# Levee Certification Report, Salt River Levee System (ID#33)

## Between Tempe Town Lake and State Route 143

## Maricopa County, Arizona

**Prepared for:**

Flood Control District of Maricopa County

2801 W. Durango Street
Phoenix, AZ 85009

**Prepared by:**

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

1 West Deer Valley Road, Suite 101
Phoenix, AZ 85027

FCD Contract No. 2007C051
Assignment #11

**June, 2011**

Scanned

U.S. Department of Homeland Security
1111 Broadway, Suite 1200
Oakland, CA 94607-4052

FEMA

June 5, 2012

Frank Brown, P.E., CFM
Senior Civil Engineer
Flood Control District Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Dear Mr. Brown:

This correspondence is in reference to the June 22, 2011, and May 10, 2012, letters and data submissions to the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding certification of city of Phoenix, city of Tempe, and the Unincorporated Areas of Maricopa County portions of the Salt River Levee System within Maricopa County in order to meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10). The pertinent information regarding the specific levees is listed below.

| | |
|---|---|
| **Identifier:** | Salt River Levee System (Levee ID No. 33) |
| **Flooding Source:** | Salt River |
| **September 30, 2005 Effective FIRM panels affected:** | 04013C2155G & 04013C2165H |
| **December 3, 2010 Preliminary FIRM panels affected:** | 04013C2230L & 04013C2240L |

In support of the Salt River Levee System segment certifications the following information was submitted:

1. A report prepared by JE Fuller Hydrology & Geomorphology, Inc., "Levee Certification Report – Salt River Levee System ID #33 between Tempe Town Lake and State Route 143, June 2011."
2. Addendum No. 1 prepared by JE Fuller Hydrology & Geomorphology, Inc. in response to FEMA's review comments, May 3, 2012.

All of the above documentation and data have been reviewed to verify 44 CFR 65.10 compliance and based on receipt of this information the Salt River Levee System (Levee ID No. 33), as shown on the attached Salt River Levee System Map, was determined to meet the minimum certification criteria outlined in 44 CFR 65.10. Therefore, we plan to continue to accredit this levee system on the new Digital Flood Insurance Rate Map (FIRM) as providing protection from the 1-percent-annual-chance (base) flood. The area protected from the base flood by this levee system will continue to be mapped as a shaded Zone X and a note will be placed in that area warning of the flood risk that still exists.

Please be advised that levee systems and the estimated level of protection provided by these systems can and do change with time. Future map updates may require the levee system to be certified again at the time of update. Also, design, construction, operation, and/or maintenance documents may be requested at any time. Deviations from the documentation and data submitted to FEMA could result in the levee system no longer being mapped as providing protection from the base flood on future FIRMs. If at any point additional information is provided to FEMA that shows the levee system no longer meets certification criteria as outlined in 44 CFR 65.10, we will contact the levee owner and community about the possibility of de-accrediting the levee system.

Even though we have mapped the referenced levees as providing protection from the 1-percent-annual-chance flood, it is important to note that levees are only designed to provide a specific level of protection. They can be overtopped or fail in larger flood events. Levee systems require regular maintenance and periodic upgrades to retain their level of protection. When levees do fail, they fail catastrophically, and damage may be more significant than if the levee was not there. Therefore, we encourage you to annually discuss the status and condition of your levees with your governing body. Additionally, it is highly recommended that you consider this risk in your local emergency management plans, including creating evacuation plans for this area.

Everyone should understand the risk to life and property that resides behind levees—risk that even the best flood-control system can not completely eliminate. For this reason, FEMA encourages people to understand their risk. The National Flood Insurance Program (NFIP) was created to reduce flood damages by identifying flood risks, encouraging sound community floodplain management practices, and providing flood insurance to lessen the financial impact of flooding. Through the NFIP, property owners in participating communities are able to purchase flood insurance that will insure against flood losses. We hope that you will encourage property owners to purchase flood insurance.

If you have additional questions regarding this matter, please contact me, either by telephone at (510) 627-7274, or by email at robert.bezek@dhs.gov.

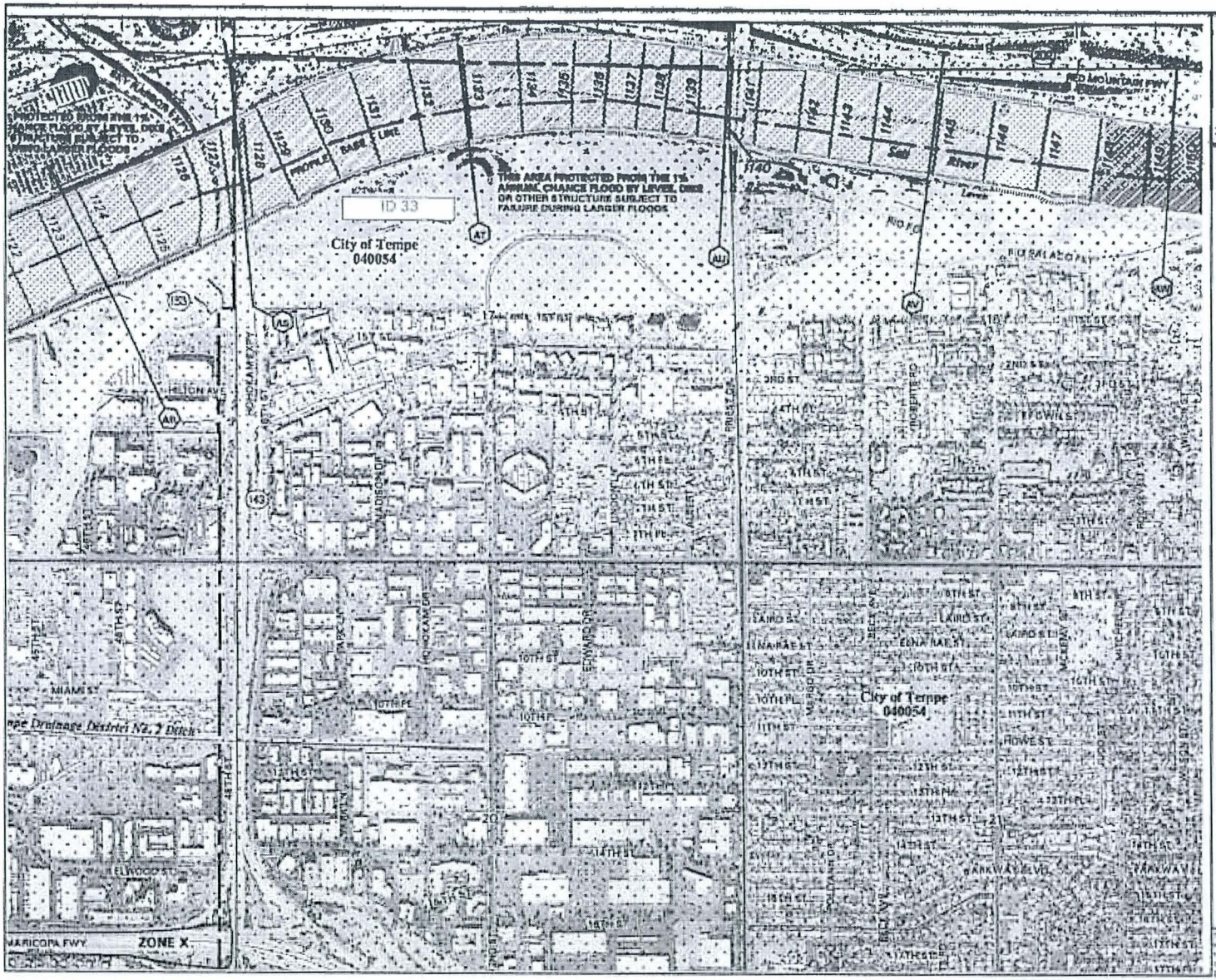
Sincerely,

Robert J. Bezek, CFM
Regional Engineer
Mitigation Division

Enclosure:
Salt River Levee System Map

Copies Furnished (w/out enclosures):

Tony Freiman, AMEC Earth & Environmental, Inc.
Jon T. Ahern, JE Fuller Hydrology & Geomorphology, Inc.
David Cavazos, City Manager, City of Phoenix
Hasan Mushtaq, Floodplain Administrator, City of Phoenix
Charlie Meyer, City Manager, City of Tempe
Andy Goh, Floodplain Administrator, City of Tempe
Tim Murphy, Flood Control District of Maricopa County
Brian Cosson, AZ DWR, NFIP State Coordinator




MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2165H

# FIRM

## FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA

AND INCORPORATED AREAS

**PANEL 2165 OF 4350**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| GUADALUPE, TOWN OF | 040111 | 2165 | H |
| MARICOPA COUNTY | 040037 | 2165 | H |
| PHOENIX, CITY OF | 040051 | 2165 | H |
| TEMPE, CITY OF | 040054 | 2165 | H |

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER

04013C2165H

MAP REVISED

SEPTEMBER 30, 2005

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT version 2.0. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. Further information about National Flood Insurance Program flood hazard maps is available at http://msc.fema.gov/

# Flood Control District
of Maricopa County

**Board of Directors**
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May 10, 2012

Robert J. Bezek, CFM
Regional Engineer
U.S. Department of Homeland Security
Mitigation Division, FEMA Region IX
1111 Broadway, Suite 1200
Oakland, CA 94607-4052

**Subject: Response to FEMA Review Comments for Levee Certification Package for Salt River Levees, PAL ID#33, June 2011**

Dear Mr. Bezek:

This letter is in response to your November 2, 2011 review comments letter on the Levee Certification Report, Salt River Levee System ID#33, between Tempe Town Lake and State Route 143, June 2011. This Certification Report was submitted per the Provisionally Accredited Levee (PAL) agreement which Maricopa County, the City of Phoenix and the City of Tempe entered into with the Federal Emergency Management Agency in June 2009 for the Salt River Levees.

Enclosed is Addendum No. 1 prepared by JE Fuller Hydrology & Geomorphology, Inc. This responds to FEMA comments (Checklist Item No. B.5) by providing an updated Protected Area Map. The enclosed addendum explains the methodology and approach for this updated map. The entire addendum is included on the enclosed disk, which also contains all of the originally submitted certification documents, such that this one updated disk has all files for this levee certification package. FEMA could either destroy the original disk, or mark it with "superseded" or similar notation.

We ask that FEMA agree with the Flood Control District of Maricopa County that this map addresses the review comment and that these Salt River Levees are in full compliance with 44CFR §65.10 to provide protection from flooding during from the 1 percent annual chance flood, and request that these levees be moved from Provisionally Accredited to Accredited status on the FIRM Panels.

If you have questions concerning this submittal, please call me at 602-506-4617.

Sincerely,

Frank Edward Brown, P.E., CFM
Senior Civil Engineer, Mitigation Planning & Technical Programs Branch,
Floodplain Management and Services Division

Enclosures: Paper copy of Addendum No. 1 with Protected Areas Map, 11 by 17
Disk with Addendum No. 1 added to previous submittal/certification report disk

Cc: Sarah Houghland, Michael Baker Corporation (with enclosures)
Brian Cosson, ADWR, NFIP Coordinator
Jon T. Ahern, JE Fuller Hydrology & Geomorphology, Inc.
David Cavazos, City Manager, City of Phoenix
Hasan Mushtaq, Floodplain Administrator, City of Phoenix (with enclosures)
Charlie Mater, City Manager, City of Tempe
Andy Goh, Floodplain Administrator, City of Tempe (with enclosures)

**JE FULLER**
HYDROLOGY & GEOMORPHOLOGY, INC.

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623.889.0166

Date: May 3, 2012

TO: Frank E. Brown, P.E., CFM
Senior Civil Engineer
Flood Control District of Maricopa County

FROM: Jon Ahern, P.E., CFM
Project Manager
JE Fuller/Hydrology & Geomorphology, Inc.

RE: **Addendum No 1.** - Response to Federal Emergency Managements Agency's (FEMA) Review Comments regarding Levee Certification Package for Salt River Levees, PAL ID#33, June 2011

Frank,

This letter is in response to FEMA's November 2, 2011 review comment letter regarding the Levee Certification Report, Salt River Levee System ID#33, between Tempe Town Lake and State Route 143 prepared by JE Fuller dated June 2011 (Salt River Levee Report).

Enclosed is an updated Protected Area Map, requested per the review comment letter Checklist Item No. B.5. Within the Salt River Levee Report, there are five pages of maps in Appendix A that was prepared with best available data at the time of submittal. Additional data was collected subsequent to the June 2011 submittal and is reflected in the attached figure. This map is issued as **Addendum No. 1** to the Salt River Levee Report.

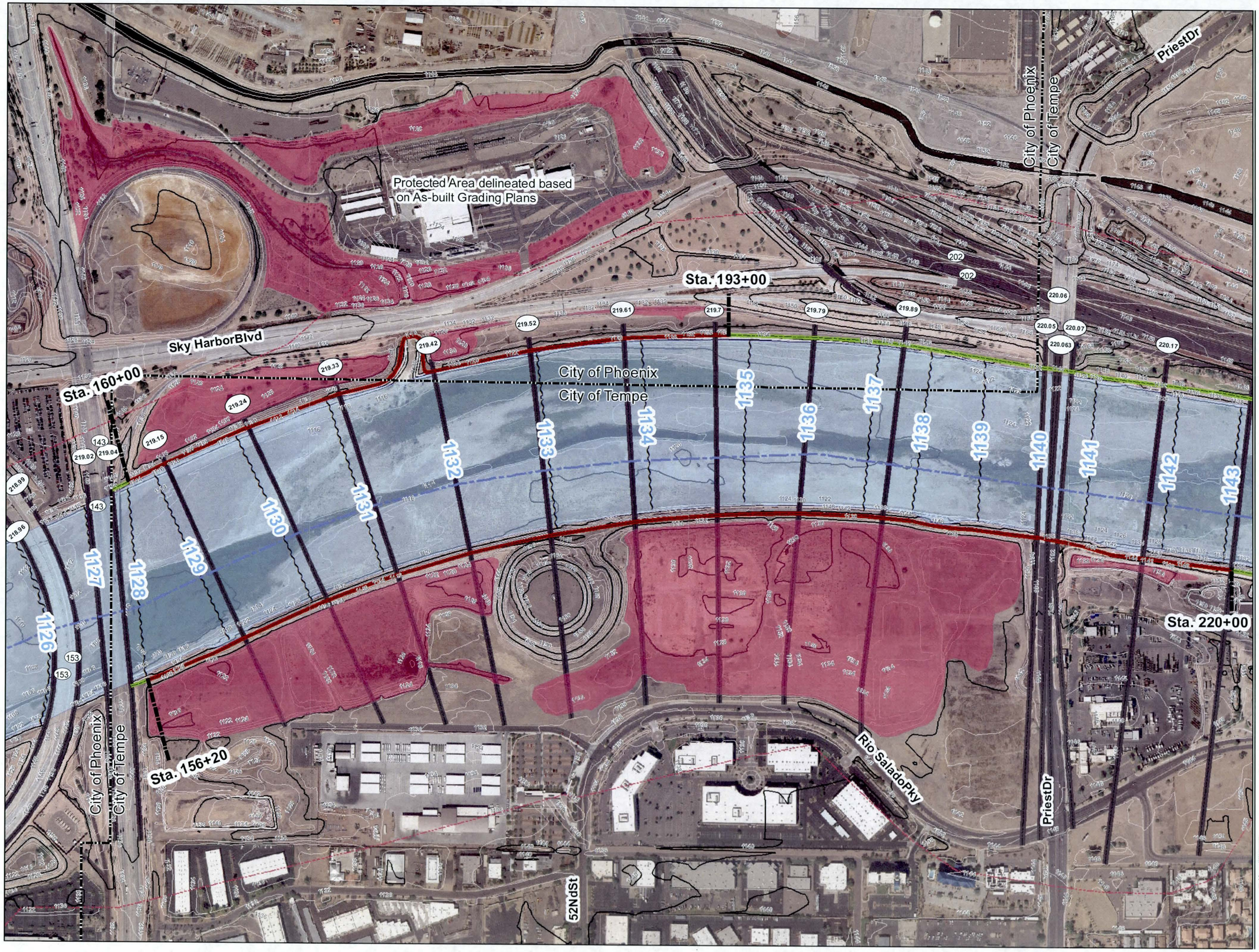
The additional data is in the form of As-Built Grading and Drainage Plans for the Light Rail Maintenance Facility (aka MSF Yard). These plans were utilized for a majority of the protected area on the north side of the river. Grading and Drainage Plans prepared for the MSF Yard are stamped "As-Built" and contained in the file named *MSF As-Builts Book 1 of 2.PDF* (which has 424 pages). The sheets 1 to 15 are pdf pages 26 through 41 out of 424. Within sheets 1 to 15, the 100-year water surface elevation is called out with a cloud and a number inside of a diamond, with the text "100 YEAR APPROX. WATER SURFACE". These pages were rectified in ArcView and the limits were digitized and incorporated into the attached figure.

Additional Protected Areas to the north and along the south were delineated using the FEMA Effective water surface elevations within the Salt River along with topographic data from the Salt/Gila River Master Plan (FCD 92-01, December 14, 1991) and Salt River Mapping (FCD 07-38, June 21, 2008), both with a vertical datum of NAVD 1929.

The complete project disk is included with this addendum containing all data from the June 2011 Certification Report along with a separate folder containing Addendum 1 material.

Attachment: Exhibit – Area Protected by Salt River levee ID 33, North and South Banks
DVD – Updated Data Disk from Levee Certification Report, Salt River Levee System (ID#33) with Addendum 1 material

## Protected Areas Map




Flood Control District of Maricopa County

**LEVEE CERTIFICATION REPORT, SALT RIVER LEVEE SYSTEM ID#33 BETWEEN TEMPE TOWN LAKE AND STATE ROUTE 143**

## Legend

- s_pol_ln
- *Area_Protected_by_Levee*
- Levee condition
- Non-levee condition
- Effective BFE

**FEMA Zone**

- A
- FW

**Contours**

- Index Contours
- Intermediate Contours

**DATUM: NGVD 29**

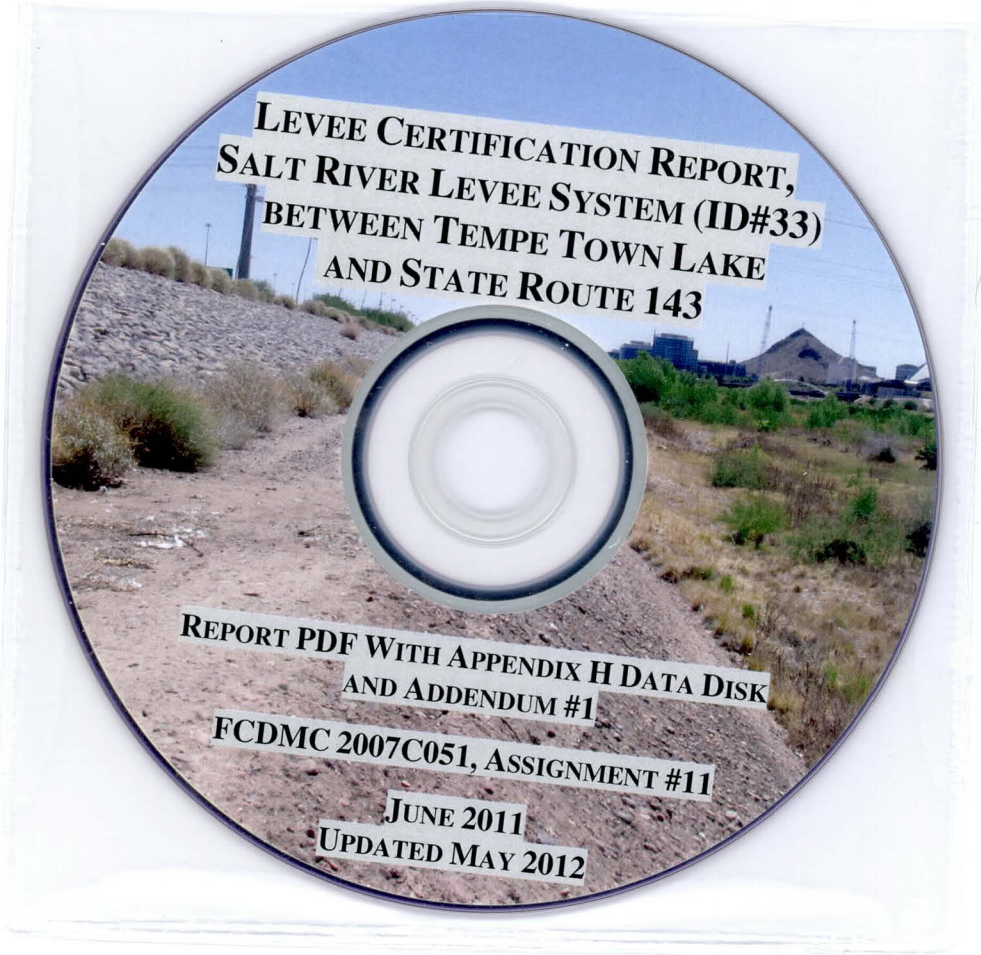
200 100 0 200
Feet

*MAY 2012*

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.
1 WEST DEER VALLEY ROAD
SUITE 101
PHOENIX, AZ 85027
623-889-0166 (O)
480-839-2193 (F)

**AREA PROTECTED BY SALT RIVER LEVEE ID 33 NORTH AND SOUTH BANKS**

**Updated Data Disk with Addendum No. 1 Protected Areas Map (PDF), complete set of As-Builts and previous submittal disk**




End of Addendum #1

Salt River

## Frank Brown - FCDX

**From:** hasan.mushtaq@phoenix.gov
**Sent:** Thursday, March 15, 2012 3:55 PM
**To:** Frank Brown - FCDX
**Cc:** myesha.harris@phoenix.gov
**Subject:** Re: Salt River Protected Area Map : response to your telephone question
**Attachments:** ID33.pdf

Frank:

Thank you very much for your response below. It appears that you have applied a more detailed approach to delineate the area protected by the north Levee of the Salt River. While the results from your analysis shows a floodplain boundary which is different from an exhibit prepared by HDR in 2009 (see attached), I am confident that results from your analysis is more accurate.

Therefore, the City does not have any additional comments at this time. Thank you very much for the opportunity to review your submittal.

Sincerely,

Hasan Mushtaq

Planning, Design, & Programming Division
Street Transportation Department
200 W. Washington Street
Phoenix, Arizona 85003-1611
602.262.4026 (W), 602.262.7322 (F)
hasan.mushtaq@phoenix.gov

-----Frank Brown - FCDX <FrankBrown@mail.maricopa.gov> wrote: -----

To: Hasan Mushtaq/STR/PHX@PHXENT, Myesha Harris/STR/PHX@PHXENT
From: Frank Brown - FCDX <FrankBrown@mail.maricopa.gov>
Date: 03/15/2012 02:38PM
cc: Jon Ahern <jon.ahern@jefuller.com>
Subject: Salt River Protected Area Map : response to your telephone question

Hello Hasan and Myesha,

In response to your telephone question: To delineate the protected area north of the Salt River at the rail yard, which is protected by the Salt River Levee (ID#33), the as-built drawings sent by the light rail yard were utilized to portray the 100-year floodplain.

Enclosed are Sheets 1 to 15 of the Grading and Drainage Plan, stamped "as-built" and contained in the file named MSF As-Builts Book 1 of 2.PDF (which has 424 pages). The sheets 1 to 15 are pdf pages 26 through 41 out of 424. Within the enclosed sheets, please look for a cloud and a number inside of a diamond, with the text "100 YEAR APPROX. WATER SURFACE".

Also enclosed are the sheets following the above sheets, which are stamped "Record Drawing As-built". The two sets of drawings appear to contain the same information for the 100 year water surface, thus the above set of As-Builts were used for the actual work. The second pdf file enclosed are sheets 42 to 62 of the original 424 page document, and is named Pages 42-62 from MSF As-Builts Book 1 of 2.pdf

Each sheet was imported into drawing software, the Northings and Easting's coordinates appearing on each sheet were utilized for proper registration and then the 100 year water surface was digitized. The final line work was compared to and back checked against a set of 11 by 17 plots of the as-built drawings that are taped together with the line of interest highlighted in yellow.

The resulting shape file of the protected area will be sent to FEMA in response to their review comment, please let me know if the City would like this same shape file.

Sincerely,

*>>> Below my signature block is a survey that I would appreciate you fill out.*

*Frank*

Frank Brown, P.E., CFM

*Senior Civil Engineer*

Mitigation Planning & Technical Programs Branch | *Floodplain Management and Services Division* |

**Flood Control District of Maricopa County**

*2801 W. Durango Street, Phoenix, AZ 85009*

Direct (602) 506-4617 | Fax (602) 506-7346 | Main (602) 506-1501

FrankBrown@mail.maricopa.gov

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The Flood Control District strives to provide excellent customer service to residents of Maricopa County. Your participation in this survey will help us to ensure that we are achieving our goal. Click here to take our Customer Service Survey

[attachment "Pages 26-41 from MSF As-Builts Book 1 of 2.pdf" removed by Hasan Mushtaq/STR/PHX]
[attachment "Pages 42-62 from MSF As-Builts Book 1 of 2.pdf" removed by Hasan Mushtaq/STR/PHX]

U.S. Department of Homeland Security
1111 Broadway, Suite 1200
Oakland, CA 94607-4052

FEMA

November 2, 2011

Frank Brown, P.E., CFM
Senior Civil Engineer
Flood Control District Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Dear Mr. Brown:

This letter is in reference to your June 22, 2011, submittal of regarding the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10) data submission for the Provisionally Accredited Levee system along the Salt River with identification number 33 in the City of Tempe, City of Phoenix, and Maricopa County. The following information was submitted in support of certification for this levee system:

- A report prepared by JE Fuller Hydrology & Geomorphology, Inc., "Levee Certification Report – Salt River Levee System ID #33 between Tempe Town Lake and State Route 143."

We have completed our review of the report. Attached is a checklist identifying areas that are compliant and those areas that still require attention. Please review the deficient areas and submit updated information to this office. Once all areas are found to be compliant with 44 CFR 65.10 the levee can be certified and the maps updated to account for the change in levee status.

Thank you for your cooperation. If you have any questions or concerns, please contact me either by telephone at (510) 627-7274 or by email at robert.bezek@dhs.gov.

Sincerely,

Robert J. Bezek, CFM
Regional Engineer
Mitigation Division

Enclosure: Maricopa, AZ – Levee Certification Review Comments for the Salt River Levee system with identification number 33

Copies Furnished:
Brian Cosson, AZ DWR, NFIP Coordinator
Tony Freiman, AMEC Earth & Environmental, Inc.
Jon T. Ahern, JE Fuller Hydrology & Geomorphology, Inc.
David Cavazos, City Manager, City of Phoenix
Hasan Mushtaq, Floodplain Administrator, City of Phoenix
Charlie Meyer, City Manager, City of Tempe
Andy Goh, Floodplain Administrator, City of Tempe

memo

BakerAECOM
An Integrated Production Team

| | |
|---|---|
| **DATE:** | November 2, 2011 |
| **MEMORANDUM FOR:** | Frank Brown, P.E., CFM, Flood Control District of Maricopa County |
| **CC:** | Robert Bezek, Senior Engineer, FEMA Region IX |
| **FROM:** | Sarah Houghland, PE, CFM, BakerAECOM |
| **SUBJECT:** | **Maricopa County, AZ – Levee Accreditation Submittal Review Levee System ID 33 along the Salt River** |

On June 22, 2011, we received your report, "Levee Certification Report – Salt River Levee System ID #33 between Tempe Town Lake and State Route 143", prepared for the Flood Control District of Maricopa County by JE Fuller Hydrology & Geomorphology, Inc.. This study included levee certification information for the Salt River Levee ID 33. Under the direction of the FEMA Region IX office, BakerAECOM has completed a review of the submitted report and supporting data. The purpose of this memo is to summarize our review comments and provide corresponding documentation of our review.

The submitted hydraulic analyses are reasonable and well documented. However, there are a few issues that must be addressed before this report can be approved. The checklist below is based on guidelines set forth in FEMA's Procedure Memorandum 63. This document can be found at http://www.fema.gov/library/viewRecord.do?id=4331. Following the checklist is a summary of the items that need to be addressed prior to approval of the levee certification.

**REVIEW CHECKLIST:**

A. Tier 1 Review

| | | |
|---|---|---|
| Item 1: All Items Signed by a registered P.E. | [X] Yes | [ ] No |
| Item 2: Freeboard Check | [X] Yes | [ ] No |

B. Tier 2 Review

| | | |
|---|---|---|
| Item 3: Regulations | [X] Yes | [ ] No |
| Item 4: Operations and Maintenance Plan | [X] Yes | [ ] No |
| Item 5: Areas Protected by Levee Analysis | [X] Yes | [ ] No |

memo

C. Tier 3 Review

| | | |
|---|---|---|
| Item 6: Levee System and Cross Reference Check | [X] Yes | [ ] No |
| Item 7: Interior Drainage Analysis | [X] Yes | [ ] No |
| Item 8: Structural Design Requirements | [X] Yes | [ ] No |
| 1) Closure Structure Data | | |
| 2) Embankment Protection | | |
| 3) Embankment and Foundation Stability | | |
| 4) Settlement | | |
| 5) All Other, as Applicable | | |
| Item 9: Inspection Reports | [X] Yes | [ ] No |

D. Mapping the Levee

| | | |
|---|---|---|
| Item 10: Final Completeness Check | [] Yes | [X] No |

**SPECIFIC COMMENTS ARE REFERENCED TO THE CHECKLIST ITEMS:**

Specific comments related to the checklist items shown above are described in detail below:

1. Checklist Item No. A.2 (Freeboard Check) – Note. Review of upstream and downstream tie-in to high ground for the top of protection indicates that the downstream area is ok and ties into high ground near the State 143 Bridge for both the north and south levees. Based on review of the submitted information, both upstream levees with the extra freeboard to the top of levees will also tie-in to high ground along the existing levees, at approximately 1000 feet and 500 feet from the upstream end of each levee for the north and south levees respectively. No further information is necessary.

2. Checklist Item No. B.5 (Areas Protected by Levee) – Please provide a work map to showing the areas which are protected by this levee system, or provide reference to where that information is shown in the submitted information.

3. Checklist Item D.10 (Completeness Check) – When Item 2 is satisfactorily addressed this item will be considered complete.

memo

We would be happy to discuss our review in further detail with you if you are interested. If you have any questions or comments regarding this memo, please contact me at slhoughland@mbakercorp.com. Please respond to the issues detailed above within 30 days of the date of this memo.

# Levee Certification Report, Salt River Levee System ID#33 between Tempe Town Lake and State Route 143

## Maricopa County, Arizona

**Prepared for:**

Flood Control District of Maricopa County

2801 W. Durango Street
Phoenix, AZ 85009

**Prepared by:**

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

1 West Deer Valley Road, Suite 101
Phoenix, AZ 85027

June 2011

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 JE Fuller Hydrology & Geomorphology, Inc., shall be without liability to JE Fuller Hydrology & Geomorphology, Inc.

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B. Hydraulic Data for Levee Freeboard Determination
C. Scour Evaluation for Embankment Toe Down
D. Interior Drainage
E. As-Built Drawings
F. Field Survey Data
G. Salt River Levee Photos
H. Data Disk

## List of Acronyms

| | |
|---|---|
| 44CFR65.10 | Title 44 of the Code of Federal Regulations, Section 65.10, Mapping of Areas Protected by Levees |
| ADOT | Arizona Department of Transportation |
| BFE | Base Flood Elevation |
| cfs | cubic feet per second |
| DEM | digital elevation model |
| DFIRM | Digital Flood Insurance Rate Map |
| DTM | Digital Terrain Model |
| EM | Engineering Manual |
| ETL | Engineering Technical Letter |
| FEMA | Federal Emergency Management Agency |
| FIS | Flood Insurance Study |
| fps | feet per second |
| ft | feet |
| H&H | Hydrology and Hydraulics |
| H:V | Horizontal:Vertical |
| HEC-1 | U.S. Army Corps of Engineers hydrologic modeling program |
| HEC-2 | U.S. Army Corps of Engineers hydraulic modeling program |
| HEC-GeoRAS | An extension for support of HEC-RAS using ArcGIS |
| HEC-RAS | Hydrologic Engineering Centers River Analysis System (USACE, Hydraulic Model) |
| Hr | Hour |
| Hrs | Hours |
| in | Inches |
| mins | Minutes |
| NAD 83 | North American Datum of 1983 |
| NFIP | National Flood Insurance Program |
| NGVD 29 | National Geodetic Vertical Datum of 1929 |
| P.E. | Professional Engineer |
| PAL | Provisionally Accredited Levees |
| SOP | Standard Operating Procedure |
| SPF | Standard Project Flood |
| SR | State Route |
| USACE | U.S. Army Corps of Engineers |

# 1 Introduction

## 1.1 Project Objectives

This Levee Certification Report has been prepared to document Federal Emergency Management Agency (FEMA) accreditation requirements of the Levee Certification Report for the Salt River Levee System between Tempe Town Lake and State Route 143 located in Maricopa County, AZ. The objectives of the Levee Certification Report are as follows:

1. Collect and review existing studies and design/construction documentation pertaining to the Salt River Levee System (FEMA ID #33).

2. Document compliance with the requirements put forth in Title 44 Code of Federal Regulations Section 65.10 (44CFR65.10).

The Salt River Levee System is currently shown on effective FEMA Federal Insurance Rate Map (FIRM) Panel 04013C2165H, however, the levees are not presently certified via 44CFR65.10 requirements. At the time of this report, FEMA has classified the Salt River Levee System via a Provisionally Accredited Levee (PAL) based on the understanding that the Flood Control District of Maricopa County (FCDMC) will have the systems certified within a two-year time frame. The PAL is schedule expired June 25, 2011. The assessment discussed in this report is intended to aid in the FEMA accreditation process.

## 1.2 Authority for the Study

Study team contact information is presented below:

**JE Fuller Hydrology & Geomorphology, Inc.**

Address: 1 W. Deer Valley Rd, Suite 101
Phoenix, Arizona 85027

Phone: (623) 889-01688

Project Manager: Jon Ahern, P.E., CFM

**Flood Control District of Maricopa County.**

Address: 2801 W. Durango Street
Phoenix, AZ 85009

Phone: (602) 506-1501

Project Manager: Frank Brown P. E. CFM.

## 1.3 Site Location and Description

The study area is located within Maricopa County along the boundary between the Cities of Phoenix and Tempe. The study area includes Sections 7, 8, 9, 16, 17, and 18 of Township 01N, Range 04E of the Salt River Baseline and Meridian. (See **Figure 1-1** and **Figure 1-2**)

## 1.4 General Discussion of the Levee System

The Salt River Levee System ID#33 extends along the north and south banks of the Salt River between State Route 143 at the west to Tempe Town Lake to the east (and upstream). Both embankments contain long stretches where the lowest adjacent grade on the landside is higher than the computed base flood elevation. This condition is shown as "non-levee" on **Figure 1-2**. The north embankment extends a length of approximately 9,400 feet, however the total length of levee condition is 3,500 feet. Similarly, the south embankment extends a length of approximately 9,200 feet but the levee condition extends 6,300 feet.

This system was originally constructed as a part of a channelization project of a larger reach of the Salt River. The channelization project was done by the Arizona Department of Transportation and was "As-built" in January 1993 (ADOT, 1993). The original channel was designed for a discharge of 283,000 cfs; defined as the Standard Project Flood. At that time the 100-year discharge was 215,000 cfs.

Following the channelization project, the United States Army Corps of Engineers completed improvements to Roosevelt Dam to increase its storage (USACE, 1996). With these modifications completed in 1996, the 100-year discharge was reduced to 169,000 cfs (USACE, 1996). The effective FEMA model for this reach was prepared by Michael Baker, Jr., Inc. for a Letter of Map Revision (Baker, 1999). The effective model uses the 169,000 cfs discharge.

The most recent hydraulic model prepared for this reach is a HEC-RAS model prepared by Stantec Consulting Inc. for the Flood Control District of Maricopa County as a part of their Salt River Hydraulic Master Plan (SRHMP). This model uses the effective model cross section alignments and discharge, but updates the channel topography and Manning's roughness values (Stantec, 2009).

## 1.5 Report Format

As noted above, this report discusses the Salt River Levee System (ID#33) compliance with the requirements put forth in 44CFR65.10. This compliance is documented in the following sections:

Section 2: 44CFR65.10 Requirements

Section 3: FEMA MT-2 Forms

Section 4: Certification Statement

Section 5: Limitations

## 1.6 Document Under Separate Cover

Geotechnical elements assessed for compliance with 44CFR65.10 are documented within the *Geotechnical Study for Federal Emergency Management Agency (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011.*

Operation and Maintenance Elements are documented in *FCDMC, Operations and Maintenance Division, Standard Operating Procedures (SOP's) Deficiency Levels, Maintenance Standards, and Standard Drawings, Revised 2005.*

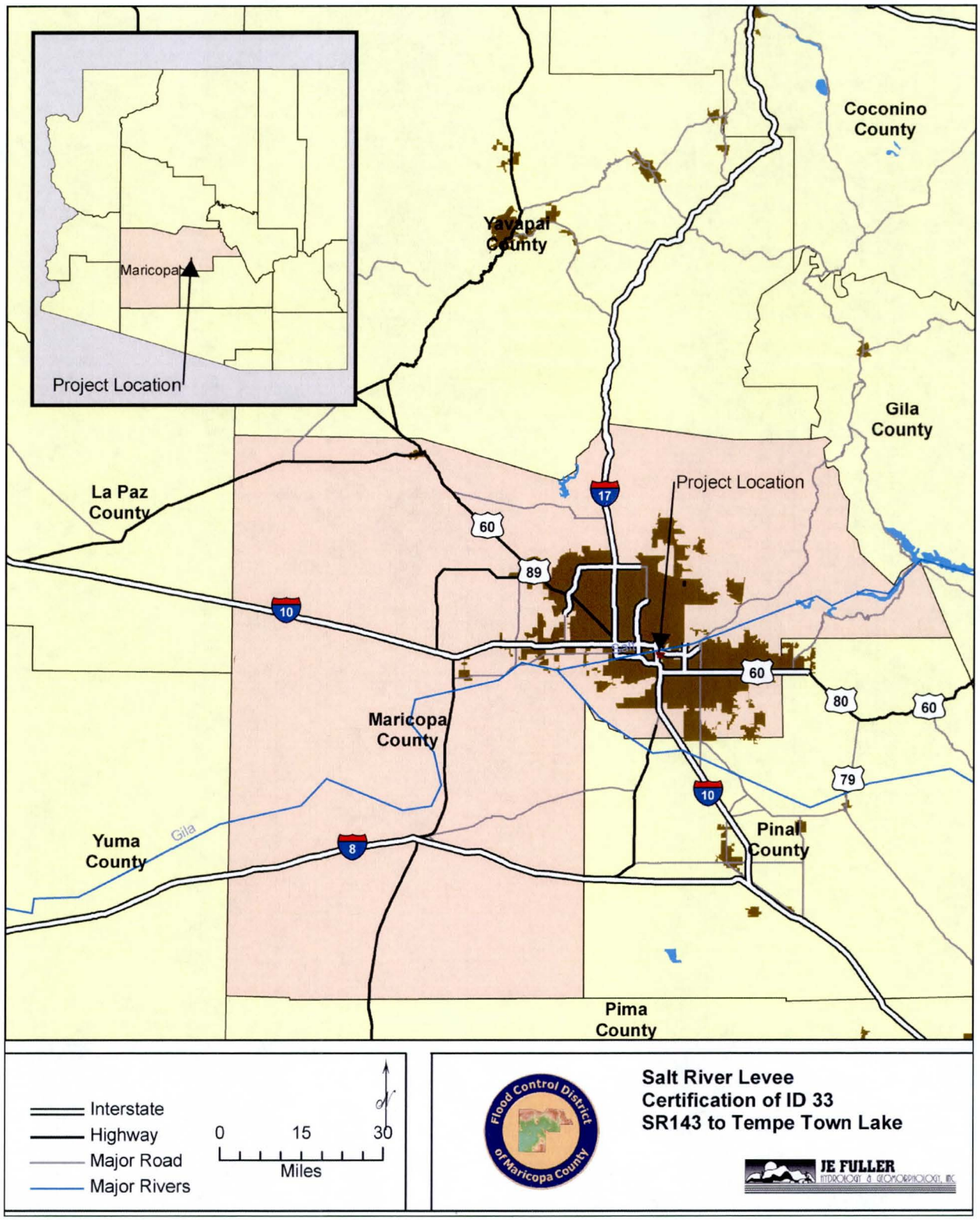



**Figure 1-1: Project Location**

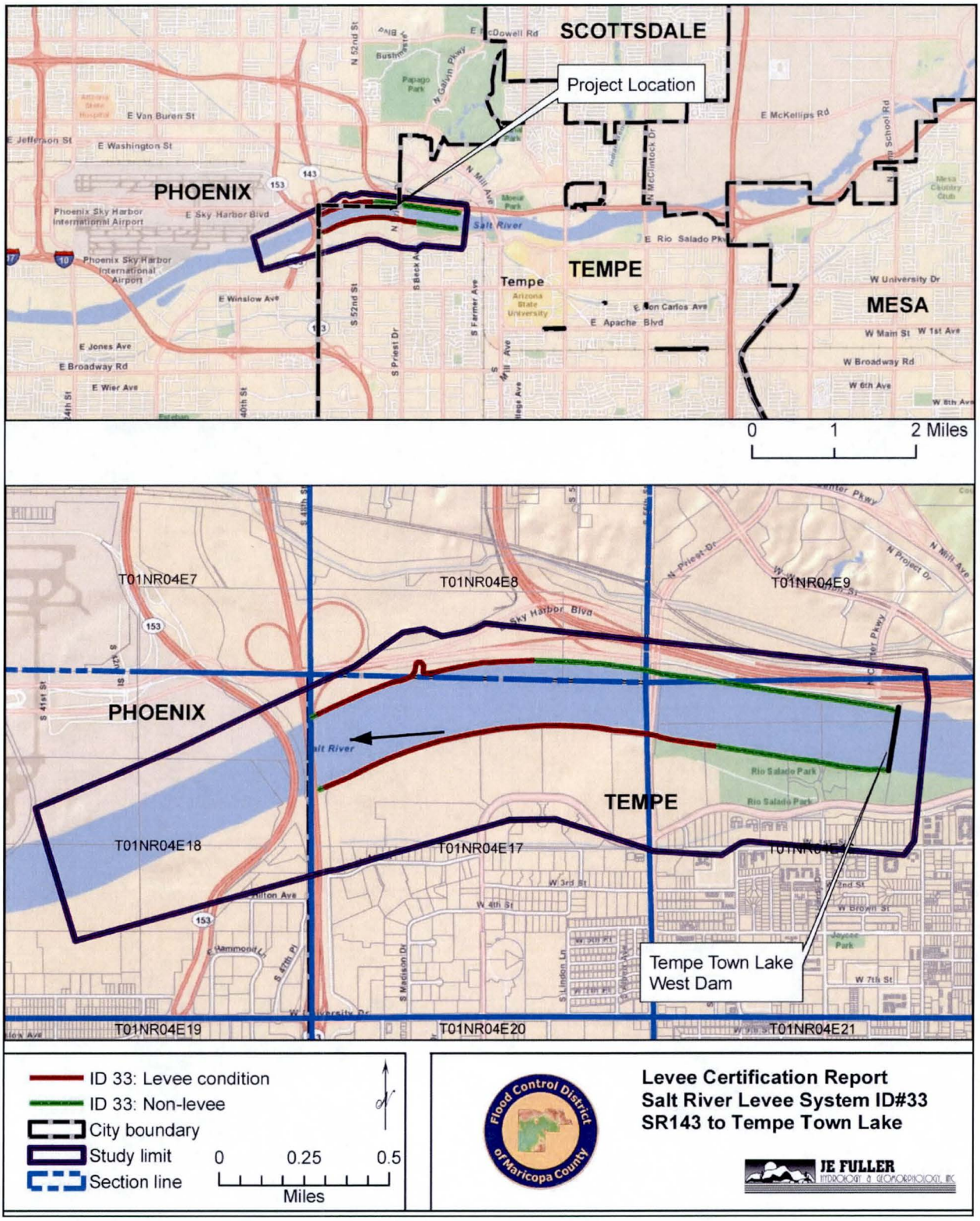



**Figure 1-2: Project Limits**

# 2 44CFR65.10 Requirements

## 2.1 General

**Section 2** contains excerpts in *"italics"* from 44CFR65.10. Below the excerpt, within each subsection, is a discussion on compliance of the Salt River Levee System. Sections of code are reproduced in their entirety. Subsections that do not apply to this evaluation are so noted. In addition, **Table 2-1** lists 44CFR65.10 criteria cross referenced with the location of supporting documentation.

**Table 2-1: Levee Compliance Summary for 44CFR65.10**

| Criteria | Comment and Location of Supporting Documentation |
|---|---|
| **65.10.b Design Criteria** | |
| 65.10.b.1 Minimum freeboard<br>• 3' above BFE all along length<br>• Additional 1' within 100' of structures and at constrictions<br>• Additional 0.5' at the upstream end of levee (tie-in) | Discussed in **Section 2.2.1** |
| 65.10.b.2 All openings protected with closure devices | Discussed in **Section 2.2.2** |
| 65.10.b.3 Embankment erosion protection analysis | Discussed in **Section 2.2.3** |
| 65.10.b.4 Embankment and foundation stability analysis | Discussed in **Section 2.2.4** with detailed documentation presented in *Geotechnical Study for Federal Emergency Management Agency (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011* under separate cover |
| 65.10.b.5 Settlement analysis | Discussed in **Section 2.2.5** with detailed documentation presented in *Geotechnical Study for Federal Emergency Management Agency (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011* under separate cover |
| 65.10.b.6 Interior drainage analysis<br>• Identify Flooding Source<br>• Identify extents of flooding greater than 1 foot<br>• Analysis based on the joint probability of interior and exterior flooding | Discussed in **Section 2.2.6** |
| 65.10.b.7 Other design criteria may be required at FEMA's discretion | None Applicable |

**Table 2-1: Levee Compliance Summary for 44CFR65.10 (Continued)**

| Criteria | | Comment and Location of Supporting Documentation |
|---|---|---|
| **65.10.c Operation** | | |
| • Officially adopted manual<br>• Under jurisdiction of a recognized Agency | | Discussed in **Section 2.3.1**<br>• *FCDMC, Operations and Maintenance Division, Standard Operating Procedures (SOP's) Deficiency Levels, Maintenance Standards, and Standard Drawings, Revised 2005* (hereafter referred to as FCD O&M Manual) under separate cover<br>• Flood Control District of Maricopa County, Arizona<br>2801 W. Durango Street<br>Phoenix, AZ 85009 |
| 65.10.c.1 | Closure Devices | |
| 65.10.c.1.i | Documentation of flood warning system | Flood Emergency Operations and Assignment responsibilities are noted in SOP #18. |
| 65.10.c.1.ii | Formal plan of operation with specific assignments | FCD O&M Manual, SOP #14 |
| 65.10.c.1.iii | Provisions for periodic (annual or more often) operation (testing and training) | FCD O&M Manual, Standard Operating Procedure #9 (SOP #9) |
| 65.10.c.2 | Interior Drainage Systems | |
| 65.10.c.2.i | Documentation of interior drainage flood warning system with specific assignments | Flood Emergency Operations and Assignment responsibilities are noted in SOP #18. |
| 65.10.c.2.ii | Formal plan of operation for interior drainage | FCD O&M Manual, SOP #14 |
| 65.10.c.2.iii | Provisions for manual backup for activation of automatic systems | Not Applicable. No Automated Systems |
| 65.10.c.2.iv | Provisions for periodic (annual or more often) inspection and operation of mechanized systems (testing and training) | FCD O&M Manual, SOP #9 |
| 65.10.c.3 | Other operation plans may be required at FEMA's discretion | Not Applicable |

**Table 2-1: Levee Compliance Summary for 44CFR65.10 (Continued)**

| Criteria | Comment and Location of Supporting Documentation |
|---|---|
| **65.10.d Maintenance plan** | |
| • Officially adopted manual<br>• Under jurisdiction of a recognized Agency | Discussed in **Section 2.4.1**<br>• *FCDMC, Operations and Maintenance Division, Standard Operating Procedures (SOP's) Deficiency Levels, Maintenance Standards, and Standard Drawings, Revised 2005* (hereafter referred to as FCD O&M Manual) under separate cover<br>• Flood Control District of Maricopa County, Arizona<br>2801 W. Durango Street<br>Phoenix, AZ 85009 |
| **65.10.e Certification** | |
| • Certification by a Registered Engineered | **Section 4** |
| • Certified As-built plans | Hard copy contained in **Appendix E** and electronic copy in pdf format on CD in **Appendix H**. |

## 2.2 Design Criteria

### 2.2.1 Freeboard

*"(1) Freeboard. (i) Riverine levees must provide a minimum freeboard of three feet above the water-surface level of the base flood. An additional one foot above the minimum is required within 100 feet in either side of structures (such as bridges) riverward of the levee or wherever the flow is constricted. An additional one-half foot above the minimum at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee, is also required."*

#### 2.2.1.1 Existing Conditions Evaluation of the Levee Freeboard

**Hydrology for the Salt River**

The effective 100-year peak discharge is 169,000 cfs for this reach per the Effective FEMA Flood Insurance Study (FIS) at Mill Avenue Bridge. (See portions of the Effective FIS in **Appendix A**).

**Revised Levee Limits based on Water Surface Elevations**

The limits of the levee to be certified were determined by comparing the Effective FEMA Base Flood Elevation (BFE) against the landside elevation (the point where the back of levee embankment meets natural grade and elevations begin to rise again). **Plate 1** in **Appendix B** shows the locations where the BFE exceeds the landside ground elevation as "Levee condition". Those areas where the landside elevation exceeds the BFE are shown on **Plate 1** as "Non-levee condition". These terms are defined in **Figure B-2**.

The landside ground elevations were obtained from topography and the RLS Sealed ground survey performed for this project. This elevation is listed in **Table B-1** through **Table B-4** in **Appendix B** along with the BFE, for both the north and south levee and for both NGVD 29 and NAVD 88 datums. The following criteria were used to define the levee limits for Certification:

- For the locations defined as "Non-levee condition", the landside elevation exceeds both the effective FEMA BFE and the WSE defined in the project HEC-RAS model.
- The north levee extends from centerline station 160+00 to 193+00 (as superimposed on the north levee). This includes RM 219.15 to 219.70. Areas outside of this, within the project limits, are in a non-levee condition.
- The south levee extends from centerline station 156+20 to 220+00 (as superimposed on the south levee). This includes RM 219.15 to 220.26. Areas outside these extents, within the project limits, are in a non-levee condition.

Levee limits discussed in this report and presented for certification, refer to the revised levee limits discussed above and displayed on **Plate 1**. "Non-Levee condition" segments between SR143 and Tempe Town Lake were not evaluated further.

**Freeboard Calculations for the Salt River Levee System ID#33**

Water surface elevations along the Salt River Levees were computed using HEC-RAS, version 4.1.0 (SR_Levee_ID33.prj) and updated topographic mapping (2007). A detailed discussion on modeling methodology and results is contained in **Appendix B**.

- Along the Salt River Levee North between levee stations 160+00 to 193+00 the

minimum freeboard elevation is 9.6 feet.

- Along the Salt River Levee South between levee stations 156+20 to 220+00 the minimum freeboard is 8.8 feet.

#### 2.2.1.2 Certification note for 44CFR65.10 (b)(1)

As shown in **Table D-1** though **Table D-4** in **Appendix B**, the Salt River Levee North between Stations160+00 to 193+00 and the Salt River Levee South between and Stations. 156+20 to 220+00, meet 44CFR65.10 (b)(1) freeboard requirements.

## 2.2.2 Closures

*"(2) Closures. All openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice. "*

### 2.2.2.1 Structures, Closures, and Tributaries

**Bridge**

There are three bridge crossings within the study area: SR153, SR143, and Priest Drive. Both SR 143 and SR 153 are downstream of the levee but are included in the HEC-RAS model.

**Closures**

There are a total of 4 openings in the south levee (See **Figure 2-1**). All of the south bank openings have closure structures. **Table 2-2** summarizes the closures found along the levee with stationing relative to the as-built plans. **Figure 2-1** below and **Plate 2** in **Appendix B** show the openings through the two levees.

**Table 2-2: Levee Openings**

| Levee Station [ft] | HEC-RAS RM | Opening size | Structure type | Closure Type |
|---|---|---|---|---|
| 165+00 (SL) | 219.20 | 72 inch | Concrete Pipe | Flap Gate |
| 210+25 (SL) | 220.04 | 42 inch | Concrete Pipe | Flap Gate |
| 218+15 (SL) | 220.19 | 36 inch | Concrete Pipe | Flap Gate |
| 222+05 (SL) | 220.27 | 36 inch | Concrete Pipe | Flap Gate |
| 460+10 (NL) | 219.37 | 3 barrel 16 ftx14ft | Box Culvert | None |

Abbreviations: NL – Salt River Levee North
SL – Salt River Levee South
RM – River Mile

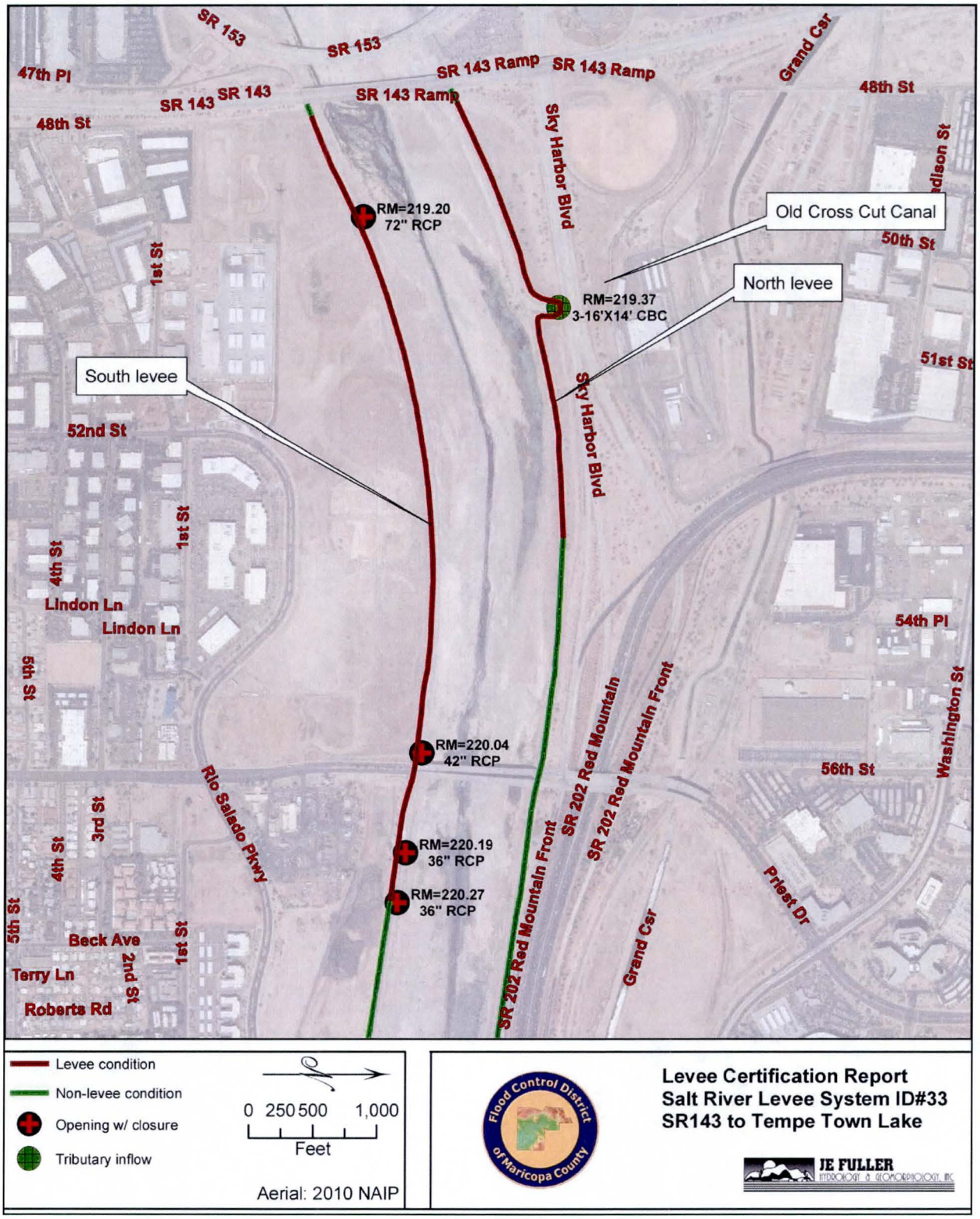



**Figure 2-1: Levee Openings**

## Field Observations

In addition, **Photographs 2-1** through **2-6** provided below show various culvert headwalls along the Salt River Levees.

**Photo 2-1:** Opening with closure at RM 219.20. (Levee Station 165+00)

**Photo 2-2:** Opening with closure at RM 220.04. (Levee Station 210+25).

**Photo 2-3:** Opening with closure at RM 220.19. (Levee Station 218+15)

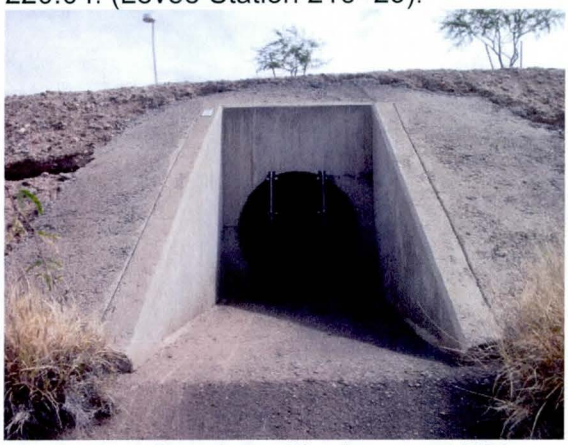


**Photo 2-4:** Opening with closure at RM 220.27. (Levee Station 222+05)

All closures have been inspected during a field visit conducted on May 3rd, 2011 and are currently in place and operable. (See **Appendix G** for additional site photographs and photograph location map).

## Old Cross Cut Canal Tributary

A tributary (Old Cross Cut Canal) comes into the Salt River along the north bank at RM 219.37. The soil cement embankment is formed around this tributary and extends to the higher ground of Sky Harbor Blvd. The Old Cross Cut Canal is a large, constructed channel which conveys flow under Sky Harbor Blvd via a 3 barrel 16'x14' CBC. The peak discharge in this channel is 6,502 cfs (100-year, 6-hour) per the "Hydrologic Study Report for Metro Phoenix Area Drainage Master Study/Plan".

**Photo 2-5**: Facing south (downstream) towards CBC for Old Cross Cut Canal.

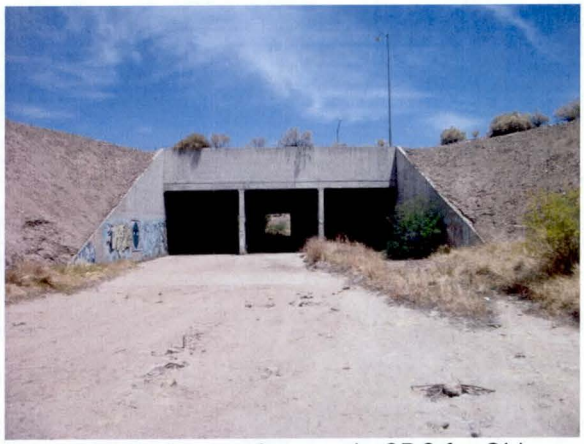


**Photo 2-6**: Facing north towards CBC for Old Cross Cut Canal. Levee ties into road embankment on either side.

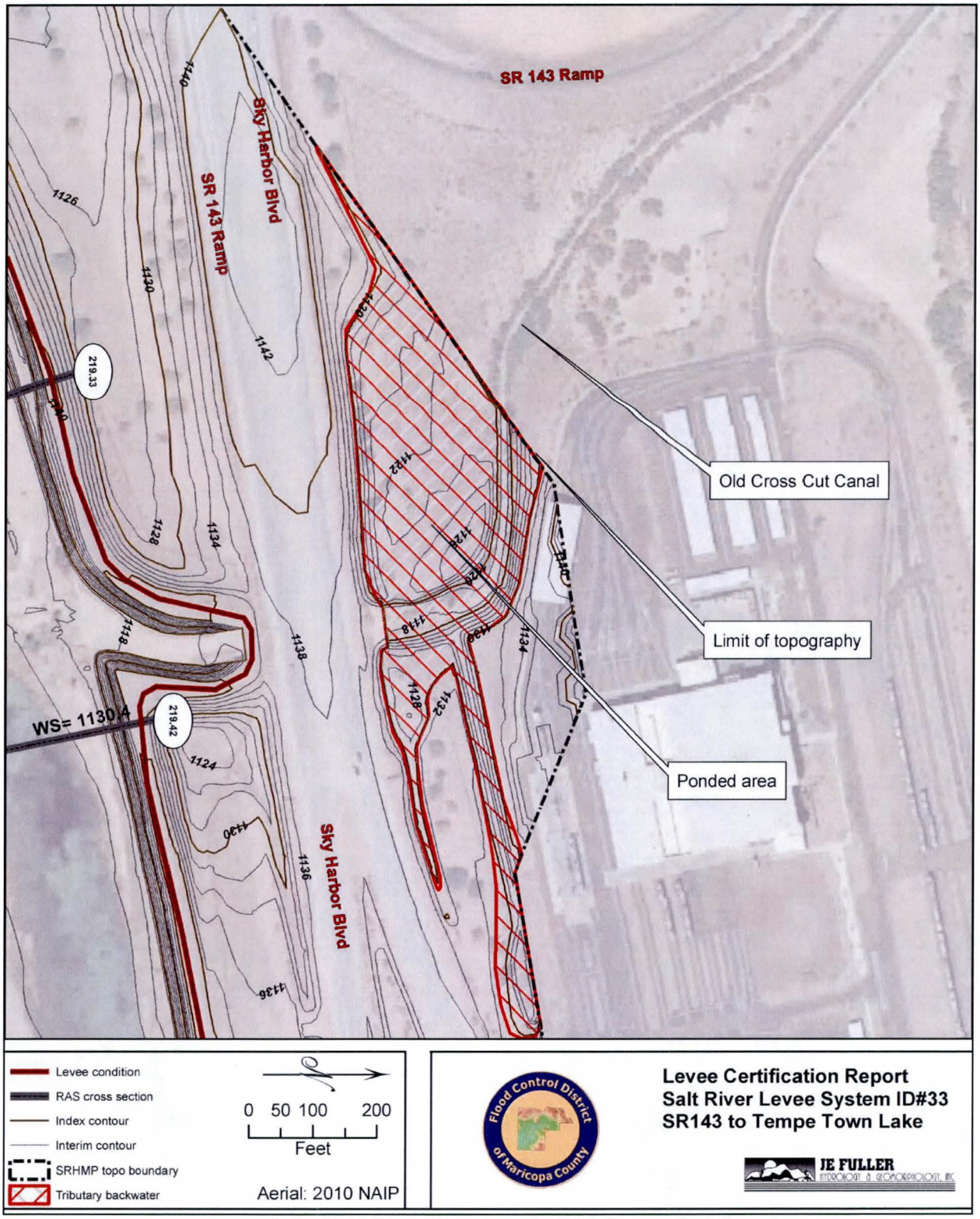



**Figure 2-2: Salt River Ponding in Old Cross Cut Canal**

A floodplain has been delineated for the Old Cross Cut Canal due to the lack of closures at the culvert. This is shown on **Plate 1** and **Figure 2-4**. The topography available for this study extends just a short distance up the channel, so the floodplain is only extended to the limit of the study. The floodplain was delineated to the water surface elevation for RM 219.42 (1130.4).

#### 2.2.2.2 Certification note for 44CFR65.10 (b)(2)

Based on visual observations the closure devices associated with Salt River Levee System, meet the requirements of 44CFR65.10 (b)(2).

### 2.2.3 Embankment Protection for North and South Levees

"*(3) Embankment protection. Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability. The factors to be addressed in such analyses include, but are not limited to: Expected flow velocities (especially in constricted areas); expected wind and wave action; ice loading; impact of debris; slope protection techniques; duration of flooding at various stages and velocities; embankment and foundation materials; levee alignment, bends, and transitions; and levee side slopes.*"

#### 2.2.3.1 Existing Conditions Evaluation of the Embankment Protection

As discussed in **Section 2.2.1.2**, a HEC-RAS hydraulic model was prepared to assess the existing hydraulic conditions within the Salt River. The **expected velocities** adjacent to levees range from 10.7 fps to 12.6 fps.

Throughout the reach, the flows adjacent to the levee are within the lower soil cement portion of the levee and as such the upper gabion portion of the levee was not assessed for resistance to flow (See **Photos 2-7 and 2-8**).

**Photo 2-7:** Typical Gabion fill material

**Photo 2-8:** Typical composite levee section.

During site visits conducted on May 3rd, 2011, the embankment protection appeared to be in satisfactory condition with no visible general scouring along the toe of the levee embankment. Local erosion of the North Levee embankment was seen near Station 160+00 (See **Photo 2-9**).

**Photo 2-9: Minor Soil Cement Bank Erosion, SRL North Levee Station 160+00.**

**Scour Evaluation for Embankment Toe Down**

The as-built toe-down elevations are documented on the plans prepared by DMJM Consulting Engineers for the Arizona Department of Transportation (RAM-600-3-511) dated 4/1989, as-built 1/25/1993 and 1/27/1993. It should be noted that during construction, bedrock was encountered along portions of the study reach. Per the construction plans, the toe-down was founded on bedrock when encountered. The revised toe-down elevations are documented on the as-built plans.

An evaluation was conducted as part of this assessment to evaluate the existing depth of the toe protection. A detailed evaluation using existing FCDMC methodology was conducted and is presented in **Appendix C**. The total scour potential is computed as the sum of six individual components: long term degradation, general scour, bend scour, bedform scour, local scour and low-flow incisement. Scour potential was evaluated along the entire length of the revised levee limits.

The results indicate that the computed toe-down elevations based on scour estimates are above the design toe elevations for both the North and South levees along the Salt River with a minimum safety factor of 1.1. Based on discussions with FCDMC, a safety factor above 1.1 is acceptable for this levee toe down assessment.

### 2.2.3.2 Certification note for 44CFR65.10 (b)(3)

Based on the calculations and engineering judgment the embankment protection for the Salt River Levee (North and South) meet the 44CFR65.10 (b)(3) requirements.

### 2.2.4 Embankment and Foundation Stability

"*(4) Embankment and foundation stability. Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the U.S. Army Corps of Engineers (COE) manual, "Design and Construction of Levees" (EM 1110–2–1913, Chapter 6, Section II), may be used. The factors that shall be addressed in the analyses include: Depth of flooding, duration of flooding, embankment geometry and length of seepage path at critical locations, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting seepage (such as drainage layers), and other design factors affecting embankment and foundation stability (such as berms). "*

#### 2.2.4.1 Certification note for 44CFR65.10 (b)(4)

Geotechnical analysis and review of design documentation, was conducted and documented by AMEC Earth & Environmental, Inc. (AMEC). Documentation is presented under separate cover (*Geotechnical Study for Federal Emergency Management Agency (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011*).

