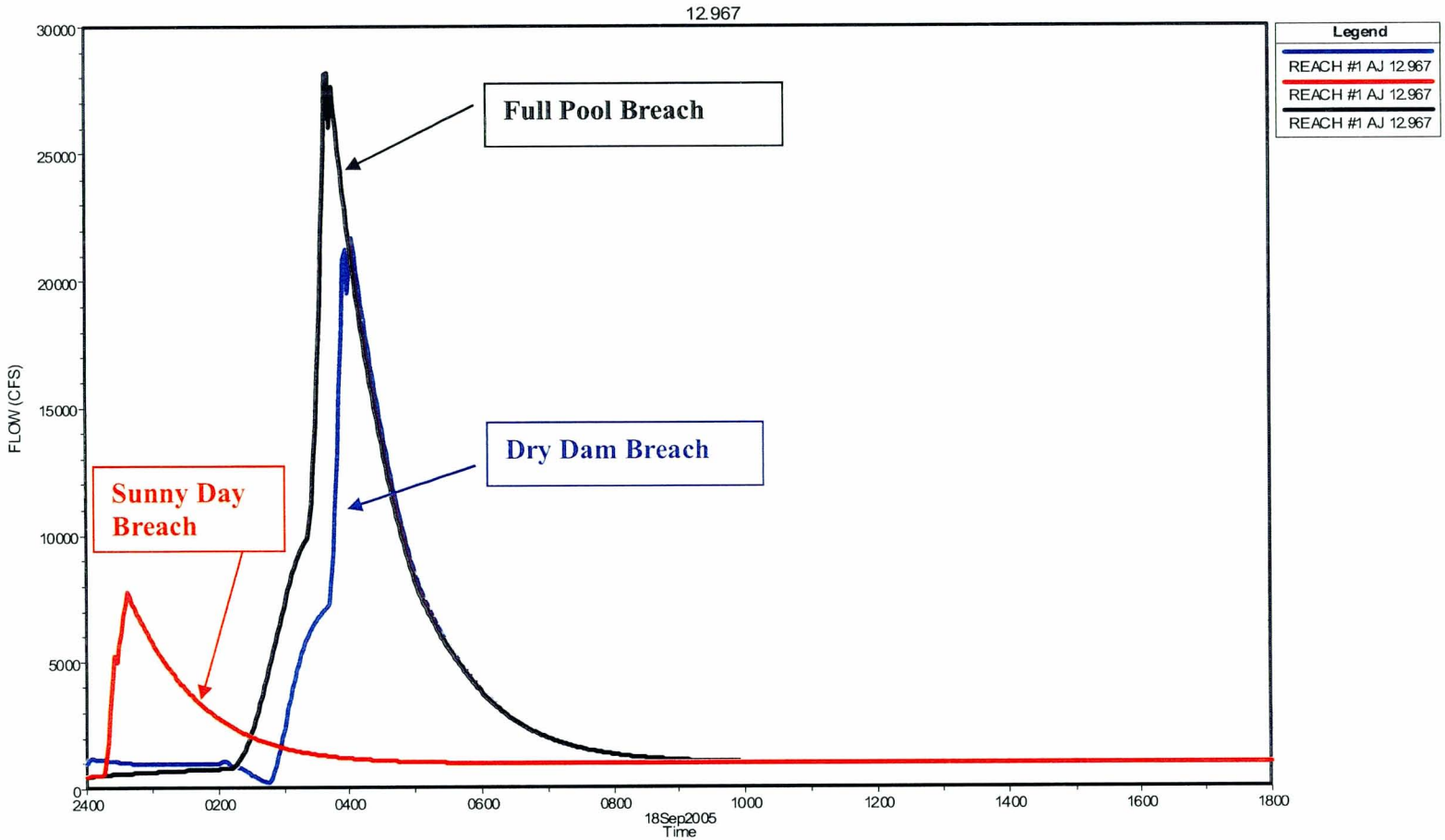


Figure 1. Breach Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS (Breach For All Three Scenarios).

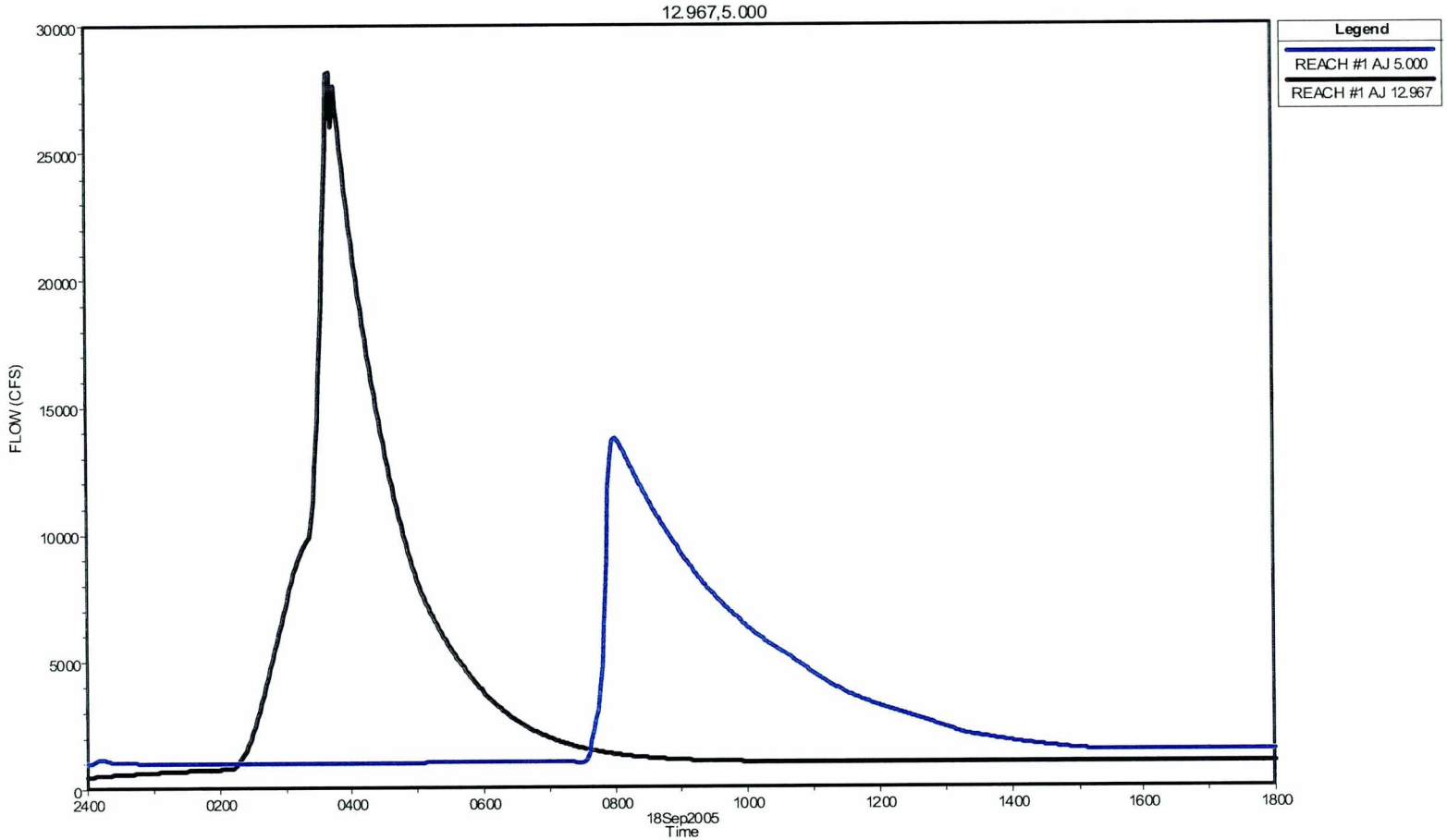


Figure 2. Flow Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Full Pool). Travel Time For Floodwave Peak Is Approximately 4.3 Hours.

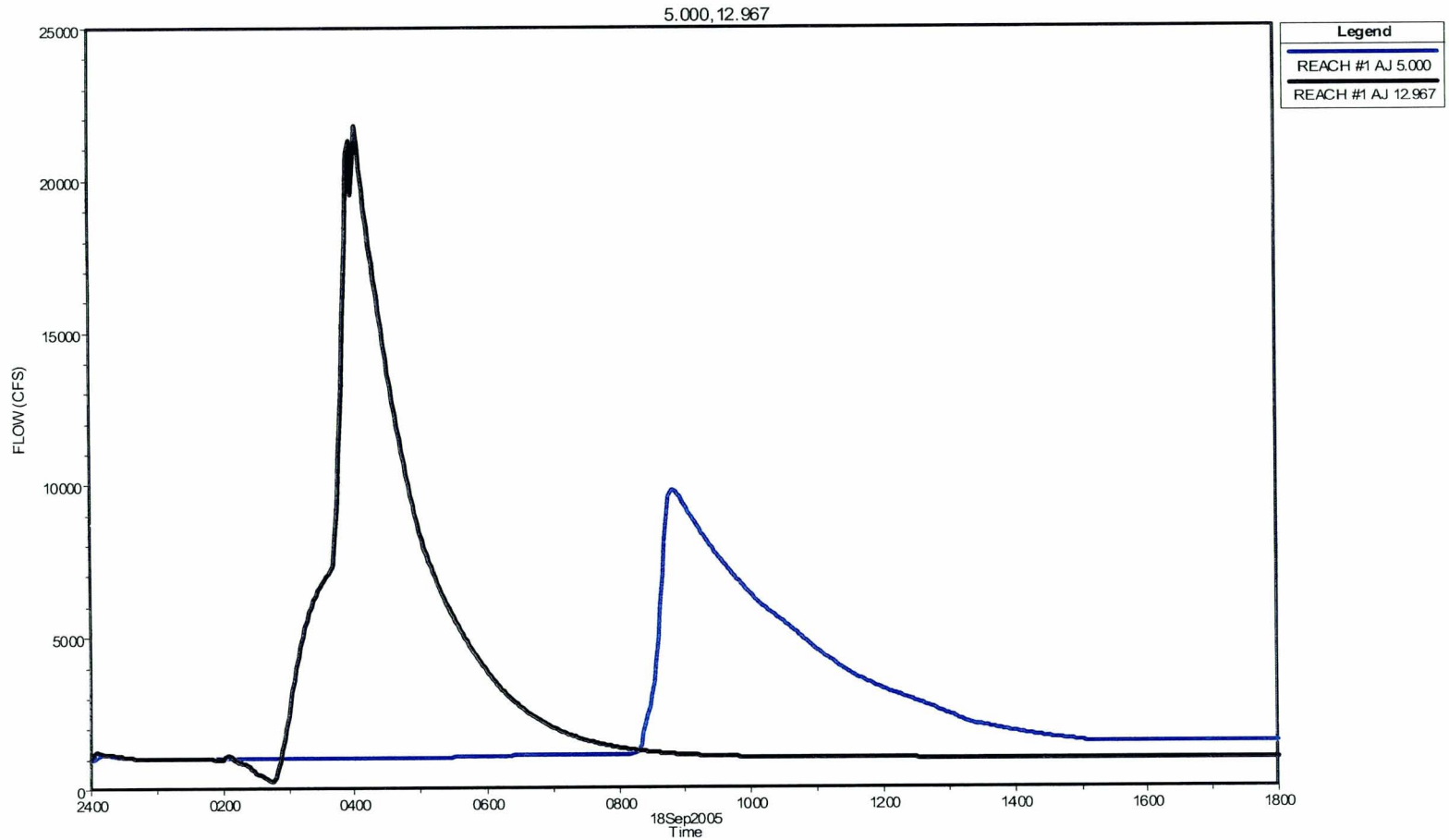


Figure 3. Flow Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Empty Pool). Travel Time For Floodwave Peak Is Approximately 4.7 Hours.

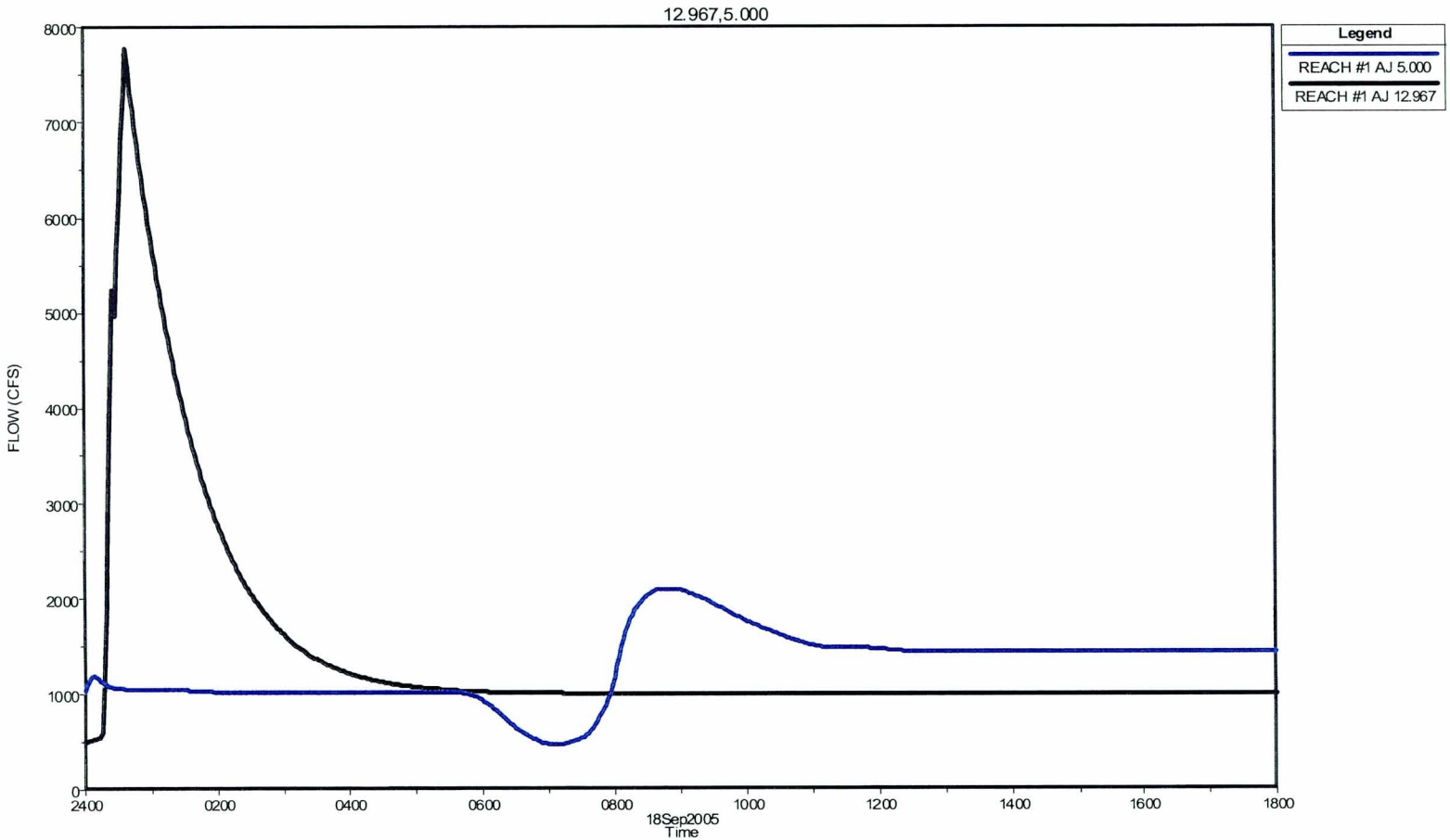


Figure 4. Flow Hydrographs At First Downstream Cross Section (12.967) From Apache Junction FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Sunny Day). Travel Time For Floodwave Peak Is Approximately 8.1 Hours.

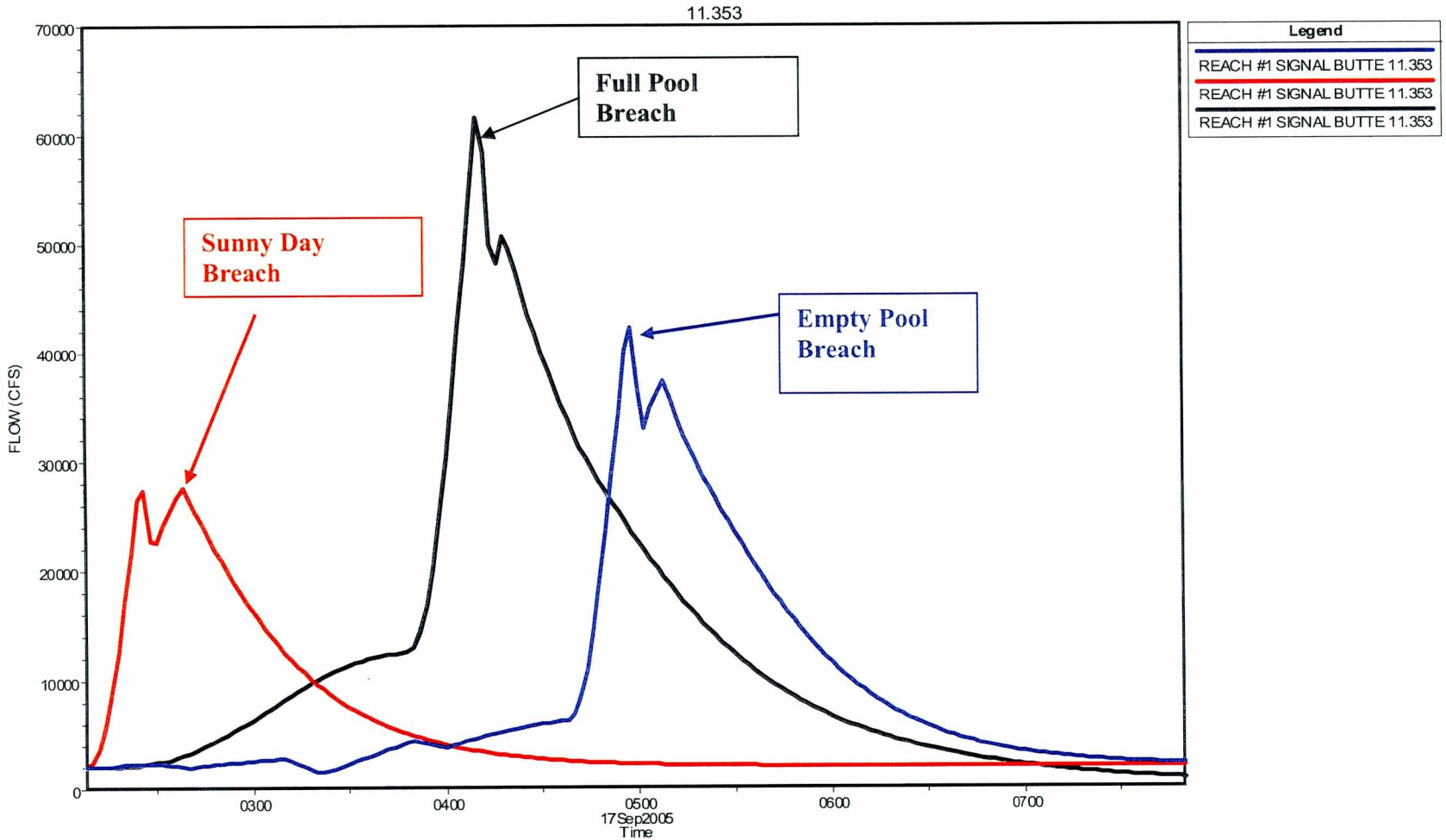


Figure 5. Breach Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS (Breach For All Three Scenarios).

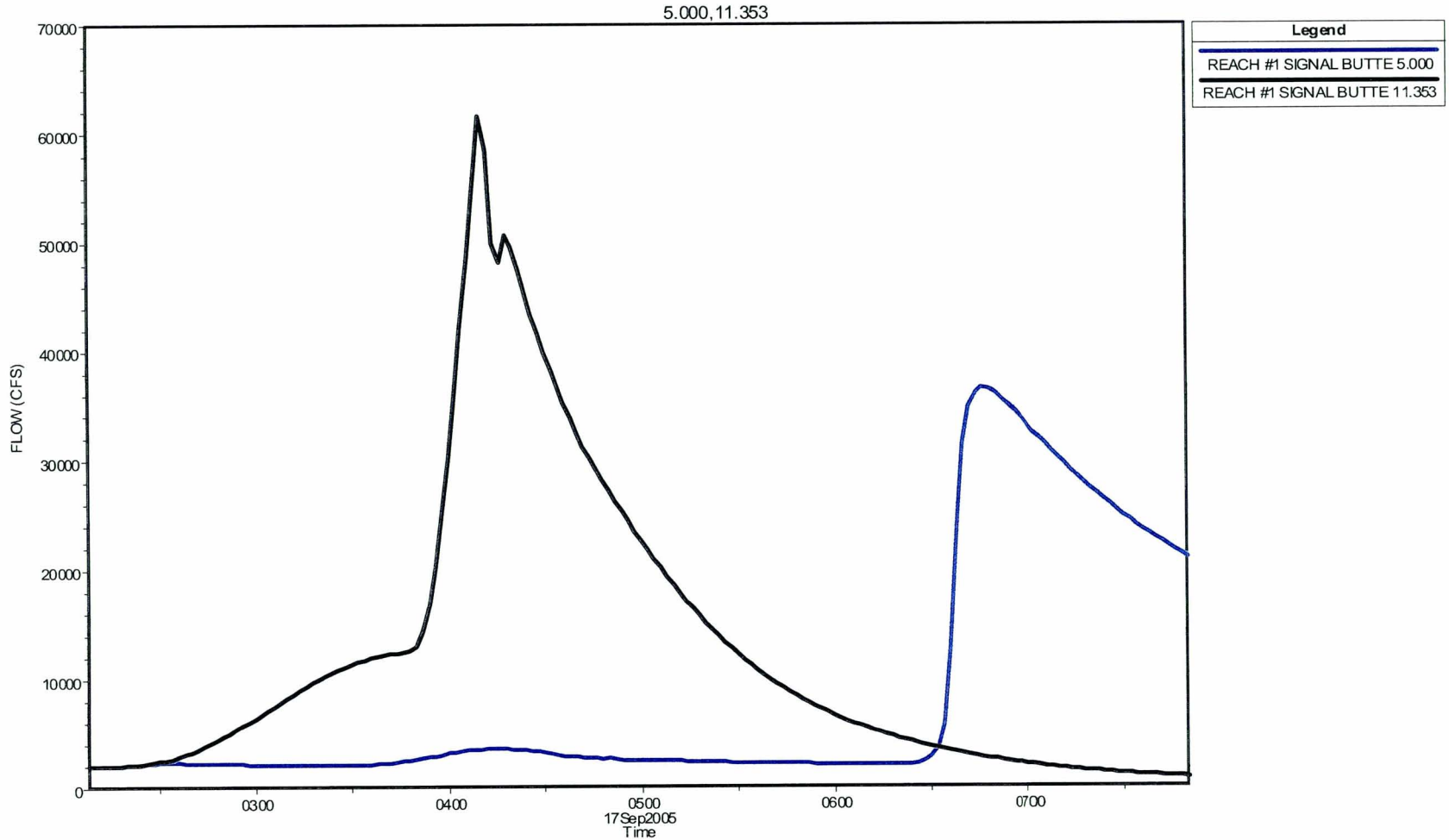


Figure 6. Flow Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Full Pool). Travel Time For Floodwave Peak Is Approximately 2.4 Hours.

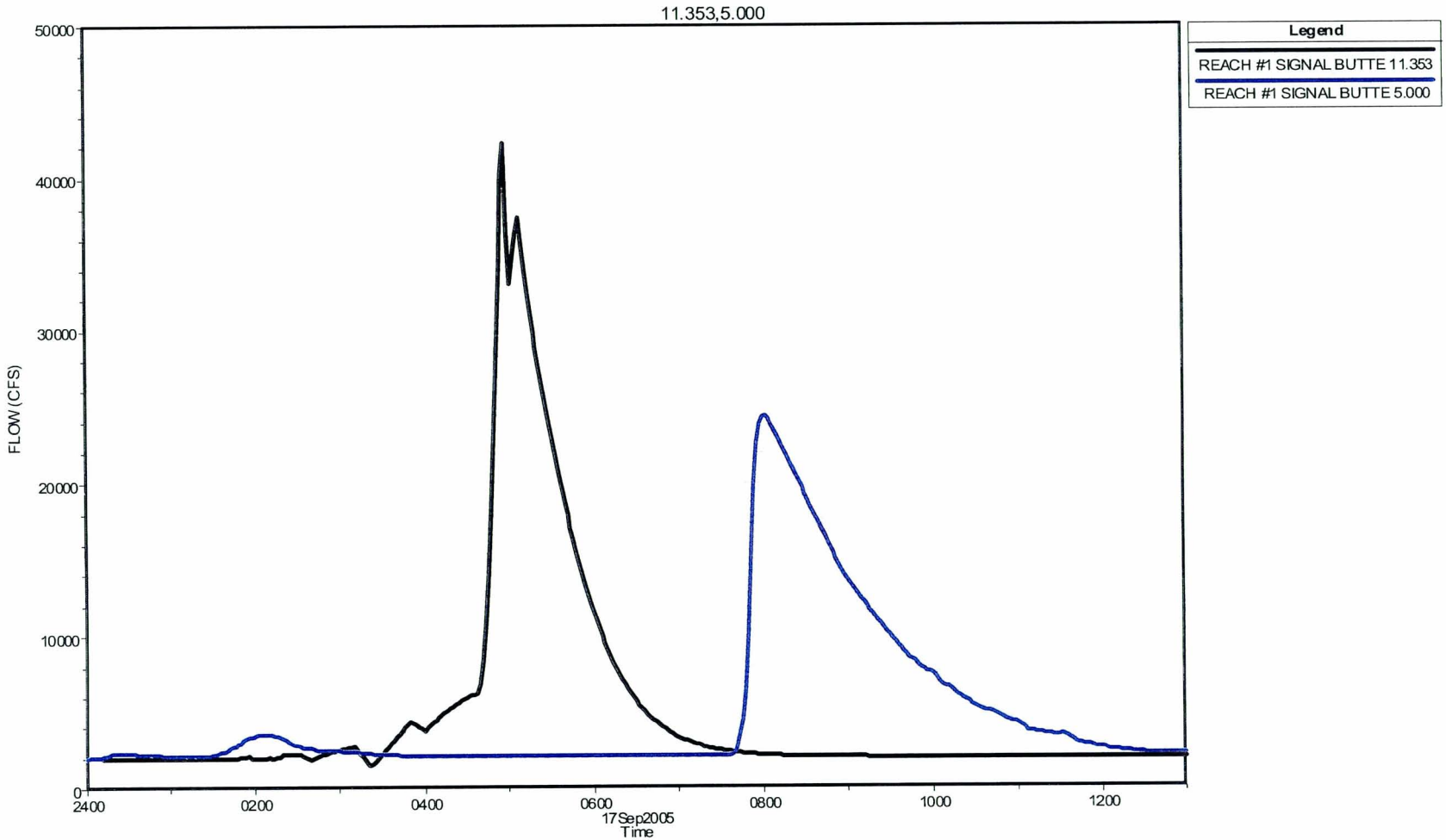


Figure 7. Flow Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Empty Pool). Travel Time For Floodwave Peak Is Approximately 3.1 Hours.

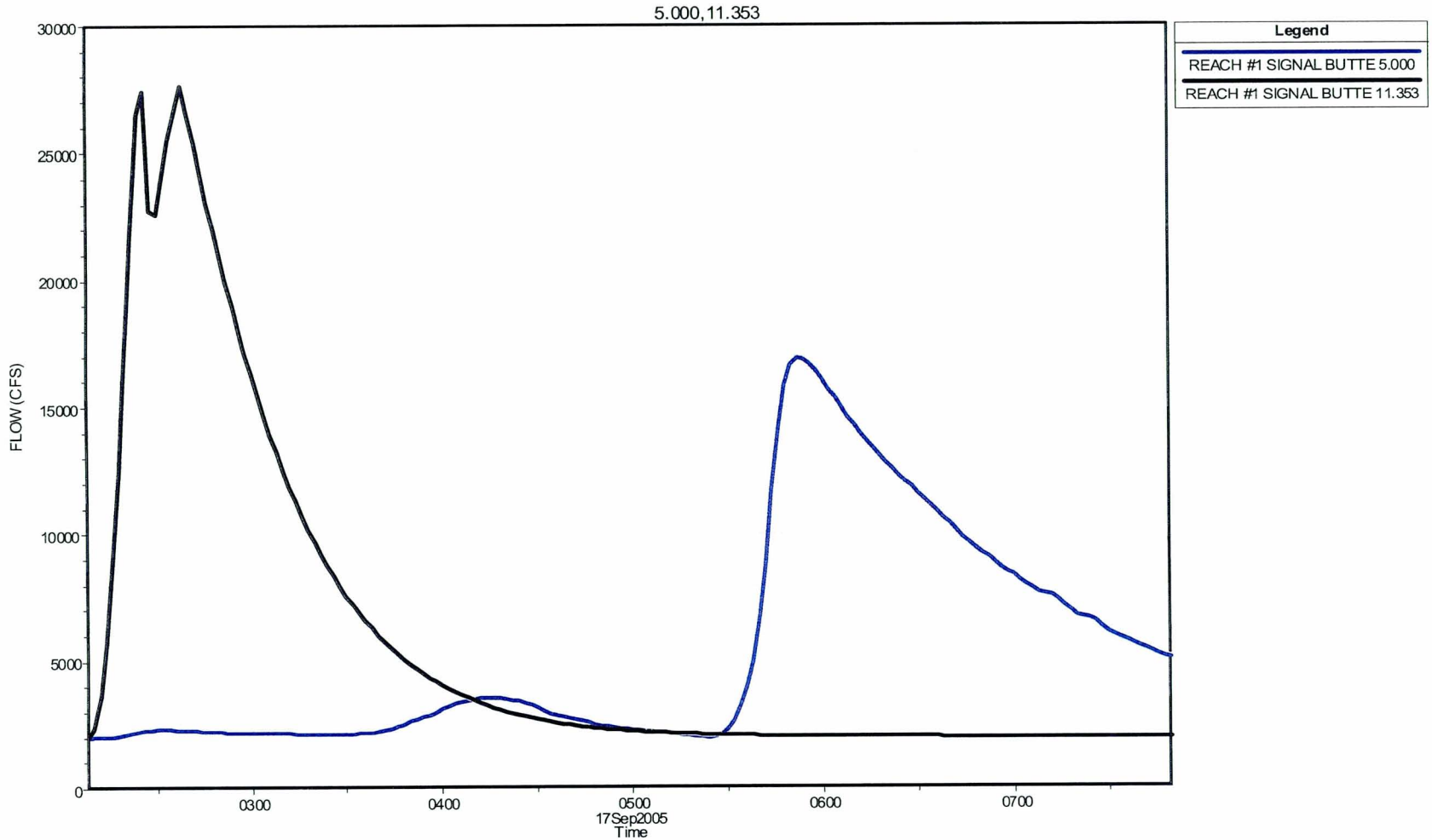


Figure 8. Flow Hydrographs At First Downstream Cross Section (11.353) From Signal Butte FRS And Last Cross Section (5.000) In Downstream Inundation Reach (Breach For Sunny Day). Travel Time For Floodwave Peak Is Approximately 3.2 Hours.

10.0 Discussion of Assumptions

This section of the report presents a discussion of the assumptions for the portions of the updated November 2005 dambreak study revised by this addendum study. A discussion of the dambreak assumptions is provided in Section 10 of the dambreak study of November 2005. Section 10 included discussion of the selection of breach parameters, lateral structure and in-line weir representation of the dams, selection of the appropriate failure mode, Manning's roughness coefficients, and the use of ineffective permanent areas, pilot channels, and in-line gates for the dams.

10.1 Downstream Flood Inundation Delineation

The delineation of the flooding limits in the downstream inundation areas as a result of the dambreak discharge hydrographs and the inclusion of the CAP embankment from the Empty Pool, Full Pool, and Sunny Day scenarios for both dams are provided in **Appendix C** (as **Exhibit C-1, C-2**, and **C-3**, for Apache Junction FRS and **Exhibit C-4, C-5**, and **C-6** for Signal Butte FRS). The inundation exhibits include hydraulic summary tables to be incorporated as part of the EAP report.

The downstream study limits for the dambreak and addendum study were determined during the scoping of a previous contract (FCD 2003C062. The limits were estimated by extending projections of the existing Natural Resources Conservation Service dambreak inundation limits for both Apache Junction FRS and Signal Butte FRS from the studies downstream to US 60.

A review of the routed floodwave hydrographs at the downstream limit of the study (HEC-RAS cross section 5.00) for Signal Butte FRS under all three scenarios indicates that the floodwaves could travel further downstream (west) past the downstream limits of the study. A review of the routed floodwave hydrograph at cross section 5.00 for Apache Junction for two of the three scenarios (full pool and empty pool) could extend further downstream as floodplain flow. The routed floodwave under the sunny day scenario for Apache Junction FRS appears to be contained in local drainage channels which includes the large ADOT channel on the north side of US 60. The inundation mapping in **Appendix C** provides a note indicating that the potential may occur for the dambreak floodwave to continue downstream beyond the current mapping limits.