### 2.2.5 Settlement

*"(5) Settlement. Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained within the minimum standards set forth in paragraph (b)(1) of this section. This analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the COE manual, "Soil Mechanics Design— Settlement Analysis" (EM 1100–2–1904) must be submitted. "*

#### 2.2.5.1 Certification note for 44CFR65.10 (b)(5)

Geotechnical analysis and review of design documentation, was conducted and documented by AMEC Earth & Environmental, Inc. (AMEC). Documentation is presented under separate cover (*Geotechnical Study for Federal Emergency Management Agency (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011*).

### 2.2.6 Interior Drainage

*"(6) Interior drainage. An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than one foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters."*

#### 2.2.6.1 Existing Conditions Evaluation of the Interior Drainage

A hydrologic evaluation model was created for this levee certification effort to assess the interior drainage. The hydrologic modeling is detailed in **Appendix D**. The contributing areas are detailed in **Plate 1** in **Appendix B** with water surface elevations noted at each location based on delineation of contributing areas from available topo and simplified method for determine volume using FCD standards. **Figure 2-2** shows the general contributing areas.

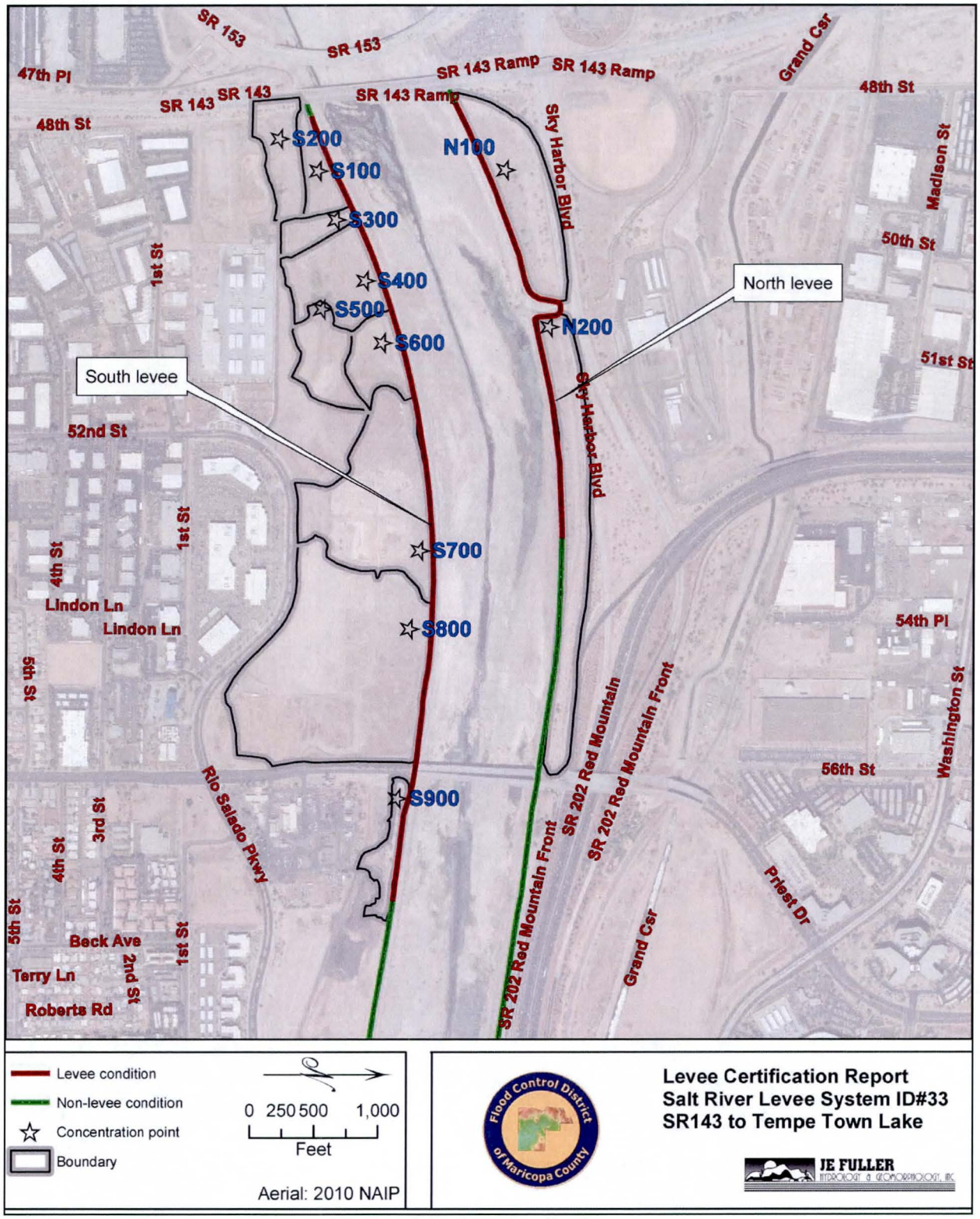



**Figure 2-3: Interior Drainage**

Interior areas delineated along the north and south levees do not have outlets and will infiltrate based on the percolation rate associated with the basin soil type.

Final ponding depths (maximum) for the interior drainage areas behind the north and south levees range from 1 foot for sub basin S300 to 9 feet for sub basin N200. Average ponding depths range from 6 inches to 3.5 feet (N200). Details of the interior drainage analysis are contained in **Appendix D**.

### 2.2.6.2 Certification note for 44CFR65.10 (b)(6)

Interior drainage areas for the Salt River Levee System (North and South) meet the requirements of 44CFR65.10 (b)(6).

## 2.3 Operation Plans and Criteria

*"(c) Operation plans and criteria. For a levee system to be recognized, the operational criteria must be as described below. All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP.*

*(1) Closures. Operation plans for closures must include the following:*

*(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.*

*(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.*

*(iii) Provisions for periodic operation, at not less than one-year intervals, of the closure structure for testing and training purposes.*

*(2) Interior drainage systems. Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan:*

*(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.*

*(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.*

*(iii) Provision for manual backup for the activation of automatic systems.*

*(iv) Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than one year shall elapse between either the inspections or the operations.*

*(3) Other operation plans and criteria. Other operating plans and criteria may be required by FEMA to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based."*

### 2.3.1 Salt River Levee System Operation Plan

**Operation Responsibility**

FCDMC operates and maintains the County structures under the *Standard Operating Procedures (SOP's), Deficiency Levels, Maintenance Standards, and Standard Drawings* (O&M Manual) under separate cover.

Within this document Flood Emergency Operations and Assignment responsibilities are noted in SOP #18.

**Closures Devices and Interior Drainage Plan**

Provisions for periodic operation of closure structures are noted in SOP #9.

## 2.4 Maintenance Plans and Criteria

" *(d) Maintenance plans and criteria. For levee systems to be recognized as providing protection from the base flood, the maintenance criteria must be as described herein. Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner. All maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance."*

### 2.4.1 Levee System Maintenance Plan

As noted above the FCDMC utilizes the O&M Manual for County structures. Under SOP #14, specific yearly inspection/maintenance intervals are outlined as well as a general list of priority maintenance items. Origination charts are included on pages 148 and 149.

Annual Inspection and Maintenance Inspection Reports for Salt River Levees (Part of Rio Salado) are included on the data disk in **Appendix H**.

## 2.5 Certification Requirements

"*(e) Certification requirements. Data submitted to support that a given levee system complies with the structural requirements set forth in paragraphs (b)(1) through (7) of this section must be certified by a registered professional engineer. Also, certified as-built plans of the levee must be submitted. Certifications are subject to the definition given at § 65.2 of this subchapter. In lieu of these structural requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection against the base flood. "*

Certification Language is included in **Section 4** and portions of the As-Built plans are included in **Appendix E** with a full electronic copy in pdf format included on the data disk in **Appendix H**.

# 3 FEMA Forms

Salt River Levee System, MT-2 Form 3, Pages 1 through 10

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

# RIVERINE STRUCTURES FORM

*O.M.B No. 1660-0016*
*Expires: 12/31/2010*

## PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: Salt River
**Note:** Fill out one form for each flooding source studied

## A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization.....complete Section B
Bridge/Culvert.....complete Section C
Dam/Basin.....complete Section D
Levee/Floodwall.....complete Section E
Sediment Transport .....complete Section F (if required)

Description Of Structure

1. **Name of Structure:** **Salt River Levee System ID#33**

   Type (check one): ☐ Channelization ☐ Bridge/Culvert ☒ Levee/Floodwall ☐ Dam/Basin

   Location of Structure: Maricopa County, Arizona

   Downstream Limit/Cross Section: RM 219.15 (North and South Levee)

   Upstream Limit/Cross Section: RM219.70 North Levee and RM220.26 South Levee

2. **Name of Structure:**

   Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

   Location of Structure:

   Downstream Limit/Cross Section:

   Upstream Limit/Cross Section:

3. **Name of Structure:**

   Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

   Location of Structure:

   Downstream Limit/Cross Section:

   Upstream Limit/Cross Section:

**NOTE: For more structures, attach additional pages as needed.**

## B. CHANNELIZATION

Flooding Source:

Name of Structure:

1. Accessory Structures

The channelization includes (check one):

- ☐ Levees [Attach Section E (Levee/Floodwall)]
- ☐ Superelevated sections
- ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)]
- ☐ Other (Describe):
- ☐ Drop structures
- ☐ Transition in cross sectional geometry
- ☐ Energy dissipator

2. Drawing Checklist

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Hydraulic Considerations

The channel was designed to carry (cfs) and/or the -year flood.

The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump in the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

- ☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions
- ☐ Other locations (specify):

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

NOT APPLICABLE

## C. BRIDGE/CULVERT

Flooding Source:

Name of Structure:

1. This revision reflects (check one):

- ☐ Bridge/culvert not modeled in the FIS
- ☐ Modified bridge/culvert previously modeled in the FIS
- ☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8):
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

- ☐ Dimensions (height, width, span, radius, length)
- ☐ Shape (culverts only)
- ☐ Material
- ☐ Beveling or Rounding
- ☐ Wing Wall Angle
- ☐ Skew Angle
- ☐ Distances Between Cross Sections
- ☐ Erosion Protection
- ☐ Low Chord Elevations – Upstream and Downstream
- ☐ Top of Road Elevations – Upstream and Downstream
- ☐ Structure Invert Elevations – Upstream and Downstream
- ☐ Stream Invert Elevations – Upstream and Downstream
- ☐ Cross-Section Locations

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

NOT APPLICABLE

## D. DAM/BASIN

Flooding Source:

Name of Structure:

1. This request is for (check one): ☐ Existing dam ☐ New dam ☐ Modification of existing dam

2. The dam was designed by (check one): ☐ Federal agency ☐ State agency ☐ Local government agency ☐ Private organization

   Name of the agency or organization:

3. The Dam was permitted as (check one):

   a. ☐ Federal Dam ☐ State Dam

      Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

      Permit or ID number Permitting Agency or Organization

   b. ☐ Local Government Dam ☐ Private Dam

      Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm?

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport).
   If No, then attach your explanation for why debris/sediment analysis was not considered.

6. Does the Base Flood Elevation behind the dam or downstream of the dam change?

   ☐ Yes ☐ No If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

   Stillwater Elevation Behind the Dam

| FREQUENCY (% annual chance) | FIS | REVISED |
|---|---|---|
| 10-year (10%) | | |
| 50-year (2%) | | |
| 100-year (1%) | | |
| 500-year (0.2%) | | |
| Normal Pool Elevation | | |

7. Please attach a copy of the formal Operation and Maintenance Plan

NOT APPLICABLE

## E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

- ☐ upgrading of an existing levee/floodwall system
- ☐ a newly constructed levee/floodwall system
- ☒ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

North Levee Limits (160+00 to 195+00)
South Levee Limits (156+20 to 220.26)
*(Construction beginning and end Stations)

- ☒ earthen embankment, dike, berm, etc.
- ☐ structural floodwall
- ☐ Other (describe):

c. Structural Type (check one):

- ☐ monolithic cast-in place reinforced concrete
- ☐ reinforced concrete masonry block
- ☐ sheet piling
- ☒ Other (describe): Earthen Embankment (Levee section is comprised of lower soil cement section with upper section of gabion mattress on Earthen embankment.

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☒ No

If Yes, by which agency?

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):
A portion of the As-Built drawings are included in **Appendix E** (8 ½ x 11) with electronic copy included on data disk in **Appendix H**. Profile plots do not include BFE.

1. Plan of the levee embankment and floodwall structures. — Sheet Numbers: Sheets 2.1 thru 2.14
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. — Sheet Numbers: Sheets 2.1 thru 2.14
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. — Sheet Numbers: Sheets 9.1 thru 9.6 and 8.1
4. A layout detail for the embankment protection measures. — Sheet Numbers: Sheets 1.4 thru 1.7 and 7.1 thru 7.2
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. — Sheet Numbers: Sheets 2.1 thru 2.14
*As-Built Drawings do not include BFE Profile.

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

| | | |
|---|---|---|
| 3.0 feet or more at the downstream end and throughout | ☒ Yes | ☐ No |
| 3.5 feet or more at the upstream end | ☒ Yes | ☐ No |
| 4.0 feet within 100 feet upstream of all structures and/or constrictions | ☒ Yes | ☐ No |

Coastal

| | | |
|---|---|---|
| 1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater). Not Applicable | ☐ Yes | ☐ No |
| 2.0 feet above the 1%-annual-chance stillwater surge elevation Not Applicable | ☐ Yes | ☐ No |

E. LEVEE/FLOODWALL (CONTINUED)

2. Freeboard (continued)

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☒ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☒ exists ☐ does not exist

If opening exists, list all closures:

| Channel Station | Left or Right Bank | Opening Type | Highest Elevation for Opening Invert (NGVD 29) | Type of Closure Device |
|---|---|---|---|---|
| South Levee 165+00 | Left | 72" RCP | Outlet Invert = 1119.6 ft. | Flap Gate |
| South Levee 210+25 | Left | 42" RCP | Outlet Invert = 1133.7 ft. | Flap Gate |
| South Levee 218+15 | Left | 36" RCP | Outlet Invert = 1131.5 ft. | Flap Gate |
| South Levee 222+05 | Left | 36" RCP | Outlet Invert = 1133.3 ft. | Flap Gate |
| North Levee 175+25 | Right | 3 barrel 16'x14' CBC | Outlet Invert = 1120.6 ft. | None |

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope landside is: 3H:1V

b. The maximum levee slope floodside is: 1.5H:1V

c. The range of velocities along the levee during the base flood is: 10.7 ft/sec (min.) to 12.6 ft/sec (max.)

d. Embankment material is protected by (describe what kind): Soil Cement/Gabion Mattresses

e. Riprap Design Parameters (check one): ☒ Velocity ☐ Tractive stress
Attach references
Soil Cement used to withstand velocities greater than 10 fps. See embankment scour assessment in Appendix C.

| Reach | Sideslope | **Flow Depth | **Velocity | Curve or Straight | Stone Riprap | | | Depth of Toedown |
|---|---|---|---|---|---|---|---|---|
| | | | | | $D_{100}$ | $D_{50}$ | Thickness | |
| Sta: to | | | | | | | | |
| Sta to | | | | | | | | |
| Sta to | | | | | | | | |

Hydraulic data from SRHMP Model (LILCOL.dat). Electronic copy in **Appendix H**

(Extend table on an added sheet as needed and reference each entry)

## E. LEVEE/FLOODWALL (CONTINUED)

4. Embankment Protection (continued)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☒ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:

*Please refer to Geotechnical Study for Federal Emergency Management Agency (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011, for items in a. through h. below*

☐ Overall height: Sta. ; height ft.

☐ Limiting foundation soil strength:

Sta. , depth to

strength $\phi$ = degrees, c = psf

slope: SS = (h) to (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

c. Summary of stability analysis results:

| Case | Loading Conditions | Critical Safety Factor | Criteria (Min.) |
|---|---|---|---|
| I | End of construction | XXX | 1.3 |
| II | Sudden drawdown | XXX | 1.0 |
| III | Steady seepage at flood stage | XXX | 1.4 |
| IV | Earthquake (Case I) | XXX | 1.0 |

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☒ Yes ☐ No

If Yes, describe methodology used: XXX.

e. Was a seepage analysis for the foundation performed? ☒ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☒ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☒ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is XXX hours (XXX).

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one):

☐ UBC (1988) or ☐ Other (specify):

b. Stability analysis submitted provides for:

☐ Overturning ☐ Sliding If not, explain:

c. Loading included in the analyses were:

☐ Lateral earth @ $P_A$ = psf; $P_p$ = psf

☐ Surcharge-Slope @ , ☐ surface psf

☐ Wind @ $P_w$ = psf

☐ Seepage (Uplift); ☐ Earthquake @ $A_{eq}$ = %g

☐ 1%-annual-chance significant wave height: ft.

☐ 1%-annual-chance significant wave period: sec.

d. Summary of Stability Analysis Results: Factors of Safety.

Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

| Loading Condition | Criteria (Min) | | Sta | To | Sta | To |
|---|---|---|---|---|---|---|
| | Overturn | Sliding | Overturn | Sliding | Overturn | Sliding |
| Dead & Wind | 1.5 | 1.5 | | | | |
| Dead & Soil | 1.5 | 1.5 | | | | |
| Dead, Soil, Flood, & Impact | 1.5 | 1.5 | | | | |
| Dead, Soil, & Seismic | 1.3 | 1.3 | | | | |

(Ref: FEMA 114 Sept 1985, USACE EM 1110-2-2502)

(Note: Extend table on an additional sheet as needed and reference)

e. Foundation bearing strength for each soil type:

| Bearing Pressure | Sustained Load (psf) | Short Term Load (psf) |
|---|---|---|
| Computed design maximum | | |
| Maximum allowable | | |

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

NOT APPLICABLE

## E. LEVEE/FLOODWALL (CONTINUED)

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☒ Yes ☐ No

b. The computed range of settlement is XXX ft. to XXX ft.

c. Settlement of the levee crest is determined to be primarily from :

☐ Foundation consolidation
☐ Embankment compression
☐ Other (Describe):

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction. (XXX)

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: 0.0 sq. mi.
Draining to ponding area: 155 acres.

b. Relationships Established

| | | |
|---|---|---|
| Ponding elevation vs. storage | ☒ Yes | ☐ No |
| Ponding elevation vs. gravity flow | ☐ Yes | ☒ No |
| Differential head vs. gravity flow | ☐ Yes | ☒ No |

c. The river flow duration curve is enclosed: ☐ Yes ☒ No

d. Specify the discharge capacity of the head pressure conduit: (Not applicable)

e. Which flooding conditions were analyzed?

| | | |
|---|---|---|
| • Gravity flow (Interior Watershed) | ☒ Yes | ☐ No |
| • Common storm (River Watershed) | ☐ Yes | ☐ No (Not applicable) |
| • Historical ponding probability | ☐ Yes | ☐ No (Not applicable) |
| • Coastal wave overtopping | ☐ Yes | ☐ No (Not applicable) |

If No for any of the above, attach explanation.

f. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No (Not applicable)

If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is cfs (Seepage due to interior drainage was not analyzed)

h. The length of levee system used to drive this seepage rate in item g: ft. (Seepage due to interior drainage was not analyzed)

## E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☒ No

If Yes, include the number of pumping plants:
For each pumping plant, list:

NOT APPLICABLE

| | Plant #1 | Plant #2 |
|---|---|---|
| The number of pumps | | |
| The ponding storage capacity | | |
| The maximum pumping rate | | |
| The maximum pumping head | | |
| The pumping starting elevation | | |
| The pumping stopping elevation | | |
| Is the discharge facility protected? | | |
| Is there a flood warning plan? | | |
| How much time is available between warning and flooding? | | |

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

XXX

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No Not Applicable

Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☒ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

See **Appendix C** for discussion on Channel/Embankment Scour

## E. LEVEE/FLOODWALL (CONTINUED)

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☒ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☒ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☒ Yes ☐ No

If the answer is No to any of the above, please attach supporting documentation.

11. Maintenance Plan

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☒ Yes ☐ No
If No, please attach supporting documentation.

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

See Operation and Maintenance Elements documented in *FCDMC, Operations and Maintenance Division, Standard Operating Procedures (SOP's) Deficiency Levels, Maintenance Standards, and Standard Drawings, Revised 2005* under separate Cover.

## F. SEDIMENT TRANSPORT

Flooding Source:

Name of Structure:

See **Appendix C** for discussion on Channel/Embankment Scour

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume acre-feet

Debris load associated with the base flood discharge: Volume acre-feet

Sediment transport rate (percent concentration by volume)

Method used to estimate sediment transport:

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition:

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport:
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

# 4 Certification Statement

I, Jon Ahern, a registered Professional Civil Engineer in the State of Arizona (Certificate No. 34141), certify that based on my review of both the current on-site conditions of the Salt River Levee System ID#33 (North and South levee limits as defined in **Section 2**), that this levee system does, as of the date of this certification, meet the minimum design criteria to provide protection from the base flood as set forth in the Code of Federal Regulations, 44CFR 65.10. The specific paragraphs of 44CFR65.10 that I certify are indicated directly below.

- (b)(1) Freeboard
- (b)(2) Closures
- (b)(3) Embankment protection related to adequate scour depth of levee toe down.
- (b)(6) Interior Drainage

No Other Design Criteria ((b) (7)) were identified for Certification.

Certification Statement for Embankment, Foundation Stability, and Settlement ((b)(3), (b)(4) and (b)(5)) are included in the Geotechnical analysis and review of design documentation, was conducted and documented by AMEC Earth & Environmental, Inc. (AMEC). Documentation is presented under separate cover (*Geotechnical Study for Federal Emergency Management Agency (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011*).

# 5 Limitations

According to FEMA and USACE documents, levee certification is a technical finding that, for the floodplain in question, there is a certainty that the levee system protecting the area will contain the base (1% annual exceedance) flood. The sole purpose of levee certification is to validate that areas protected from flooding by the levee in question may be shown on Flood Insurance Rate Maps (FIRMS) as protected from the 1% chance exceedance flood. Levee certification findings do not address, nor are the findings concerned, with public safety, performance of the levee system for floods other than the 1% event, or risk to floodplain residents from floods that will exceed system capacity. Recommendations contained in this report are based on our field observations, hydrologic/hydraulic assessments, and our present knowledge of the proposed construction.

We have prepared this report in substantial accordance with the generally accepted engineering practice as it exists in the site area at the time of our study. No warranty, either expressed or implied, is made.

Other standards or documents referenced in this report, or otherwise relied upon by the author of this report, are only mentioned in the given standard; they are not incorporated into this report body or "included by reference", as that latter term is used relative to contracts or other matters of law. This report may be used only by FCDMC for the purposes stated within a reasonable time from its issuance. The Salt River Levee System ID #33 Certification (Section 4) is valid within ten (10) years from the date of this report. It is recommended that the FCDMC re-evaluate the certification requirements of the Levee System following the 10-year date. Land or facility use, on and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time.

# A. References

## A.1 References

## A.2 FEMA Documents

## A.1 References

## References


1) Arizona Department of Water Resources, Design Manual for Engineering Analysis of Fluvial Systems, Simons Li Associates, 1985.

2) "Design and Construction of Levees" (EM 1110-2-1913) U.S. Army Corps of Engineers.

3) "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, 2009.

4) FCDMC, Operations and Maintenance Division, Standard Operating Procedures (SOP's) Deficiency Levels, Maintenance Standards, and Standard Drawings, Revised 2005.

5) Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, Hydraulics, 2010.

6) Geotechnical Study for Federal Emergency Management (FEMA) Partial Certification, PAL ID No. 33, Salt River Levee, Tempe, Arizona, June 2011.

7) "Hydrologic Study Report for Metro Phoenix Area Drainage Master Study/Plan".

8) J2 Engineering and Environment Design, SR143-Sky Harbor Blvd. TI. Initial Salt River Drainage Concept Report, 2009.

9) Pemberton, E.L., and Lara, J.M., Computing Degradation and Local Scour, Technical Guideline for Bureau of Reclamation, Denver, Colorado, January1984.

10) "Plans for the Construction of Priest Drive Bridge – Rio Salado Parkways to Washington Street", Maricopa County Highway Department, Project No. 68456, 1991.

11) "Preliminary Grading, Drainage, and Utility Plans for East Valley Maintenance Yard", 2005.

12) Richardson, E.V., Davis, S.R., U.S. Department of Transportation, Federal Highway Administration, Evaluating Scour at Bridges, Fourth Edition, FHWA NHI 01-001, May 2001.

13) "Salt-Gila River Floodplain Delineation Restudy", FEMA, Baker, 1999.

14) "Salt River Channelization, Hohokam (University-Sky Harbor)", State of Arizona Department of Transportation Highways Division, RAM-600-3-511), 1993.

15) Stantec Consulting Inc., Salt River Hydraulic Master Plan (SRHMP), 2009.

16) Survey Report – Salt River Levee Survey", Wilson & Company, 2011.

17) USACE, "Section 7 Study for Modified Roosevelt Dam, Arizona Theodore Roosevelt Dam – Hydrologic Evaluation of Water Control Plans – Salt River Project to Gila River at Gillespie Dam" (TRD Report), 1996.

18) "U.S. Army Corps of Engineer, Rio Salado Environmental Restoration Project, 1993.

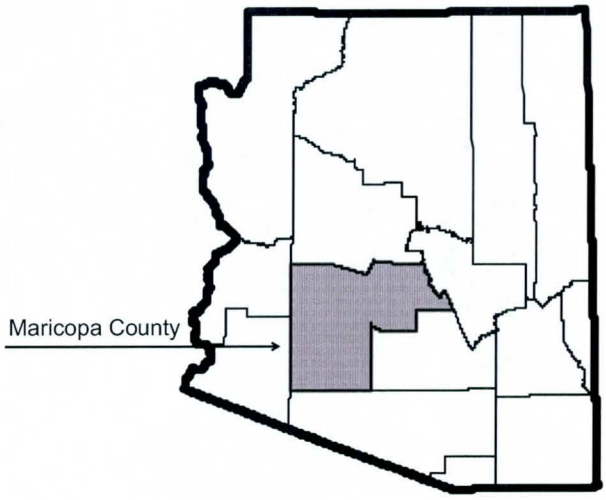
19) US Geological Survey, "Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated in Central Arizona", 2007.

## A.2 FEMA Documents

# FLOOD INSURANCE STUDY

# MARICOPA COUNTY, ARIZONA
## AND INCORPORATED AREAS
### VOLUME 3 OF 17

| COMMUNITY NAME | COMMUNITY NUMBER |
|---|---|
| AVONDALE, CITY OF | 040038 |
| BUCKEYE, TOWN OF | 040039 |
| CAREFREE, TOWN OF | 040126 |
| CAVE CREEK, TOWN OF | 040129 |
| CHANDLER, CITY OF | 040040 |
| EL MIRAGE, CITY OF | 040041 |
| FOUNTAIN HILLS, TOWN OF | 040135 |
| GILA BEND, TOWN OF | 040043 |
| GILBERT, TOWN OF | 040044 |
| GLENDALE, CITY OF | 040045 |
| GOODYEAR, CITY OF | 040046 |
| GUADALUPE, TOWN OF | 040111 |
| LITCHFIELD PARK, CITY O | 040128 |
| MARICOPA COUNTY (UNINCORPORATED AREAS) | 040037 |
| MESA, CITY OF | 040048 |
| PARADISE VALLEY, TOWN OF | 040049 |
| PEORIA, CITY OF | 040050 |
| PHOENIX, CITY OF | 040051 |
| QUEEN CREEK, TOWN OF | 040132 |
| SCOTTSDALE, CITY O | 045012 |
| SURPRISE, CITY OF | 040053 |
| TEMPE, CITY OF | 040054 |
| TOLLESON, CITY OF | 040055 |
| WICKENBURG, TOWN OF | 040056 |
| YOUNGTOWN, TOWN OF | 040057 |




REVISED

September 30, 2005

Federal Emergency Management Agency

**FLOOD INSURANCE STUDY NUMBER**
**04013CV003A**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Salt River (Cont'd) | | | | | | | | |
| AA | 12.105 | 526 | 10,619 | 15.6 | 1,043.7 | 1,043.7 | 1,043.9 | 0.2 |
| AB | 12.556 | 550 | 11,613 | 14.3 | 1,048.6 | 1,048.6 | 1,048.7 | 0.1 |
| AC | 13.031 | 558 | 9,738 | 17.1 | 1,056.2 | 1,056.2 | 1,056.3 | 0.1 |
| AD | 13.409 | 636 | 11,740 | 14.1 | 1,063.5 | 1,063.5 | 1,063.6 | 0.1 |
| AE | 13.809 | 880 | 19,319 | 8.8 | 1,068.0 | 1,068.0 | 1,068.0 | 0.0 |
| AF | 14.141 | 852 | 13,541 | 12.5 | 1,069.2 | 1,069.2 | 1,069.2 | 0.0 |
| AG | 14.520 | 745 | 15,305 | 11.0 | 1,074.2 | 1,074.2 | 1,074.2 | 0.0 |
| AH | 14.900 | 900 | 22,831 | 7.4 | 1,076.9 | 1,076.9 | 1,076.9 | 0.0 |
| AI | 15.337 | 1,054 | 17,199 | 9.8 | 1,078.1 | 1,078.1 | 1,078.1 | 0.0 |
| AJ | 15.750 | 594 | 9,383 | 18.0 | 1,081.9 | 1,081.9 | 1,081.9 | 0.0 |
| AK | 16.223 | 890 | 14,237 | 11.9 | 1,088.3 | 1,088.3 | 1,088.3 | 0.0 |
| AL | 16.515 | 907 | 11,465 | 14.7 | 1,093.7 | 1,093.7 | 1,093.7 | 0.0 |
| AM | 16.990 | 947 | 14,614 | 11.6 | 1,098.9 | 1,098.9 | 1,098.9 | 0.0 |
| AN | 17.328 | 897 | 16,768 | 10.1 | 1,103.1 | 1,103.1 | 1,103.1 | 0.0 |
| AO | 17.802 | 999 | 14,340 | 11.8 | 1,107.2 | 1,107.2 | 1,107.2 | 0.0 |
| AP | 18.273 | 824 | 11,392 | 14.8 | 1,111.7 | 1,111.7 | 1,111.7 | 0.0 |
| AQ | 18.750 | 1,035 | 14,553 | 11.6 | 1,118.2 | 1,118.2 | 1,118.2 | 0.0 |
| AR | 19.224 | 987 | 14,890 | 11.4 | 1,123.6 | 1,123.6 | 1,123.6 | 0.0 |
| AS | 19.553 | 1,027 | 14,367 | 11.8 | 1,127.8 | 1,127.8 | 1,127.8 | 0.0 |
| AT | 20.026 | 1,006 | 14,993 | 11.3 | 1,132.9 | 1,132.9 | 1,132.9 | 0.0 |
| AU | 20.547 | 907 | 13,097 | 12.9 | 1,139.7 | 1,139.7 | 1,139.7 | 0.0 |
| AV | 20.960 | 912 | 14,837 | 11.4 | 1,145.0 | 1,145.0 | 1,145.0 | 0.0 |
| AW | 21.435 | 906 | 15,058 | 11.2 | 1,149.4 | 1,149.4 | 1,149.4 | 0.0 |
| AX | 21.719 | 973 | 17,696 | 9.6 | 1,152.2 | 1,152.2 | 1,152.2 | 0.0 |
| AY | 22.015 | 929 | 13,822 | 12.4 | 1,154.6 | 1,154.6 | 1,154.6 | 0.0 |
| AZ | 22.503 | 1,012 | 16,481 | 10.4 | 1,159.0 | 1,159.0 | 1,159.0 | 0.0 |

[1]Miles above confluence with Gila River

# FLOOD INSURANCE STUDY

# MARICOPA COUNTY, ARIZONA
## AND INCORPORATED AREAS
### VOLUME 7 OF 17

| COMMUNITY NAME | COMMUNITY NUMBER |
|---|---|
| AVONDALE, CITY OF | 040038 |
| BUCKEYE, TOWN OF | 040039 |
| CAREFREE, TOWN OF | 040126 |
| CAVE CREEK, TOWN OF | 040129 |
| CHANDLER, CITY OF | 040040 |
| EL MIRAGE, CITY OF | 040041 |
| FOUNTAIN HILLS, TOWN OF | 040135 |
| GILA BEND, TOWN OF | 040043 |
| GILBERT, TOWN OF | 040044 |
| GLENDALE, CITY OF | 040045 |
| GOODYEAR, CITY OF | 040046 |
| GUADALUPE, TOWN OF | 040111 |
| LITCHFIELD PARK, CITY O | 040128 |
| MARICOPA COUNTY (UNINCORPORATED AREAS) | 040037 |
| MESA, CITY OF | 040048 |
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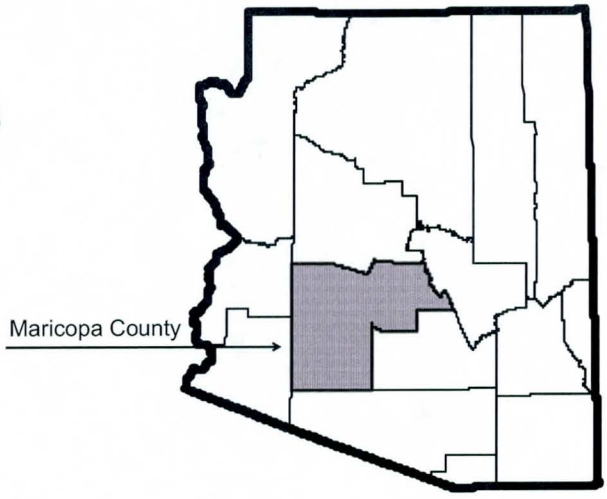
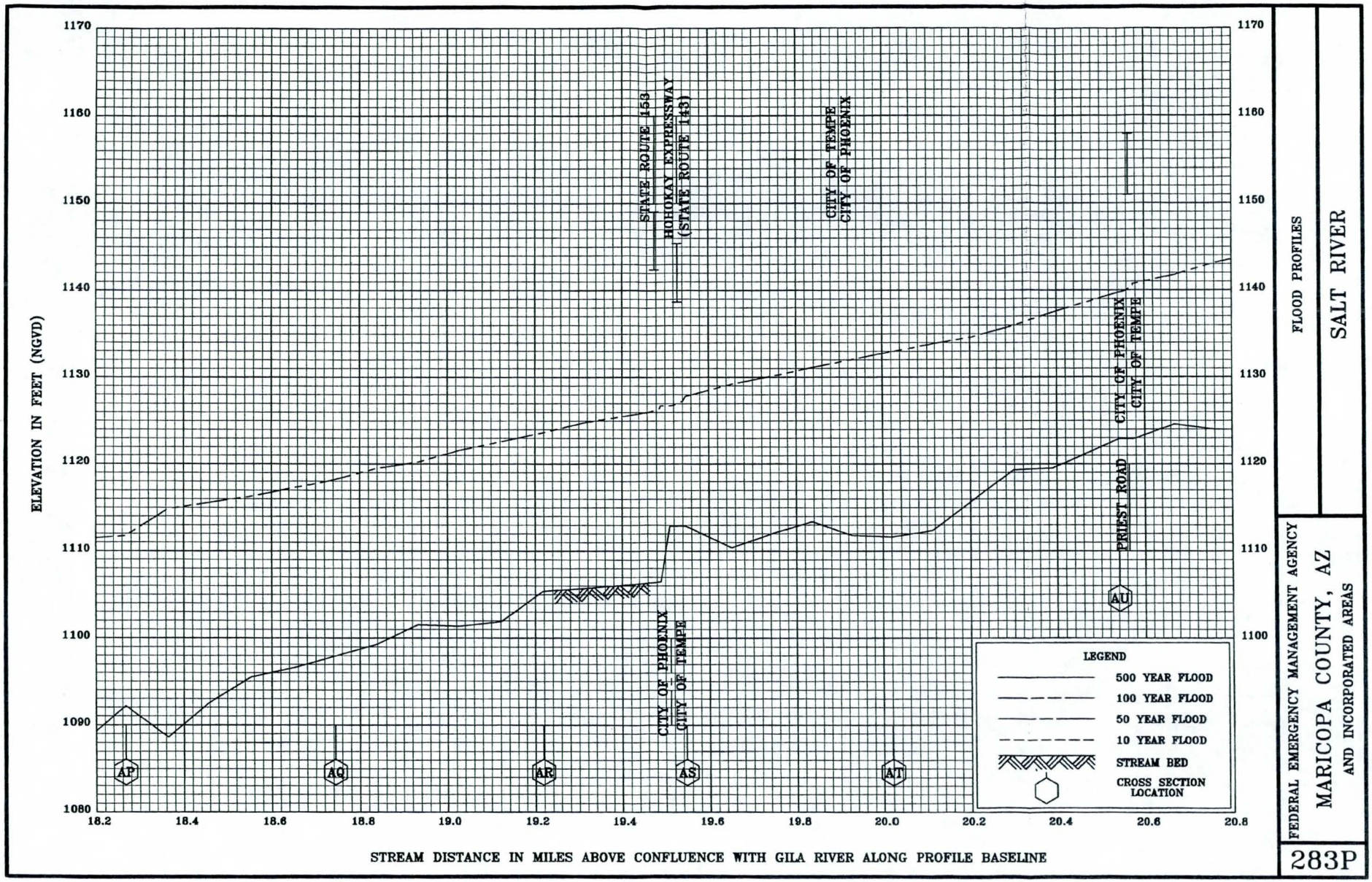
| PEORIA, CITY OF | 040050 |
| PHOENIX, CITY OF | 040051 |
| QUEEN CREEK, TOWN OF | 040132 |
| SCOTTSDALE, CITY O | 045012 |
| SURPRISE, CITY OF | 040053 |
| TEMPE, CITY OF | 040054 |
| TOLLESON, CITY OF | 040055 |
| WICKENBURG, TOWN OF | 040056 |
| YOUNGTOWN, TOWN OF | 040057 |




REVISED
September 30, 2005

Federal Emergency Management Agency

**FLOOD INSURANCE STUDY NUMBER**
**04013CV007A**




FLOOD PROFILES

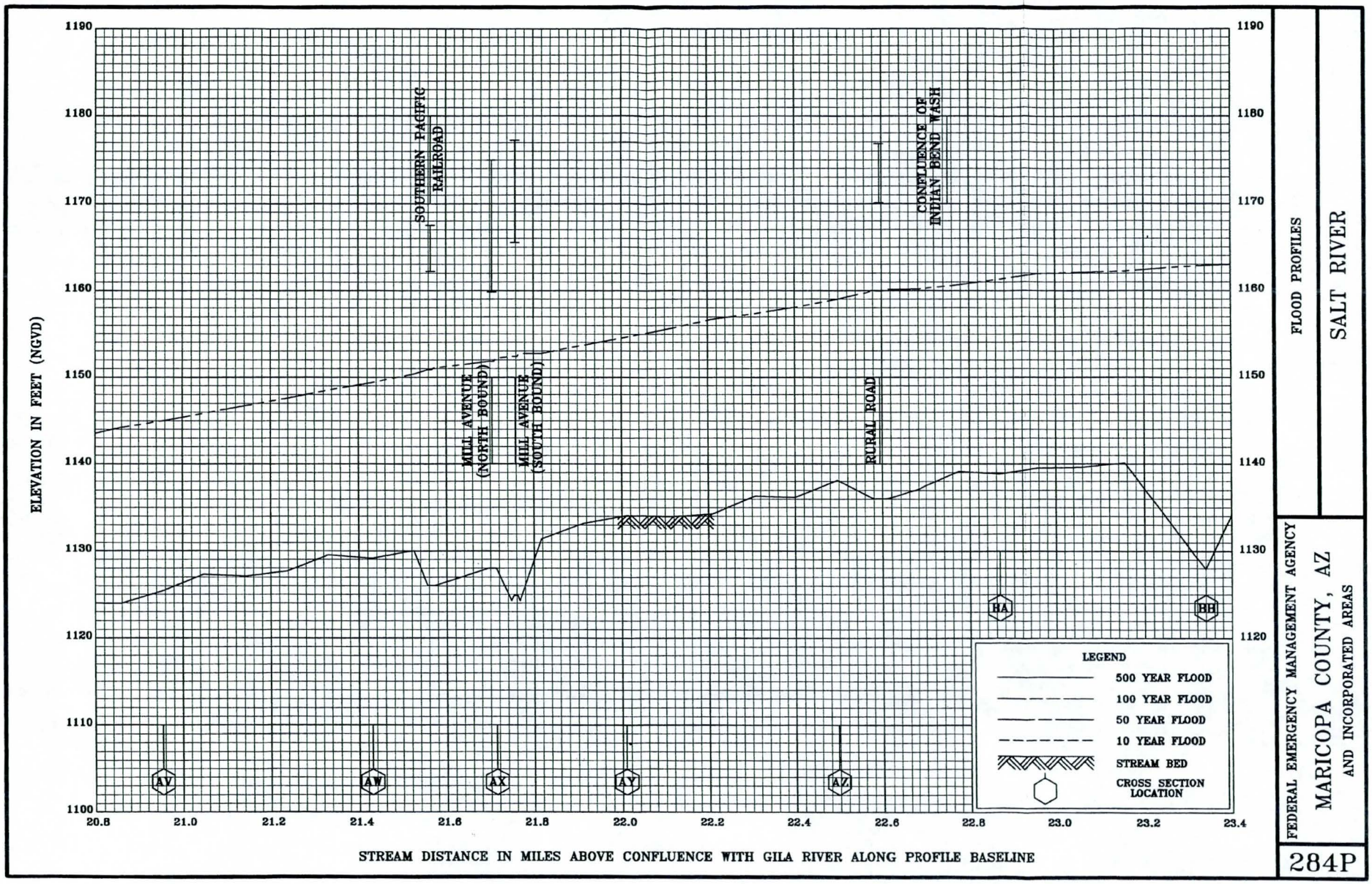
SALT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ

AND INCORPORATED AREAS

283P




FLOOD PROFILES

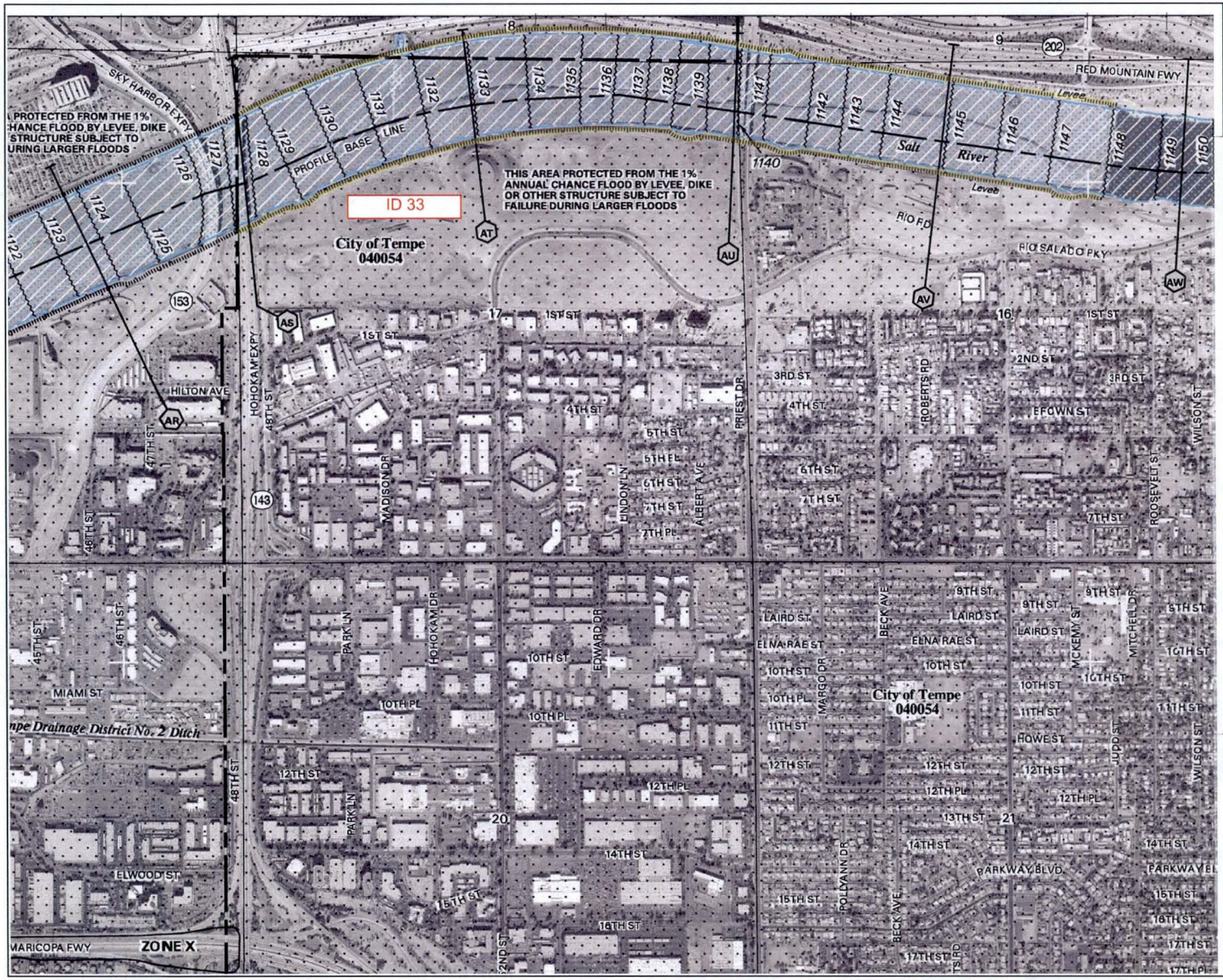
SALT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ

AND INCORPORATED AREAS

284P




MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2165H

# FIRM

## FLOOD INSURANCE RATE MAP

## MARICOPA COUNTY, ARIZONA

## AND INCORPORATED AREAS

**PANEL 2165 OF 4350**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| GUADALUPE, TOWN OF | 040111 | 2165 | H |
| MARICOPA COUNTY | 040037 | 2165 | H |
| PHOENIX, CITY OF | 040051 | 2165 | H |
| TEMPE, CITY OF | 040054 | 2165 | H |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER**

**04013C2165H**

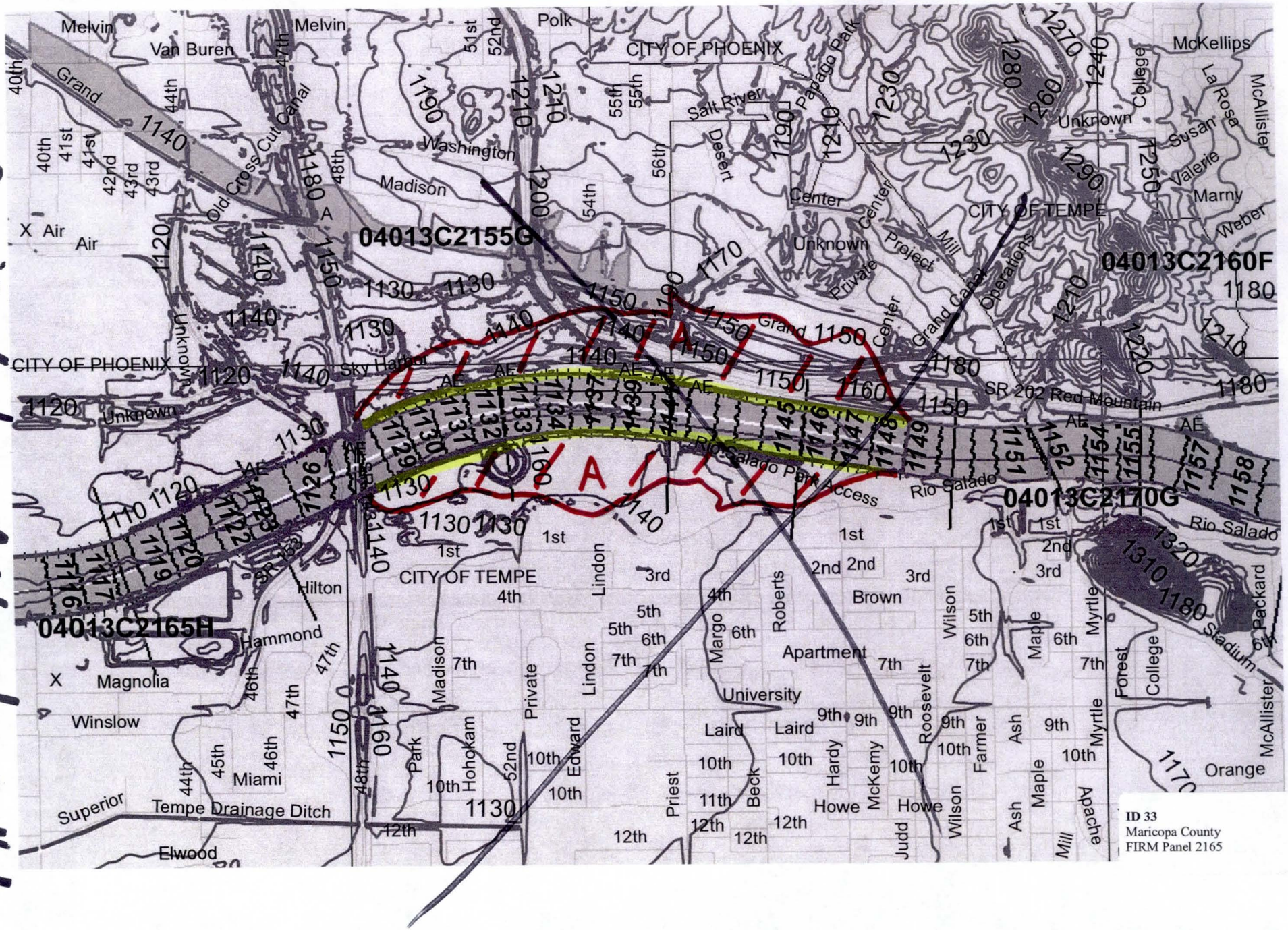
**MAP REVISED**

**SEPTEMBER 30, 2005**

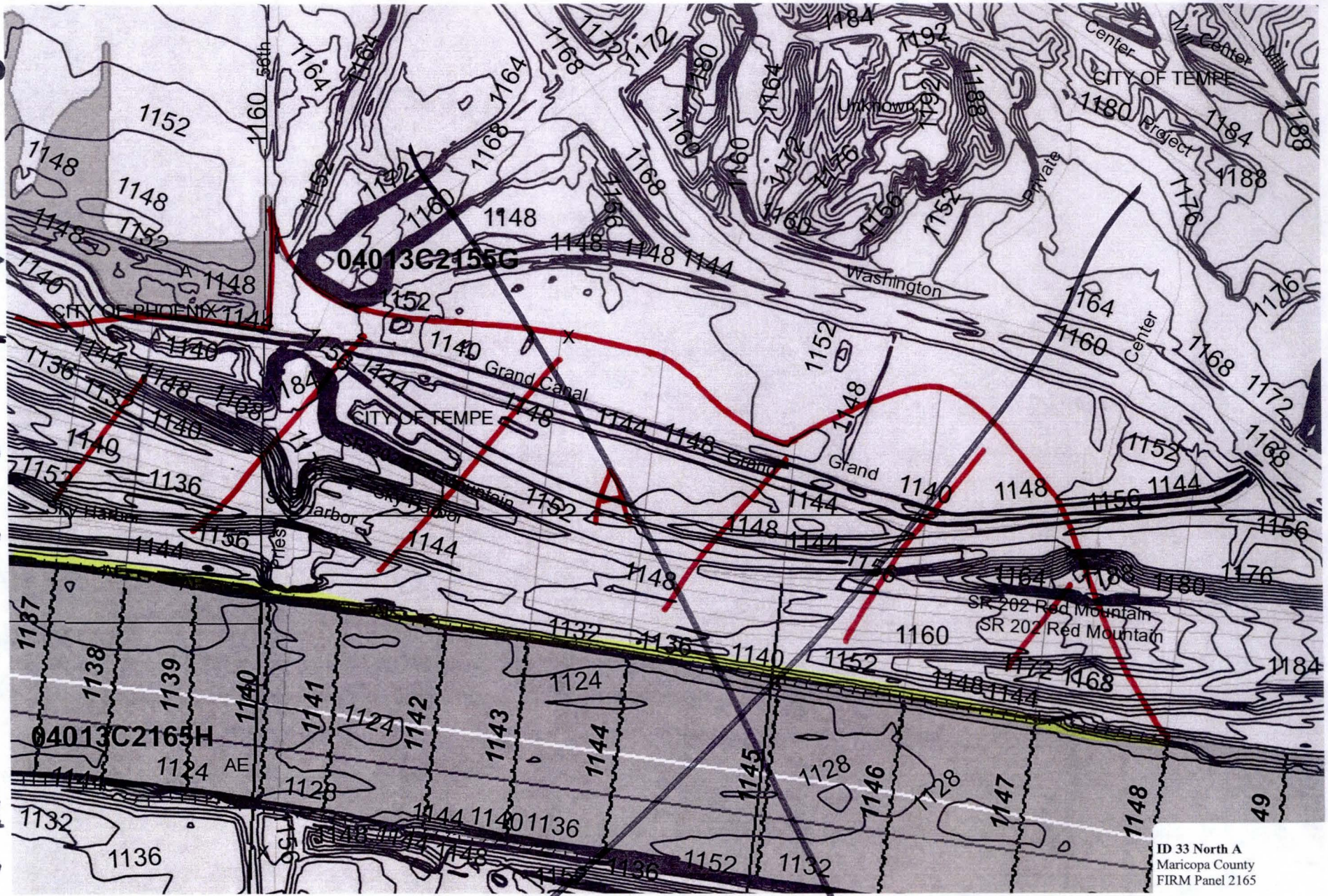
Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT version 2.0. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. Further information about National Flood Insurance Program flood hazard maps is available at http://msc.fema.gov/.

Revised by Addendum #1



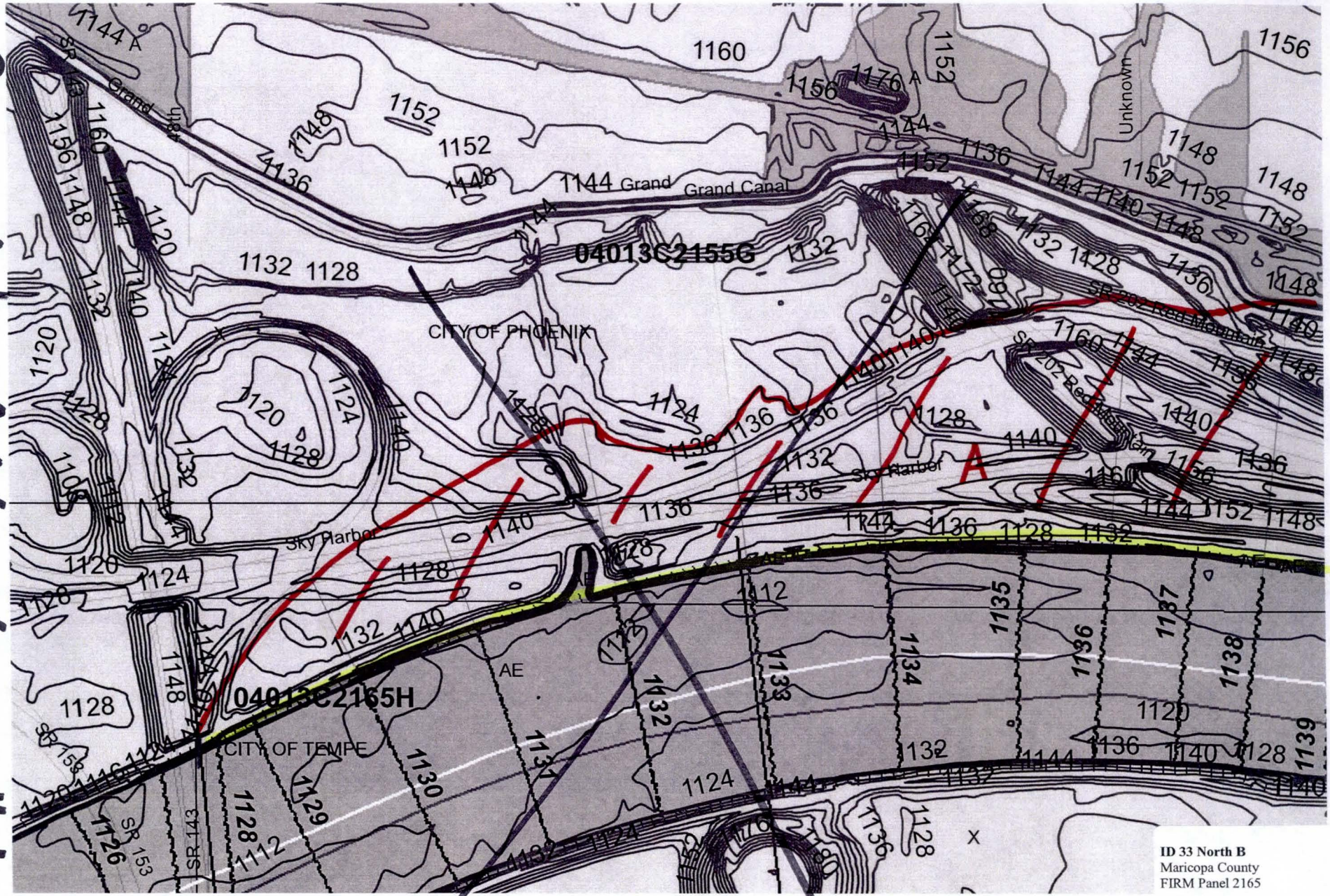
Revised by ADWR 1/




**ID 33 North A**
Maricopa County
FIRM Panel 2165

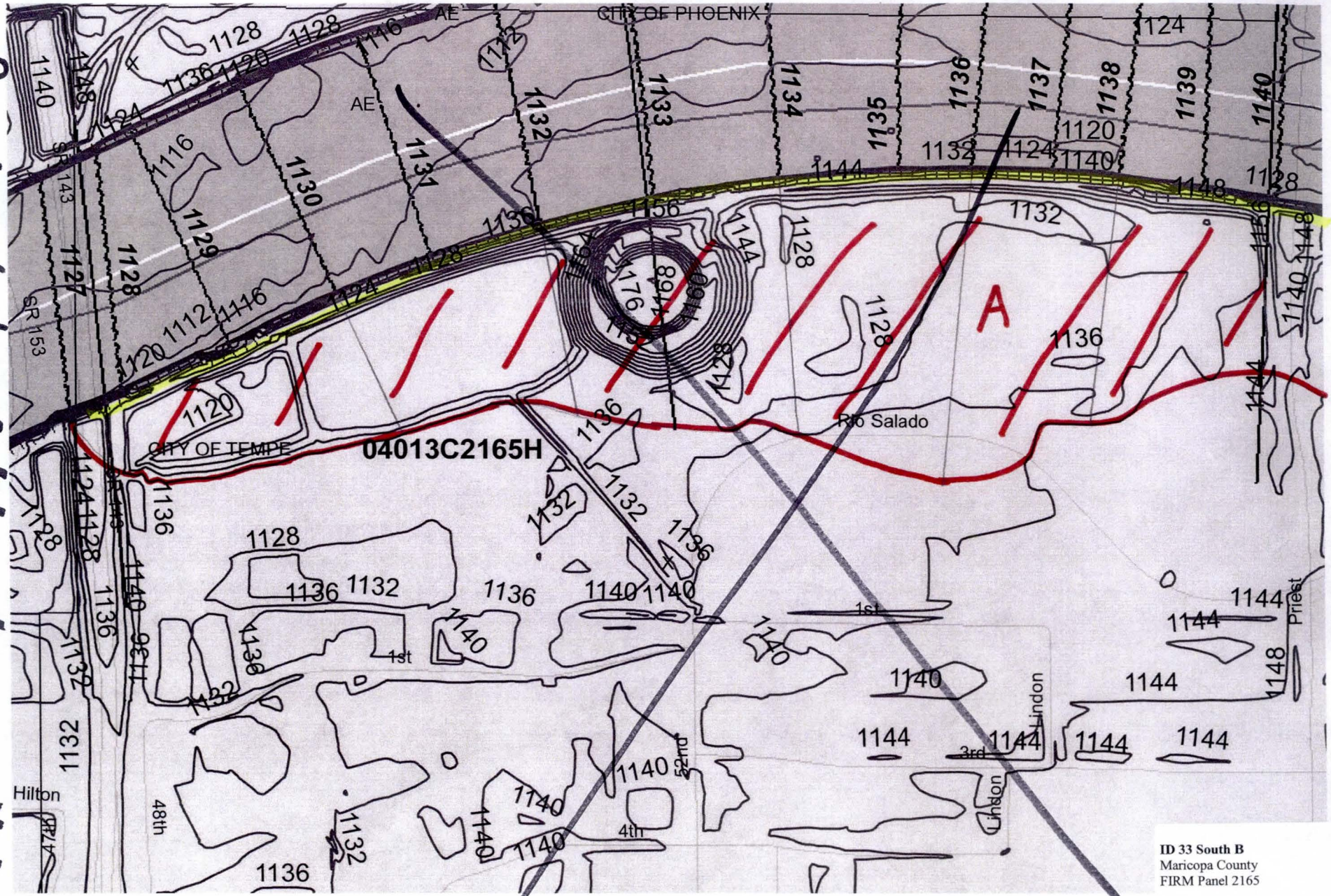
Revised by Addendum #1

Revised by Addendum #1




**ID 33 North B**
Maricopa County
FIRM Panel 2165

Revised by Addendum #1



# B. Hydraulic Data for Levee Freeboard Determination

# Appendix B

## Levee Certification Report
## Salt River Levee System ID#33
## Maricopa County, Arizona

## Freeboard Evaluation

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   - 1.2 Workmaps ..... 1
   - 1.3 Horizontal and Vertical Definitions ..... 1
   - 1.4 Referenced As-Built Plans ..... 1
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   - 1.6 Project Survey ..... 2
   - 1.7 Effective Base Flood Elevations ..... 2
   - 1.8 Project HEC-RAS Model ..... 2
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Plate 2. Annotated As-builts (2 sheets) ..... Appendix B.4

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B.2 HEC-RAS Plots

B.3 HEC-RAS Summary Tables

B.4 Plates

# 1. HEC-RAS Modeling and Freeboard Analysis

## 1.1 Overview

A hydraulic model based on current channel conditions was used to evaluate Salt River Levee System ID#33 to determine levee limits, levee freeboard and provide hydraulic input data for embankment scour depth determination. The study area, as originally defined by FEMA, extends along the Salt River from State Route (SR) 143 at the west limit to Tempe Town Lake to the east limit. Specifically this project is from River Mile (RM) 219.04 (equating to FEMA Cross Section AS) to RM 220.78 (between FEMA Cross Sections AV and AW). This appendix discusses the levee freeboard evaluation and delineates the extent of the levee system based on land side ground elevations.

## 1.2 Workmaps

- **Plate 1** in **Appendix B.4** shows the cross section alignments and project topography along with other relevant features.
- **Plate 2** in **Appendix B.4** shows the levee as-built information along with cross section alignments superimposed.

## 1.3 Horizontal and Vertical Definitions

- All elevations referenced in the hydraulic model, report, and on the exhibits are NGVD 29 unless otherwise indicated.
- Conversion to NAVD88 from NGVD29 was based upon an adjustment of 2.1 feet per application of the NGS Vertcon program. (NAVD88=NGVD29+2.1)
- NAD_1983_HARN_StatePlane_Arizona_Central_FIPS_0202_Feet_Intl was used as the horizontal coordinate system.
- River stationing is in miles and consistent with the Salt River Hydraulic Master Plan HEC-RAS model.
- **Plate 1** shows centerline stations with reference to as-built plans for the Salt River channelization.

## 1.4 Referenced As-Built Plans

As-built plans referenced in this study are as follows:

- "Salt River Channelization, Hohokam (University-Sky Harbor)", State of Arizona Department of Transportation Highways Division, RAM-600-3-511, as-built 1/25/1993. This set of as-built plans document the levee as it was originally constructed. These plans pre-date the Tempe Town Lake and the bridges (SR143, SR153, and Priest Drive), however they do show the bridge alignments as all three were planned at that time. A set of annotated as-builts are included to show the HEC-RAS cross section alignments superimposed onto the as-builts in both plan and profile (**Plate 2**). PDF of plan set version is included on data disk in **Appendix H.**
- "Plans for the Construction of Priest Drive Bridge – Rio Salado Parkway to Washington Street" Maricopa County Highway Department, Project No. 68456, as-built 9/6/1991. The Priest Drive Bridge over the Salt River is shown on these plans. Stantec referenced these plans in developing the RAS model. PDF version of plan set is included on data disk in **Appendix H.**

- "Phoenix Urbanized Area Hohokam Expressway (SR143)", State of Arizona Department of Transportation Highway Division, HDP-920-5(001), as-built 12/201992. Stantec referenced these plans in developing the RAS model. PDF version of plan set is included on data disk in **Appendix H.**

- "State Highway Sky Harbor Expressway (SR153)", State of Arizona Department of Transportation Highway Division, HDP-920-5(001), as-built 5/1/1997. The SR143 Bridge over the Salt River is shown on these plans. Stantec referenced these plans in developing the RAS model. PDF version of plan set is included on data disk in **Appendix H.**

## 1.5 Topographic Mapping

Topography shown on **Plate 1** and used in the HEC-RAS model was originally developed for use in the "Salt River Hydraulic Master Plan" (SRHMP), dated August 2009 prepared by Stantec Consulting, Inc. The original data sources include:

1. Aerial mapping performed in October and November of 2007. Topographic data was obtained June 21, 2008 with horizontal coordinates being on NAD-83, State Plane, Central Zone 0202 (NAD-83) and NGVD 29 used for vertical control.

2. Cross-sectional field surveys, top-of-levee surveys, and bridge field surveys. Surveys were conducted using NAD-83 and NGVD 29.

## 1.6 Project Survey

Cross sectional ground survey of both levees was conducted in May 2011 to verify the elevations in the model. At most locations the ground survey indicates a slightly higher (~6 inches or so) top of levee. RLS Sealed Survey report is included in **Appendix F**.

## 1.7 Effective Base Flood Elevations

The effective FEMA model is documented in a report entitled "Salt-Gila River Floodplain Delineation Restudy" by Baker (Baker Report) and dated May 1999. Water surface elevations obtained in shape file format and plotted on **Plate 1**. **Plate 1** also shows lettered cross section alignments. **Figure B-1** shows applicable FIRM information.

## 1.8 Project HEC-RAS Model

The project specific model, submitted with this report, represents a portion of a recent HEC-RAS model prepared from the SRHMP. The SRHMP model appears to have used the same cross section alignments as the effective model with updated topography and current conditions vegetation characteristics (mannings 'n'). **Plate 1** shows the cross section alignments and water surface elevations for the project model. The analyses described in Sections 1.9 and 1.10 and a scour analysis described separately are based upon this model. Based on field observations, the mannings n values in the SRHMP are consistent with existing vegetation in the Salt River.

### 1.8.1 Overview of SRHMP Model

The SRHMP report is included on data disk in **Appendix H**, for reference, but the following is an overview of the methodology used in preparing the model and how it was applied to the current study.

- The model is georeferenced. Stations and elevations were developed from digital terrain

model data provided by FCD. This data references NAD 83 and NGVD 29.

- A host of scenarios were included in the SRHMP model including existing conditions which represents the river as it exists today, and several encroachment analyses for future scenarios. The current study uses the existing conditions geometry file.
- The SRHMP model included a number of peak discharges for multiple events and for different scenarios of the upstream Roosevelt Dam. The current study uses the 100-year discharge with Roosevelt Dam modifications in-place, as discussed in below **Section 1.8.2**.
- Manning's n values were determined on a reach-by-reach basis following locally accepted methodology. This methodology references the US Geological Survey (USGS) publication "Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona", 2007.
- In general the effective water surface elevations are 1 to 2 feet higher than the more recent model predicts.

### 1.8.2 Steady Flow Data

The study reach has a design discharge of 289,000 cfs (standard project flood) as shown on the as-built plans. At the time of the design the 100-year discharge was 215,000 cfs. However recent modifications to the Roosevelt Dam (upstream) have increased its storage and reduced the peak discharge through the study location. These modifications were completed in 1996 and are reported by the USACE in a 1996 report entitled "Section 7 Study for Modified Roosevelt Dam, Arizona Theodore Roosevelt Dam – Hydrologic Evaluation of Water Control Plans – Salt River Project to Gila River at Gillespie Dam" (TRD Report). The effective 100-year peak discharge is 169,000 cfs at this location per the Effective FEMA Flood Insurance Study (FIS) at Mill Avenue Bridge. This discharge was originally documented on Table 2-4 of the TRD Report at CP-110.

### 1.8.3 Current Conditions HEC-RAS Model

The SRHMP model originally extended from I-10 (RM 216.34, ~3 miles downstream of SR 143) to Alma School Road (226.63, ~6 miles upstream of Tempe Town Lake). This model was trimmed to include a reach from RM 218.24 to RM 220.83. The starting constraint at RM 218.24 was set to the water surface elevation at the corresponding cross section from the SRHMP model at this location.

The model used for the freeboard evaluation and submitted along with this report is as follows:

- Project: SR_Levee_ID33
- File: SR_Levee_ID33.prj
- BFE Plan: BaseFlood, SR_Levee_ID33.p01
  - Geometry File: Salt River-For ID33, SR_Levee_ID33.g01
  - Steady Flow File: EffectiveQ for ID 33, SR_Levee_ID33.f01

## 1.9 Definition of Levee-Condition

The original levee limits were reduced (See **Figure B-1**) based on the landside ground elevations and the levee freeboard as illustrated in **Figure B-2**. **Plate 1** shows the locations where the BFE exceeds the landside ground elevation as "Levee condition".

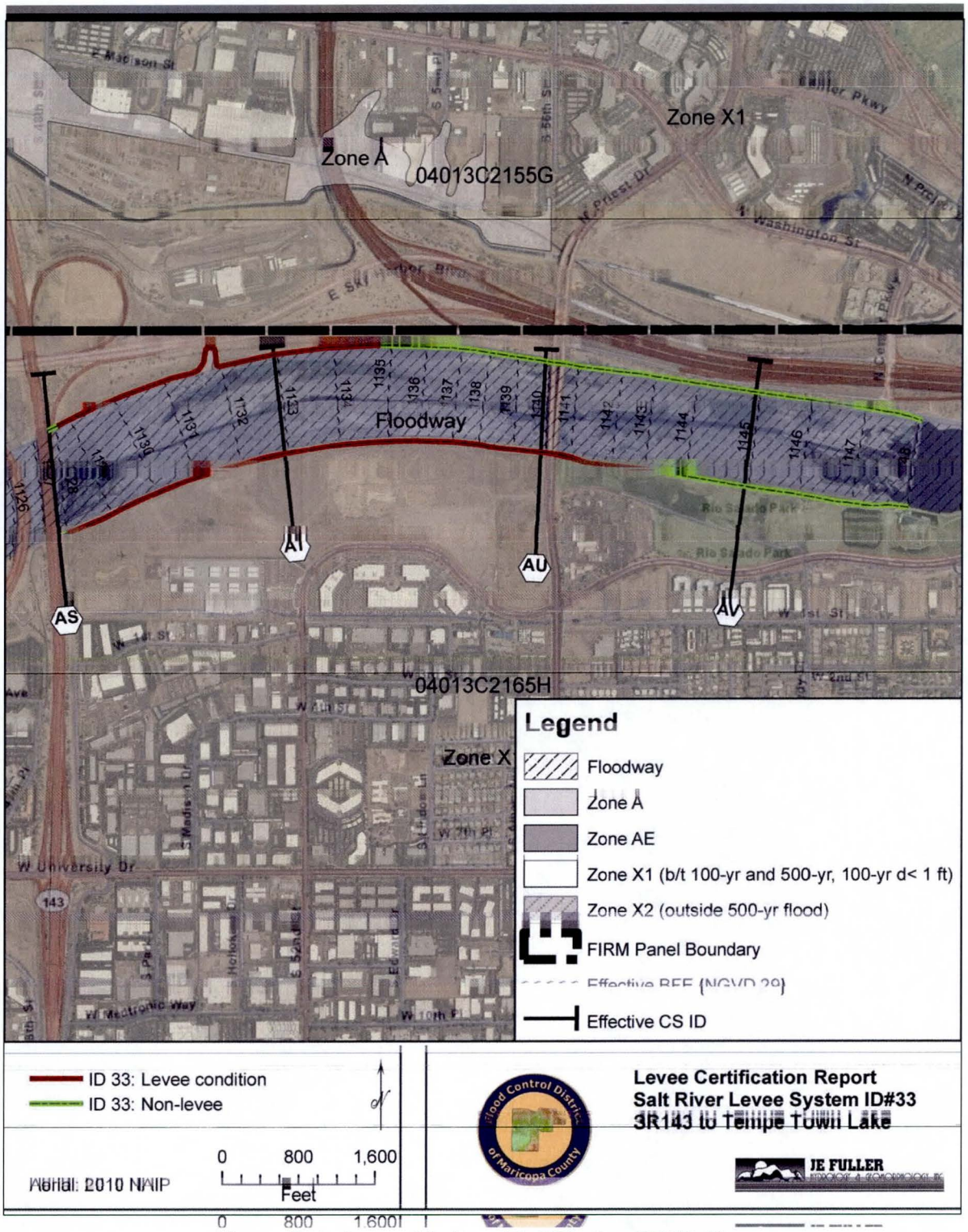



**Figure B-1. Levee Limits with Effective FEMA Map**

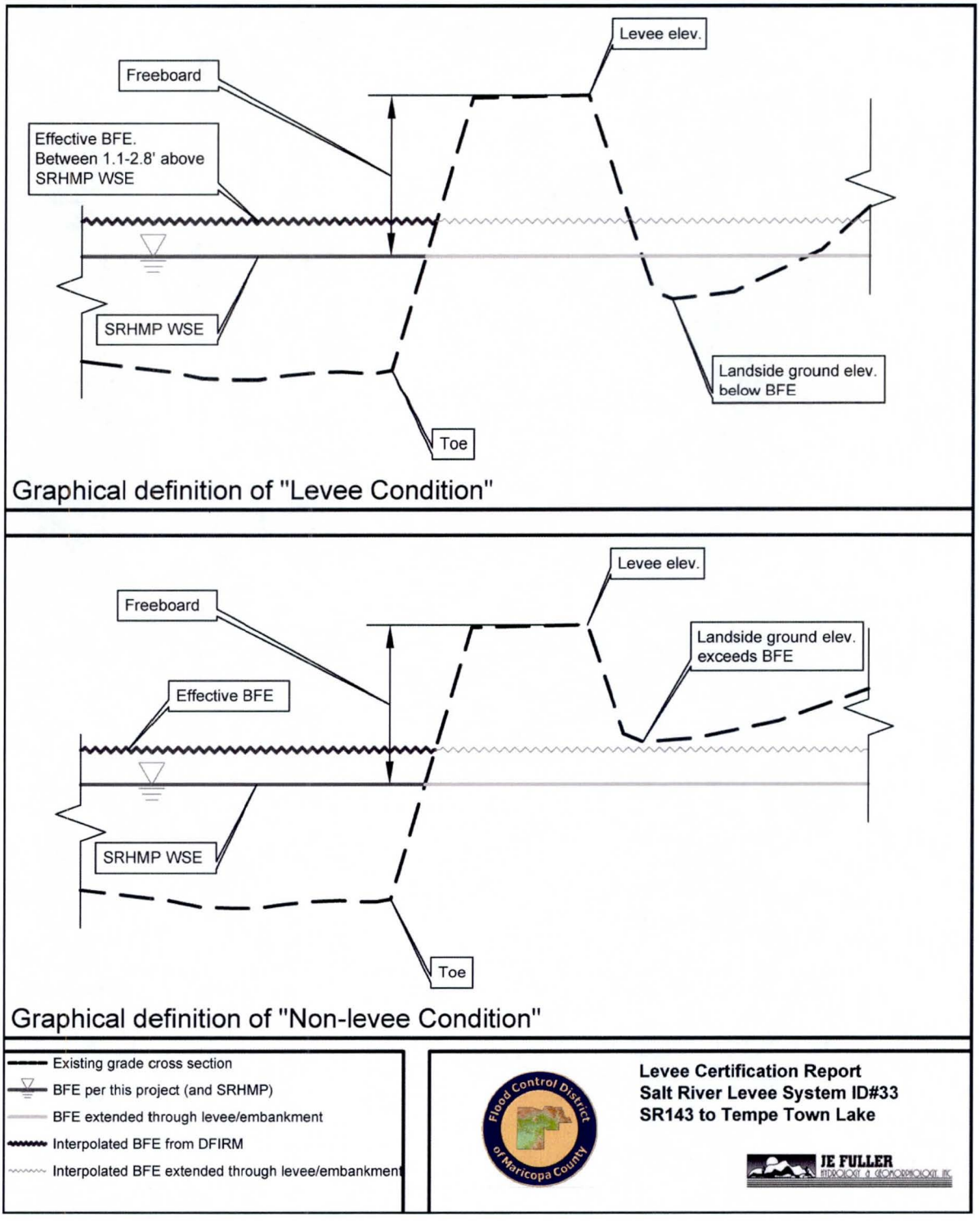



**Figure B-2. Illustration of Levee Condition Definition**

Those areas where the landside elevation exceeds the BFE are shown on **Plate 1** as "Non-levee condition".

The landside ground elevations were obtained from topography (see **Section 1.5**) and the survey performed for this project. This elevation is listed in **Table B-1** through **Table B-4** along with the BFE, for both the north and south levee and for both NGVD 29 and NAVD 88 datums. The following defines the areas which are true levees:

- For the locations defined as "Non-levee condition", the landside elevation exceeds both the effective FEMA BFE and the WSE defined in the project HEC-RAS model.
- The north levee extends from centerline station 160+00 to 193+00 (as superimposed on the north levee). This includes RM 219.15 to 219.70. Areas outside of this, within the project limits, are in a non-levee condition.
- The south levee extends from centerline station 156+20 to 220+00 (as superimposed on the south levee). This includes RM 219.15 to 220.26. Areas outside of this, within the project limits, are in a non-levee condition.

## 1.10 Freeboard Evaluation

The water surface profile from the HEC-RAS model was compared to the top-of-levee profiles (both north and south levees) from the HEC-RAS model. The project model, representing the current hydraulic conditions, was used as the primary base flood elevation source. For comparison to Effective FEMA model was also compared to the levee elevations. The minimum freeboard provided is 9.0 feet for the north levee and 8.3 for the south levee. Comparing the BFE from the effective model to the top of levee shows that the minimum freeboard provided is 7.1 feet.

## Table B-1 - Available North Levee Freeboard on NGVD 29

| River Mile | SRHMP Water Surface Elevation | North Levee Elevation | Effective Base Flood Elev.[1] | Freeboard[2] | Landside Ground Elev.[3] | As-built Plan Station (at levee) |
|---|---|---|---|---|---|---|
| | (ft, NGVD 29) | | | (ft) | (ft) | |
| Non-levee condition: 219.02 – 219.04 | | | | | | |
| 219.02 | 1125.87 | 1136.37 | 1127.1 | 10.5 | N/A | 157+42 |
| 219.04 | 1126.36 | 1136.52 | 1127.6 | 10.2 | 1147.0 | 158+86 |
| Levee condition: 219.15 – 219.7 | | | | | | |
| **219.15** | **1127.22** | **1136.97** | **1129.2** | **9.8** | **1127.3** | **162+33** |
| **219.24** | **1128.35** | **1138.81** | **1130.2** | **10.5** | **1123.5** | **167+29** |
| **219.33** | **1129.37** | **1140.41** | **1131.2** | **11.0** | **1127.1** | **172+31** |
| **219.42** | **1130.41** | **1139.97** | **1132** | **9.6** | **1130.4** | **177+25** |
| **219.52** | **1131.52** | **1141.92** | **1133** | **10.4** | **1132.4** | **182+54** |
| **219.61** | **1132.59** | **1143.14** | **1133.9** | **10.6** | **1130.2** | **187+40** |
| **219.7** | **1133.64** | **1144.51** | **1134.7** | **10.9** | **1130.0** | **192+26** |
| Non-levee condition: 219.79 – 220.78 | | | | | | |
| 219.79 | 1134.69 | 1145.51 | 1136 | 10.8 | 1136.4 | 197+36 |
| 219.89 | 1135.91 | 1145.63 | 1137.5 | 9.7 | N/A | 202+16 |
| 220.05 | 1138.08 | 1147.06 | 1140 | 9.0 | N/A | 209+80 |
| 220.06 | 1138.43 | 1147.54 | 1140.2 | 9.1 | N/A | 210+42 |
| 220.063 | 1138.44 | 1148.09 | 1140.3 | 9.6 | N/A | 210+67 |
| 220.07 | 1138.77 | 1150.09 | 1140.5 | 11.3 | N/A | 211+38 |
| 220.17 | 1139.78 | 1149.95 | 1141.8 | 10.2 | N/A | 216+57 |
| 220.26 | 1140.87 | 1150.96 | 1143.1 | 10.1 | N/A | 221+55 |
| 220.35 | 1141.85 | 1152.24 | 1144.2 | 10.4 | N/A | 226+70 |
| 220.45 | 1142.86 | 1153.75 | 1144.9 | 10.9 | N/A | 231+69 |
| 220.54 | 1143.85 | 1154.92 | 1145.9 | 11.1 | N/A | 236+75 |
| 220.64 | 1144.80 | 1155.75 | 1146.8 | 11.0 | N/A | 241+78 |
| 220.73 | 1145.75 | 1157.16 | 1147.7 | 11.4 | N/A | 246+74 |
| 220.78 | 1145.30 | 1156.73 | 1148.1 | 11.4 | N/A | 249+24 |

*Note 1: Effective BFE obtained from FIRM panels. DFIRM references NGVD 29, no vertical adjustment made to elevations.*
*Note 2: Freeboard relative to current HEC-RAS model. N/A shown if levee condition does not exist.*
*Note 3: Landside ground elevation listed as N/A where top of levee ties into grade with no back slope.*

## Table B-2 - Available South Levee Freeboard on NGVD 29

| River Mile | SRHMP Water Surface Elevation | North Levee Elevation | Effective Base Flood Elev.[1] | Freeboard[2] | Landside Ground Elev.[3] | As-built Plan Station (at levee) |
|---|---|---|---|---|---|---|
| | (ft, NGVD 29) | | | (ft) | (ft) | |
| Non-levee condition: 219.02 – 219.04 | | | | | | |
| 219.02 | 1125.87 | 1134.20 | 1127.1 | 8.3 | N/A | 153+76 |
| 219.04 | 1126.36 | 1135.28 | 1127.6 | 8.9 | 1142.8 | 155+20 |
| Levee condition: 219.15 – 220.17 | | | | | | |
| **219.15** | **1127.22** | **1137.24** | **1129.2** | **10.0** | **1122.8** | **162+20** |
| **219.24** | **1128.35** | **1137.42** | **1130.2** | **9.1** | **1121.0** | **167+45** |
| **219.33** | **1129.37** | **1138.71** | **1131.2** | **9.3** | **1120.5** | **172+04** |
| **219.42** | **1130.41** | **1139.57** | **1132** | **9.2** | **1118.0** | **176+79** |
| **219.52** | **1131.52** | **1140.59** | **1133** | **9.1** | **1180.2** | **181+68** |
| **219.61** | **1132.59** | **1141.37** | **1133.9** | **8.8** | **1129.3** | **186+82** |
| **219.7** | **1133.64** | **1142.93** | **1134.7** | **9.3** | **1128.1** | **191+88** |
| **219.79** | **1134.69** | **1143.63** | **1136** | **8.9** | **1130.2** | **196+91** |
| **219.89** | **1135.91** | **1145.77** | **1137.5** | **9.9** | **1131.0** | **201+93** |
| **220.05** | **1138.08** | **1148.41** | **1140** | **10.3** | **1153.7** | **210+87** |
| **220.06** | **1138.43** | **1148.32** | **1140.2** | **9.9** | **1155.8** | **211+47** |
| **220.063** | **1138.44** | **1148.32** | **1140.3** | **9.9** | **1156.0** | **211+51** |
| **220.07** | **1138.77** | **1147.94** | **1140.5** | **9.2** | **1154.8** | **212+09** |
| **220.17** | **1139.78** | **1150.54** | **1141.8** | **10.8** | **1134.8** | **216+95** |
| Non-levee condition: 220.26 – 220.78 | | | | | | |
| 220.26 | 1140.87 | 1151.48 | 1143.1 | 10.6 | 1145.5 | 221+97 |
| 220.35 | 1141.85 | 1152.56 | 1144.2 | 10.7 | N/A | 226+92 |
| 220.45 | 1142.86 | 1153.75 | 1144.9 | 10.9 | N/A | 232+00 |
| 220.54 | 1143.85 | 1154.68 | 1145.9 | 10.8 | N/A | 236+88 |
| 220.64 | 1144.80 | 1155.38 | 1146.8 | 10.6 | N/A | 241+89 |
| 220.73 | 1145.75 | 1155.77 | 1147.7 | 10.0 | N/A | 246+94 |
| 220.78 | 1145.30 | 1157.14 | 1148.1 | 11.8 | N/A | 249+27 |

*Note 1: Effective BFE obtained from FIRM panels. DFIRM references NGVD 29, no vertical adjustment made to elevations.*
*Note 2: Freeboard relative to current HEC-RAS model. N/A shown if levee condition does not exist.*
*Note 3: Landside ground elevation listed as N/A where top of levee ties into grade with no back slope.*

**Table B-3 - Available North Levee Freeboard on NAVD 88**

| River Mile | SRHMP Water Surface Elevation | North Levee Elevation | Effective Base Flood Elev.[1] | Freeboard[2] | Landside Ground Elev.[3] | As-built Plan Station (at levee) |
|---|---|---|---|---|---|---|
| | (ft, NAVD 88) | | | (ft) | (ft) | |
| Non-levee condition: 219.02 – 219.04 | | | | | | |
| 219.02 | 1127.97 | 1138.47 | 1129.20 | 10.5 | N/A | 157+42 |
| 219.04 | 1128.46 | 1138.62 | 1129.70 | 10.2 | 1149.1 | 158+86 |
| Levee condition: 219.15 – 219.7 | | | | | | |
| **219.15** | **1129.32** | **1139.07** | **1131.30** | **9.8** | **1129.4** | **162+33** |
| **219.24** | **1130.45** | **1140.91** | **1132.30** | **10.5** | **1125.6** | **167+29** |
| **219.33** | **1131.47** | **1142.51** | **1133.30** | **11.0** | **1129.2** | **172+31** |
| **219.42** | **1132.51** | **1142.07** | **1134.10** | **9.6** | **1132.5** | **177+25** |
| **219.52** | **1133.62** | **1144.02** | **1135.10** | **10.4** | **1134.5** | **182+54** |
| **219.61** | **1134.69** | **1145.24** | **1136.00** | **10.6** | **1132.3** | **187+40** |
| **219.7** | **1135.74** | **1146.61** | **1136.80** | **10.9** | **1132.1** | **192+26** |
| Non-levee condition: 219.79 – 220.78 | | | | | | |
| 219.79 | 1136.79 | 1147.61 | 1138.10 | 10.8 | 1138.5 | 197+36 |
| 219.89 | 1138.01 | 1147.73 | 1139.60 | 9.7 | N/A | 202+16 |
| 220.05 | 1140.18 | 1149.16 | 1142.10 | 9.0 | N/A | 209+80 |
| 220.06 | 1140.53 | 1149.64 | 1142.30 | 9.1 | N/A | 210+42 |
| 220.063 | 1140.54 | 1150.19 | 1142.40 | 9.6 | N/A | 210+67 |
| 220.07 | 1140.87 | 1152.19 | 1142.60 | 11.3 | N/A | 211+38 |
| 220.17 | 1141.88 | 1152.05 | 1143.90 | 10.2 | N/A | 216+57 |
| 220.26 | 1142.97 | 1153.06 | 1145.20 | 10.1 | N/A | 221+55 |
| 220.35 | 1143.95 | 1154.34 | 1146.30 | 10.4 | N/A | 226+70 |
| 220.45 | 1144.96 | 1155.85 | 1147.00 | 10.9 | N/A | 231+69 |
| 220.54 | 1145.95 | 1157.02 | 1148.00 | 11.1 | N/A | 236+75 |
| 220.64 | 1146.90 | 1157.85 | 1148.90 | 11.0 | N/A | 241+78 |
| 220.73 | 1147.85 | 1159.26 | 1149.80 | 11.4 | N/A | 246+74 |
| 220.78 | 1147.40 | 1158.83 | 1150.20 | 11.4 | N/A | 249+24 |

*Note 1: Effective BFE obtained from FIRM panels. DFIRM references NGVD 29, 2.1 feet added to get to NAVD 88.*
*Note 2: Freeboard relative to current HEC-RAS model. N/A shown if levee condition does not exist.*
*Note 3: Landside ground elevation listed as N/A where top of levee ties into grade with no back slope.*

## Table B-4 - Available South Levee Freeboard on NAVD 88

| River Mile | SRHMP Water Surface Elevation | North Levee Elevation | Effective Base Flood Elev.[1] | Freeboard[2] | Landside Ground Elev.[3] | As-built Plan Station (at levee) |
|---|---|---|---|---|---|---|
| | (ft, NAVD 88) | | | (ft) | (ft) | |
| Non-levee condition: 219.02 – 219.04 | | | | | | |
| 219.02 | 1127.97 | 1136.30 | 1129.20 | 8.3 | N/A | 153+76 |
| 219.04 | 1128.46 | 1137.38 | 1129.70 | 8.9 | 1144.9 | 155+20 |
| Levee condition: 219.15 – 220.17 | | | | | | |
| **219.15** | **1129.32** | **1139.34** | **1131.30** | **10.0** | **1124.9** | **162+20** |
| **219.24** | **1130.45** | **1139.52** | **1132.30** | **9.1** | **1123.1** | **167+45** |
| **219.33** | **1131.47** | **1140.81** | **1133.30** | **9.3** | **1122.6** | **172+04** |
| **219.42** | **1132.51** | **1141.67** | **1134.10** | **9.2** | **1120.1** | **176+79** |
| **219.52** | **1133.62** | **1142.69** | **1135.10** | **9.1** | **1182.3** | **181+68** |
| **219.61** | **1134.69** | **1143.47** | **1136.00** | **8.8** | **1131.4** | **186+82** |
| **219.7** | **1135.74** | **1145.03** | **1136.80** | **9.3** | **1130.2** | **191+88** |
| **219.79** | **1136.79** | **1145.73** | **1138.10** | **8.9** | **1132.3** | **196+91** |
| **219.89** | **1138.01** | **1147.87** | **1139.60** | **9.9** | **1133.1** | **201+93** |
| **220.05** | **1140.18** | **1150.51** | **1142.10** | **10.3** | **1155.8** | **210+87** |
| **220.06** | **1140.53** | **1150.42** | **1142.30** | **9.9** | **1157.9** | **211+47** |
| **220.063** | **1140.54** | **1150.42** | **1142.40** | **9.9** | **1158.1** | **211+51** |
| **220.07** | **1140.87** | **1150.04** | **1142.60** | **9.2** | **1156.9** | **212+09** |
| **220.17** | **1141.88** | **1152.64** | **1143.90** | **10.8** | **1136.9** | **216+95** |
| Non-levee condition: 220.26 – 220.78 | | | | | | |
| 220.26 | 1142.97 | 1153.58 | 1145.20 | 10.6 | 1147.6 | 221+97 |
| 220.35 | 1143.95 | 1154.66 | 1146.30 | 10.7 | N/A | 226+92 |
| 220.45 | 1144.96 | 1155.85 | 1147.00 | 10.9 | N/A | 232+00 |
| 220.54 | 1145.95 | 1156.78 | 1148.00 | 10.8 | N/A | 236+88 |
| 220.64 | 1146.90 | 1157.48 | 1148.90 | 10.6 | N/A | 241+89 |
| 220.73 | 1147.85 | 1157.87 | 1149.80 | 10.0 | N/A | 246+94 |
| 220.78 | 1147.40 | 1159.24 | 1150.20 | 11.8 | N/A | 249+27 |

*Note 1: Effective BFE obtained from FIRM panels. DFIRM references NGVD 29, 2.1 feet added to get to NAVD 88.*
*Note 2: Freeboard relative to current HEC-RAS model. N/A shown if levee condition does not exist.*
*Note 3: Landside ground elevation listed as N/A where top of levee ties into grade with no back slope.*

# B. Hydraulic Data for Levee Freeboard Evaluation

## B.1 References

Included on data disk in **Appendix H** under **"As-Built and Design Plans"**

SRHMP Field Reconnaissance Memo (digitally submitted)
SRHMP Salt River Hydraulic Master Plan report (digitally submitted)
Salt River Channelization As-Built Plans
Priest Drive As-Built Plans
SR143 As-Built Plans
SR153 As-Built Plans

## B.2 HEC-RAS Plots

HEC-RAS cross sections

HEC-RAS profile

## B.3 HEC-RAS Summary Tables

Standard Table 1

**HEC-RAS Report on data disk in **Appendix H**

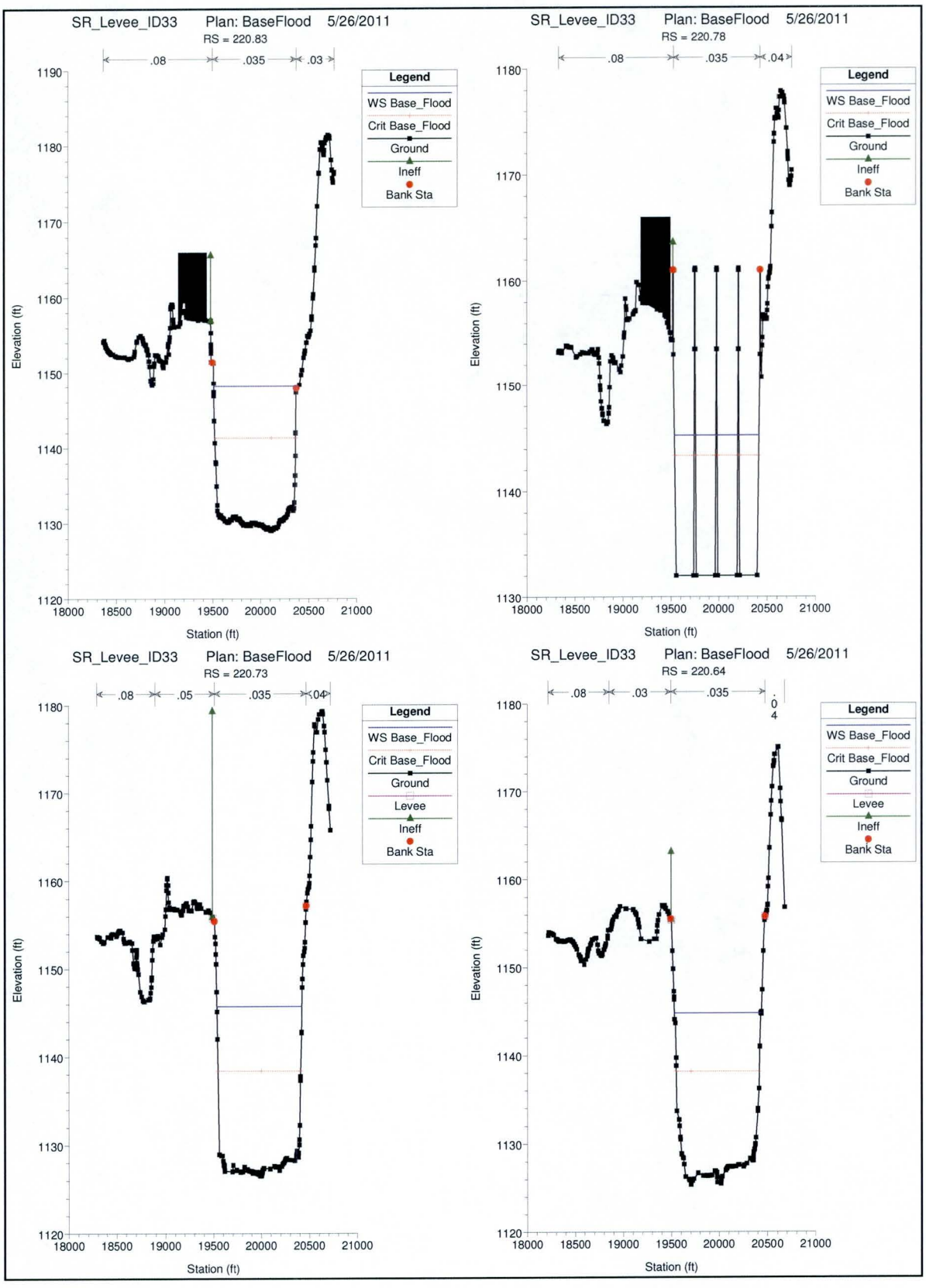
## B.4 Plates

**Plate 1. Cross Section Workmap (3 sheets, 24x36)**
**Plate 2. Annotated As-builts (2 sheets)**

## B.1 References

Included on data disk in **Appendix H**

## B.2 HEC-RAS Plots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.03
Legend
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Crit Base_Flood
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.78
.08
.035
.04
Legend
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Crit Base_Flood
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.73
.08
.05
.035
.04
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.64
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.03
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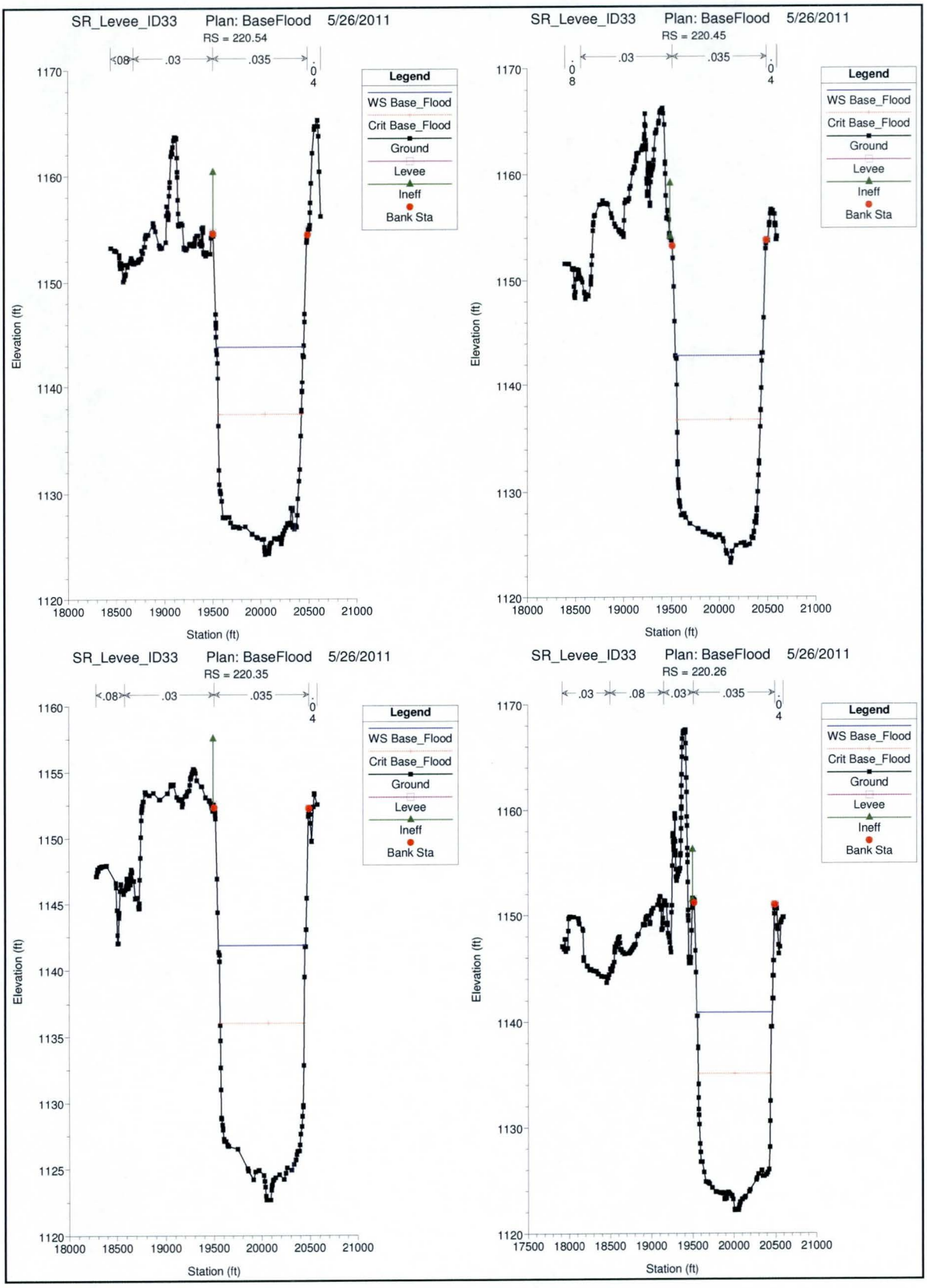
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Legend
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Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.45
.08 .03 .035 .04
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
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.08 .03 .035 .04
Legend
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Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.26
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Legend
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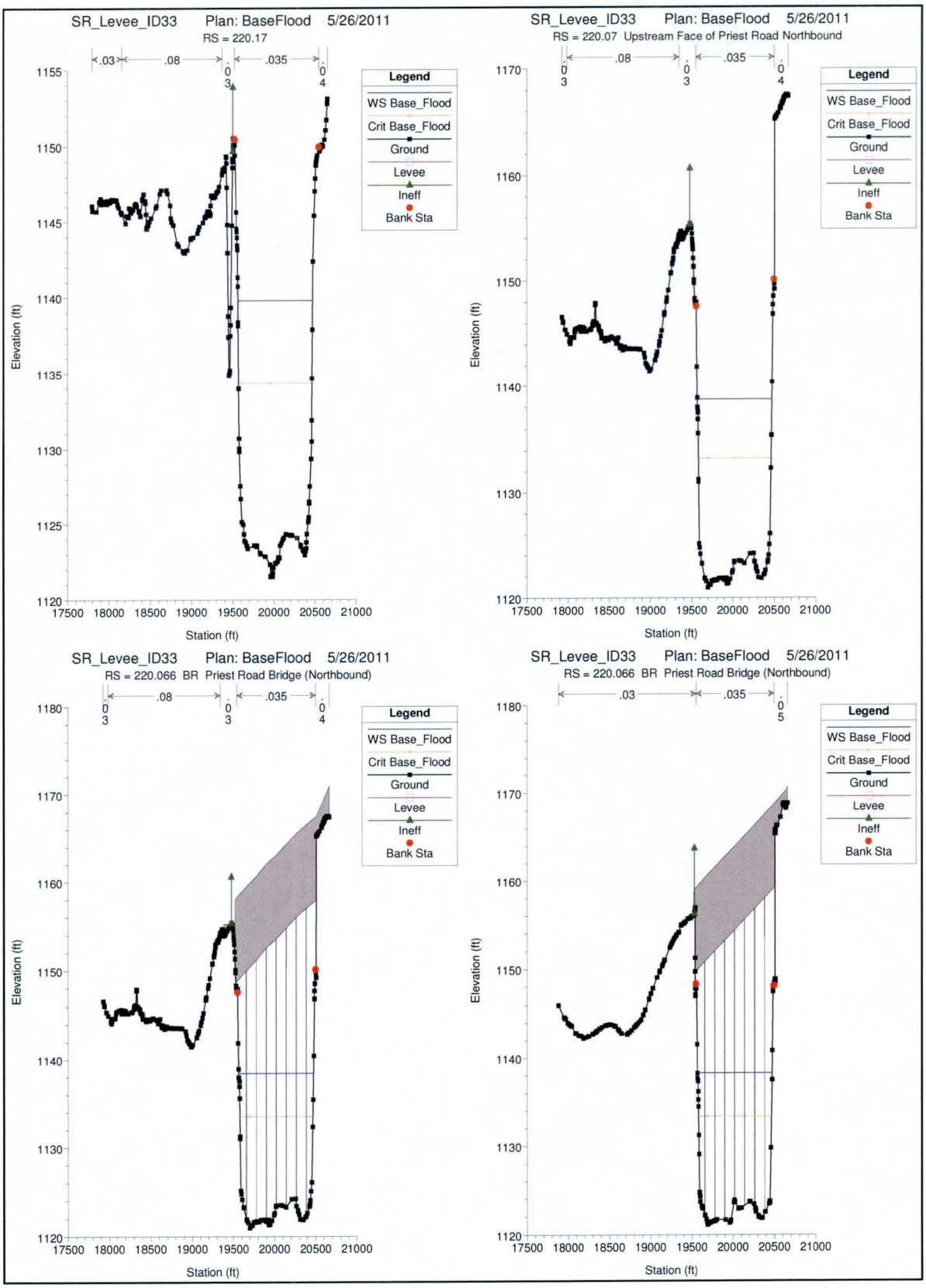
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)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.035
Legend
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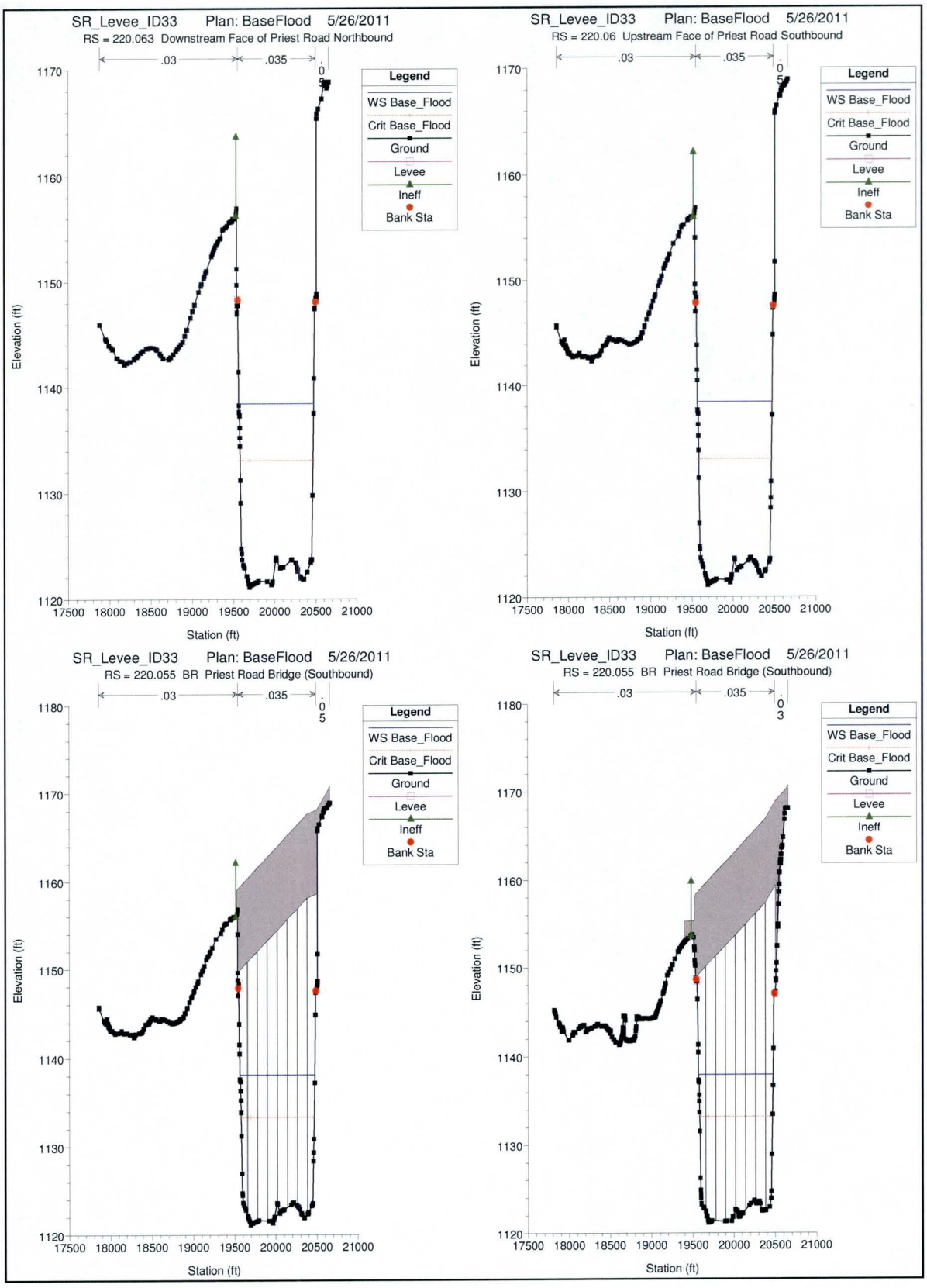
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.07 Upstream Face of Priest Road Northbound
.08
.035
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.066 BR Priest Road Bridge (Northbound)
.08
.035
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.066 BR Priest Road Bridge (Northbound)
.03
.035
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)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SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.06 Upstream Face of Priest Road Southbound
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.055 BR Priest Road Bridge (Southbound)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 220.055 BR Priest Road Bridge (Southbound)
.03
.035
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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1150
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18500
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20000
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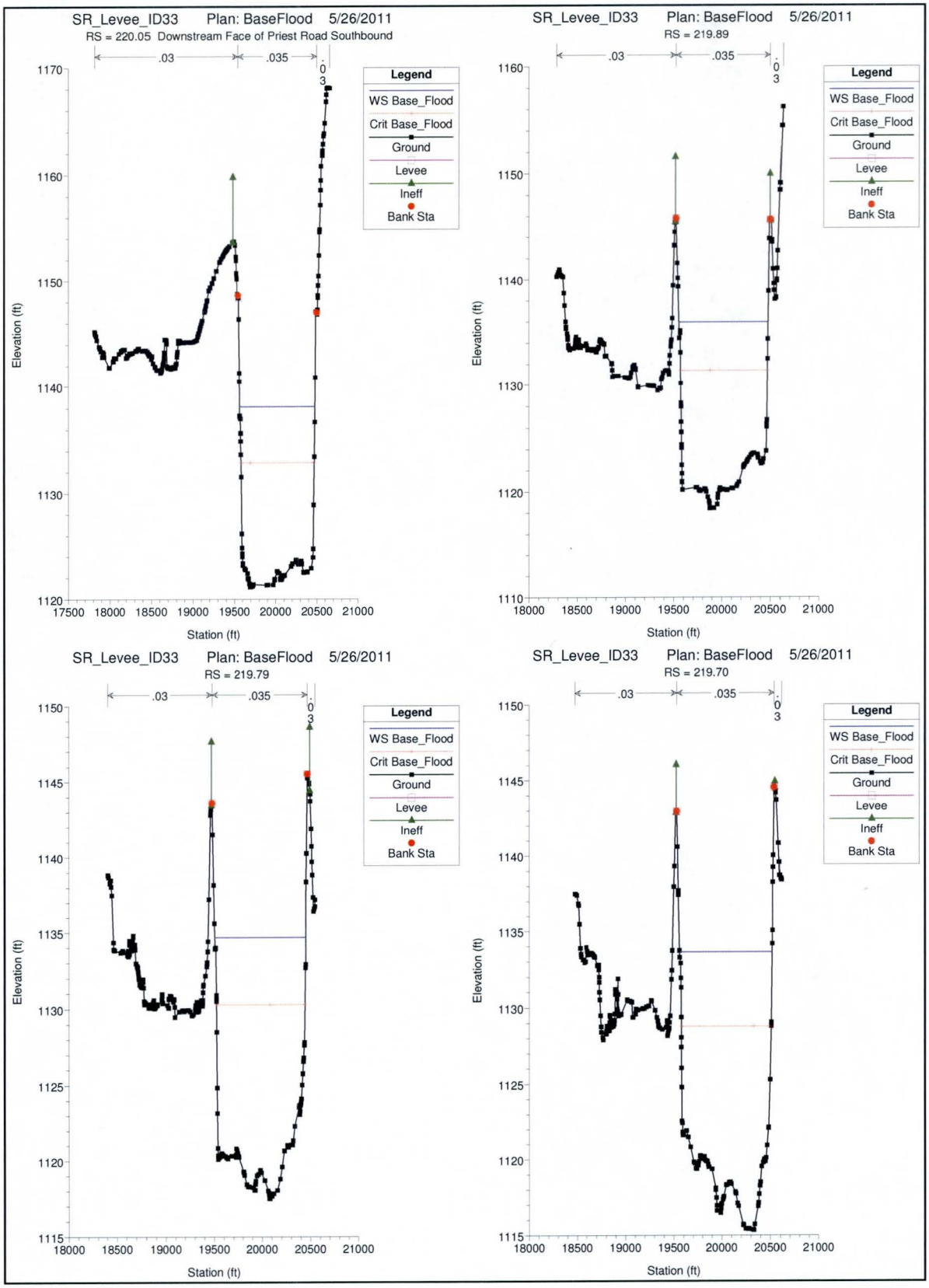
21000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Legend
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Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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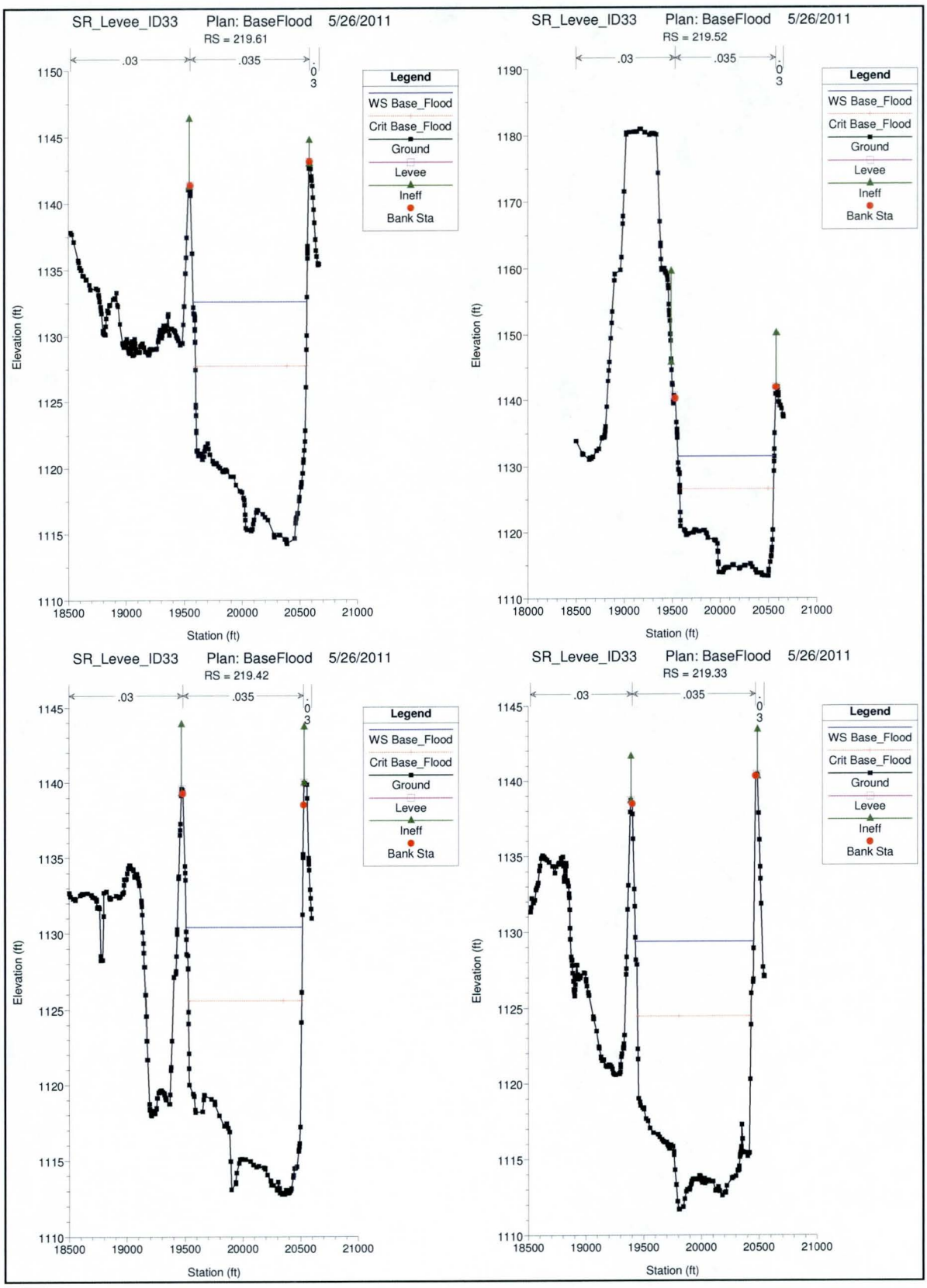
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 219.70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Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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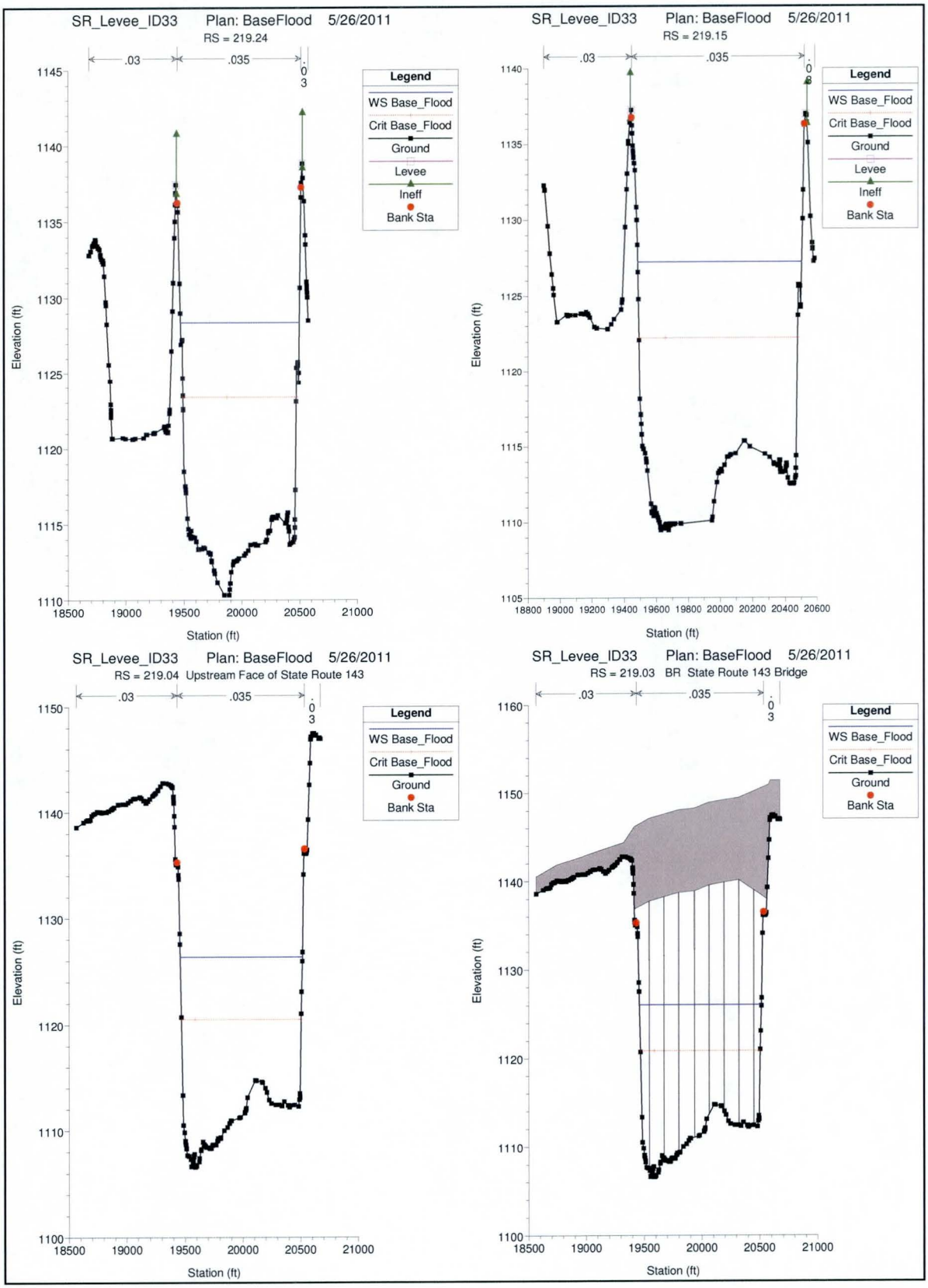
RS = 219.42
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 219.33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RS = 219.24
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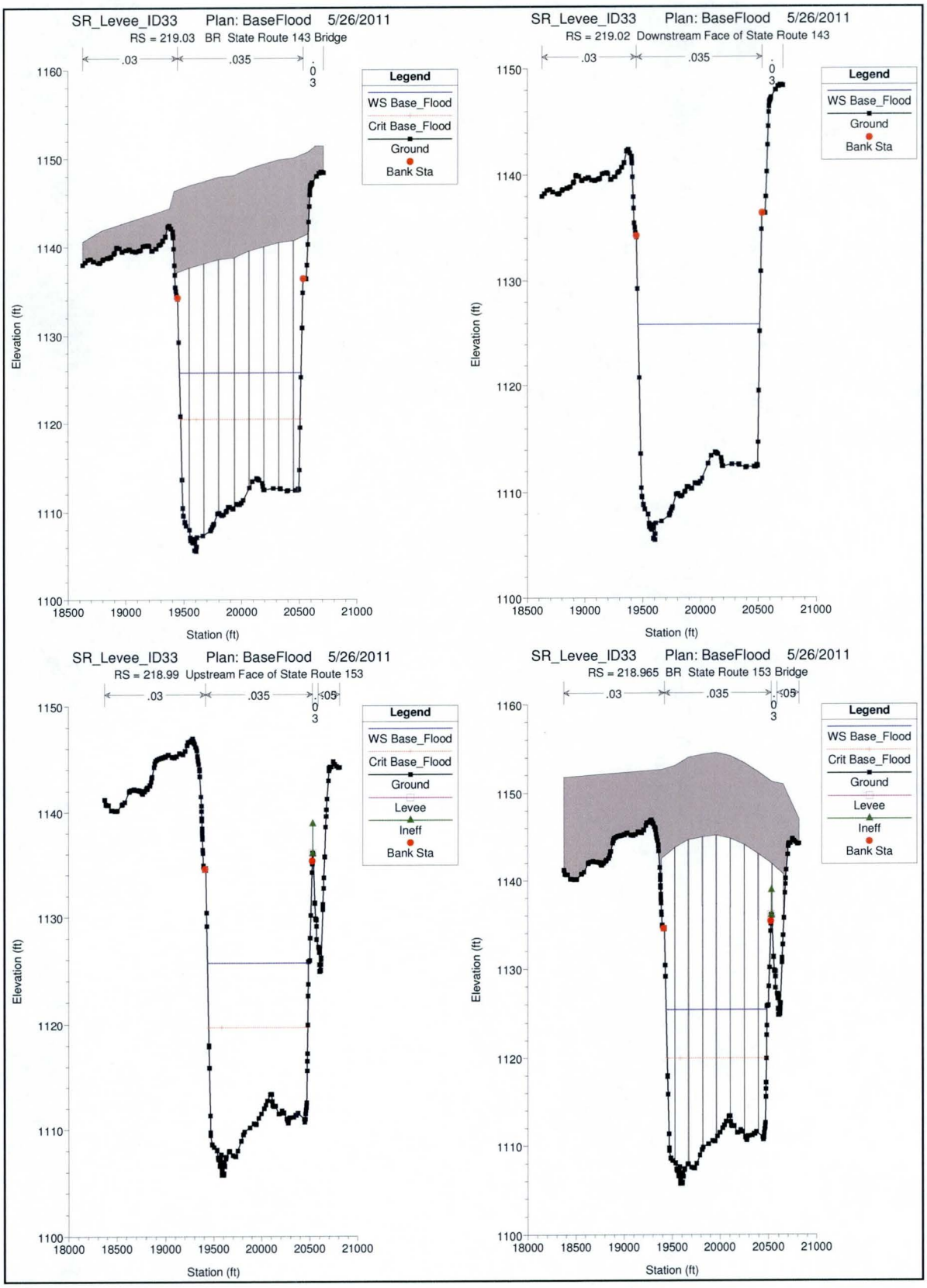
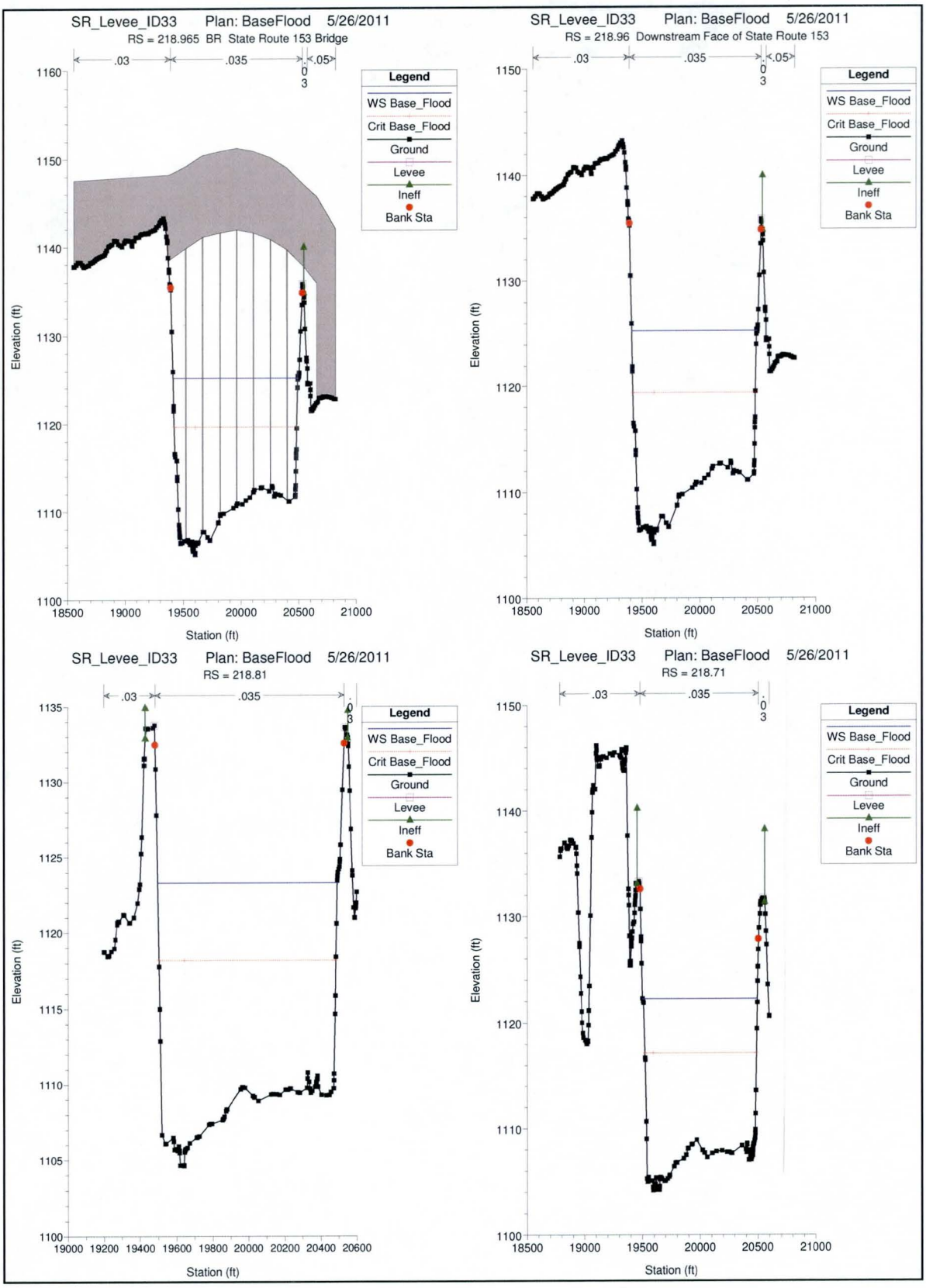
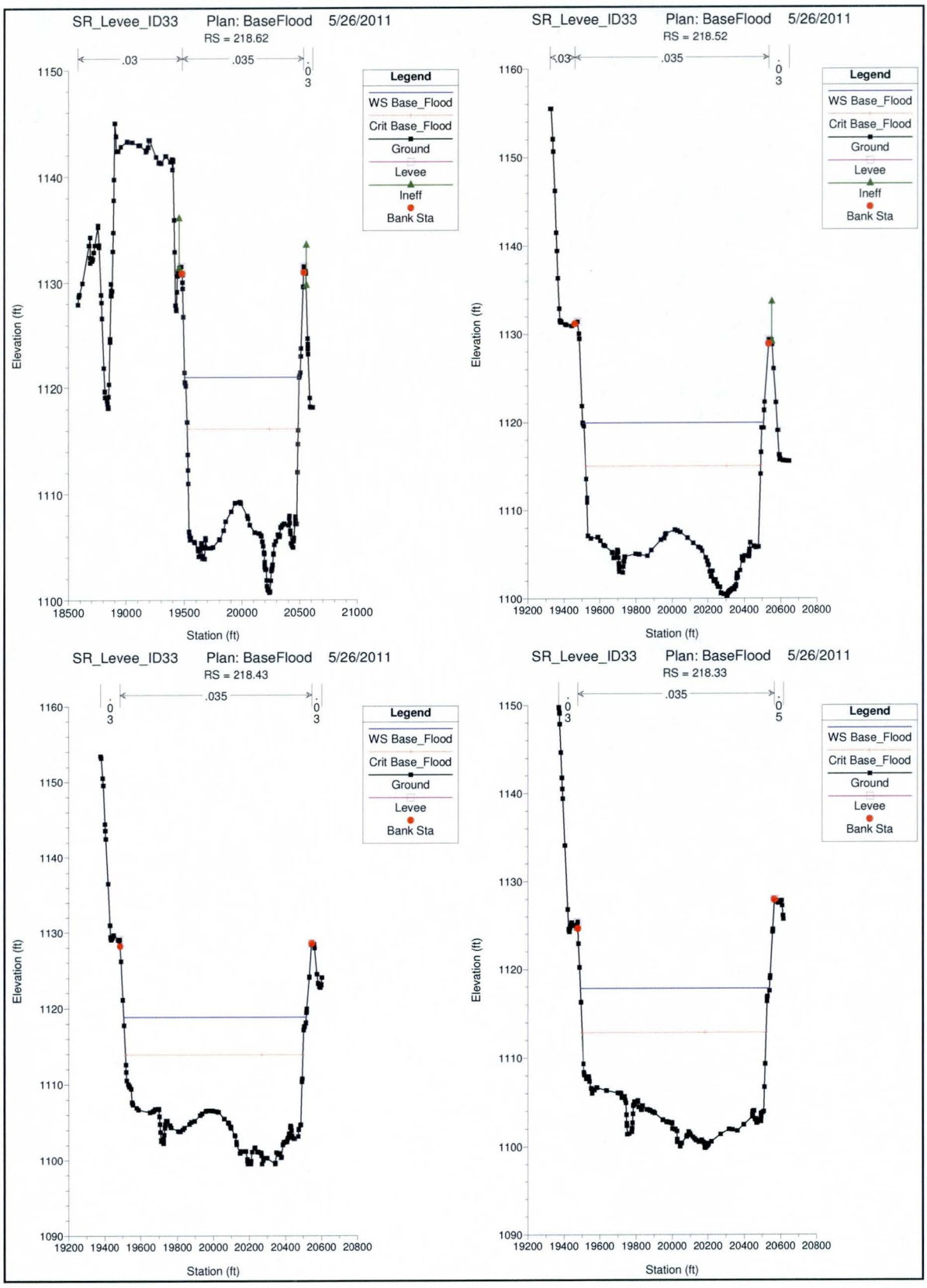
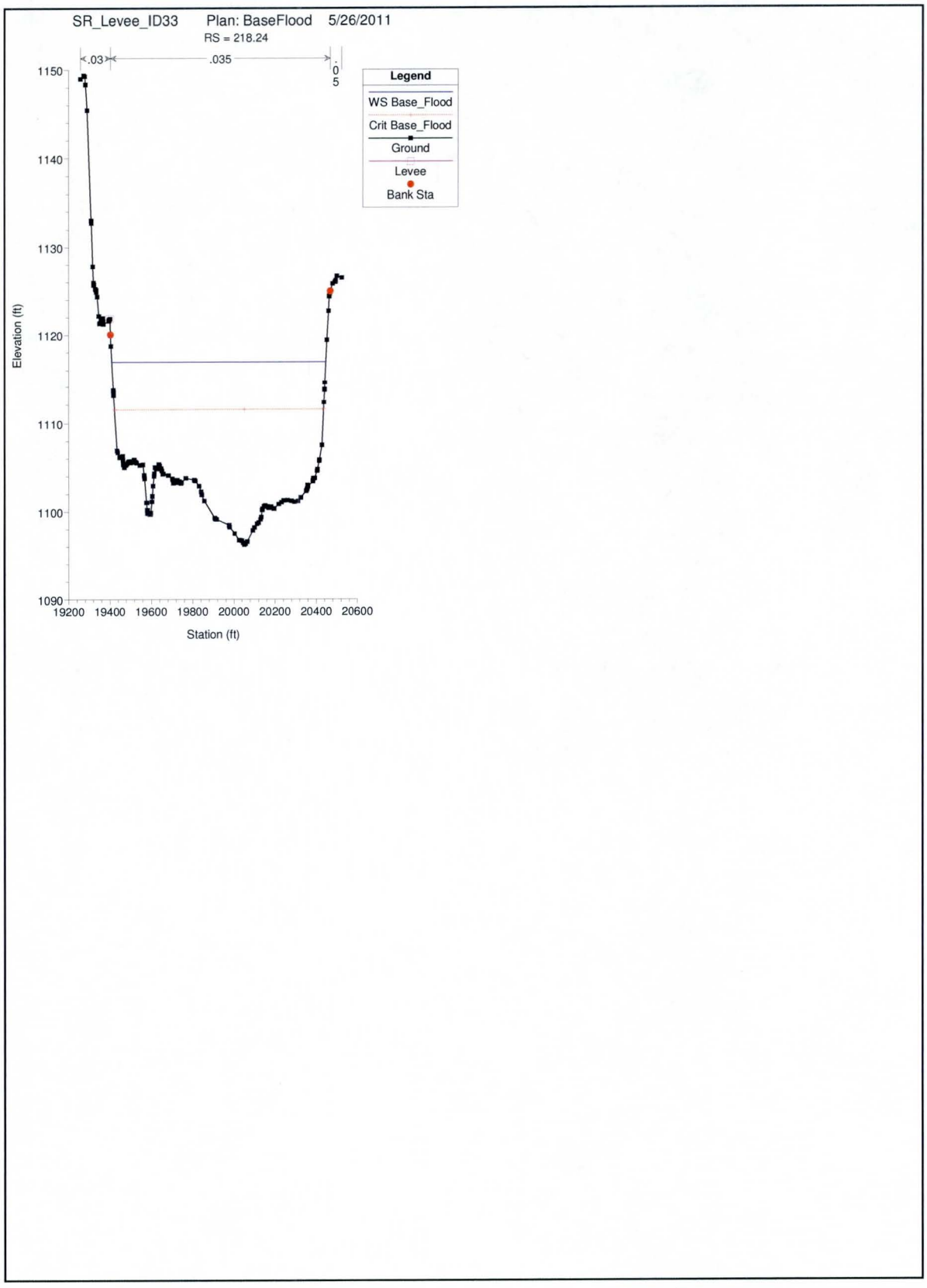
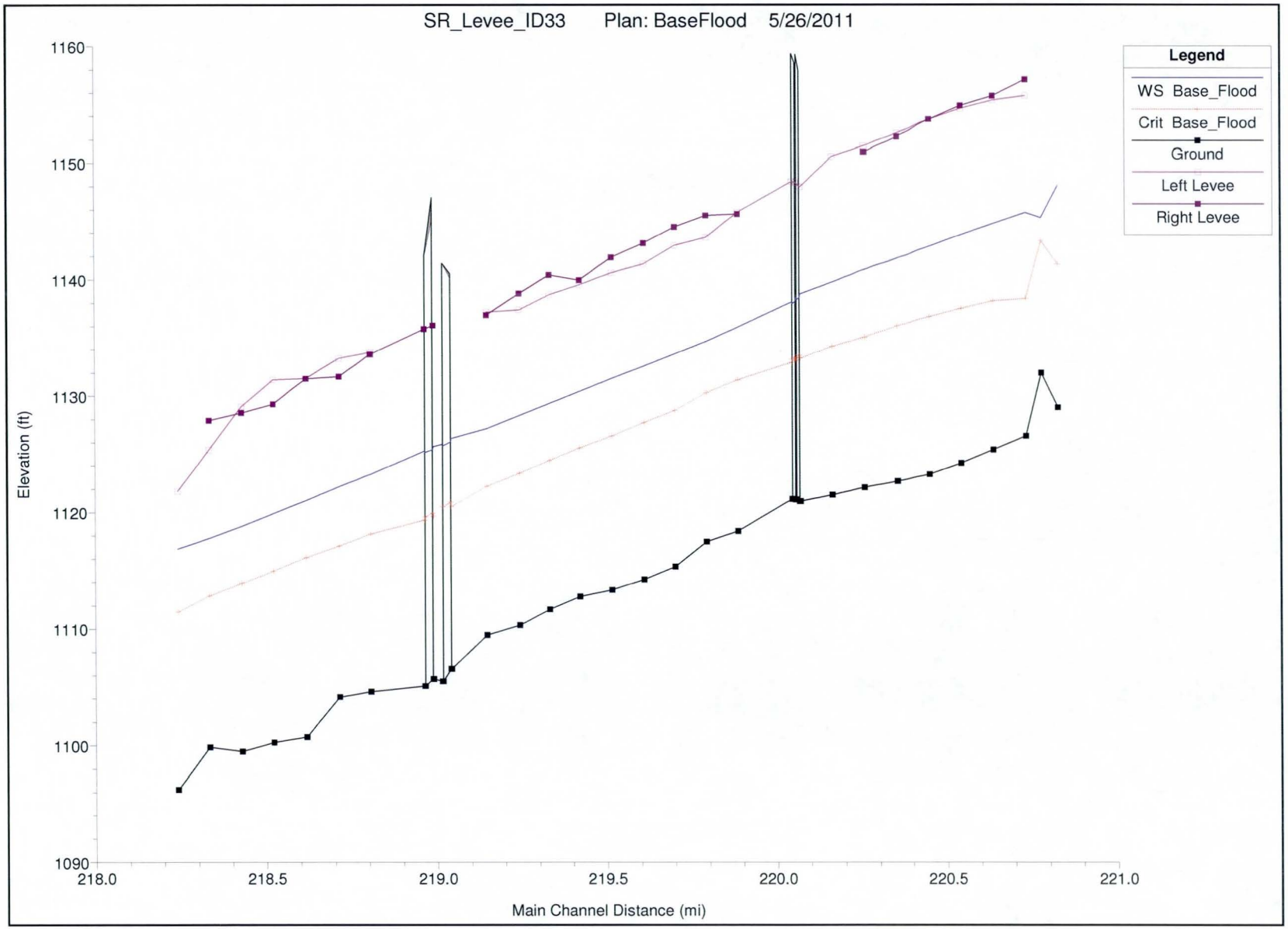
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 219.15
.03
.035
.08
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 219.04 Upstream Face of State Route 143
.03
.035
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 219.03 BR State Route 143 Bridge
.03
.035
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Bank Sta
Elevation (ft)
Station (ft)


SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 219.03 BR State Route 143 Bridge
.03
.035
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 219.02 Downstream Face of State Route 143
.03
.035
.03
Legend
WS Base_Flood
Ground
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.99 Upstream Face of State Route 153
.03
.035
.05
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.965 BR State Route 153 Bridge
.03
.035
.05
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.965 BR State Route 153 Bridge
.03
.035
.05
0
3
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.96 Downstream Face of State Route 153
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.81
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.71


SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.62
.03
.035
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.52
.03
.035
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.43
.03
.035
.03
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.33
.03
.035
.05
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


SR_Levee_ID33 Plan: BaseFlood 5/26/2011
RS = 218.24
.03
.035
.05
Legend
WS Base_Flood
Crit Base_Flood
Ground
Levee
Bank Sta
Elevation (ft)
1150
1140
1130
1120
1110
1100
1090
19200
19400
19600
19800
20000
20200
20400
20600
Station (ft)


SR_Levee_ID33 Plan: BaseFlood 5/26/2011
Legend
WS Base_Flood
Crit Base_Flood
Ground
Left Levee
Right Levee
Elevation (ft)
1160
1150
1140
1130
1120
1110
1100
1090
218.0
218.5
219.0
219.5
220.0
220.5
221.0
Main Channel Distance (mi)

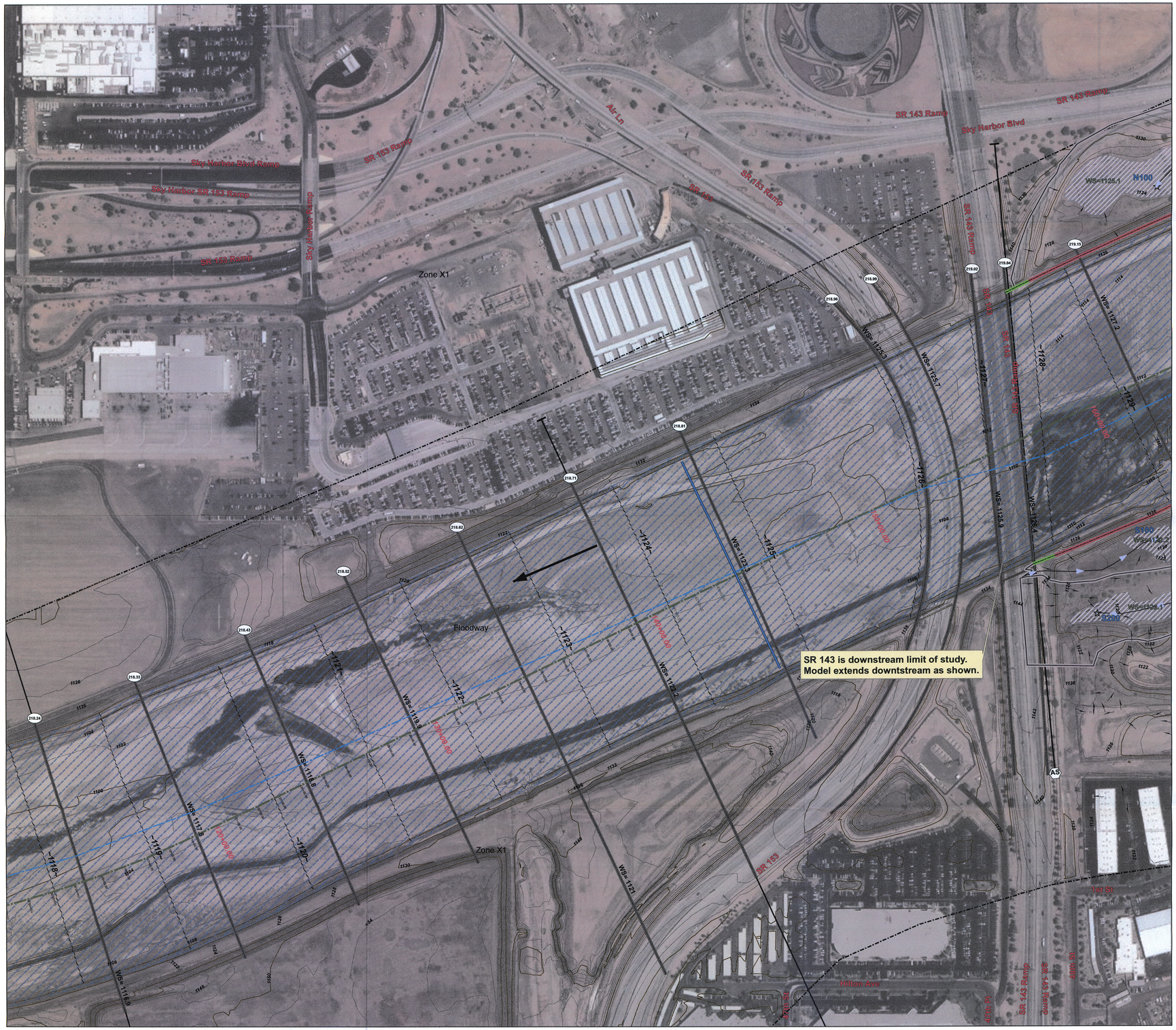
## B.3 HEC-RAS Summary Tables

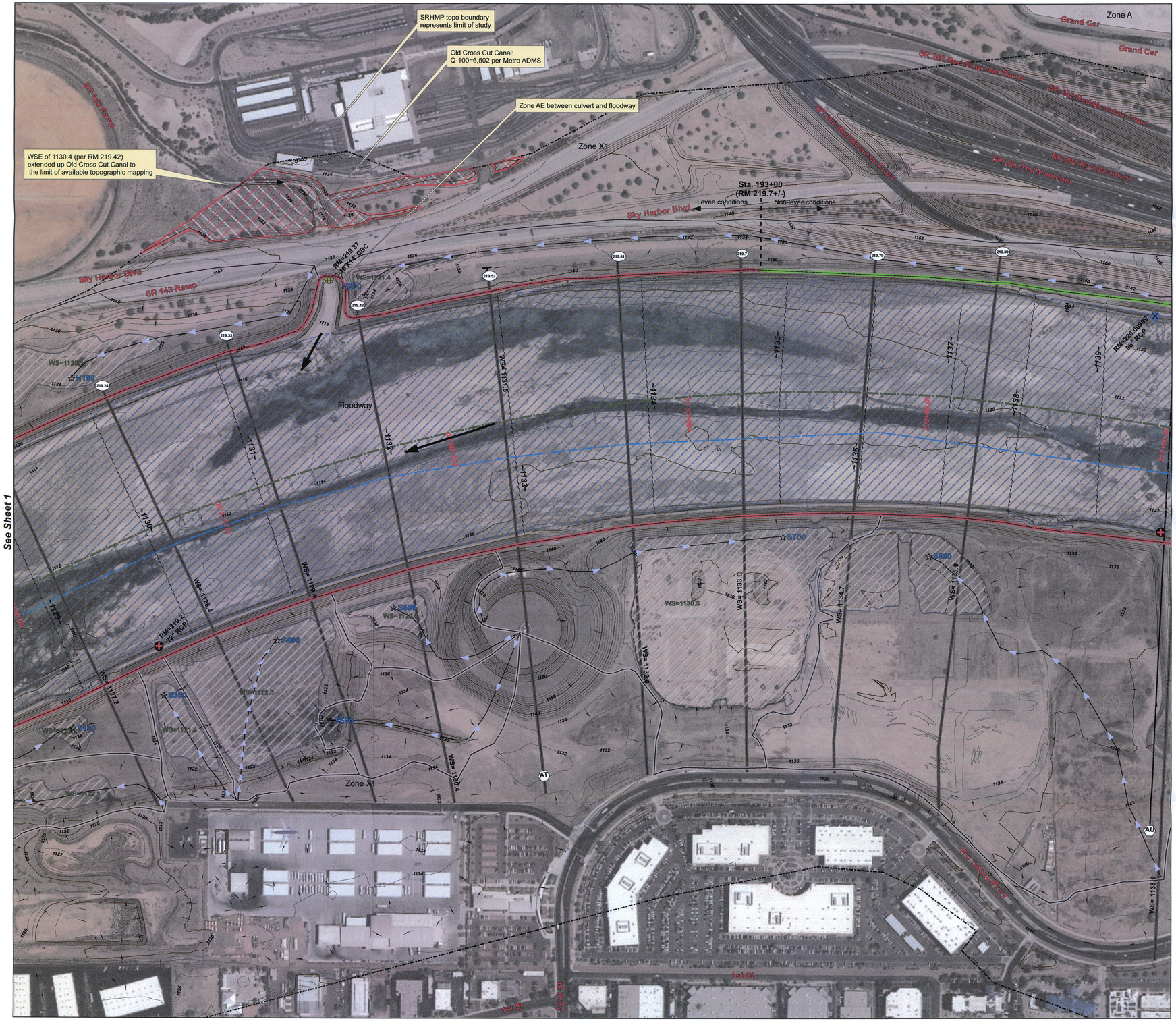
HEC-RAS Plan: BaseFlood River: Salt River Reach: Salt River Profile: Base_Flood

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Salt River | 218.24 | Base_Flood | 169000.00 | 1096.23 | 1116.89 | 1111.48 | 1118.81 | 0.001923 | 11.11 | 15214.55 | 1037.37 | 0.51 |
| Salt River | 218.33 | Base_Flood | 169000.00 | 1099.85 | 1117.82 | 1112.86 | 1119.84 | 0.002145 | 11.41 | 14811.75 | 1050.46 | 0.54 |
| Salt River | 218.43 | Base_Flood | 169000.00 | 1099.50 | 1118.84 | 1113.91 | 1120.96 | 0.002211 | 11.69 | 14451.88 | 1009.86 | 0.54 |
| Salt River | 218.52 | Base_Flood | 169000.00 | 1100.27 | 1119.92 | 1115.00 | 1122.07 | 0.002239 | 11.76 | 14365.48 | 1004.48 | 0.55 |
| Salt River | 218.62 | Base_Flood | 169000.00 | 1100.72 | 1121.04 | 1116.14 | 1123.22 | 0.002260 | 11.85 | 14261.23 | 992.74 | 0.55 |
| Salt River | 218.71 | Base_Flood | 169000.00 | 1104.16 | 1122.23 | 1117.15 | 1124.34 | 0.002147 | 11.66 | 14494.21 | 995.41 | 0.54 |
| Salt River | 218.81 | Base_Flood | 169000.00 | 1104.63 | 1123.29 | 1118.17 | 1125.38 | 0.002119 | 11.60 | 14563.19 | 996.05 | 0.53 |
| Salt River | 218.96 | Base_Flood | 169000.00 | 1105.11 | 1125.29 | 1119.37 | 1126.98 | 0.001682 | 10.46 | 16164.29 | 1089.81 | 0.48 |
| Salt River | 218.965 | | Bridge | | | | | | | | | |
| Salt River | 218.99 | Base_Flood | 169000.00 | 1105.72 | 1125.68 | 1119.68 | 1127.42 | 0.001668 | 10.58 | 15978.46 | 1051.27 | 0.48 |
| Salt River | 219.02 | Base_Flood | 169000.00 | 1105.53 | 1125.87 | | 1127.67 | 0.001792 | 10.79 | 15660.77 | 1055.46 | 0.49 |
| Salt River | 219.03 | | Bridge | | | | | | | | | |
| Salt River | 219.04 | Base_Flood | 169000.00 | 1106.59 | 1126.36 | 1120.52 | 1128.14 | 0.001749 | 10.70 | 15792.97 | 1058.04 | 0.49 |
| Salt River | 219.15 | Base_Flood | 169000.00 | 1109.49 | 1127.22 | 1122.25 | 1129.32 | 0.002186 | 11.62 | 14549.60 | 1018.90 | 0.54 |
| Salt River | 219.24 | Base_Flood | 169000.00 | 1110.33 | 1128.35 | 1123.37 | 1130.44 | 0.002200 | 11.60 | 14574.13 | 1029.15 | 0.54 |
| Salt River | 219.33 | Base_Flood | 169000.00 | 1111.69 | 1129.37 | 1124.49 | 1131.49 | 0.002236 | 11.67 | 14482.11 | 1025.87 | 0.55 |
| Salt River | 219.42 | Base_Flood | 169000.00 | 1112.78 | 1130.41 | 1125.57 | 1132.55 | 0.002237 | 11.75 | 14383.54 | 1008.46 | 0.55 |
| Salt River | 219.52 | Base_Flood | 169000.00 | 1113.36 | 1131.52 | 1126.58 | 1133.65 | 0.002195 | 11.71 | 14432.91 | 1001.87 | 0.54 |
| Salt River | 219.61 | Base_Flood | 169000.00 | 1114.26 | 1132.59 | 1127.74 | 1134.79 | 0.002274 | 11.91 | 14186.62 | 986.41 | 0.55 |
| Salt River | 219.70 | Base_Flood | 169000.00 | 1115.35 | 1133.64 | 1128.78 | 1135.90 | 0.002297 | 12.07 | 13999.68 | 962.51 | 0.56 |
| Salt River | 219.79 | Base_Flood | 169000.00 | 1117.50 | 1134.69 | 1130.30 | 1137.14 | 0.002560 | 12.56 | 13460.36 | 945.94 | 0.59 |
| Salt River | 219.89 | Base_Flood | 169000.00 | 1118.42 | 1135.91 | 1131.41 | 1138.38 | 0.002530 | 12.60 | 13410.19 | 926.95 | 0.58 |
| Salt River | 220.05 | Base_Flood | 169000.00 | 1121.14 | 1138.08 | 1132.90 | 1140.39 | 0.002209 | 12.20 | 13857.10 | 908.57 | 0.55 |
| Salt River | 220.055 | | Bridge | | | | | | | | | |
| Salt River | 220.06 | Base_Flood | 169000.00 | 1121.11 | 1138.43 | 1133.05 | 1140.67 | 0.002112 | 12.03 | 14053.36 | 910.13 | 0.54 |
| Salt River | 220.063 | Base_Flood | 169000.00 | 1121.11 | 1138.44 | 1133.11 | 1140.70 | 0.002136 | 12.07 | 13996.32 | 908.84 | 0.54 |
| Salt River | 220.066 | | Bridge | | | | | | | | | |
| Salt River | 220.07 | Base_Flood | 169000.00 | 1120.97 | 1138.77 | 1133.26 | 1140.98 | 0.002052 | 11.93 | 14163.29 | 908.48 | 0.53 |
| Salt River | 220.17 | Base_Flood | 169000.00 | 1121.50 | 1139.78 | 1134.29 | 1142.00 | 0.002045 | 11.96 | 14134.61 | 902.10 | 0.53 |
| Salt River | 220.26 | Base_Flood | 169000.00 | 1122.15 | 1140.87 | 1135.07 | 1143.01 | 0.001968 | 11.75 | 14381.53 | 915.86 | 0.52 |
| Salt River | 220.35 | Base_Flood | 169000.00 | 1122.68 | 1141.85 | 1136.03 | 1144.00 | 0.001969 | 11.77 | 14358.83 | 911.41 | 0.52 |
| Salt River | 220.45 | Base_Flood | 169000.00 | 1123.26 | 1142.86 | 1136.83 | 1144.98 | 0.001882 | 11.68 | 14468.66 | 899.33 | 0.51 |
| Salt River | 220.54 | Base_Flood | 169000.00 | 1124.24 | 1143.85 | 1137.53 | 1145.89 | 0.001798 | 11.46 | 14745.44 | 910.93 | 0.50 |
| Salt River | 220.64 | Base_Flood | 169000.00 | 1125.40 | 1144.80 | 1138.18 | 1146.77 | 0.001685 | 11.26 | 15010.81 | 907.72 | 0.49 |
| Salt River | 220.73 | Base_Flood | 169000.00 | 1126.56 | 1145.75 | 1138.39 | 1147.57 | 0.001440 | 10.82 | 15623.43 | 888.28 | 0.45 |
| Salt River | 220.78 | Base_Flood | 169000.00 | 1132.00 | 1145.30 | 1143.35 | 1149.20 | 0.005152 | 15.85 | 10663.71 | 841.80 | 0.78 |
| Salt River | 220.83 | Base_Flood | 169000.00 | 1129.02 | 1148.05 | 1141.33 | 1150.08 | 0.001659 | 11.41 | 14810.56 | 880.67 | 0.49 |

## B.4 Plates

# Levee Certification Report
# Salt River Levee System ID#33
# SR143 to Tempe Town Lake
# June 2011


Sky Harbor Blvd Ramp
Sky Harbor SR 143 Ramp
SR 143 Ramp
Air Ln
SR 143 Ramp
Sky Harbor Blvd
SR 143 Ramp
Sky Harbor Ramp
SR 143 Ramp
SR 143 Ramp
SR 143
Zone X1
WS=1125.1
N100
WS=1127.2
WS=1125.0
WS=1125.1
WS=1125.0
WS=1126.4
WS=1123.3
WS=1122.2
WS=1119.3
WS=1117.8
WS=1116.9
WS=1121
S100
WS=1124.1
S200
WS=1124.8
Floodway
Zone X1
SR 143 is downstream limit of study.
Model extends downstream as shown.
SR 143
Hilton Ave
40th St
SR 143 Ramp
40th St
40th Pl
Washington St
Van Buren St
Fillmore St
Polk St
Grant St
Buchanan St
Monroe St
Madison St
Jefferson St
Adams St
Jackson St
Lincoln St
Taylor St
Tyler St
Pierce St
Harrison St
Garfield St
Filmore St
Roosevelt St
Van Buren St
Monroe St
Madison St
Jefferson St
Adams St
Jackson St
Lincoln St
Taylor St
Tyler St
Pierce St
Harrison St
Garfield St
Buchanan St
Polk St
Grant St
Roosevelt St
Filmore St
Washington St
Hayden Ferry Lakeside
Hayden Ferry Lakeside
Hayden Ferry Lakeside




# Levee Certification Report
# Salt River Levee System ID#33
# SR143 to Tempe Town Lake
# June 2011

0 200 400 800
1 inch = 200 feet

N W E S

**Contour Interval: 2 feet**
**Datum: NGVD 29**

## ID 33 Features

- Levee condition
- Non-levee condition
- Opening w/out closure
- Opening w/ closure
- Tributary inflow

## Interior Watershed

- Boundary
- Concentration point
- Flow arrow
- Concentration path
- Ponding

## Effective Model

- Floodway
- Zone A
- Zone AE
- Zone X1
- BFE Contour
- Lettered CS ID

## HEC-RAS Features

- Reach centerline
- RAS section

## Other Features

- Sheet match line
- Tributary backwater

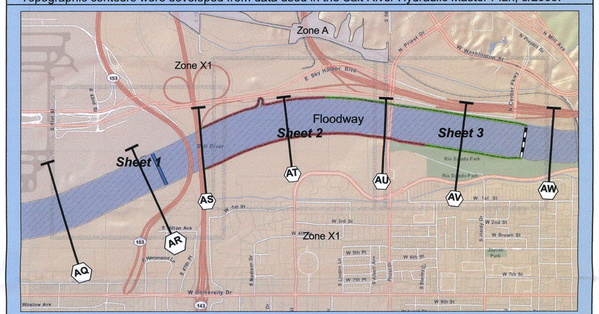
## Survey & As-built

- Grade control structure
- Dam
- Index contour *(w/ or w/out label)*
- Interim contour *(w/ or w/out label)*
- SRHMP topo boundary
- Salt River as-built CL *(Maricopa County, RAM-600-3-511, 1989)*

## Interior Drainage (100 yr)

| Sub-basin | Discharge (cfs) | Volume (ac-ft) | Depth (ft) |
|---|---|---|---|
| N100 | 67 | 2.5 | 2.3 |
| N200 | 68 | 3.0 | 9.0 |
| S100 | 18 | 0.7 | 3.9 |
| S200 | 29 | 1.1 | 5.0 |
| S300 | 13 | 0.5 | 1.0 |
| S400 | 46 | 1.7 | 1.2 |
| S500 | 31 | 1.1 | 3.5 |
| S600 | 27 | 1.0 | 2.5 |
| S700 | 108 | 4.0 | 2.3 |
| S800 | 208 | 7.9 | 1.5 |
| S900 | 17 | 0.6 | 3.2 |

Aerial photographs are 2010 NAIP (http://gis.apfo.usda.gov/arcgis/services).
Topographic contours were developed from data used in the Salt River Hydraulic Master Plan, 8/2009.




Location Map background data source:
http://services.arcgisonline.com/arcgis/services

0 0.25 0.5 1 Miles

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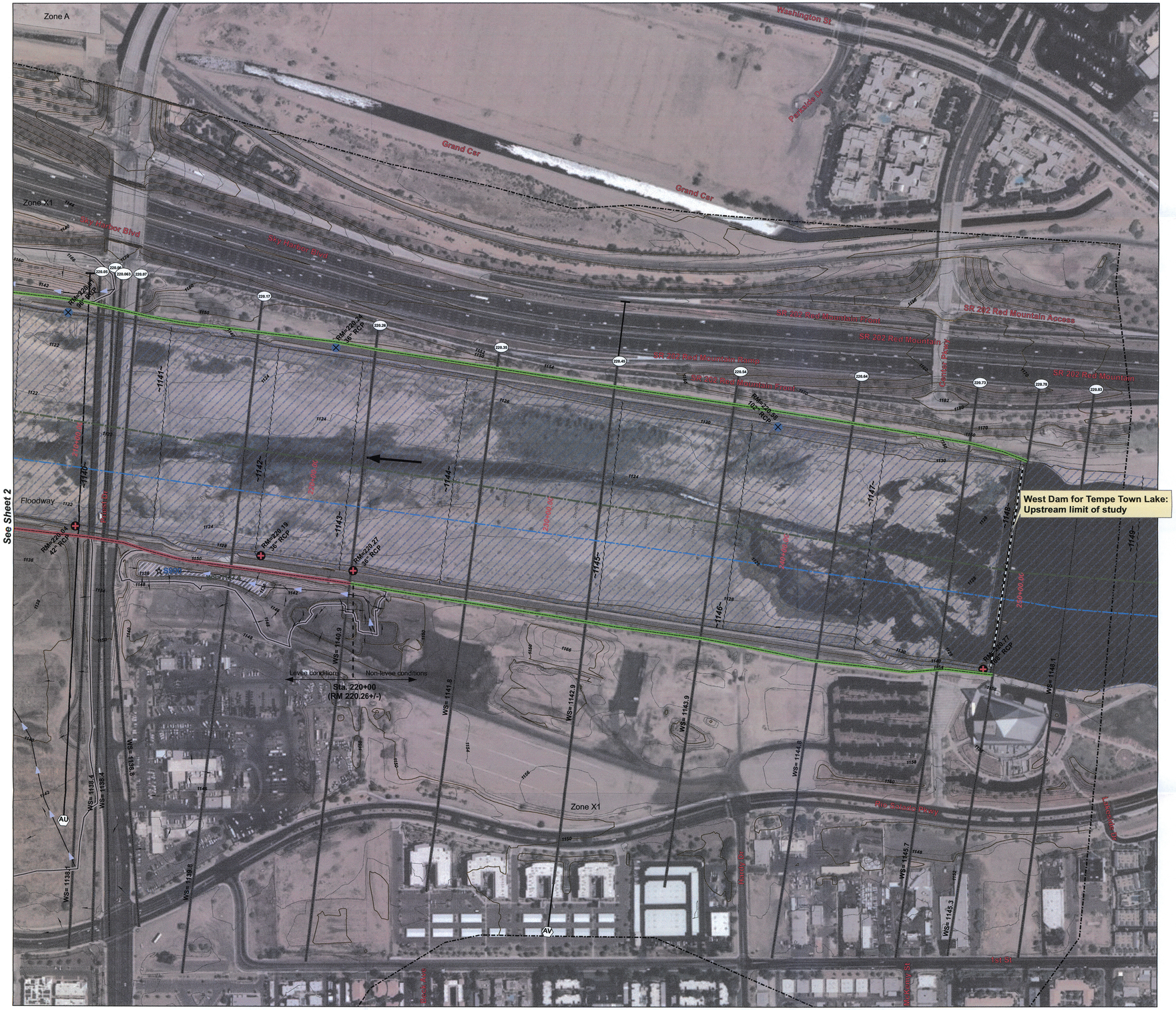
Drawn: Ian Sharp PM: Jon Ahern

# Plate 1 - Cross Section Workmap
# Sheet 2 of 3

# Levee Certification Report
# Salt River Levee System ID#33
# SR143 to Tempe Town Lake
# June 2011




## ID 33 Features

- Levee condition
- Non-levee condition
- Opening w/out closure
- Opening w/ closure
- Tributary inflow

## Interior Watershed

- Boundary
- Concentration point
- Flow arrow
- Concentration path
- Ponding

## Effective Model

- Floodway
- Zone A
- Zone AE
- Zone X1
- BFE Contour
- Lettered CS ID

## HEC-RAS Features

- Reach centerline
- RAS section

## Other Features

- Sheet match line
- Tributary backwater

## Survey & As-built

- Grade control structure
- Dam
- Index contour *(w/ or w/out label)*
- Interim contour *(w/ or w/out label)*
- SRHMP topo boundary
- Salt River as-built CL *(Maricopa County, RAM-600-3-511, 1989)*

0 200 400 800

1 inch = 200 feet

N W E S

**Contour Interval: 2 feet**
**Datum: NGVD 29**

## Interior Drainage (100 yr)

| Sub-basin | Discharge (cfs) | Volume (ac-ft) | Depth (ft) |
|---|---|---|---|
| N100 | 67 | 2.5 | 2.3 |
| N200 | 68 | 3.0 | 9.0 |
| S100 | 18 | 0.7 | 3.9 |
| S200 | 29 | 1.1 | 5.0 |
| S300 | 13 | 0.5 | 1.0 |
| S400 | 46 | 1.7 | 1.2 |
| S500 | 31 | 1.1 | 3.5 |
| S600 | 27 | 1.0 | 2.5 |
| S700 | 108 | 4.0 | 2.3 |
| S800 | 208 | 7.9 | 1.5 |
| S900 | 17 | 0.6 | 3.2 |

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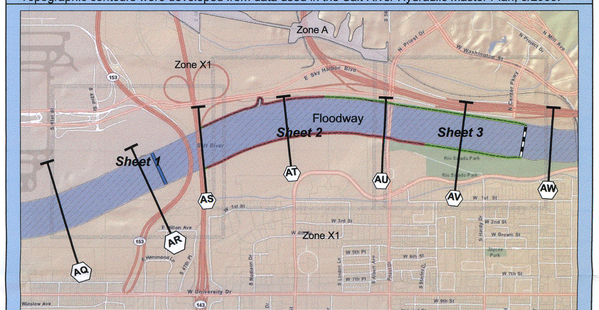


Location Map background data source:
http://services.arcgisonline.com/arcgis/services

0 0.25 0.5 1 Miles


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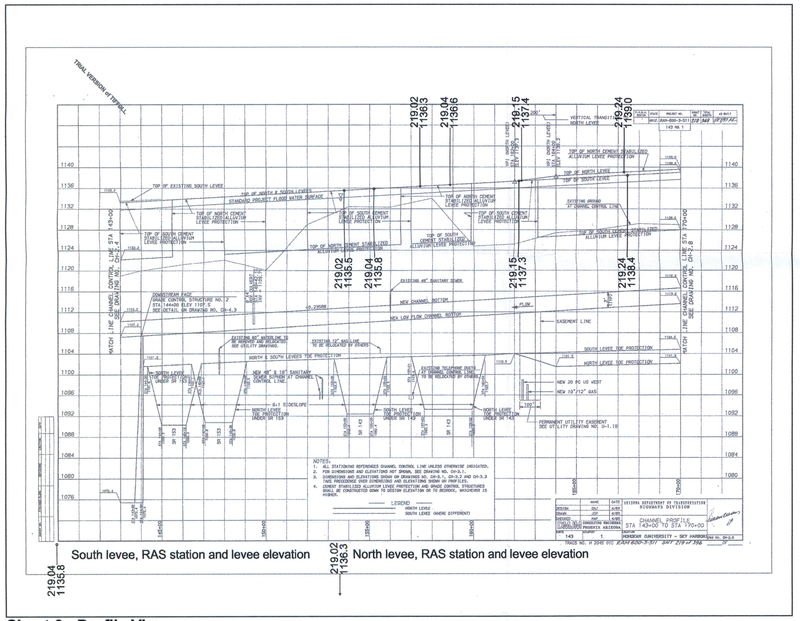
Drawn: Ian Sharp PM: Jon Ahern

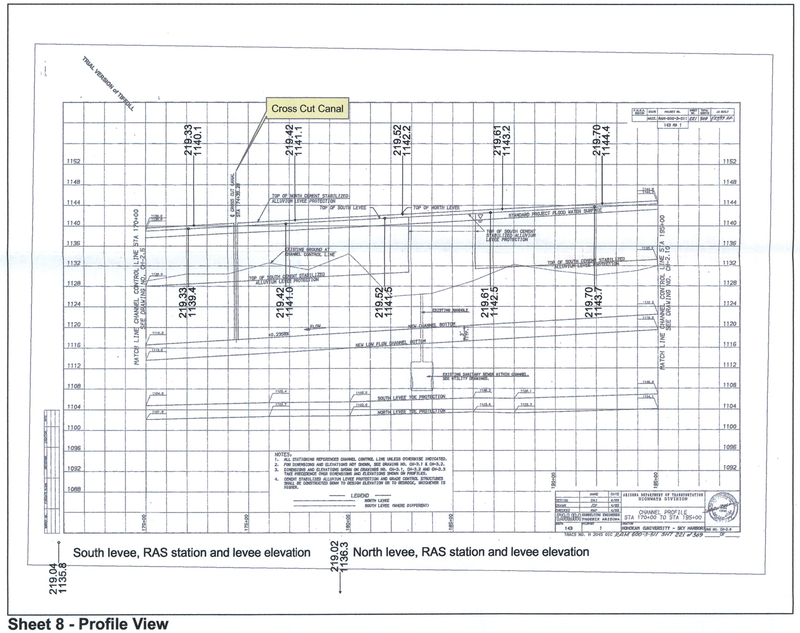

## Plate 1 - Cross Section Workmap
## Sheet 3 of 3




South levee, RAS station and levee elevation

North levee, RAS station and levee elevation

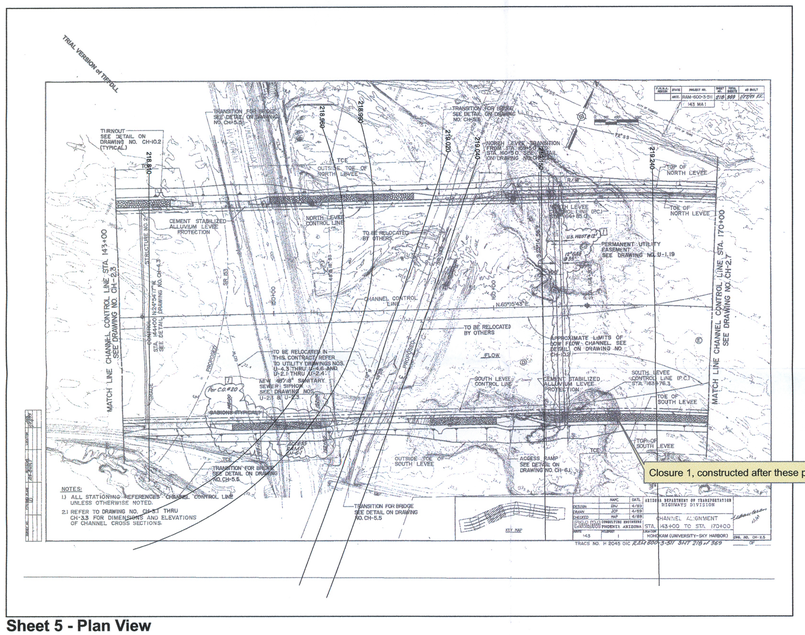
**Sheet 6 - Profile View**




South levee, RAS station and levee elevation

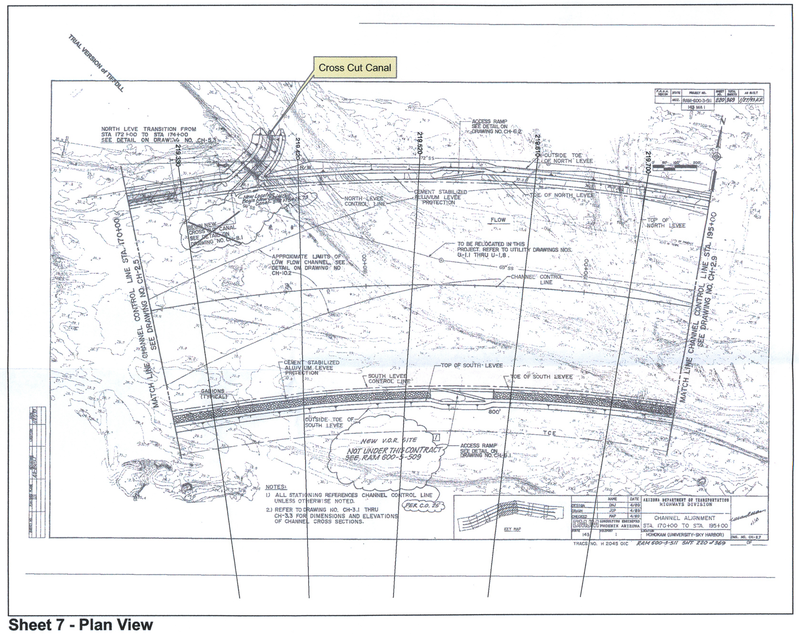
North levee, RAS station and levee elevation

**Sheet 8 - Profile View**




Closure 1, constructed after these plans

**Sheet 5 - Plan View**

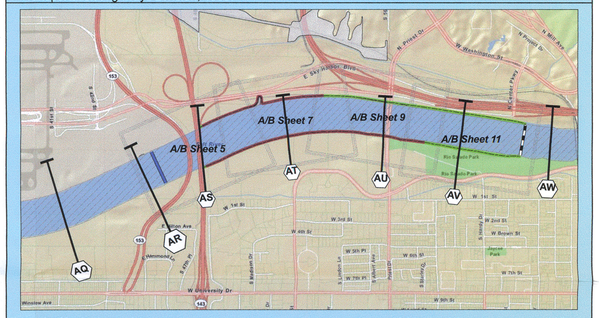



**Sheet 7 - Plan View**

See Sheet 2

# Levee Certification Report
# Salt River Levee System ID#33
# SR143 to Tempe Town Lake
# June 2011

Source: "Salt River Channelization - Hohokam (University-Sky Harbor)", State of Arizona Dept. of Transportation Highways Division, 1993.




Location Map background data source:
http://services.arcgisonline.com/arcgis/services

0 0.25 0.5 1 Miles

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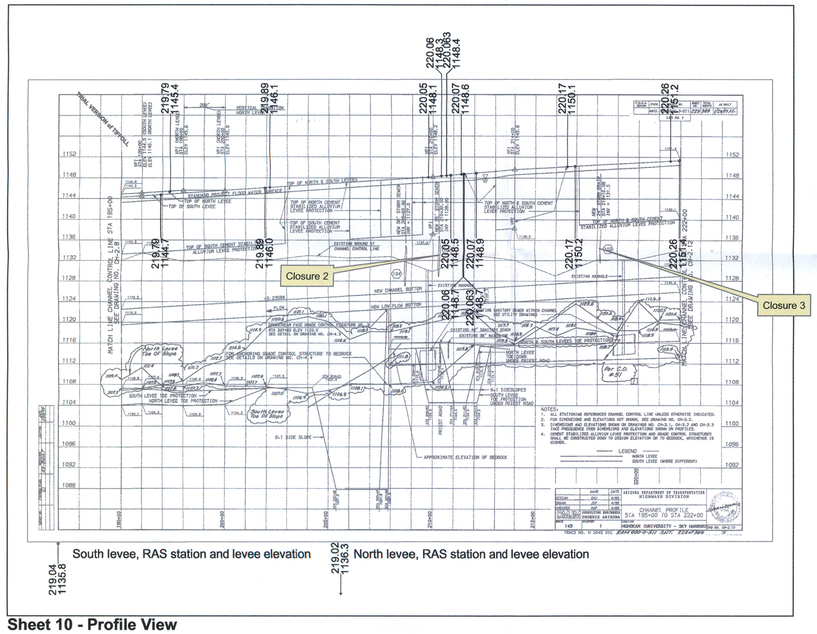
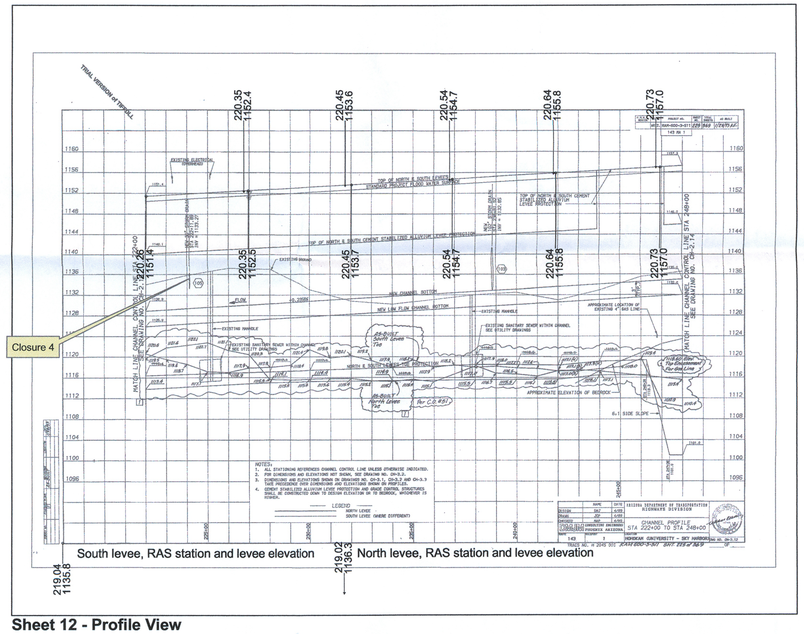
Drawn: Ian Sharp PM: Jon Ahern

## Plate 2 - Annotated As-builts
## Sheet 1 of 2

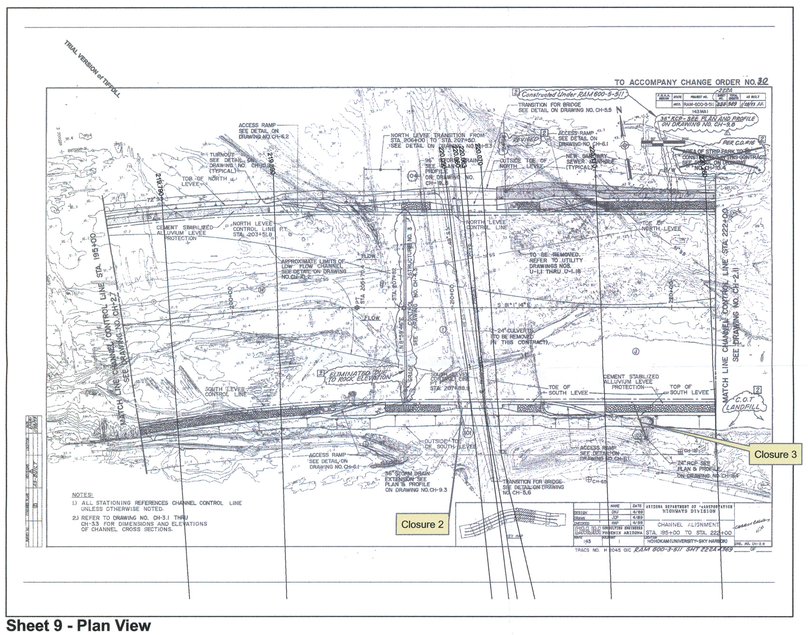



**Sheet 10 - Profile View**

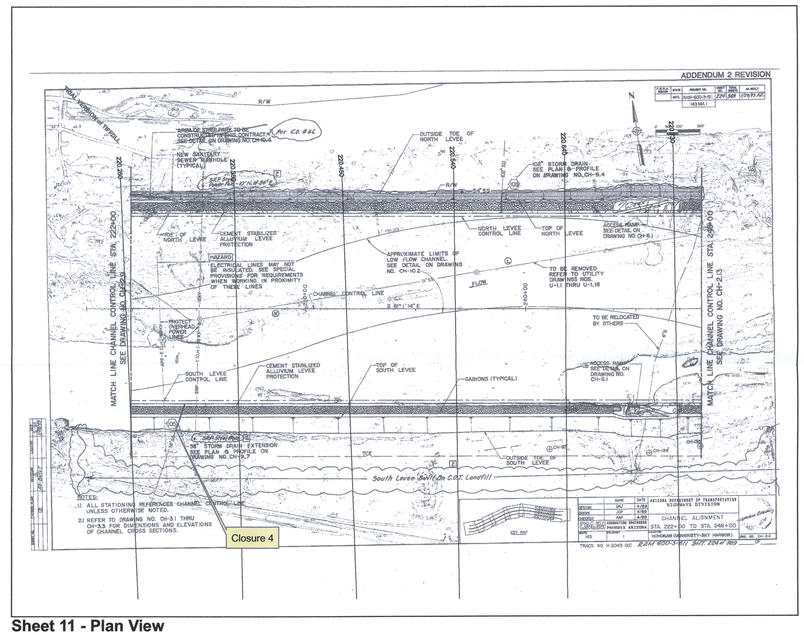



**Sheet 12 - Profile View**

See Sheet 2




**Sheet 9 - Plan View**




**Sheet 11 - Plan View**

# Levee Certification Report
# Salt River Levee System ID#33
# SR143 to Tempe Town Lake
# June 2011

Source: "Salt River Channelization - Hohokam (University-Sky Harbor)", State of Arizona Dept. of Transportation Highways Division, 1993.

Location Map background data source:
http://services.arcgisonline.com/arcgis/services

0 0.25 0.5 1 Miles

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## Plate 2 - Annotated As-builts
## Sheet 2 of 2

# C. Scour Evaluation for Embankment Toe Down

# Appendix C

## Levee Certification Report
## Salt River Levee System ID#33
## Maricopa County, Arizona

## Scour Evaluation for Embankment Toe Down

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# 1. As-Built Toe-down Depths

The as-built toe-down elevations are documented on the plans prepared by DMJM Consulting Engineers for the Arizona Department of Transportation (RAM-600-3-511) dated 4/1989, as-built 1/25/1993 and 1/27/1993. It should be noted that during construction bedrock was encountered along portions of the study reach. Per the construction plans, the toe-down was founded on bedrock when encountered. The revised toe-down elevations are documented on the as-built plans. Portions of the As Built plans are included in **Appendix E** with a full set in pdf format included on data disk in **Appendix H**.

# 2. Current Conditions Topography and Hydraulics

## 2.1 Topographic Changes

Updated topographic data was obtained from FCDMC for the study reach as part of the Salt River Hydraulic Master Plan (SRHMP, FCD 2007C017). Additional survey data was also obtained and provided by the FCDMC at selected locations along the levees to supplement the mapping. See **Appendix F** for RLS Sealed Survey Report.

## 2.2 Hydraulic Modeling

A new steady-state HEC-RAS model was also developed as part of the SRHMP. The new hydraulic model is provided by the FCDMC for use in this evaluation and trimmed down as discussed in **Appendix B**.

# 3. Current Conditions Scour Assessment

## 3.1 Total Scour Equation

The scour computations used to evaluate the adequacy of the levee toe-downs are presented in this section. The total scour potential is computed as the sum of six individual components: long term degradation, general scour, bend scour, bedform scour, local scour and low-flow Incisement. Scour potential was evaluated along the entire length of the revised levee limits.

The scour potential for both the north and south bank levees that make up Salt River Levee ID#33 were estimated using the procedures outlined in the Arizona Department of Water Resources report, "Engineering Analysis of Fluvial Systems" (1985), Flood Control District of Maricopa County "Drainage Design Manual - Hydraulics" (draft June 2010), the U.S. Bureau of Reclamation report on "Computing Degradation and Local Scour" by Pemberton and Lara (1984) and the FHWA Publication, Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges, Fourth Edition, May 2001 (HEC-18). The total scour equation is:

$$Z_t = SF\ (Z_{deg} + Z_{gs} + \tfrac{1}{2} Z_a + Z_{ls} + Z_{bs} + Z_{lft}\ )$$

where:

$Z_t$ = Design scour depth, (ft)
SF = Safety factor (1.0 – 1.5)
$Z_{deg}$= Long-term degradation, (ft)
$Z_{gs}$ = General scour depth, (ft)
$Z_a$ = Bed-form depth, (ft)
$Z_{ls}$ = Local scour depth, (ft)
$Z_{bs}$ = Bend scour depth, (ft)
$Z_{lft}$ = Low-flow thalweg depth, (ft)

The total scour depth is applied downwards starting from the Applied Invert (See discussion in **Section 3.2.8**) elevation, which was taken from the cross-sectional geometry of the channel.

## 3.2 Scour Components

### 3.2.1 Long-Term Channel Degradation

Long-term scour describes the gradual lowering of a watercourse through multiple events and longer periods of time, (10-year flows). Long-term scour was determined using a stable channel slope methodology.

The long-term scour component is determined based on the potential lowering of the channel bed within the project reach in the long-term. There can be a variety of causes leading to the wide scale lowering of the channel. Any significant disruption in sediment continuity could result in bed changes over the long-term.

The presence of a soil cement grade control structure approximately 1300 feet downstream of SR 143 provides a control point for applying long-term scour based on stable channel methodology. This grade control protects against long-term lowering of the bed elevations at the location of the grade control. The locations upstream of the grade control could be subject to long-term lowering with the constraint that bed elevations at the grade control are fixed by the grade control elevation.

Another phenomenon influencing the long-term channel bed variations is armoring. The channel bed within the study reach consists of sediment ranging from fine sand to large cobbles (Reference 5). The overall channel bed conditions indicate the presence of an armored layer consisting of gravels and cobbles. This is also an indication of limited sediment supply to the study reach and a low probability of channel aggradation.

The procedures adopted for determining the long term potential for channel degradation are discussed below.

### 3.2.1.1 Equilibrium Slope

Equilibrium slope computations are performed to determine the long-term stable slope. The equilibrium slope can be viewed as the slope that the channel would tend to move towards over a long period of time. The grade control located approximately 1300 feet downstream of SR 143, at an elevation of 1107.5ft (NGVD29), provides a hardpoint and was used as the downstream starting point in determining stable channel bed elevations.

Equilibrium slope[1] is defined as the slope which causes the channel's sediment transport capacity to equal the incoming sediment supply (ADWR, 1985). If the slope is too steep, channel velocities will be high and net degradation will occur. If the slope is too flat, channel velocities will be low and net aggradation will occur. The equilibrium slope is the slope that the undisturbed, natural channel will tend towards over the long term.

**Methodology**

Most equilibrium slope equations are based on the mean annual flood, the "channel-forming," or "bankfull" discharge. On many perennial alluvial streams, particularly in humid climates, the mean annual flood and the channel-forming and bankfull discharges are nearly equivalent. However, on ephemeral streams where flow events are rare, the channel-forming discharge is often difficult to determine. It is assumed that the 10-year event better approximates bankfull conditions in the study reach.

The 10-year hydraulic results from the HEC-RAS model have been used in the application of equilibrium slope equations for the study area

Guidelines provided in the USBR (Pemberton and Lara, 1984) Manual for computing scour and channel degradation downstream of dams or other structures that interrupt the natural sediment supply to the downstream channel describe three equations that can be used in the estimation of the equilibrium slope. All three equations are zero bed sediment discharge (clear water) equations, and represent minimum slopes that would occur if sediment supply were disrupted. Clear water conditions can be expected to occur in the lower flow events due to the presence of the Tempe Town Lake upstream of the Study Reach. Of the three, the Schoklitsch equation was used, since it provided the most conservative estimate. The Schoklitsch equation is given by:

[1] Equilibrium slope is also referred to as stable slope or limiting slope.

**Schoklitsch Equation**

The Schoklitsch (Shulits, 1935) equation is based on the concept of zero bedload transport.

$$S_L = K_s (D W_{bf}/Q)^{3/4}$$

Where $S_L$ = Stable slope (ft/ft)

$K_s$ = 0.00174
$W_{bf}$ = Bankfull width (ft)
D = Mean bed sediment diameter (mm)
Q = Dominant discharge (cfs)

### 3.2.1.2 Long-term Results

The equilibrium slope computations were performed to determine the potential overall lowering of the channel going upstream from the grade control structure located approximately 1300 feet downstream of SR 143. The computed equilibrium is 0.22%, which is equal to the average energy slope (0.22%) and approximately equal to the overall bed slope (0.23%). After the levee/channel improvements were completed, as documented on the 1993 as-built plans, the study reach was impacted by two significant flow events – one event that measured approximately 129,000 cfs and one that measured approximately 44,000 cfs. In addition, the U.S. Army Corps of Engineers, in cooperation with the Town of Tempe constructed a small, approximately 20 to 40-foot-wide, secondary low-flow channel as part of the Rio Salado Environmental Restoration Project. Collectively, these natural and man-made changes have resulted in a low-flow channel profile, with an overall slope that is approximately equal to 0.23%, which is approximately three feet lower than the design profile for the 400-foot-wide low-flow channel (0.236%), which is controlled by a grade-control structure. Since the existing low-flow channel profile is lower than the equilibrium profile and the overall slope approximates the minimum equilibrium slope computed using the Schoklitsch equation, the long-term degradation depth is zero (i.e., the bed profile can be assumed to be at equilibrium). See results in **Table C-11**.

## 3.2.2 General Scour

General scour, $Z_{gs}$, is the component of scour that represents the mobile portion of the bed-material of the channel bottom during a specified flow event. General scour was computed using the Lacey method as described in the US Bureau of Reclamation's "Computing Degradation and Local Scour" (Pemberton and Lara, 1984). The Lacey equation is well suited to channels in which live-bed scour occurs. It is anticipated that the Lacey equation provides a realistic value and is appropriate for the conditions encountered in the Salt River for higher flow events.

Lacey's equation for general scour is applicable to natural streams where the sediment is not captured upstream. Although Tempe Town Lake acts as a sediment trap for all flood flows less than 36,000 cfs, the inflatable dams are designed with an automated control system that will fully deflate the dams for all flow inexcess of 36,000 cfs. Therefore, it is reasonable to assume that during the 100-year event, sediments stored behind the dam will be conveyed downstream and the channel will behave like a natural stream with no upstream controls.

The Lacey equation is given by:

**Lacey Equation**

$$Z_{gs} = Z\,(0.50\,[Q/f]^{1/3})$$

where

$Z_{gs}$ = general scour depth (ft);
$Q$ = design discharge (cfs);
$f$ = Lacey's silt factor = $1.76(D_m)_{1/2}$
$D_m$ = mean grain size which is taken as $D_{50}$, (mm);
$D_{50}$ = defined as the diameter where 50% is finer by weight, (mm);
$Z$ = multiplying factor (0.25 for straight reach, 0.5 for moderate bend, 0.75 for severe bend, 1.0 for right angle bends, 1.25 for a vertical rock bank or wall).

For the 100-year event, the general scour component was estimated to be 5.2 feet for the North Levee and 2.6 feet for the South Levee. See results in **Tables C-8** and **C-9**.

### 3.2.3 Bend Scour

Bend scour, $Z_{bs}$, occurs on the outside of bends in a stream channel. The general scour component described above using the Lacey Equation incorporates the bend scour component; therefore, a separate calculation was not required. The curvature of the Salt River within the study reach is considered moderate (Z = 0.50) and is applied to the North Levee along the outside of the gradual curve. For the South Levee, on the inside of the gradual curve, the Lacey Z factor is set to 0.25.

### 3.2.4 Bedform Scour

Bedform scour describes the development of dunes and troughs along the channel bottom during high flow events; this form of scour is particularly prevalent in sand-bed watercourses. Bedform scour was calculated based upon the methodology presented in the Flood Control District of Maricopa County "Drainage Design Manual - Hydraulics". Variables for the calculations were derived from the project HEC-RAS model. These variables included Froude number, channel velocity, and channel hydraulic depth.

The dune height for lower regime flow where Froude numbers are less than 0.7 is given by (Gyr and Hoyer, 2006, Zanke, 1976) as

$$0.15 < d_h/y_h < 0.3$$

where $d_h$ is the dune height and $y_h$ is the hydraulic radius.

Since a range is given for dune height in above equation, the ratio $d_h/y_h$ is assumed to be 0.2 due to the presence of larger size sediment within the study reach.

Anti-dune trough depth, $Z_a$, is the component of scour caused by movement of dune shaped bed forms along the bottom of the channel. The anti-dune trough depth was estimated using the following equation:

$$Z_a = 0.0273\,V^2_m$$

where:

$V_m$ = Average velocity of flow at design discharge (ft/sec)

The anti-dune trough depth is limited to a maximum of ½ the flow depth (since $Z_a$ cannot be greater than the flow depth, ADWR Manual p. 24).

The results indicate that the bedform scour component is approximately 1.5 feet. See results in **Table C-10**.

### 3.2.5 Low-flow/Thalweg Scour

Low-flow thalweg scour, $Z_{lft}$, occurs if a small channel forms to convey minor flows within the main channel of a stream. Normally, the low-flow thalweg component of scour is not considered for a natural channel, since the natural channel minimum elevation already reflects the elevation of the thalweg. The low-flow channel within the study reach is represented in the cross-sectional geometry. Consequently, the low-flow thalweg scour component is zero.

### 3.2.6 Local Scour

Local scour, $Z_{ls}$, occurs where there is an abrupt change in the direction of flow caused by obstructions such as bridge piers, abutments, or other structures such as grade control structures. The SR 143 Bridge and the Priest Road Bridge are the only structures along the study reach that could introduce a local-scour component. Since the abutments for both bridges are on the landside of the embankment protection, local scour at the bridge piers is the only applicable component that was analyzed for the local scour component.

Based on the results of the analysis, the local scour potential associated with the SR 143 piers and the Priest Road piers was determined to be 15.94 feet and 13.98 feet, respectively. See results in **Tables C-12** and **C-13**. To determine if the scour holes could impact the levee protection, the top width of the scour hole was estimated by assuming that the bottom width of the scour hole was equal to one pier diameter and the angle of repose for the bed sediments was 3:1 (horizontal to vertical). Based on this assumption, only the north pier set associated with the SR 143 Bridge was close enough to the levee protection to introduce a local-scour component. The local scour component of less than 3.5 feet was added to the overall scour calculations at HEC-RAS station 219.04. General guidelines for determining scour hole top width is given in HEC-18.

### 3.2.7 Factor of Safety

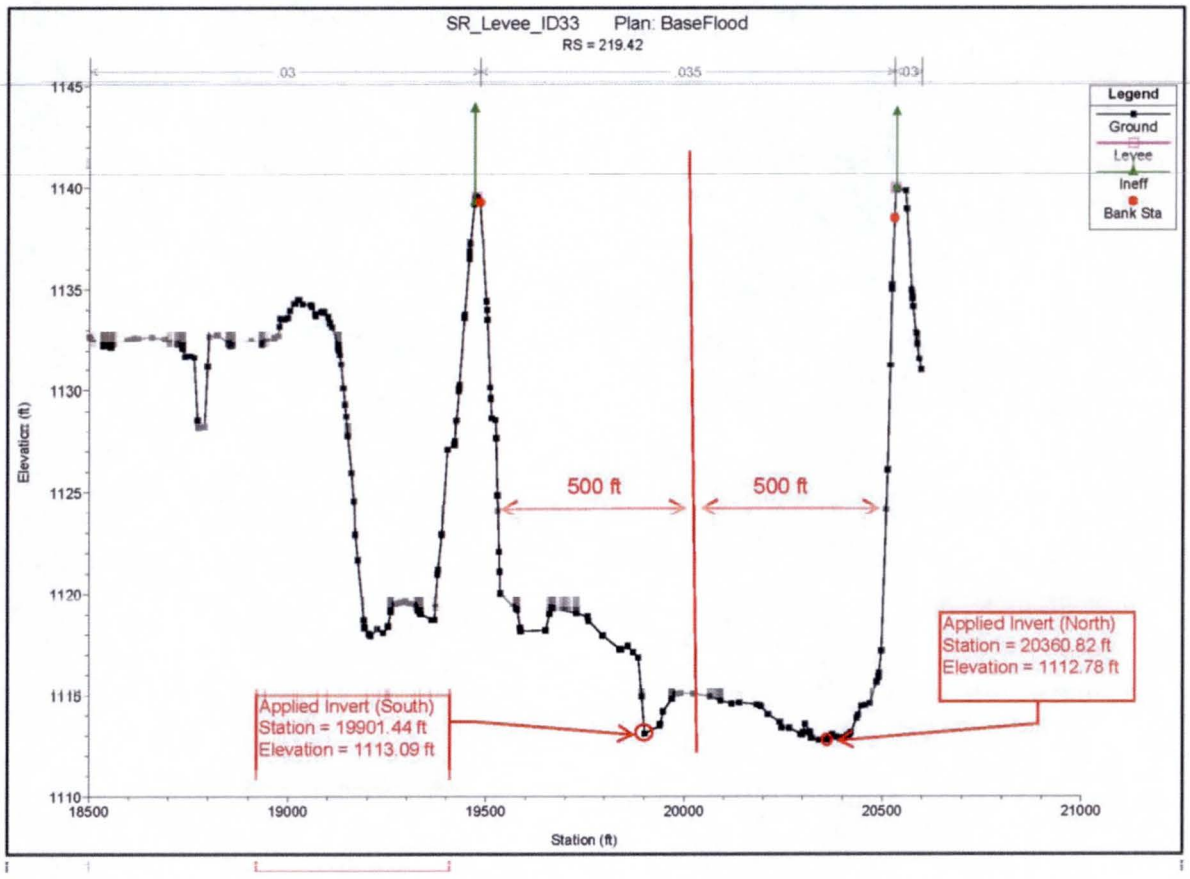
The ADWR Manual states that the safety factor generally varies between 1.0 and 1.5, but should be selected based on risk, consequence of failure, incremental construction cost, and regulatory factors. For the purpose of this toe-down evaluation, a resultant safety factor was determine by comparing the calculated scour elevation to the design toe of soil cement from the As Built drawings for *Salt River Channelization, Hohokam (University-Sky Harbor), DMJM, 1989* for both the North and South levees.

### 3.2.8 Applied Invert

The applied invert varied along the channel reach for both the North and South Levees. As illustrated in **Figure C-1**, the applied invert for each levee (North and South) was taken from the minimum channel elevation within 500 feet of the levee embankment protection. **Table C-1** provides the station/elevation of the north and south levee along with the station/elevation for the minimum channel elevation for each of the HEC-RAS model cross section within the levee

limits.

**Figure C-1: Example of Applied Invert Determination**



## Table C-1: Applied Invert – North Levee

| [1]Levee Station (North) | [1]HEC-RAS Cross Section | Toe of Embankment | | [2]Applied Invert HEC-RAS Min Elevation within 500 ft of Embankment | |
|---|---|---|---|---|---|
| | | Station (ft) | Elevation (ft) | (ft) | (ft) |
| 158+86 | 219.04 | 20482.67 | 1112.28 | 19980.69 | 1111.27 |
| 162+33 | 219.15 | 20456.25 | 1112.57 | 20450.05 | 1112.52 |
| 167+29 | 219.24 | 20443.2 | 1113.82 | 19953.13 | 1112.59 |
| 172+31 | 219.33 | 20401.91 | 1115.2 | 20182.21 | 1112.61 |
| 177+25 | 219.42 | 20497.57 | 1117.2 | 20360.82 | 1112.78 |
| 182+54 | 219.52 | 20497.69 | 1113.36 | 20497.69 | 1113.36 |
| 187+40 | 219.61 | 20453.18 | 1114.67 | 20388.55 | 1114.26 |
| 192+26 | 219.7 | 20452.35 | 1119.88 | 20333.08 | 1115.35 |

Note: 1. Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
2. Applied invert from HEC-RAS model
All elevations NAVD 1929.

## Table C-2: Applied Invert – South Levee

| [1]Levee Station (South) | [1]HEC-RAS Cross Section | Toe of Embankment | | [2]Applied Invert HEC-RAS Min Elevation within 500 ft of Embankment | |
|---|---|---|---|---|---|
| | | Station (ft) | Elevation (ft) | (ft) | (ft) |
| 155+20 | 219.04 | 19485.53 | 1110.51 | 19587.43 | 1106.59 |
| 162+20 | 219.15 | 195113.5 | 1115.02 | 19677.09 | 1109.49 |
| 167+45 | 219.24 | 19496.88 | 1118.48 | 19889.03 | 1110.33 |
| 172+04 | 219.33 | 19456.87 | 1119.01 | 19805.87 | 1111.69 |
| 176+79 | 219.42 | 19536.25 | 1120.01 | 19901.44 | 1113.09 |
| 181+68 | 219.52 | 19586.1 | 1120.93 | 20029.3 | 1113.88 |
| 186+82 | 219.61 | 19604.66 | 1121.34 | 20078.54 | 1115.23 |
| 191+88 | 219.7 | 19586.03 | 1122.54 | 19989.61 | 1116.46 |
| 196+91 | 219.79 | 19541.39 | 1120.11 | 19924.7 | 1118.06 |
| 201+93 | 219.89 | 19591.86 | 1120.18 | 19880.15 | 1118.42 |
| 210+87 | 220.05 | 19602.9 | 1123.37 | 19691.53 | 1121.14 |
| 211+47 | 220.06 | 19594.79 | 1124.72 | 19694.11 | 1121.11 |
| 211+51 | 220.063 | 19595.33 | 1124.75 | 19695.43 | 1121.11 |
| 212+09 | 220.07 | 19593.4 | 1125.14 | 19701.06 | 1120.97 |
| 216+95 | 220.17 | 19580.53 | 1130.04 | 19961.54 | 1121.5 |
| 221+97 | 220.26 | 19602.16 | 1126.72 | 20011.66 | 1122.15 |

Note: 1. Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
2. Applied invert from HEC-RAS model
All elevations NAVD 1929.