10.2 Central Arizona Project Canal

The CAP canal traverses across the downstream inundation areas of both dams. The CAP canal location is shown on the map exhibits in **Appendix C**. The canal has eleven multi-barrel cross drainage structures within the study area. The structures convey stormwater flows ranging from local low flows to the 100-year local storm event from the east side of the canal and discharges into facilities on the west side of the canal. For the purposes of this addendum study the CAP cross drainage structures were not considered

due to the relatively small cumulative conveyance for flood magnitudes associated with a dambreak floodwave, especially under the full pool and empty pool scenarios.

It was assumed in this addendum study that the dambreak floodwaves overtop the canal under all three modeling scenarios for both dams. The results of this study indicate that this potential does exist, more so for the empty pool and full pool scenarios. The modeling approach assumed that the CAP embankment was a single earth structure (as compared to a three element facility: an upstream embankment, an excavated canal, and a downstream embankment). No accounting for storage by the canal was provided in this addendum study. It was assumed that the CAP canal prism would not provide substantial storage under the higher flood discharges for the full pool and empty pool scenarios. However, the CAP canal could provide storage for lower flood discharges such as the sunny day scenario for both dams.

The crest of the CAP canal embankment ranges in elevation from 1574 feet at the north end, 1572 feet within a middle portion, and then rises to 1578 feet at the south end. The higher canal embankment occurs at the downstream end of the CAP canal within the study area at the location of the canal's crossing of the US 60 freeway. If flows were to overtop the upstream canal embankment those flows would spill into the CAP canal and fill the available freeboard volume. The CAP canal could continue to fill under large inflows until flows would overtop the downstream embankment at an elevation of approximately 1572 feet (it was assumed that the upstream and downstream canal embankments have the same crest profile). The eleven cross drainage structures would be operating and conveying flood flows.

11.0 Discussion and Comparison of Results

A summary of the hydraulic results of the unsteady flow dambreak models was provided in tabular form in **Tables 1** through **6** and in graphical form in **Figures 1** through **8** in **Section 9**. The hydraulic summary tables have been highlighted to indicate maximum values for the represented hydraulic parameters. Maximum velocities and peak discharges are generally located just downstream of each dam for each scenario. Maximum flood widths are on the order of 10,900 feet wide for Signal Butte FRS and 10,700 feet wide for Apache Junction FRS. **Figure 1** and **Figure 5** provide the breach hydrographs at the most adjacent downstream cross section of each dam for Apache Junction FRS and Signal Butte FRS, respectively.

The floodplain at the CAP canal crossing increased for the Signal Butte FRS under this addendum study compared to the November 2005 study. This increase in floodplain width is reflective of the storage provided upstream of the embankment and the CAP embankment profile. The storage resulted in attenuation of the dambreak floodwave. The CAP canal embankment impounds (provides storage) the dambreak floodwave for both dams under all three modeling scenarios. This storage results in attenuation of the peak discharges downstream of the CAP compared to the November 2005 results (without the CAP canal embankment). The degree of attenuation is greatest for Apache Junction FRS under the full pool scenario.

For this addendum study, the depth of overtopping of the canal embankment is less than 0.4 foot for the sunny day scenario for the Apache Junction FRS dambreak floodwave. The depth of overtopping for the empty pool and full pool scenario is 1.2 feet and 1.5 feet, respectively. The depth of overtopping for the dambreak floodwaves from Signal Butte FRS under the sunny day, empty pool, and full pool scenarios is 1.7 feet, 2.1 feet, and 2.5 feet, respectively. The depths of overtopping for the Signal Butte FRS dambreak floodwaves are greater than the Apache Junction FRS dambreak floodwaves was due to the fact that the peak discharges from the Signal Butte FRS dambreak hydrographs are greater than the peak discharges from the Apache Junction FRS dambreak hydrographs. The Signal Butte FRS also has a larger flood storage volume than the Apache Junction FRS which under dambreak conditions would result in larger volumes of floodwater coursing in the downstream direction. Finally, the Apache Junction FRS is located further upstream than Signal Butte FRS. The Apache Junction dambreak floodwaves will have attenuated to a relatively greater degree than the Signal Butte floodwaves by the time the floodwaves approach the CAP canal.

The flood inundation limits have been provided on the exhibits in **Appendix C**. The exhibits include hydraulic summary tables that include the arrival times for the floodwaves at various downstream locations.

The modeling approach to the CAP canal was to evaluate the impacts of the CAP canal on the routed dambreak floodwave. The CAP canal is overtopped from the routed dambreak floodwaves from both dams for all three scenarios. The depths of overtopping of the CAP embankment are the greatest for the full pool scenarios and the lowest for the sunny day scenarios. The CAP canal does attenuate the peak of the routed floodwave for the inundation area downstream of the CAP canal. The CAP canal also impounds water on the upstream canal embankment to the height of the routed water surface elevation. The depth of impoundment is greatest for the full pool scenarios: approximately 10.6 feet for Apache Junction FRS dambreak and 10.5 feet for the Signal Butte FRS dambreak. Water will evacuate from the impounded area by overtopping of the canal and by gradual release through the eleven cross drainage structures.

Study results (from the 2005 dambreak study and this addendum) for each dambreak scenario (empty pool, full pool, and sunny day) are compared using hydraulic summary tables that lists hydraulic variables for depths of flow at each reported cross section, dambreak routed maximum flow, floodwave time to peak, average cross section flow velocity, channel flow velocity, hydraulic depth of flow, and water surface elevations (NAVD88). The hydraulic summary tables are presented in **Appendix D** as **Tables D-1** through **D-7**. **Tables D-2** through **D-7** are a three part table listing the November 2005 study results at the top of the table, the addendum study results in the middle of the table, and the difference in parameter values between the two studies listed in the bottom of the table.

11.1 Depths of Flow

The November 2005 study reported dambreak floodwave depths of flow on the inundation exhibits based on the maximum depth in each cross section for each dambreak scenario. The maximum depth of flow in each cross section generally corresponded to flow in either local drainage channels or depth of water stored in detention basins. Maximum water depths were observed in the ADOT detention basins located along the north side of US 60 (Superstition Freeway). The reported depths of flow (from the HEC-RAS output as "maximum channel depth") in the November 2005 study were based on these local drainage facilities (which made the depths greater than those anticipated where development occurs on the floodplain).

Several of the reported maximum channel depths in the November 2005 study were also associated with pilot channels. The use of the pilot channels are discussed and explained in the 2005 study. Basically the pilot channels are fictitious earth cuts of 2-ft wide and 4 to 6-ft deep and implemented with the pilot channel editor of HEC-RAS. Pilot channels were used in the study for model stabilization during initial conditions warm-up. In the reaches where pilot channels are used, HEC-RAS reports channel depths based on the invert of the pilot channel (the invert of the pilot channel is lower than lowest existing grade). These reported depths are not the depths of flow on the floodplain where development exists. The correct depths of flow to report are discussed in the next paragraph.

This addendum study has documented dambreak floodwave depths of flow based on the depth of flow over the floodplain surface across each cross section (as opposed to depths in local drainage channels or detention basins or pilot channels). Selected cross sections were plotted with the water surface elevation for each dambreak scenario. The selected cross section plots (which provide the basis of the floodplain flow depths in **Tables D-2** through **D-7**) are presented in **Appendix D** for each dambreak study (Apache Junction FRS and Signal Butte FRS). The floodplain ground elevation was observed to be the lowest ground elevation not associated with a local drainage channel or ADOT detention basin. The depth of flow was then determined as the difference between the maximum water surface elevation for each dambreak scenario and the floodplain ground elevation (the floodplain ground elevation was determined from the plots in **Appendix D** and summarize in **Table D-1**). This resulted in lower depths of flow reported for each selected cross section compared to the November 2005 study. These reported depths of flow are those depths that would occur where development exists as opposed to the local drainage channels and the detention basins. **Table D-1A** and **D-1B** presents the floodplain depths and floodplain ground elevations observed from the cross section plots for Apache Junction FRS and Signal Butte FRS, respectively.

11.2 Routed Flows

The dambreak routed peak flow remained approximately unchanged when comparing the November 2005 study and this addendum study from each dam downstream to the CAP

canal for each dambreak scenario. The Tables in **Appendix D** provide a summary of the routed flows. The flows from just upstream of the CAP canal and downstream to the study limits are reduced in this addendum study. The CAP canal embankment results in an attenuating effect by temporarily storing floodwaters on the upstream side of the canal embankment. Dambreak floodwave flow ponds on the upstream side of the canal embankment until ponding reaches the minimum elevation of the canal embankment (1572 ft) upon which flow overtops the canal embankment. It was assumed in the addendum study that the canal embankment was a very wide weir as such no storage was included within the canal prism and the downstream canal embankment has the same profile as the upstream canal embankment.

11.3 Times to Peak

The dambreak floodwave time to peak increased for each modeling scenario for Apache Junction FRS. The increase in time to peak is a result of the storage of floodwaters upstream of the CAP embankment and the attenuating impacts on flood peaks. Apache Junction FRS floodwave times to peak increased from 0.4 to 0.5 hours for the empty pool scenario and 0.3 to 0.4 hours and 1.4 to 2.0 hours for the full pool and sunny day scenarios, respectively. Signal Butte FRS floodwave times to peak increased to 0.1 hours for a cross section and decreased to 0.2 hours downstream of the CAP for the empty pool scenario and no change and an increase from 0.2 to 0.3 hours for the full pool and sunny day scenarios, respectively.

11.4 Flood Elevations

Corresponding with a reduction in the flow and depths of flow in the addendum study (with CAP) compared to the November 2005 study (without CAP) downstream of the CAP was a reduction in flood elevations at the reported cross sections in **Tables D-2** through **D-7**. As anticipated, for each dambreak model, the water surface elevations increased at the CAP canal and just upstream of the CAP canal and decreased downstream of the CAP canal. An examination of the ponding depth on the upstream side of the CAP embankment from the full pool scenario for each dambreak indicated a ponding depth of 10.5 to 10.6 feet.

12.0 Recommendations for Local Flood Response

The following are recommendations for local jurisdictions to monitor the CAP canal and embankment during flood flows and from potential dambreaks from either the Apache Junction FRS or the Signal Butte FRS.

- Note that the cross drainage structures will flow first. This is an early warning indicator that flows could be impounded upstream of the canal.
- The low portion on the crest of the upstream canal embankment is approximately at elevation 1572 feet. This occurs within the middle third of the CAP embankment within the study area. This area of the CAP embankment should be

monitored during high flooding events as this portion of the CAP embankment will be the location where overtopping would occur first.

- Impounded water upstream of the CAP canal embankment will drain at a slower rate compared to the passage of the higher velocity dambreak floodwave. Access to the impounded area cannot occur until the floodwaters are drained through the CAP cross drainage structures.

13.0 Conclusions

The objective of this addendum was to evaluate the impacts of the CAP embankment on the dambreak floodwave for all three modeling scenarios for both dams and to estimate the upstream ponding levels due to the impoundment of floodwaters. The results of the modeling, based on the assumptions and modeling approach, indicate that the CAP embankment does attenuate the routed floodwave for both dams under all three scenarios. This was an anticipated observation. The results from the unsteady/dynamic models are reasonable for the downstream inundation reach and mapping.

APPENDIX A

Addendum to Dambreak Study for
Apache Junction FRS and Signal Butte FRS

Appendix A: Data Collection and References

Arizona Department of Water Resources. "PMF Studies for Evaluation of Spillway Adequacy – General Guidelines". Office of Water Engineering. Dam Safety and Flood Mitigation. Revised March 2004.

Daniel, Mann, Johnson, and Mendenhall. "Spook Hill FRS Existing Conditions Analysis". Prepared for Arizona Department of Transportation. 2002

Federal Emergency Management Agency. "Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners". FEMA 64. October 1998.

Flood Control District of Maricopa County, (FCD 1999), "Delineation of Spillway Flows for Signal Butte Flood Retarding Structure" August, 1999. Prepared by A-N West, Inc.

Flood Control District of Maricopa County, (FCD 2000), "Apache Junction Flood Retarding Structure Spillway Inundation Study" July, 2000. Prepared by Michael Baker Jr., Inc.

Flood Control District of Maricopa County, (FCD 2004), "Spook Hill FRS Vertical Datum Transformation Report" November 2004. Prepared by Ron Barbala.

Flood Control District of Maricopa County, (FCD 2005a), "Apache Junction FRS Vertical Datum Transformation Report" January, 2005. Prepared by Ron Barbala.

Flood Control District of Maricopa County, (FCD 2005b), "Signal Butte FRS Vertical Datum Transformation Report" January, 2005. Prepared by Ron Barbala.

Kimley-Horn and Associates, Inc. "Individual Structures Assessment Report: Spook Hill FRS, Signal Butte FRS, and Apache Junction FRS". Prepared for Flood Control District of Maricopa County. FCD Contract 98-41. KHA Project No. 091131005. April, 2001.

Kimley-Horn and Associates, Inc. "Technical Memorandum Hydrology Review". Buckhorn-Mesa Structures. Prepared for Flood Control District of Maricopa County and LTM Engineering, Inc. March, 2005.

Kimley-Horn and Associates, Inc. "Technical Memorandum – Dambreak Review, Buckhorn-Mesa Structures". Prepared for Flood Control District of Maricopa County. FCD Contract 2003C062. and LTM Engineering, Inc. KHA Project No. 091725005. May, 2005.

Kimley-Horn and Associates, Inc. "Technical Memorandum – Probable Maximum Precipitation/Probable Maximum Flood Analysis, Buckhorn-Mesa Structures". Prepared for Flood Control District of Maricopa County. FCD Contract 2003C062. and LTM Engineering, Inc. KHA Project No. 091725005. September, 2005.

Kimley-Horn and Associates, Inc. "Dambreak Study for Apache Junction FRS and Signal Butte FRS, Buckhorn-Mesa Structures". Prepared for Flood Control District of Maricopa County. FCD Contract 2003C062. and LTM Engineering, Inc. KHA Project No. 091725005. November, 2005.

Natural Resources Conservation Service. "Hydrologic Investigation – Emergency Action Plan – Signal Butte FRS, Buckhorn-Mesa Watershed". August, 1984.

Natural Resources Conservation Service. "Technical Release No. 66 – Simplified Dam-Breach Routing Procedure". Revised December, 1981.

Natural Resources Conservation Service. "Technical Release No. 66 – Simplified Dam-Breach Routing Procedure". Third Edition. September, 1985.

Natural Resources Conservation Service. "Apache Junction Flood Retention Structure Downstream Inundation Study". Prepared for USDA Soil Conservation Service. Ebasco Services Incorporated. February, 1986. Located in Phase IV.2 – Final Design Report. "Apache Junction Floodwater Retarding Structure & Floodway". Buckhorn-Mesa Watershed Protection and Flood Prevention Project. Volume II. Ebasco Services Incorporated. October, 1986.

Natural Resources Conservation Service. "Spook Hill FRS and Floodway Design". 1976

Natural Resources Conservation Service. "Signal Butte FRS, Floodway, and Pass Mountain Diversion Design Report". 1985.

Natural Resources Conservation Service. "Apache Junction FRS and Floodway and Bulldog Floodway Design". Ebasco, 1985.

United States Army Corps of Engineers (USACE, 2005). Hydrologic Engineering Center HEC-RAS River Analysis System. Version 3.1.3. May, 2005.

Von Thun, J. L., and David R. Gillette. "Guidance on Breach Parameters". March, 1990. Unpublished document United States Bureau of Reclamation.

Wahl, Tony. "The Uncertainty of Embankment Dam Breach Parameter Prediction Based on Dam Failure Case Studies". June, 1995. United States Bureau of Reclamation

Wood Patel and Associates, Inc. Spook Hill Area Drainage Master Plan". Prepared for the Flood Control District of Maricopa County. 1999 - 2001.

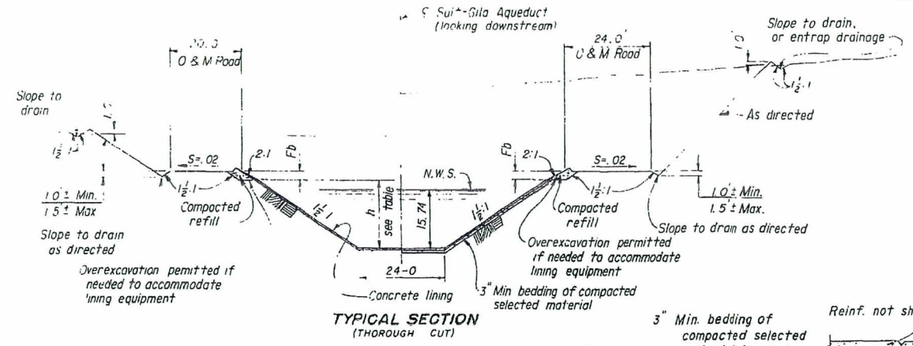
Wood Patel and Associates, Inc. Spook Hill Area Drainage Master Plan Update". Prepared for the Flood Control District of Maricopa County. Appendix A Volume 1 HEC-1 Modeling Input Data and Output Files Level III. September, 2002.

Wood Patel and Associates, Inc. Spook Hill Area Drainage Master Plan Update". Prepared for the Flood Control District of Maricopa County. Appendix A Volume 2 SCS TR-20 Hydrology Analysis. September, 2002.

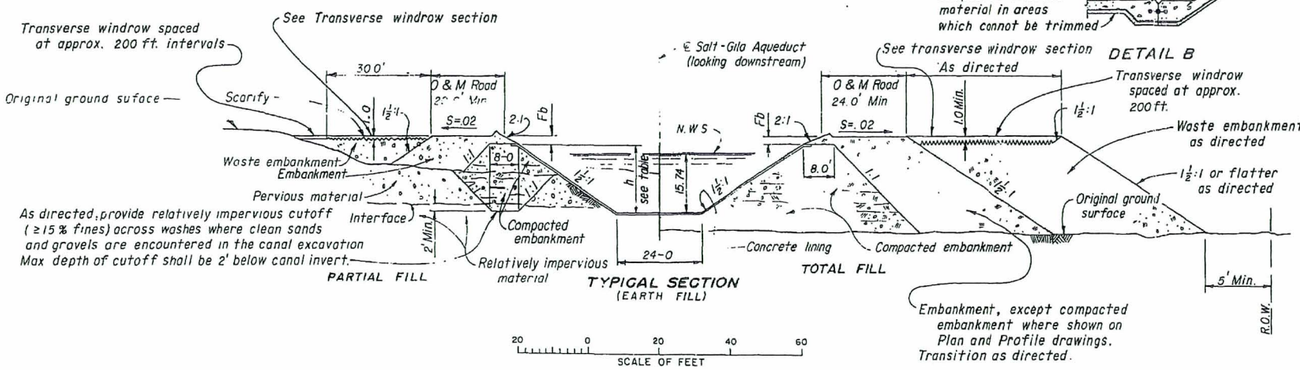
Wood Patel and Associates, Inc. Spook Hill Area Drainage Master Plan Update". Prepared for the Flood Control District of Maricopa County. Appendix A Volume 3 TR-20 Hydrology Analysis. September, 2002.

APPENDIX B

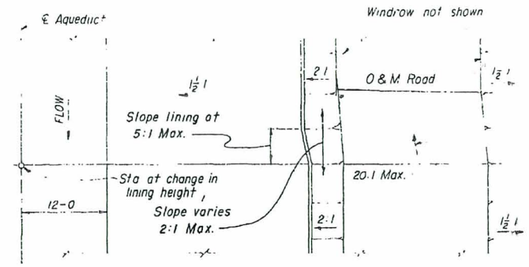
Addendum to Dambreak Study for
Apache Junction FRS and Signal Butte FRS



TYPICAL SECTION
(THOROUGH CUT)



DETAIL B



TYPICAL PLAN-LINING TRANSITION

LINING HEIGHT TABLE

STATION	TO STATION	Fb	h
331+00	to 353+00	7.7	18.3
353+00	to 392+00	7.2	18.8
DELETED			
393+16.29	to 415+00	8.1	17.9
415+00	to 465+00	7.1	18.9
465+00	to 476+00	6.6	19.4
476+00	to 495+50	4.1	21.9
495+00	to 506+00	3.3	22.7
506+00	to 514+00	2.2	24.2
514+00	to 534+00	2.2	26.7
534+00	to 564+50	2.2	28.2
564+50	to 588+00	2.2	29.9

NOTE: Sta. 440+00 to 453+00. Fb = 2.2 on right side of aqueduct. Ramp O & M Road as directed.

Invert S=.00008

Fb+h

1548.37

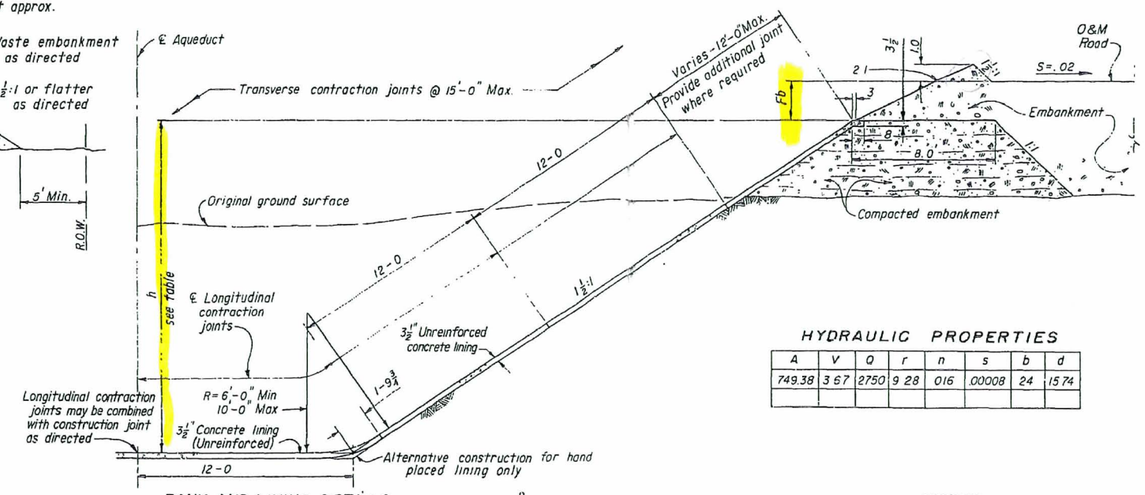
26.0
26.0
26.0
26.0
26.4
28.9
30.4
32.1

420+00

560+00

Elev
415+00 1548.37
475+00 1547.89

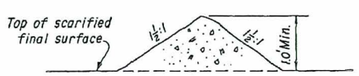
555+00
1547.41



BANK AND LINING DETAILS
(UNREINFORCED CONCRETE LINING SHOWN)

HYDRAULIC PROPERTIES

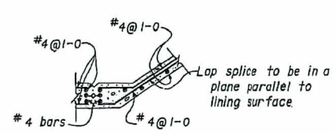
A	V	Q	r	n	s	b	d
749.38	3.67	2750	9.28	.016	.00008	24	15.74



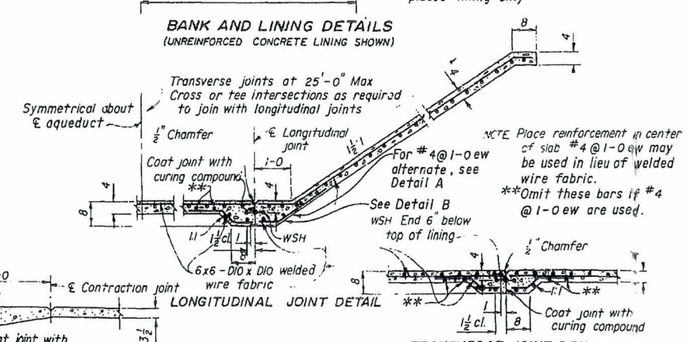
TRANSVERSE WINDROW SECTION

Reinforced Concrete Lining to be placed in the following locations.

Sta. 383+27.10	to	Sta. 384+89.12	
Sta. 386+33.64	to	Sta. 387+95.66	
Sta. 482+45.79	to	Sta. 483+77.12	
Sta. 484+72.90	to	Sta. 486+04.23	
Sta. 507+25.20	to	Sta. 508+73.22	
Sta. 509+51.64	to	Sta. 510+99.66	
Sta. 518+35.16	to	Sta. 520+00.62	
Sta. 520+66.51	to	Sta. 522+31.97	
Sta. 582+00	to	Sta. 584+62.49	
Sta. 586+50.37	to	Sta. 588+00	

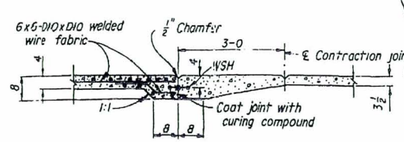


DETAIL A
(Similar to Longitudinal Joint Detail except #4@1-0)



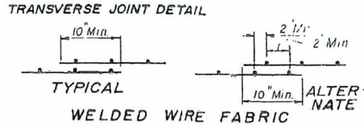
LONGITUDINAL JOINT DETAIL

TRANSVERSE JOINT DETAIL



JOINT DETAIL BETWEEN REINFORCED LINING AND UNREINFORCED LINING

REINFORCED CONCRETE LINING DETAILS



WELDED WIRE FABRIC SPLICE DETAILS

NOTES

In areas other than rock formations, the 3" bedding may be omitted if the inplace material can be trimmed to the equivalent smoothness and compactness of the replaced selected bedding material.
Transverse contraction joints around curves to be on radial lines spaced along ℄ aqueduct at 15-0 centers.
For details of contraction joints for unreinforced lining, see 344-D-7163.
For details and spacing of safety ladders, see 40-D-6460.
Concrete lining design is based on a compressive strength of 3000 psi. @ 28 days
For details of waterstop, see 40-D-2867 Waterstop shall be continuous in reinforced lining joints

11-10-83 D-DWS	REVISED LINING HEIGHT TABLE.
8-10-83 D-DLB	MINOR NOTE CHANGE. REVISED LINING HEIGHT TABLE.
6-29-83 D-DWS	CHANGED TYPICAL SECTION. ADDED REINFORCED LINING TABLE. ADDED #4 @ 1-0 ew OPTION.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
SALT - GILA DIVISION - ARIZONA

SALT-GILA AQUEDUCT
REACH 1B

TYPICAL CANAL SECTIONS

DESIGNED David A. Mostrom TECHNICAL APPROVAL Robert L. Hawkins
DRAWN M.A.R. SUBMITTED Jack E. Johnson
CHECKED David A. Edwards APPROVED G. A. Hornsby
CHIEF, WATER CONVEYANCE BRANCH

DENVER, COLORADO MAY 5, 1982 344-D-8355

12-2-85 D-D.D.G. AS BUILT BY 330, LTR. 9-13-85. FOR SPECIFICATION NO. DC-7557.

ALWAYS THINK SAFETY

427+15 and 429+20
72" Dia 3 barrel pipe overchutes

87"x63" 3 BBL
CMP-arch road
culverts

431+83.00
Apache Trail Bridge
West Bound

435+19.60
Apache Trail Bridge
East Bound

Remove existing
concrete box
culvert

432+54.3
℄ Merton
Skew 82°17'0" LT
and drain inlet
Lt & Rt

425+03.32
℄ Crismon Road Bridge
Skew 57°15'41" Rt

471+03.13
72" Dia 3 BBL
pipe overchute

Min Dike crest
El 1569.0

474+71.71
℄ Broadway
Road Bridge
Skew 56°30'00" LT

PT Eq. 460+64.99 BK=
460+13.38 AH

7'-0" Chain link fence

456+60
60" Dia Double BBL
pipe overchute

℄ SALT-GILA AQUEDUCT
REACH 1B

MATCH LINE

P.I. 427+99.96
Δ = 56°28'23"
D = 8°
R = 716.20
T = 384.61
L = 705.91
P.C. 424+15.35
P.T. 431+21.26

P.I. 445+20.57
Δ = 08°31'47.4" LT
D = 8°
R = 716.20'
T = 53.29.58
T = 427.28'
L = 852.98'
P.C. 440+93.29
P.T. 449+46.27

P.I. 456+79.51
Δ = 74°03'57.6" LT
D = 8°
R = 716.20'
T = 540.34'
L = 925.82'
P.C. 451+39.17
P.T. Eq. 460+64.99 BK=
460+13.38 AH

P.I. 469+50.23
Δ = 28°22'37.35" RT
D = 12°
R = 477.46'
T = 120.71'
L = 236.47'
P.C. 468+29.52
P.T. 470+65.99

P.I. 472+60.95
Δ = 28°22'37.35" RT
D = 12°
R = 477.46'
T = 120.71'
L = 236.47'
P.C. 471+40.24
P.T. 473+76.71

HYDRAULIC PROPERTIES

A	V	Q	r	n	s	b	d
749.38	3.67	2750	9.28	.016	.00008	24	15.74

SCALE OF FEET
CONTOUR INTERVAL 2 FEET

Top of left O&M road
El 1577.9

Top of right O&M road
El 1576.8

Existing ground surface

Inv El 1548.37

S = .00008

Aqueduct bottom grade

Inv El 1548.01

Inv El 1549.01

Inv El 1547.09

EQUATION
PT 460+64.99 BK
460+13.38 AH

STATIONS 415+00 420+00 430+00 440+00 450+00 470+00 475+00

NOTES

For General Notes, see (8359)
For utility crossings, see (8365)
For chain link fence on right side
at turns, see Detail A (8359)

THIS DRAWING COMPILED FROM FIELD DWG 344-330-510

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
SALT-GILA DIVISION-ARIZONA

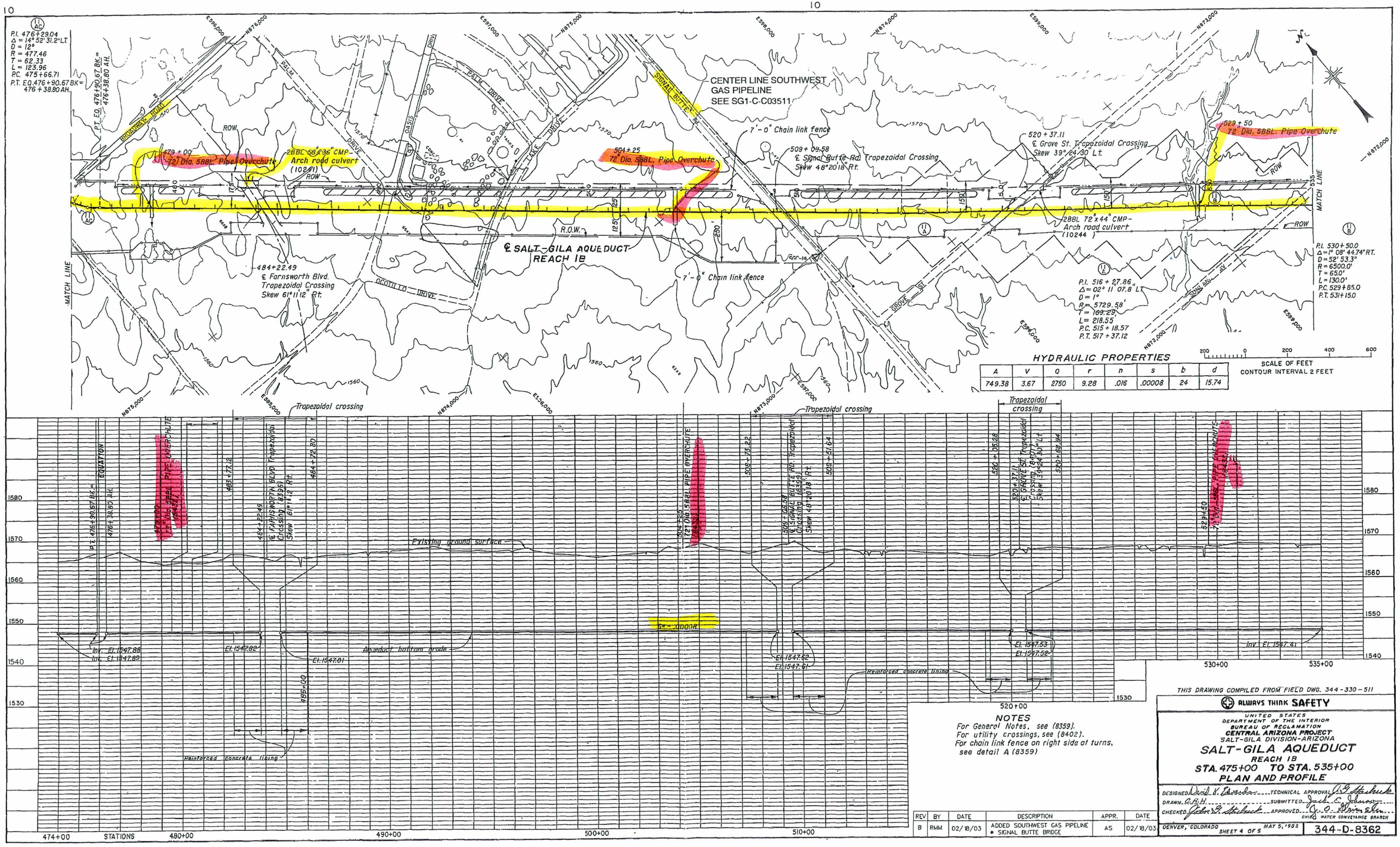
SALT-GILA AQUEDUCT
REACH 1B
STA. 415+00 TO STA. 475+00
PLAN AND PROFILE

DESIGNED David K. Brown TECHNICAL APPROVAL
DRAWN C.R.H. J.M.H. SUBMITTED
CHECKED APPROVED
CHIEF, WATER CONVEYANCE BRANCH

DENVER, COLORADO SHEET 3 OF 5 MAY 5, 1982 344-D-8361

12-2-85 D-S.D.B.	AS BUILT BY 330, LTR 9-13-85 FOR SPECIFICATION NO. DC-7557.
8-10-83 D-RDB	CHANGED R O W FENCE
7-5-83 D-DKL	CHANGED STATIONS

ONE OVERLAY—INFORMATION



HYDRAULIC PROPERTIES

A	V	Q	r	n	s	b	d
749.38	3.67	2750	9.28	.016	.00008	24	15.74

NOTES

For General Notes, see (8359).
For utility crossings, see (8402).
For chain link fence on right side at turns, see detail A (8359)

REV	BY	DATE	DESCRIPTION	APPR.	DATE
B	RMM	02/18/03	ADDED SOUTHWEST GAS PIPELINE & SIGNAL BUTTE BRIDGE	AS	02/18/03

THIS DRAWING COMPILED FROM FIELD DWG. 344-330-511

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
SALT-GILA DIVISION-ARIZONA

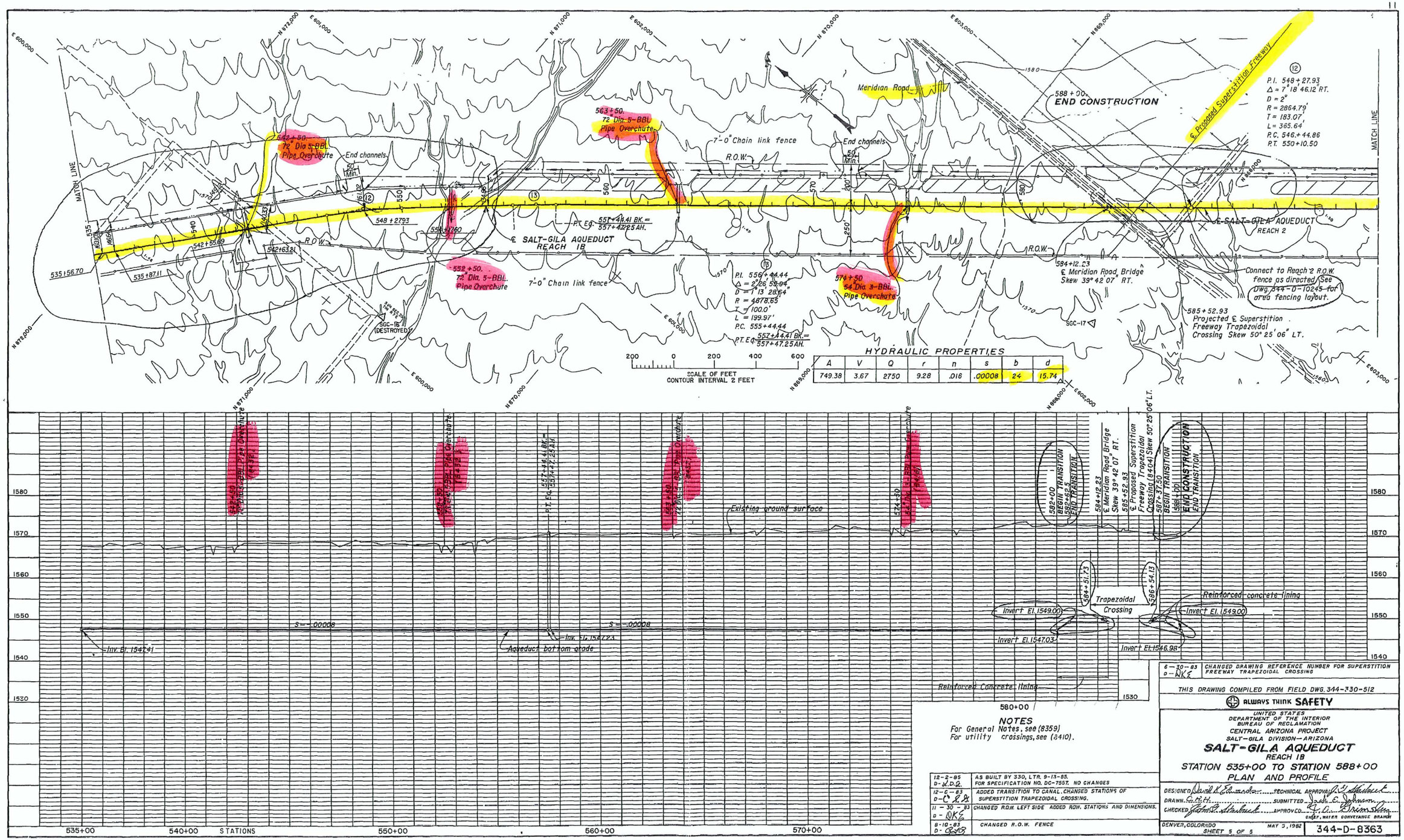
SALT-GILA AQUEDUCT
REACH 1B
STA. 475+00 TO STA. 535+00
PLAN AND PROFILE

DESIGNED David V. Edwards — TECHNICAL APPROVAL
DRAWN A.R.H. — SUBMITTED Jack E. Johnson
CHECKED John P. Stichnoth — APPROVED Jack D. Winsten, CHIEF WATER CONVEYANCE BRANCH

DENVER, COLORADO — SHEET 4 OF 5 — MAY 5, 1982 — 344-D-8362

ONE OVERLAY-INFORMATION

7-1289M (7-72)
Bureau of Reclamation



HYDRAULIC PROPERTIES

A	V	Q	r	n	s	b	d
749.38	3.67	2750	9.28	.016	.00008	24	15.74

NOTES

For General Notes, see (8359)
For utility crossings, see (8410).

12-2-85 D-L.D.L.	AS BUILT BY 330, LTR. 9-13-85. FOR SPECIFICATION NO. DC-7557. NO CHANGES
12-6-83 D-C.R.H.	ADDED TRANSITION TO CANAL. CHANGED STATIONS OF SUPERSTITION TRAPEZOIDAL CROSSING.
11-30-83 D-DKE	CHANGED R.O.W. LEFT SIDE ADDED ROW. STATIONS AND DIMENSIONS.
6-10-83 D-[illegible]	CHANGED R.O.W. FENCE
6-30-83 D-DKE	CHANGED DRAWING REFERENCE NUMBER FOR SUPERSTITION FREEWAY TRAPEZOIDAL CROSSING

THIS DRAWING COMPILED FROM FIELD DWG. 344-330-512

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
SALT-GILA DIVISION—ARIZONA

SALT-GILA AQUEDUCT

REACH 1B

STATION 535+00 TO STATION 588+00

PLAN AND PROFILE

DESIGNED David K. Edwards ... TECHNICAL APPROVAL [illegible]
DRAWN C.R.H. ... SUBMITTED Jack E. Johnson
CHECKED [illegible] ... APPROVED [illegible]
CHIEF, WATER CONVEYANCE BRANCH

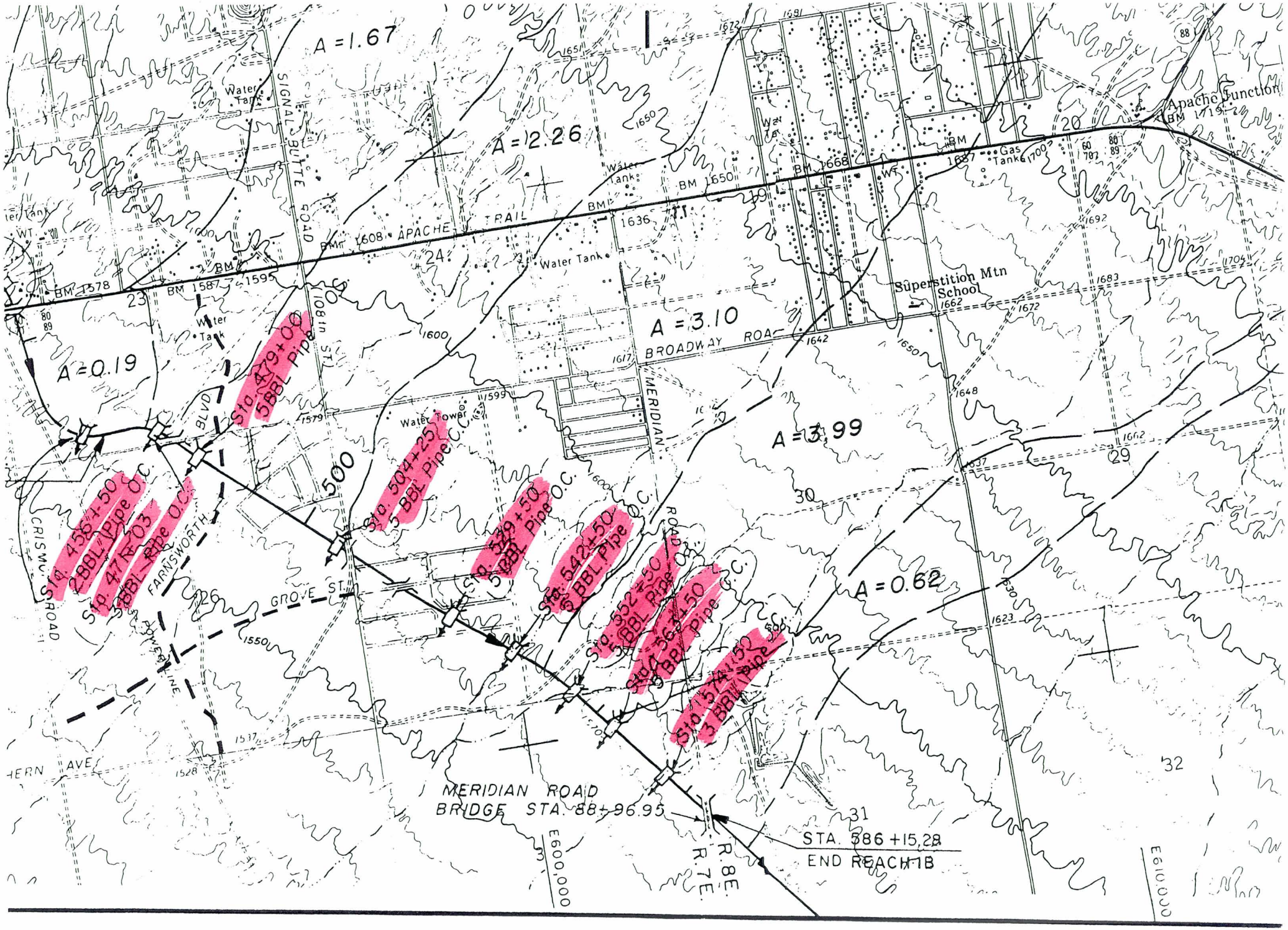
DENVER, COLORADO — MAY 3, 1982 — SHEET 5 OF 5

344-D-8363

GPO 740-882 (8750-1081)

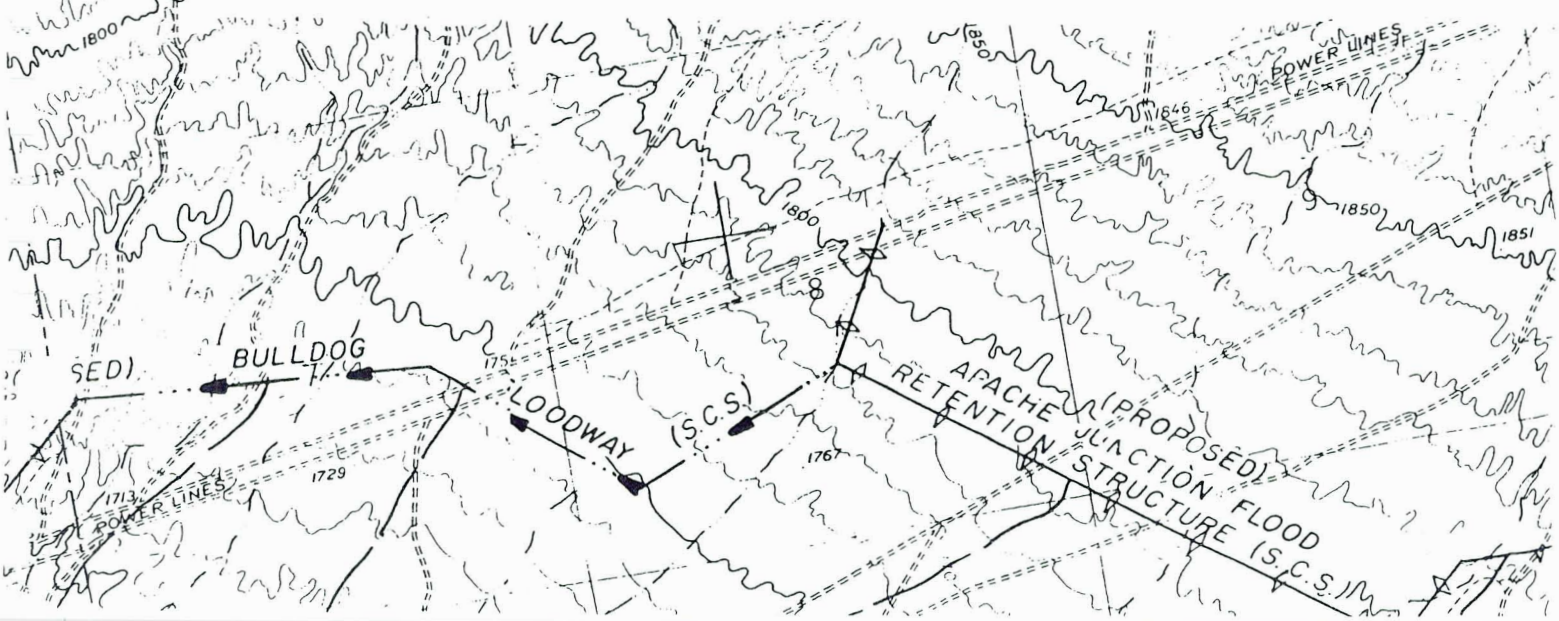
ONE OVERLAY—INFORMATION

21" x 36"


A = 1.67
A = 12.26
A = 3.10
A = 3.99
A = 0.62
A = 0.19
APACHE TRAIL
BROADWAY ROAD
MERIDIAN ROAD
SIGNAL BUTTE ROAD
Apache Junction
Superstition Mtn School
Water Tank
Water Tower
Gas Tank
Sta. 455+50 2 BBL Pipe O.C.
Sta. 477+03 3 BBL Pipe O.C.
Sta. 479+00 5 BBL Pipe
Sta. 504+25 3 BBL Pipe O.C.
Sta. 529+50 5 BBL Pipe O.C.
Sta. 542+50 6 BBL Pipe O.C.
Sta. 552+50 5 BBL Pipe O.C.
Sta. 567+50 6 BBL Pipe O.C.
Sta. 574+50 3 BBL Pipe
MERIDIAN ROAD BRIDGE STA. 88+96.95
STA. 586+15.28
END REACH 1B
R. 8 E.
R. 7 E.
E600,000
E610,000
GROVE ST.
FARNSWORTH
CRISMON ROAD
500

CROSS DRAINAGE STRUCTURES

STATION	SIZE	PEAK Q in (cfs)	STORAGE CAPACITY (ac.ft)	PEAK Q out (cfs)	DESIGN STORM
345+30	54" DIA. 3BL PIPE OVERCHUTE	230	0	230	100yr. 6hr GENERAL STORM
374+00	40' 10" WIDE FLUME OVERCHUTE	445	0	445	"
396+00	40' 10" WIDE FLUME OVERCHUTE	410	0	410	"
427+15	72" DIA. 3BL PIPE OVERCHUTE	370	0	370	"
429+20	72" DIA 3BL PIPE OVERCHUTE	370	0	370	"
456+50	60" DIA. 2BL PIPE OVERCHUTE	130	0	130	"
471+03	72" DIA. 3BL PIPE OVERCHUTE	608	0	608	"
479+00	72" DIA. 5BL PIPE OVERCHUTE	400	0	400	"
504+25	72" DIA. 5BL PIPE OVERCHUTE	400	0	400	"
529+50	72" DIA. 5BL PIPE OVERCHUTE	565	0	565	"
542+50	72" DIA. 5BL PIPE OVERCHUTE	565	0	565	"
552+50	72" DIA. 5BL PIPE OVERCHUTE	610	0	610	"
563+50	72" DIA. 5BL PIPE OVERCHUTE	610	0	610	"
574+50	54" DIA. 3BL PIPE OVERCHUTE	251	0	251	"



INPUT DATA FOR FLOOD ROUTING
SALT- GILA AQUEDUCT REACH 1

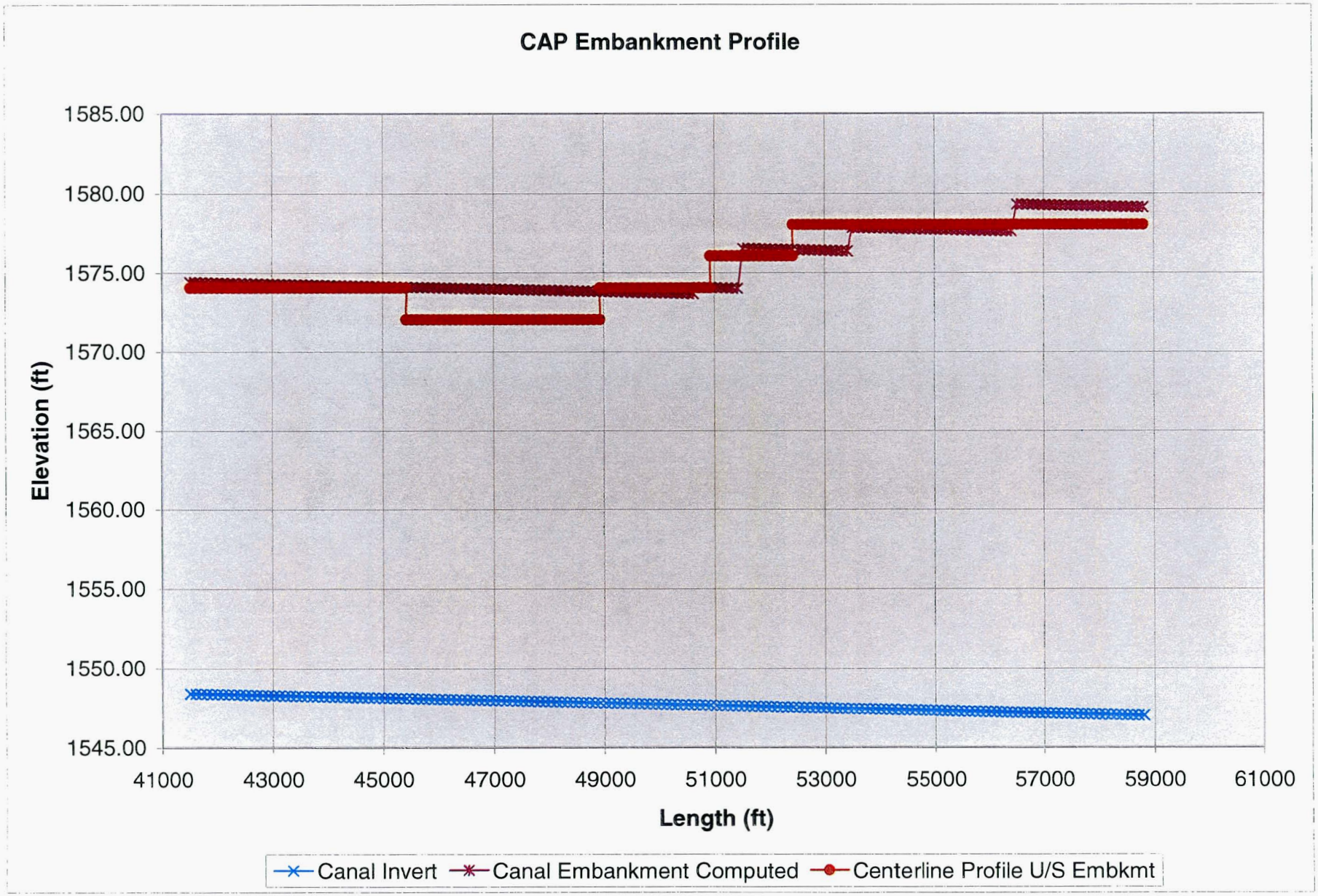
STATION	STRUCT. TYPE	SIZE	INVERT ELEV.	CREST ELEV.	STORAGE CAPACITY DATA ELEV.	AC.FT	ELEV.	AC.FT.	
14+95.07									
	Protected by Spook Hill Flood Retarding Structure. Designed by Soil Conservation Service and Operated by Maricopa County Flood Control District. Emergency spillway located at Station 127+62.3. Principle spillway is on east side of the aqueduct and pumping plant.778								
331+00									
345+30	Pipe OC	3-54"	1565.90	1575.0	No routing considered for this area, due to lack of Right-of-Way available.				
374+00	Flume	40'-10"	1565.08	1571.83					
396+00	Flume	40'-10"	1564.90	1571.65		"			
427+15	Pipe OC	3-72"	1568.32	1577.9		"			
429+20	Pipe OC	3-72"	1568.32	1577.9		"			
456+50	Pipe OC	2-60"	1556.16	1574.0		"			
471+03	Pipe OC	3-72"	1560.68	1573.9		"			
479+00	Pipe OC	5-72"	1562.20	1573.9	95+00	"			Δ
504+25	Pipe OC	5-72"	1562.26	1573.6	120+25	"	FLO INVERT	1559.40	-2.86
529+50	Pipe OC	5-72"	1562.59	1576.4		"	FLO INVERT	1560.00	-2.59
542+50	Pipe OC	5-72"	1562.59	1577.8		"	FLO INVERT	1560.00	-2.59
552+50	Pipe OC	5-72"	1563.76	1577.7		"	FLO INVERT	1561.00	-2.71
563+50	Pipe OC	5-72"	1563.76	1577.6		"			
574+50	Pipe OC	3-54"	1566.08	1577.5		"			

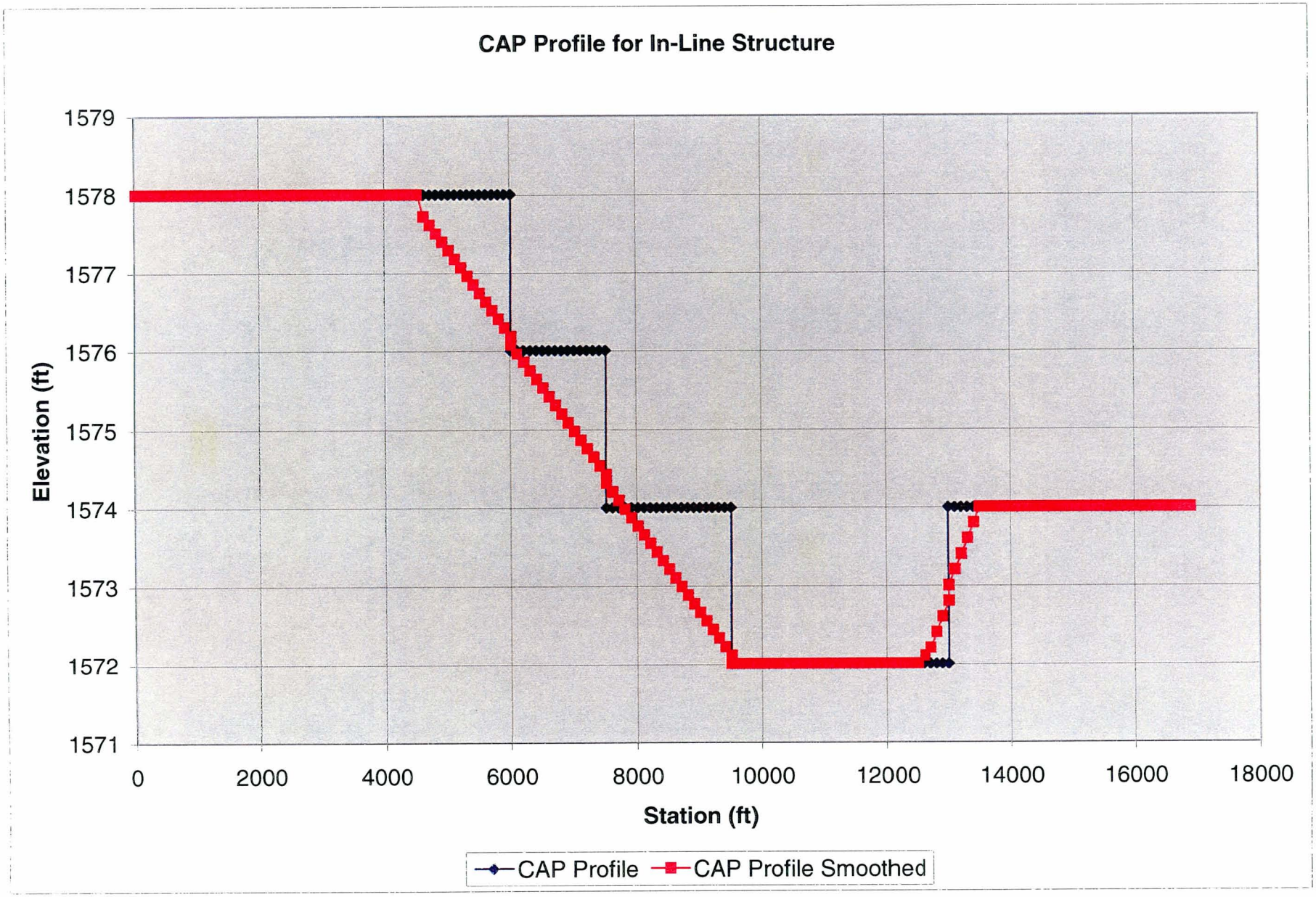
AVE Δ = -2.70 F

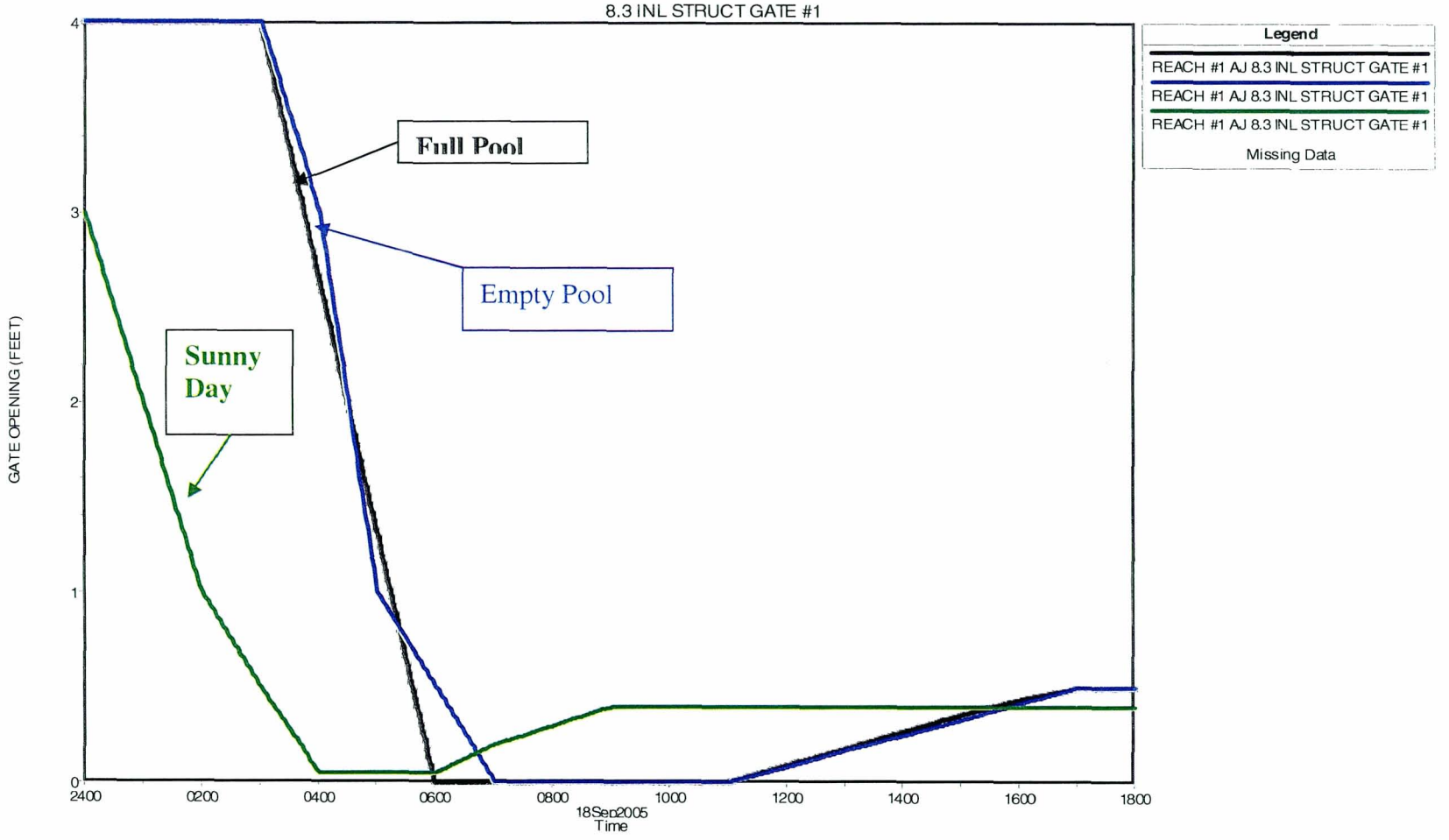
sta eqn

427+15 = 43+15
429+20 = 45+20
456+50 = 72+50
471+03 = 87+03

479+00 = 95+00
504+25 = 120+25 ✓
529+50 = 145+50 ✓
542+50 = 158+50 ✓
552+50 = 168+50 ✓
563+50 = 179+50 ✓
574+50 = 190+50 ✓

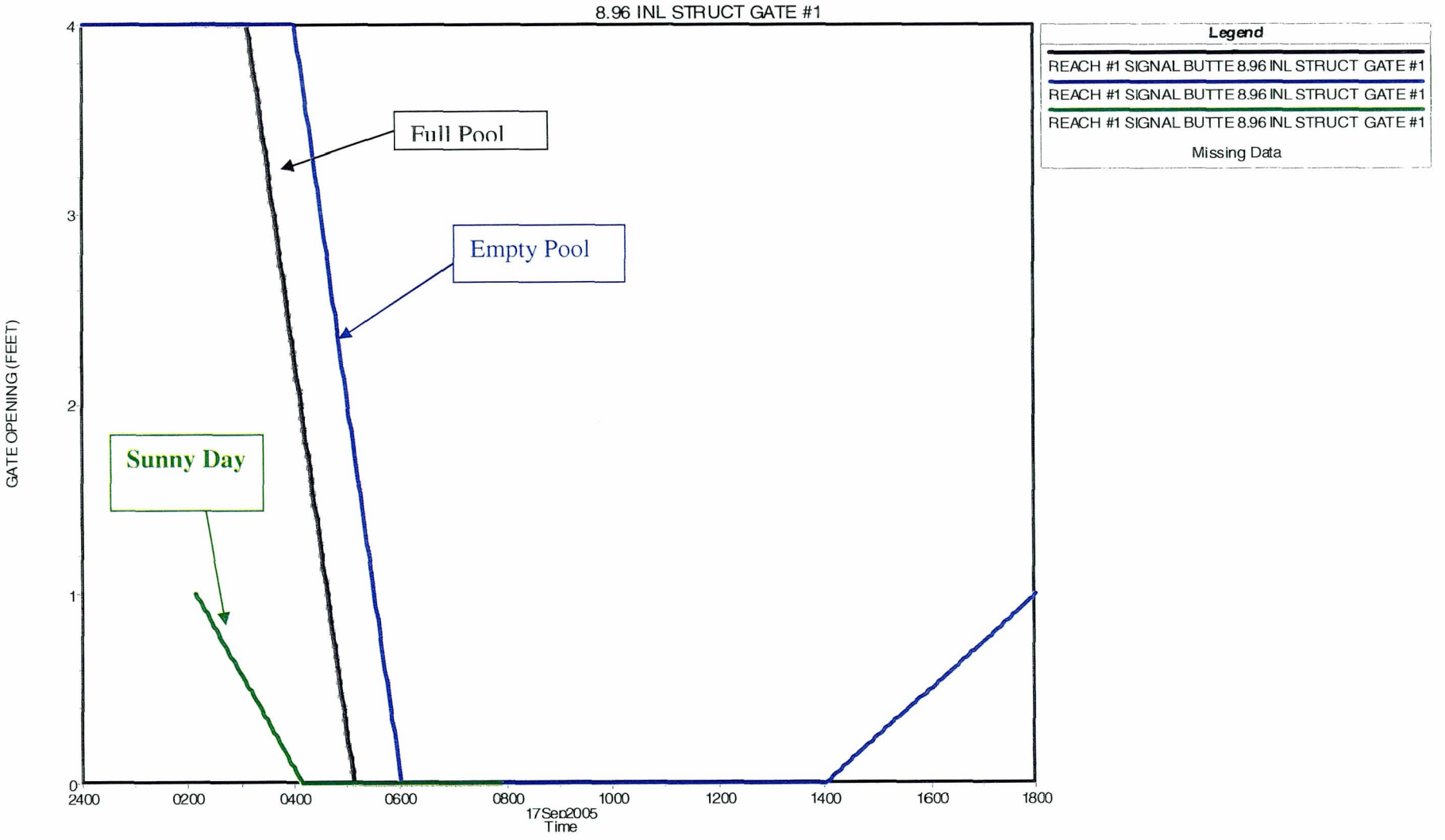

CAP Embankment Profile
1585.00
1580.00
1575.00
1570.00
1565.00
1560.00
1555.00
1550.00
1545.00
Elevation (ft)
41000
43000
45000
47000
49000
51000
53000
55000
57000
59000
61000
Length (ft)
Canal Invert
Canal Embankment Computed
Centerline Profile U/S Embkmt


CAP Profile for In-Line Structure
Elevation (ft)
1579
1578
1577
1576
1575
1574
1573
1572
1571
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Station (ft)
CAP Profile
CAP Profile Smoothed



Gate Time Series for CAP – Apache Junction FRS (Full Pool, Empty Pool, and Sunny Day)

Kimley-Horn and Associates, Inc.