# 4. Results

The scour calculations for each of the scour components were performed using the procedures discussed in **Section 3**. The hydraulic parameters were obtained from the 10- and 100-year HEC-RAS hydraulic modeling results. The details of the computations and results are presented in **Appendix C.2**. **Table C-3** lists the summary of calculated scour depths estimated using the methodology presented in this evaluation for the North Levee protection and **Table C-4** lists the values for the South Levee protection. The results indicate that the computed toe-down elevations based on scour estimates are above the design toe elevations for both the North and South levees along the Salt River with a minimum safety factor of 1.1.

**Table C-3: Scour Calculation Summary – North Levee**

| [1]Levee Station (North) | [1]HEC-RAS Cross Section | Total Scour Depth | [2]Applied Invert | Calculated Scour Elevation | [3]Design Toe of Soil Cement | Calculated Safety Factor | Adequate Toe-down? |
|---|---|---|---|---|---|---|---|
| | | (ft) | (ft) | (ft) | (ft) | | |
| 158+86 | 219.04 | 10.2 | 1111.3 | 1101.1 | 1096.5 | 1.5 | Yes |
| 162+33 | 219.15 | 6.6 | 1112.5 | 1105.9 | 1103.5 | 1.4 | Yes |
| 167+29 | 219.24 | 6.6 | 1112.6 | 1106.0 | 1101.7 | 1.6 | Yes |
| 172+31 | 219.33 | 6.6 | 1112.6 | 1106.0 | 1102.2 | 1.6 | Yes |
| 177+25 | 219.42 | 6.6 | 1112.8 | 1106.2 | 1102.7 | 1.5 | Yes |
| 182+54 | 219.52 | 6.6 | 1113.4 | 1106.7 | 1103.1 | 1.5 | Yes |
| 187+40 | 219.61 | 6.6 | 1114.3 | 1107.6 | 1103.4 | 1.6 | Yes |
| 192+26 | 219.7 | 6.6 | 1115.4 | 1108.7 | 1103.8 | 1.7 | Yes |

Note: 1. Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
2. Applied invert from HEC-RAS model. See Section 3.2.8
3. Levee elevations from Salt River Channelization, Hohokam (University-Sky Harbor) Plans. All elevations NAVD 1929.

## Table C-4: Scour Calculation Summary – South Levee

| [1]Levee Station (South) | [1]HEC-RAS Cross Section | Total Scour Depth | [2]Applied Invert | Calculated Scour Elevation | Design Toe of Soil Cement | Calculated Safety Factor | [4]Adequate Toe-down? |
|---|---|---|---|---|---|---|---|
| | | (ft) | (ft) | (ft) | (ft) | | |
| 155+20 | 219.04 | 4.1 | 1106.6 | 1102.5 | 1092.2 | 3.5 | Yes |
| 162+20 | 219.15 | 4.0 | 1109.5 | 1105.5 | 1103.9 | 1.4 | Yes |
| 167+45 | 219.24 | 4.0 | 1110.3 | 1106.3 | 1104.4 | 1.5 | Yes |
| 172+04 | 219.33 | 6.0 | 1111.7 | 1105.7 | 1104.9 | 1.1 | Yes |
| 176+79 | 219.42 | 4.0 | 1113.1 | 1109.1 | 1105.4 | 1.9 | Yes |
| 181+68 | 219.52 | 4.0 | 1113.9 | 1109.8 | 1105.7 | 2.0 | Yes |
| 186+82 | 219.61 | 4.0 | 1115.2 | 1111.2 | 1106.2 | 2.3 | Yes |
| 191+88 | 219.7 | 4.0 | 1116.5 | 1112.4 | 1106.8 | 2.4 | Yes |
| 196+91 | 219.79 | 4.0 | 1118.1 | 1114.0 | 1107.8 | 2.5 | Yes |
| 201+93 | 219.89 | 4.0 | 1118.4 | 1114.4 | 1107.6 | 2.7 | Yes |
| 210+87 | 220.05 | 4.1 | 1121.1 | 1117.0 | 1111.7 | 2.3 | Yes |
| 211+47 | 220.06 | 4.1 | 1121.1 | 1117.0 | 1113.9 | 1.8 | Yes |
| 211+51 | 220.063 | 4.1 | 1121.1 | 1117.0 | 1114.0 | 1.7 | Yes |
| 212+09 | 220.07 | 4.2 | 1121.0 | 1116.8 | 1115.8 | 1.2 | Yes |
| 216+95 | 220.17 | 4.2 | 1121.5 | 1117.3 | 1123.5 | NA | BR |
| 221+97 | 220.26 | 4.2 | 1122.2 | 1118.0 | 1120.6 | NA | BR |

Note: 1. Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
2. Applied invert from HEC-RAS model. See Section 3.2.8
3. Levee elevations from Salt River Channelization, Hohokam (University-Sky Harbor) Plans.
4. BR denotes toe-down founded on bedrock.
All elevations NAVD 1929.

# 5. References

1) Arizona Department of Water Resources, Design Manual for Engineering Analysis of Fluvial Systems, 1985. Prepared by Simons Li Associates.

2) FHWA Publication, Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges, Fourth Edition (HEC-18), May 2001

3) Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, Hydraulics: Sedimentation, 2010.

4) Pemberton, E.L., and Lara, J.M., 1984, Computing Degradation and Local Scour, Technical Guideline for Bureau of Reclamation. Denver, Colorado. January.

5) Richardson, E.V., Davis, S.R., U.S. Department of Transportation, Federal Highway Administration,HEC-18, Evaluating Scour at Bridges, Fourth Edition, FHWA NHI 01-001, May 2001.

6) J2 Engineering and Environmental Design, SR143-Sky Harbor Blvd. TI. Initial Salt River Drainage Concept Report, 2009.

## C.1 HEC-RAS Summary Table

**Project:** **Salt River Levee ID #33**
**Location:** **Maricopa County, Arizona**

**Table C-5: Summary of Hydraulic Properties used in Scour Analysis**

**Study Reach 100-year**

| As-Built Station | | River Sta | Q Total (cfs) | Q Channel (cfs) | Area Channel (sq ft) | Top W Chnl (ft) | Max Chl Dpth (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Invert Slope | Hydr Depth C (ft) | Length Chnl (ft) | Mann Wtd Chnl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 219.03 | **Bridge (SR 143 Northbound)** | | | | | | | | | 1293 | |
| | North Bank Levee | 219.04 | 169000 | 169000 | 15793.0 | 1058.0 | 19.77 | 0.0017 | 10.70 | 0.0000 | 14.93 | 4.0 | 0.035 |
| | | 219.15 | 169000 | 169000 | 14549.6 | 1018.9 | 17.73 | 0.0022 | 11.62 | 0.0052 | 14.28 | 558.5 | 0.035 |
| | | 219.24 | 169000 | 169000 | 14574.1 | 1029.2 | 18.02 | 0.0022 | 11.60 | 0.0016 | 14.16 | 511.3 | 0.035 |
| | | 219.33 | 169000 | 169000 | 14482.1 | 1025.9 | 17.68 | 0.0022 | 11.67 | 0.0029 | 14.12 | 467.9 | 0.035 |
| | | 219.42 | 169000 | 169000 | 14383.5 | 1008.5 | 17.63 | 0.0022 | 11.75 | 0.0023 | 14.26 | 470.9 | 0.035 |
| South Bank Levee | | 219.52 | 169000 | 169000 | 14432.9 | 1001.9 | 18.16 | 0.0022 | 11.71 | 0.0012 | 14.41 | 497.5 | 0.035 |
| | | 219.61 | 169000 | 169000 | 14186.6 | 986.4 | 18.33 | 0.0023 | 11.91 | 0.0018 | 14.38 | 499.4 | 0.035 |
| | 193+00 | 219.70 | 169000 | 169000 | 13999.7 | 962.5 | 18.28 | 0.0023 | 12.07 | 0.0023 | 14.55 | 477.0 | 0.035 |
| | | 219.79 | 169000 | 169000 | 13460.4 | 945.9 | 17.19 | 0.0026 | 12.56 | 0.0044 | 14.23 | 490.5 | 0.035 |
| | | 219.89 | 169000 | 169000 | 13410.2 | 927.0 | 17.49 | 0.0025 | 12.60 | 0.0019 | 14.47 | 484.6 | 0.035 |
| | | 220.05 | 169000 | 169000 | 13857.1 | 908.6 | 16.94 | 0.0022 | 12.20 | 0.0032 | 15.25 | 843.7 | 0.035 |
| | | 220.06 | **Bridge (Priest Southbound)** | | | | | | | | | | |
| | | 220.06 | 169000 | 169000 | 14053.4 | 910.1 | 17.32 | 0.0021 | 12.03 | 0.0000 | 15.44 | 3.0 | 0.035 |
| | | 220.06 | 169000 | 169000 | 13996.3 | 908.8 | 17.33 | 0.0021 | 12.07 | 0.0000 | 15.40 | 10.5 | 0.035 |
| | | 220.07 | **Bridge (Priest Northbound)** | | | | | | | | | | |
| | | 220.07 | 169000 | 169000 | 14163.3 | 908.5 | 17.80 | 0.0021 | 11.93 | 0.0000 | 15.59 | 10.2 | 0.035 |
| | | 220.17 | 169000 | 169000 | 14134.6 | 902.1 | 18.28 | 0.0020 | 11.96 | 0.0011 | 15.67 | 495.8 | 0.035 |
| 222+00 | | 220.26 | 169000 | 169000 | 14381.5 | 915.9 | 18.72 | 0.0020 | 11.75 | 0.0013 | 15.70 | 500.8 | 0.035 |
| | | | **average:** | **169000** | **14241.1** | **963.6** | **17.92** | **0.00219** | **11.88** | **--** | **14.80** | **--** | **0.035** |

**Distance from Grade-Control Structure (North Bank):** **4779.4 ft**
**Distance from Grade-Control Structure (South Bank):** **7618.4 ft** **Existing Slope:** **0.00230 ft/ft**

**Study Reach 10-year**

| As-Built Station | | River Sta | Q Total (cfs) | Q Channel (cfs) | Area Channel (sq ft) | Top W Chnl (ft) | Max Chl Dpth (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Invert Slope | Hydr Depth C (ft) | Length Chnl (ft) | Mann Wtd Chnl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 157+00 | 157+00 | 219.03 | **Bridge (SR 143 Northbound)** | | | | | | | | | 1460.3 | |
| | | 219.04 | 55000 | 55000 | 7730.5 | 1031.1 | 12.04 | 0.0019 | 7.11 | 0.0000 | 7.50 | 4.0 | 0.035 |
| | North Bank Levee | 219.15 | 55000 | 55000 | 7098.3 | 978.8 | 10.23 | 0.0024 | 7.75 | 0.0052 | 7.25 | 558.5 | 0.035 |
| | | 219.24 | 55000 | 55000 | 7194.9 | 973.8 | 10.61 | 0.0023 | 7.64 | 0.0016 | 7.39 | 511.3 | 0.035 |
| | | 219.33 | 55000 | 55000 | 7142.1 | 976.7 | 10.31 | 0.0023 | 7.70 | 0.0029 | 7.31 | 467.9 | 0.035 |
| | | 219.42 | 55000 | 55000 | 7156.5 | 975.9 | 10.32 | 0.0023 | 7.69 | 0.0023 | 7.33 | 470.9 | 0.035 |
| South Bank Levee | | 219.52 | 55000 | 55000 | 7284.8 | 968.6 | 10.89 | 0.0022 | 7.55 | 0.0012 | 7.52 | 497.5 | 0.035 |
| | | 219.61 | 55000 | 55000 | 7170.4 | 952.9 | 11.06 | 0.0022 | 7.67 | 0.0018 | 7.53 | 499.4 | 0.035 |
| | 193+00 | 219.70 | 55000 | 55000 | 7163.5 | 924.7 | 11.01 | 0.0021 | 7.68 | 0.0023 | 7.75 | 477.0 | 0.035 |
| | | 219.79 | 55000 | 55000 | 6738.4 | 907.5 | 9.92 | 0.0026 | 8.16 | 0.0044 | 7.43 | 490.5 | 0.035 |
| | | 219.89 | 55000 | 55000 | 6827.3 | 894.5 | 10.23 | 0.0024 | 8.06 | 0.0019 | 7.63 | 484.6 | 0.035 |
| | | 220.05 | 55000 | 55000 | 7200.0 | 876.4 | 9.46 | 0.0020 | 7.64 | 0.0032 | 8.22 | 843.7 | 0.035 |
| | | 220.06 | **Bridge (Priest Southbound)** | | | | | | | | | | |
| | | 220.06 | 55000 | 55000 | 7249.9 | 877.5 | 9.68 | 0.0019 | 7.59 | 0.0000 | 8.26 | 3.0 | 0.035 |
| | | 220.06 | 55000 | 55000 | 7207.5 | 875.8 | 9.70 | 0.0020 | 7.63 | 0.0000 | 8.23 | 10.5 | 0.035 |
| | | 220.07 | **Bridge (Priest Northbound)** | | | | | | | | | | |
| | | 220.07 | 55000 | 55000 | 7256.0 | 876.7 | 10.04 | 0.0019 | 7.58 | 0.0000 | 8.28 | 10.2 | 0.035 |
| | | 220.17 | 55000 | 55000 | 7167.0 | 881.4 | 10.46 | 0.0020 | 7.67 | 0.0011 | 8.13 | 495.8 | 0.035 |
| 222+00 | | 220.26 | 55000 | 55000 | 7381.2 | 872.1 | 10.82 | 0.0018 | 7.45 | 0.0013 | 8.46 | 500.8 | 0.035 |
| | | | **average:** | **55000** | **7185.5** | **927.8** | **10.42** | **0.0021** | **7.66** | **--** | **7.76** | **--** | **0.035** |

## C.2 Scour Calculations

**Project:** Salt River Levee ID #33
**Location:** Maricopa County, Arizona

**Table C-6: Scour Calculation Summary Table - North Levee**

Calc'd by: RLS Date: 5/25/2011 Checked: JTA Date: 6/5/2011

| [1]Levee Station (North) | [1]HEC-RAS Cross Section | [2]Long Term Scour | [3]General Scour | [4]Bedform Scour | [5]Low Flow Incisement | Local Scour Depth | Total Scour Depth | [6]Applied Invert | Calculated Scour Elevation | Design Toe of Soil Cement | Calculated Safety Factor | Adequate Toe-down? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | | |
| 158+86 | 219.04 | 0.0 | 5.18 | 1.49 | 0.0 | 3.48 | 10.2 | 1111.3 | 1101.1 | 1096.5 | 1.5 | Yes |
| 162+33 | 219.15 | 0.0 | 5.18 | 1.43 | 0.0 | 0.0 | 6.6 | 1112.5 | 1105.9 | 1103.5 | 1.4 | Yes |
| 167+29 | 219.24 | 0.0 | 5.18 | 1.42 | 0.0 | 0.0 | 6.6 | 1112.6 | 1106.0 | 1101.7 | 1.6 | Yes |
| 172+31 | 219.33 | 0.0 | 5.18 | 1.41 | 0.0 | 0.0 | 6.6 | 1112.6 | 1106.0 | 1102.2 | 1.6 | Yes |
| 177+25 | 219.42 | 0.0 | 5.18 | 1.43 | 0.0 | 0.0 | 6.6 | 1112.8 | 1106.2 | 1102.7 | 1.5 | Yes |
| 182+54 | 219.52 | 0.0 | 5.18 | 1.44 | 0.0 | 0.0 | 6.6 | 1113.4 | 1106.7 | 1103.1 | 1.5 | Yes |
| 187+40 | 219.61 | 0.0 | 5.18 | 1.44 | 0.0 | 0.0 | 6.6 | 1114.3 | 1107.6 | 1103.4 | 1.6 | Yes |
| 192+26 | 219.7 | 0.0 | 5.18 | 1.46 | 0.0 | 0.0 | 6.6 | 1115.4 | 1108.7 | 1103.8 | 1.7 | Yes |

Notes:
(1) - Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
(2) - Schoklitsch equilibrium slope applied
(3) - Live bed conditions assumed - Lacey Equation applied for general scour (USBR, "Computing Degradation and Local Scour", 1984)
(4) - Bedform scour calculated per Flood Control District of Maricopa County Method (FCDMC, "Hydraulics Design Manual").
(5) - Low flow Incisement set to 0.
(6) - Applied invert from HEC-RAS model.

All Elevations in NAVD 1929

**Project:** Salt River Levee ID #33
**Location:** Maricopa County, Arizona

**Table C-7: Scour Calculations Summary - South Levee**

Calc'd by: RLS Date: 5/22/2011 Checked: JTA Date: 6/3/2011

| [1]Levee Station (South) | [1]HEC-RAS Cross Section | [2]Long Term Scour | [3]General Scour | [4]Bedform Scour | [5]Low Flow Incisement | Local Scour Depth | Total Scour Depth | [6]Applied Invert | Calculated Scour Elevation | Design Toe of Soil Cement | Calculated Safety Factor | [7]Adequate Toe-down? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | | |
| 155+20 | 219.04 | 0.0 | 2.59 | 1.49 | 0.0 | 0.0 | 4.1 | 1106.6 | 1102.5 | 1092.2 | 3.5 | Yes |
| 162+20 | 219.15 | 0.0 | 2.59 | 1.43 | 0.0 | 0.0 | 4.0 | 1109.5 | 1105.5 | 1103.9 | 1.4 | Yes |
| 167+45 | 219.24 | 0.0 | 2.59 | 1.42 | 0.0 | 0.0 | 4.0 | 1110.3 | 1106.3 | 1104.4 | 1.5 | Yes |
| 172+04 | 219.33 | 0.0 | 2.59 | 1.41 | 0.0 | 2.0 | 6.0 | 1111.7 | 1105.7 | 1104.9 | 1.1 | Yes |
| 176+79 | 219.42 | 0.0 | 2.59 | 1.43 | 0.0 | 0.0 | 4.0 | 1113.1 | 1109.1 | 1105.4 | 1.9 | Yes |
| 181+68 | 219.52 | 0.0 | 2.59 | 1.44 | 0.0 | 0.0 | 4.0 | 1113.9 | 1109.8 | 1105.7 | 2.0 | Yes |
| 186+82 | 219.61 | 0.0 | 2.59 | 1.44 | 0.0 | 0.0 | 4.0 | 1115.2 | 1111.2 | 1106.2 | 2.3 | Yes |
| 191+88 | 219.7 | 0.0 | 2.59 | 1.46 | 0.0 | 0.0 | 4.0 | 1116.5 | 1112.4 | 1106.8 | 2.4 | Yes |
| 196+91 | 219.79 | 0.0 | 2.59 | 1.42 | 0.0 | 0.0 | 4.0 | 1118.1 | 1114.0 | 1107.8 | 2.5 | Yes |
| 201+93 | 219.89 | 0.0 | 2.59 | 1.45 | 0.0 | 0.0 | 4.0 | 1118.4 | 1114.4 | 1107.6 | 2.7 | Yes |
| 210+87 | 220.05 | 0.0 | 2.59 | 1.53 | 0.0 | 0.0 | 4.1 | 1121.1 | 1117.0 | 1111.7 | 2.3 | Yes |
| 211+47 | 220.06 | 0.0 | 2.59 | 1.54 | 0.0 | 0.0 | 4.1 | 1121.1 | 1117.0 | 1113.9 | 1.8 | Yes |
| 211+51 | 220.063 | 0.0 | 2.59 | 1.54 | 0.0 | 0.0 | 4.1 | 1121.1 | 1117.0 | 1114.0 | 1.7 | Yes |
| 212+09 | 220.07 | 0.0 | 2.59 | 1.56 | 0.0 | 0.0 | 4.2 | 1121.0 | 1116.8 | 1115.8 | 1.2 | Yes |
| 216+95 | 220.17 | 0.0 | 2.59 | 1.57 | 0.0 | 0.0 | 4.2 | 1121.5 | 1117.3 | 1123.5 | NA | BR |
| 221+97 | 220.26 | 0.0 | 2.59 | 1.57 | 0.0 | 0.0 | 4.2 | 1122.2 | 1118.0 | 1120.6 | NA | BR |

Notes:
(1) - Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
(2) - Schoklitsch equilibrium slope applied - reach at equilibrium
(3) - Live bed conditions assumed - Lacey Equation applied for general scour (USBR, "Computing Degradation and Local Scour", 1984)
(4) - Bedform scour calculated per Flood Control District of Maricopa County Method (FCDMC, "Hydraulics Design Manual").
(5) - Low flow Incisement set to 0.
(6) - Applied invert from HEC-RAS model.
(7) - BR = Toe-down founded on bedrock.
All Elevations in NAVD 1929

**Project:** Salt River Levee ID #33
**Location:** Maricopa County, Arizona

**Table C-8: General Scour Calculations - North Levee**

Calc'd by: RLS Checked: JTA
Date: 5/25/2011 Date: 5/25/2011

| [1]Levee Station | [1]HEC-2 Cross Section | [2]Q cfs | [3]D50 mm | Z Factor | General Scour Depth (ft) | Comments |
|---|---|---|---|---|---|---|
| 158+86 | 219.04 | 169000 | 80.000 | 0.5 | 5.18 | |
| 162+33 | 219.15 | 169000 | 80.000 | 0.5 | 5.18 | |
| 167+29 | 219.24 | 169000 | 80.000 | 0.5 | 5.18 | |
| 172+31 | 219.33 | 169000 | 80.000 | 0.5 | 5.18 | |
| 177+25 | 219.42 | 169000 | 80.000 | 0.5 | 5.18 | |
| 182+54 | 219.52 | 169000 | 80.000 | 0.5 | 5.18 | |
| 187+40 | 219.61 | 169000 | 80.000 | 0.5 | 5.18 | |
| 192+26 | 219.7 | 169000 | 80.000 | 0.5 | 5.18 | |

Notes:
(1) - Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
(2) - $Q_{100}$ per SRHMP
(3) - $D_{50}$ per SRHMP

**Project:** Salt River Levee ID #33
**Location:** Maricopa County, Arizona

**Table C-9: General Scour Calculations - South Levee**

Calc'd by: RLS Checked: JTA
Date: 5/22/2011 Date: 6/3/2011

| [1]Levee Station | [1]HEC-2 Cross Section | [2]Q | [3]D50 | Z Factor | General Scour Depth | Comments |
|---|---|---|---|---|---|---|
| | | cfs | mm | | (ft) | |
| 158+86 | 219.04 | 169000 | 80.000 | 0.25 | 2.59 | |
| 162+33 | 219.15 | 169000 | 80.000 | 0.25 | 2.59 | |
| 167+29 | 219.24 | 169000 | 80.000 | 0.25 | 2.59 | |
| 172+31 | 219.33 | 169000 | 80.000 | 0.25 | 2.59 | |
| 177+25 | 219.42 | 169000 | 80.000 | 0.25 | 2.59 | |
| 182+54 | 219.52 | 169000 | 80.000 | 0.25 | 2.59 | |
| 187+40 | 219.61 | 169000 | 80.000 | 0.25 | 2.59 | |
| 192+26 | 219.7 | 169000 | 80.000 | 0.25 | 2.59 | |
| 197+36 | 219.79 | 169000 | 80.000 | 0.25 | 2.59 | |
| 202+16 | 219.89 | 169000 | 80.000 | 0.25 | 2.59 | |
| 209+80 | 220.05 | 169000 | 80.000 | 0.25 | 2.59 | |
| 210+42 | 220.06 | 169000 | 80.000 | 0.25 | 2.59 | |
| 210+67 | 220.063 | 169000 | 80.000 | 0.25 | 2.59 | |
| 211+38 | 220.07 | 169000 | 80.000 | 0.25 | 2.59 | |
| 216+57 | 220.17 | 169000 | 80.000 | 0.25 | 2.59 | |
| 221+55 | 220.26 | 169000 | 80.000 | 0.25 | 2.59 | |

Notes:
(1) - Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
(2) - $Q_{100}$ per SRHMP
(3) - $D_{50}$ per SRHMP

**Project:** **Salt River Levee ID #33**
**Location:** **Maricopa County, Arizona**

**Table C-10: Bedform Scour Calculations - North and South Levees**

Calc'd by: RLS Checked: JTA
Date: 522/2011 Date: 6/3/2011

| Levee Station | HEC-RAS Cross Section | Hydraulic Depth (ft) | Froude No. | Channel Velocity ft/s | Controlling: | Dune Height (ft) | Anti-Dune Height (ft) | Scour Component (ft) | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 158+86 | 219.04 | 14.93 | 0.49 | 10.7 | Dune | 2.99 | 3.09 | 1.49 | |
| 162+33 | 219.15 | 14.28 | 0.54 | 11.62 | Dune | 2.86 | 3.65 | 1.43 | |
| 167+29 | 219.24 | 14.16 | 0.54 | 11.6 | Dune | 2.83 | 3.63 | 1.42 | |
| 172+31 | 219.33 | 14.12 | 0.55 | 11.67 | Dune | 2.82 | 3.68 | 1.41 | |
| 177+25 | 219.42 | 14.26 | 0.55 | 11.75 | Dune | 2.85 | 3.73 | 1.43 | |
| 182+54 | 219.52 | 14.41 | 0.54 | 11.71 | Dune | 2.88 | 3.70 | 1.44 | |
| 187+40 | 219.61 | 14.38 | 0.55 | 11.91 | Dune | 2.88 | 3.83 | 1.44 | |
| 192+26 | 219.7 | 14.55 | 0.56 | 12.07 | Dune | 2.91 | 3.93 | 1.46 | |
| 197+36 | 219.79 | 14.23 | 0.59 | 12.56 | Dune | 2.85 | 4.26 | 1.42 | |
| 202+16 | 219.89 | 14.47 | 0.58 | 12.6 | Dune | 2.89 | 4.29 | 1.45 | |
| 209+80 | 220.05 | 15.25 | 0.55 | 12.2 | Dune | 3.05 | 4.02 | 1.53 | |
| 210+42 | 220.06 | 15.44 | 0.54 | 12.03 | Dune | 3.09 | 3.91 | 1.54 | |
| 210+67 | 220.063 | 15.4 | 0.54 | 12.07 | Dune | 3.08 | 3.93 | 1.54 | |
| 211+38 | 220.07 | 15.59 | 0.53 | 11.93 | Dune | 3.12 | 3.84 | 1.56 | |
| 216+57 | 220.17 | 15.67 | 0.53 | 11.96 | Dune | 3.13 | 3.86 | 1.57 | |
| 221+55 | 220.26 | 15.7 | 0.52 | 11.75 | Dune | 3.14 | 3.73 | 1.57 | |

Note:
From Equations 10.13 and 10.14 in Draft Flood Control District of Maricopa County Drainage Design Manual Hydraulics
- Yh is channel hydraulic depth from HEC-RAS model.

**Project: Salt River Levee ID #33**
**Location: Maricopa County, Arizona**

**Table C-11: Equilibrium Slope Difference - North and South Levees**

Calc'd by: RLS Checked: JTA
Date: 5/22/2011 Date: 6/3/2011

| [1]Levee Station | [1]HEC-RAS Cross Section | Cumulative Distance from GCS | [2]Applied Average Equilibrium Slope | Elevation from Equilibrium Slope | Existing Low Flow Channel Elevation | Existing Low Flow Channel below Elevation from Equilibrium Slope | [3]Long Term Sour Component Applied to Channel |
|---|---|---|---|---|---|---|---|
| | | (ft) | ft/ft | (ft) | (ft) | (Yes/No) | (ft) |
| 158+86 | 219.04 | 1110.00 | 0.0022 | 1109.92 | 1106.59 | Yes | 0.00 |
| 162+33 | 219.15 | 1810.00 | 0.0022 | 1111.44 | 1109.49 | Yes | 0.00 |
| 167+29 | 219.24 | 2335.00 | 0.0022 | 1112.59 | 1110.33 | Yes | 0.00 |
| 172+31 | 219.33 | 2794.00 | 0.0022 | 1113.59 | 1111.69 | Yes | 0.00 |
| 177+25 | 219.42 | 3269.00 | 0.0022 | 1114.62 | 1112.78 | Yes | 0.00 |
| 182+54 | 219.52 | 3758.00 | 0.0022 | 1115.68 | 1113.36 | Yes | 0.00 |
| 187+40 | 219.61 | 4272.00 | 0.0022 | 1116.80 | 1114.26 | Yes | 0.00 |
| 192+26 | 219.7 | 4778.00 | 0.0022 | 1117.91 | 1115.35 | Yes | 0.00 |
| 197+36 | 219.79 | 5281.00 | 0.0022 | 1119.00 | 1117.50 | Yes | 0.00 |
| 202+16 | 219.89 | 5783.00 | 0.0022 | 1120.10 | 1118.42 | Yes | 0.00 |
| 209+80 | 220.05 | 6677.00 | 0.0022 | 1122.04 | 1121.14 | Yes | 0.00 |
| 210+42 | 220.06 | 6737.00 | 0.0022 | 1122.17 | 1121.11 | Yes | 0.00 |
| 210+67 | 220.063 | 6741.00 | 0.0022 | 1122.18 | 1121.11 | Yes | 0.00 |
| 211+38 | 220.07 | 6799.00 | 0.0022 | 1122.31 | 1120.97 | Yes | 0.00 |
| 216+57 | 220.17 | 7285.00 | 0.0022 | 1123.37 | 1121.50 | Yes | 0.00 |
| 221+55 | 220.26 | 7787.00 | 0.0022 | 1124.46 | 1122.15 | Yes | 0.00 |

(1) - Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
(2) - Schoklitsch equilibrium = 0.0022 ft/ft
(3) - Scour Component added to total scour if applied invert (North/South) above calculated elevation from equilibrium slope
(4) - Elevation at top of Grade Control Structure = 1107.5 (NGVD29)
GCS - Grade Control Structure

## Table C-12: Local Scour Calculations - Priest Road Bridge

### LOCAL-SCOUR DEPTH FOR BRIDGE PIERS AND SIMILAR OBSTRUCTIONS

(scour depth using CSU's equation, $Y_s = Y_1 (2.0\ K_1\ K_2\ K_3\ K_4\ (a/Y_1)^{0.65}\ Fr^{0.43})$, HEC-18, 2001, Eq. 6.1,Pg 6.2]

| | |
|---|---|
| Y1, upstream flow depth = | 15.59 ft. |
| Fr, froude no. = | 0.53 |
| a, width of obstruction = | 4.50 ft. |
| K1, pier shape coefficient or correction factor (Table 6.1) = | 1.00 |
| K2, correction factor for angle of attack (Eq. 6.4 or Table 6.2) = | 2.35 |
| K3, correction factor for bed condition (Table 6.3) = | 1.10 |
| K4, correction factor for armoring (Eq. 6.5) = | 0.51 |
| composite coefficient (2.0*K1*K2*K3*K4) = | 2.64 |
| Ys, local-scour depth = | 13.98 ft. |

Table 6.1

| Pier Nose Shape | Coefficient (K1) |
|---|---|
| square nose | 1.1 |
| round nose | 1.0 |
| cylinder | 1.0 |
| sharp nose | 0.9 |
| group of cylinders | 1.0 |

Table 6.2

| Angle of Attack (degrees) | Pier Length/Width Ratio (K2) | | |
|---|---|---|---|
| | L/a = 4 | L/a = 8 | L/a = 12 |
| 0 | 1.0 | 1.0 | 1.0 |
| 15 | 1.5 | 2.0 | 2.5 |
| 30 | 2.0 | 2.75 | 3.5 |
| 45 | 2.3 | 3.3 | 4.3 |
| 90 | 2.5 | 3.9 | 5.0 |

Equation 6.4 angle = 15.0 degrees
L = 48.0 ft
K2 = 2.35

Comments

a) If the obstruction width includes debris accumulation, use a pier shape coefficient (K1) of 1.1; otherwise use the appropriate coefficient listed above.

b) As a rule-of-thumb, the maximum scour depth for round nose piers aligned with the flow is:

| | | |
|---|---|---|
| Ys ≤ 2.4 times the pier width (a) for Fr ≤ 0.8 | 2.4 * a = | 10.80 ft. |
| Ys ≤ 3.0 times the pier width (a) for Fr ≥ 0.8 | 3.0 * a = | 13.50 ft. |

c) CSU's equation, as outlined above, was obtained from HEC-18. It is the same procedure used by ADWR and the City of Tucson. However, the ADWR and COT procedures are approached in a slightly different manner. A composite coefficient of 2.2 is the default condition. It is based on K1 and K2 only, with K1 = 1.1 and K2 = 2. Reduction factors are then applied to adjust for different pier nose shapes. The reduction factor is as follows:

| Pier Nose Shape | Reduction Factor |
|---|---|
| square nose | 1.0 |
| round nose | 0.9 |
| cylinder | 0.9 |
| sharp nose | 0.8 |
| group of cylinders | 0.9 |

d) K3 - correction factor to account for variations in bed form and sediment transport.

Table 6.3

| Bed Condition | Dune Height, H (ft) | Coefficient (K3) |
|---|---|---|
| clear-water scour | n/a | 1.1 |
| plane bed and antidune flow | n/a | 1.1 |
| small dunes | $10 > H \geq 2$ | 1.1 |
| medium dunes | $30 > H \geq 10$ | 1.2 to 1.1 |
| large dunes | $H \geq 30$ | 1.3 |

e) K4 - correction factor for armoring  K4<1 applicable ?  Yes

Eq. 6.5  K4 = 0.51

| particle diameter (mm) | | | |
|---|---|---|---|
| | | Vr = | 5.02 |
| | | V1 = | 11.93 |
| D50 = | 80 | Vicd50 = | 6.27 |
| D95 = | 280 | Vcd50 = | 11.30 |
| | | Vicd95 = | 10.18 |
| Note: Vc and Vic per Laursen's | | Vcd95 = | 17.16 |

Limits for Bed Material Size and K4 values

| Factor | Mininum Size | Min. K4 value | Particle Size (ft) |
|---|---|---|---|
| K4 | D50 ≥ 0.006 ft | 0.4 | 0.262 |
| | D95 ≥ 0.06 ft | | 0.92 |

Note: The local scour depth at the bridge piers was determined to be 13.98 feet. Assuming the toe of the local scour hole is one width of the obstruction (4.5 feet) from the pier and projecting upwards at a 3:1 angle of repose for the side slope of the scour hole, the width of the local scour hole at the bed will be appproximately 46.4 feet. If the distance between the pier and the toe of the bank is less than 46.4 feet, a portion of the computed local scour depth at the pier must be included as a component in the total scour depth at the toe of the bank protection.

The distance between the toe of the south bank and the first pier set is approximately 62.9 feet and the distance between the north bank and the first pier set is approximately 66.21 feet. Therefore, local scour is not a factor relative to the toe protection for either the south bank or the north bank.

## Table C-13: Local Scour Calculations - SR 143 Bridge

### LOCAL-SCOUR DEPTH FOR BRIDGE PIERS AND SIMILAR OBSTRUCTIONS

(scour depth using CSU's equation, $Y_s = Y_1 (2.0\ K_1\ K_2\ K_3\ K_4\ (a/Y_1)^{0.65}\ Fr^{0.43})$, HEC-18, 2001, Eq. 6.1,Pg 6.2]

| | |
|---|---|
| Y1, upstream flow depth = | 14.93 ft. |
| Fr, froude no. = | 0.49 |
| a, width of obstruction = | 6.00 ft. |
| K1, pier shape coefficient or correction factor (Table 6.1) = | 1.00 |
| K2, correction factor for angle of attack (Eq. 6.4 or Table 6.2) = | 2.49 |
| K3, correction factor for bed condition (Table 6.3) = | 1.10 |
| K4, correction factor for armoring (Eq. 6.5) = | 0.48 |
| composite coefficient (2.0*K1*K2*K3*K4) = | 2.63 |
| Ys, local-scour depth = | 15.94 ft. |

Table 6.1

| Pier Nose Shape | Coefficient (K1) |
|---|---|
| square nose | 1.1 |
| round nose | 1.0 |
| cylinder | 1.0 |
| sharp nose | 0.9 |
| group of cylinders | 1.0 |

Table 6.2

| Angle of Attack (degrees) | Pier Length/Width Ratio (K2) | | |
|---|---|---|---|
| | L/a = 4 | L/a = 8 | L/a = 12 |
| 0 | 1.0 | 1.0 | 1.0 |
| 15 | 1.5 | 2.0 | 2.5 |
| 30 | 2.0 | 2.75 | 3.5 |
| 45 | 2.3 | 3.3 | 4.3 |
| 90 | 2.5 | 3.9 | 5.0 |

Equation 6.4 angle = 15.0 degrees
L = 72.0 ft
K2 = 2.49

Comments

a) If the obstruction width includes debris accumulation, use a pier shape coefficient (K1) of 1.1; otherwise use the appropriate coefficient listed above.

b) As a rule-of-thumb, the maximum scour depth for round nose piers aligned with the flow is:

| | | |
|---|---|---|
| Ys ≤ 2.4 times the pier width (a) for Fr ≤ 0.8 | 2.4 * a = | 14.40 ft. |
| Ys ≤ 3.0 times the pier width (a) for Fr ≥ 0.8 | 3.0 * a = | 18.00 ft. |

c) CSU's equation, as outlined above, was obtained from HEC-18. It is the same procedure used by ADWR and the City of Tucson. However, the ADWR and COT procedures are approached in a slightly different manner. A composite coefficient of 2.2 is the default condition. It is based on K1 and K2 only, with K1 = 1.1 and K2 = 2. Reduction factors are then applied to adjust for different pier nose shapes. The reduction factor is as follows:

| Pier Nose Shape | Reduction Factor |
|---|---|
| square nose | 1.0 |
| round nose | 0.9 |
| cylinder | 0.9 |
| sharp nose | 0.8 |
| group of cylinders | 0.9 |

d) K3 - correction factor to account for variations in bed form and sediment transport.

Table 6.3

| Bed Condition | Dune Height, H (ft) | Coefficient (K3) |
|---|---|---|
| clear-water scour | n/a | 1.1 |
| plane bed and antidune flow | n/a | 1.1 |
| small dunes | 10 > H ≥ 2 | 1.1 |
| medium dunes | 30 > H ≥ 10 | 1.2 to 1.1 |
| large dunes | H ≥ 30 | 1.3 |

e) K4 - correction factor for armoring  K4<1 applicable ?  Yes

Eq. 6.5  K4 = 0.48

| particle diameter (mm) | | | |
|---|---|---|---|
| | | Vr = | 3.59 |
| | | V1 = | 10.70 |
| D50 = | 80 | Vicd50 = | 6.13 |
| D95 = | 280 | Vcd50 = | 11.22 |
| | | Vicd95 = | 9.95 |
| Note: Vc and Vic per Laursen's | | Vcd95 = | 17.04 |

Limits for Bed Material Size and K4 values

| Factor | Mininum Size | Min. K4 value | Particle Size (ft) |
|---|---|---|---|
| K4 | D50 ≥ 0.006 ft | 0.4 | 0.262 |
| | D95 ≥ 0.06 ft | | 0.92 |

Note: The local scour depth at the bridge piers was determined to be 15.94 feet. Assuming the toe of the local scour hole is one width of the obstruction (6.0 feet) from the pier and projecting upwards at a 3:1 angle of repose for the side slope of the scour hole, the width of the local scour hole at the bed will be appproximately 53.8 feet. If the distance between the pier and the toe of the bank is less than 53.8 feet, a portion of the computed local scour depth at the pier must be included as a component in the total scour depth at the toe of the bank protection.

The distance between the toe of the south bank and the first pier set is approximately 55.4 feet. Therefore, local scour is not a factor relative to the toe protection for the south bank. However, it is a factor for the toe protection for the north bank, since the distance is limited to approximately 42.5 feet. Consequently, an additional 3.93 feet must be added to the scour depth associated with the north bank to account for local scour at the adjacent pier.

# D. Interior Drainage

# Appendix D

## Levee Certification Report
## Salt River Levee System ID#33
## Maricopa County, Arizona

## Interior Drainage

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# 1. Interior Drainage

## 1.1 Overview

This appendix discusses the interior drainage and summarizes the drainage structures within the project. The limits of the Salt River Levee System ID#33 which are truly in levee condition (explained in a separate appendix) are shown on **Plate 1** (in **Appendix B**) and summarized as follows:

- The north levee extends from centerline station 160+00 to 193+00 (as superimposed on the north levee). This includes RM 219.15 to 219.70.
- The south levee extends from centerline station 156+20 to 220+00 (as superimposed on the south levee). This includes RM 219.15 to 220.26.

## 1.2 Workmaps

- Plate 1 (in Appendix B) is the project workmap with interior drainage areas shown in detail.
- Plate 2 (in **Appendix B**) shows the levee as-built information including locations of several of the structures (openings and closures).

## 1.3 Referenced As-Built Plans, Topography, and Survey

The discussion in this appendix references the following as-built plans, reports, and survey:

- "Salt River Channelization, Hohokam (University-Sky Harbor)", State of Arizona Department of Transportation Highways Division, RAM-600-3-511, as-built 1/25/1993. **Plate 1** (in **Appendix B**) shows centerline stationing interpolated from this as-built set. Stations for the various structures reference this centerline. Also, this set of as-built plans document the levee as it was originally constructed with portions annotated on **Plate 2** (in **Appendix B**).
- "Salt River Hydraulic Master Plan", Stantec Consulting, 2009. This study shows the most recent topographic information and also shows several of the structures. Topography from this study and shown on Plate 1 is NGVD29.
- "Preliminary Grading, Drainage, and Utility Plans for East Valley Maintenance Yard", 2005. This set of plans shows a storm drain which was constructed after the levee (RM 219.20, as-built Sta. 165+00).
- "Survey Report – Salt River Levee Survey", Wilson & Company, May 2011. This report was prepared for FCDMC for this project. The survey identified the openings and closures in this project and also provided cross sectional survey of the levee.

## 1.4 Methodology

The levees in question are not ring levees, but there are limited areas located on the landside of each levee that could be considered interior drainage. These areas are represented on **Figure D-1** and **Plate 1** (in **Appendix B**) and discussed below. Peak discharge and runoff volume for the 100-year event (6 hour duration) were determined using the rational equation per Maricopa

County methodology. All of the interior drainage areas are impoundments with no positive drainage. Therefore the ponded water surface elevation was estimated with a stage-storage table for each sub-basin. This water surface is represented on **Plate 1** (in **Appendix B**). **Table D-1** summarizes the peak discharge and runoff volume along with the maximum 100-year ponded water surface elevation. Average depth is also listed and is a function of ponded volume and maximum wetted area.

## 1.5 Northern Drainage Areas

There are two interior drainage areas along the north levee: N100 and N200. Both drain to isolated low points near the toe along the backside of the levee. These sub-basins are located along either side of a tributary which pierces the levee.

## 1.6 Southern Drainage Areas

There are eight sub-basins along the south levee between SR143 and Priest Drive. Most of these are retention-like areas with ponding occurring over a relatively large and flat area. All of these are contained to the south by higher natural grade and/or Rio Salado Parkway. In general the sub-basins are divided by small ridgelines. All of the area represented by these sub-basins has been highly disturbed and is irregular.

Sub-basins S100 and S200 are located along the east side of SR143. Sub-basin S100 drains to a low point along the levee while sub-basin S200 drains away from the levee. S200 was modeled to determine if it had any contribution to S100, which it does not.

Sub-basin S300 is a retention area with flow ponding along a broad area at the bottom.

S500 extends to the east up a manmade hill for a radio tower and drains to a local low point which, when it overtops, will spill into S400. The combined runoff of the two areas spreads over a relatively large area within S400.

Sub-basin S600 is another retention-like area which drains to a low point along the levee.

S700 and S800 are separated by a ridgeline that is overtopped by S800 runoff which spills into S700.

There is one sub-basin along the south levee to the east of Priest Drive: sub-basin S900. This area bounded on the west by Priest Drive, along the east by a small ridgeline, and the south by a road and elevated commercial area. This sub-basin drains to a low point along the levee.

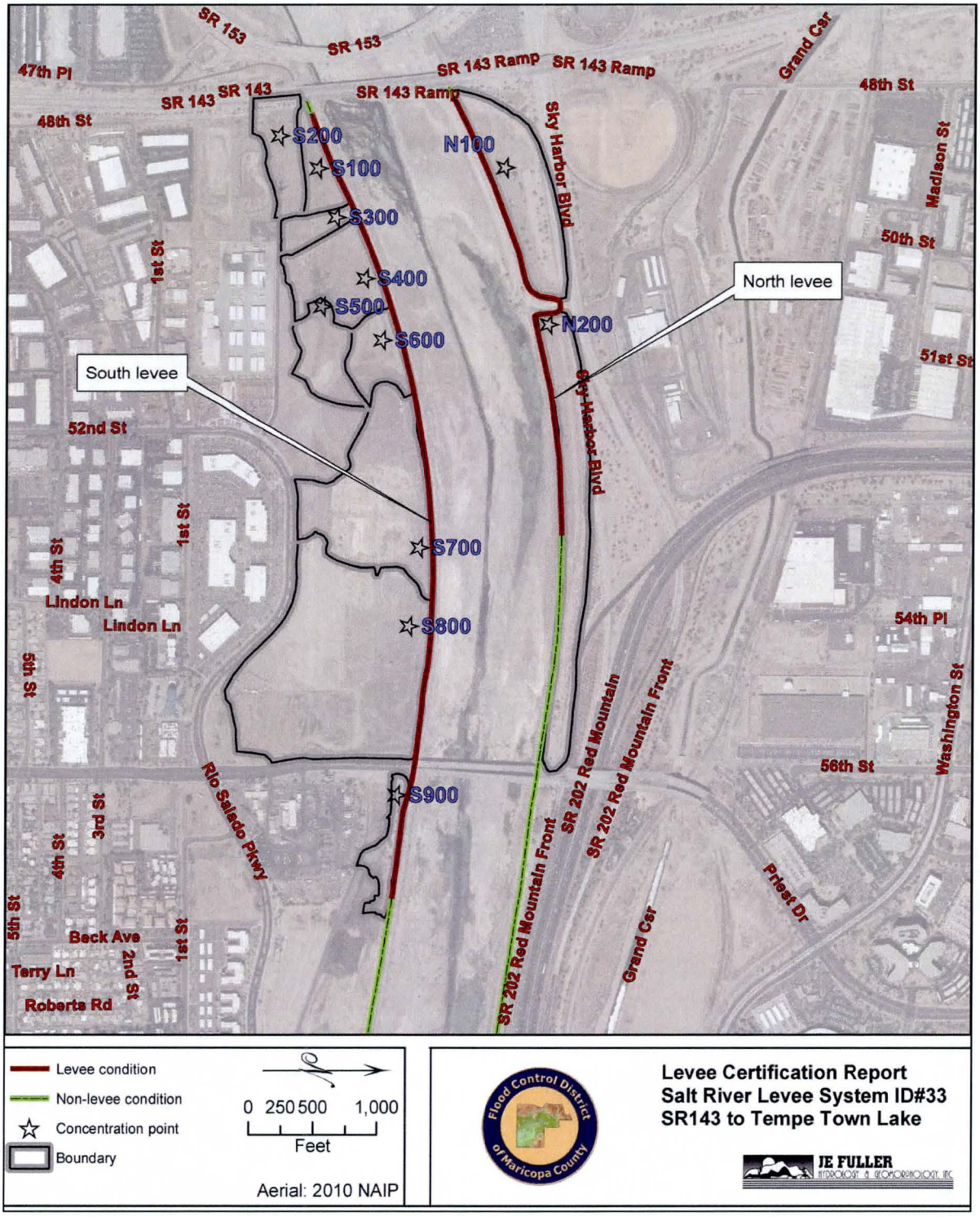



**Figure D-1. Interior Drainage**

**Table D-1 - Interior Drainage Areas**

| Sub-basin | Area | Q-100 | Runoff Volume | Invert | Ponded WS | Maximum Depth | Average Depth |
|---|---|---|---|---|---|---|---|
| | (acres) | (cfs) | (ac-ft) | (ft) | (ft) | (ft) | (ft) |
| N100 | 14.21 | 67 | 2.47 | 1122.8 | 1125.1 | 2.3 | 1.0 |
| N200 | 17.28 | 68 | 3.00 | 1122.4 | 1131.4 | 9.0 | 3.5 |
| S100 | 3.93 | 18 | 0.68 | 1118.3 | 1122.2 | 3.9 | 1.6 |
| S200 | 6.18 | 29 | 1.07 | 1117.1 | 1122.1 | 5.0 | 1.0 |
| S300 | 2.75 | 13 | 0.48 | 1120.4 | 1121.4 | 1.0 | 0.5 |
| S400 | 9.74 | 46 | 1.69 | 1120.1 | 1121.3 | 1.2 | 0.5 |
| S500 | 6.50 | 31 | 1.13 | 1117.8 | 1121.3 | 3.5 | 0.5 |
| S400&500 | 16.24 | 76 | 2.82 | n/a | n/a | n/a | 0.5 |
| S600 | 5.67 | 27 | 0.98 | 1118.0 | 1120.5 | 2.5 | 1.2 |
| S700 | 23.08 | 108 | 4.01 | 1128.0 | 1130.3 | 2.3 | 0.8 |
| S800 | 45.42 | 208 | 7.88 | 1129.0 | 1130.5 | 1.5 | 0.8 |
| S700&800 | 68.51 | 285 | 11.89 | n/a | n/a | n/a | 0.8 |
| S900 | 3.69 | 17 | 0.64 | 1134.2 | 1137.4 | 3.2 | 1.6 |

# D. Data for Interior Drainage

## D.1 Hydrology Calculations

FCDMC Procedure computation sheets

Basin volume computation sheets

# D.1 Hydrology Calculations

**Project:** Salt River Levee **Return Period:** 100-yr

**Summary Table**

| Sub-basin | Area | Flowpath length | Flowpath slope | Time of Conc. | C | i | Q-100 | Runoff Volume | Unit runoff |
|---|---|---|---|---|---|---|---|---|---|
| | (acres) | (miles) | (ft/mile) | (hours) | | (in/hr) | (cfs) | (ac-ft) | (cfs/ac) |
| N100 | 14.21 | 0.223 | 67 | 0.13 | 0.85 | 5.52 | 67 | 2.47 | 27 |
| N200 | 17.28 | 0.674 | 68 | 0.24 | 0.85 | 4.60 | 68 | 3.00 | 23 |
| S100 | 3.93 | 0.113 | 230 | 0.07 | 0.85 | 5.52 | 18 | 0.68 | 27 |
| S200 | 6.18 | 0.132 | 121 | 0.09 | 0.85 | 5.52 | 29 | 1.07 | 27 |
| S300 | 2.75 | 0.100 | 110 | 0.08 | 0.85 | 5.52 | 13 | 0.48 | 27 |
| S400 | 9.74 | 0.132 | 91 | 0.09 | 0.85 | 5.52 | 46 | 1.69 | 27 |
| S500 | 6.50 | 0.203 | 315 | 0.08 | 0.85 | 5.52 | 31 | 1.13 | 27 |
| S400&500 | 16.24 | 0.203 | 315 | 0.08 | 0.85 | 5.52 | 76 | 2.82 | 27 |
| S600 | 5.67 | 0.121 | 521 | 0.05 | 0.85 | 5.52 | 27 | 0.98 | 27 |
| S700 | 23.08 | 0.269 | 193 | 0.10 | 0.85 | 5.52 | 108 | 4.01 | 27 |
| S800 | 45.42 | 0.333 | 42 | 0.17 | 0.85 | 5.40 | 208 | 7.88 | 26 |
| S700&800 | 68.51 | 0.453 | 38 | 0.21 | 0.85 | 4.90 | 285 | 11.89 | 24 |
| S900 | 3.69 | 0.195 | 133 | 0.10 | 0.85 | 5.52 | 17 | 0.64 | 27 |

| Sub-basin | Invert | Ponded WS | Depth |
|---|---|---|---|
| | (ft) | (ft) | (ft) |
| N100 | 1122.8 | 1125.1 | 2.3 |
| N200 | 1122.4 | 1131.4 | 9.0 |
| S100 | 1118.3 | 1122.2 | 3.9 |
| S200 | 1117.1 | 1122.1 | 5.0 |
| S300 | 1120.4 | 1121.4 | 1.0 |
| S400 | 1120.1 | 1121.3 | 1.2 |
| S500 | 1117.8 | 1121.3 | 3.5 |
| S600 | 1118.0 | 1120.5 | 2.5 |
| S700 | 1128.0 | 1130.3 | 2.3 |
| S800 | 1129.0 | 1130.5 | 1.5 |
| S900 | 1134.2 | 1137.4 | 3.2 |

**Arizona 33.434 N 111.966 W 1184 feet**

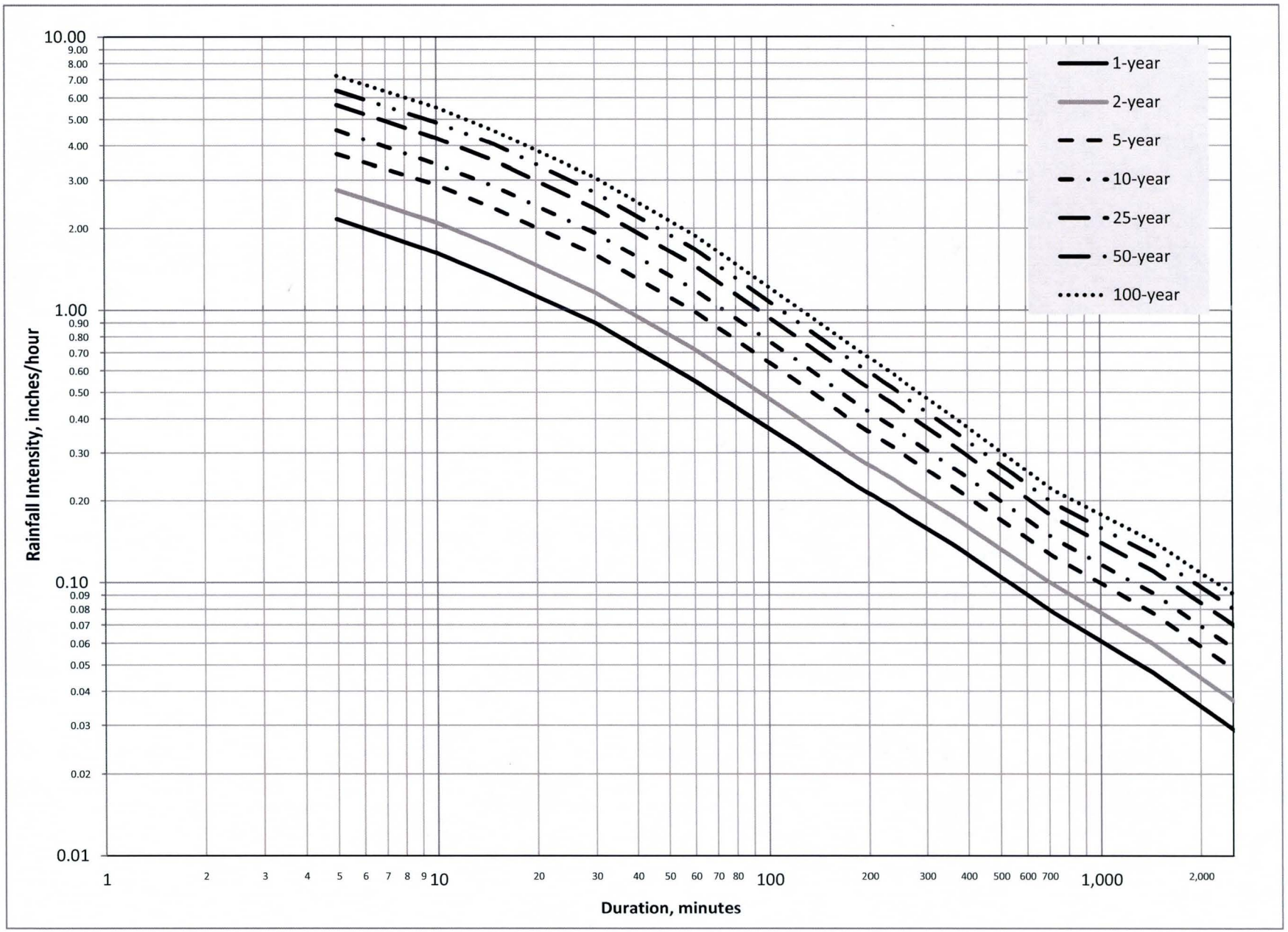
**Precipitation Frequency Estimates (inches)**

| ARI* (years) | 5 min | 10 min | 15 min | 30 min | 60 min | 120 min | 3 hr | 6 hr | 12 hr | 24 hr | 48 hr | 4 day | 7 day | 10 day | 20 day | 30 day | 45 day | 60 day |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.18 | 0.27 | 0.33 | 0.45 | 0.55 | 0.64 | 0.69 | 0.83 | 0.93 | 1.12 | 1.23 | 1.36 | 1.5 | 1.63 | 2 | 2.33 | 2.71 | 3.01 |
| **2** | 0.23 | 0.35 | 0.43 | 0.58 | 0.72 | 0.82 | 0.88 | 1.05 | 1.18 | 1.43 | 1.57 | 1.74 | 1.91 | 2.08 | 2.57 | 3 | 3.49 | 3.88 |
| **5** | 0.31 | 0.48 | 0.59 | 0.8 | 0.99 | 1.11 | 1.17 | 1.35 | 1.5 | 1.85 | 2.06 | 2.29 | 2.52 | 2.75 | 3.39 | 3.95 | 4.6 | 5.1 |
| **10** | 0.38 | 0.57 | 0.71 | 0.96 | 1.19 | 1.33 | 1.39 | 1.59 | 1.75 | 2.19 | 2.46 | 2.73 | 3.01 | 3.28 | 4.01 | 4.67 | 5.41 | 5.99 |
| **25** | 0.47 | 0.71 | 0.88 | 1.18 | 1.46 | 1.62 | 1.7 | 1.92 | 2.09 | 2.65 | 3 | 3.37 | 3.71 | 4.02 | 4.84 | 5.64 | 6.48 | 7.14 |
| **50** | 0.53 | 0.81 | 1.01 | 1.35 | 1.68 | 1.85 | 1.95 | 2.18 | 2.35 | 3.02 | 3.44 | 3.88 | 4.26 | 4.62 | 5.48 | 6.38 | 7.29 | 7.99 |
| **100** | 0.6 | 0.92 | 1.13 | 1.53 | 1.89 | 2.09 | 2.21 | 2.45 | 2.62 | 3.4 | 3.9 | 4.42 | 4.86 | 5.25 | 6.13 | 7.14 | 8.1 | 8.84 |
| **200** | 0.67 | 1.02 | 1.27 | 1.71 | 2.11 | 2.33 | 2.49 | 2.73 | 2.89 | 3.79 | 4.38 | 5 | 5.49 | 5.92 | 6.79 | 7.91 | 8.91 | 9.67 |
| **500** | 0.77 | 1.17 | 1.45 | 1.95 | 2.41 | 2.65 | 2.87 | 3.11 | 3.26 | 4.34 | 5.05 | 5.81 | 6.38 | 6.84 | 7.67 | 8.95 | 9.97 | 10.76 |
| **1000** | 0.84 | 1.28 | 1.58 | 2.13 | 2.64 | 2.9 | 3.17 | 3.41 | 3.54 | 4.77 | 5.59 | 6.47 | 7.09 | 7.59 | 8.36 | 9.74 | 10.77 | 11.56 |
| Minutes | 5 | 10 | 15 | 30 | 60 | 120 | 180 | 360 | 720 | 1,440 | 2,880 | 5,760 | 10,080 | 14,400 | 28,800 | 43,200 | 64,800 | 86,400 |
| Hours | 0.083 | 0.167 | 0.25 | 0.5 | 1 | 2 | 3 | 6 | 12 | 24 | 48 | 96 | 168 | 240 | 480 | 720 | 1080 | 1440 |

**Precipitation Intensity (inches/hour)**

| ARI* (years) | 5 min | 10 min | 15 min | 30 min | 60 min | 120 min | 3 hr | 6 hr | 12 hr | 24 hr | 48 hr | 4 day | 7 day | 10 day | 20 day | 30 day | 45 day | 60 day |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 2.16 | 1.62 | 1.32 | 0.90 | 0.55 | 0.32 | 0.23 | 0.14 | 0.078 | 0.047 | 0.026 | 0.014 | 0.009 | 0.0068 | 0.0042 | 0.0032 | 0.0025 | 0.0021 |
| **2** | 2.76 | 2.10 | 1.72 | 1.16 | 0.72 | 0.41 | 0.29 | 0.18 | 0.098 | 0.060 | 0.033 | 0.018 | 0.011 | 0.0087 | 0.0054 | 0.0042 | 0.0032 | 0.0027 |
| **5** | 3.72 | 2.88 | 2.36 | 1.60 | 0.99 | 0.56 | 0.39 | 0.23 | 0.125 | 0.077 | 0.043 | 0.024 | 0.015 | 0.0115 | 0.0071 | 0.0055 | 0.0043 | 0.0035 |
| **10** | 4.56 | 3.42 | 2.84 | 1.92 | 1.19 | 0.67 | 0.46 | 0.27 | 0.146 | 0.091 | 0.051 | 0.028 | 0.018 | 0.0137 | 0.0084 | 0.0065 | 0.0050 | 0.0042 |
| **25** | 5.64 | 4.26 | 3.52 | 2.36 | 1.46 | 0.81 | 0.57 | 0.32 | 0.174 | 0.110 | 0.063 | 0.035 | 0.022 | 0.0168 | 0.0101 | 0.0078 | 0.0060 | 0.0050 |
| **50** | 6.36 | 4.86 | 4.04 | 2.70 | 1.68 | 0.93 | 0.65 | 0.36 | 0.196 | 0.126 | 0.072 | 0.040 | 0.025 | 0.0193 | 0.0114 | 0.0089 | 0.0068 | 0.0055 |
| **100** | 7.20 | 5.52 | 4.52 | 3.06 | 1.89 | 1.05 | 0.74 | 0.41 | 0.218 | 0.142 | 0.081 | 0.046 | 0.029 | 0.0219 | 0.0128 | 0.0099 | 0.0075 | 0.0061 |
| **200** | 8.04 | 6.12 | 5.08 | 3.42 | 2.11 | 1.17 | 0.83 | 0.46 | 0.241 | 0.158 | 0.091 | 0.052 | 0.033 | 0.0247 | 0.0141 | 0.0110 | 0.0083 | 0.0067 |
| **500** | 9.24 | 7.02 | 5.80 | 3.90 | 2.41 | 1.33 | 0.96 | 0.52 | 0.272 | 0.181 | 0.105 | 0.061 | 0.038 | 0.0285 | 0.0160 | 0.0124 | 0.0092 | 0.0075 |
| **1000** | 10.08 | 7.68 | 6.32 | 4.26 | 2.64 | 1.45 | 1.06 | 0.57 | 0.295 | 0.199 | 0.116 | 0.067 | 0.042 | 0.0316 | 0.0174 | 0.0135 | 0.0100 | 0.0080 |

Reference: NOAA Atlas 14 <<http://hdsc.nws.noaa.gov>>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7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
Rainfall Intensity, inches/hour
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
100
200
300
400
500
600
700
1,000
2,000
Duration, minutes
1-year
2-year
5-year
10-year
25-year
50-year
100-year

## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** N100 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 14.21
C= 0.85 **...Q=12.07 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

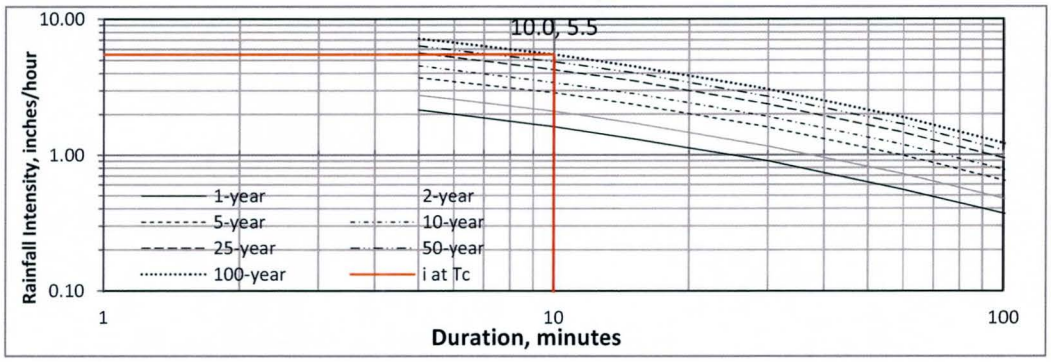
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.033**
L= 0.223
S= 67.3 **...Tc=0.247 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 15 | 0.25 | 4.5 | 0.14 | 0.11 | No | |
| 2 | 8.4 | 0.14 | 7.2 | 0.12 | 0.02 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.13 | 0.04 | No | Tc=10 applied |

**...Tc= 0.13** and **Q=67 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=2.47 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Prepared by IPS
Date 05/2011

## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** N200 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 17.28
C= 0.85 **...Q=14.69 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

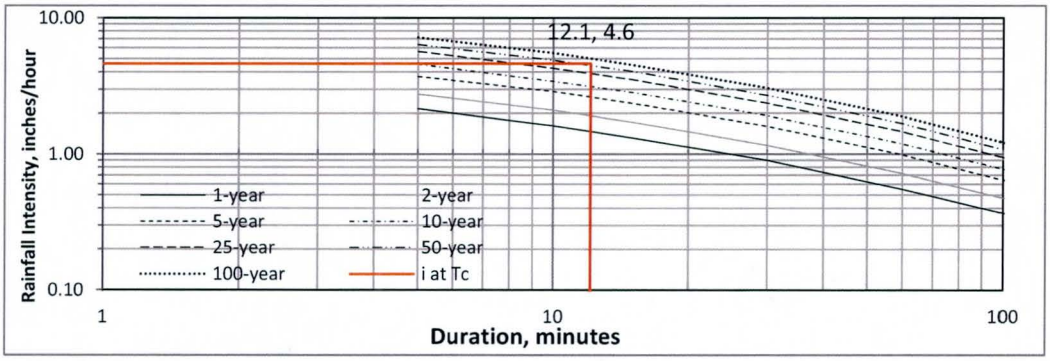
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.032**
L= 0.674
S= 68.2 **...Tc=0.424 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? |
|---|---|---|---|---|---|---|
| 1 | 20 | 0.33 | 3.9 | 0.25 | 0.08 | No |
| 2 | 15.3 | 0.26 | 7.2 | 0.20 | 0.05 | No |
| 3 | 12.1 | 0.20 | 4.6 | 0.24 | -0.04 | No |

**...Tc= 0.24** and **Q=68 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=3.00 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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Date 05/2011

## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S100 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 3.93
C= 0.85 **...Q=3.34 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

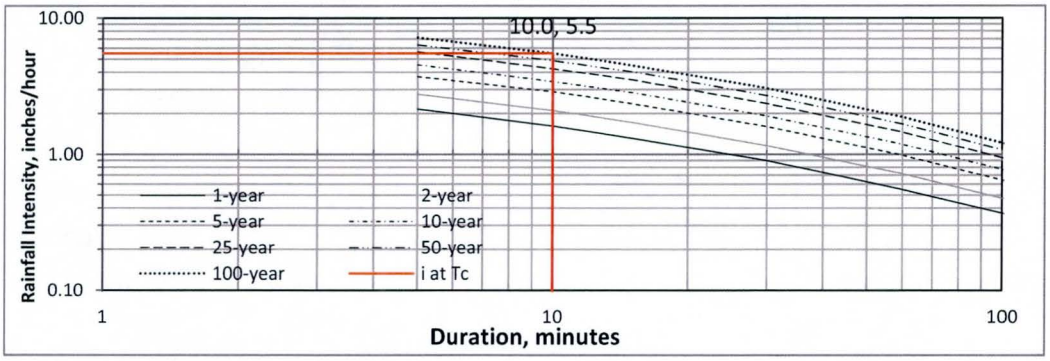
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.036**
L= 0.113
S= 230.1 **...Tc=0.127 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.07 | 0.10 | No | |
| 2 | 4 | 0.07 | 7.2 | 0.06 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.07 | 0.10 | No | Tc=10 applied |

**...Tc= 0.07** and **Q=18 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=0.68 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S200 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 6.18
C= 0.85 **...Q=5.25 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

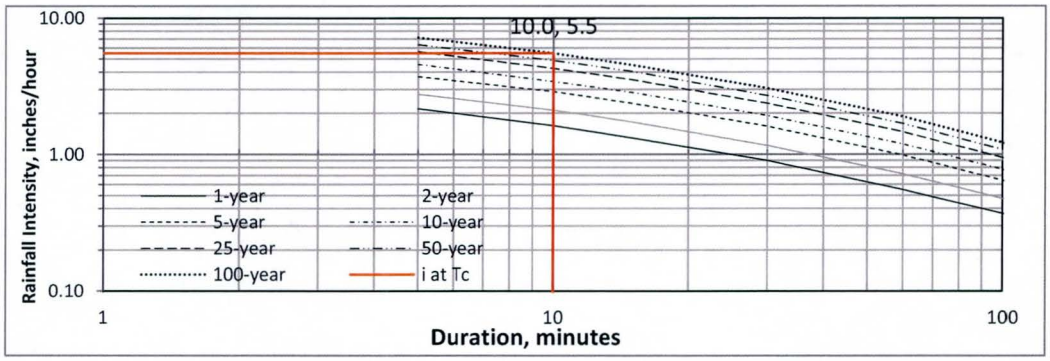
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.035**
L= 0.132
S= 121.2 **...Tc=0.164 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.09 | 0.08 | No | |
| 2 | 5.2 | 0.09 | 7.1 | 0.08 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.09 | 0.08 | No | Tc=10 applied |

**...Tc= 0.09** and **Q=29 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=1.07 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S300 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 2.75
C= 0.85 **...Q=2.34 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

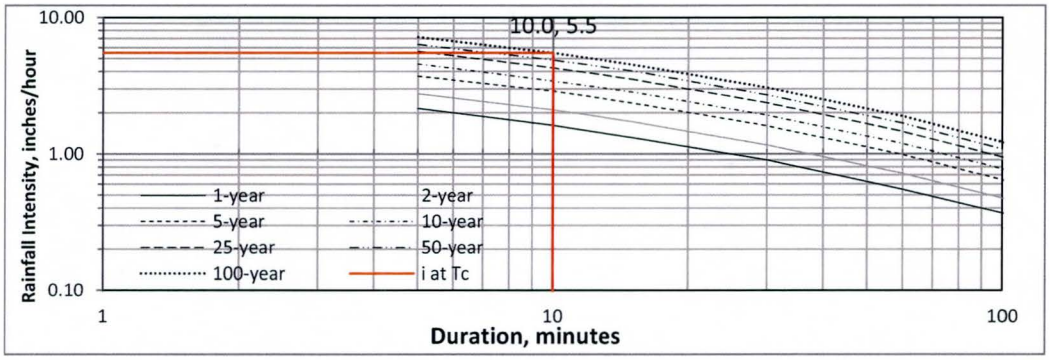
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.037**
L= 0.100
S= 110.0 **...Tc=0.152 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.08 | 0.09 | No | |
| 2 | 4.8 | 0.08 | 7.2 | 0.07 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.08 | 0.09 | No | Tc=10 applied |

**...Tc= 0.08** and **Q=13 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=0.48 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S400 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 9.74
C= 0.85 **...Q=8.28 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

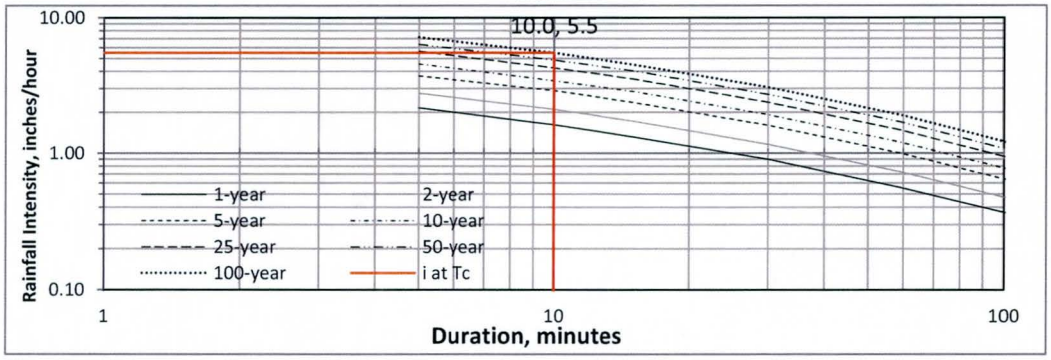
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.034**
L= 0.132
S= 90.9 **...Tc=0.176 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.09 | 0.07 | No | |
| 2 | 5.6 | 0.09 | 6.9 | 0.08 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.09 | 0.07 | No | Tc=10 applied |

**...Tc= 0.09** and **Q=46 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=1.69 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S500 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 6.50
C= 0.85 **...Q=5.53 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

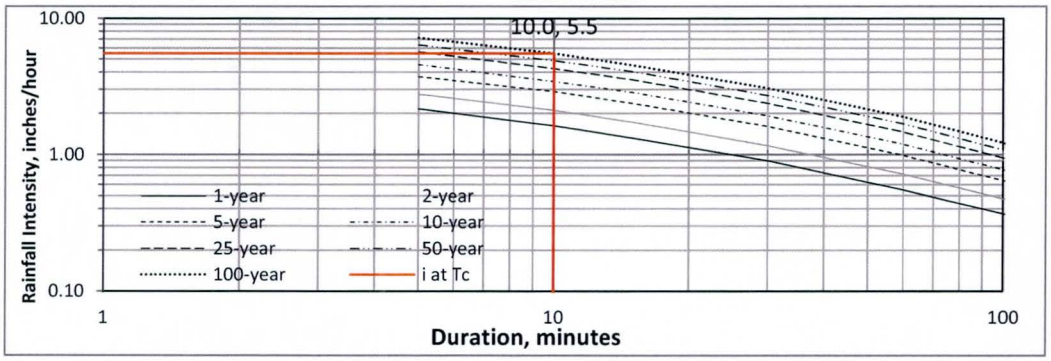
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.035**
L= 0.203
S= 315.3 **...Tc=0.151 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.08 | 0.09 | No | |
| 2 | 4.8 | 0.08 | 7.2 | 0.07 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.08 | 0.09 | No | Tc=10 applied |

**...Tc= 0.08** and **Q=31 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=1.13 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S400 WITH 500 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 16.24
C= 0.85 **...Q=13.81 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

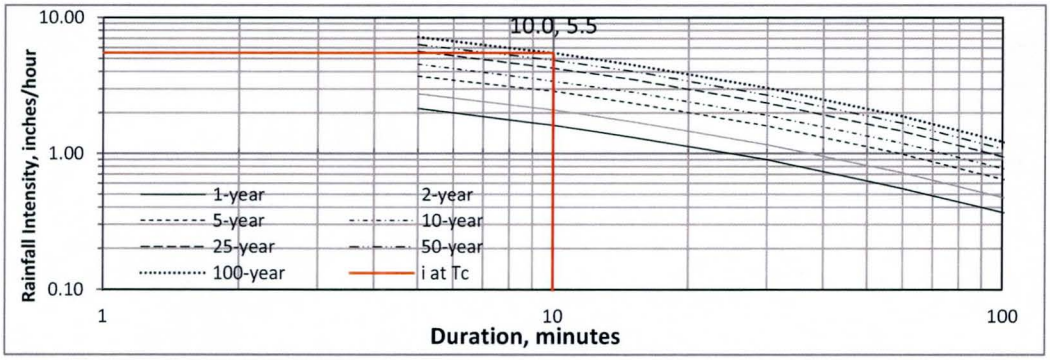
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.032**
L= 0.203
S= 315.3 **...Tc=0.145 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.08 | 0.09 | No | |
| 2 | 4.6 | 0.08 | 6.9 | 0.07 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.08 | 0.09 | No | Tc=10 applied |

**...Tc= 0.08** and **Q=76 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=2.82 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S600 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 5.67
C= 0.85 **...Q=4.82 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

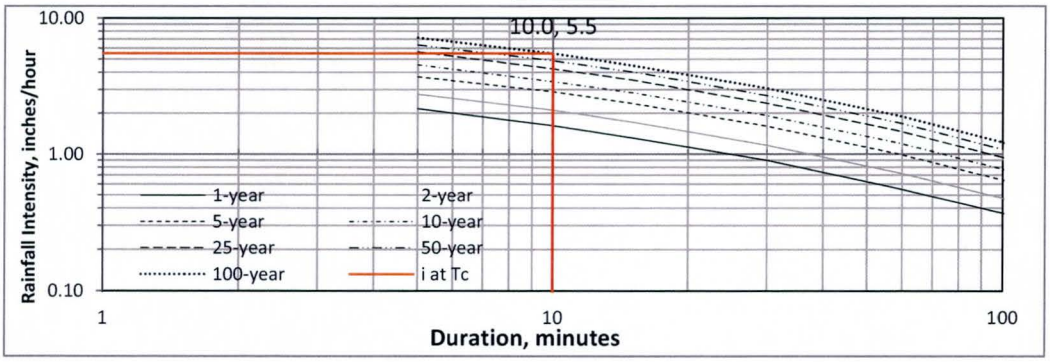
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.035**
L= 0.121
S= 520.7 **...Tc=0.100 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.05 | 0.11 | No | |
| 2 | 3.2 | 0.05 | 7.2 | 0.05 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.05 | 0.11 | No | Tc=10 applied |

**...Tc= 0.05** and **Q=27 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=0.98 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S700 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 23.08
C= 0.85 **...Q=19.62 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

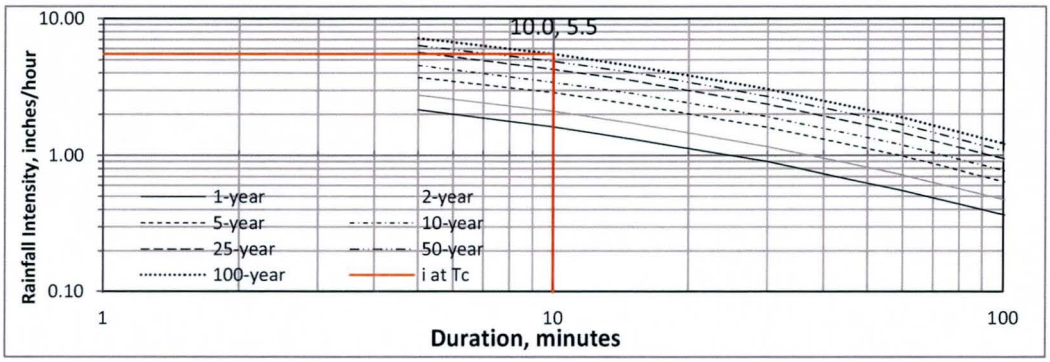
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.031**
L= 0.269
S= 193.3 **...Tc=0.191 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.10 | 0.07 | No | |
| 2 | 6.1 | 0.10 | 6.7 | 0.09 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.10 | 0.07 | No | Tc=10 applied |

**...Tc= 0.10** and **Q=108 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=4.01 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S800 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 45.42
C= 0.85 **...Q=38.61 * i**

**Eq. 1.1:** $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

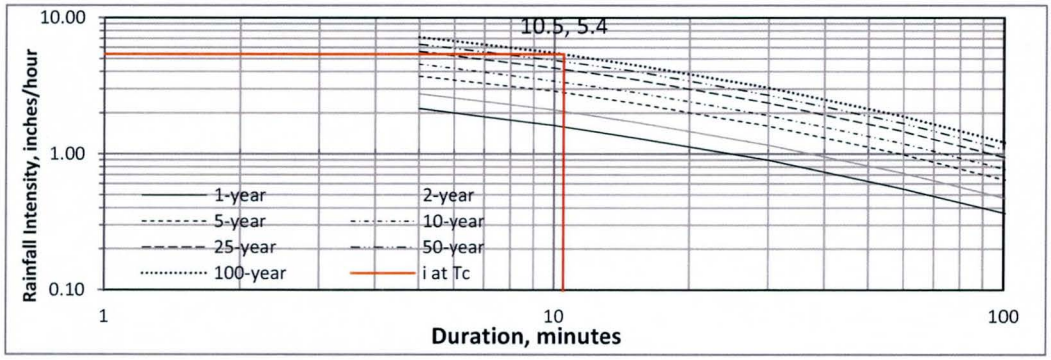
**Eq. 1.2:** $K_b=m*\log_{10}A+b$

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.030**
L= 0.333
S= 42.0 **...Tc=0.331 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? |
|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.17 | -0.01 | No |
| 2 | 10.4 | 0.17 | 5.4 | 0.17 | 0.00 | Yes |
| 3 | 10.5 | 0.18 | 5.4 | 0.17 | 0.00 | Yes |

**...Tc= 0.17** and **Q=208 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=7.88 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

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## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S700 WITH 800 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 68.51
C= 0.85 **...Q=58.23 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

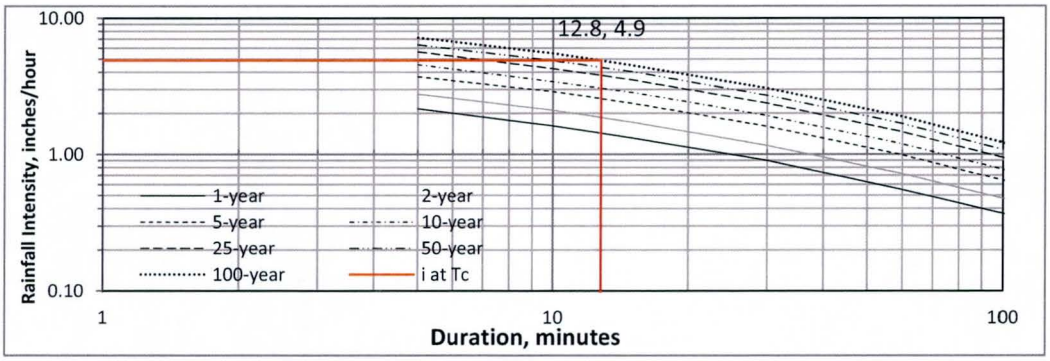
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.029**
L= 0.453
S= 37.8 **...Tc=0.391 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? |
|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.20 | -0.04 | No |
| 2 | 12.3 | 0.21 | 5.0 | 0.21 | -0.01 | No |
| 3 | 12.8 | 0.21 | 4.9 | 0.21 | 0.00 | Yes |

**...Tc= 0.21** and **Q=285 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=11.89 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Prepared by IPS
Date 05/2011

## Hydrologic Data Sheet for Computing Peak Discharge per FCDMC Method

**Project:** Salt River Levee **CP:** S900 **Return Period:** 100-yr

**Eq. 1.0: Q=CiA**

where: Q=peak discharge, cfs
C=runoff coefficient, unitless
i=average rainfall intensity, inches/hour, lasting for a $T_c$, (per Eq. 2)
A=drainage area, acres

A= 3.69
C= 0.85 **...Q=3.14 * i**

**Eq. 1.1: $T_c=11.4*L^{0.5}*K_b^{0.52}*S^{-0.31}*i^{-0.38}$**

where: $T_c$=time of concentration, hours
$K_b$=watershed resistance coefficient, (per Eq. 3)
L=length of the longest flow path, miles
S=watercourse slope, feet/mile
i=average rainfall intensity, inches/hour, lasting for a $T_c$

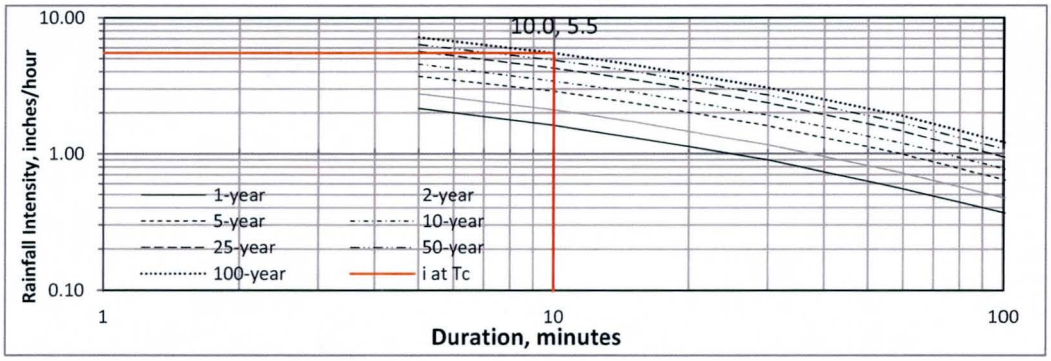
**Eq. 1.2: $K_b=m*\log_{10}A+b$**

where: m and b are defined by Table 3.1 of Reference 1

m= -0.00625
b= 0.04 **...Kb=0.036**
L= 0.195
S= 133.3 **...Tc=0.197 * $i^{-0.38}$**

| Iteration | $T_c$ (min) | $T_c$ (hr) | i per IDF (in/hr) | Eq. 3 $T_c$ (hr) | Delta $T_c$ (hr) | Accept? | |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 0.17 | 5.5 | 0.10 | 0.06 | No | |
| 2 | 6.2 | 0.10 | 6.6 | 0.10 | 0.01 | No | Tc<10! |
| 3 | 10 | 0.17 | 5.5 | 0.10 | 0.06 | No | Tc=10 applied |

**...Tc= 0.10** and **Q=17 cfs**




**Eq. 2.0: V=C*(P/12)*A**

where: V=calculated volume, acre-feet
P=rainfall depth, inches
C and A already defined above

P= 2.45 (in.) (6 hour)

**V=0.64 ac-ft**

Ref. 1: "Drainage Design Manual for Maricopa County, Arizona, Hydrology", Flood Control District of Maricopa County, Nov. 2009

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Prepared by IPS
Date 05/2011

**Basin ID** **N100** **Goal V 2.47** **~WSE 1125.1**
**~Depth 2.3**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1122.8 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1123 | 173 | 0.067 | 173 | 12 | 12 | 0.000 |
| 1123.5 | 22198 | 0.167 | 24331 | 4055 | 4067 | 0.093 |
| 1124 | 60730 | 0.167 | 119644 | 19941 | 24007 | 0.551 |
| 1124.5 | 82738 | 0.167 | 214353 | 35725 | 59733 | 1.371 |
| 1125 | 103162 | 0.167 | 278287 | 46381 | 106114 | 2.436 |
| 1125.5 | 121433 | 0.167 | 336520 | 56087 | 162201 | 3.724 |

**Basin ID** **N200** **Goal V 3.00** **~WSE 1131.4**
**~Depth 9.0**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1122.4 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1122.5 | 40 | 0.033 | 40 | 1 | 1 | 0.000 |
| 1125 | 7006 | 0.833 | 7575 | 6313 | 6314 | 0.145 |
| 1127.5 | 15109 | 0.833 | 32404 | 27003 | 33317 | 0.765 |
| 1130 | 28503 | 0.833 | 64364 | 53637 | 86954 | 1.996 |
| 1131 | 34874 | 0.333 | 94905 | 31635 | 118589 | 2.722 |
| 1131.5 | 38621 | 0.167 | 110195 | 18366 | 136955 | 3.144 |

**Basin ID** **S100** **Goal V 0.68** **~WSE 1122.2**
**~Depth 3.9**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1118.3 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1118.5 | 1184 | 0.067 | 1184 | 79 | 79 | 0.002 |
| 1120 | 6749 | 0.500 | 10760 | 5380 | 5459 | 0.125 |
| 1121.5 | 12875 | 0.500 | 28946 | 14473 | 19932 | 0.458 |
| 1122 | 16376 | 0.167 | 43771 | 7295 | 27227 | 0.625 |
| 1122.5 | 22058 | 0.167 | 57440 | 9573 | 36800 | 0.845 |

**Basin ID** **S200** **Goal V 1.07** **~WSE 1122.1**
**~Depth 5.0**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1117.1 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1117.5 | 707 | 0.133 | 707 | 94 | 94 | 0.002 |
| 1120 | 8395 | 0.833 | 11538 | 9615 | 9709 | 0.223 |
| 1121 | 13977 | 0.333 | 33204 | 11068 | 20778 | 0.477 |
| 1121.5 | 17790 | 0.167 | 47536 | 7923 | 28700 | 0.659 |
| 1122 | 41302 | 0.167 | 86199 | 14366 | 43067 | 0.989 |
| 1122.5 | 63478 | 0.167 | 155983 | 25997 | 69064 | 1.585 |

**Basin ID** **S300** **Goal V 0.48** **~WSE 1121.4**
**~Depth 1.0**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1120.4 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1120.5 | 4142 | 0.033 | 4142 | 138 | 138 | 0.003 |
| 1121 | 27271 | 0.167 | 42041 | 7007 | 7145 | 0.164 |
| 1121.5 | 47604 | 0.167 | 110906 | 18484 | 25629 | 0.588 |

**Basin ID S400&500 Goal V 2.82** **~WSE 1121.3**
**~Depth 3.5**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1117.8 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1118 | 698 | 0.067 | 698 | 47 | 47 | 0.001 |
| 1120 | 5584 | 0.667 | 8256 | 5504 | 5551 | 0.127 |
| 1120.5 | 46312 | 0.167 | 67977 | 11330 | 16880 | 0.388 |
| 1121 | 204283 | 0.167 | 347861 | 57977 | 74857 | 1.718 |
| 1121.5 | 259892 | 0.167 | 694591 | 115765 | 190622 | 4.376 |

**Basin ID** **S600** **Goal V 0.98** **~WSE 1120.5**
**~Depth 2.5**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1118 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1118.5 | 2240 | 0.167 | 2240 | 373 | 373 | 0.009 |
| 1119 | 13552 | 0.167 | 21302 | 3550 | 3924 | 0.090 |
| 1119.5 | 24935 | 0.167 | 56870 | 9478 | 13402 | 0.308 |
| 1120 | 30196 | 0.167 | 82571 | 13762 | 27164 | 0.624 |
| 1120.5 | 34490 | 0.167 | 96958 | 16160 | 43323 | 0.995 |

**Basin ID** **S700** **S700 V** **4.01** **~WSE 1130.3**

**Goal V (with S800)** **9.99** **~Depth 2.3**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1128 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1128.5 | 16542 | 0.167 | 16542 | 2757 | 2757 | 0.063 |
| 1129 | 92876 | 0.167 | 148614 | 24769 | 27526 | 0.632 |
| 1129.5 | 247506 | 0.167 | 491998 | 82000 | 109526 | 2.514 |
| 1130 | 498483 | 0.167 | 1097240 | 182873 | 292399 | 6.713 |
| 1130.5 | 520963 | 0.167 | 1529045 | 254841 | 547240 | 12.563 |

**Basin ID** **S800** **Goal V 7.88** **~WSE 1130.5**

Stored **1.90** **~Depth 1.2**

Flow into S700 **6**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1129.3 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1129.5 | 7530 | 0.067 | 7530 | 502 | 502 | 0.012 |
| 1130 | 122345 | 0.167 | 160227 | 26705 | 27207 | 0.625 |
| 1130.5 | 102513 | 0.167 | 336849 | 56141 | 83348 | 1.913 |

**Basin ID S700&800 Goal V 11.89** **~WSE 1130.3**
**~Depth 2.3**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1128 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1128.5 | 16542 | 0.167 | 16542 | 2757 | 2757 | 0.063 |
| 1129 | 92876 | 0.167 | 148614 | 24769 | 27526 | 0.632 |
| 1129.5 | 255036 | 0.167 | 501817 | 83636 | 111162 | 2.552 |
| 1130 | 620828 | 0.167 | 1273775 | 212296 | 323458 | 7.426 |
| 1130.5 | 698276 | 0.167 | 1977518 | 329586 | 653044 | 14.992 |

**Basin ID** **S900** **Goal V 0.64** **~WSE 1137.4**
**~Depth 3.2**

| Elevation (feet) | Area (sq-ft) | (h2-h1)/3 | A1+A2+(A1*A2)^0.5 | deltaS (cu-ft) | Cummulative S (cu-ft) | Cummulative S (ac-ft) |
|---|---|---|---|---|---|---|
| 1134.2 | 0 | 0.000 | 0 | 0 | 0 | 0.000 |
| 1134.5 | 942 | 0.100 | 942 | 94 | 94 | 0.002 |
| 1135 | 5605 | 0.167 | 8845 | 1474 | 1568 | 0.036 |
| 1135.5 | 8880 | 0.167 | 21540 | 3590 | 5158 | 0.118 |
| 1136 | 5998 | 0.167 | 22176 | 3696 | 8854 | 0.203 |
| 1136.5 | 14420 | 0.167 | 29718 | 4953 | 13807 | 0.317 |
| 1137 | 16494 | 0.167 | 46336 | 7723 | 21530 | 0.494 |
| 1137.5 | 18249 | 0.167 | 52092 | 8682 | 30212 | 0.694 |

# E. As-Built Drawings

TRIAL VERSION of TIFFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 207 | 369 | 1/25/93 KF |
| | | 143 MA 1 | | | |

# STATE of ARIZONA
# DEPARTMENT of TRANSPORTATION
# HIGHWAYS DIVISION

# SALT RIVER CHANNELIZATION

## HOHOKAM (UNIVERSITY-SKY HARBOR)
## RAM-600-3-511
## 143 MA 1

## MARICOPA COUNTY
## 1989

## GENERAL NOTES

THIS PROJECT HAS BEEN DESIGNED USING THE 1986 CONSTRUCTION STANDARDS AND CURRENT REVISIONS TO SAME.

THIS PROJECT HAS BEEN DESIGNED USING THE STATE OF ARIZONA 1987 STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.

FOR ADDITIONAL RIGHT-OF-WAY INFORMATION, SEE RIGHT-OF-WAY PROJECT NUMBER RBA-600-3-708.

THE CONTRACTOR SHALL REMOVE ALL STRUCTURES AND OBSTRUCTIONS WITHIN THE PROJECT LIMITS UNLESS OTHERWISE NOTED ON THE PLANS.

RIGHT-OF-WAY MARKERS SHALL BE FURNISHED AND PLACED BY THE CONTRACTOR, AS DIRECTED BY THE ENGINEER, STANDARD C-21.10.

BENCH MARKERS SHALL BE FURNISHED BY THE STATE AND PLACED BY THE CONTRACTOR, STANDARD C-21.20.

THE INFORMATION ON THESE DRAWINGS CONCERNING THE TYPE, SIZE, AND LOCATION OF UTILITIES HAS BEEN SHOWN BASED ON THE BEST INFORMATION AVAILABLE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE EXACT LOCATION OF ALL EXISTING UTILITY FACILITIES PRIOR TO CONSTRUCTION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PROTECT ALL EXISTING UTILITIES, IN PLACE, UNLESS OTHERWISE NOTED OR SPECIFIED.

ALL SOIL BORINGS AND TEST PITS ENCOUNTERING LANDFILL REFUSE, AS DOCUMENTED IN THE PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT; DESIGN SECTION 7, SALT RIVER CHANNELIZATION, DATED MARCH 17, 1988, ARE SHOWN ON DRAWING NO. CH-2.1 THRU CH-2.14. THE REMAINING SOIL BORINGS AND TEST PITS APPLICABLE TO THIS PROJECT, ARE INCLUDED IN THE PRELIMINARY GEOTECHNICAL INVESTIGATION REPORTS; DESIGN SECTION 7, SALT RIVER CHANNELIZATION, DATED MARCH 17, 1988, DESIGN SECTIONS 8B AND 8C, DATED OCTOBER 26, 1988 AND THE GEOTECHNICAL INVESTIGATION REPORT, PRIEST DRIVE BRIDGE & ROADWAY DESIGN, DATED OCTOBER 21, 1986.

EXISTING GROUND WITHIN THE CHANNEL BOTTOM BELOW DESIGN ELEVATION SHALL BE LEFT AS IS.

TOPOGRAPHIC INFORMATION SHOWN ON CHANNEL ALIGNMENT PLANS (CH-2.1, 2.3, 2.5, 2.7, 2.9, 2.11 AND 2.13) ARE BASED ON AERIAL PHOTOGRAPHIC INFORMATION DATED MARCH THRU APRIL, 1987. THE SUMMARY OF EARTHWORK QUANTITIES AND THE OFFSETS AND ELEVATIONS SHEETS ARE BASED ON UPDATED AERIAL PHOTOGRAPHIC INFORMATION DATED JANUARY 24, 1989.

## DESIGN DATA

SALT RIVER CHANNELIZATION DESIGN FLOWS:

10-YEAR FREQUENCY FLOOD = 93,000 CFS
100-YEAR FREQUENCY FLOOD = 215,000 CFS
STANDARD PROJECT FLOOD = 289,000 CFS

## SPECIAL SYMBOLS

⊕ CH-12 SOIL BORING INDICATING LANDFILL REFUSE.
⊞ CH-18 TEST PIT INDICATING LANDFILL REFUSE.
Ⓐ APPROXIMATE CENTERLINE OF LOW FLOW CHANNEL.

## DRAWING INDEX


| DRAWING NO. | TITLE |
|---|---|
| CH-1 | TITLE SHEET |
| G-4.6 | SUMMARY OF CHANNEL EARTHWORK |
| G-4.7 | STORM DRAIN PIPE SCHEDULE |
| CH-1.2 THRU 1.3 | GEOMETRIC LAYOUT |
| CH-1.4 THRU 1.7 | TYPICAL SECTIONS |
| CH-2.1 THRU 2.14 | CHANNEL ALIGNMENT PLANS AND PROFILES |
| CH-3.1 THRU 3.3 | OFFSET AND ELEVATION SHEETS |
| CH-4.1 THRU 4.4 | GRADE CONTROL STRUCTURES |
| CH-5.1 THRU 5.6 | LEVEE TRANSITION DETAILS |
| CH-6.1 THRU 6.2 | ACCESS RAMP DETAILS |
| CH-7.1 THRU 7.2 | GABION MATTRESS DETAILS |
| CH-8.1 | CROSS CUT CANAL CONNECTION DETAIL |
| CH-9.1 THRU 9.6 | STORM DRAIN EXTENSION PLANS AND PROFILES |
| CH-10.1 THRU 10.4 | MISCELLANEOUS DETAILS |


"AS Builts"

APPROVED _____ DATE _____
MARICOPA COUNTY FLOOD CONTROL DISTRICT

| | NAME | DATE |
|---|---|---|
| DESIGN | DMJM | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

TITLE SHEET

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

DWG NO. CH-1.1

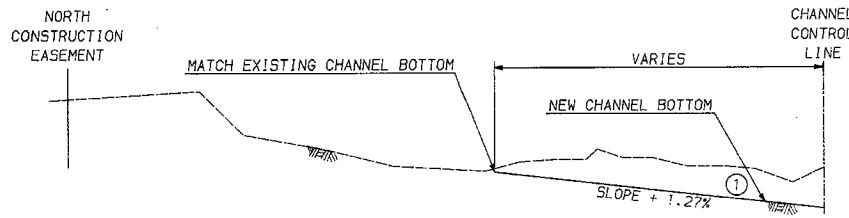
TRACS NO. H 2045 01C

RAM 600-3-511 SHT 207 of 369

SALT RIVER CHANNELIZATION AS BUILT ADOT PLANS HOHOKAM (UNIVERSITY TO SKY HARBOR)
RAM 600-3-511 125

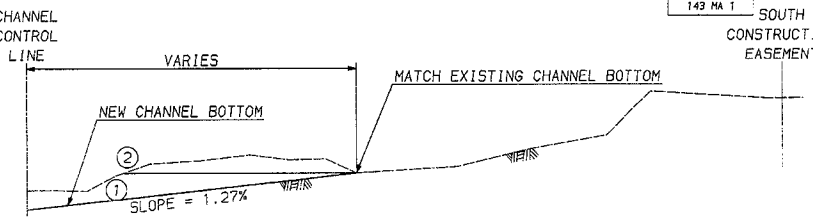
TRIAL VERSION of TIFFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 210 | 369 | 1/26/93 FF |
| | | 143 MA 1 | | | |




NORTH LEVEE

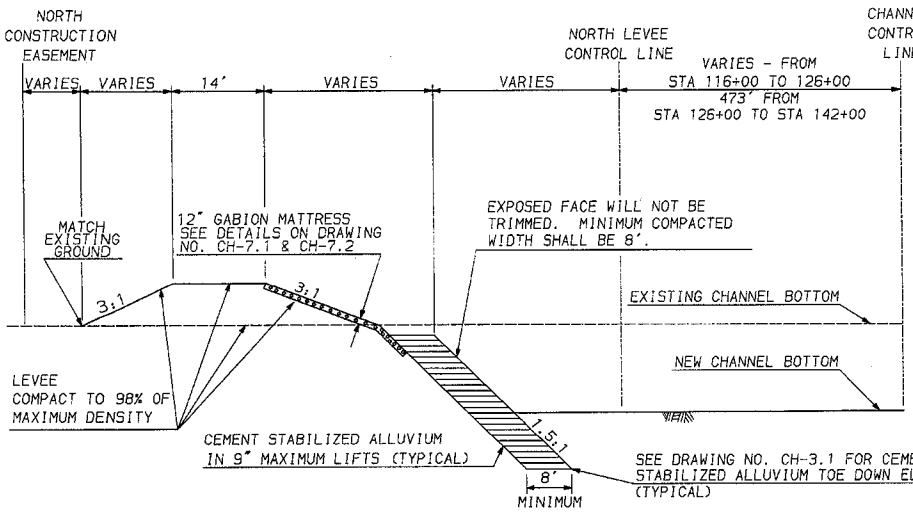
(1) STATION 100+35 TO STATION 114+00




SOUTH LEVEE

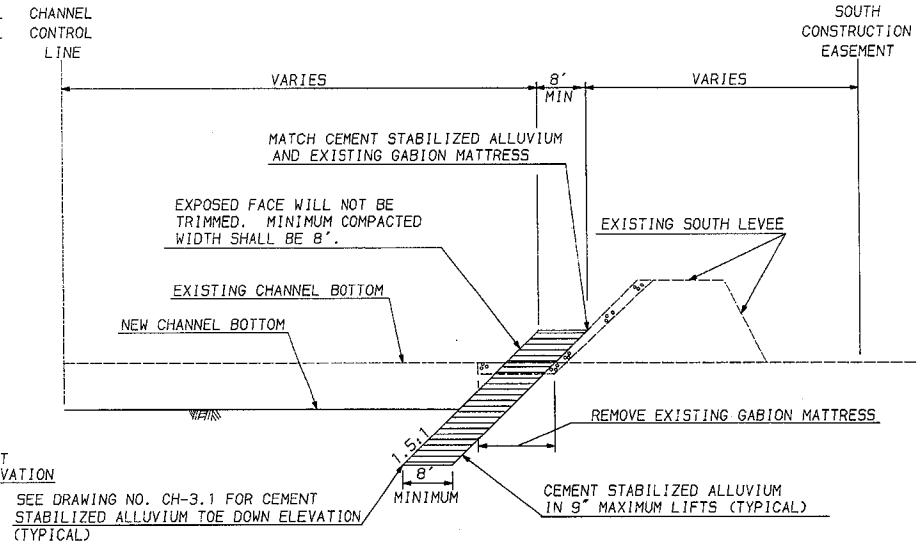
(1) STATION 100+35 TO STATION 116+00

(2) STATION 116+00 TO STATION 126+00




NORTH LEVEE

STATION 114+00 TO STATION 142+00




SOUTH LEVEE

STATION 126+00 TO STATION 142+00

NOTES:

1. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.1
2. BEGIN NORTH LEVEE CEMENT STABILIZED ALLUVIUM PROTECTION AT STATION 116+00.
3. BEGIN SOUTH LEVEE CEMENT STABILIZED ALLUVIUM PROTECTION AT STATION 126+00.
4. NORTH CHANNEL TRANSITION ON NORTH LEVEE STATION 115+80 TO STATION 116+00 SEE DETAIL ON DRAWING NO. CH-5.1
5. FOR LOW FLOW CHANNEL TYPICAL SECTION, SEE DETAIL ON DRAWING NO. CH-10.2.

## TYPICAL SECTION NO. 1 - HALF SECTIONS

STATION 100+35 TO STATION 142+00

NOT TO SCALE

| | NAME | DATE |
|---|---|---|
| DESIGN | DWJ | 4/89 |
| DRAWN | SLB | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

TYPICAL SECTIONS STA 100+35 TO STA 142+00

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

DWG NO. CH-1.4

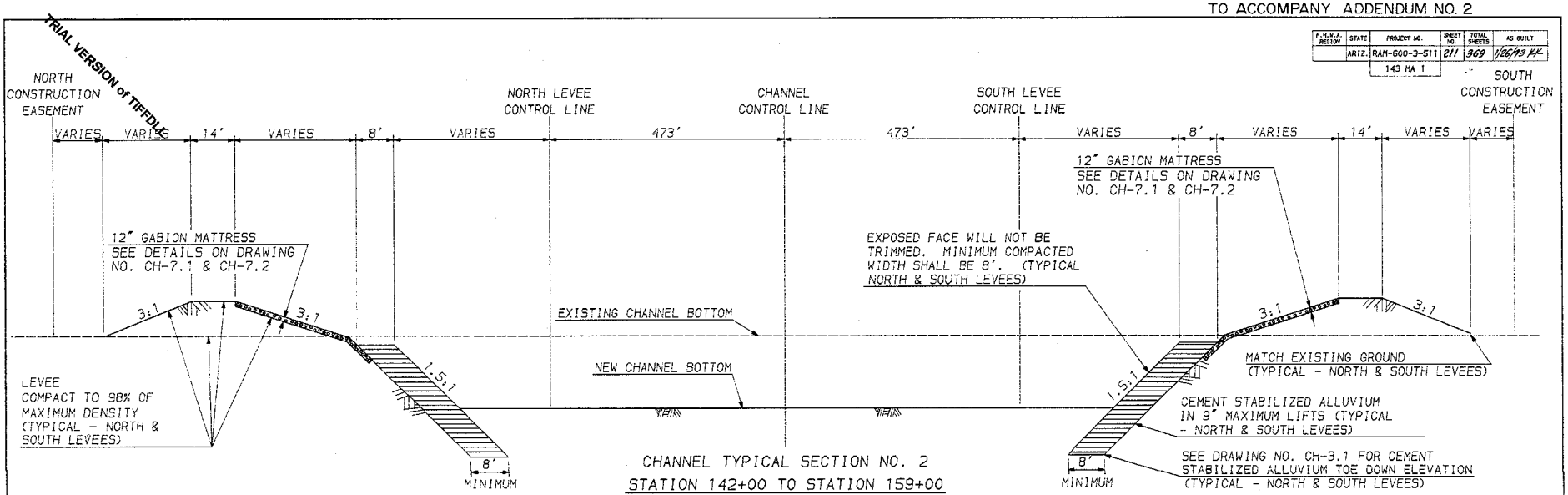
TRACS NO. H 2045 01C RAM 600-3-511 SHT 210 of 369 OF

SURVEY NO. | FINISH PLANS | REVISIONS | LOCATION | DATE

TO ACCOMPANY ADDENDUM NO. 2

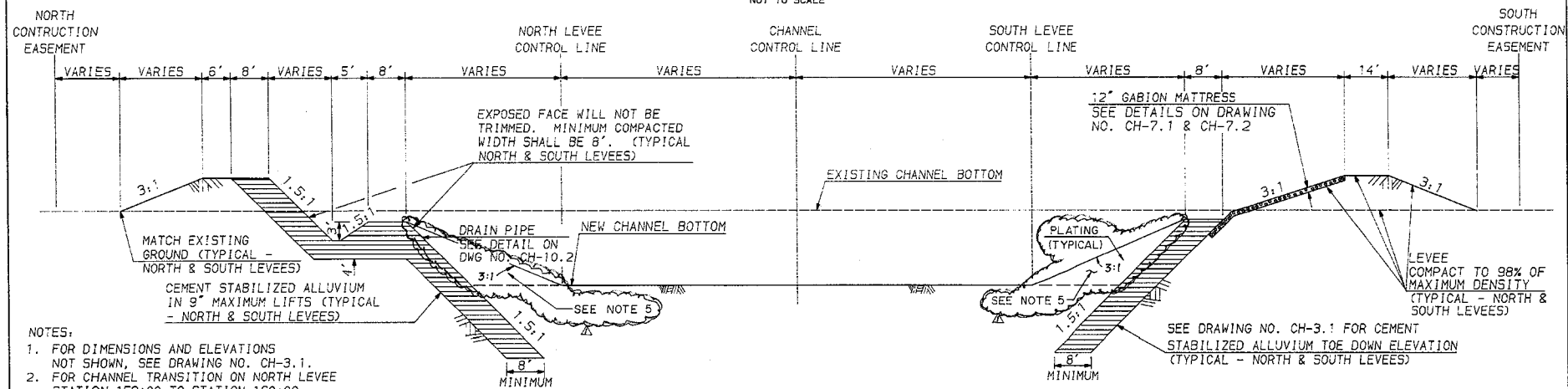
TRIAL VERSION of TIFFDUP

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 211 | 369 | 1/26/93 HK |
| | | 143 MA 1 | | | |




CHANNEL TYPICAL SECTION NO. 2
STATION 142+00 TO STATION 159+00

NOT TO SCALE




CHANNEL TYPICAL SECTION NO.3
STATION 159+00 TO STATION 174+00

NOT TO SCALE

NOTES:
1. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.1.
2. FOR CHANNEL TRANSITION ON NORTH LEVEE STATION 159+00 TO STATION 160+00 SEE DETAIL ON DRAWING NO. CH-5.3.
3. FOR CHANNEL TRANSITION ON NORTH LEVEE STATION 172+00 TO STATION 174+00 SEE DETAIL ON DRAWING NO. CH-5.3.
4. FOR LOW FLOW CHANNEL TYPICAL SECTION, SEE DETAIL ON DRAWING NO. CH-10.2.
5. BEGIN PLATING ALONG NORTH LEVEE AT STA. 160+50. END PLATING ALONG NORTH LEVEE AT STA. 174+00. BEGIN PLATING ALONG SOUTH LEVEE AT STA. 163+12.

| | NAME | DATE |
|---|---|---|
| DESIGN | D.N.J. | 4/89 |
| DRAWN | S.L.B. | 4/89 |
| CHECKED | M.A.P. | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

TYPICAL SECTIONS STA. 142+00 TO STA. 174+00

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

DWG NO. CH-1.5

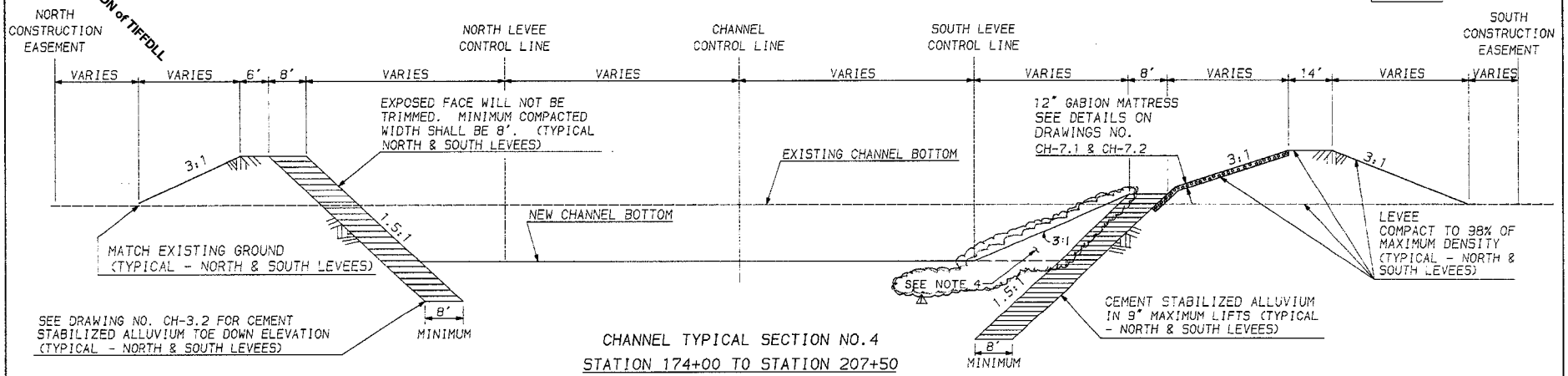
TRACS NO. H 2045 01C RAM 600-3-511 SHT 211 of 369 ____ OF ____

DATE 8/89 | LOCATION | REVISIONS | FINISHED PLANS | PROJECT NO.

TO ACCOMPANY ADDENDUM NO. 2

TRIAL VERSION of TIFFDLL

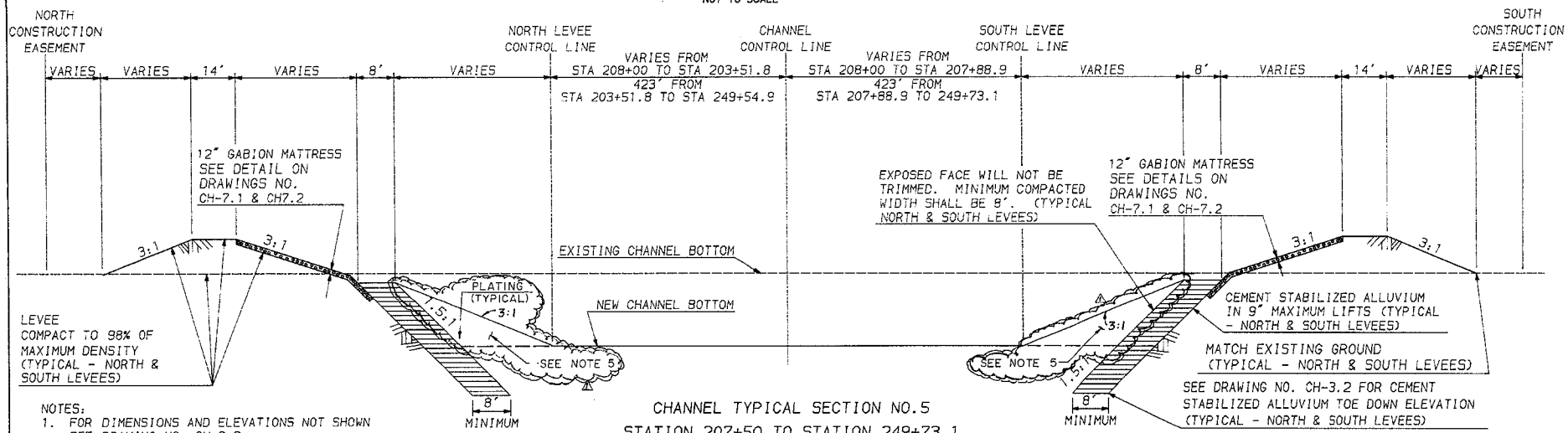
| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 212 | 369 | 1/26/93 KK |
| | | 143 MA 1 | | | |




CHANNEL TYPICAL SECTION NO.4

STATION 174+00 TO STATION 207+50

NOT TO SCALE




CHANNEL TYPICAL SECTION NO.5

STATION 207+50 TO STATION 249+73.1

NOTES:
1. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN SEE DRAWING NO. CH-3.2
2. FOR CHANNEL TRANSITION FROM STA 206+00 TO STA 207+50 SEE DETAIL ON DRAWING NO. CH-5.3
3. FOR LOW WATER CHANNEL TYPICAL SECTION, SEE DETAIL ON DRAWING NO. CH-10.2
4. END PLATING ALONG SOUTH LEVEE AT STA. 203+76.
5. BEGIN PLATING ALONG NORTH LEVEE AT STA. 217+24 AND END PLATING AT STA. 249+54.9. BEGIN PLATING ALONG SOUTH LEVEE AT STA. 217+24 AND END PLATING AT STA. 249+73.1. PROVIDE GAPS IN PLATING AT ACCESS RAMPS.

NOT TO SCALE

| | NAME | DATE |
|---|---|---|
| DESIGN | D.N.J. | 4/89 |
| DRAWN | S.L.B. | 4/89 |
| CHECKED | K.A.P. | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

TYPICAL SECTIONS STA 174+00 - STA 249+73.1

| ROUTE | MILEPOST |
|---|---|
| 143 | 1 |

LOCATION HOHOKAM CUNIVERSITY - SKY HARBOR

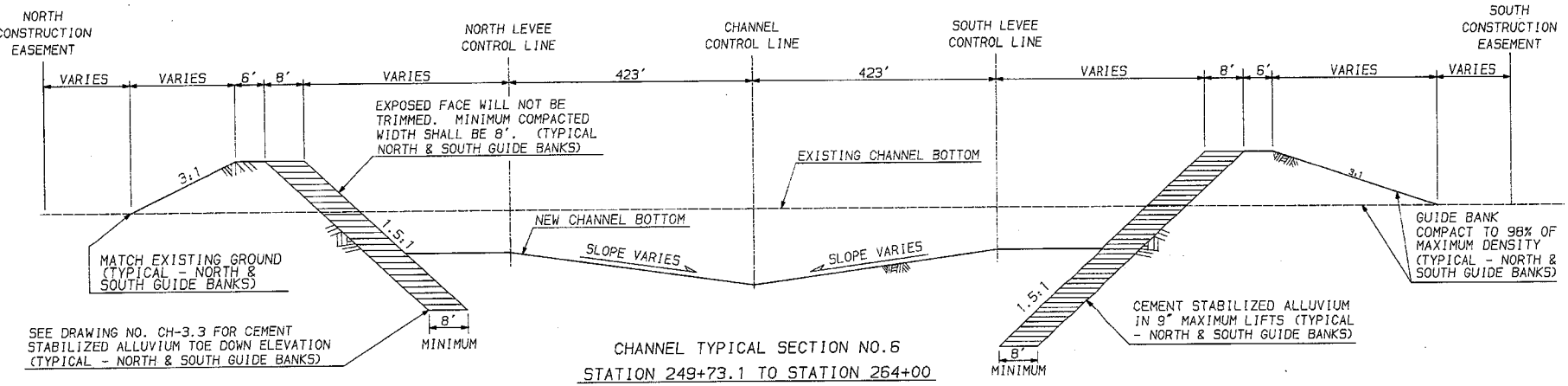
DWG NO. CH-1.6

TRACS NO. H 2045 01C RAM 600-3-511 SHT. 212 of 369 ____ OF ____

| DATE | LOCATION | REVISIONS | TRACINGS FILMED | SURVEY NO. |
|---|---|---|---|---|
| 6/89 | | | | |

TRIAL VERSION of TIFFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 213 | 369 | 1/26/93 KF |
| | | 143 MA 1 | | | |




## CHANNEL TYPICAL SECTION NO.6
## STATION 249+73.1 TO STATION 264+00

NOT TO SCALE

NOTES;
1. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN SEE DRAWING NO. CH-3.3
2. FOR LOW FLOW CHANNEL TYPICAL SECTION, SEE DETAIL ON DRAWING NO. CH-10.2.

| | NAME | DATE |
|---|---|---|
| DESIGN | D.N.J. | 4/89 |
| DRAWN | J.C.P. | 4/89 |
| CHECKED | M.A.P. | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

TYPICAL SECTIONS
STA 249+73.1 TO STA 264+00

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

DWG NO. CH-1.7

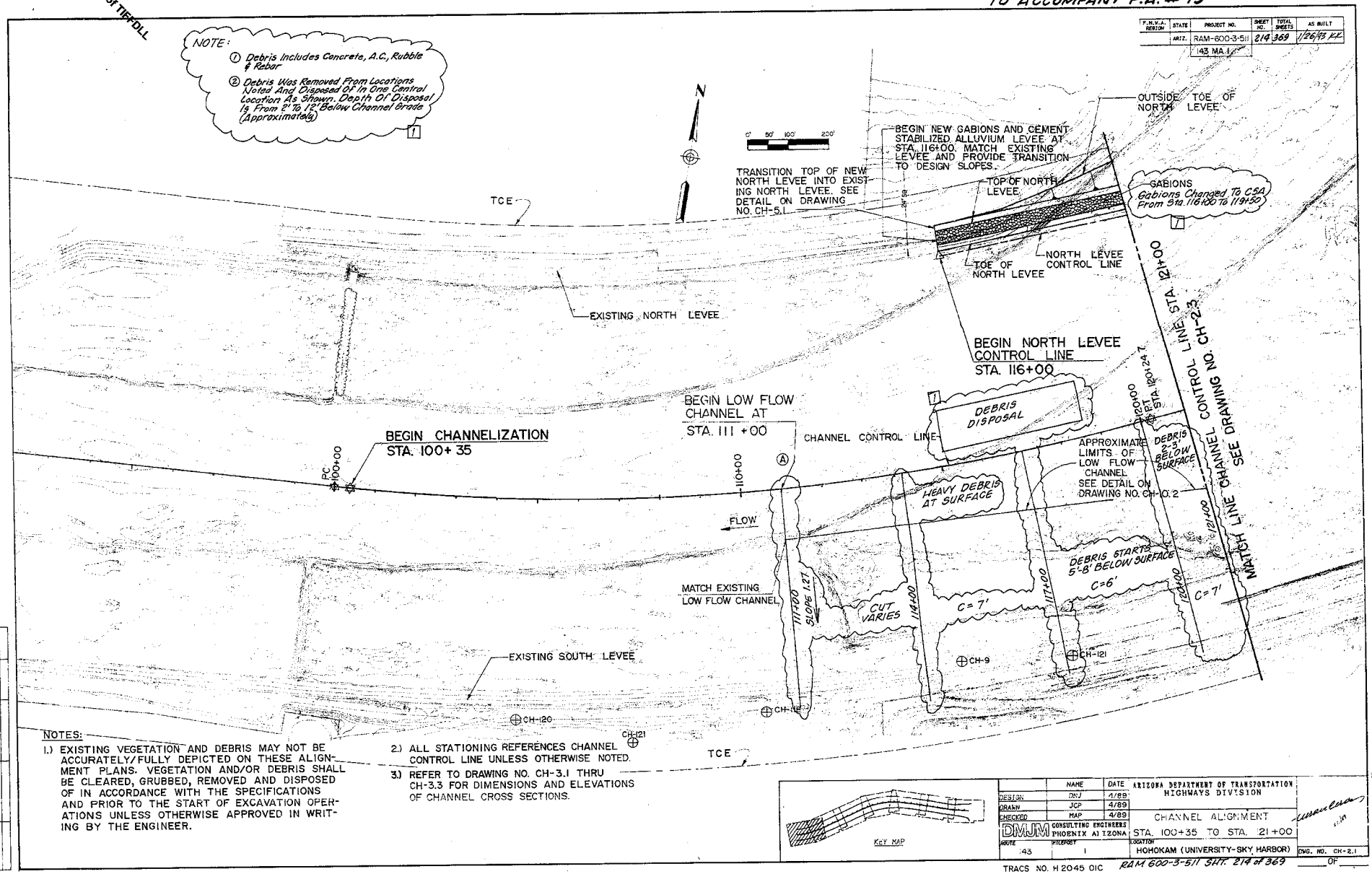
TRACS NO. H 2045 01C RAM 600-3-511 SHT. 213 of 369 ____ OF ____

DATE | LOCATION | DESIGNER | PROJECT ENGR. | BRANCH NO.

TRIAL VERSION of TIEFDLL

TO ACCOMPANY F.A. # 19

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 214 | 369 | 1/26/93 KL |
| | | 143 MA. I | | | |




NOTES:

1.) EXISTING VEGETATION AND DEBRIS MAY NOT BE ACCURATELY/FULLY DEPICTED ON THESE ALIGNMENT PLANS. VEGETATION AND/OR DEBRIS SHALL BE CLEARED, GRUBBED, REMOVED AND DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATIONS AND PRIOR TO THE START OF EXCAVATION OPERATIONS UNLESS OTHERWISE APPROVED IN WRITING BY THE ENGINEER.

2.) ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

3.) REFER TO DRAWING NO. CH-3.1 THRU CH-3.3 FOR DIMENSIONS AND ELEVATIONS OF CHANNEL CROSS SECTIONS.

| REVISIONS | DATE | LOCATION |
|---|---|---|
| AS BUILT | 1/26/93 | |

FED. PROJ. NO. 19

SHEET NO.




| | NAME | DATE |
|---|---|---|
| DESIGN | DNJ | 1/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ROUTE 143 SITE/KEY 1

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL ALIGNMENT

STA. 100+35 TO STA. 21+00

LOCATION HOHOKAM (UNIVERSITY-SKY HARBOR)

DWG. NO. CH-2.1

TRACS NO. H 2045 01C

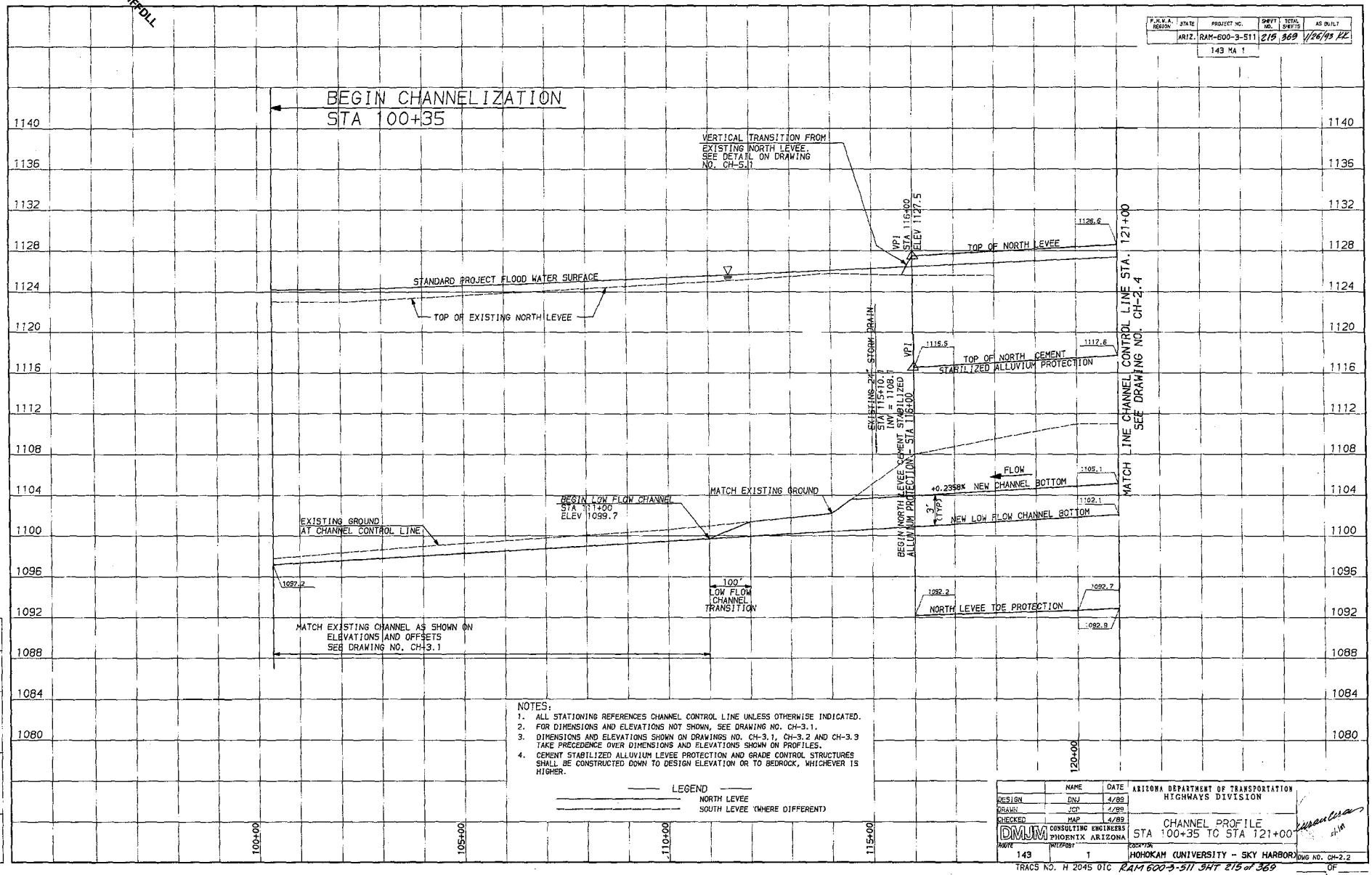
RAM 600-3-511 SHT. 214 of 369

OF

TRIAL VERSION of TIFFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 215 | 369 | 1/26/93 KK |

143 MA 1




NOTES:
1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE INDICATED.
2. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.1.
3. DIMENSIONS AND ELEVATIONS SHOWN ON DRAWINGS NO. CH-3.1, CH-3.2 AND CH-3.3 TAKE PRECEDENCE OVER DIMENSIONS AND ELEVATIONS SHOWN ON PROFILES.
4. CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION AND GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICHEVER IS HIGHER.

LEGEND
NORTH LEVEE
SOUTH LEVEE (WHERE DIFFERENT)

| | NAME | DATE |
|---|---|---|
| DESIGN | DNJ | 4/99 |
| DRAWN | JCP | 4/99 |
| CHECKED | MAP | 4/99 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

CHANNEL PROFILE
STA 100+35 TO STA 121+00

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

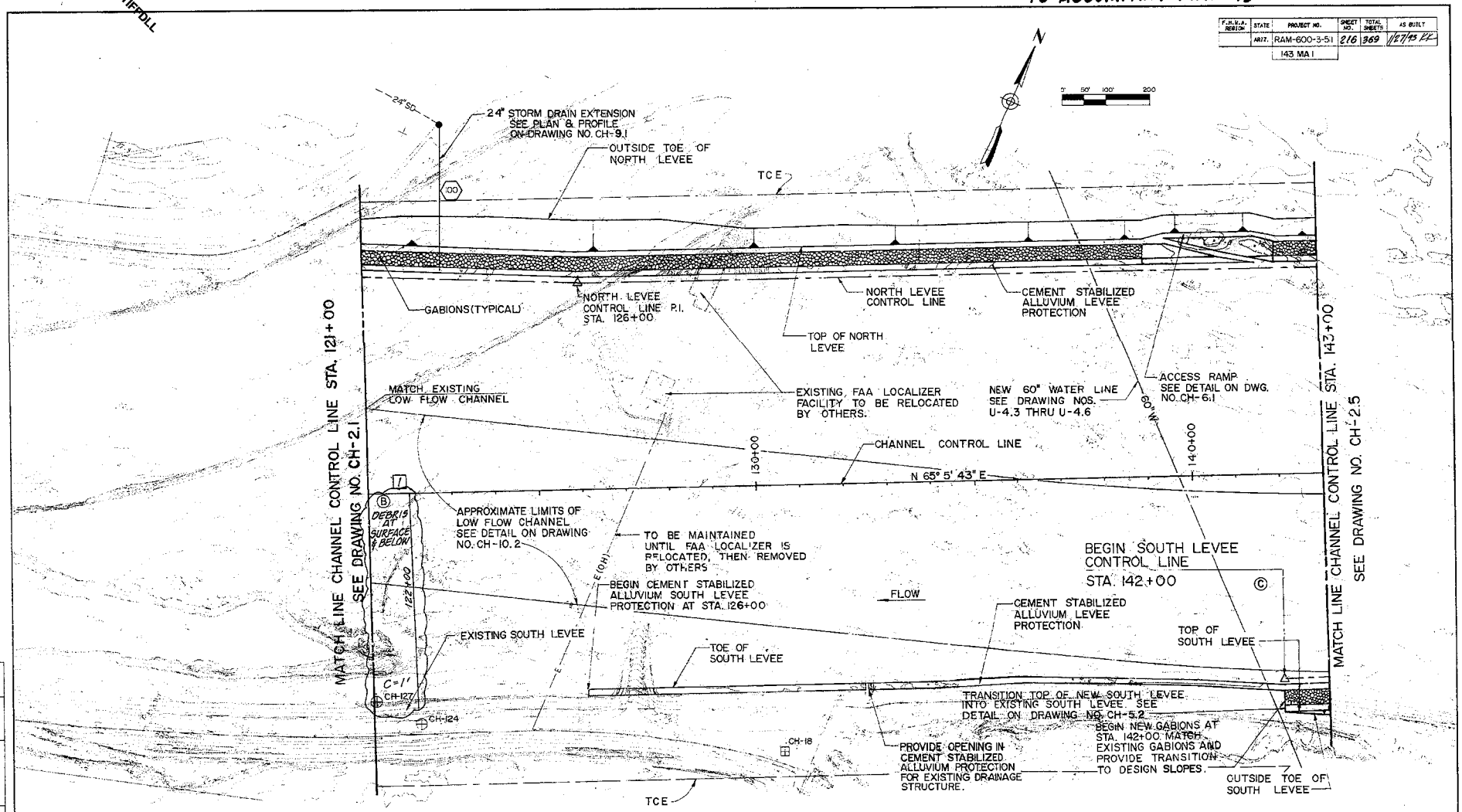
DWG NO. CH-2.2

TRACS NO. H 2045 01C RAM 600-3-511 SHT 215 of 369 ____ OF ____

TRIAL VERSION of TIFFDLL

TO ACCOMPANY F.A. #19

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 216 | 369 | 1/27/95 EK |
| | | 143 MA I | | | |




NOTES:

1.) ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

2.) REFER TO DRAWING NO. CH-3.1 THRU CH-3.3 FOR DIMENSIONS AND ELEVATIONS OF CHANNEL CROSS SECTIONS.

| DATE | ISSUE | DESCRIPTION |
|---|---|---|
| 1/95 | | AS-BUILT |

SHEET NO. 11 OF 11 SHEETS

KEY MAP

| | NAME | DATE |
|---|---|---|
| DESIGN | DNJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL ALIGNMENT

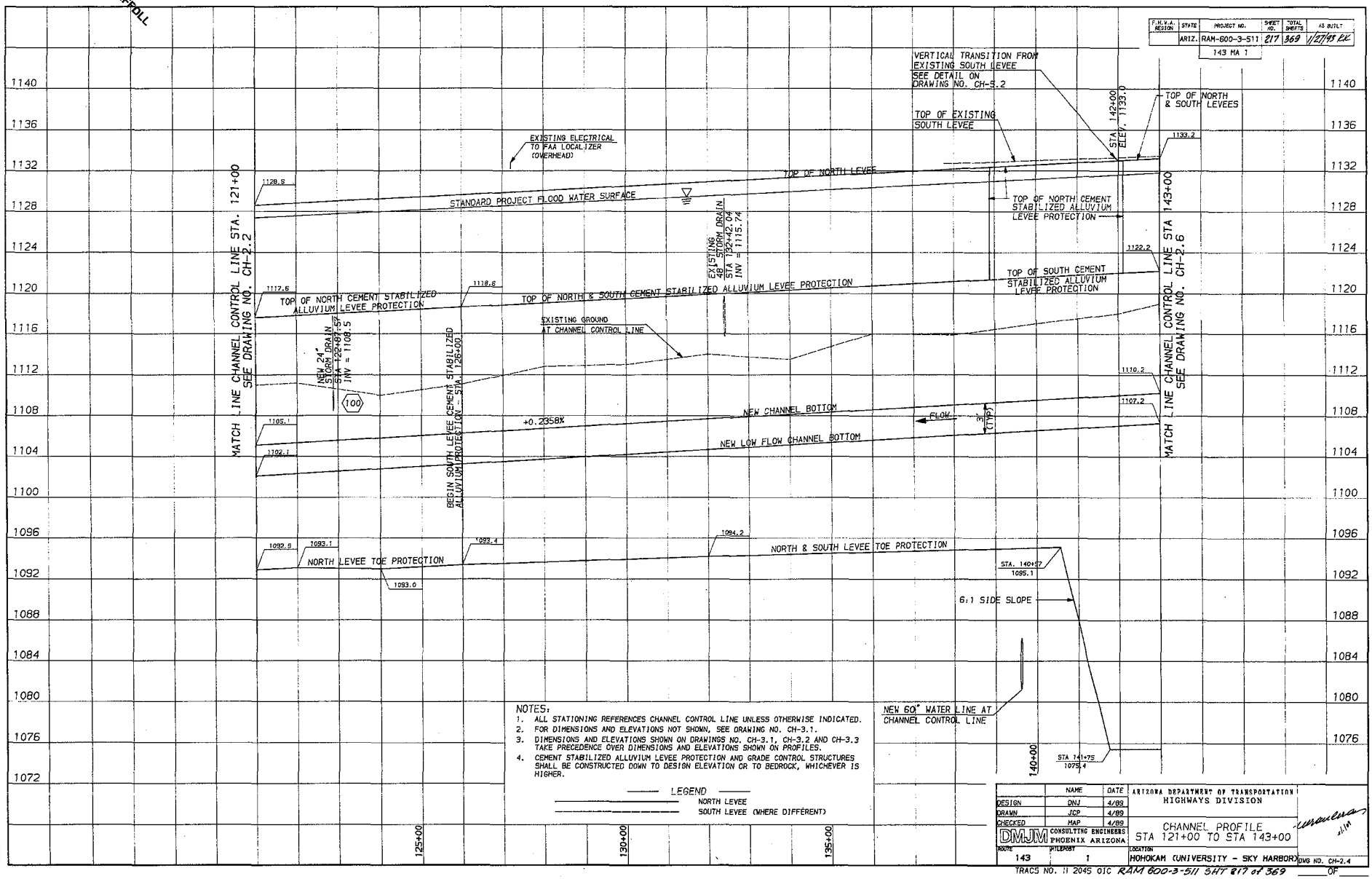
STA. 121+00 TO STA. 143+00

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY-SKY HARBOR) |

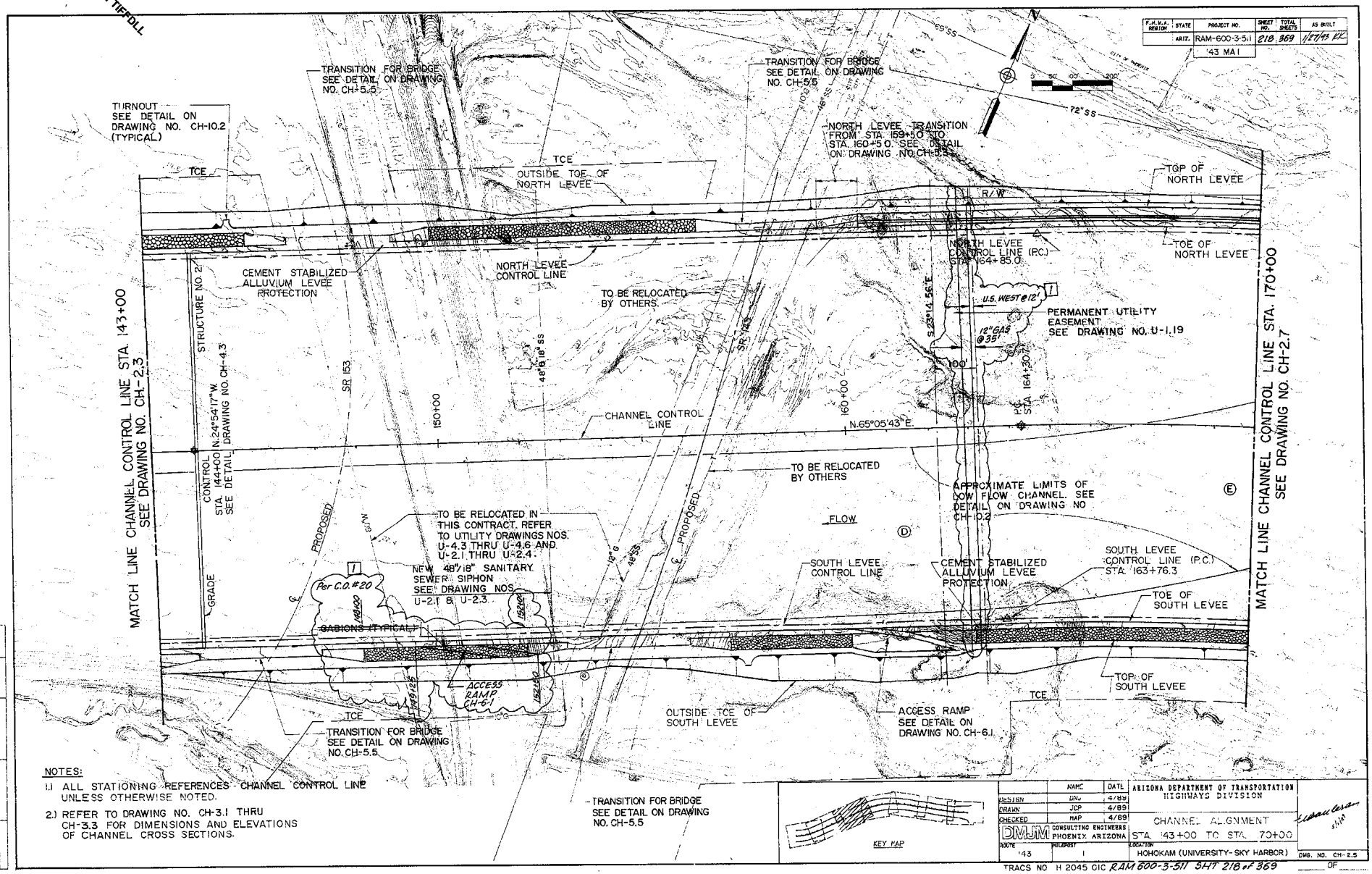
DWG. NO. CH-2.3

TRACS NO. H 2045 01C RAM 600-3-511 SHT. 216 of 369

TRIAL VERSION of TIFFOLL



TRIAL VERSION of TIEFDLL




| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 218 | 369 | 1/27/93 RC |

'43 MAI

NOTES:

1.) ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

2.) REFER TO DRAWING NO. CH-3.1 THRU CH-3.3 FOR DIMENSIONS AND ELEVATIONS OF CHANNEL CROSS SECTIONS.

| | NAME | DATE |
|---|---|---|
| DESIGN | DMJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL ALIGNMENT

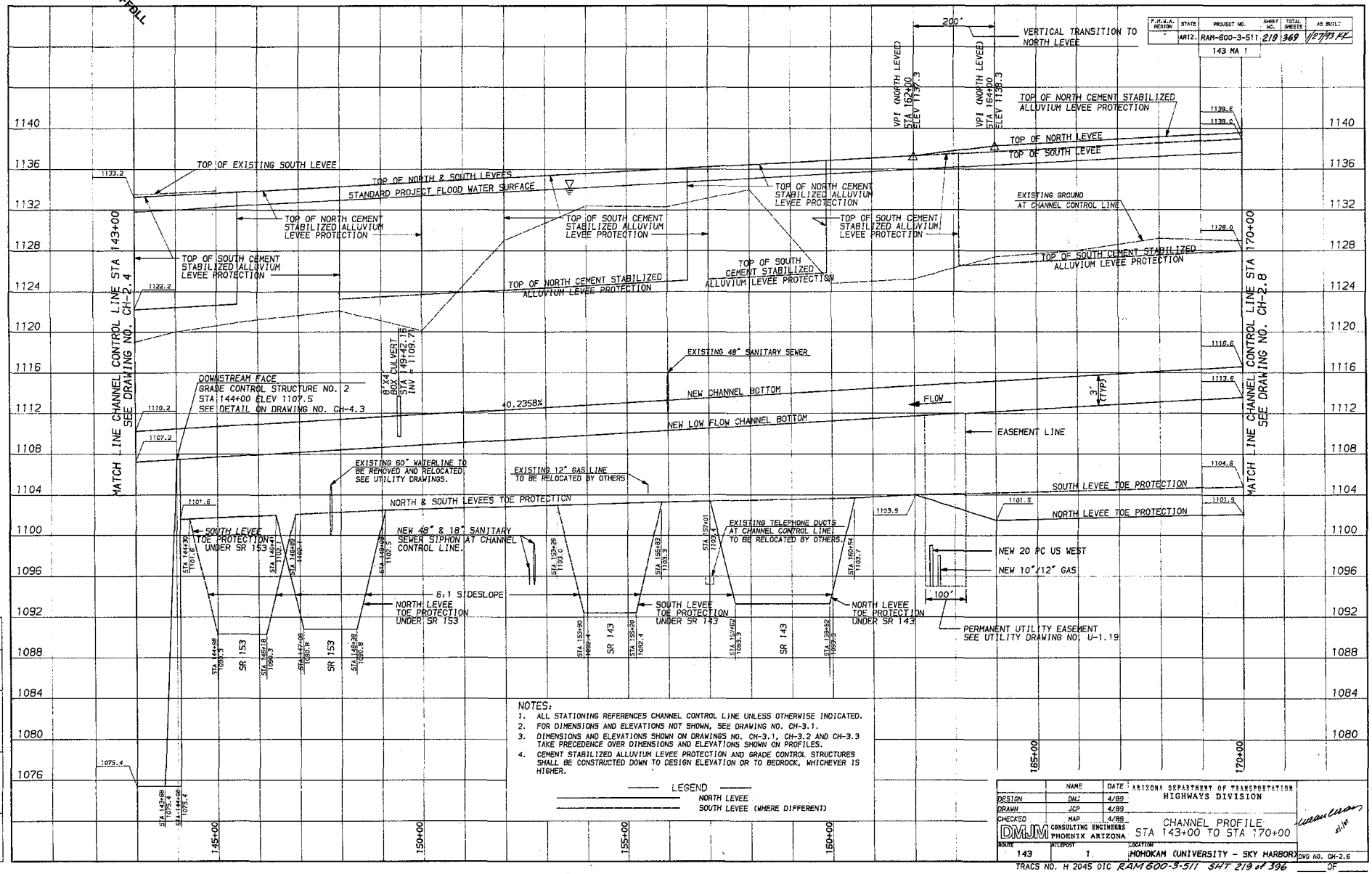
STA. 143+00 TO STA. 170+00

ROUTE '43 MILEPOST 1 LOCATION HOHOKAM (UNIVERSITY-SKY HARBOR)

DWG. NO. CH-2.5

TRACS NO H 2045 01C RAM 600-3-511 SHT 218 OF 369

TRIAL VERSION of TIFFOLL




NOTES:

1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE INDICATED.
2. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.1.
3. DIMENSIONS AND ELEVATIONS SHOWN ON DRAWINGS NO. CH-3.1, CH-3.2 AND CH-3.3 TAKE PRECEDENCE OVER DIMENSIONS AND ELEVATIONS SHOWN ON PROFILES.
4. CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION AND GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICHEVER IS HIGHER.

LEGEND
NORTH LEVEE
SOUTH LEVEE (WHERE DIFFERENT)

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| - | ARIZ. | RAM-600-3-511 | 219 | 369 | 10/7/93 KF |

143 MA 1

| | NAME | DATE |
|---|---|---|
| DESIGN | DNJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

CHANNEL PROFILE
STA 143+00 TO STA 170+00

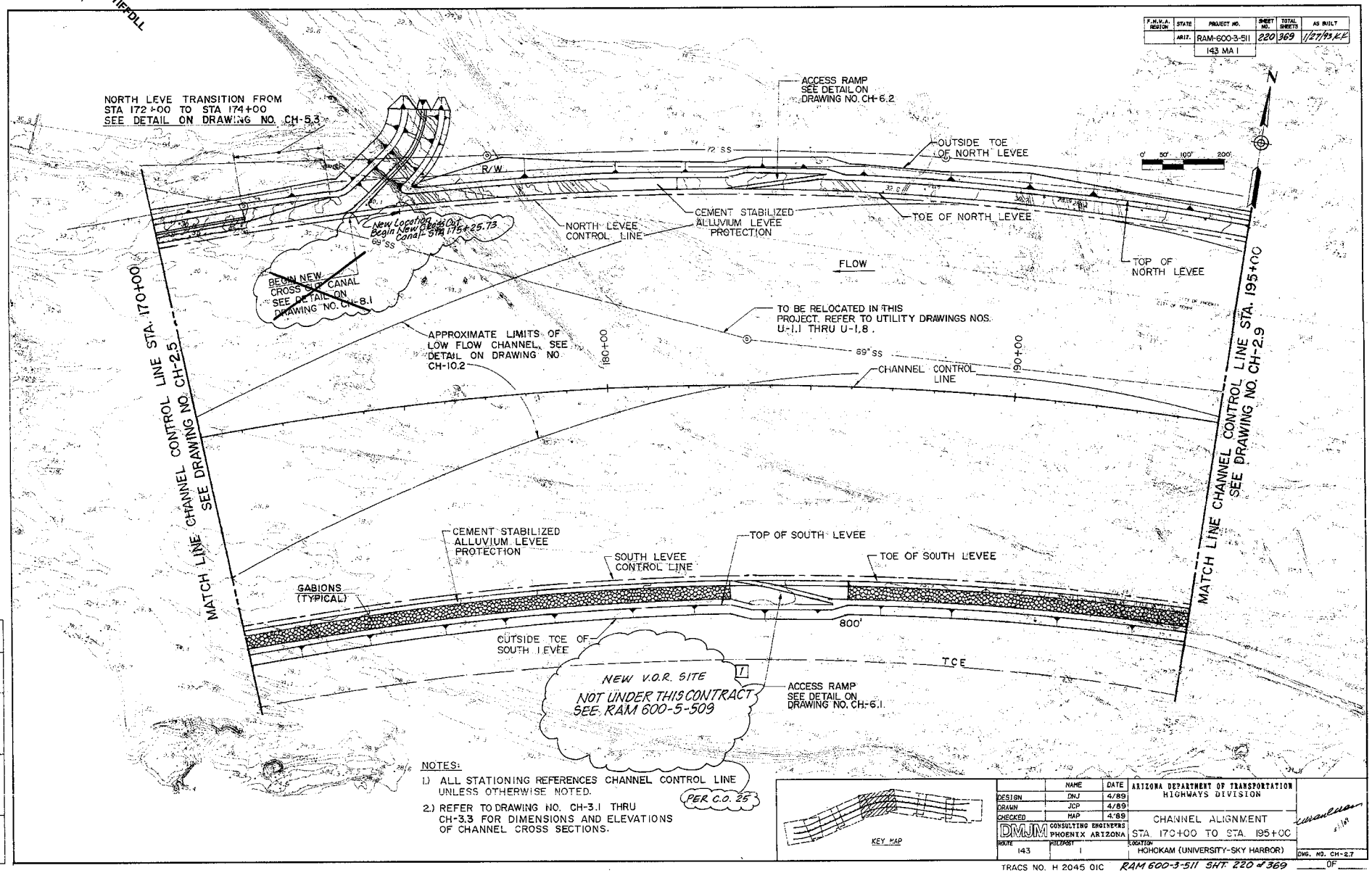
| ROUTE | MILEPOST | LOCATION | DWG NO. |
|---|---|---|---|
| 143 | 1. | HOHOKAM (UNIVERSITY - SKY HARBOR) | CH-2.6 |

TRACS NO. H 2045 01C RAM 600-3-511 SHT 219 of 396 OF

| SHEET NO. | TIN/BID PLANS | REVISIONS | LOCATION | DATE |
|---|---|---|---|---|

TRIAL VERSION of TIEFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 220 | 369 | 1/27/93 KE |
| | | 143 MA 1 | | | |




NOTES:

1) ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

2.) REFER TO DRAWING NO. CH-3.1 THRU CH-3.3 FOR DIMENSIONS AND ELEVATIONS OF CHANNEL CROSS SECTIONS.

PER C.O. 25

KEY MAP

| | NAME | DATE |
|---|---|---|
| DESIGN | DNJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL ALIGNMENT

STA. 170+00 TO STA. 195+00

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY-SKY HARBOR) |

DWG. NO. CH-2.7

TRACS NO. H 2045 01C RAM 600-3-511 SHT. 220 of 369

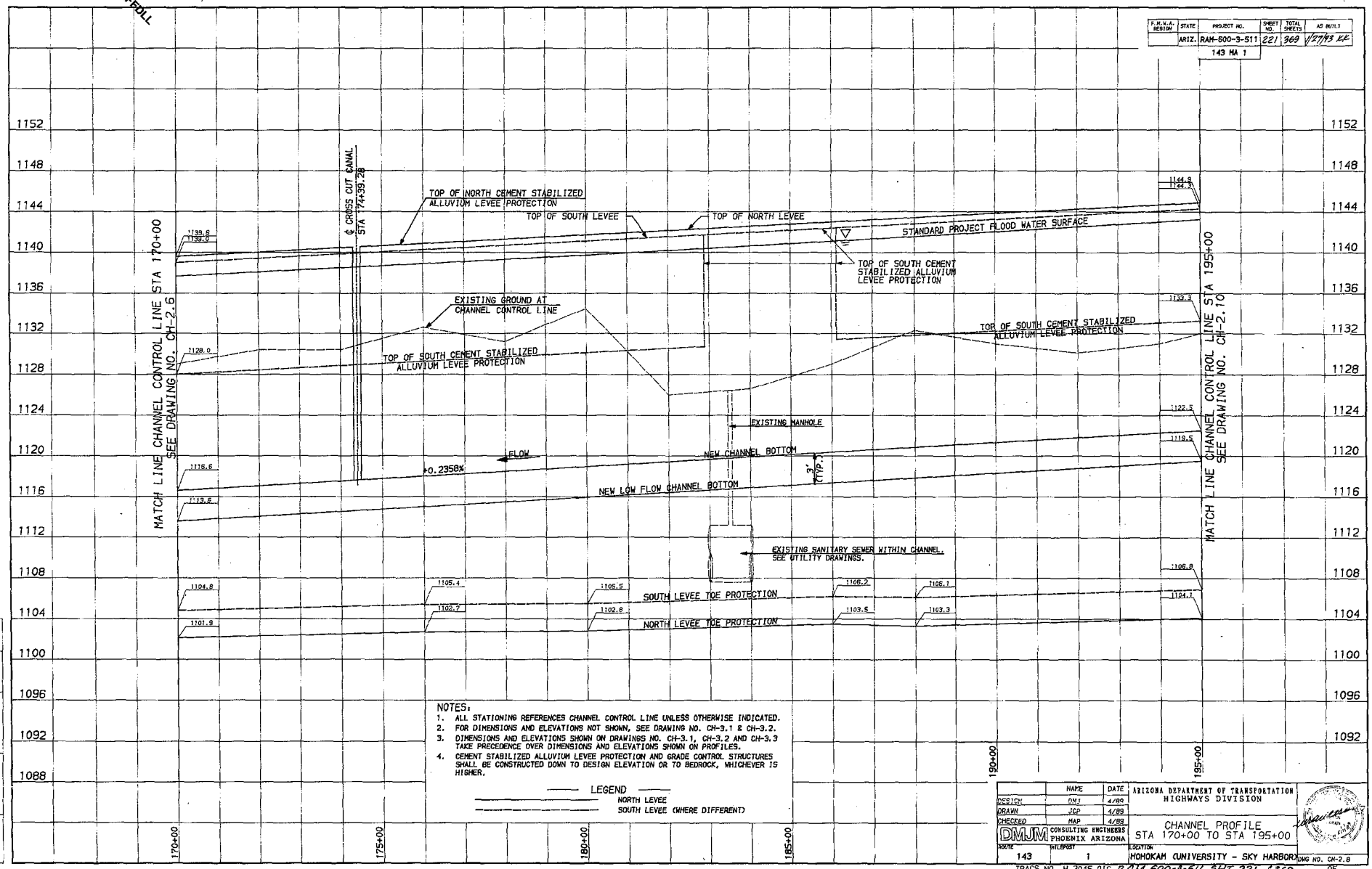
AS-BUILT 1/27/93

SHEET NO. 11

TRIAL VERSION of TIFFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 221 | 369 | 1/27/93 KE |

143 MA 1




NOTES:

1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE INDICATED.
2. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.1 & CH-3.2.
3. DIMENSIONS AND ELEVATIONS SHOWN ON DRAWINGS NO. CH-3.1, CH-3.2 AND CH-3.3 TAKE PRECEDENCE OVER DIMENSIONS AND ELEVATIONS SHOWN ON PROFILES.
4. CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION AND GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICHEVER IS HIGHER.

LEGEND

NORTH LEVEE

SOUTH LEVEE (WHERE DIFFERENT)

| | NAME | DATE |
|---|---|---|
| DESIGN | DMJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL PROFILE STA 170+00 TO STA 195+00

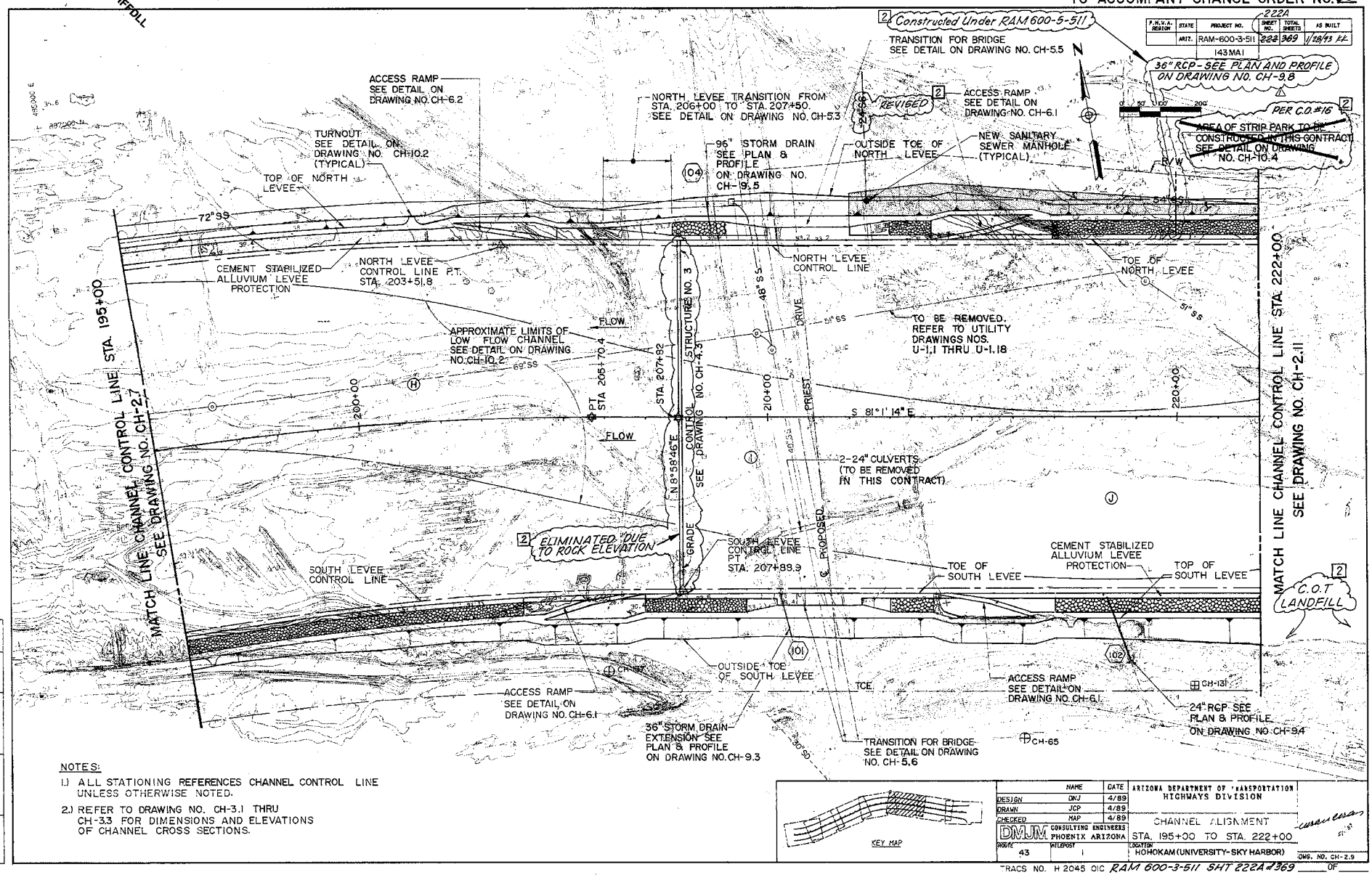
| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM CUNIVERSITY - SKY HARBOR |

DWG NO. CH-2.8

TRACS NO. H 2045 01C RAM 600-3-511 SHT 221 of 369 OF

TRIAL VERSION of TIFFDLL

TO ACCOMPANY CHANGE ORDER NO. 30




| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 222A | 369 | 11/28/93 EF |
| | | 143 MA I | | | |

NOTES:

1.) ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

2.) REFER TO DRAWING NO. CH-3.1 THRU CH-3.3 FOR DIMENSIONS AND ELEVATIONS OF CHANNEL CROSS SECTIONS.

KEY MAP

| | NAME | DATE |
|---|---|---|
| DESIGN | DMJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL ALIGNMENT

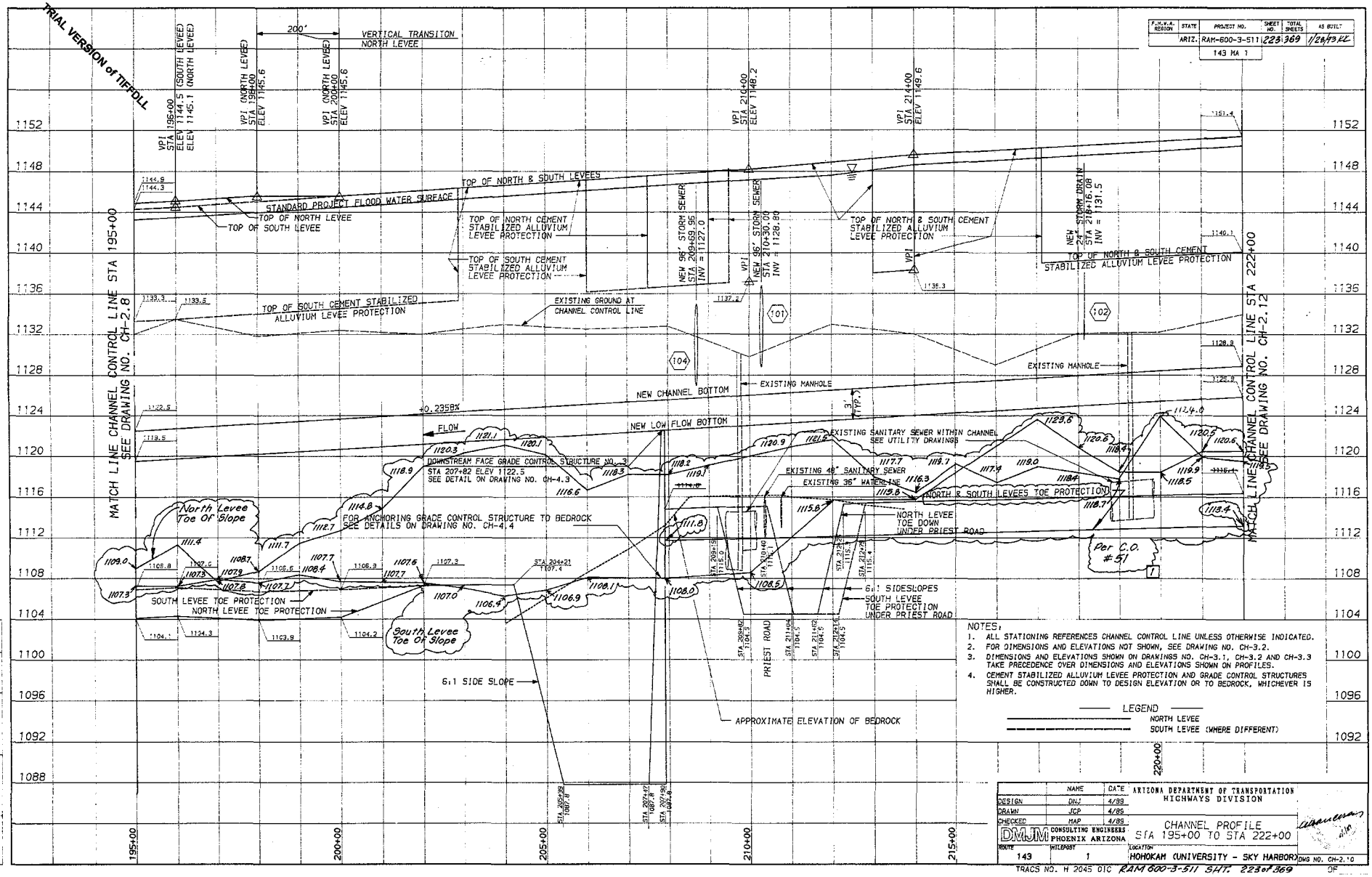
STA. 195+00 TO STA. 222+00

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 43 | 1 | HOHOKAM (UNIVERSITY-SKY HARBOR) |

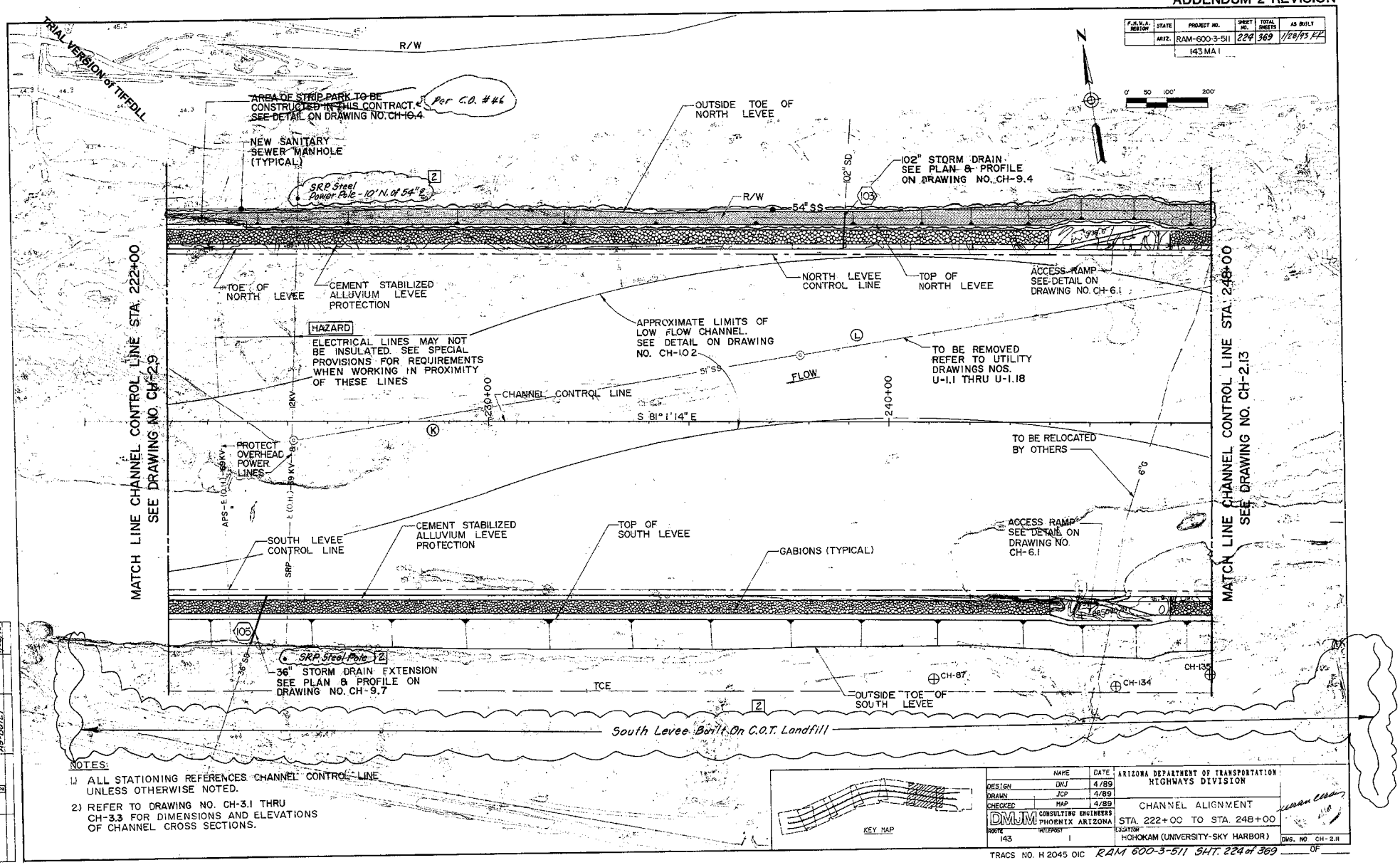
DWG. NO. CH-2.9

TRACS NO. H 2045 01C RAM 600-3-511 SHT 222A 369 OF

| DATE | BY | DESCRIPTION |
|---|---|---|
| 11/93 | EF | AS BUILT |
| 12/93 | | |
| | | |
| | | |
|


TRIAL VERSION of TIEFDLL
F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT
ARIZ. RAM-600-3-511 223 369 1/28/99 EL
143 MA 1
VERTICAL TRANSITON NORTH LEVEE
200'
VPI STA 196+00 ELEV 1144.5 (SOUTH LEVEE) ELEV 1145.1 (NORTH LEVEE)
VPI (NORTH LEVEE) STA 198+00 ELEV 1145.6
VPI (NORTH LEVEE) STA 200+00 ELEV 1145.6
VPI STA 210+00 ELEV 1148.2
VPI STA 214+00 ELEV 1149.6
TOP OF NORTH & SOUTH LEVEES
STANDARD PROJECT FLOOD WATER SURFACE
TOP OF NORTH LEVEE
TOP OF SOUTH LEVEE
TOP OF NORTH CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION
TOP OF SOUTH CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION
NEW 96" STORM SEWER STA 209+69.96 INV = 1127.0
NEW 96" STORM SEWER STA 210+30.00 INV = 1128.80
TOP OF NORTH & SOUTH CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION
NEW STORM DRAIN STA 216+16.08 INV = 1131.5
TOP OF NORTH & SOUTH CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION
TOP OF SOUTH CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION
EXISTING GROUND AT CHANNEL CONTROL LINE
MATCH LINE CHANNEL CONTROL LINE STA 195+00 SEE DRAWING NO. CH-2.8
MATCH LINE CHANNEL CONTROL LINE STA 222+00 SEE DRAWING NO. CH-2.12
EXISTING MANHOLE
NEW CHANNEL BOTTOM
+0.235BX
3' TYP.
FLOW
NEW LOW FLOW BOTTOM
EXISTING SANITARY SEWER WITHIN CHANNEL SEE UTILITY DRAWINGS
DOWNSTREAM FACE GRADE CONTROL STRUCTURE NO. 3 STA 207+82 ELEV 1122.5 SEE DETAIL ON DRAWING NO. CH-4.3
EXISTING 48" SANITARY SEWER
EXISTING 36" WATER LINE
NORTH & SOUTH LEVEES TOE PROTECTION
FOR ANCHORING GRADE CONTROL STRUCTURE TO BEDROCK SEE DETAILS ON DRAWING NO. CH-4.4
NORTH LEVEE TOE DOWN UNDER PRIEST ROAD
Per C.O. #51
North Levee Toe Of Slope
South Levee Toe Of Slope
SOUTH LEVEE TOE PROTECTION
NORTH LEVEE TOE PROTECTION
6:1 SIDESLOPES
SOUTH LEVEE TOE PROTECTION UNDER PRIEST ROAD
PRIEST ROAD
6:1 SIDE SLOPE
APPROXIMATE ELEVATION OF BEDROCK
101
102
104
NOTES,
1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE INDICATED.
2. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.2.
3. DIMENSIONS AND ELEVATIONS SHOWN ON DRAWINGS NO. CH-3.1, CH-3.2 AND CH-3.3 TAKE PRECEDENCE OVER DIMENSIONS AND ELEVATIONS SHOWN ON PROFILES.
4. CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION AND GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICHEVER IS HIGHER.
LEGEND
NORTH LEVEE
SOUTH LEVEE (WHERE DIFFERENT)
NAME | DATE
DESIGN DMJ 4/99
DRAWN JCP 4/85
CHECKED MAP 4/85
ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION
DMJM CONSULTING ENGINEERS PHOENIX ARIZONA
CHANNEL PROFILE STA 195+00 TO STA 222+00
ROUTE 143 | MILEPOST 1 | LOCATION HOHOKAM (UNIVERSITY - SKY HARBOR)
DWG NO. CH-2.10
TRACS NO. H 2045 DIC RAM 600-3-511 SHT. 223 of 369
SHEET NO. 10 | TRACING FILE AS-BUILT | REVISIONS | DATE | CONTROL | DATE 1/28/99

ADDENDUM 2 REVISION




| F.A.R.V.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 224 | 369 | 1/28/93 RP |
| | | 143 MA I | | | |

NOTES:

1.) ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

2.) REFER TO DRAWING NO. CH-3.1 THRU CH-3.3 FOR DIMENSIONS AND ELEVATIONS OF CHANNEL CROSS SECTIONS.




| | NAME | DATE |
|---|---|---|
| DESIGN | DNJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ROUTE 143 | MILEPOST 1

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL ALIGNMENT

STA. 222+00 TO STA. 248+00

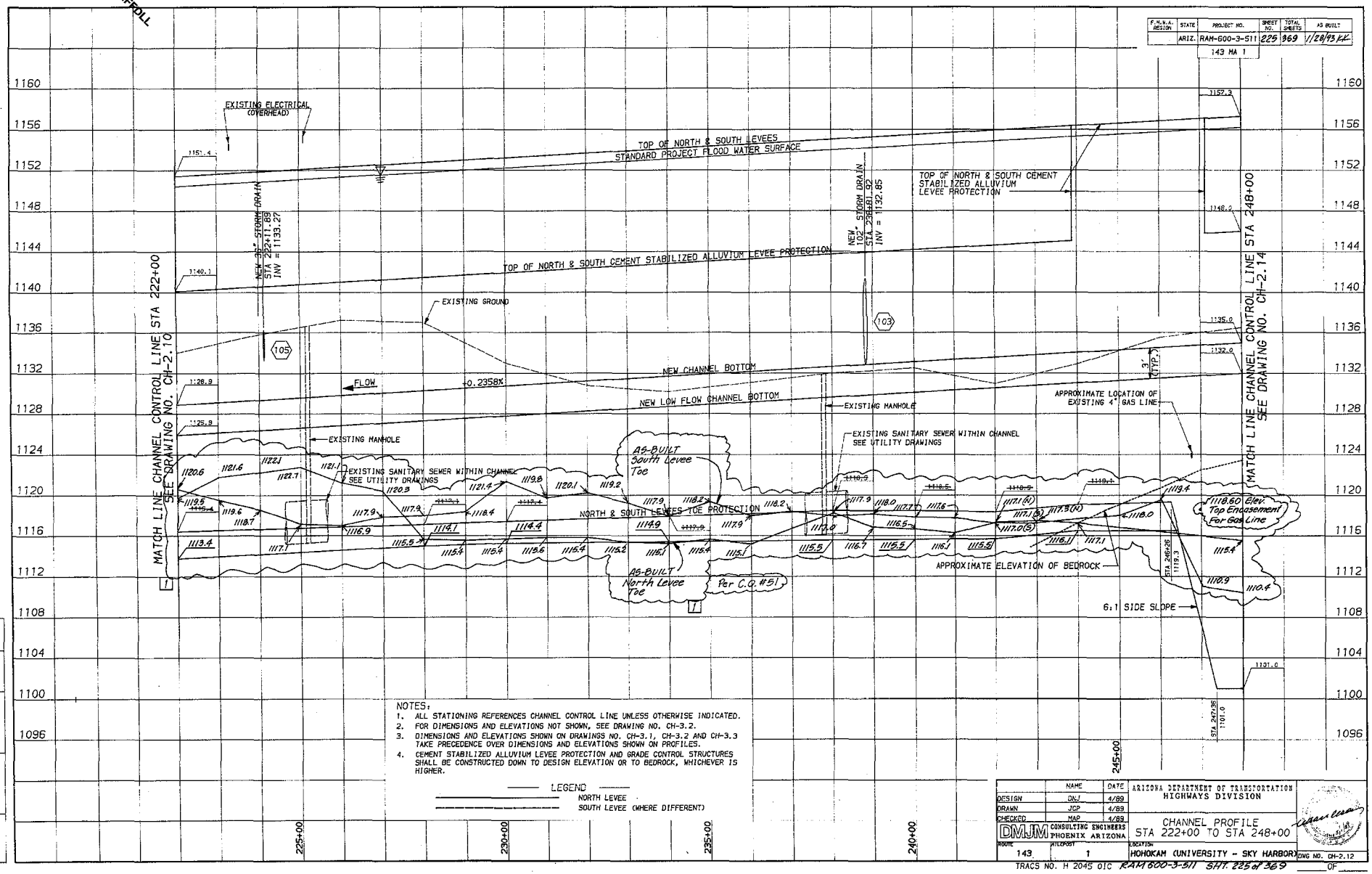
LOCATION HOHOKAM (UNIVERSITY-SKY HARBOR)

DWG. NO CH-2.11

TRACS NO. H 2045 01C RAM 600-3-511 SHT. 224 of 369 OF

| DATE | LOCATION | REVISIONS | FINISHED PLANS | SHEET NO. |
|---|---|---|---|---|
| 5-89 | 1/28/93 | AS-BUILT | 12 | |

TRIAL VERSION of TIFFOLL




| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 225 | 369 | 11/28/95 KK |

143 MA 1

NOTES:
1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE INDICATED.
2. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.2.
3. DIMENSIONS AND ELEVATIONS SHOWN ON DRAWINGS NO. CH-3.1, CH-3.2 AND CH-3.3 TAKE PRECEDENCE OVER DIMENSIONS AND ELEVATIONS SHOWN ON PROFILES.
4. CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION AND GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICHEVER IS HIGHER.

LEGEND
NORTH LEVEE
SOUTH LEVEE (WHERE DIFFERENT)

| | NAME | DATE |
|---|---|---|
| DESIGN | DMJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

CHANNEL PROFILE
STA 222+00 TO STA 248+00

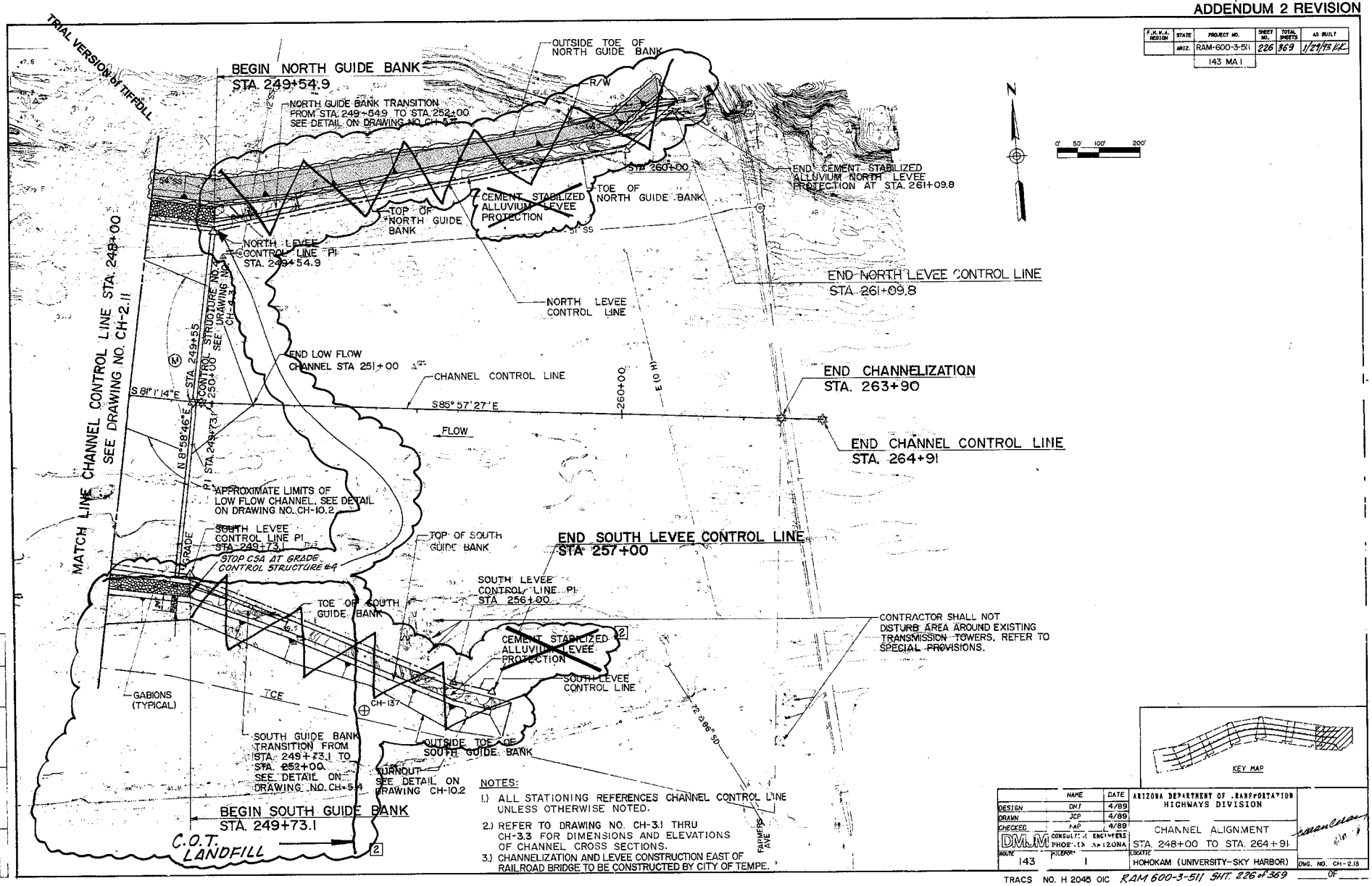
| ROUTE | INTERCHANGE | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

DWG NO. CH-2.12

TRACS NO. H 2045 01C RAM600-3-511 SHT. 225 of 369 ____ OF ____

FINISH PLANS 11/28/95 — LOCATION — REVISIONS AS-BUILT — SHEET NO.

ADDENDUM 2 REVISION




NOTES:

1.) ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

2.) REFER TO DRAWING NO. CH-3.1 THRU CH-3.3 FOR DIMENSIONS AND ELEVATIONS OF CHANNEL CROSS SECTIONS.

3.) CHANNELIZATION AND LEVEE CONSTRUCTION EAST OF RAILROAD BRIDGE TO BE CONSTRUCTED BY CITY OF TEMPE.

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 226 | 369 | 1/29/93 KL |
| | | 143 MA I | | | |

KEY MAP

| | NAME | DATE |
|---|---|---|
| DESIGN | DNT | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DM&M CONSULTING ENGINEERS PHOENIX, ARIZONA

ROUTE 143 MILEPOST 1

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

CHANNEL ALIGNMENT
STA. 248+00 TO STA. 264+91

LOCATION HOHOKAM (UNIVERSITY-SKY HARBOR)

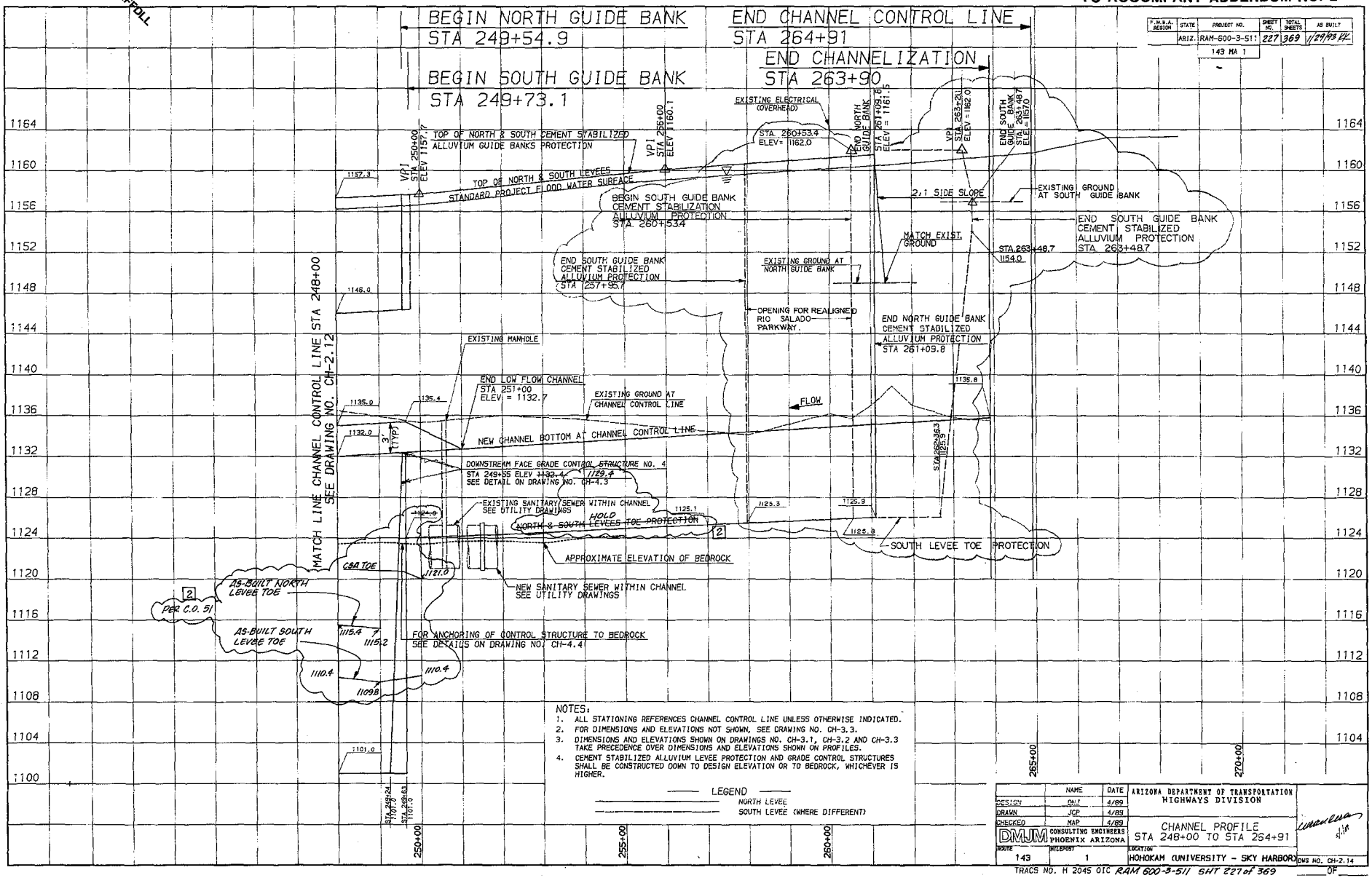
DWG. NO. CH-2.13

SHEET NO. OF

TRACS NO. H 2045 01C RAM 600-3-511 SHT. 226 of 369

TRIAL VERSION of TIFFDLL

**TO ACCOMPANY ADDENDUM NO. 2**




NOTES:
1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE INDICATED.
2. FOR DIMENSIONS AND ELEVATIONS NOT SHOWN, SEE DRAWING NO. CH-3.3.
3. DIMENSIONS AND ELEVATIONS SHOWN ON DRAWINGS NO. CH-3.1, CH-3.2 AND CH-3.3 TAKE PRECEDENCE OVER DIMENSIONS AND ELEVATIONS SHOWN ON PROFILES.
4. CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION AND GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICHEVER IS HIGHER.

LEGEND
NORTH LEVEE
SOUTH LEVEE (WHERE DIFFERENT)

| | NAME | DATE |
|---|---|---|
| DESIGN | DMJ | 4/89 |
| DRAWN | JCP | 4/89 |
| CHECKED | MAP | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION

CHANNEL PROFILE STA 248+00 TO STA 264+91

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

DWG NO. CH-2.14

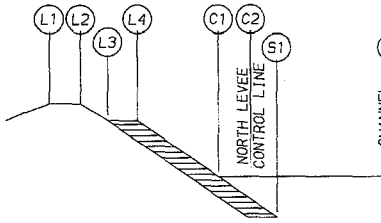
TRACS NO. H 2045 01C RAM 600-3-511 SHT 227 of 369

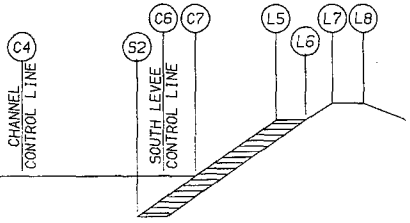
| DATE | LOCATION | REVISIONS | STRUCTURE NO. | SURVEY NO. |
|---|---|---|---|---|
| MAR 2009 11/2022 | | AS-BUILT | 4 | |

TRIAL VERSION of TIFFDLL

| F.A.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 228 | 369 | 1/04/93 RF |
| | | 143 MA 1 | | | |