Gate Time Series for CAP – Signal Butte FRS (Full Pool, Empty Pool, and Sunny Day)

APPENDIX C

Addendum to Dambreak Study for
Apache Junction FRS and Signal Butte FRS

NOTES

1. TIME ZERO IS TAKEN AT THE TIME OF MAXIMUM FLOW THROUGH THE DAM BREACH.
2. MAPPED INUNDATION LIMITS AT CROSS SECTIONS CORRESPOND TO MAXIMUM STAGE ELEVATION.
3. INFLOW DESIGN FLOOD = 6-HR PROBABLE MAXIMUM FLOOD DEVELOPED IN PMP/PMF STUDY CONDUCTED UNDER FCD CONTRACT 2003C062.
4. THE STRUCTURAL INTEGRITY AND HYDRAULIC INTEGRITY OF ANY LEVEES, BERMS, CANAL EMBANKMENTS, DETENTION/RETENTION BASINS, OR FILL TO WITHSTAND EROSION (OR FAILURE) DURING FLOODING WAS NOT EVALUATED AS PART OF THIS STUDY.
5. THIS EXHIBIT SHOWS INUNDATION LIMITS FOR POTENTIAL PIPING FAILURE.
6. MAPPING/INUNDATION LIMITS FOR POTENTIAL OVERTOPPING OF BULLDOG FLOODWAY OR SIGNAL BUTTE FLOODWAY NOT INCLUDED IN SCOPE OF WORK.
7. MODEL SCENARIO NO. 1 ASSUMES APACHE JUNCTION FRS HAS EMPTY POOL AT BEGINNING OF SIMULATION. DAM BREACH INITIATION STARTS AT ELEVATION OF 1810.0 FT.
8. DAM CREST ELEVATION OF APACHE JUNCTION FRS 1812.014 FT. (NAVD 88)
9. DAM BREAK FLOOD WAVE POTENTIALLY EXTENDS PAST (WEST) OF CROSS SECTION 9, AS INDICATED BY FLOW ARROWS.
10. DAM BREACH LOCATED AT APPROXIMATE MAXIMUM DAM SECTION.
11. HYDRAULIC BASELINE SET TO STATION 10,000.
12. DUE TO THE NATURE OF THE TOPOGRAPHY OF THIS AREA AND THE RESULTING BROAD, SHALLOW FLOODING ACROSS THE CROSS SECTIONS, THERE ARE SOME CROSS SECTIONS WITHIN THE MODELING WHICH SHOW FLOWS WITHIN A NATURAL SWALE WHEREAS THE SECTION IMMEDIATELY DOWNSTREAM MAY NOT SHOW FLOWS WITHIN THAT SAME SWALE. IN AREAS WHERE IT APPEARS THAT FLOWS WOULD CONTINUE (DUE TO TOPOGRAPHY, STREETS, TRAILER PARKS), THE INUNDATION LIMITS HAVE BEEN EXPANDED TO INCLUDE THOSE AREAS EVEN THOUGH THE HEC-RAS MODEL MAY NOT SHOW THESE AS INUNDATED AREAS.

BASE MAPPING SOURCE:

BASE MAPPING FROM FCD CONTRACT NUMBER FCD 03-49

MAPPING BASED ON NORTH AMERICAN VERTICAL DATUM 1988.

LEGEND

DAM BREAK INUNDATION BOUNDARY

CROSS SECTION LABEL (0)

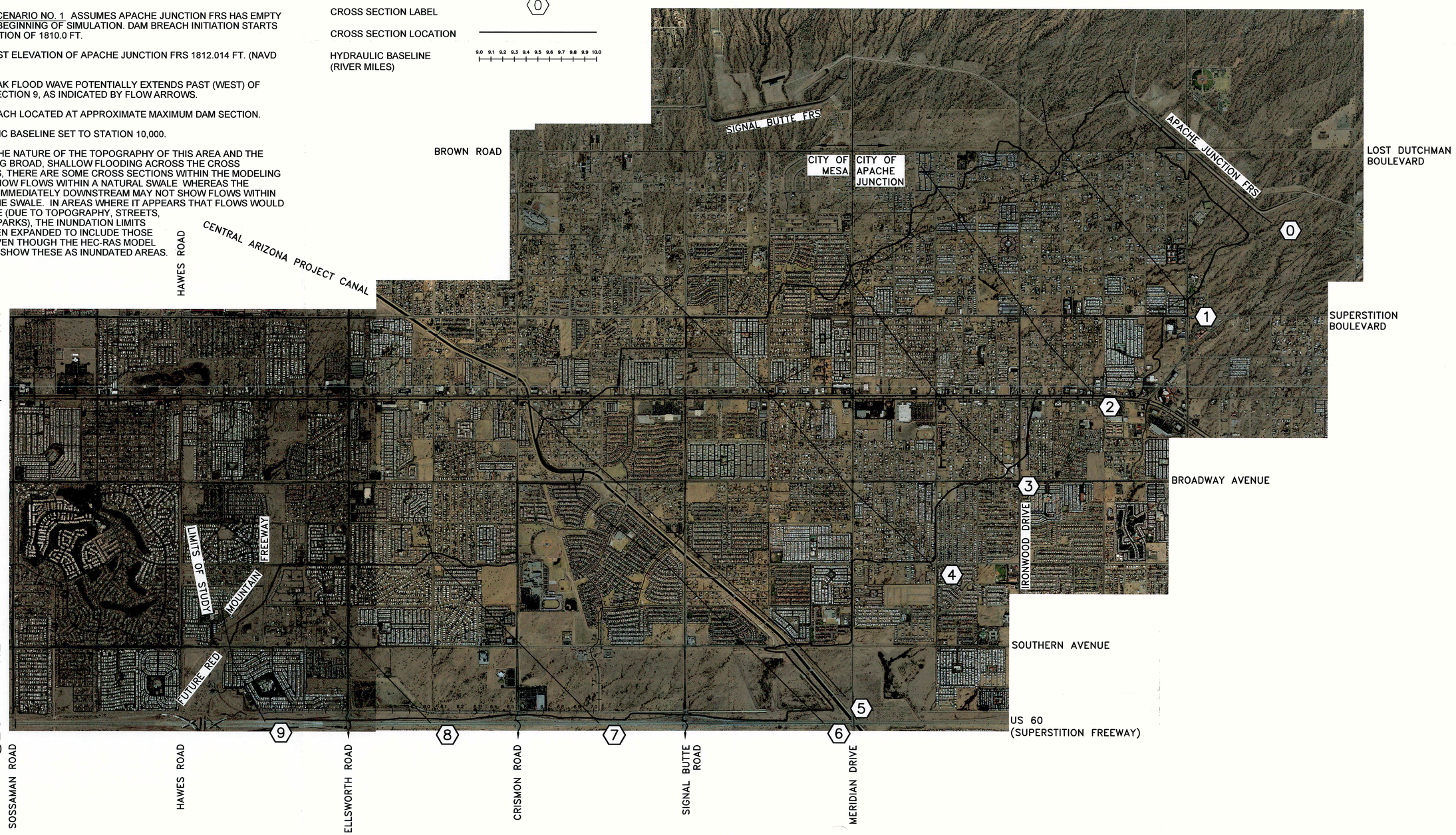
CROSS SECTION LOCATION

HYDRAULIC BASELINE (RIVER MILES) 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0

Cross Section ID	HEC-RAS Cross Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time To Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD 88)	Cross Section Reference
0	0.00	2.7	21,796	0.0	4.1	5.5	2.1	1788.77	APACHE JUNCTION FRS
1	0.56	2.8	21,173	0.2	2.9	4.4	1.4	1750.81	LOST DUTCHMAN BOULEVARD
2	1.37	2.3	20,639	0.5	3.0	4.3	1.1	1702.30	SUPERSTITION BOULEVARD
3	2.15	2.4	20,005	0.9	1.8	7.2	1.4	1662.43	APACHE TRAIL
4	3.21	2.7	18,629	1.5	2.1	7.1	1.5	1618.66	BROADWAY ROAD
5	4.58	3.2	12,342	2.2	0.4	1.4	2.7	1573.21	SOUTHERN AVENUE
6	4.76	2.9	12,212	2.9	1.5	6.4	1.7	1560.98	SIGNAL BUTTE ROAD
7	6.01	1.1	11,575	3.6	2.3	5.8	1.1	1515.12	CRISMON ROAD
8	7.01	1.0	10,947	4.1	2.5	7.3	1.1	1483.06	ELLSWORTH ROAD
9	7.97	2.7	9,827	4.8	2.5	8.5	1.5	1454.67	RED MOUNTAIN FREEWAY

N

GRAPHIC SCALE
1500 0 750 1500 3000
(IN FEET)



NO.	REVISION	BY	DATE	APPR.

Kimley-Horn and Associates, Inc.

© 2006 KIMLEY-HORN AND ASSOCIATES, INC.
7878 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=1500'
SCALE (V): NONE
DESIGNED BY: PAC
DRAWN BY: PAC
CHECKED BY: RAE
DATE: 05/31/06

EXHIBIT C-1. BUCKHORN MESA STRUCTURES
DAMBREAK MODEL SCENARIO NO. 1
EMPTY POOL
APACHE JUNCTION FLOOD RETARDING STRUCTURE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 24767
ROBERT A. EICHINGER
Date Signed 05/31/06
ARIZONA, U.S.A.

PROJECT NO. 091725006

DRAWING NAME MODEL-AJ1

1 OF 1

K:\WaterResources\091725006\CADD\Exhibits\MODEL-AJ1.dwg May 31, 2006 Pat.Crawford
XREFS: AJSTA X7250066AE02 X7250066TP AJ DAMBREAK AJ XS LOC
THE SOLE PURPOSE OF THIS DOCUMENT IS TO PROVIDE A PRELIMINARY SERVICE. IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND UNAPPROVED RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

NOTES

1. TIME ZERO IS TAKEN AT THE TIME OF MAXIMUM FLOW THROUGH THE DAM BREACH.
2. MAPPED INUNDATION LIMITS AT CROSS SECTIONS CORRESPOND TO MAXIMUM STAGE ELEVATION.
3. INFLOW DESIGN FLOOD = 6-HR PROBABLE MAXIMUM FLOOD DEVELOPED IN PMP/PMF STUDY CONDUCTED UNDER FCD CONTRACT 2003C062.
4. THE STRUCTURAL INTEGRITY AND HYDRAULIC INTEGRITY OF ANY LEVEES, BERMS, CANAL EMBANKMENTS, DETENTION/RETENTION BASINS, OR FILL TO WITHSTAND EROSION (OR FAILURE) DURING FLOODING WAS NOT EVALUATED AS PART OF THIS STUDY.
5. THIS EXHIBIT SHOWS INUNDATION LIMITS FOR POTENTIAL PIPING FAILURE.
6. MAPPING/INUNDATION LIMITS FOR POTENTIAL OVERTOPPING OF BULLDOG FLOODWAY OR SIGNAL BUTTE FLOODWAY NOT INCLUDED IN SCOPE OF WORK.
7. MODEL SCENARIO NO. 2 ASSUMES APACHE JUNCTION FRS HAS FULL POOL AT BEGINNING OF SIMULATION. DAM BREACH INITIATION STARTS AT ELEVATION OF 1812.0 FT.
8. DAM CREST ELEVATION OF APACHE JUNCTION FRS 1812.014 FT. (NAVD 88)
9. DAM BREAK FLOOD WAVE POTENTIALLY EXTENDS PAST (WEST) OF CROSS SECTION 9, AS INDICATED BY FLOW ARROWS.
10. DAM BREACH LOCATED AT APPROXIMATE MAXIMUM DAM SECTION.
11. HYDRAULIC BASELINE SET TO STATION 10,000.
12. DUE TO THE NATURE OF THE TOPOGRAPHY OF THIS AREA AND THE RESULTING BROAD, SHALLOW FLOODING ACROSS THE CROSS SECTIONS, THERE ARE SOME CROSS SECTIONS WITHIN THE MODELING WHICH SHOW FLOWS WITHIN A NATURAL SWALE WHEREAS THE SECTION IMMEDIATELY DOWNSTREAM MAY NOT SHOW FLOWS WITHIN THAT SAME SWALE. IN AREAS WHERE IT APPEARS THAT FLOWS WOULD CONTINUE (DUE TO TOPOGRAPHY, STREETS,TRAILER PARKS), THE INUNDATION LIMITS HAVE BEEN EXPANDED TO INCLUDE THOSE AREAS EVEN THOUGH THE HEC-RAS MODEL MAY NOT SHOW THESE AS INUNDATED AREAS.

BASE MAPPING SOURCE:

BASE MAPPING FROM FCD CONTRACT NUMBER FCD 03-49

MAPPING BASED ON NORTH AMERICAN VERTICAL DATUM 1988.

Cross Section ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time To Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD 88)	Cross Section Reference
0	0.00	3.2	28,569	0.0	4.5	6.0	2.5	1789.17	APACHE JUNCTION FRS
1	0.56	3.0	27,289	0.2	3.2	4.8	1.6	1751.05	LOST DUTCHMAN BOULEVARD
2	1.37	2.6	26,459	0.6	3.1	4.6	1.4	1702.55	SUPERSTITION BOULEVARD
3	2.15	2.7	25,817	0.9	1.9	7.5	1.6	1662.69	APACHE TRAIL
4	3.21	3.0	24,403	1.4	2.3	7.5	1.7	1618.99	BROADWAY ROAD
5	4.58	3.5	17,262	2.0	0.5	1.8	3.0	1573.51	SOUTHERN AVENUE
6	4.76	3.4	17,042	2.7	1.6	6.8	2.0	1561.40	SIGNAL BUTTE ROAD
7	6.01	1.4	16,118	3.3	2.5	6.1	1.4	1515.43	CRISMON ROAD
8	7.01	1.4	15,314	3.7	2.6	7.7	1.4	1483.41	ELLSWORTH ROAD
9	7.97	3.3	13,779	4.3	2.5	9.0	2.1	1455.30	RED MOUNTAIN FREEWAY

N

GRAPHIC SCALE
1500 0 750 1500 3000
(IN FEET)

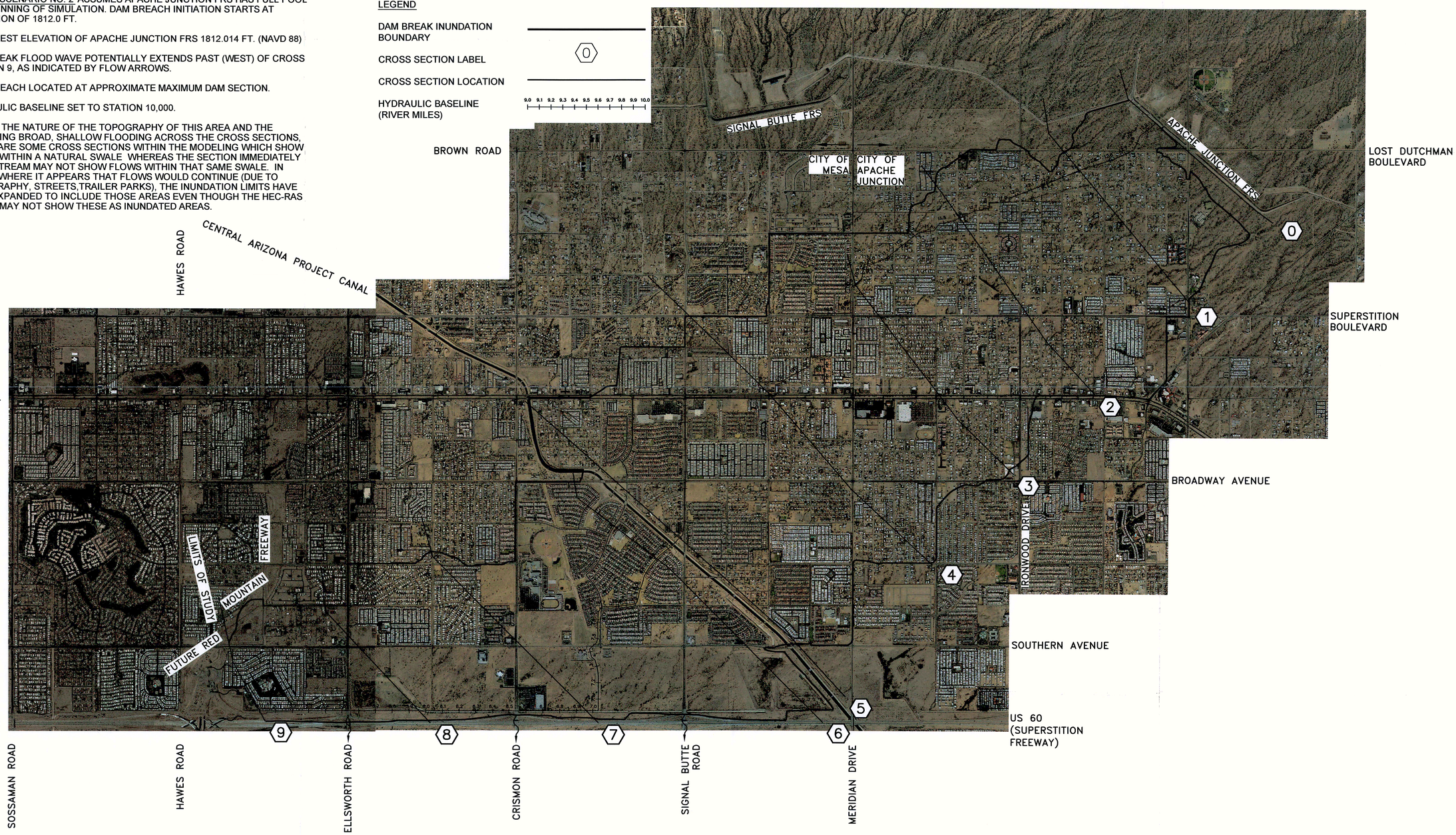
LEGEND

DAM BREAK INUNDATION BOUNDARY

CROSS SECTION LABEL (0)

CROSS SECTION LOCATION

HYDRAULIC BASELINE (RIVER MILES) 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0



NO.	REVISION	BY	DATE	APPR.

Kimley-Horn and Associates, Inc.
© 2006 KIMLEY-HORN AND ASSOCIATES, INC.
7878 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=1500'
SCALE (V): NONE
DESIGNED BY: PAC
DRAWN BY: PAC
CHECKED BY: RAE
DATE: 05/31/06

EXHIBIT C-2. BUCKHORN MESA STRUCTURES DAMBREAK MODEL SCENARIO NO. 2 FULL POOL

APACHE JUNCTION FLOOD RETARDING STRUCTURE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 24767
ROBERT A. EICHINGER
Date Signed 05/31/06
ARIZONA, U.S.A.

PROJECT NO. 091725006

DRAWING NAME MODEL-AJ2

1 OF 1

K:\WaterResources\91725006\CADD\Exhibits\MODEL-AJ2.dwg May 31, 2006 Pat.Crawford
XREFS: AJSTA X72500BAE AJ XS LOC AJ DAMBREAK
THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

NOTES

1. TIME ZERO IS TAKEN AT THE TIME OF MAXIMUM FLOW THROUGH THE DAM BREACH.
2. MAPPED INUNDATION LIMITS AT CROSS SECTIONS CORRESPOND TO MAXIMUM STAGE ELEVATION.
3. INFLOW DESIGN FLOOD = 6-HR PROBABLE MAXIMUM FLOOD DEVELOPED IN PMP/PMF STUDY CONDUCTED UNDER FCD CONTRACT 2003C062.
4. THE STRUCTURAL INTEGRITY AND HYDRAULIC INTEGRITY OF ANY LEVEES, BERMS, CANAL EMBANKMENTS, DETENTION/RETENTION BASINS, OR FILL TO WITHSTAND EROSION (OR FAILURE) DURING FLOODING WAS NOT EVALUATED AS PART OF THIS STUDY.
5. THIS EXHIBIT SHOWS INUNDATION LIMITS FOR POTENTIAL PIPING FAILURE.
6. MAPPING/INUNDATION LIMITS FOR POTENTIAL OVERTOPPING OF BULLDOG FLOODWAY OR SIGNAL BUTTE FLOODWAY NOT INCLUDED IN SCOPE OF WORK.
7. MODEL SCENARIO NO. 3 ASSUMES APACHE JUNCTION FRS HAS FULL POOL AT BEGINNING OF SIMULATION.
8. DAM CREST ELEVATION OF APACHE JUNCTION FRS 1812.014 FT. (NAVD 88)
9. DAM BREAK FLOOD WAVE POTENTIALLY EXTENDS PAST (WEST) OF CROSS SECTION 9, AS INDICATED BY FLOW ARROWS.
10. DAM BREACH LOCATED AT APPROXIMATE MAXIMUM DAM SECTION.
11. HYDRAULIC BASELINE SET TO STATION 10,000.
12. DUE TO THE NATURE OF THE TOPOGRAPHY OF THIS AREA AND THE RESULTING BROAD, SHALLOW FLOODING ACROSS THE CROSS SECTIONS, THERE ARE SOME CROSS SECTIONS WITHIN THE MODELING WHICH SHOW FLOWS WITHIN A NATURAL SWALE WHEREAS THE SECTION IMMEDIATELY DOWNSTREAM MAY NOT SHOW FLOWS WITHIN THAT SAME SWALE. IN AREAS WHERE IT APPEARS THAT FLOWS WOULD CONTINUE (DUE TO TOPOGRAPHY, STREETS,TRAILER PARKS), THE INUNDATION LIMITS HAVE BEEN EXPANDED TO INCLUDE THOSE AREAS EVEN THOUGH THE HEC-RAS MODEL MAY NOT SHOW THESE AS INUNDATED AREAS.

BASE MAPPING SOURCE:

BASE MAPPING FROM FCD CONTRACT NUMBER FCD 03-49

MAPPING BASED ON NORTH AMERICAN VERTICAL DATUM 1988.

LEGEND

DAMBREAK INUNDATION BOUNDARY

CROSS SECTION LABEL (0)

CROSS SECTION LOCATION

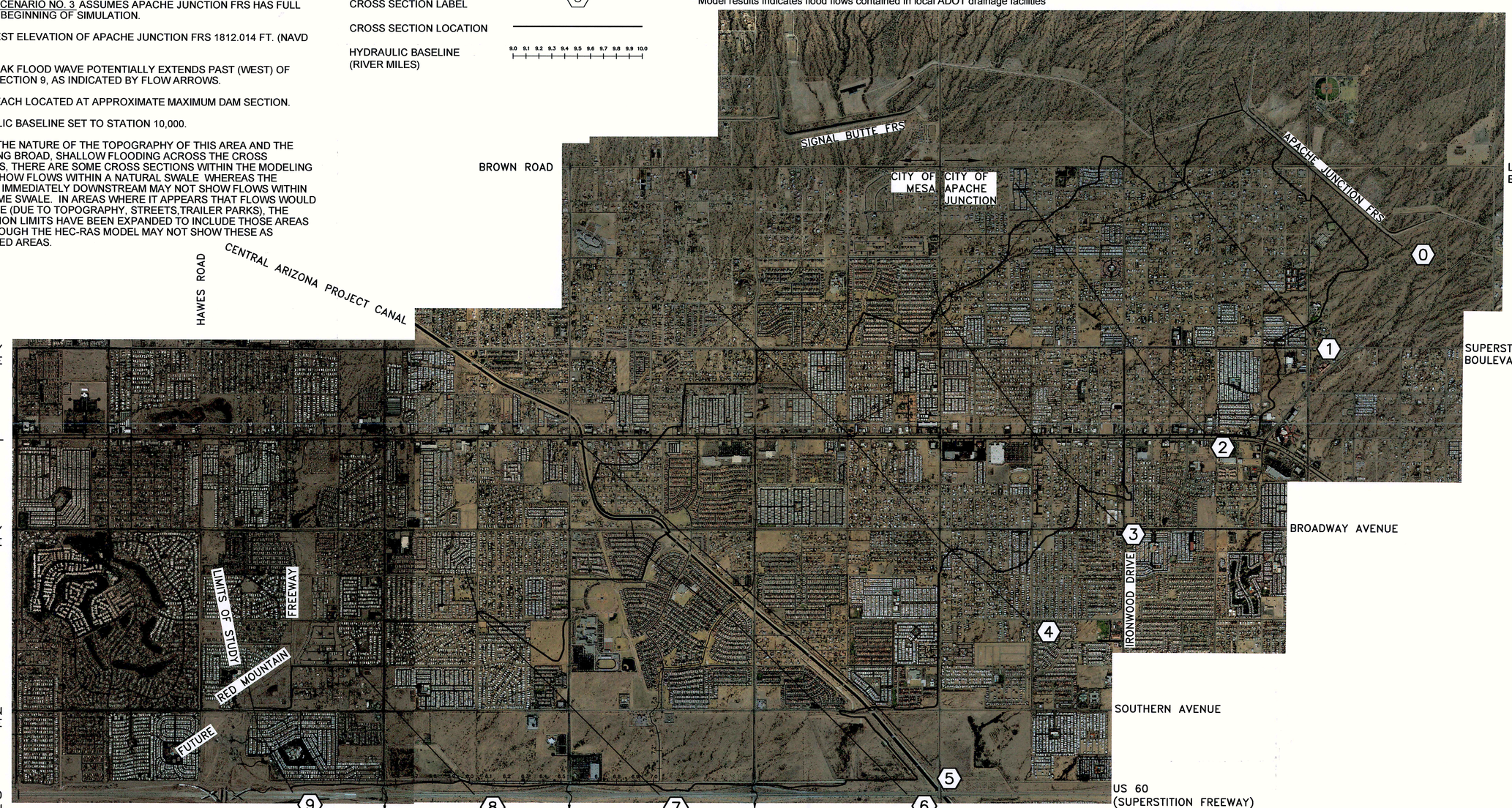
HYDRAULIC BASELINE (RIVER MILES) 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0

Cross Section ID	HEC-RAS Cross Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time To Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD 88)	Cross Section Reference
0	0.00	1.6	7,729	0.0	3.0	3.7	1.4	1787.56	APACHE JUNCTION FRS
1	0.56	1.9	7,372	0.3	2.5	2.8	1.2	1749.94	LOST DUTCHMAN BOULEVARD
2	1.37	1.3	7,108	0.8	2.5	3.0	1.0	1701.30	SUPERSTITION BOULEVARD
3	2.15	1.3	6,877	1.3	1.5	5.2	1.1	1661.30	APACHE TRAIL
4	3.21	1.4	6,238	2.2	1.8	5.2	1.2	1617.36	BROADWAY ROAD
5	4.58	2.5	2,660	3.1	0.1	0.4	1.9	1572.45	SOUTHERN AVENUE
6	4.76	1.2	2,575	4.9	1.1	3.9	1.3	1559.18	SIGNAL BUTTE ROAD
7	6.01	0.0*	2,239	6.6	3.6	5.1	0.2	1514.01	CRISMON ROAD
8	7.01	0.0*	2,139	7.6	3.5	4.0	2.8	1481.44	ELLSWORTH ROAD
9	7.97	0.0*	2,102	8.1	4.1	6.2	2.1	1451.38	RED MOUNTAIN FREEWAY

* Model results indicates flood flows contained in local ADOT drainage facilities

N

GRAPHIC SCALE
1500 0 750 1500 3000
(IN FEET)



NO.	REVISION	BY	DATE	APPR.

Kimley-Horn and Associates, Inc.

© 2006 KIMLEY-HORN AND ASSOCIATES, INC.

7878 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=1500'
SCALE (V): NONE
DESIGNED BY: PAC
DRAWN BY: PAC
CHECKED BY: RAE
DATE: 05/31/06

EXHIBIT C-3. BUCKHORN MESA STRUCTURES DAMBREAK MODEL SCENARIO NO. 3 SUNNY DAY

APACHE JUNCTION FLOOD RETARDING STRUCTURE

Registered Professional Engineer (Civil) CERTIFICATE NO. 24767 ROBERT A. EICHINGER Date Signed 05/31/06 ARIZONA, U.S.A.

PROJECT NO 091725006

DRAWING NAME MODEL-AJ3

1 OF 1

K:\WaterResources\091725006\CADD\Exhibits\MODEL-AJ3.dwg May 31, 2006 Pat Crawford
XREFS: AJSTA AJ DAMBREAK AJ XS LOC X725006AE02 X725006AE
THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

NOTES

1. TIME ZERO IS TAKEN AT THE TIME OF MAXIMUM FLOW THROUGH THE DAM BREACH.
2. MAPPED INUNDATION LIMITS AT CROSS SECTIONS CORRESPOND TO MAXIMUM STAGE ELEVATION.
3. INFLOW DESIGN FLOOD = 6-HR PROBABLE MAXIMUM FLOOD. DEVELOPED IN PMP/PMF STUDY CONDUCTED UNDER FCD CONTRACT 2003C062.
4. THE STRUCTURAL INTEGRITY AND HYDRAULIC INTEGRITY OF ANY LEVEES, BERMS, CANAL EMBANKMENTS, DETENTION/RETENTION BASINS, OR FILL TO WITHSTAND EROSION (OR FAILURE) DURING FLOODING WAS NOT EVALUATED AS PART OF THIS STUDY.
5. THIS EXHIBIT SHOWS INUNDATION LIMITS FOR POTENTIAL PIPING FAILURE.
6. MAPPING/INUNDATION LIMITS FOR POTENTIAL OVERTOPPING OF BULLDOG FLOODWAY OR SIGNAL BUTTE FLOODWAY NOT INCLUDED IN SCOPE OF WORK.
7. MODEL SCENARIO NO. 2 ASSUMES SIGNAL BUTTE FRS HAS EMPTY POOL AT BEGINNING OF SIMULATION. DAM BREACH INITIATION STARTS AT ELEVATION OF 1721.0 FT. (NAVD 88)
8. DAM CREST ELEVATION OF SIGNAL BUTTE FRS 1725.06 FT. (NAVD 88)
9. DAM BREAK FLOOD WAVE POTENTIALLY EXTENDS PAST (WEST) OF CROSS SECTION 8, AS INDICATED BY FLOW ARROWS.
10. DAM BREACH LOCATED AT APPROXIMATE MAXIMUM DAM SECTION.
11. HYDRAULIC BASELINE SET TO STATION 10,000.
12. DUE TO THE NATURE OF THE TOPOGRAPHY OF THIS AREA AND THE RESULTING BROAD, SHALLOW FLOODING ACROSS THE CROSS SECTIONS, THERE ARE SOME CROSS SECTIONS WITHIN THE MODELING WHICH SHOW FLOWS WITHIN A NATURAL SWALE WHEREAS THE SECTION IMMEDIATELY DOWNSTREAM MAY NOT SHOW FLOWS WITHIN THAT SAME SWALE. IN AREAS WHERE IT APPEARS THAT FLOWS WOULD CONTINUE (DUE TO TOPOGRAPHY, STREETS,TRAILER PARKS), THE INUNDATION LIMITS HAVE BEEN EXPANDED TO INCLUDE THOSE AREAS EVEN THOUGH THE HEC-RAS MODEL MAY NOT SHOW THESE AS INUNDATED AREAS.

BASE MAPPING SOURCE:

BASE MAPPING FROM FCD CONTRACT NUMBER FCD 03-49

MAPPING BASED ON NORTH AMERICAN VERTICAL DATUM 1988.

Cross Section ID	Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time To Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD 88)	Cross Section Reference
0	0	4.8	43,581	0.0	5.5	9.2	2.4	1692.75	SIGNAL BUTTE FRS
1	0.18	4.5	41,236	0.0	4.1	7.1	2.7	1682.46	LOST DUTCHMAN BOULEVARD
2	1.37	4.7	35,728	0.5	2.2	4.9	2.6	1626.67	SUPERSTITION BOULEVARD
3	2.36	1.9	33,706	1.1	2.8	6.3	2.7	1575.94	APACHE TRAIL/CAP CANAL
4	2.74	1.7	32,367	1.2	2.1	5.5	1.9	1559.67	BROADWAY ROAD/CRISMON ROAD
5	3.74	2.8	30,109	1.8	2.4	5.3	1.5	1510.79	ELLSWORTH ROAD
6	4.65	2.5	29,044	2.2	2.7	3.7	1.6	1482.49	RED MOUNTAIN FREEWAY
7	5.64	2.0	27,121	2.6	2.8	7.6	1.9	1446.01	HAWES ROAD
8	6.36	3.7	24,424	3.1	2.5	8.0	2.8	1425.73	80TH STREET

N

GRAPHIC SCALE
1500 0 750 1500 3000
(IN FEET)

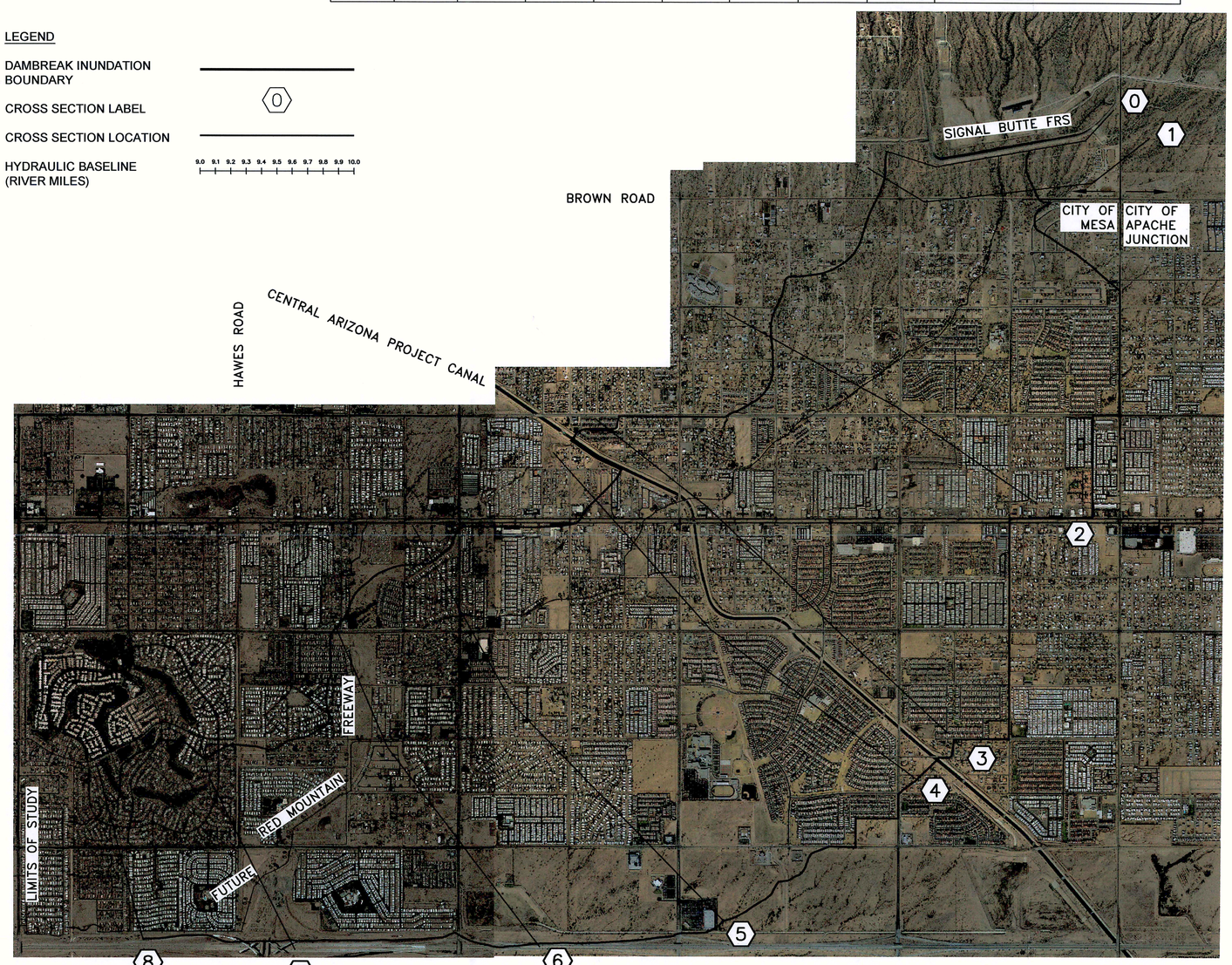
LEGEND

DAMBREAK INUNDATION BOUNDARY

CROSS SECTION LABEL (0)

CROSS SECTION LOCATION

HYDRAULIC BASELINE (RIVER MILES) 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0



NO.	REVISION	BY	DATE	APPR.

Kimley-Horn and Associates, Inc.

© 2006 KIMLEY-HORN AND ASSOCIATES, INC.
7878 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=1500'
SCALE (V): NONE
DESIGNED BY: PAC
DRAWN BY: PAC
CHECKED BY: RAE
DATE: 05/31/06

EXHIBIT C-4. BUCKHORN MESA STRUCTURES DAMBREAK MODEL SCENARIO NO. 1 EMPTY POOL SIGNAL BUTTE FLOOD RETARDING STRUCTURE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 24767
ROBERT A. EICHINGER
Date Signed 05/31/06
ARIZONA, U.S.A.

PROJECT NO. 091725006

DRAWING NAME MODEL-SB1

1 OF 1

K:\WaterResources\091725006\CADD\Exhibits\MODEL-SB1.dwg May 31, 2006 Pat.Crawford
XREFS: SBSTA SB XS LOC SB DAMBREAK X725006AE X725006AL02 X725006AE
THIS DRAWING IS AN INSTRUMENT OF SERVICE IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

NOTES

1. TIME ZERO IS TAKEN AT THE TIME OF MAXIMUM FLOW THROUGH THE DAM BREACH.
2. MAPPED INUNDATION LIMITS AT CROSS SECTIONS CORRESPOND TO MAXIMUM STAGE ELEVATION.
3. INFLOW DESIGN FLOOD = 6-HR PROBABLE MAXIMUM FLOOD. DEVELOPED IN PMP/PMF STUDY CONDUCTED UNDER FCD CONTRACT 2003C062.
4. THE STRUCTURAL INTEGRITY AND HYDRAULIC INTEGRITY OF ANY LEVEES, BERMS, CANAL EMBANKMENTS, DETENTION/RETENTION BASINS, OR FILL TO WITHSTAND EROSION (OR FAILURE) DURING FLOODING WAS NOT EVALUATED AS PART OF THIS STUDY.
5. THIS EXHIBIT SHOWS INUNDATION LIMITS FOR POTENTIAL PIPING FAILURE.
6. MAPPING/INUNDATION LIMITS FOR POTENTIAL OVERTOPPING OF BULLDOG FLOODWAY OR SIGNAL BUTTE FLOODWAY NOT INCLUDED IN SCOPE OF WORK.
7. MODEL SCENARIO NO. 2 ASSUMES SIGNAL BUTTE FRS HAS FULL POOL AT BEGINNING OF SIMULATION. DAM BREACH INITIATION STARTS AT ELEVATION OF 1725.0 FT. (NAVD 88)
8. DAM CREST ELEVATION OF SIGNAL BUTTE FRS 1725.06 FT. (NAVD 88)
9. DAM BREAK FLOOD WAVE POTENTIALLY EXTENDS PAST (WEST) OF CROSS SECTION 8, AS INDICATED BY FLOW ARROWS.
10. DAM BREACH LOCATED AT APPROXIMATE MAXIMUM DAM SECTION.
11. HYDRAULIC BASELINE SET TO STATION 10,000.
12. DUE TO THE NATURE OF THE TOPOGRAPHY OF THIS AREA AND THE RESULTING BROAD, SHALLOW FLOODING ACROSS THE CROSS SECTIONS, THERE ARE SOME CROSS SECTIONS WITHIN THE MODELING WHICH SHOW FLOWS WITHIN A NATURAL SWALE WHEREAS THE SECTION IMMEDIATELY DOWNSTREAM MAY NOT SHOW FLOWS WITHIN THAT SAME SWALE. IN AREAS WHERE IT APPEARS THAT FLOWS WOULD CONTINUE (DUE TO TOPOGRAPHY, STREETS,TRAILER PARKS), THE INUNDATION LIMITS HAVE BEEN EXPANDED TO INCLUDE THOSE AREAS EVEN THOUGH THE HEC-RAS MODEL MAY NOT SHOW THESE AS INDUNDATED AREAS.

BASE MAPPING SOURCE:

BASE MAPPING FROM FCD CONTRACT NUMBER FCD 03-49

MAPPING BASED ON NORTH AMERICAN VERTICAL DATUM 1988.

Cross Section ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time To Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD 88)	Cross Section Reference
0	0	5.4	62,833	0.0	6.2	10.0	3.0	1693.43	SIGNAL BUTTE FRS
1	0.18	5.2	60,547	0.0	4.7	7.7	3.4	1683.23	LOST DUTCHMAN BOULEVARD
2	1.37	5.4	52,006	0.4	2.5	5.7	3.2	1627.41	SUPERSTITION BOULEVARD
3	2.36	2.6	48,446	0.9	3.2	7.6	2.7	1576.58	APACHE TRAIL/CAP CANAL
4	2.74	2.3	46,925	1.0	2.2	6.3	2.0	1560.25	BROADWAY ROAD/CRISMON ROAD
5	3.74	3.3	44,417	1.5	2.7	5.8	1.8	1511.28	ELLSWORTH ROAD
6	4.65	3.0	42,811	1.8	2.9	4.3	2.0	1483.03	RED MOUNTAIN FREEWAY
7	5.64	2.6	39,979	2.3	3.1	7.8	2.5	1446.64	HAWES ROAD
8	6.36	4.8	36,665	2.6	2.7	8.7	3.7	1426.78	80TH STREET

N

GRAPHIC SCALE
1500 0 750 1500 3000
(IN FEET)

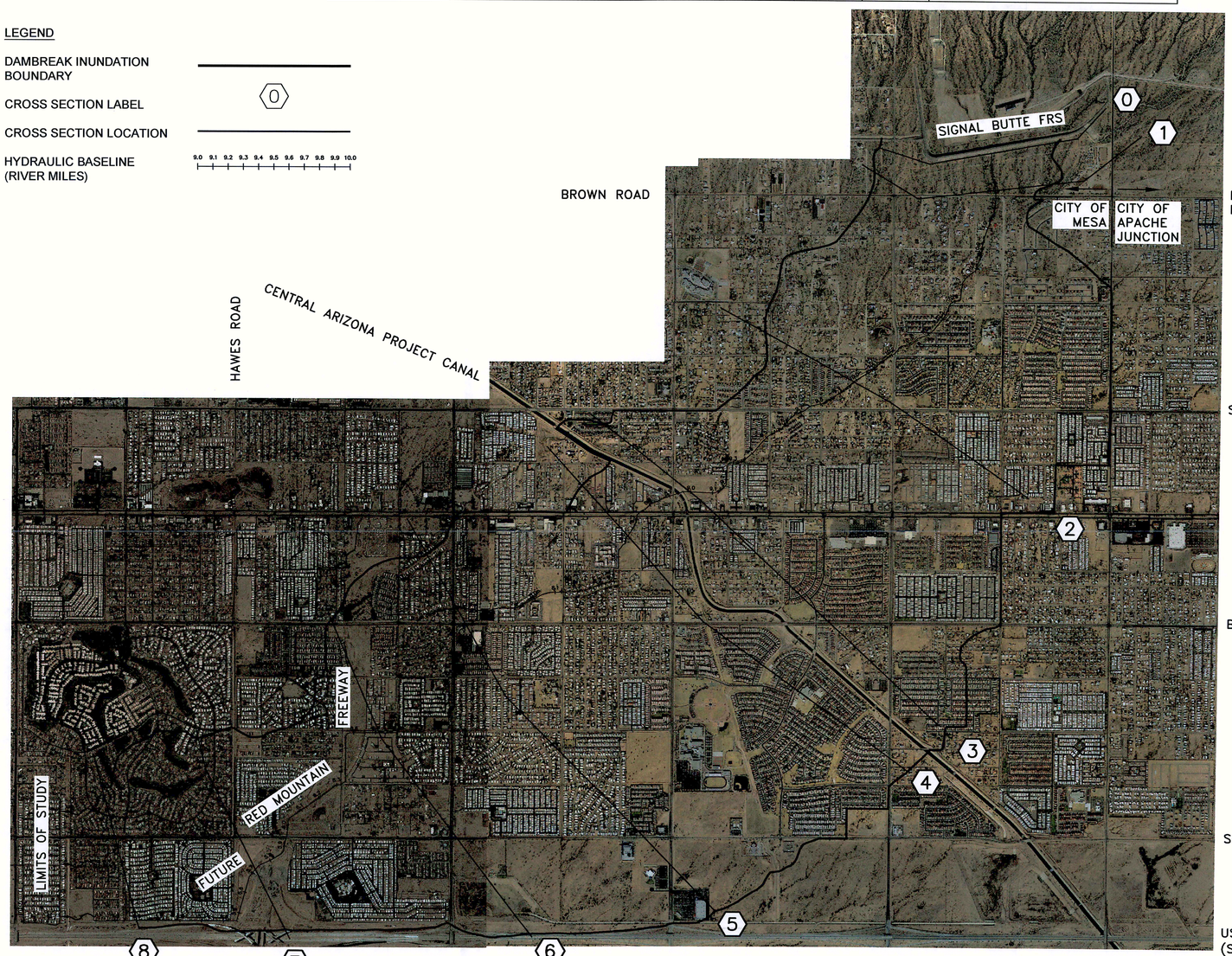
LEGEND

DAMBREAK INUNDATION BOUNDARY

CROSS SECTION LABEL (0)

CROSS SECTION LOCATION

HYDRAULIC BASELINE (RIVER MILES) 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0



NO.	REVISION	BY	DATE	APPR.

Kimley-Horn and Associates, Inc.

© 2006 KIMLEY-HORN AND ASSOCIATES, INC.

7878 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=1500'
SCALE (V): NONE

DESIGNED BY: PAC
DRAWN BY: PAC
CHECKED BY: RAE

DATE: 05/31/06

EXHIBIT C-5. BUCKHORN MESA STRUCTURES
DAMBREAK MODEL SCENARIO NO. 2
FULL POOL
SIGNAL BUTTE FLOOD RETARDING STRUCTURE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 24767
ROBERT A. EICHINGER
Date Signed 05/31/06
ARIZONA, U.S.A.

PROJECT NO. 091725006

DRAWING NAME MODEL-SB2

1 OF 1

K:\WaterResources\091725006\CADD\Exhibits\MODEL-SB2.dwg May 31, 2006 Pat.Crawford
XREFS: SBSTA SB DAMBREAK SB XS LOC X7250064E02 X7250064E
THIS DRAWING WAS PREPARED FOR THE USE OF KIMLEY-HORN AND ASSOCIATES, INC. AND SHALL NOT BE REPRODUCED IN WHOLE OR IN PART WITHOUT WRITTEN AUTHORIZATION BY KIMLEY-HORN AND ASSOCIATES, INC. THIS DOCUMENT WAS PREPARED FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

NOTES

1. TIME ZERO IS TAKEN AT THE TIME OF MAXIMUM FLOW THROUGH THE DAM BREACH.
2. MAPPED INUNDATION LIMITS AT CROSS SECTIONS CORRESPOND TO MAXIMUM STAGE ELEVATION.
3. INFLOW DESIGN FLOOD = 6-HR PROBABLE MAXIMUM FLOOD. DEVELOPED IN PMP/PMF STUDY CONDUCTED UNDER FCD CONTRACT 2003C062.
4. THE STRUCTURAL INTEGRITY AND HYDRAULIC INTEGRITY OF ANY LEVEES, BERMS, CANAL EMBANKMENTS, DETENTION/RETENTION BASINS, OR FILL TO WITHSTAND EROSION (OR FAILURE) DURING FLOODING WAS NOT EVALUATED AS PART OF THIS STUDY.
5. THIS EXHIBIT SHOWS INUNDATION LIMITS FOR POTENTIAL PIPING FAILURE.
6. MAPPING/INUNDATION LIMITS FOR POTENTIAL OVERTOPPING OF BULLDOG FLOODWAY OR SIGNAL BUTTE FLOODWAY NOT INCLUDED IN SCOPE OF WORK.
7. MODEL SCENARIO NO. 3 ASSUMES SIGNAL BUTTE FRS HAS FULL POOL AT BEGINNING OF SIMULATION. DAM BREACH INITIATION STARTS AT ELEVATION OF 1716.0 FT. (NAVD 88)
8. DAM CREST ELEVATION OF SIGNAL BUTTE FRS 1725.06 FT. (NAVD 88)
9. DAM BREAK FLOOD WAVE POTENTIALLY EXTENDS PAST (WEST) OF CROSS SECTION 8, AS INDICATED BY FLOW ARROWS.
10. DAM BREACH LOCATED AT APPROXIMATE MAXIMUM DAM SECTION.
11. HYDRAULIC BASELINE SET TO STATION 10,000.
12. DUE TO THE NATURE OF THE TOPOGRAPHY OF THIS AREA AND THE RESULTING BROAD, SHALLOW FLOODING ACROSS THE CROSS SECTIONS, THERE ARE SOME CROSS SECTIONS WITHIN THE MODELING WHICH SHOW FLOWS WITHIN A NATURAL SWALE WHERE AS THE SECTION IMMEDIATELY DOWNSTREAM MAY NOT SHOW FLOWS WITHIN THAT SAME SWALE. IN AREAS WHERE IT APPEARS THAT FLOWS WOULD CONTINUE (DUE TO TOPOGRAPHY, STREETS,TRAILER PARKS), THE INUNDATION LIMITS HAVE BEEN EXPANDED TO INCLUDE THOSE AREAS EVEN THOUGH THE HEC-RAS MODEL MAY NOT SHOW THESE AS INUNDATED AREAS.

BASE MAPPING SOURCE:

BASE MAPPING FROM FCD CONTRACT NUMBER FCD 03-49

MAPPING BASED ON NORTH AMERICAN VERTICAL DATUM 1988.

Cross Section ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time To Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD 88)	Cross Section Reference
0	0	4.0	28,596	0.0	5.2	7.9	2.5	1692.00	SIGNAL BUTTE FRS
1	0.18	3.6	27,251	0.2	3.8	6.2	2.4	1681.60	LOST DUTCHMAN BOULEVARD
2	1.37	4.0	25,480	0.7	2.0	4.2	2.1	1626.07	SUPERSTITION BOULEVARD
3	2.36	1.4	23,895	1.3	2.5	5.6	2.3	1575.37	APACHE TRAIL/CAP CANAL
4	2.74	1.2	22,777	1.4	1.9	5.0	1.5	1559.22	BROADWAY ROAD/CRISMON ROAD
5	3.74	2.4	21,232	2.1	2.3	4.9	1.2	1510.42	ELLSWORTH ROAD
6	4.65	2.0	20,452	2.4	2.6	3.2	1.2	1482.06	RED MOUNTAIN FREEWAY
7	5.64	1.6	19,137	3.0	2.6	7.4	1.6	1445.57	HAWES ROAD
8	6.36	2.9	16,919	3.4	2.4	7.4	2.1	1424.88	80TH STREET

N

GRAPHIC SCALE

1500 0 750 1500 3000

(IN FEET)

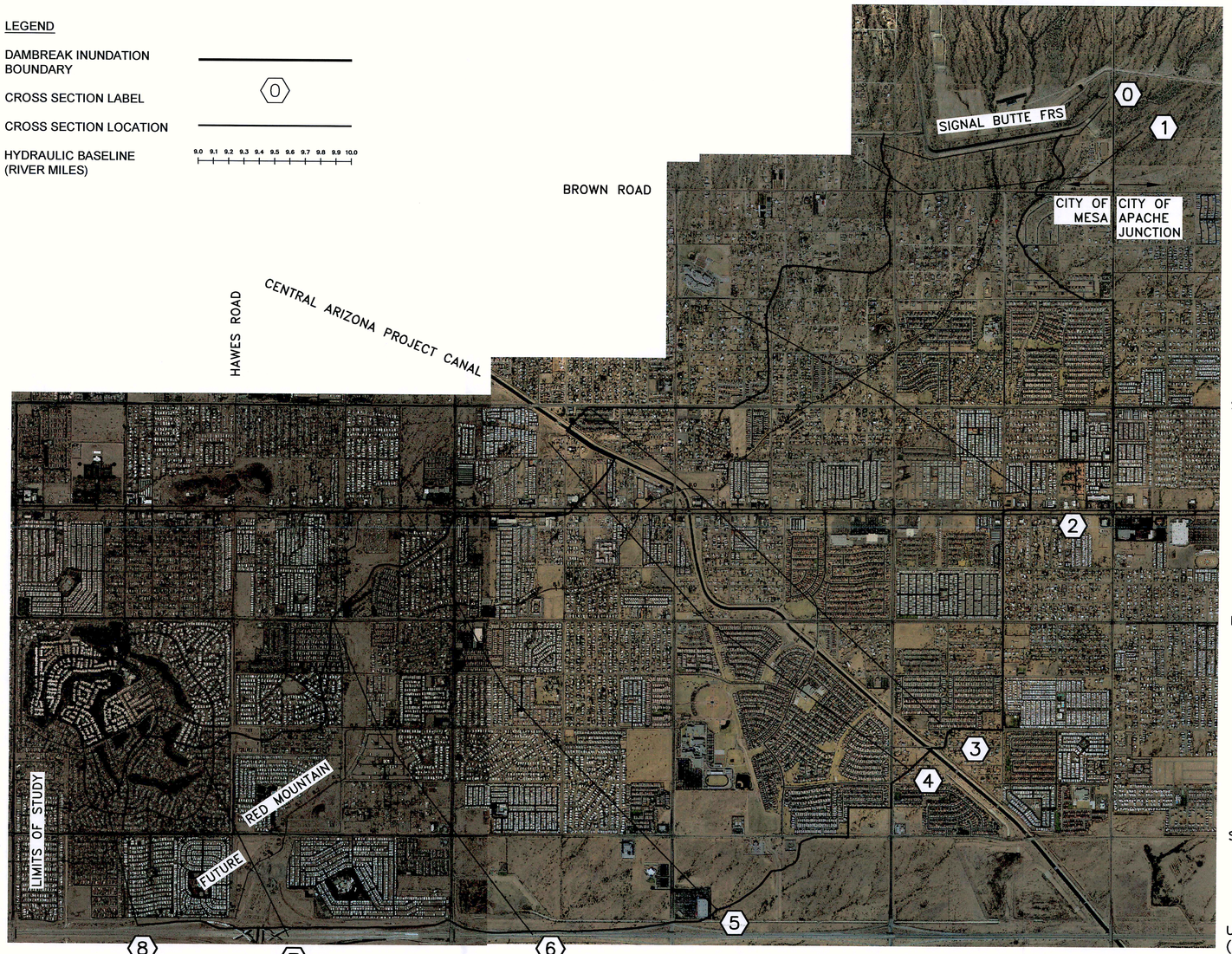
LEGEND

DAMBREAK INUNDATION BOUNDARY

CROSS SECTION LABEL (0)

CROSS SECTION LOCATION

HYDRAULIC BASELINE (RIVER MILES) 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0



NO.	REVISION	BY	DATE	APPR.

Kimley-Horn and Associates, Inc.

© 2006 KIMLEY-HORN AND ASSOCIATES, INC.

7878 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=1500'
SCALE (V): NONE

DESIGNED BY: PAC
DRAWN BY: PAC
CHECKED BY: RAE

DATE: 05/31/06

EXHIBIT C-6. BUCKHORN MESA STRUCTURES DAMBREAK MODEL SCENARIO NO. 3 SUNNY DAY

SIGNAL BUTTE FLOOD RETARDING STRUCTURE

Registered Professional Engineer (Civil) CERTIFICATE NO. 24767 ROBERT A. EICHINGER Date Signed 05/31/06 ARIZONA U.S.A.

PROJECT NO. 091725006

DRAWING NAME MODEL-SB3

1 OF 1

K:\Water\Resources\091725006\CADD\Exhibits\MODEL-SB3.dwg May 31, 2006 Pat Crawford
XREFS: SSTA SBUBASE XS LOX2700HAS03 2700BASE
This DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

APPENDIX D

Addendum to Dambreak Study for
Apache Junction FRS and Signal Butte FRS

Table D-1a

RAS SECTION ID Apache Junction	Section Location (mi) Downstream from Dam	Floodplain Depth at Max Flow (ft) Empty Pool	Floodplain Depth at Max Flow (ft) Full Pool	Floodplain Depth at Max Flow (ft) Sunny Day	Floodplain Ground Elevation (ft)
12.932	0.00	2.70	3.20	1.60	1786
12.406	0.56	2.80	3.00	1.90	1748
11.600	1.37	2.30	2.60	1.30	1700
10.817	2.15	2.40	2.70	1.30	1660
9.760	3.21	2.70	3.00	1.40	1616
8.391	4.58	3.20	3.50	2.50	1570
8.206	4.76	2.90	3.40	1.20	1558
6.959	6.01	1.10	1.40	0.00	1514
5.957	7.01	1.00	1.40	0.00	1482
5.000	7.97	2.70	3.30	0.00	1452

Table D-1b

RAS SECTION ID Signal Butte	Section Location (mi) Downstream from Dam	Floodplain Depth at Max Flow (ft) Empty Pool	Floodplain Depth at Max Flow (ft) Full Pool	Floodplain Depth at Max Flow (ft) Sunny Day	Floodplain Ground Elevation (ft)
11.353	0.00	4.80	5.40	4.00	1688
11.178	0.18	4.50	5.20	3.60	1678
9.983	1.37	4.70	5.40	4.00	1622
8.996	2.36	1.90	2.60	1.40	1574
8.612	2.74	1.70	2.30	1.20	1558
7.602	3.74	2.80	3.30	2.40	1508
6.715	4.65	2.50	3.00	2.00	1480
5.716	5.64	2.00	2.60	1.60	1444
5.000	6.36	3.70	4.80	2.90	1422

Table D-2

RAS SECTION ID	Section Location (mi)	Maximum Channel Depth (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	8.8	43,580	0.0	5.5	9.2	2.4	1692.75	SIGNAL BUTTE FRS
11.178	0.18	8.5	41,233	0.3	4.1	7.1	2.7	1682.46	LOST DUTCHMAN BOULEVARD
9.983	1.37	4.7	35,727	0.5	2.2	4.9	2.6	1626.67	SUPERSTITION BOULEVARD
8.996	2.36	9.9	33,837	1.1	2.9	6.4	2.7	1575.88	APACHE TRAIL/CAP CANAL
8.612	2.74	9.5	33,156	1.2	2.1	5.5	1.9	1559.70	BROADWAYROAD/CRISMON ROAD
7.602	3.74	6.8	31,087	1.7	2.4	5.4	1.5	1510.83	ELLSWORTH ROAD
6.715	4.65	26.5	30,229	2.4	2.7	3.7	1.6	1482.54	RED MOUNTAIN FREEWAY
5.716	5.64	16.1	28,840	2.8	2.9	7.6	2.0	1446.10	HAWES ROAD
5	6.36	11.9	26,153	3.2	2.5	8.1	2.9	1425.90	80TH STREET

RAS SECTION ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	4.8	43,581	0.0	5.5	9.2	2.4	1692.75	SIGNAL BUTTE FRS
11.178	0.18	4.5	41,236	0.0	4.1	7.1	2.7	1682.46	LOST DUTCHMAN BOULEVARD
9.983	1.37	4.7	35,728	0.5	2.2	4.9	2.6	1626.67	SUPERSTITION BOULEVARD
8.996	2.36	1.9	33,706	1.1	2.8	6.3	2.7	1575.94	APACHE TRAIL/CAP CANAL
8.612	2.74	1.7	32,367	1.2	2.1	5.5	1.9	1559.67	BROADWAYROAD/CRISMON ROAD
7.602	3.74	2.8	30,109	1.8	2.4	5.3	1.5	1510.79	ELLSWORTH ROAD
6.715	4.65	2.5	29,044	2.2	2.7	3.7	1.6	1482.49	RED MOUNTAIN FREEWAY
5.716	5.64	2.0	27,121	2.6	2.8	7.6	1.9	1446.01	HAWES ROAD
5	6.36	3.7	24,424	3.1	2.5	8.0	2.8	1425.73	80TH STREET

RAS SECTION ID	Section Location (mi)	Change in Depth at Max Flow (ft)	Change in Maximum Flow (cfs)	Change in Time to Peak (hr)	Change in Average Cross Section Velocity (ft/sec)	Change in Channel Velocity (ft/sec)	Change in Hydraulic Depth (ft)	Change in Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	4.0	-1	0.0	0.0	0.0	0.0	0.00	SIGNAL BUTTE FRS
11.178	0.18	4.0	-2	0.3	0.0	0.0	0.0	0.00	LOST DUTCHMAN BOULEVARD
9.983	1.37	0.0	-1	0.0	0.0	0.0	0.0	0.00	SUPERSTITION BOULEVARD
8.996	2.36	8.0	131	0.0	0.1	0.2	0.0	-0.06	APACHE TRAIL/CAP CANAL
8.612	2.74	7.8	789	0.0	0.0	0.0	0.0	0.03	BROADWAYROAD/CRISMON ROAD
7.602	3.74	4.0	978	-0.1	0.0	0.0	0.0	0.04	ELLSWORTH ROAD
6.715	4.65	24.0	1,185	0.2	0.0	0.1	0.0	0.05	RED MOUNTAIN FREEWAY
5.716	5.64	14.1	1,719	0.2	0.0	0.0	0.1	0.09	HAWES ROAD
5	6.36	8.2	1,729	0.1	0.0	0.1	0.1	0.17	80TH STREET

Table D-3

RAS SECTION ID	Section Location (mi)	Maximum Channel Depth (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	9.4	62,880	0.0	6.2	10.0	3.0	1693.43	SIGNAL BUTTE FRS
11.178	0.18	9.2	60,580	0.1	4.7	7.7	3.4	1683.23	LOST DUTCHMAN BOULEVARD
9.983	1.37	5.4	52,051	0.4	2.5	5.7	3.2	1627.40	SUPERSTITION BOULEVARD
8.996	2.36	10.5	48,570	0.9	3.2	7.7	2.7	1576.52	APACHE TRAIL/CAP CANAL
8.612	2.74	10.1	47,445	1.0	2.2	6.3	2.0	1560.26	BROADWAYROAD/CRISMON ROAD
7.602	3.74	7.3	45,010	1.5	2.7	5.8	1.8	1511.30	ELLSWORTH ROAD
6.715	4.65	27.1	43,635	1.8	3.0	4.3	2.1	1483.06	RED MOUNTAIN FREEWAY
5.716	5.64	16.7	41,400	2.2	3.1	7.8	2.5	1446.71	HAWES ROAD
5	6.36	13.0	38,370	2.6	2.7	8.7	3.9	1426.90	80TH STREET

RAS SECTION ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	5.4	62,833	0.0	6.2	10.0	3.0	1693.43	SIGNAL BUTTE FRS
11.178	0.18	5.2	60,547	0.0	4.7	7.7	3.4	1683.23	LOST DUTCHMAN BOULEVARD
9.983	1.37	5.4	52,006	0.4	2.5	5.7	3.2	1627.41	SUPERSTITION BOULEVARD
8.996	2.36	2.6	48,446	0.9	3.2	7.6	2.7	1576.58	APACHE TRAIL/CAP CANAL
8.612	2.74	2.3	46,925	1.0	2.2	6.3	2.0	1560.25	BROADWAYROAD/CRISMON ROAD
7.602	3.74	3.3	44,417	1.5	2.7	5.8	1.8	1511.28	ELLSWORTH ROAD
6.715	4.65	3.0	42,811	1.8	2.9	4.3	2.0	1483.03	RED MOUNTAIN FREEWAY
5.716	5.64	2.6	39,979	2.3	3.1	7.8	2.5	1446.64	HAWES ROAD
5	6.36	4.8	36,665	2.6	2.7	8.7	3.7	1426.78	80TH STREET

RAS SECTION ID	Section Location (mi)	Change in Depth at Max Flow (ft)	Change in Maximum Flow (cfs)	Change in Time to Peak (hr)	Change in Average Cross Section Velocity (ft/sec)	Change in Channel Velocity (ft/sec)	Change in Hydraulic Depth (ft)	Change in Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	4.0	47	0.0	0.0	0.0	0.0	0.00	SIGNAL BUTTE FRS
11.178	0.18	4.0	33	0.1	0.0	0.0	0.0	0.00	LOST DUTCHMAN BOULEVARD
9.983	1.37	0.0	45	0.0	0.0	0.0	0.0	-0.01	SUPERSTITION BOULEVARD
8.996	2.36	7.9	124	0.0	0.1	0.2	-0.1	-0.06	APACHE TRAIL/CAP CANAL
8.612	2.74	7.8	520	0.0	0.0	0.0	0.0	0.01	BROADWAYROAD/CRISMON ROAD
7.602	3.74	4.0	593	0.0	0.0	0.0	0.0	0.02	ELLSWORTH ROAD
6.715	4.65	24.1	824	0.0	0.0	0.0	0.0	0.03	RED MOUNTAIN FREEWAY
5.716	5.64	14.1	1,421	-0.1	0.0	0.0	0.1	0.07	HAWES ROAD
5	6.36	8.2	1,705	0.0	0.0	0.1	0.1	0.12	80TH STREET

RAS SECTION ID	Section Location (mi)	Maximum Channel Depth (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	8.0	28,730	0.0	5.2	8.9	1.8	1691.96	SIGNAL BUTTE FRS
11.178	0.18	7.6	27,315	0.1	3.8	6.2	2.4	1681.62	LOST DUTCHMAN BOULEVARD
9.983	1.37	4.1	25,544	0.5	2.0	4.2	2.1	1626.09	SUPERSTITION BOULEVARD
8.996	2.36	9.3	24,025	1.1	2.6	5.7	2.3	1575.34	APACHE TRAIL/CAP CANAL
8.612	2.74	9.1	23,525	1.2	1.9	5.1	1.5	1559.26	BROADWAYROAD/CRISMON ROAD
7.602	3.74	6.5	21,890	1.8	2.3	5.0	1.2	1510.46	ELLSWORTH ROAD
6.715	4.65	26.1	21,210	2.2	2.6	3.3	1.2	1482.12	RED MOUNTAIN FREEWAY
5.716	5.64	15.7	20,080	2.7	2.6	7.4	1.6	1445.64	HAWES ROAD
5	6.36	11.0	18,090	3.1	2.4	7.5	2.2	1425.04	80TH STREET

RAS SECTION ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	4.0	28,596	0.0	5.2	7.9	2.5	1692.00	SIGNAL BUTTE FRS
11.178	0.18	3.6	27,251	0.2	3.8	6.2	2.4	1681.60	LOST DUTCHMAN BOULEVARD
9.983	1.37	4.0	25,480	0.7	2.0	4.2	2.1	1626.07	SUPERSTITION BOULEVARD
8.996	2.36	1.4	23,895	1.3	2.5	5.6	2.3	1575.37	APACHE TRAIL/CAP CANAL
8.612	2.74	1.2	22,777	1.4	1.9	5.0	1.5	1559.22	BROADWAYROAD/CRISMON ROAD
7.602	3.74	2.4	21,232	2.1	2.3	4.9	1.2	1510.42	ELLSWORTH ROAD
6.715	4.65	2.0	20,452	2.4	2.6	3.2	1.2	1482.06	RED MOUNTAIN FREEWAY
5.716	5.64	1.6	19,137	3.0	2.6	7.4	1.6	1445.57	HAWES ROAD
5	6.36	2.9	16,919	3.4	2.4	7.4	2.1	1424.88	80TH STREET

RAS SECTION ID	Section Location (mi)	Change in Depth at Max Flow (ft)	Change in Maximum Flow (cfs)	Change in Time to Peak (hr)	Change in Average Cross Section Velocity (ft/sec)	Change in Channel Velocity (ft/sec)	Change in Hydraulic Depth (ft)	Change in Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
11.353	0.00	4.0	134	0.0	0.0	1.0	-0.7	-0.04	SIGNAL BUTTE FRS
11.178	0.18	4.0	64	-0.1	0.0	0.0	0.0	0.02	LOST DUTCHMAN BOULEVARD
9.983	1.37	0.1	64	-0.2	0.0	0.0	0.0	0.02	SUPERSTITION BOULEVARD
8.996	2.36	7.9	130	-0.2	0.1	0.1	0.0	-0.03	APACHE TRAIL/CAP CANAL
8.612	2.74	7.9	748	-0.2	0.0	0.0	0.0	0.04	BROADWAYROAD/CRISMON ROAD
7.602	3.74	4.1	659	-0.3	0.0	0.0	0.0	0.04	ELLSWORTH ROAD
6.715	4.65	24.1	757	-0.2	0.0	0.0	0.0	0.06	RED MOUNTAIN FREEWAY
5.716	5.64	14.1	943	-0.3	0.0	0.0	0.1	0.07	HAWES ROAD
5	6.36	8.1	1,171	-0.3	0.0	0.1	0.1	0.16	80TH STREET

RAS SECTION ID	Section Location (mi)	Maximum Channel Depth (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	8.7	21,780	0.0	4.1	5.5	2.1	1788.77	APACHE JUNCTION FRS
12.406	0.56	2.8	21,150	0.2	2.9	4.4	1.4	1750.82	LOST DUTCHMAN BOULEVARD
11.6	1.37	2.3	20,620	0.5	3.0	4.3	1.1	1702.3	SUPERSTITIION BOULEVARD
10.817	2.15	4.4	20,008	0.9	1.8	7.2	1.4	1662.43	APACHE TRAIL
9.76	3.21	4.7	18,580	1.5	2.1	7.1	1.5	1618.66	BROADWAY ROAD
8.391	4.58	9.2	17,270	2.2	1.7	5.5	1.4	1571.22	SOUTHERN AVENUE
8.206	4.76	19.5	15,653	2.4	1.5	6.0	2.1	1561.39	SIGNAL BUTTE ROAD
6.959	6.01	9.3	14,430	3.2	2.4	6.0	1.3	1515.32	CRISMON ROAD
5.957	7.01	23.3	13,508	3.7	2.6	7.6	1.3	1483.27	ELLSWORTH ROAD
5	7.97	13.0	12,020	4.3	2.5	8.8	1.8	1455.02	RED MOUNTAIN FREEWAY

RAS SECTION ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	2.7	21,796	0.0	4.1	5.5	2.1	1788.77	APACHE JUNCTION FRS
12.406	0.56	2.8	21,173	0.2	2.9	4.4	1.4	1750.81	LOST DUTCHMAN BOULEVARD
11.6	1.37	2.3	20,639	0.5	3.0	4.3	1.1	1702.30	SUPERSTITIION BOULEVARD
10.817	2.15	2.4	20,005	0.9	1.8	7.2	1.4	1662.43	APACHE TRAIL
9.76	3.21	2.7	18,629	1.5	2.1	7.1	1.5	1618.66	BROADWAY ROAD
8.391	4.58	3.2	12,342	2.2	0.4	1.4	2.7	1573.21	SOUTHERN AVENUE
8.206	4.76	2.9	12,212	2.9	1.5	6.4	1.7	1560.98	SIGNAL BUTTE ROAD
6.959	6.01	1.1	11,575	3.6	2.3	5.8	1.1	1515.12	CRISMON ROAD
5.957	7.01	1.0	10,947	4.1	2.5	7.3	1.1	1483.06	ELLSWORTH ROAD
5	7.97	2.7	9,827	4.8	2.5	8.5	1.5	1454.67	RED MOUNTAIN FREEWAY

RAS SECTION ID	Section Location (mi)	Change in Depth at Max Flow (ft)	Change in Maximum Flow (cfs)	Change in Time to Peak (hr)	Change in Average Cross Section Velocity (ft/sec)	Change in Channel Velocity (ft/sec)	Change in Hydraulic Depth (ft)	Change in Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	6.0	-16	0.0	0.0	0.0	0.0	0	APACHE JUNCTION FRS
12.406	0.56	0.0	-23	0.0	0.0	0.0	0.0	0.01	LOST DUTCHMAN BOULEVARD
11.6	1.37	0.0	-19	0.0	0.0	0.0	0.0	0	SUPERSTITIION BOULEVARD
10.817	2.15	2.0	2	0.0	0.0	0.0	0.0	0	APACHE TRAIL
9.76	3.21	2.0	-49	0.0	0.0	0.0	0.0	0	BROADWAY ROAD
8.391	4.58	6.0	4,928	0.0	1.3	4.1	-1.3	-1.99	SOUTHERN AVENUE
8.206	4.76	16.6	3,441	-0.5	0.0	-0.3	0.4	0.41	SIGNAL BUTTE ROAD
6.959	6.01	8.2	2,855	-0.4	0.1	0.2	0.2	0.2	CRISMON ROAD
5.957	7.01	22.3	2,562	-0.4	0.1	0.3	0.2	0.21	ELLSWORTH ROAD
5	7.97	10.3	2,193	-0.5	-0.1	0.2	0.4	0.35	RED MOUNTAIN FREEWAY

RAS SECTION ID	Section Location (mi)	Maximum Channel Depth (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	9.1	28,200	0.0	4.5	6.0	2.5	1789.14	APACHE JUNCTION FRS
12.406	0.56	3.1	26,960	0.2	3.2	4.8	1.6	1751.04	LOST DUTCHMAN BOULEVARD
11.6	1.37	2.5	26,130	0.6	3.1	4.6	1.3	1702.54	SUPERSTITIION BOULEVARD
10.817	2.15	4.7	25,475	0.9	1.9	7.5	1.6	1662.68	APACHE TRAIL
9.76	3.21	5.0	24,000	1.4	2.2	7.4	1.7	1618.97	BROADWAY ROAD
8.391	4.58	9.5	22,490	2.1	1.8	5.8	1.6	1571.53	SOUTHERN AVENUE
8.206	4.76	20.2	17,720	2.2	1.1	5.0	1.5	1562.02	SIGNAL BUTTE ROAD
6.959	6.01	9.6	19,070	3.0	2.6	6.3	1.5	1515.61	CRISMON ROAD
5.957	7.01	23.6	18,400	3.4	2.8	8.0	1.5	1483.6	ELLSWORTH ROAD
5	7.97	13.5	16,230	4.0	2.2	6.0	2.7	1455.52	RED MOUNTAIN FREEWAY

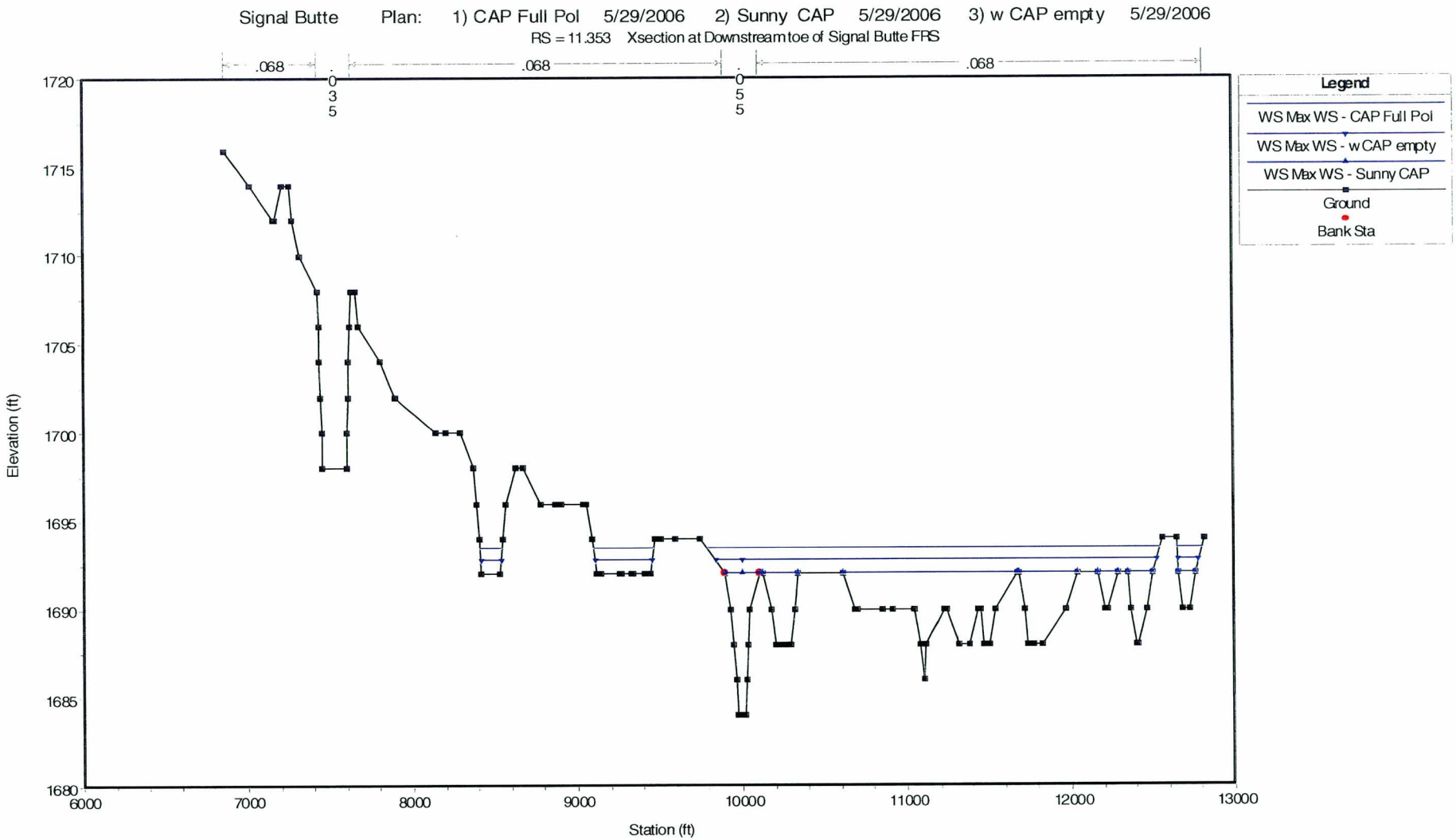
RAS SECTION ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	3.2	28,569	0.0	4.5	6.0	2.5	1789.17	APACHE JUNCTION FRS
12.406	0.56	3.0	27,289	0.2	3.2	4.8	1.6	1751.05	LOST DUTCHMAN BOULEVARD
11.6	1.37	2.6	26,459	0.6	3.1	4.6	1.4	1702.55	SUPERSTITIION BOULEVARD
10.817	2.15	2.7	25,817	0.9	1.9	7.5	1.6	1662.69	APACHE TRAIL
9.76	3.21	3.0	24,403	1.4	2.3	7.5	1.7	1618.99	BROADWAY ROAD
8.391	4.58	3.5	17,262	2.0	0.5	1.8	3.0	1573.51	SOUTHERN AVENUE
8.206	4.76	3.4	17,042	2.7	1.6	6.8	2.0	1561.40	SIGNAL BUTTE ROAD
6.959	6.01	1.4	16,118	3.3	2.5	6.1	1.4	1515.43	CRISMON ROAD
5.957	7.01	1.4	15,314	3.7	2.6	7.7	1.4	1483.41	ELLSWORTH ROAD
5	7.97	3.3	13,779	4.3	2.5	9.0	2.1	1455.30	RED MOUNTAIN FREEWAY

RAS SECTION ID	Section Location (mi)	Change in Depth at Max Flow (ft)	Change in Maximum Flow (cfs)	Change in Time to Peak (hr)	Change in Average Cross Section Velocity (ft/sec)	Change in Channel Velocity (ft/sec)	Change in Hydraulic Depth (ft)	Change in Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	5.9	-369	0.0	0.0	0.0	0.0	-0.03	APACHE JUNCTION FRS
12.406	0.56	0.0	-329	0.0	0.0	0.0	0.0	-0.01	LOST DUTCHMAN BOULEVARD
11.6	1.37	-0.1	-329	0.0	0.0	0.0	0.0	-0.01	SUPERSTITIION BOULEVARD
10.817	2.15	2.0	-342	0.0	0.0	0.0	0.0	-0.01	APACHE TRAIL
9.76	3.21	2.0	-403	0.0	0.0	-0.1	0.0	-0.02	BROADWAY ROAD
8.391	4.58	6.0	5,228	0.1	1.3	4.1	-1.3	-1.98	SOUTHERN AVENUE
8.206	4.76	16.8	678	-0.4	-0.5	-1.8	-0.5	0.62	SIGNAL BUTTE ROAD
6.959	6.01	8.2	2,952	-0.3	0.1	0.2	0.2	0.18	CRISMON ROAD
5.957	7.01	22.2	3,086	-0.3	0.1	0.3	0.1	0.19	ELLSWORTH ROAD
5	7.97	10.2	2,451	-0.3	-0.3	-3.0	0.6	0.22	RED MOUNTAIN FREEWAY

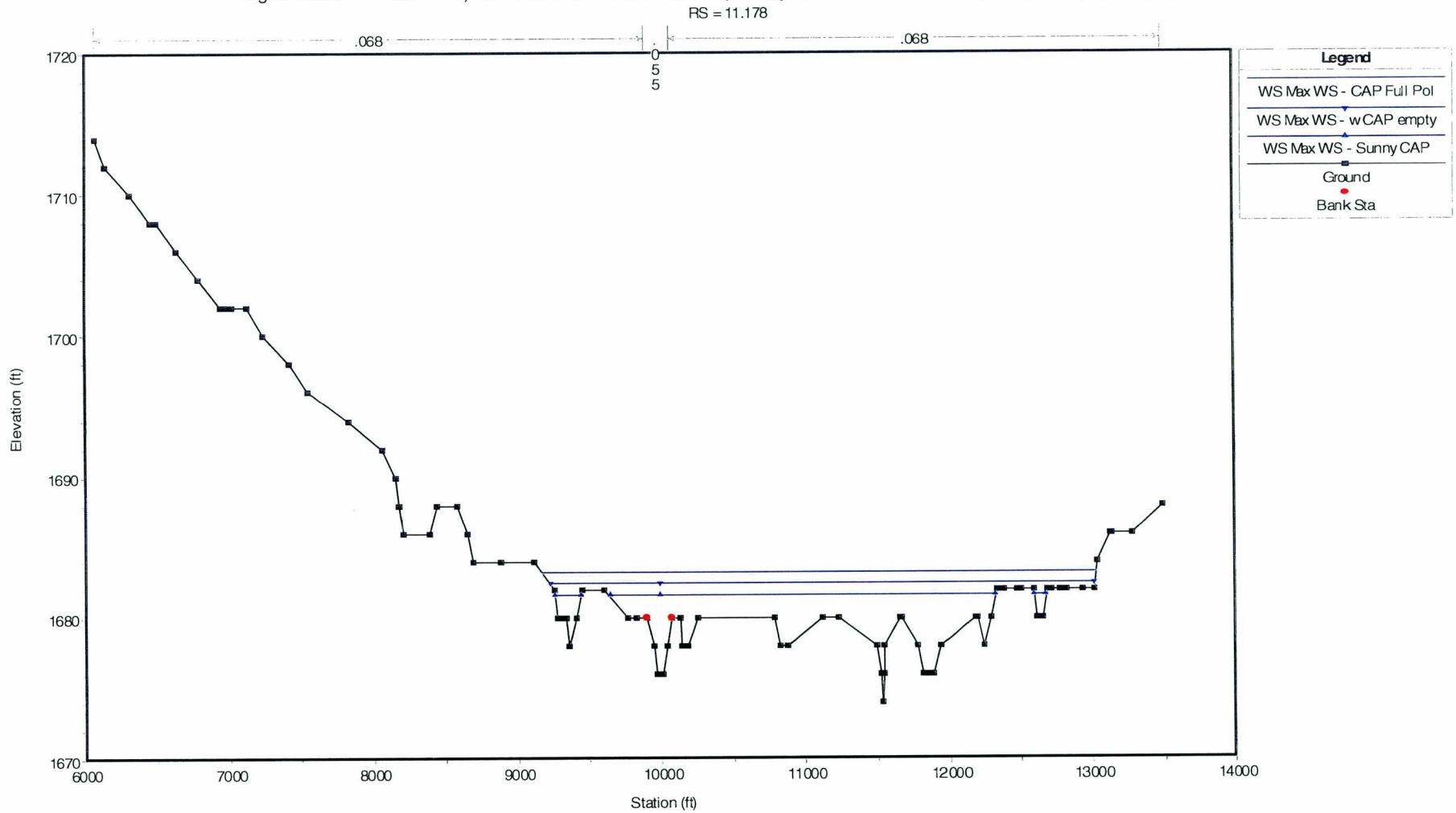
RAS SECTION ID	Section Location (mi)	Maximum Channel Depth (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	7.5	7,610	0.0	3.0	3.7	1.4	1787.54	APACHE JUNCTION FRS
12.406	0.56	1.9	7,274	0.3	2.5	2.8	1.2	1749.92	LOST DUTCHMAN BOULEVARD
11.6	1.37	1.3	7,001	0.8	2.5	3.0	1.0	1701.29	SUPERSTITIION BOULEVARD
10.817	2.15	3.3	6,770	1.3	1.5	5.2	1.1	1661.29	APACHE TRAIL
9.76	3.21	3.3	5,943	2.2	1.8	5.2	1.2	1617.32	BROADWAY ROAD
8.391	4.58	8.1	5,239	3.2	2.9	3.9	0.3	1570.06	SOUTHERN AVENUE
8.206	4.76	17.9	4,958	3.4	1.4	4.8	1.8	1559.86	SIGNAL BUTTE ROAD
6.959	6.01	8.4	4,287	4.7	2.0	5.1	0.6	1514.44	CRISMON ROAD
5.957	7.01	22.1	3,748	5.6	3.6	5.9	0.4	1482.09	ELLSWORTH ROAD
5	7.97	10.5	3,562	6.3	4.3	7.0	1.8	1452.46	RED MOUNTAIN FREEWAY

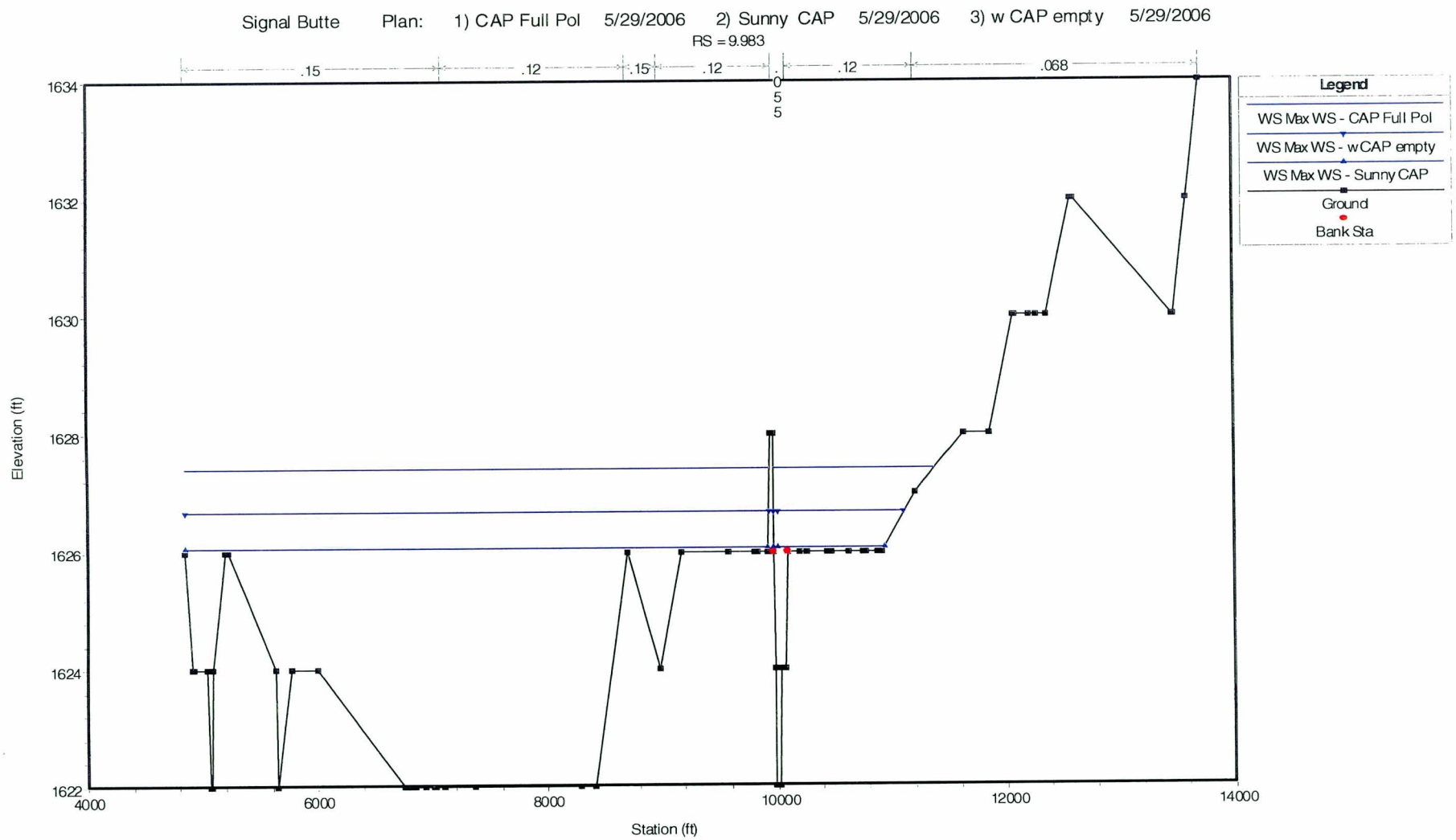
Cross Section ID	Section Location (mi)	Floodplain Depth at Max Flow (ft)	Maximum Flow (cfs)	Time to Peak (hr)	Average Cross Section Velocity (ft/sec)	Channel Velocity (ft/sec)	Hydraulic Depth (ft)	Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	1.6	7,729	0.0	3.0	3.7	1.4	1787.56	APACHE JUNCTION FRS
12.406	0.56	1.9	7,372	0.3	2.5	2.8	1.2	1749.94	LOST DUTCHMAN BOULEVARD
11.6	1.37	1.3	7,108	0.8	2.5	3.0	1.0	1701.3	SUPERSTITIION BOULEVARD
10.817	2.15	1.3	6,877	1.3	1.5	5.2	1.1	1661.3	APACHE TRAIL
9.76	3.21	1.4	6,238	2.2	1.8	5.2	1.2	1617.36	BROADWAY ROAD
8.391	4.58	2.5	2,660	3.1	0.1	0.4	1.9	1572.45	SOUTHERN AVENUE
8.206	4.76	1.2	2,575	4.9	1.1	3.9	1.3	1559.18	SIGNAL BUTTE ROAD
6.959	6.01	0.0	2,239	6.6	3.6	5.1	0.2	1514.01	CRISMON ROAD
5.957	7.01	0.0	2,139	7.6	3.5	4.0	2.8	1481.44	ELLSWORTH ROAD
5	7.97	0.0	2,102	8.1	4.1	6.2	2.1	1451.38	RED MOUNTAIN FREEWAY

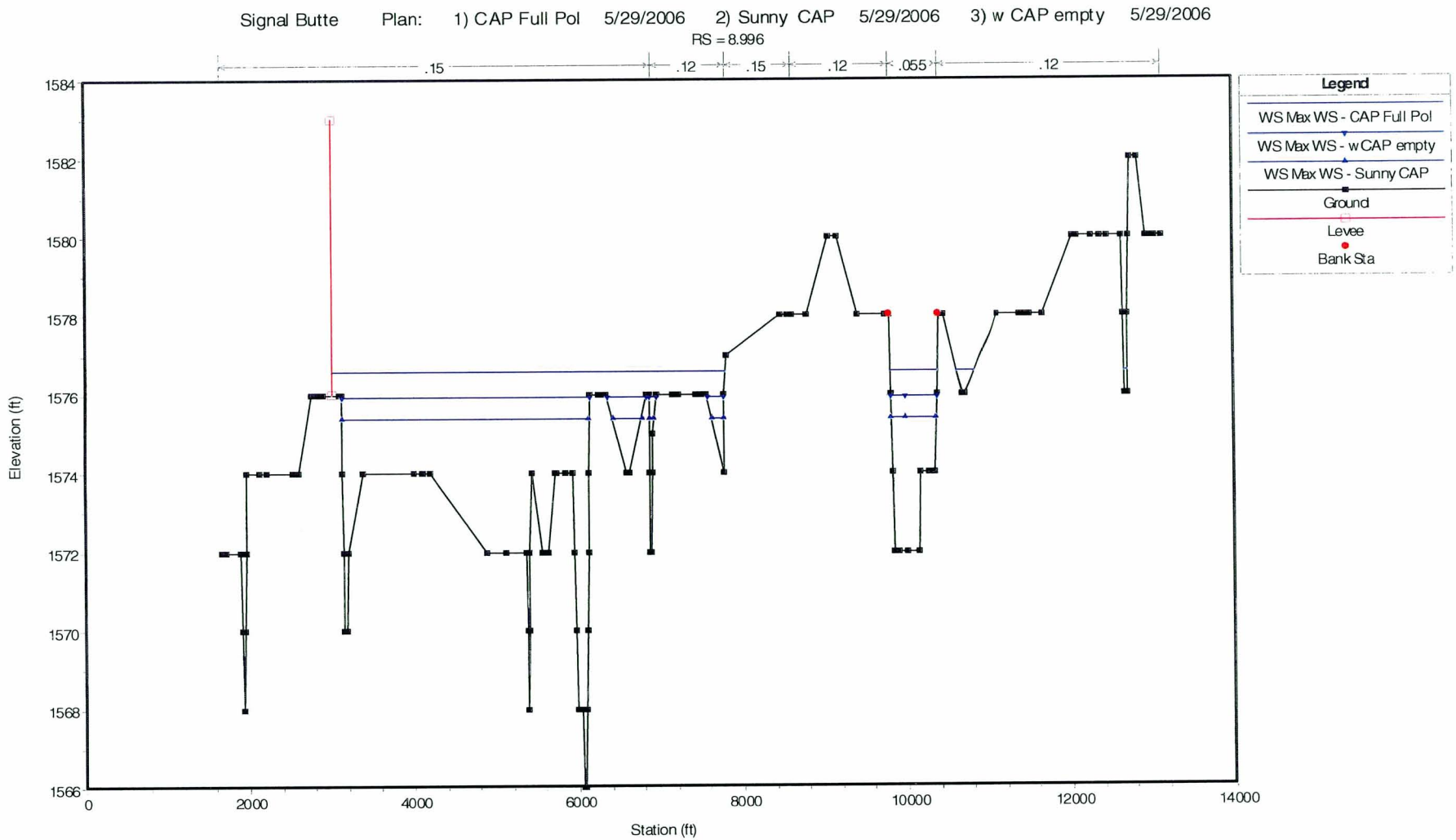
RAS SECTION ID	Section Location (mi)	Change in Depth at Max Flow (ft)	Change in Maximum Flow (cfs)	Change in Time to Peak (hr)	Change in Average Cross Section Velocity (ft/sec)	Change in Channel Velocity (ft/sec)	Change in Hydraulic Depth (ft)	Change in Maximum Stage Elevation (ft) (NAVD88)	Cross Section Reference
12.932	0.00	5.9	-119	0.0	0.0	0.0	0.0	-0.02	APACHE JUNCTION FRS
12.406	0.56	0.0	-98	0.0	0.0	0.0	0.0	-0.02	LOST DUTCHMAN BOULEVARD
11.6	1.37	0.0	-107	0.0	0.0	0.0	0.0	-0.01	SUPERSTITIION BOULEVARD
10.817	2.15	2.0	-107	0.0	0.0	0.0	0.0	-0.01	APACHE TRAIL
9.76	3.21	1.9	-295	0.0	0.0	-0.1	0.0	-0.04	BROADWAY ROAD
8.391	4.58	5.6	2,579	0.1	2.7	3.4	-1.7	-2.39	SOUTHERN AVENUE
8.206	4.76	16.7	2,383	-1.4	0.3	0.9	0.5	0.68	SIGNAL BUTTE ROAD
6.959	6.01	8.4	2,049	-1.9	-1.6	0.0	0.4	0.43	CRISMON ROAD
5.957	7.01	22.1	1,609	-2.0	0.1	2.0	-2.5	0.65	ELLSWORTH ROAD
5	7.97	10.5	1,460	-1.7	0.2	0.8	-0.4	1.08	RED MOUNTAIN FREEWAY

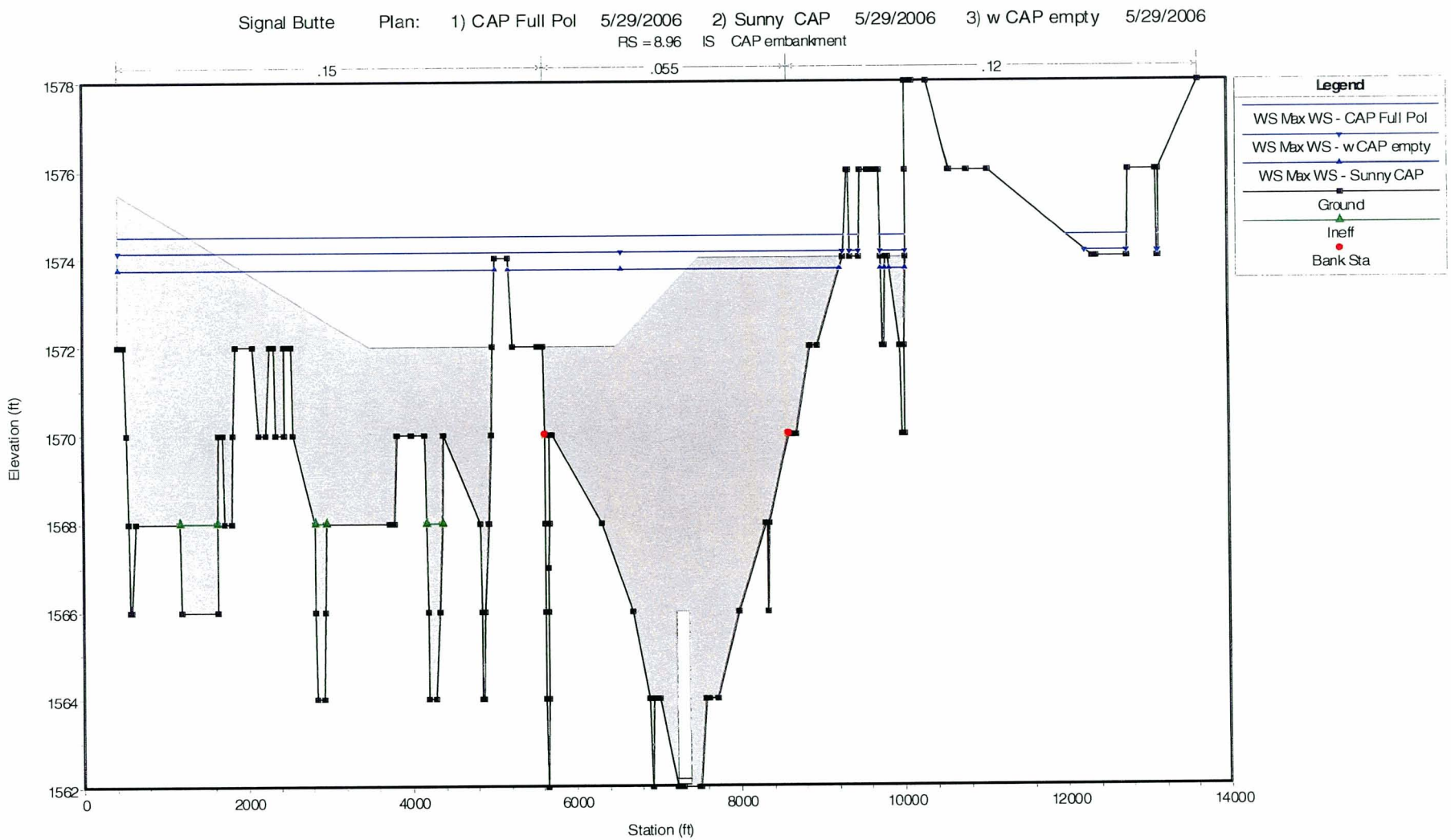

Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 11.353 Xsection at Downstream toe of Signal Butte FRS
.068
.035
.068
.055
.068
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Bank Sta
Elevation (ft)
1720
1715
1710
1705
1700
1695
1690
1685
1680
6000
7000
8000
9000
10000
11000
12000
13000
Station (ft)

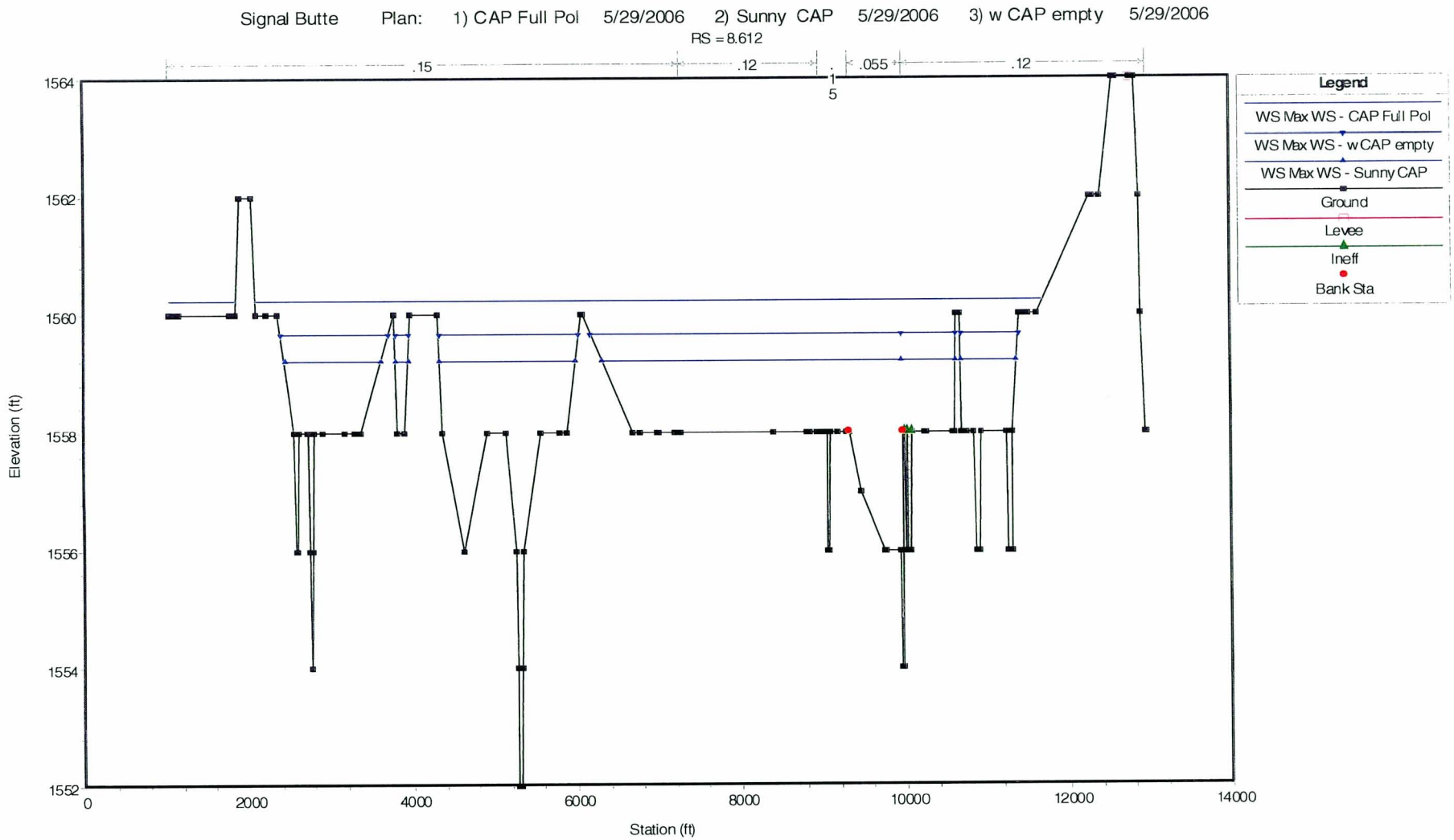
Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006

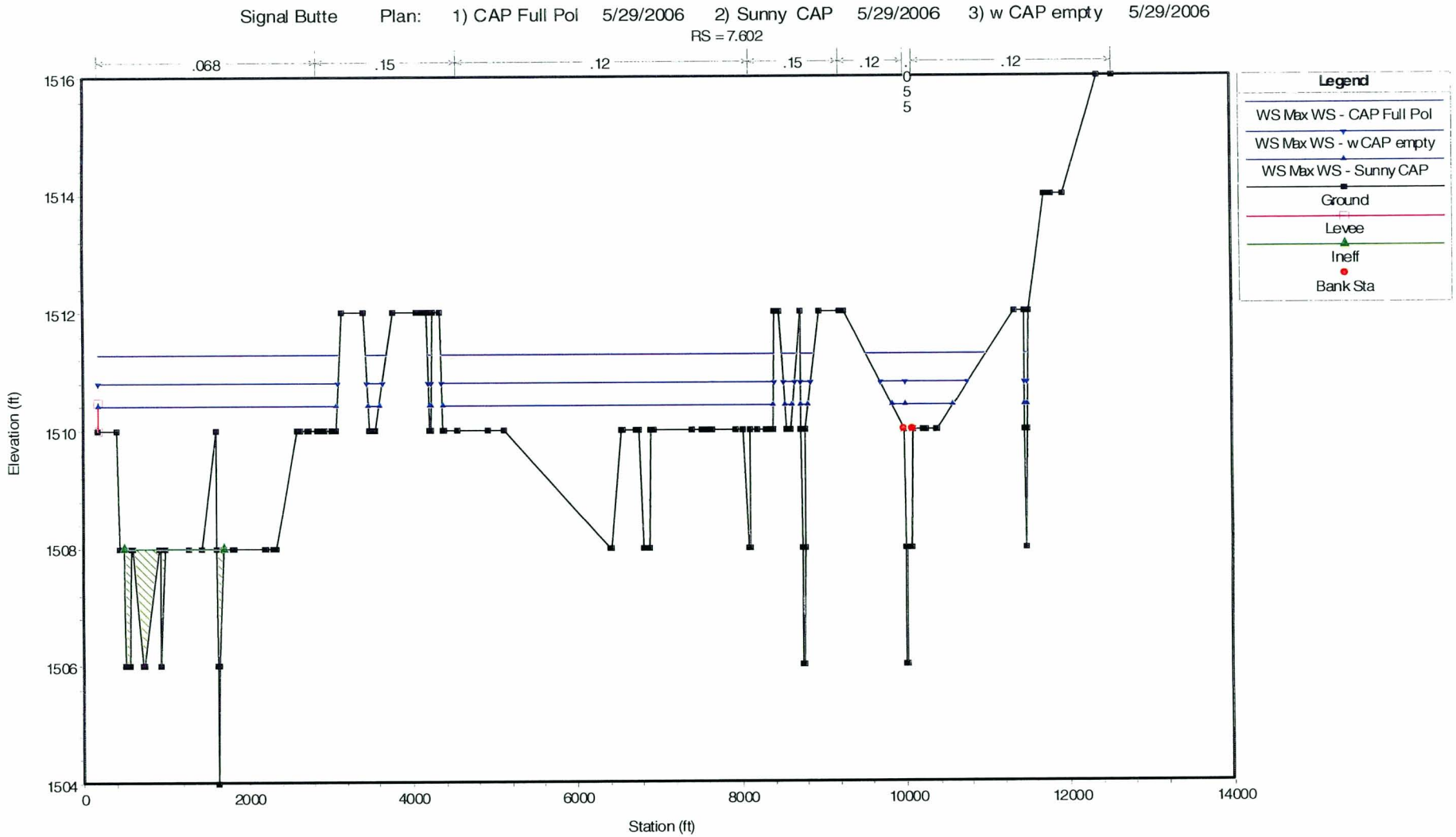


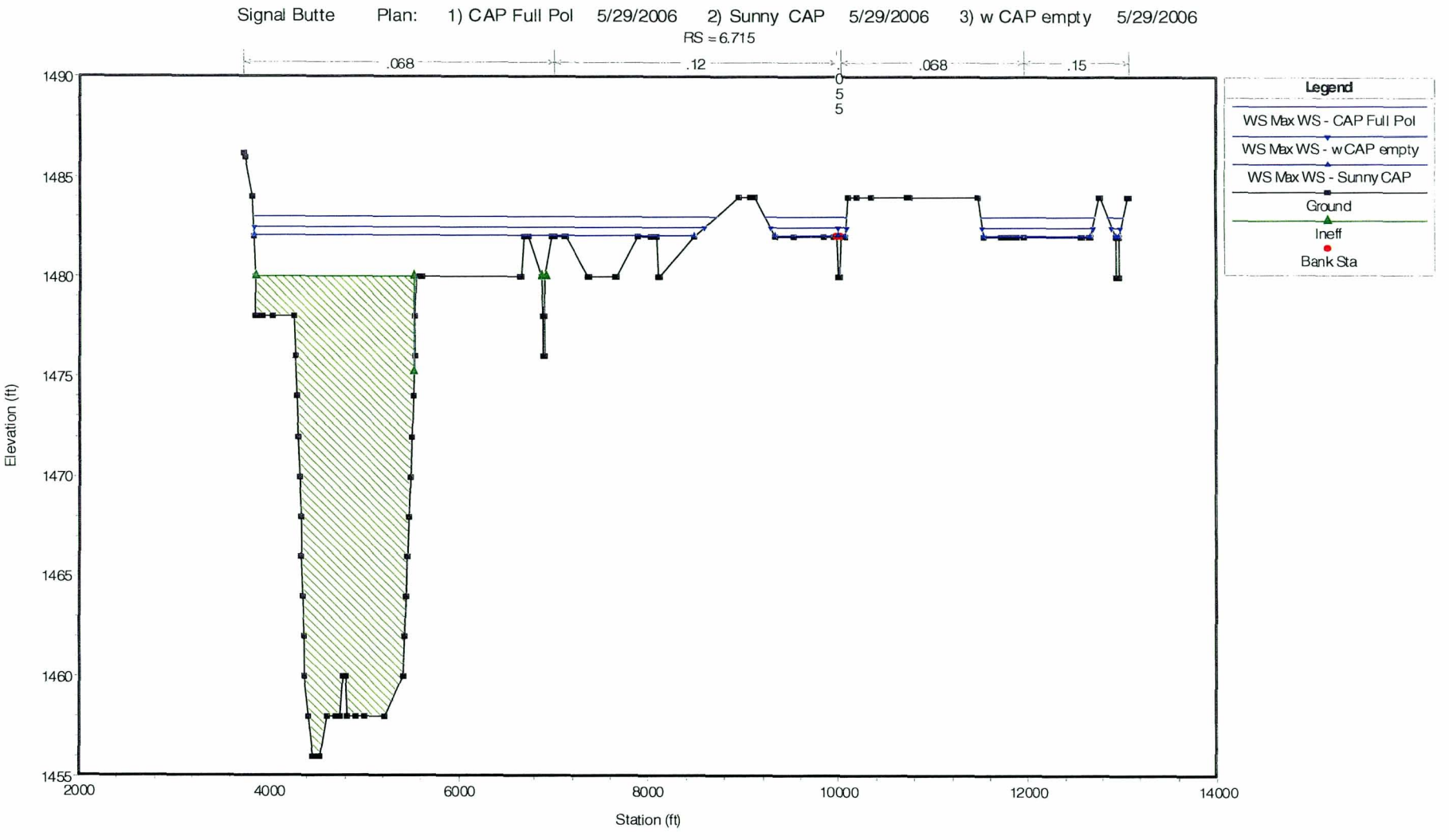

Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 9.983
.15
.12
.15
.12
.055
.12
.068
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Bank Sta
Elevation (ft)
1634
1632
1630
1628
1626
1624
1622
4000
6000
8000
10000
12000
14000
Station (ft)

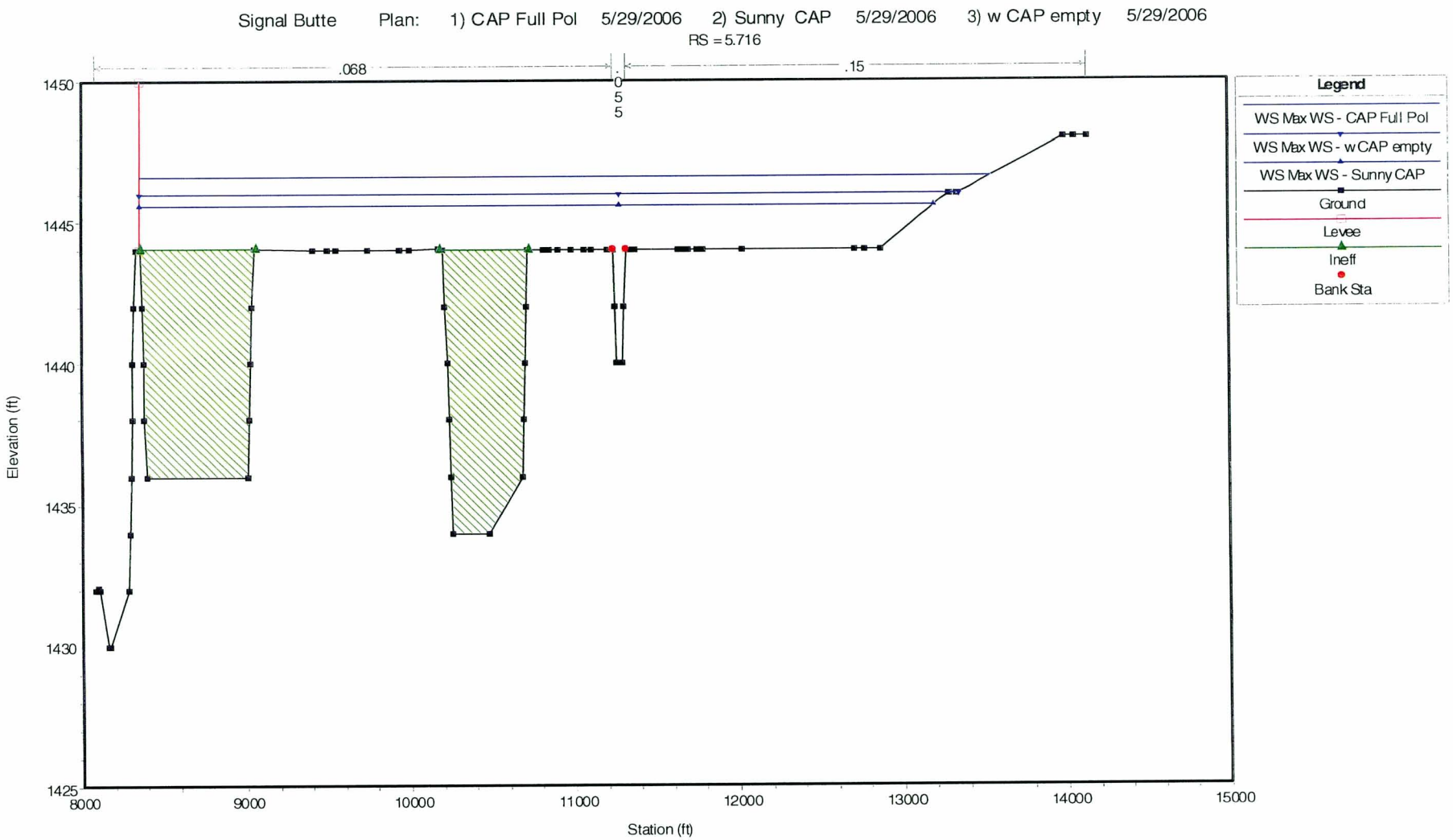

Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 8.996
.15
.12
.15
.12
.055
.12
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Levee
Bank Sta
Elevation (ft)
1584
1582
1580
1578
1576
1574
1572
1570
1568
1566
0
2000
4000
6000
8000
10000
12000
14000
Station (ft)

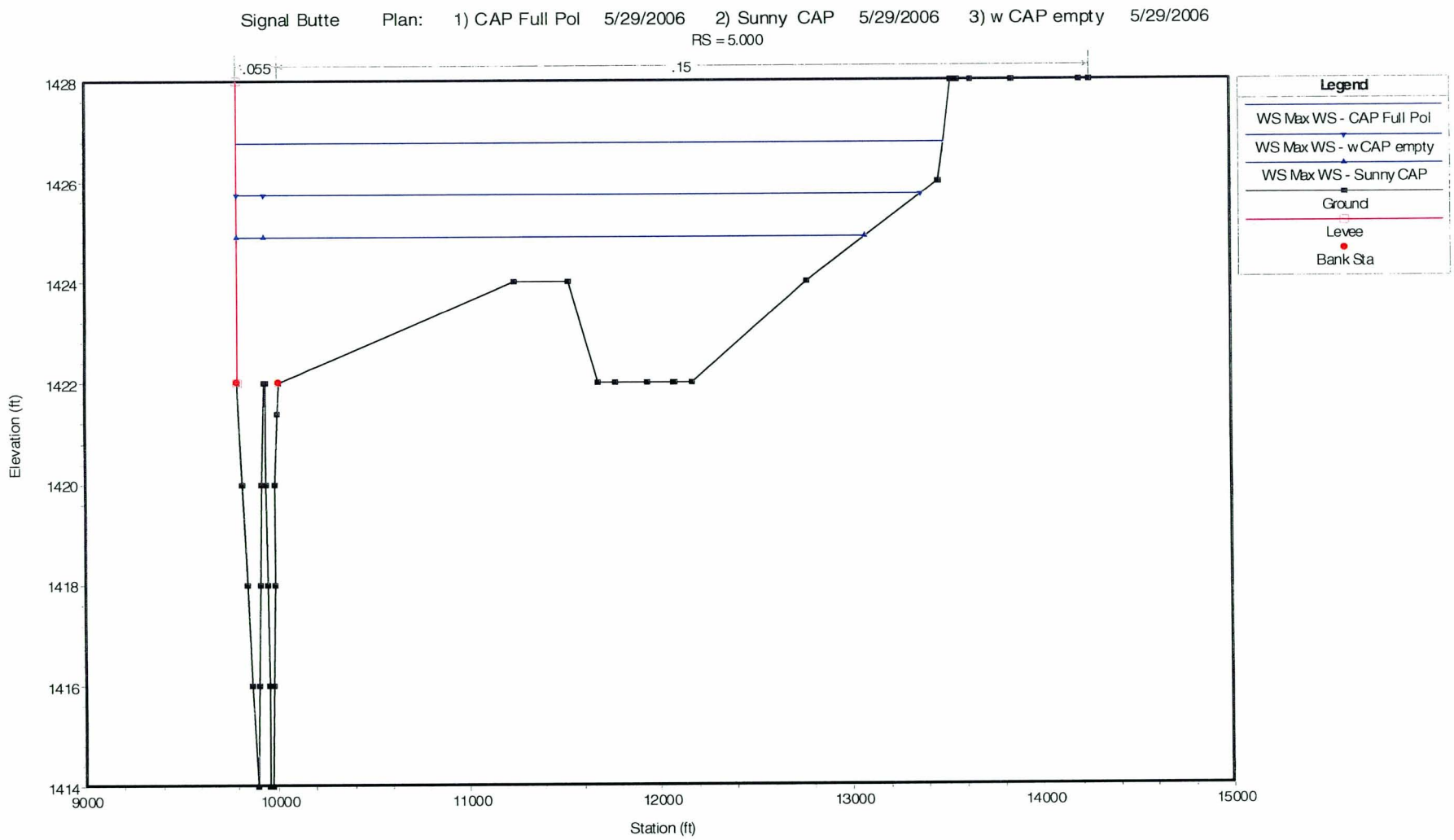

Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 8.96 IS CAP embankment
.15
.055
.12
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Ineff
Bank Sta
Elevation (ft)
1578
1576
1574
1572
1570
1568
1566
1564
1562
0
2000
4000
6000
8000
10000
12000
14000
Station (ft)


Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 8.612
.15
.12
.055
.12
1
5
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1564
1562
1560
1558
1556
1554
1552
0
2000
4000
6000
8000
10000
12000
14000
Station (ft)


Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 7.602
.068
.15
.12
.15
.12
.12
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1516
1514
1512
1510
1508
1506
1504
0
2000
4000
6000
8000
10000
12000
14000
Station (ft)

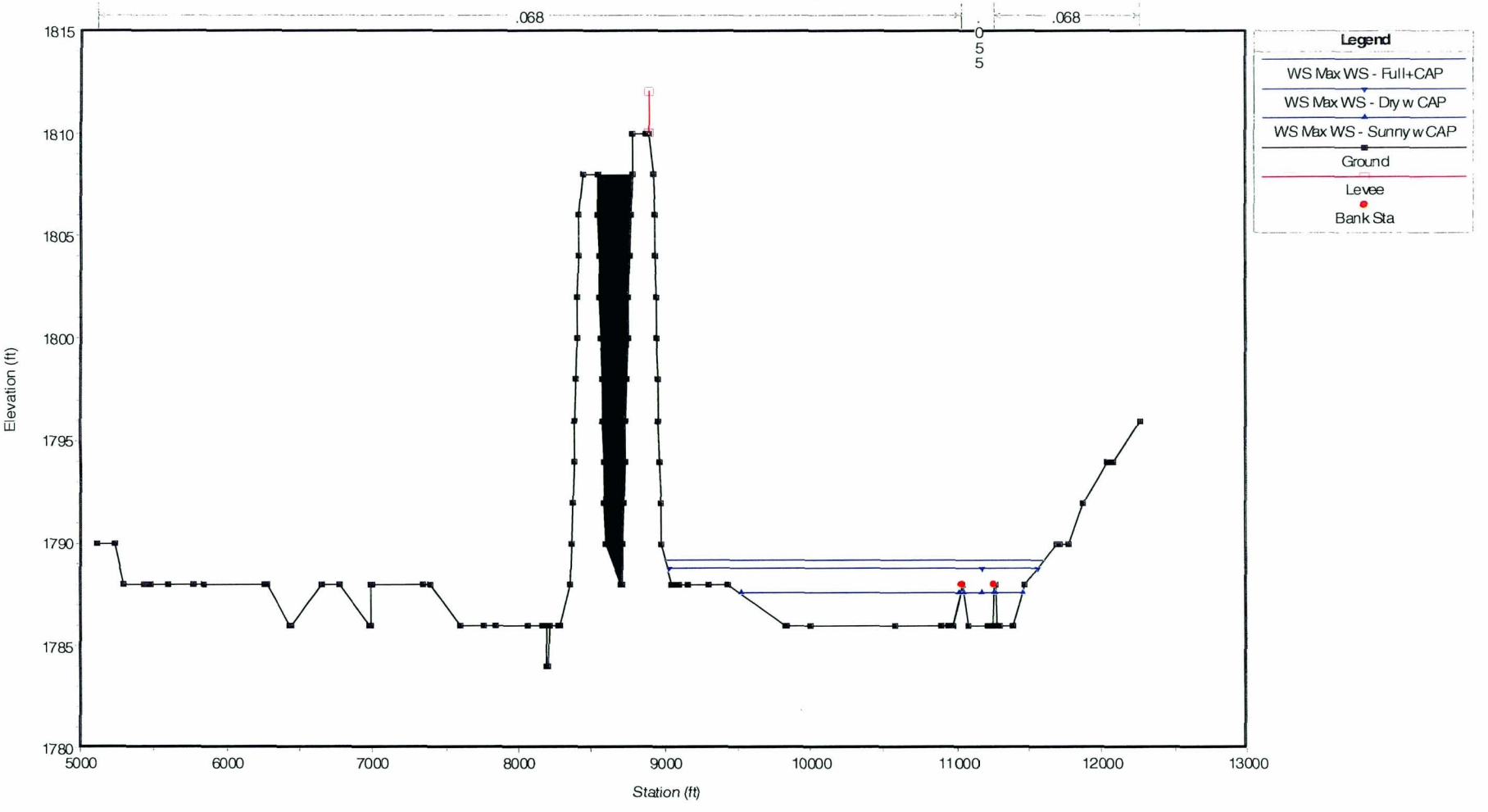

Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 6.715
.068
.12
.068
.15
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1490
1485
1480
1475
1470
1465
1460
1455
2000
4000
6000
8000
10000
12000
14000

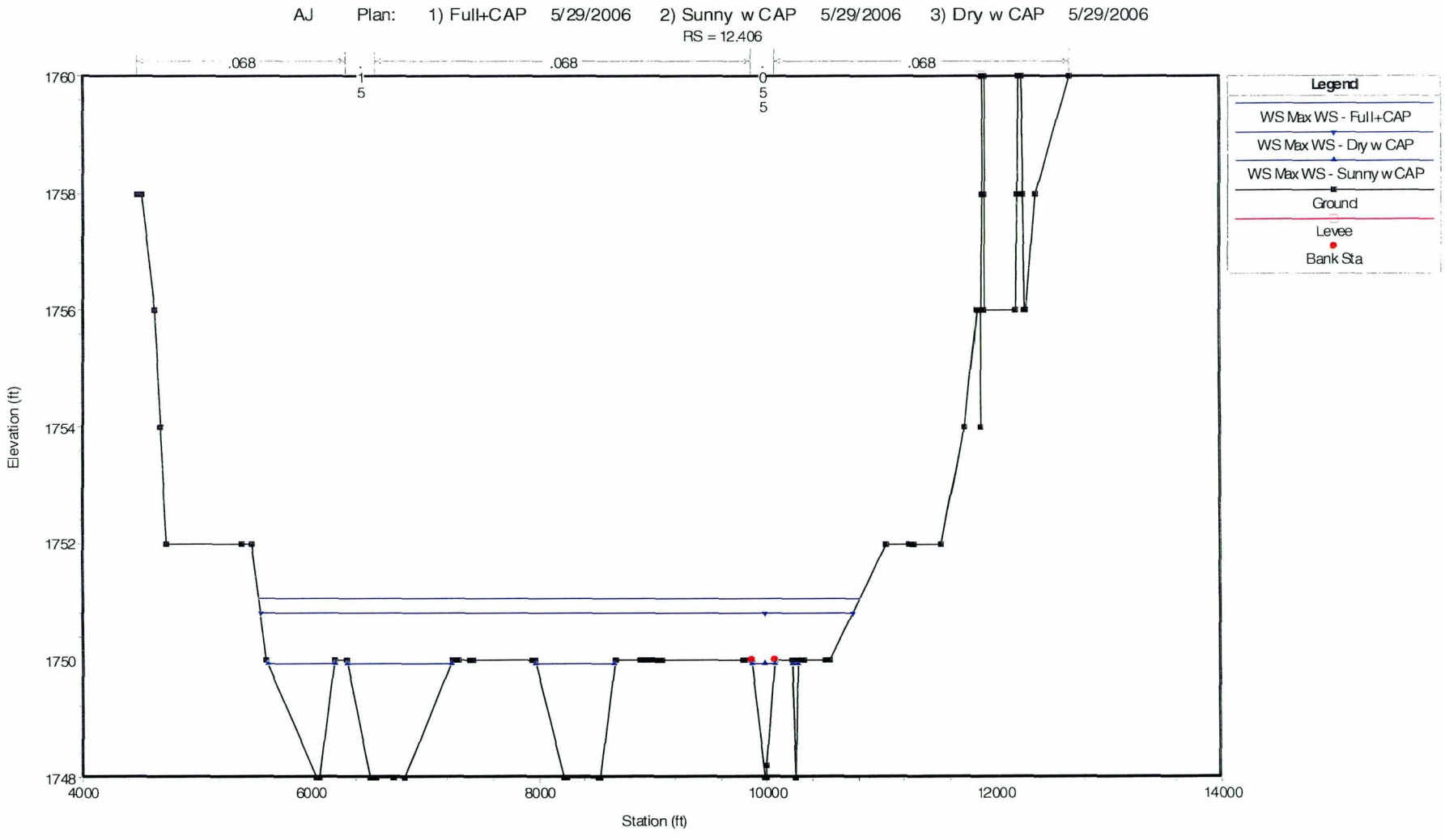

Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 5.716
.068
.055
.15
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1450
1445
1440
1435
1430
1425
8000
9000
10000
11000
12000
13000
14000
15000
Station (ft)

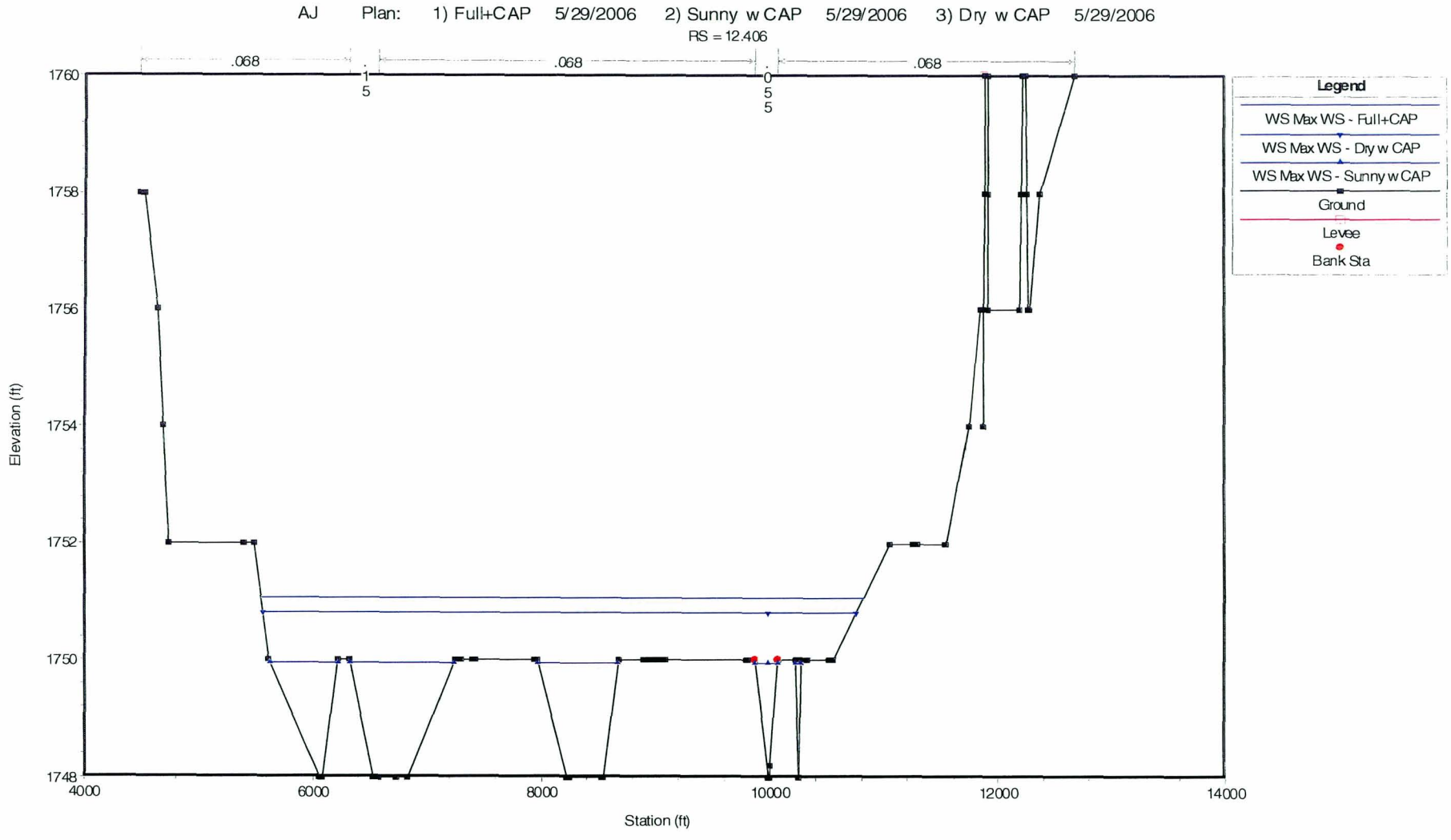

Signal Butte Plan: 1) CAP Full Pol 5/29/2006 2) Sunny CAP 5/29/2006 3) w CAP empty 5/29/2006
RS = 5.000
.055
.15
Legend
WS Max WS - CAP Full Pol
WS Max WS - w CAP empty
WS Max WS - Sunny CAP
Ground
Levee
Bank Sta
Elevation (ft)
1428
1426
1424
1422
1420
1418
1416
1414
9000
10000
11000
12000
13000
14000
15000
Station (ft)

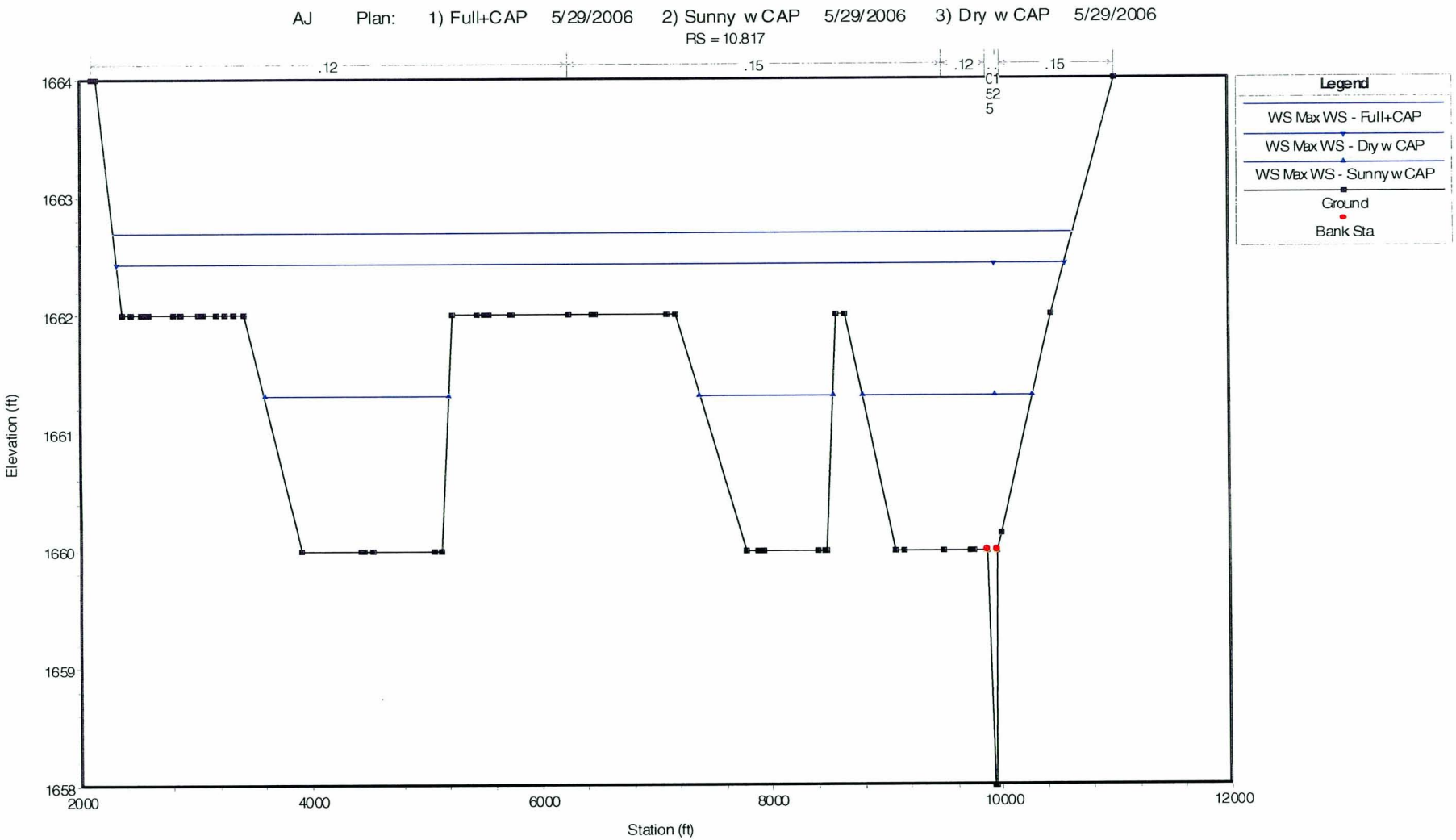
AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006

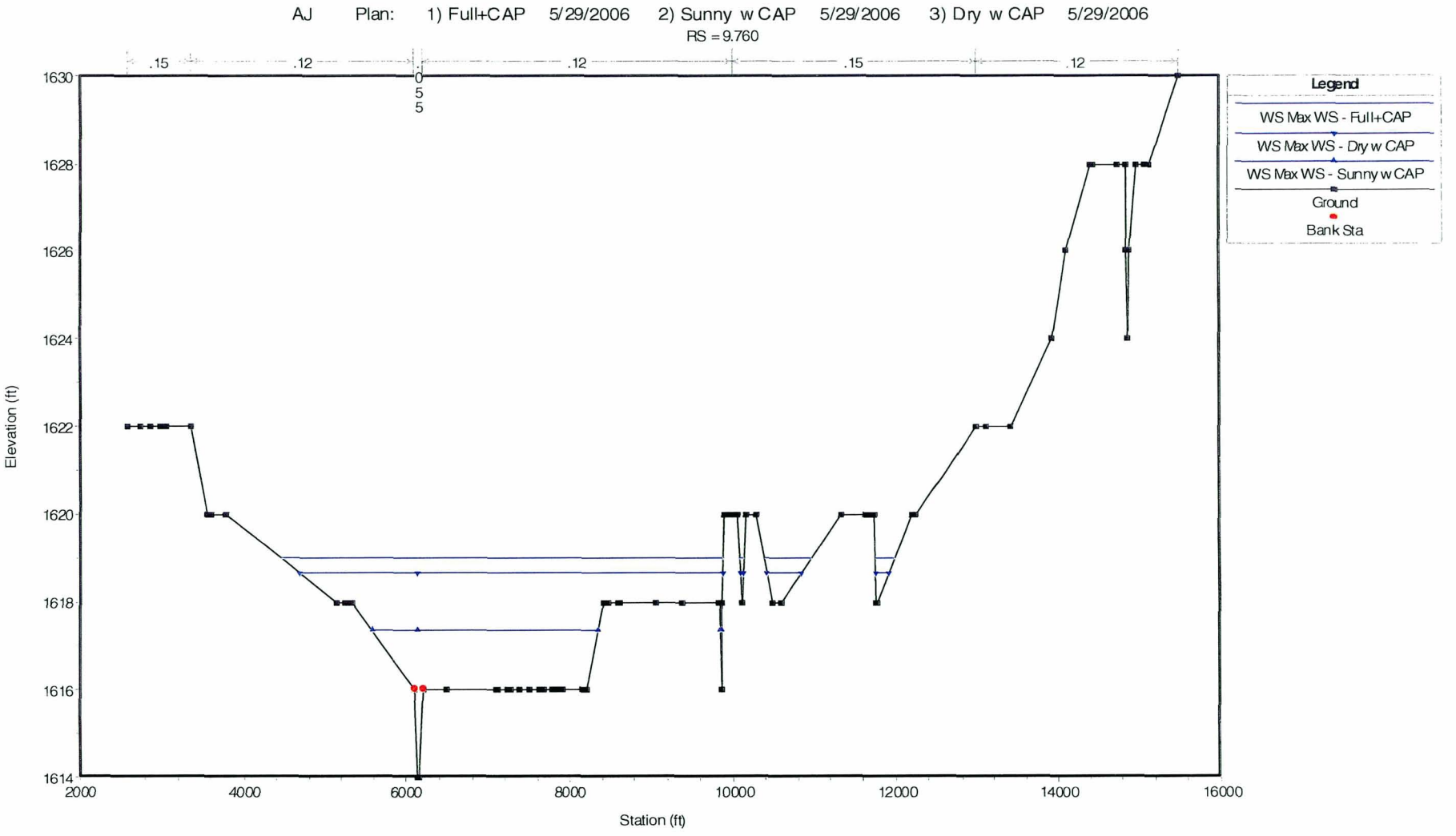
RS = 12.932 Center is roadway over dam

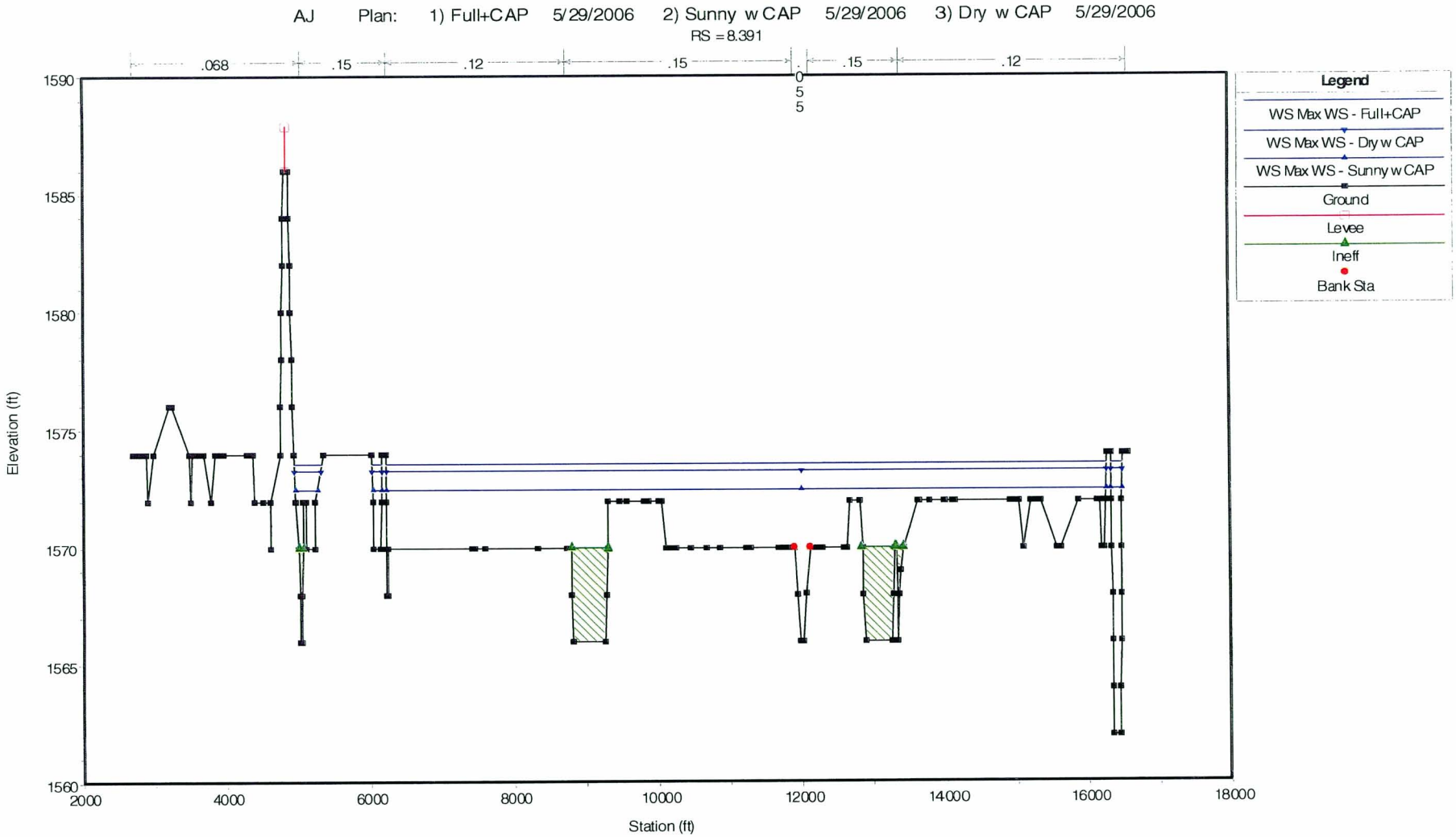


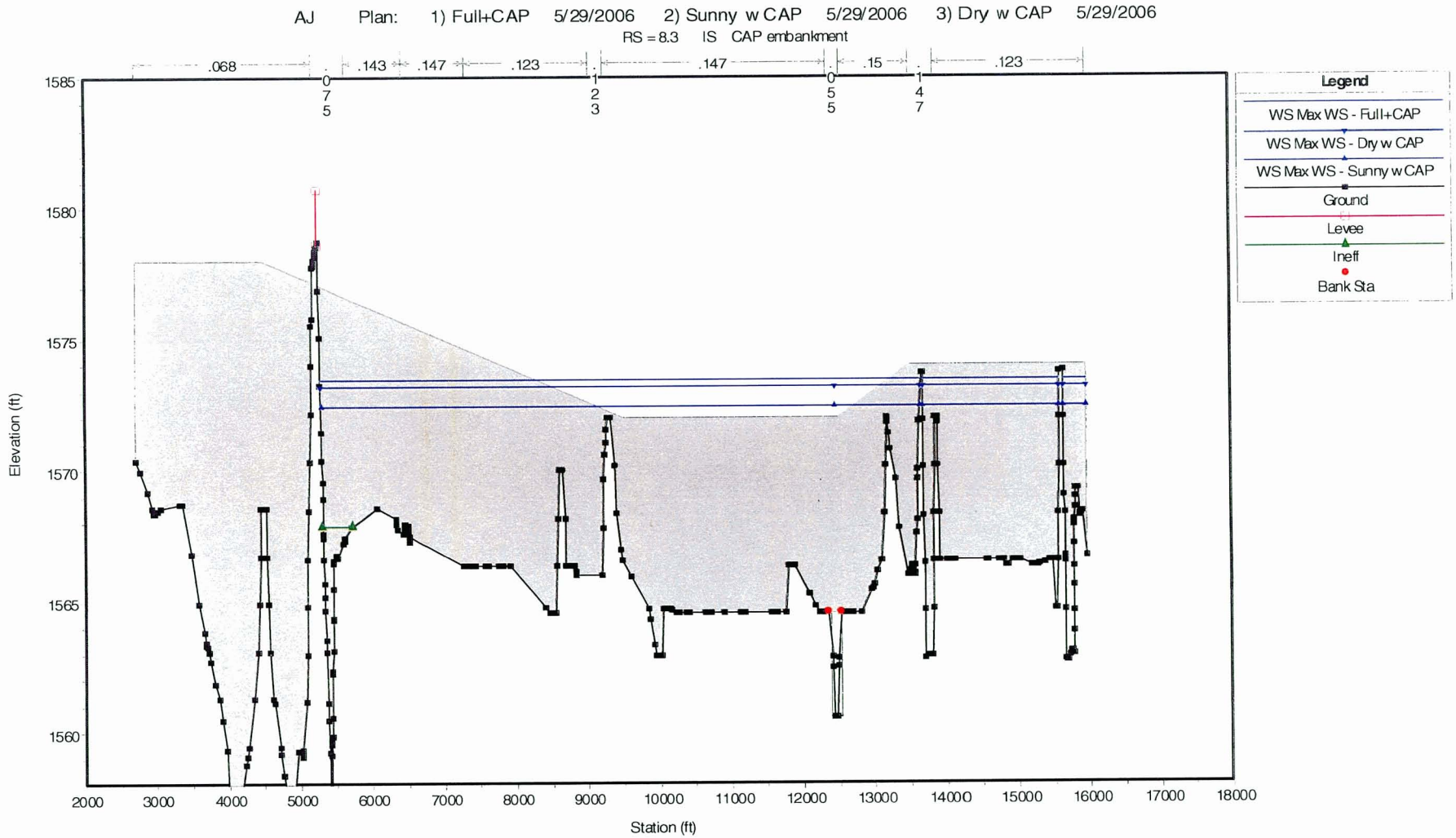

AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 12.406
.068
.068
.068
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Levee
Bank Sta
Elevation (ft)
1760
1758
1756
1754
1752
1750
1748
4000
6000
8000
10000
12000
14000
Station (ft)

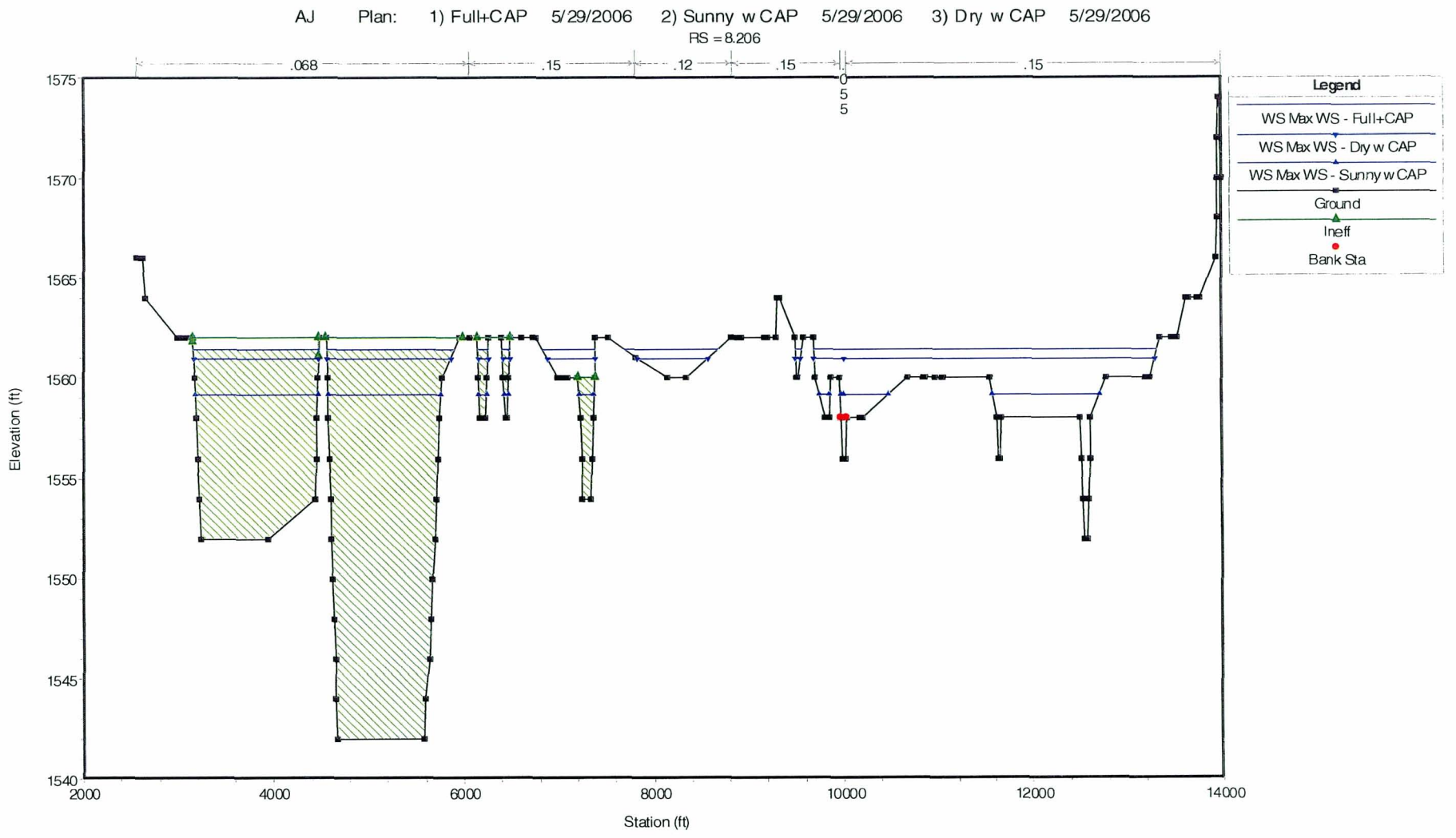

AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 12.406
.068
.068
.068
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Levee
Bank Sta
Elevation (ft)
1760
1758
1756
1754
1752
1750
1748
4000
6000
8000
10000
12000
14000
Station (ft)

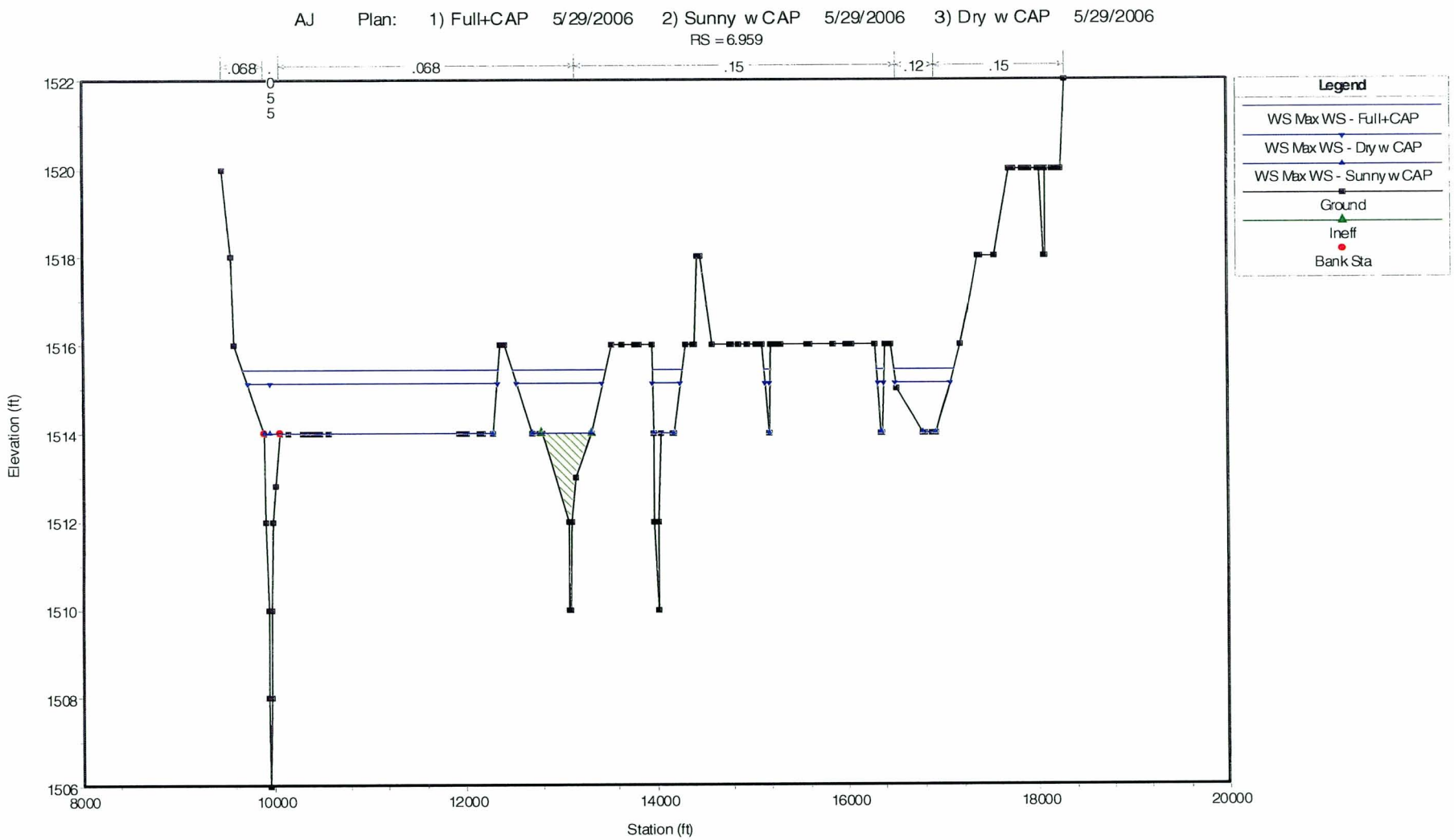

AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 10.817
.12
.15
.12
.15
C1
52
5
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Bank Sta
Elevation (ft)
1664
1663
1662
1661
1660
1659
1658
2000
4000
6000
8000
10000
12000
Station (ft)

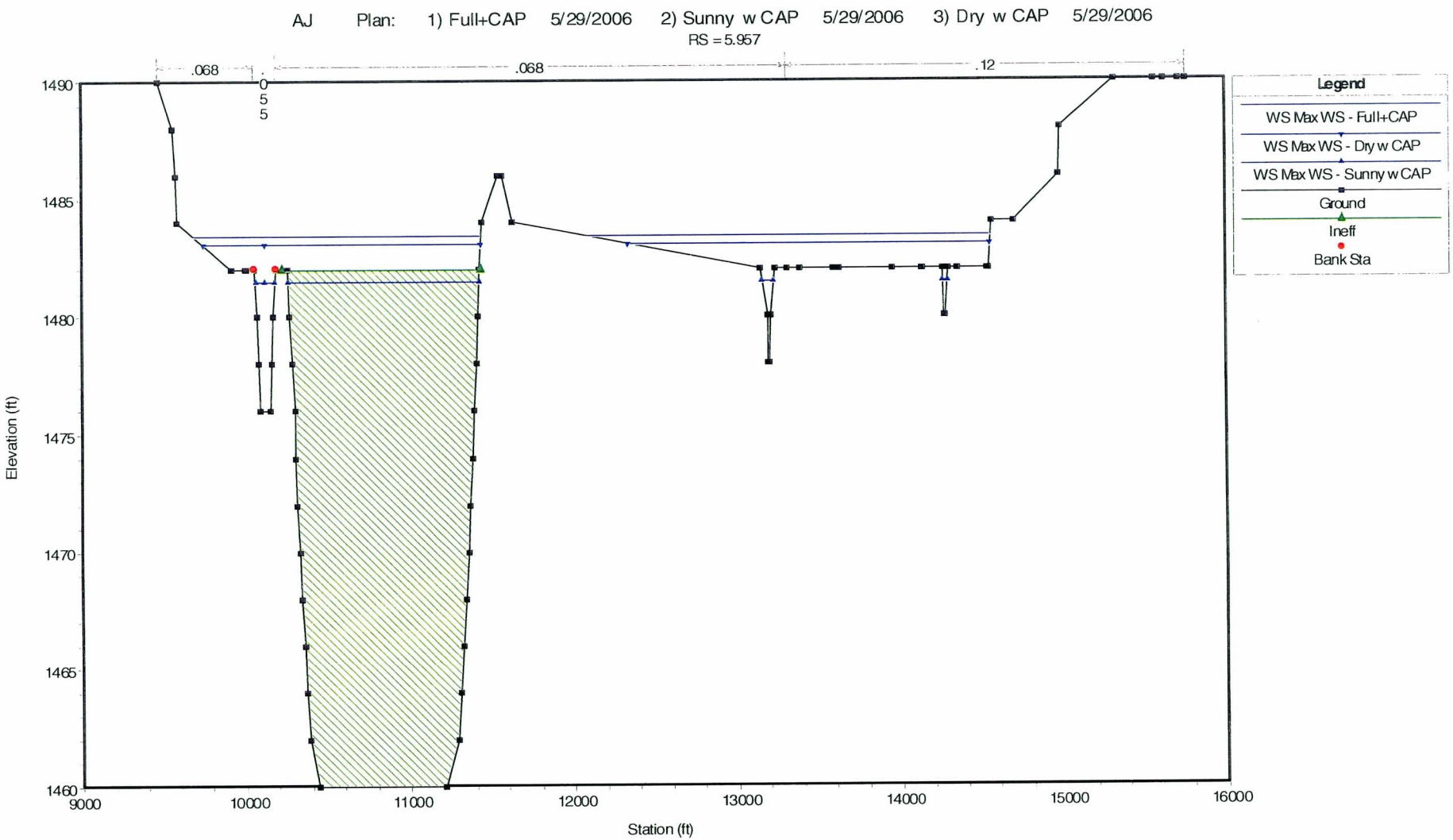

AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 9.760
.15
.12
.055
.12
.15
.12
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Bank Sta
Elevation (ft)
1630
1628
1626
1624
1622
1620
1618
1616
1614
2000
4000
6000
8000
10000
12000
14000
16000
Station (ft)

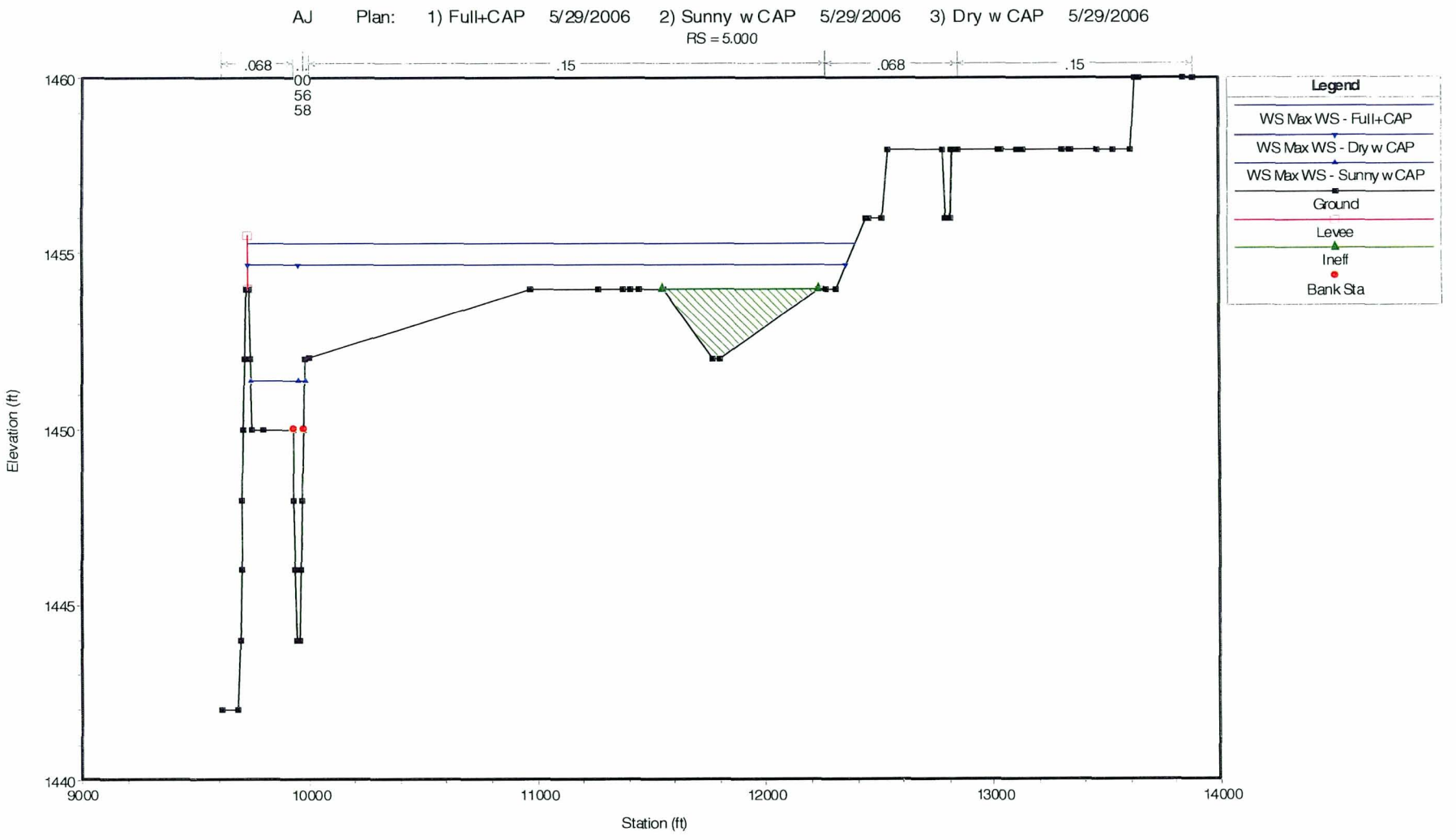

AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 8.391
.068
.15
.12
.15
.15
.12
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1590
1585
1580
1575
1570
1565
1560
2000
4000
6000
8000
10000
12000
14000
16000
18000
Station (ft)


AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 8.3 IS CAP embankment
.068
.143
.147
.123
.147
.15
.123
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 8.206
.068
.15
.12
.15
.055
.15
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Ineff
Bank Sta
Elevation (ft)
1575
1570
1565
1560
1555
1550
1545
1540
2000
4000
6000
8000
10000
12000
14000
Station (ft)


AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 6.959
.068
.055
.068
.15
.12
.15
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Ineff
Bank Sta
Elevation (ft)
1522
1520
1518
1516
1514
1512
1510
1508
1506
8000
10000
12000
14000
16000
18000
20000
Station (ft)


AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 5.957
.068
.055
.068
.12
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Ineff
Bank Sta
Elevation (ft)
1490
1485
1480
1475
1470
1465
1460
9000
10000
11000
12000
13000
14000
15000
16000
Station (ft)


AJ Plan: 1) Full+CAP 5/29/2006 2) Sunny w CAP 5/29/2006 3) Dry w CAP 5/29/2006
RS = 5.000
.068
.1
00
56
58
.15
.068
.15
Legend
WS Max WS - Full+CAP
WS Max WS - Dry w CAP
WS Max WS - Sunny w CAP
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1460
1455
1450
1445
1440
9000
10000
11000
12000
13000
14000
Station (ft)