NORTH LEVEE



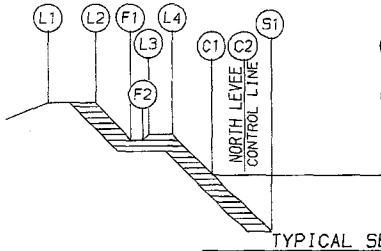



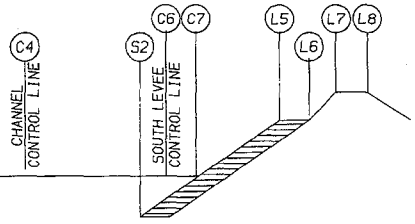

SOUTH LEVEE




## TYPICAL SECTIONS NO. 2
## STATION 100+35 TO STATION 160+00

NORTH LEVEE




SOUTH LEVEE




## TYPICAL SECTION NO. 3
## STATION 160+00 TO STATION 174+00

| STATION | L1 OFFSET (-) | L1 ELEVATION | L2 OFFSET (-) | L2 ELEVATION | F1 (-) | F1 ELEVATION | F2 OFFSET (-) | F2 ELEVATION | L3 OFFSET (-) | L3 ELEVATION | L4 OFFSET (-) | L4 ELEVATION | C1 OFFSET (-) | C1 ELEVATION | C2 OFFSET (-) | C2 ELEVATION | S1 OFFSET (-) | S1 ELEVATION | C4 OFFSET (+) | C4 ELEVATION | S2 OFFSET (+) | S2 ELEVATION | C6 OFFSET (+) | C6 ELEVATION | C7 OFFSET (+) | C7 ELEVATION | L5 OFFSET (+) | L5 ELEVATION | L6 OFFSET (+) | L6 ELEVATION | L7 OFFSET (+) | L7 ELEVATION | L8 OFFSET (+) | L8 ELEVATION | STATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TYPICAL SECTION NO. 2 - STATION 100+35 TO STATION 160+00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 100+35 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1097.2 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 100+35 |
| 102+00 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1097.6 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 102+00 |
| 104+00 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1098.1 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 104+00 |
| 106+00 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1098.5 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 106+00 |
| 108+00 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1098.9 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 108+00 |
| 110+00 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1099.5 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 110+00 |
| 112+00 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1103.0 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 112+00 |
| 114+00 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | # | # | ----- | ------ | 0 | 1103.4 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 114+00 |
| 116+00 | 582.6 | 1127.5 | 581.8 | 1127.5 | ----- | ------ | ----- | ------ | 548.8 | 1116.5 | 540.8 | 1116.5 | 521.9 | 1103.9 | 512.0 | 1103.9 | 504.4 | 1092.2 | 0 | 1103.9 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 116+00 |
| 118+00 | 582.6 | 1127.9 | 582.4 | 1127.9 | ----- | ------ | ----- | ------ | 549.4 | 1116.9 | 541.4 | 1116.9 | 522.6 | 1104.4 | 512.9 | 1104.4 | 504.6 | 1092.4 | 0 | 1104.4 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 118+00 |
| 120+00 | 582.5 | 1128.4 | 582.7 | 1128.4 | ----- | ------ | ----- | ------ | 549.7 | 1117.4 | 535.7 | 1117.4 | 516.8 | 1104.8 | 506.9 | 1104.8 | 498.7 | 1092.7 | 0 | 1104.8 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 120+00 |
| 121+00 | 581.7 | 1128.6 | 576.9 | 1128.6 | ----- | ------ | ----- | ------ | 537.9 | 1117.6 | 529.9 | 1117.6 | 511.1 | 1105.1 | 501.4 | 1105.1 | 492.8 | 1092.9 | 0 | 1105.1 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 121+00 |
| 122+00 | 576.0 | 1128.8 | 565.2 | 1128.8 | ----- | ------ | ----- | ------ | 532.2 | 1117.8 | 524.2 | 1117.8 | 505.4 | 1105.3 | 495.7 | 1105.3 | 487.1 | 1093.1 | 0 | 1105.3 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 122+00 |
| 124+00 | 564.4 | 1129.2 | 553.6 | 1129.2 | ----- | ------ | ----- | ------ | 520.6 | 1118.2 | 512.6 | 1118.2 | 494.0 | 1105.8 | 484.4 | 1105.8 | 474.6 | 1093.0 | 0 | 1105.8 | ----- | ------ | # | # | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 124+00 |
| 126+00 | 553.0 | 1129.8 | 542.2 | 1129.8 | ----- | ------ | ----- | ------ | 509.2 | 1118.6 | 501.2 | 1118.8 | 482.6 | 1106.2 | 473.0 | 1106.2 | 463.4 | 1093.4 | 0 | 1106.2 | xx | 1093.4 | ----- | ------ | xx | 1118.6 | xx | 1118.6 | ----- | ------ | ----- | ------ | ----- | ------ | 126+00 |
| 128+00 | 553.0 | 1130.0 | 542.2 | 1130.0 | ----- | ------ | ----- | ------ | 509.2 | 1119.1 | 501.2 | 1119.1 | 482.6 | 1106.7 | 473.0 | 1106.7 | 463.1 | 1093.7 | 0 | 1106.7 | xx | 1106.7 | ----- | ------ | xx | 1119.1 | xx | 1119.1 | ----- | ------ | ----- | ------ | ----- | ------ | 128+00 |
| 130+00 | 552.7 | 1130.5 | 541.9 | 1130.5 | ----- | ------ | ----- | ------ | 508.9 | 1119.5 | 500.9 | 1119.5 | 482.4 | 1107.2 | 473.0 | 1107.2 | 462.5 | 1093.9 | 0 | 1107.2 | xx | 1093.9 | ----- | ------ | xx | 1119.5 | xx | 1119.5 | ----- | ------ | ----- | ------ | ----- | ------ | 130+00 |
| 132+00 | 552.4 | 1130.9 | 541.6 | 1130.9 | ----- | ------ | ----- | ------ | 508.6 | 1119.9 | 500.6 | 1119.9 | 482.3 | 1107.7 | 473.0 | 1107.7 | 462.1 | 1094.2 | 0 | 1107.7 | xx | 1094.2 | ----- | ------ | xx | 1119.9 | xx | 1119.9 | ----- | ------ | ----- | ------ | ----- | ------ | 132+00 |
| 134+00 | 552.4 | 1131.3 | 541.6 | 1131.3 | ----- | ------ | ----- | ------ | 508.6 | 1120.3 | 500.6 | 1120.3 | 482.3 | 1108.1 | 473.0 | 1108.1 | 461.8 | 1094.3 | 0 | 1108.1 | xx | 1094.3 | ----- | ------ | xx | 1120.3 | xx | 1120.3 | ----- | ------ | ----- | ------ | ----- | ------ | 134+00 |
| 136+00 | 552.4 | 1131.8 | 541.6 | 1131.8 | ----- | ------ | ----- | ------ | 508.6 | 1120.8 | 500.6 | 1120.8 | 482.3 | 1108.6 | 473.0 | 1108.6 | 461.2 | 1094.5 | 0 | 1108.6 | xx | 1094.5 | ----- | ------ | xx | 1120.8 | xx | 1120.8 | ----- | ------ | ----- | ------ | ----- | ------ | 136+00 |
| 138+00 | 552.1 | 1132.2 | 541.3 | 1132.2 | ----- | ------ | ----- | ------ | 508.3 | 1121.2 | 500.3 | 1121.2 | 482.1 | 1109.1 | 473.0 | 1109.1 | 460.7 | 1094.8 | 0 | 1109.1 | xx | 1094.8 | ----- | ------ | xx | 1121.2 | xx | 1121.2 | ----- | ------ | ----- | ------ | ----- | ------ | 138+00 |
| 140+00 | #### | 1132.6 | #### | 1132.6 | ----- | ------ | ----- | ------ | #### | #### | #### | #### | 481.6 | 1109.5 | 473.0 | 1109.5 | 460.5 | 1095.1 | 0 | 1109.5 | xx | 1095.1 | ----- | ------ | xx | 1121.6 | xx | 1121.6 | ----- | ------ | ----- | ------ | ----- | ------ | 140+00 |
| 140+57 | #### | 1132.7 | #### | 1132.7 | ----- | ------ | ----- | ------ | #### | #### | #### | #### | 481.0 | 1109.7 | 473.0 | 1109.7 | 460.1 | 1095.1 | 0 | 1109.7 | xx | 1095.1 | ----- | ------ | xx | 1121.7 | xx | 1121.7 | ----- | ------ | ----- | ------ | ----- | ------ | 140+57 |
| 141+75 | #### | 1133.0 | #### | 1133.0 | ----- | ------ | ----- | ------ | #### | #### | #### | #### | 482.0 | 1110.0 | 473.0 | 1110.0 | 430.1 | 1075.4 | 0 | 1110.0 | xx | 1075.4 | ----- | ------ | xx | 1110.0 | xx | 1122.0 | xx | 1122.0 | ----- | ------ | ----- | ------ | 141+75 |
| 142+00 | #### | 1133.0 | #### | 1133.0 | ----- | ------ | ----- | ------ | #### | #### | #### | #### | 482.0 | 1110.0 | 473.0 | 1110.0 | 430.1 | 1075.4 | 0 | 1110.0 | 430.1 | 1075.4 | 473.0 | 1110.0 | 482.0 | 1110.0 | 500.0 | 1122.0 | 508.0 | 1122.0 | 541.0 | 1133.0 | 551.8 | 1133.0 | 142+00 |
| 144+00 | 551.8 | 1133.5 | 541.0 | 1133.5 | ----- | ------ | ----- | ------ | 508.0 | 1122.5 | 500.0 | 1122.5 | 482.0 | 1110.5 | 473.0 | 1110.5 | 429.5 | 1075.4 | 0 | 1110.5 | 429.5 | 1075.4 | 473.0 | 1110.5 | 482.0 | 1110.5 | ----- | ------ | ----- | ------ | 516.5 | 1133.5 | 551.8 | 1133.5 | 144+00 |
| 144+08 | 551.8 | 1133.5 | 541.0 | 1133.5 | ----- | ------ | ----- | ------ | 508.0 | 1122.5 | 500.0 | 1122.5 | 482.0 | 1110.5 | 473.0 | 1110.5 | 429.7 | 1101.6 | 0 | 1110.5 | 468.7 | 1101.6 | 473.0 | 1110.5 | 482.0 | 1110.5 | ----- | ------ | ----- | ------ | 516.5 | 1133.5 | 551.8 | 1133.5 | 144+08 |
| 144+30 | 551.8 | 1133.6 | 541.0 | 1133.6 | ----- | ------ | ----- | ------ | 508.0 | 1122.6 | 500.0 | 1122.6 | 482.0 | 1110.6 | 473.0 | 1110.6 | 468.5 | 1101.6 | 0 | 1110.6 | 468.5 | 1101.6 | 473.0 | 1110.6 | 482.0 | 1110.6 | ----- | ------ | ----- | ------ | 516.5 | 1133.6 | 551.8 | 1133.6 | 144+30 |
| 144+88 | 551.7 | 1133.7 | 540.9 | 1133.7 | ----- | ------ | ----- | ------ | 507.9 | 1122.7 | 499.9 | 1122.7 | 481.9 | 1110.7 | 473.0 | 1110.7 | 469.6 | 1101.6 | 0 | 1110.7 | 451.3 | 1090.3 | 473.0 | 1110.7 | 481.9 | 1110.7 | ----- | ------ | ----- | ------ | 516.4 | 1133.7 | 551.7 | 1133.7 | 144+88 |
| 146+00 | 551.5 | 1133.9 | ### | 1133.9 | ----- | ------ | ----- | ------ | ----- | ------ | 499.7 | 1122.9 | 481.9 | 1111.0 | 473.0 | 1111.0 | 468.6 | 1102.1 | 0 | 1111.0 | 450.9 | 1090.3 | 473.0 | 1111.0 | 481.9 | 1111.0 | ----- | ------ | ----- | ------ | 516.2 | 1133.9 | 551.5 | 1133.9 | 146+00 |
| 146+18 | 551.8 | 1134.0 | ### | 1134.0 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 482.0 | 1111.0 | 473.0 | 1111.0 | 468.7 | 1102.1 | 0 | 1111.0 | 451.0 | 1090.3 | 473.0 | 1111.0 | 482.0 | 1111.0 | ----- | ------ | ----- | ------ | 516.5 | 1134.0 | 551.8 | 1134.0 | 146+18 |
| 146+41 | 551.7 | 1134.0 | ### | 1134.0 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 482.0 | 1111.1 | 473.0 | 1111.1 | 468.5 | 1102.1 | 0 | 1111.1 | 457.3 | 1094.6 | 473.0 | 1111.1 | 482.0 | 1111.1 | ----- | ------ | ----- | ------ | 516.4 | 1134.0 | 551.7 | 1134.0 | 146+41 |
| 146+89 | 551.7 | 1134.1 | 516.4 | 1134.1 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 482.0 | 1111.2 | 473.0 | 1111.2 | 456.2 | 1094.0 | 0 | 1111.2 | 468.4 | 1102.1 | 473.0 | 1111.2 | 482.0 | 1111.2 | ----- | ------ | ----- | ------ | 516.4 | 1134.1 | 551.7 | 1134.1 | 146+89 |
| 147+08 | 551.6 | 1134.1 | 518.3 | 1134.1 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.8 | 1111.2 | 473.0 | 1111.2 | 451.3 | 1090.8 | 0 | 1111.2 | 468.3 | 1102.1 | 473.0 | 1111.2 | 481.9 | 1111.2 | ----- | ------ | ----- | ------ | ### | 1134.1 | 551.6 | 1134.1 | 147+08 |
| 148+00 | 551.5 | 1134.3 | 518.2 | 1134.3 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.8 | 1111.4 | 473.0 | 1111.4 | 450.9 | 1090.8 | 0 | 1111.4 | 468.2 | 1102.3 | 473.0 | 1111.4 | 481.8 | 1111.4 | 499.7 | 1123.3 | 507.7 | 1123.3 | 540.7 | 1134.3 | 551.5 | 1134.3 | 148+00 |
| 148+38 | 551.4 | 1134.4 | 518.1 | 1134.4 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.7 | 1111.5 | 473.0 | 1111.5 | 450.7 | 1090.8 | 0 | 1111.5 | 468.1 | 1102.4 | 473.0 | 1111.5 | 481.7 | 1111.5 | 499.6 | 1123.4 | 507.6 | 1123.4 | 540.6 | 1134.4 | 551.4 | 1134.4 | 148+38 |
| 149+08 | 551.3 | 1134.5 | ### | 1134.5 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.6 | 1111.7 | 473.0 | 1111.7 | 468.0 | 1102.5 | 0 | 1111.7 | 468.0 | 1102.5 | 473.0 | 1111.7 | 481.6 | 1111.7 | 499.5 | 1123.5 | 507.5 | 1123.5 | 540.5 | 1134.5 | 551.3 | 1134.5 | 149+08 |
| 150+00 | 551.2 | 1134.7 | 540.4 | 1134.7 | ----- | ------ | ----- | ------ | 507.4 | 1123.7 | 499.4 | 1123.7 | 481.6 | 1111.9 | 473.0 | 1111.9 | 467.8 | 1102.6 | 0 | 1111.9 | 467.8 | 1102.6 | 473.0 | 1111.9 | 481.7 | 1111.9 | 499.4 | 1123.7 | 507.4 | 1123.7 | 540.4 | 1134.7 | 551.2 | 1134.7 | 150+00 |
| 152+00 | 551.2 | 1135.2 | 540.4 | 1135.2 | ----- | ------ | ----- | ------ | 507.4 | 1124.2 | 499.4 | 1124.2 | 481.7 | 1112.4 | 473.0 | 1112.4 | 467.5 | 1102.9 | 0 | 1112.4 | 467.5 | 1102.9 | 473.0 | 1112.4 | 481.7 | 1112.4 | 499.4 | 1124.2 | 507.4 | 1124.2 | 540.4 | 1135.2 | 551.2 | 1135.2 | 152+00 |
| 153+26 | 551.2 | 1135.5 | 540.4 | 1135.5 | ----- | ------ | ----- | ------ | 507.4 | 1124.5 | 499.4 | 1124.5 | 481.7 | 1112.7 | 473.0 | 1112.7 | 467.2 | 1103.0 | 0 | 1112.7 | 467.2 | 1103.0 | 473.0 | 1112.7 | 481.7 | 1112.7 | ----- | ------ | ----- | ------ | 515.9 | 1135.5 | 551.2 | 1135.5 | 153+26 |
| 153+80 | 551.2 | 1135.6 | 540.4 | 1135.6 | ----- | ------ | ----- | ------ | 507.4 | 1124.6 | 499.4 | 1124.6 | 481.7 | 1112.8 | 473.0 | 1112.8 | 467.0 | 1103.2 | 0 | 1112.8 | 451.1 | 1092.4 | 473.0 | 1112.8 | 481.7 | 1112.8 | ----- | ------ | ----- | ------ | 515.9 | 1135.6 | 551.2 | 1135.6 | 153+80 |
| 154+00 | 551.2 | 1135.6 | 540.4 | 1135.6 | ----- | ------ | ----- | ------ | 507.4 | 1124.6 | 499.4 | 1124.6 | 481.7 | 1112.8 | 473.0 | 1112.8 | 467.3 | 1103.2 | 0 | 1112.8 | 451.1 | 1092.4 | 473.0 | 1112.8 | 481.7 | 1112.8 | ----- | ------ | ----- | ------ | 515.9 | 1135.6 | 551.2 | 1135.6 | 154+00 |
| 155+20 | 551.0 | 1135.8 | 540.2 | 1135.8 | ----- | ------ | ----- | ------ | 507.2 | 1124.8 | 499.2 | 1124.8 | 481.8 | 1113.1 | 473.0 | 1113.1 | 466.9 | 1103.3 | 0 | 1113.1 | 450.6 | 1092.4 | 473.0 | 1113.1 | 481.6 | 1113.1 | ----- | ------ | ----- | ------ | 515.7 | 1135.8 | 551.0 | 1135.8 | 155+20 |
| 155+83 | 550.9 | 1136.0 | 540.1 | 1136.0 | ----- | ------ | ----- | ------ | 507.1 | 1125.0 | 499.1 | 1125.0 | 481.5 | 1113.3 | 473.0 | 1113.3 | 466.5 | 1103.3 | 0 | 1113.3 | 466.5 | 1103.3 | 473.0 | 1113.3 | 481.5 | 1113.3 | ----- | ------ | ----- | ------ | 515.6 | 1136.0 | 550.9 | 1136.0 | 155+83 |
| 158+00 | 550.9 | 1136.0 | 540.1 | 1136.0 | ----- | ------ | ----- | ------ | 507.1 | 1125.0 | 499.1 | 1125.0 | 481.5 | 1113.3 | 473.0 | 1113.3 | 466.5 | 1103.3 | 0 | 1113.3 | 466.5 | 1103.3 | 473.0 | 1113.3 | 481.5 | 1113.3 | ----- | ------ | ----- | ------ | 515.6 | 1136.0 | 550.9 | 1136.0 | 156+00 |
| 157+01 | 550.6 | 1136.2 | ### | 1136.2 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.4 | 1113.6 | 473.0 | 1113.6 | 466.1 | 1103.4 | 0 | 1113.6 | 466.1 | 1103.4 | 473.0 | 1113.6 | 481.4 | 1113.6 | 498.8 | 1125.2 | 508.8 | 1125.2 | 539.8 | 1136.2 | 550.6 | 1136.2 | 157+01 |
| 157+62 | 550.6 | 1136.3 | 515.3 | 1136.3 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.4 | 1113.7 | 473.0 | 1113.7 | 450.8 | 1093.3 | 0 | 1113.7 | 466.1 | 1103.5 | 473.0 | 1113.7 | 481.4 | 1113.7 | 498.8 | 1125.3 | 508.8 | 1125.3 | 539.6 | 1136.3 | 550.6 | 1136.3 | 157+62 |
| 158+00 | 550.6 | 1136.4 | 515.3 | 1136.4 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.4 | 1113.8 | 473.0 | 1113.8 | 450.7 | 1093.3 | 0 | 1113.8 | 466.0 | 1103.5 | 473.0 | 1113.8 | 481.4 | 1113.8 | 498.8 | 1125.4 | 508.8 | 1125.4 | 539.6 | 1136.4 | 550.6 | 1136.4 | 158+00 |
| 159+92 | 550.8 | 1136.9 | ### | 1136.9 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.5 | 1114.2 | 473.0 | 1114.2 | 450.2 | 1093.3 | 0 | 1114.2 | 465.8 | 1103.7 | 473.0 | 1114.2 | 481.5 | 1114.2 | ----- | ------ | ----- | ------ | ##### | 1136.9 | #### | 1136.9 | 159+92 |
| 160+00 | 550.9 | 1136.9 | ### | 1136.9 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 481.5 | 1114.3 | 473.0 | 1114.3 | 452.1 | 1094.6 | 0 | 1114.3 | 465.8 | 1103.7 | 473.0 | 1114.3 | 481.5 | 1114.3 | ----- | ------ | ----- | ------ | ##### | 1136.9 | #### | 1136.9 | 160+00 |
| TYPICAL SECTION NO.3 - STATION 160+00 TO STATION 174+00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 160+54 | 546.8 | 1137.0 | 532.8 | 1137.0 | 511.8 | 1123.0 | 511.3 | 1123.0 | 505.8 | 1126.0 | 498.6 | 1126.0 | 481.4 | 1114.4 | 473.0 | 1114.4 | 465.4 | 1103.7 | 0 | 1114.4 | 465.4 | 1103.7 | 473.0 | 1114.4 | 481.4 | 1114.4 | #### | #### | #### | #### | #### | #### | 1137.0 | #### | 1137.0 | 160+54 |
| 162+00 | 546.8 | 1137.3 | 532.8 | 1137.3 | 511.8 | 1123.3 | 511.3 | 1123.3 | 506.8 | 1126.3 | 498.6 | 1126.3 | 481.4 | 1114.7 | 473.0 | 1114.7 | 465.2 | 1103.9 | 0 | 1114.7 | 465.2 | 1103.9 | 473.0 | 1114.7 | 481.4 | 1114.7 | #### | #### | #### | #### | #### | #### | 1137.3 | #### | 1137.3 | 162+00 |
| 164+00 | 547.4 | 1138.3 | 533.4 | 1138.3 | 511.5 | 1123.7 | 511.0 | 1123.7 | 506.5 | 1126.7 | 498.5 | 1126.7 | 481.2 | 1115.2 | 473.0 | 1115.2 | 460.7 | 1101.5 | 0 | 1115.2 | 464.9 | 1104.1 | 473.0 | 1115.2 | 481.2 | 1115.2 | 498.5 | 1127.1 | 507.5 | 1127.1 | 540.5 | 1138.1 | 551.3 | 1138.1 | 164+00 |
| 168+00 | 548.1 | 1138.7 | 534.1 | 1138.7 | 512.2 | 1124.1 | 511.7 | 1124.1 | 507.2 | 1127.1 | 498.2 | 1127.1 | 482.1 | 1115.7 | 474.0 | 1115.7 | 461.2 | 1101.8 | 0 | 1115.7 | 465.6 | 1104.5 | 474.3 | 1115.7 | 482.1 | 1115.7 | 498.5 | 1127.1 | 507.5 | 1127.1 | 540.5 | 1138.1 | 551.3 | 1138.1 | 168+00 |
| 169+54 | 548.2 | 1139.2 | 535.2 | 1139.2 | 513.3 | 1124.6 | 512.8 | 1124.6 | 508.3 | 1127.5 | 500.3 | 1127.6 | 483.2 | 1116.2 | 475.1 | 1116.2 | 462.1 | 1101.9 | 0 | 1116.2 | 466.0 | 1104.6 | 475.3 | 1116.2 | 483.4 | 1116.2 | 500.5 | 1127.6 | 508.5 | 1127.6 | 541.5 | 1138.6 | 552.3 | 1138.6 | 169+00 |
| 170+00 | 548.8 | 1139.6 | 535.9 | 1139.6 | 514.0 | 1125.0 | 513.5 | 1125.0 | 509.0 | 1128.0 | 501.0 | 1128.0 | 483.9 | 1116.6 | 475.8 | 1116.6 | 462.2 | 1102.1 | 0 | 1116.6 | 466.3 | 1104.8 | 475.8 | 1116.6 | 484.0 | 1116.6 | 501.1 | 1128.0 | 509.1 | 1128.0 | 542.1 | 1139.0 | 552.9 | 1139.0 | 170+00 |
| 172+00 | 549.9 | 1140.0 | 535.9 | 1140.0 | 514.0 | 1125.4 | 513.5 | 1125.4 | 509.0 | 1128.4 | 501.0 | 1128.4 | 484.0 | 1117.1 | 476.0 | 1117.1 | 462.0 | 1102.4 | 0 | 1117.1 | 466.6 | 1105.1 | 476.1 | 1117.1 | 484.0 | 1117.1 | 501.0 | 1128.4 | 509.0 | 1128.4 | 542.0 | 1139.4 | 552.8 | 1139.4 | 172+00 |
| 174+00 | ### | 1140.4 | ### | 1140.4 | ----- | ------ | ----- | ------ | ----- | ------ | ----- | ------ | 483.8 | 1117.6 | 476.0 | 1117.6 | 461.2 | 1102.5 | 0 | 1117.6 | 465.2 | 1105.2 | 476.0 | 1117.6 | 483.8 | 1117.6 | 500.8 | 1128.8 | 508.8 | 1128.8 | 541.6 | 1139.8 | 552.4 | 1139.8 | 174+00 |

\# MATCH EXISTING CHANNEL BOTTOM, SEE DRAWING NO. CH-1.4.

## PLACE CEMENT STABILIZED ALLUVIUM LEVEE PROTECTION OVER EXISTING GABION LEVEE PROTECTION.

### LOCATED WITHIN LEVEE TRANSITION, SEE DETAILS ON DRAWINGS NO. CH-5.1 THRU CH-5.6.

##### LOCATED WITHIN ACCESS RAMP, SEE DETAILS ON DRAWINGS NO. CH-8.1 AND CH-8.2.

NOTE: ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

| | NAME | DATE | ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION |
|---|---|---|---|
| DESIGN | DNJ | 4/93 | |
| DRAWN | SLB | 4/93 | |
| CHECKED | MAP | 4/93 | OFFSETS & ELEVATION SHEET |
| DMJM CONSULTING ENGINEERS PHOENIX ARIZONA | | | STA 100+35 TO STA 174+00 |
| ROUTE 143 | MILEPOST 1 | | LOCATION HOHOKAM (UNIVERSITY - SKY HARBOR) |

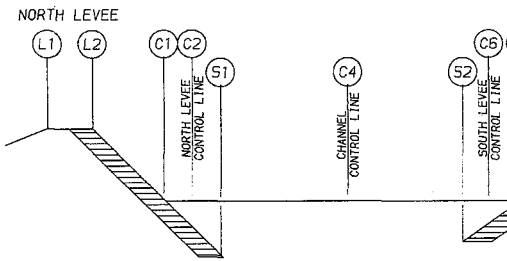
DWG. NO. CH-3.1

TRACS NO. H 2045 01C RAM 600-3-511 SHT 228 OF 369 OF

SURVEY NO. | FIELD BOOK | DES/DRWG | LOCATION | DATE

TRIAL VERSION of TIFFDLL

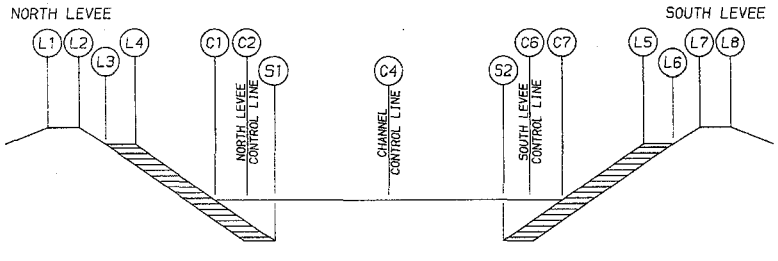
| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-500-3-511 | 229 | 369 | 1/29/93 KL |
| | | 143 MA 1 | | | |




TYPICAL SECTION NO. 4
STA 176+00 TO STA 206+00

51 Elevations Lower By 3' Or To Rock From Priest To Grade Control Str. #4

52 Elevations Lower By 3' Or To Rock From Priest East To Grade Control Structure #4




TYPICAL SECTION NO. 5
STA 206+00 TO STA 249+73.1

TYPICAL SECTION NO. 4 - STATION 176+00 TO STATION 206+00

| STATION | L1 OFFSET (-) | L1 ELEVATION | L2 OFFSET (-) | L2 ELEVATION | L3 OFFSET (-) | L3 ELEVATION | L4 OFFSET (-) | L4 ELEVATION | C1 OFFSET (-) | C1 ELEVATION | C2 OFFSET (-) | C2 ELEVATION | S1 OFFSET (-) | S1 ELEVATION | C4 OFFSET | C4 ELEVATION | S2 OFFSET (+) | S2 ELEVATION | C6 OFFSET (+) | C6 ELEVATION | C7 OFFSET (+) | C7 ELEVATION | L5 OFFSET (+) | L5 ELEVATION | L6 OFFSET (+) | L6 ELEVATION | L7 OFFSET (+) | L7 ELEVATION | L8 OFFSET (+) | L8 ELEVATION | STATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 176+00 | 531.7 | 1140.9 | 517.7 | 1140.6 | ----- | ------- | ----- | ------- | 483.3 | 1118.9 | 475.4 | 1118.0 | 480.4 | 1102.7 | 0.0 | 1118.0 | 464.5 | 1105.4 | 475.5 | 1118.0 | 483.4 | 1118.0 | 500.4 | 1128.3 | 508.4 | 1128.3 | 541.4 | 1140.3 | 552.2 | 1140.3 | 176+00 |
| 178+00 | 530.4 | 1141.3 | 518.4 | 1141.3 | ----- | ------- | ----- | ------- | 482.2 | 1118.5 | 474.4 | 1118.5 | 458.5 | 1102.7 | 0.0 | 1118.5 | 462.9 | 1105.4 | 474.7 | 1118.5 | 482.5 | 1118.5 | 499.3 | 1129.7 | 507.3 | 1129.7 | 540.3 | 1140.7 | 551.1 | 1140.7 | 178+00 |
| 180+00 | 528.8 | 1141.7 | 514.8 | 1141.7 | ----- | ------- | ----- | ------- | 480.7 | 1119.0 | 473.1 | 1119.0 | 456.4 | 1102.8 | 0.0 | 1119.0 | 460.9 | 1105.5 | 473.5 | 1119.0 | 481.1 | 1119.0 | 497.8 | 1130.1 | 505.8 | 1130.1 | 538.8 | 1141.1 | 549.6 | 1141.1 | 180+00 |
| 182+00 | 526.7 | 1142.1 | 512.7 | 1142.1 | ----- | ------- | ----- | ------- | 478.8 | 1119.5 | 471.3 | 1119.5 | 454.2 | 1103.1 | 0.0 | 1119.5 | 458.9 | 1105.8 | 471.9 | 1119.5 | 479.4 | 1119.5 | 495.9 | 1130.5 | 503.9 | 1130.5 | 536.9 | 1141.5 | 547.7 | 1141.5 | 182+00 |
| 184+00 | *** | 1142.6 | *** | 1142.6 | ----- | ------- | ----- | ------- | 476.7 | 1119.9 | 469.1 | 1119.9 | 451.8 | 1103.3 | 0.0 | 1119.9 | 456.8 | 1106.0 | 470.0 | 1119.9 | 477.6 | 1119.9 | ----- | ------- | ----- | ------- | *** | 1142.0 | *** | 1142.0 | 184+00 |
| 186+00 | *** | 1143.0 | *** | 1143.0 | ----- | ------- | ----- | ------- | 473.9 | 1120.4 | 466.4 | 1120.4 | 448.6 | 1103.5 | 0.0 | 1120.4 | 453.9 | 1106.2 | 467.7 | 1120.4 | 475.2 | 1120.4 | ----- | ------- | ----- | ------- | *** | 1142.4 | *** | 1142.4 | 186+00 |
| 188+00 | 518.5 | 1143.4 | 504.5 | 1143.4 | ----- | ------- | ----- | ------- | 473.7 | 1120.9 | 463.4 | 1120.8 | 444.9 | 1103.3 | 0.0 | 1120.9 | 450.1 | 1106.1 | 465.0 | 1120.9 | 472.3 | 1120.9 | 488.7 | 1131.8 | 496.7 | 1131.8 | 529.7 | 1142.8 | 540.5 | 1142.8 | 188+00 |
| 190+00 | 515.1 | 1143.8 | 501.1 | 1143.8 | ----- | ------- | ----- | ------- | 467.3 | 1121.3 | 460.0 | 1121.3 | 440.5 | 1103.5 | 0.0 | 1121.3 | 446.7 | 1106.2 | 462.0 | 1121.3 | 469.3 | 1121.3 | 485.7 | 1132.2 | 493.7 | 1132.2 | 526.7 | 1143.2 | 537.5 | 1143.2 | 190+00 |
| 192+00 | 511.1 | 1144.3 | 497.3 | 1144.3 | ----- | ------- | ----- | ------- | 463.5 | 1121.8 | 456.2 | 1121.8 | 436.5 | 1103.8 | 0.0 | 1121.8 | 442.9 | 1106.4 | 458.7 | 1121.8 | 466.0 | 1121.8 | 482.4 | 1132.7 | 490.4 | 1132.7 | 523.4 | 1143.7 | 534.2 | 1143.7 | 192+00 |
| 194+00 | 506.8 | 1144.7 | 492.8 | 1144.7 | ----- | ------- | ----- | ------- | 459.2 | 1122.3 | 452.0 | 1122.3 | 431.8 | 1104.0 | 0.0 | 1122.3 | 438.9 | 1106.7 | 455.0 | 1122.3 | 462.2 | 1122.3 | 478.4 | 1133.1 | 486.4 | 1133.1 | 519.4 | 1144.1 | 530.2 | 1144.1 | 194+00 |
| 195+00 | 504.5 | 1144.9 | 490.5 | 1144.9 | ----- | ------- | ----- | ------- | 456.9 | 1122.5 | 449.7 | 1122.5 | 429.3 | 1104.1 | 0.0 | 1122.5 | 436.7 | 1106.8 | 453.0 | 1122.5 | 460.2 | 1122.5 | 476.4 | 1133.3 | 484.4 | 1133.3 | 517.4 | 1144.3 | 528.2 | 1144.3 | 195+00 |
| 196+00 | 501.9 | 1145.1 | 487.9 | 1145.1 | ----- | ------- | ----- | ------- | 454.4 | 1122.8 | 447.4 | 1122.8 | 426.7 | 1104.3 | 0.0 | 1122.8 | 434.2 | 1107.0 | 450.9 | 1122.8 | 457.9 | 1122.8 | 474.0 | 1133.5 | 482.0 | 1133.5 | 515.0 | 1144.5 | 525.8 | 1144.5 | 196+00 |
| 198+00 | 497.2 | 1145.6 | 483.2 | 1145.6 | ----- | ------- | ----- | ------- | 449.6 | 1123.2 | 442.4 | 1123.2 | 420.7 | 1103.9 | 0.0 | 1123.2 | 428.8 | 1106.8 | 446.5 | 1123.2 | 453.7 | 1123.2 | 469.8 | 1134.0 | 477.9 | 1134.0 | 510.9 | 1145.0 | 521.7 | 1145.0 | 198+00 |
| 200+00 | 491.2 | 1145.6 | 477.2 | 1145.6 | ----- | ------- | ----- | ------- | 444.3 | 1123.7 | 437.0 | 1123.7 | 415.1 | 1104.2 | 0.0 | 1123.7 | 423.9 | 1106.9 | 441.8 | 1123.7 | 449.1 | 1123.7 | 465.5 | 1134.6 | 473.5 | 1134.6 | 506.5 | 1145.6 | 517.3 | 1145.6 | 200+00 |
| 202+00 | *** | 1146.1 | *** | 1146.1 | ----- | ------- | ----- | ------- | 438.5 | 1124.2 | 431.2 | 1124.2 | 413.2 | 1107.3 | 0.0 | 1124.2 | 418.7 | 1107.3 | 436.7 | 1124.2 | 444.0 | 1124.2 | 460.4 | 1135.1 | 468.4 | 1135.1 | 501.4 | 1146.1 | 512.2 | 1146.1 | 202+00 |
| 204+00 | *** | 1146.6 | *** | 1146.6 | ----- | ------- | ----- | ------- | 432.7 | 1124.6 | 425.2 | 1124.6 | 408.8 | 1107.4 | 0.0 | 1124.6 | 413.0 | 1107.4 | 431.3 | 1124.6 | 438.8 | 1124.6 | ----- | ------- | ----- | ------- | *** | 1146.6 | *** | 1146.6 | 204+00 |
| 204+21 | *** | 1146.7 | *** | 1146.7 | ----- | ------- | ----- | ------- | 432.5 | 1124.7 | 425.0 | 1124.7 | 408.6 | 1107.4 | 0.0 | 1124.7 | 412.3 | 1107.4 | 430.7 | 1124.7 | 438.2 | 1124.7 | ----- | ------- | ----- | ------- | *** | 1146.7 | *** | 1146.7 | 204+21 |
| 205+39 | *** | 1146.9 | *** | 1146.9 | ----- | ------- | ----- | ------- | 430.5 | 1125.0 | 423.7 | 1124.9 | 347.9 | 1087.8 | 0.0 | 1124.9 | 379.7 | 1087.8 | 427.8 | 1124.9 | 435.3 | 1124.9 | ----- | ------- | ----- | ------- | *** | 1146.9 | *** | 1146.9 | 205+39 |
| 206+00 | 477.5 | 1147.1 | 463.5 | 1147.1 | ----- | ------- | ----- | ------- | 430.5 | 1125.1 | 423.6 | 1125.1 | 374.6 | 1087.8 | 0.0 | 1125.1 | 377.2 | 1087.9 | 425.6 | 1125.1 | 433.1 | 1125.1 | 449.8 | 1136.1 | 457.8 | 1136.1 | 490.8 | 1147.1 | 501.4 | 1147.1 | 206+00 |

TYPICAL SECTION NO. 5 - STATION 206+00 TO STATION 249+73.1

| STATION | L1 OFFSET (-) | L1 ELEVATION | L2 OFFSET (-) | L2 ELEVATION | L3 OFFSET (-) | L3 ELEVATION | L4 OFFSET (-) | L4 ELEVATION | C1 OFFSET (-) | C1 ELEVATION | C2 OFFSET (-) | C2 ELEVATION | S1 OFFSET (-) | S1 ELEVATION | C4 OFFSET | C4 ELEVATION | S2 OFFSET (+) | S2 ELEVATION | C6 OFFSET (+) | C6 ELEVATION | C7 OFFSET (+) | C7 ELEVATION | L5 OFFSET (+) | L5 ELEVATION | L6 OFFSET (+) | L6 ELEVATION | L7 OFFSET (+) | L7 ELEVATION | L8 OFFSET (+) | L8 ELEVATION | STATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 207+90 | 499.1 | 1147.7 | 485.1 | 1147.7 | 455.3 | 1136.7 | 447.3 | 1136.7 | 430.6 | 1125.6 | 423.0 | 1125.6 | 414.4 | 1114.8 | 0.0 | 1125.6 | 414.4 | 1114.8 | 423.0 | 1125.6 | 430.6 | 1125.6 | 447.3 | 1136.7 | 455.3 | 1136.7 | 488.3 | 1147.7 | 499.1 | 1147.7 | 207+90 |
| 208+00 | 499.1 | 1147.7 | 485.1 | 1147.7 | 455.3 | 1136.7 | 447.3 | 1136.7 | 430.6 | 1125.6 | 423.0 | 1125.6 | 414.4 | 1114.8 | 0.0 | 1125.6 | 414.4 | 1114.8 | 423.0 | 1125.6 | 430.6 | 1125.6 | 447.3 | 1136.7 | 455.3 | 1136.7 | 488.3 | 1147.7 | 499.1 | 1147.7 | 208+00 |
| 209+19 | 498.1 | 1148.0 | * | 1148.0 | ----- | ------- | ----- | ------- | 430.6 | 1125.8 | 423.0 | 1125.8 | 414.3 | 1115.0 | 0.0 | 1125.8 | 414.3 | 1115.0 | 423.0 | 1125.8 | 430.6 | 1125.8 | 447.3 | 1137.0 | 455.3 | 1137.0 | 488.3 | 1148.0 | 499.1 | 1148.0 | 209+19 |
| 209+82 | 498.1 | 1148.2 | * | 1148.2 | ----- | ------- | ----- | ------- | 430.6 | 1126.0 | 423.0 | 1126.0 | 398.4 | 1104.5 | 0.0 | 1126.0 | 414.3 | 1115.1 | 423.0 | 1126.0 | 430.6 | 1126.0 | ----- | ------- | ----- | ------- | **** | 1148.2 | 499.1 | 1148.2 | 209+82 |
| 210+00 | 498.1 | 1148.2 | 463.8 | 1148.2 | ----- | ------- | ----- | ------- | 430.6 | 1126.1 | 423.0 | 1126.1 | 398.2 | 1104.5 | 0.0 | 1126.1 | 414.1 | 1115.1 | 423.0 | 1126.1 | 430.6 | 1126.1 | ----- | ------- | ----- | ------- | **** | 1148.2 | 499.1 | 1148.2 | 210+00 |
| 210+40 | 499.2 | 1148.3 | 463.9 | 1148.3 | ----- | ------- | ----- | ------- | 430.6 | 1126.1 | 423.0 | 1126.0 | 398.2 | 1104.5 | 0.0 | 1126.1 | 414.1 | 1115.1 | 423.0 | 1126.1 | 430.6 | 1126.1 | ----- | ------- | ----- | ------- | **** | 1148.3 | 499.2 | 1148.8 | 210+40 |
| 211+04 | 499.7 | 1148.8 | 464.3 | 1148.8 | ----- | ------- | ----- | ------- | 430.8 | 1126.3 | 423.0 | 1126.3 | 398.1 | 1104.5 | 0.0 | 1126.3 | 398.1 | 1104.5 | 423.0 | 1126.3 | 430.8 | 1126.3 | ----- | ------- | ----- | ------- | **** | 1148.8 | 499.7 | 1148.8 | 211+04 |
| 211+62 | 500.0 | 1148.8 | 464.5 | 1148.8 | ----- | ------- | ----- | ------- | 430.9 | 1126.4 | 423.0 | 1126.4 | 398.0 | 1104.5 | 0.0 | 1126.4 | 398.0 | 1104.5 | 423.0 | 1126.4 | 430.9 | 1126.4 | ----- | ------- | ----- | ------- | **** | 1148.8 | 500.0 | 1148.8 | 211+62 |
| 212+00 | 500.0 | 1148.9 | 464.6 | 1148.9 | ----- | ------- | ----- | ------- | 430.9 | 1126.5 | 423.0 | 1126.5 | 407.5 | 1110.9 | 0.0 | 1126.5 | 397.9 | 1104.5 | 423.0 | 1126.5 | 430.9 | 1126.5 | ----- | ------- | ----- | ------- | **** | 1148.9 | 500.0 | 1148.9 | 212+00 |
| 212+14 | 500.0 | 1148.9 | * | 1148.9 | ----- | ------- | ----- | ------- | 430.9 | 1126.6 | 423.0 | 1126.6 | 411.0 | 1113.3 | 0.0 | 1126.6 | 397.8 | 1104.5 | 423.0 | 1126.6 | 430.9 | 1126.6 | ----- | ------- | ----- | ------- | **** | 1149.0 | 500.0 | 1149.0 | 212+14 |
| 212+26 | 500.0 | 1149.0 | * | 1149.0 | ----- | ------- | ----- | ------- | 430.9 | 1126.6 | 423.0 | 1126.6 | 414.0 | 1115.3 | 0.0 | 1126.6 | 400.8 | 1106.5 | 423.0 | 1126.6 | 430.9 | 1126.6 | ----- | ------- | ----- | ------- | **** | 1149.0 | 500.0 | 1149.0 | 212+26 |
| 212+78 | 500.3 | 1149.2 | * | 1149.2 | ----- | ------- | ----- | ------- | 430.9 | 1126.7 | 423.0 | 1126.7 | 414.0 | 1115.4 | 0.0 | 1126.7 | 414.0 | 1115.4 | 423.0 | 1126.7 | 430.9 | 1126.7 | ----- | ------- | ----- | ------- | **** | 1149.2 | 500.3 | 1149.2 | 212+78 |
| 214+00 | 500.6 | 1149.6 | 469.8 | 1149.6 | 455.9 | 1138.9 | 447.9 | 1138.9 | 430.9 | 1127.0 | 423.0 | 1127.0 | 413.7 | 1115.5 | 0.0 | 1127.0 | 413.7 | 1115.5 | 423.0 | 1127.0 | 430.9 | 1127.0 | 447.9 | 1138.9 | 455.9 | 1138.9 | 489.8 | 1149.6 | 500.6 | 1149.6 | 214+00 |
| 216+00 | *** | 1150.0 | *** | 1150.0 | ----- | ------- | ----- | ------- | 430.9 | 1127.5 | 423.0 | 1127.5 | 413.4 | 1115.8 | 0.0 | 1127.5 | 413.4 | 1115.8 | 423.0 | 1127.5 | 430.9 | 1127.5 | ----- | ------- | ----- | ------- | *** | 1150.0 | *** | 1150.0 | 216+00 |
| 218+00 | 500.6 | 1150.5 | 469.8 | 1150.5 | 455.9 | 1139.2 | 447.9 | 1139.2 | 430.9 | 1127.9 | 423.0 | 1127.9 | 413.1 | 1116.0 | 0.0 | 1127.9 | 413.1 | 1116.0 | 423.0 | 1127.9 | 430.9 | 1127.9 | 447.9 | 1139.2 | 455.9 | 1139.2 | 489.8 | 1150.5 | 500.6 | 1150.5 | 218+00 |
| 220+00 | 500.6 | 1151.0 | 469.8 | 1151.0 | 455.9 | 1139.7 | 447.8 | 1139.7 | 430.9 | 1128.4 | 423.0 | 1128.4 | 412.5 | 1116.1 | 0.0 | 1128.4 | 412.5 | 1116.1 | 423.0 | 1128.4 | 430.8 | 1128.4 | 447.8 | 1139.7 | 455.8 | 1139.7 | 489.8 | 1151.0 | 500.6 | 1151.0 | 220+00 |
| 222+00 | 500.3 | 1151.4 | 469.5 | 1151.4 | 455.6 | 1140.1 | 447.8 | 1140.1 | 430.8 | 1128.9 | 423.0 | 1128.9 | 412.1 | 1116.4 | 0.0 | 1128.9 | 412.1 | 1116.4 | 423.0 | 1128.9 | 430.8 | 1128.9 | 447.8 | 1140.1 | 455.8 | 1140.1 | 489.5 | 1151.4 | 500.3 | 1151.4 | 222+00 |
| 224+00 | 500.3 | 1151.9 | 469.5 | 1151.9 | 455.6 | 1140.6 | 447.8 | 1140.6 | 430.8 | 1129.4 | 423.0 | 1129.4 | 411.8 | 1116.7 | 0.0 | 1129.4 | 411.8 | 1116.7 | 423.0 | 1129.4 | 430.8 | 1129.4 | 447.8 | 1140.6 | 455.8 | 1140.6 | 489.5 | 1151.9 | 500.3 | 1151.9 | 224+00 |
| 226+00 | 500.3 | 1152.3 | 469.5 | 1152.3 | 455.6 | 1141.0 | 447.8 | 1141.0 | 430.8 | 1129.8 | 423.0 | 1129.8 | 411.5 | 1116.9 | 0.0 | 1129.8 | 411.5 | 1116.9 | 423.0 | 1129.8 | 430.8 | 1129.8 | 447.8 | 1141.0 | 455.8 | 1141.0 | 489.5 | 1152.3 | 500.3 | 1152.3 | 226+00 |
| 228+00 | 500.3 | 1152.8 | 469.5 | 1152.8 | 455.6 | 1141.5 | 447.6 | 1141.5 | 430.8 | 1130.3 | 423.0 | 1130.3 | 411.0 | 1117.1 | 0.0 | 1130.3 | 411.0 | 1117.1 | 423.0 | 1130.3 | 430.8 | 1130.3 | 447.6 | 1141.5 | 455.6 | 1141.5 | 489.5 | 1152.8 | 500.3 | 1152.8 | 228+00 |
| 230+00 | 500.0 | 1153.2 | 469.2 | 1153.2 | 455.3 | 1141.9 | 447.3 | 1141.9 | 430.6 | 1130.8 | 423.0 | 1130.8 | 410.5 | 1117.4 | 0.0 | 1130.8 | 410.5 | 1117.4 | 423.0 | 1130.8 | 430.6 | 1130.8 | 447.3 | 1141.9 | 455.3 | 1141.9 | 489.2 | 1153.2 | 500.0 | 1153.2 | 230+00 |
| 232+00 | 500.3 | 1153.7 | 469.5 | 1153.7 | 455.6 | 1142.4 | 447.5 | 1142.4 | 430.8 | 1131.2 | 423.0 | 1131.2 | 410.4 | 1117.6 | 0.0 | 1131.2 | 410.4 | 1117.6 | 423.0 | 1131.2 | 430.8 | 1131.2 | 447.5 | 1142.4 | 455.6 | 1142.4 | 489.5 | 1153.7 | 500.3 | 1153.7 | 232+00 |
| 234+00 | 500.0 | 1154.1 | 469.2 | 1154.1 | 455.3 | 1142.9 | 447.3 | 1142.8 | 430.6 | 1131.7 | 423.0 | 1131.7 | 409.9 | 1117.9 | 0.0 | 1131.7 | 409.9 | 1117.9 | 423.0 | 1131.7 | 430.6 | 1131.7 | 447.3 | 1142.8 | 455.3 | 1142.9 | 489.2 | 1154.1 | 500.0 | 1154.1 | 234+00 |
| 236+00 | 500.0 | 1154.6 | 469.2 | 1154.6 | 455.3 | 1143.3 | 447.3 | 1143.3 | 430.6 | 1132.2 | 423.0 | 1132.2 | 409.6 | 1118.2 | 0.0 | 1132.2 | 409.6 | 1118.2 | 423.0 | 1132.2 | 430.6 | 1132.2 | 447.3 | 1143.3 | 455.3 | 1143.3 | 489.2 | 1154.6 | 500.0 | 1154.6 | 236+00 |
| 238+00 | 499.7 | 1155.0 | 468.9 | 1155.0 | 455.0 | 1143.7 | 447.2 | 1143.7 | 430.5 | 1132.7 | 423.0 | 1132.7 | 409.2 | 1118.5 | 0.0 | 1132.7 | 409.2 | 1118.5 | 423.0 | 1132.7 | 430.5 | 1132.7 | 447.0 | 1143.7 | 455.0 | 1143.7 | 488.9 | 1155.0 | 499.7 | 1155.0 | 238+00 |
| 240+00 | 500.0 | 1155.5 | 469.2 | 1155.5 | 455.3 | 1144.2 | 447.3 | 1144.2 | 430.8 | 1133.1 | 423.0 | 1133.1 | 408.7 | 1118.5 | 0.0 | 1133.1 | 408.7 | 1118.5 | 423.0 | 1133.1 | 430.8 | 1133.1 | 447.3 | 1144.2 | 455.3 | 1144.2 | 489.2 | 1155.5 | 500.0 | 1155.5 | 240+00 |
| 242+00 | 499.7 | 1155.9 | 468.9 | 1155.9 | 455.0 | 1144.6 | 447.0 | 1144.6 | 430.5 | 1133.6 | 423.0 | 1133.6 | 407.9 | 1118.5 | 0.0 | 1133.6 | 407.9 | 1118.5 | 423.0 | 1133.6 | 430.5 | 1133.6 | 447.0 | 1144.6 | 455.0 | 1144.6 | 488.9 | 1155.9 | 499.7 | 1155.9 | 242+00 |
| 244+00 | *** | 1156.4 | *** | 1156.4 | ----- | ------- | ----- | ------- | 430.5 | 1134.1 | 423.0 | 1134.1 | 408.0 | 1119.1 | 0.0 | 1134.1 | 408.0 | 1119.1 | 423.0 | 1134.1 | 430.5 | 1134.1 | ----- | ------- | ----- | ------- | *** | 1156.4 | *** | 1156.4 | 244+00 |
| 246+00 | *** | 1156.8 | *** | 1156.8 | ----- | ------- | ----- | ------- | 430.5 | 1134.5 | 423.0 | 1134.5 | 407.7 | 1119.3 | 0.0 | 1134.5 | 407.7 | 1119.3 | 423.0 | 1134.5 | 430.5 | 1134.5 | ----- | ------- | ----- | ------- | *** | 1156.8 | *** | 1156.8 | 246+00 |
| 246+26 | *** | 1156.9 | *** | 1156.9 | ----- | ------- | ----- | ------- | 430.5 | 1134.6 | 423.0 | 1134.6 | 407.6 | 1119.3 | 0.0 | 1134.6 | 407.6 | 1119.3 | 423.0 | 1134.6 | 430.5 | 1134.6 | ----- | ------- | ----- | ------- | *** | 1156.9 | *** | 1156.9 | 246+26 |
| 247+36 | 498.6 | 1157.1 | 468.8 | 1157.1 | 454.9 | 1145.8 | 446.8 | 1145.8 | 430.5 | 1134.8 | 423.0 | 1134.9 | 379.7 | 1101.0 | 0.0 | 1134.9 | 379.7 | 1101.0 | 423.0 | 1134.8 | 430.5 | 1134.9 | 446.8 | 1145.8 | 454.9 | 1145.8 | 488.6 | 1157.1 | 499.6 | 1157.1 | 247+36 |
| 249+00 | 499.7 | 1157.3 | 468.9 | 1157.3 | 455.0 | 1146.0 | 447.0 | 1146.0 | 430.5 | 1135.0 | 423.0 | 1135.0 | 379.5 | 1101.0 | 0.0 | 1135.0 | 379.5 | 1101.0 | 423.0 | 1135.0 | 430.5 | 1135.0 | 447.0 | 1146.0 | 455.0 | 1146.0 | 488.9 | 1157.3 | 499.7 | 1157.3 | 249+00 |
| 249+73.1 | ** | 1157.7 | ** | 1157.7 | ----- | ------- | ----- | ------- | ** | 1135.4 | ** | 1135.4 | ** | 1124.0 | 0.0 | 1135.4 | 413.4 | 1124.0 | 423.0 | 1135.4 | 430.5 | 1135.4 | 447.0 | 1146.4 | 455.0 | 1146.4 | 488.9 | 1157.7 | 499.7 | 1157.7 | 249+73.1 |

NOTE: ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

* LOCATED WITHIN TRANSITIONS, SEE DETAILS ON DRAWING NO. CH-5.5.

** TRANSITION ALONG NORTH LEVEE TO NORTH GUIDE BANK.

*** LOCATED WITHIN ACCESS RAMP, SEE DETAILS ON DRAWINGS NO. CH-6.1 & CH-6.2.

**** LOCATED WITHIN SOUTH LEVEE TRANSITION FOR PRIEST ROAD, SEE DETAIL ON DRAWING NO. CH-5.6.

| | NAME | DATE | ARIZONA DEPARTMENT OF TRANSPORTATION |
|---|---|---|---|
| DESIGN | W.C.D. | 4/89 | HIGHWAYS DIVISION |
| DRAWN | S.L.B. | 4/89 | |
| CHECKED | M.A.P. | 4/89 | OFFSETS & ELEVATION SHEET |
| DMJM | CONSULTING ENGINEERS PHOENIX ARIZONA | | STA 176+00 TO STA 249+73.1 |

| ROUTE | MILEPOST | LOCATION | DWG NO. CH-3.2 |
|---|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) | |

TRACS NO. H 2045 01C RAM 500-3-511 SHT. 229 of 369 ____ OF ____

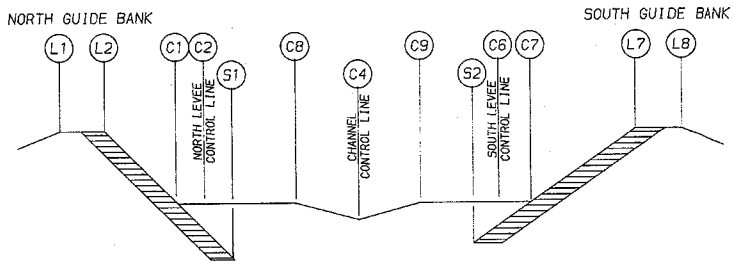
| NO. | DATE | REVISIONS | BY | APP'D |
|---|---|---|---|---|
| 1 | 1/29/93 | AS-BUILT | KL | |

FOR SHOP PLANS

SUBSCRIBE

TRIAL VERSION of TIFFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-800-3-511 | 230 | 369 | 2/1/93 PK |
| | | 143 MA 1 | | | |




TYPICAL SECTION NO. 6
STA 249+73.1 TO STA 263+90

| STATION | L1 OFFSET (-) | L1 ELEVATION | L2 OFFSET (-) | L2 ELEVATION | C1 OFFSET (-) | C1 ELEVATION | C2 OFFSET (-) | C2 ELEVATION | S1 OFFSET (-) | S1 ELEVATION | C8 OFFSET (-) | C8 ELEVATION | C4 OFFSET | C4 ELEVATION | C9 OFFSET (+) | C9 ELEVATION | S2 OFFSET (+) | S2 ELEVATION | C6 OFFSET (+) | C6 ELEVATION | C7 OFFSET (+) | C7 ELEVATION | L7 OFFSET (+) | L7 ELEVATION | L8 OFFSET (-) | L8 ELEVATION | STATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TYPICAL SECTION NO.6 - STATION 249+73.1 TO STATION 263+90 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 250+00 | * | 1157.7 | * | 1157.7 | 436.9 | 1138.5 | 425.0 | 1138.5 | 415.2 | 1124.0 | 423.0 | 1138.5 | 0.0 | ** | 423.0 | 1138.5 | 430.8 | 1124.0 | 440.3 | 1138.5 | 452.2 | 1138.5 | * | 1157.7 | * | 1157.7 | 250+00 |
| 252+00 | 526.2 | 1158.5 | 512.2 | 1158.5 | 482.9 | 1139.0 | 471.0 | 1139.0 | 460.8 | 1124.3 | 423.0 | 1139.0 | 0.0 | 1133.0 | 423.0 | 1139.0 | 507.0 | 1124.3 | 517.1 | 1139.0 | 529.0 | 1139.0 | 535.8 | 1159.3 | 549.8 | 1159.3 | 252+00 |
| 254+00 | 572.8 | 1159.3 | 558.8 | 1159.3 | 528.9 | 1139.4 | 518.9 | 1139.4 | 506.9 | 1124.7 | 423.0 | 1139.4 | 0.0 | 1139.4 | 423.0 | 1139.4 | 583.5 | 1124.7 | 593.9 | 1139.4 | 605.9 | 1139.4 | 612.8 | 1160.1 | 726.8 | 1160.1 | 254+00 |
| 256+00 | 619.1 | 1160.1 | 605.1 | 1160.1 | 574.8 | 1139.8 | 562.9 | 1139.8 | 552.5 | 1125.0 | 423.0 | 1139.9 | 0.0 | 1139.9 | 423.0 | 1139.9 | 660.2 | 1125.0 | 670.6 | 1139.9 | 682.5 | 1139.9 | 712.8 | 1160.1 | 725.8 | 1160.1 | 256+00 |
| 257+00 | 642.2 | 1160.4 | 628.2 | 1160.4 | 597.8 | 1140.1 | 585.9 | 1140.1 | 575.4 | 1125.2 | 423.0 | 1140.1 | 0.0 | 1134.1 | 423.0 | 1140.1 | 682.2 | 1125.2 | 692.8 | 1140.1 | 704.7 | 1140.1 | 735.1 | 1160.4 | 749.1 | 1160.4 | 257+00 |
| 258+00 | 665.3 | 1160.7 | 651.3 | 1160.7 | 620.8 | 1140.4 | 608.9 | 1140.4 | 598.2 | 1125.3 | 423.0 | 1140.4 | 0.0 | 1134.4 | 423.0 | 1140.4 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 258+00 |
| 260+00 | 711.5 | 1161.2 | 697.5 | 1161.2 | 666.9 | 1140.8 | 654.9 | 1140.8 | 644.1 | 1125.8 | 423.0 | 1140.8 | 0.0 | 1134.8 | 423.0 | 1140.8 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 260+00 |
| 261+09.8 | 913.7 | 1161.5 | 899.7 | 1161.5 | 869.1 | 1141.1 | 857.1 | 1141.1 | 846.3 | 1125.9 | 423.0 | 1141.1 | 0.0 | 1135.1 | 423.0 | 1141.1 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 261+09.8 |
| 262+00 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 423.0 | 1141.3 | 0.0 | 1135.3 | 423.0 | 1141.3 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 262+00 |
| 263+90 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 0.0 | 1135.8 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 263+90 |

* LOCATED WITHIN TRANSITION, SEE DETAILS ON DRAWING NO. CH-5.4.

** LOCATED WITHIN CHANNEL TRANSITION, SEE DRAWING NO. CH-2.14.

NOTE: ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.

| | NAME | DATE | ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION |
|---|---|---|---|
| DESIGN | DNJ | 4/89 | |
| DRAWN | JCP | 4/89 | |
| CHECKED | MAP | 4/89 | OFFSETS & ELEVATION SHEET |
| DMJM | CONSULTING ENGINEERS PHOENIX ARIZONA | | STA 249+73.1 TO STA 263+90 |
| ROUTE 143 | MILEPOST 1 | | LOCATION HOHOKAM (UNIVERSITY - SKY HARBOR) |

DWG NO. CH-3.3

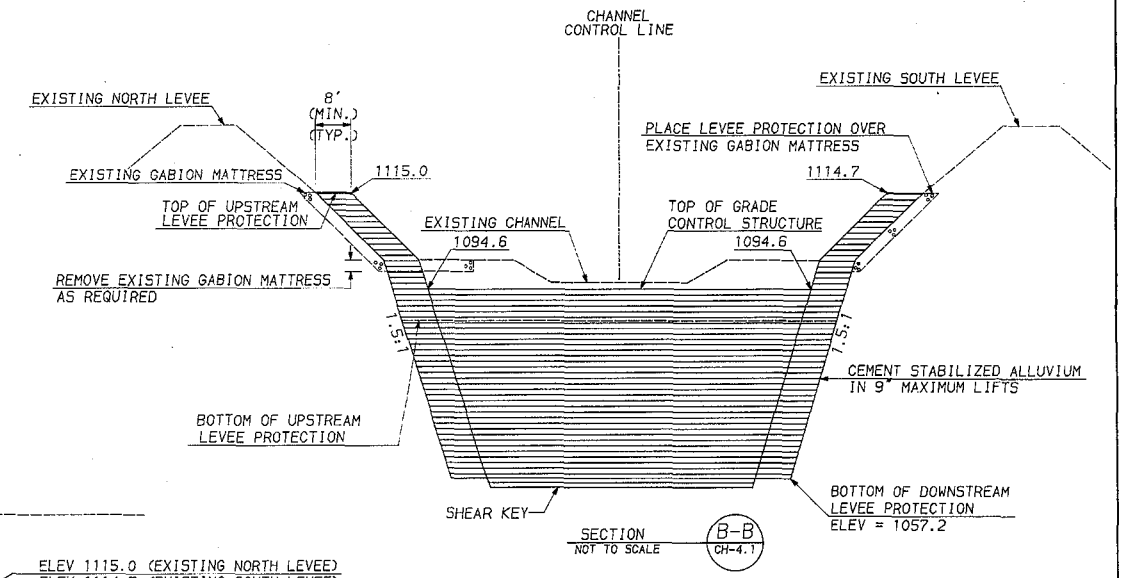
TRACS NO. H 2045 01C RAM 800-3-511 SHT. 230 of 369 OF

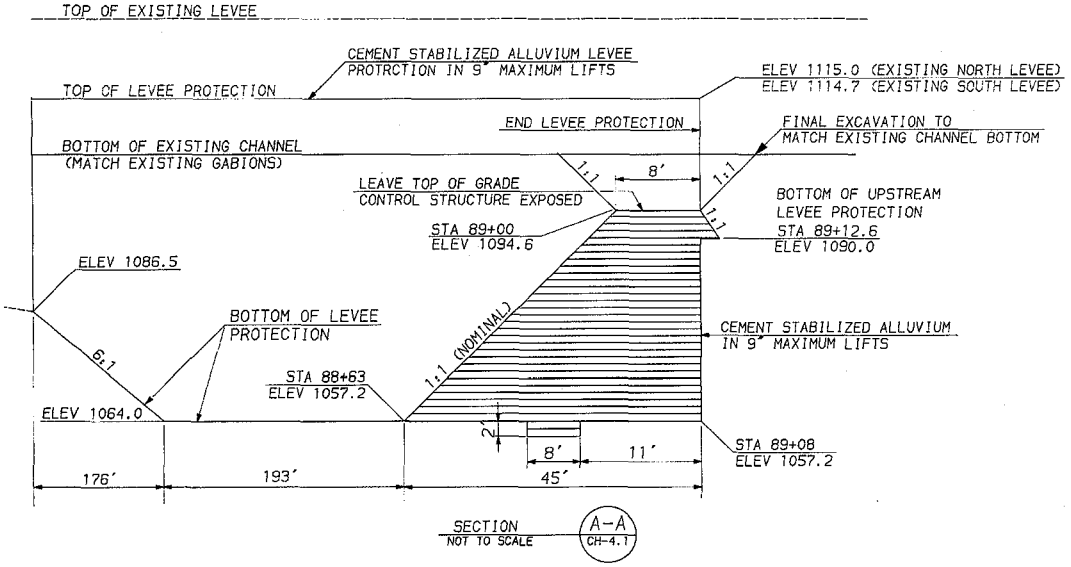
| NO. | DESCRIPTION | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

TRIAL VERSION of TIFFDLL

| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 232 | 369 | 2/11/93 KL |

143 MA 1




NOTE:
1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.
2. VERTICAL FACE OF GRADE CONTROL STRUCTURE SHALL BE CONSTRUCTED WITHOUT FORMS.
3. GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICHEVER IS HIGHER. SHOULD BEDROCK BE ENCOUNTERED, SEE DRAWING NO. CH-4.4 FOR ANCHORING GRADE CONTROL STRUCTURE TO BEDROCK.

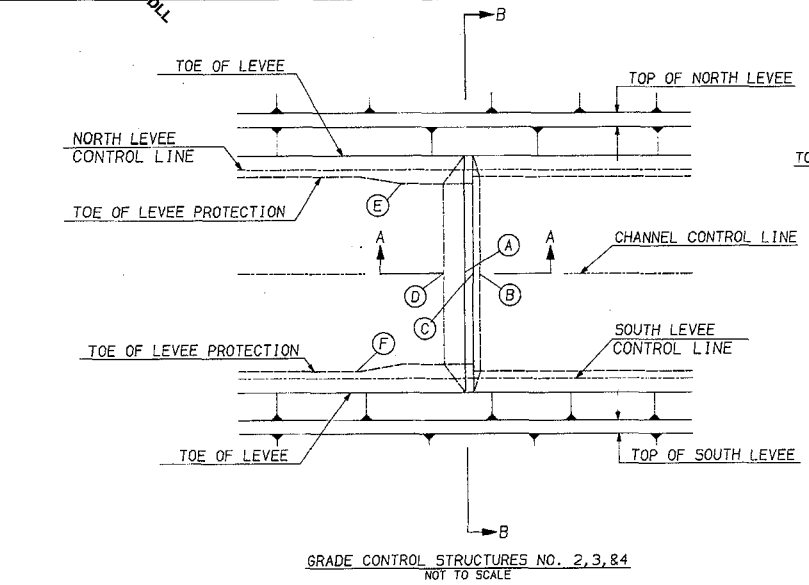
| | NAME | DATE | ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAYS DIVISION |
|---|---|---|---|
| DESIGN | D.N.J. | 4/89 | |
| DRAWN | S.L.B. | 4/89 | |
| CHECKED | M.A.P. | 4/89 | GRADE CONTROL STRUCTURE NO. 1 AT STATION 89+00 |
| DMJM | CONSULTING ENGINEERS PHOENIX ARIZONA | | |

| ROUTE | MILEPOST | LOCATION | DWG. NO. |
|---|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) | CH-4.2 |

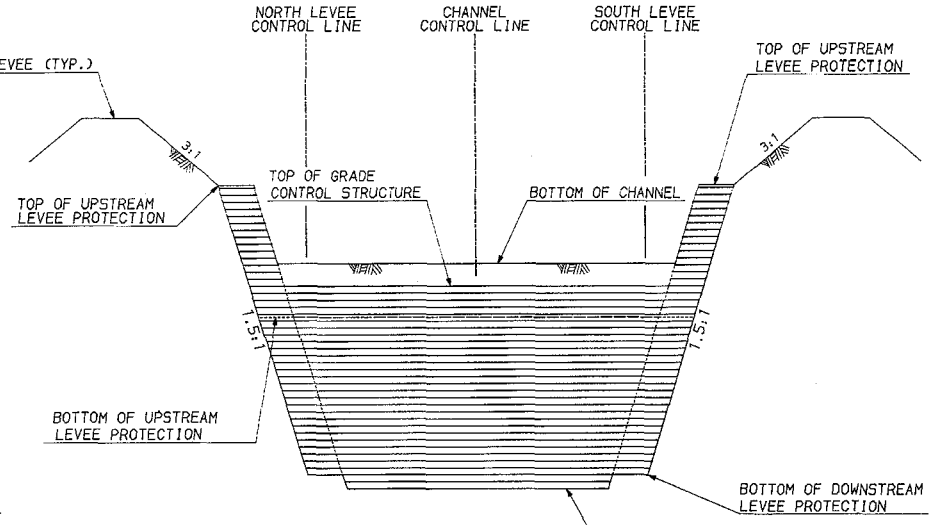
TRACS NO. H 2045 01C RAM600-3-511 SHT 232 of 369 OF

TRIAL VERSION of TIFFDLL

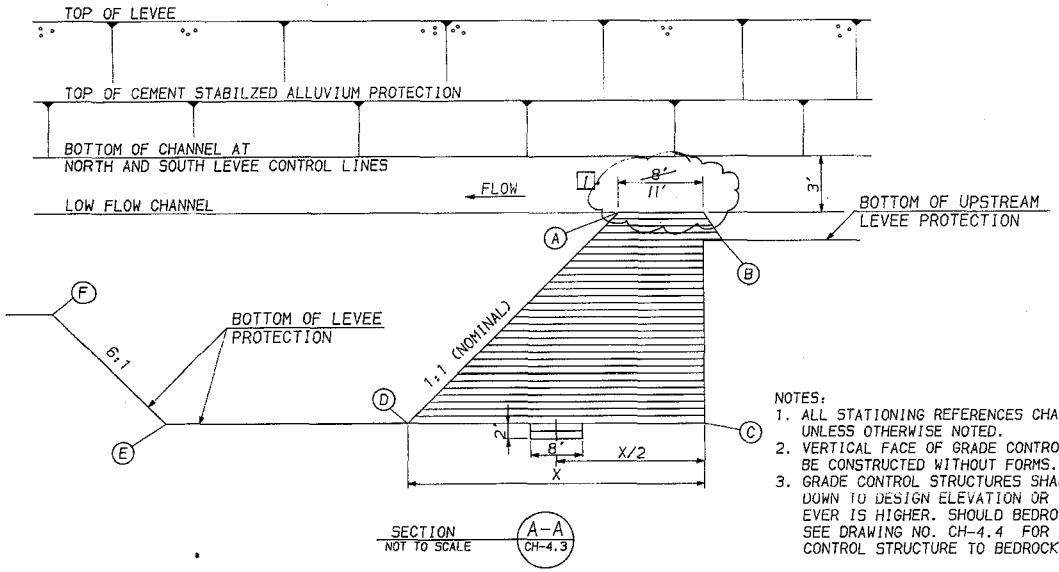
| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 233 | 369 | 2/11/93 KK |
| | | 143 MA 1 | | | |




GRADE CONTROL STRUCTURES NO. 2,3,&4
NOT TO SCALE




SECTION B-B CH-4.3
NOT TO SCALE




SECTION A-A CH-4.3
NOT TO SCALE

1 Grade Control Structure No. 3 Eliminated Due To Rock Grade C.O. #5

| | GRADE CONTROL STRUCTURE NO.2 | | GRADE CONTROL STRUCTURE NO. 3 | | GRADE CONTROL STRUCTURE NO. 4 | |
|---|---|---|---|---|---|---|
| | STATION | ELEVATION | STATION | ELEVATION | STATION | ELEVATION |
| A | 144+00 | 1107.5 | 207+82 | 1122.5 | 249+55 | 1129.4 ~~1132.4~~ |
| B | 144+14 | 1101.6 | 207+98 | 1114.8 | 249+71 | 1121.0 ~~1124.0~~ |
| C | 144+08 | 1075.4 | 207+90 | 1087.8 | 249+63 | 1101.0 |
| D | 143+68 | 1075.4 | 207+47 | 1087.8 | 249+24 | 1101.0 |
| E | 141+75 | 1075.4 | 205+39 | 1087.8 | 247+36 | 1101.0 |
| F | 140+57 | 1095.1 | 204+21 | 1107.4 | 246+26 | 1119.3 |

NOTES:
1. ALL STATIONING REFERENCES CHANNEL CONTROL LINE UNLESS OTHERWISE NOTED.
2. VERTICAL FACE OF GRADE CONTROL STRUCTURE SHALL BE CONSTRUCTED WITHOUT FORMS.
3. GRADE CONTROL STRUCTURES SHALL BE CONSTRUCTED DOWN TO DESIGN ELEVATION OR TO BEDROCK, WHICH-EVER IS HIGHER. SHOULD BEDROCK BE ENCOUNTERED, SEE DRAWING NO. CH-4.4 FOR ANCHORING GRADE CONTROL STRUCTURE TO BEDROCK.

| | NAME | DATE |
|---|---|---|
| DESIGN | D.N.J. | 4/89 |
| DRAWN | S.L.B. | 4/89 |
| CHECKED | M.A.P. | 4/89 |

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

GRADE CONTROL STRUCTURES NO. 2, 3 & 4

| ROUTE | MILEPOST | LOCATION |
|---|---|---|
| 143 | 1 | HOHOKAM (UNIVERSITY - SKY HARBOR) |

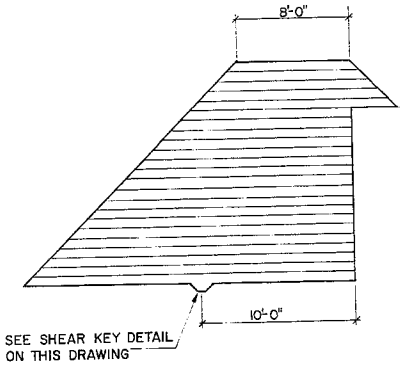
DWG. NO. CH-4.3

TRACS NO. H 2045 01C RAM 600-3-511 BAT. 233 of 369 ____ OF ____

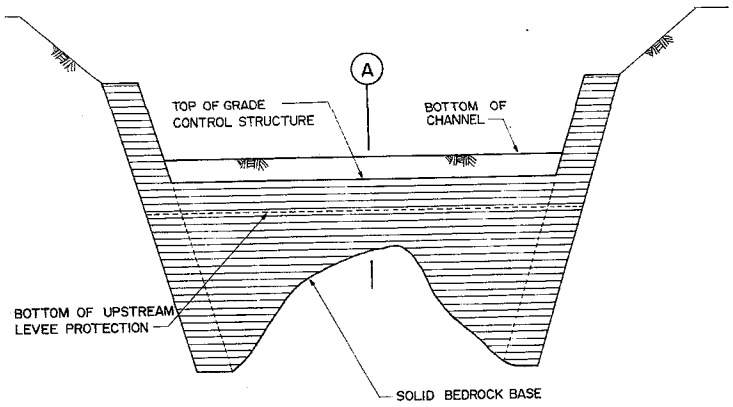
DESIGN 4/89 DRAWN 4/89 CHECKED 4/89 AS-BUILT 2/11/93 KK

TRIAL VERSION of TIFFOLL

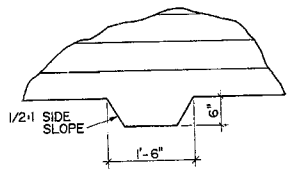
| F.H.W.A. REGION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| | ARIZ. | RAM-600-3-511 | 234 | 369 | 2/1/93 RE |
| | | 143 MA 1 | | | |




SECTION A
NOT TO SCALE




TYPICAL GRADE CONTROL STRUCTURE
NOT TO SCALE




SHEAR KEY DETAIL
NOT TO SCALE

NOTES:

1.) EXCAVATE DOWN TO SOUND BEDROCK BASE.

2.) PLACE SHEAR KEYS IN SOLID BEDROCK.

3.) TO BE CONSTRUCTED OF CEMENT STABILIZED ALLUVIUM PROPORTIONED, MIXED AND PLACED AS INDICATED IN THE SPECIAL PROVISIONS TO SPECIFICATIONS. COMPACTION SHALL BE BY VIBRATORY ROLLER.

4.) FOR DIMENSIONS SEE DRAWING CH-4.3

5.) APPLICABLE FOR GRADE CONTROL STRUCTURES 3 AND 4 ONLY.

| | NAME | DATE |
|---|---|---|
| DESIGN | BM | 4/89 |
| DRAWN | DLS | 4/89 |
| CHECKED | MAP | 4/89 |

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

DMJM CONSULTING ENGINEERS PHOENIX ARIZONA

GRADE CONTROL STRUCTURE
ANCHOR DETAIL

ROUTE 143 INTERPOST 1 LOCATION HOHOKAM (UNIVERSITY - SKY HARBOR)

DWG. NO. CH-4.4

TRACS NO. H 2045 01C RAM 600-3-511 SHT 234 of 369 OF

# F. Field Survey Data

Electronic terrain data for the Salt River Levee was provided by the Flood Control District of Maricopa County. Terrain data included mass points, breaklines, spot elevations, and contour lines in Shape file format based on the following control:

- Horizontal Control: North American Datum 1983 (NAD 83), Arizona State Plane – Central Zone.
- Vertical Control: National Geodetic Vertical Datum 1929 (NGVD 29).

Electronic data is included on the data disk in **Appendix H** and displayed in various exhibits through the Report.

## F.1 Supplemental Field Survey

Select Pages from Survey Report, Salt River Levee Survey, Wilson & Company Engineers & Architects

Full Survey Report and electronic files included in data disk in **Appendix H**

# F.1 Supplemental Field Survey

*Survey Report*

# Salt River Levee Survey

submitted to:
Flood Control District of Maricopa County

submitted by:
Wilson & Company, Inc., Engineers & Architects

WILSON
&COMPANY
ENGINEERS & ARCHITECTS

May, 2011

WILSON &COMPANY

410 N. 44th Street
Suite 460
Phoenix, AZ 85008
602-283-2701
602-273-1230 Fax

Albuquerque
Colorado Springs
Denver
Fort Worth
Houston
Kansas City
Lenexa
Omaha
Pasadena
Phoenix
Rio Rancho
Salina
San Bernardino
San Diego

Wilson & Company
Latin America, LLC

May 13, 2011

Flood Control District of Maricopa County
2801 W. Durango Street
Phoenix, Arizona 85009

# Salt River Levee

# Survey Report

# 2011

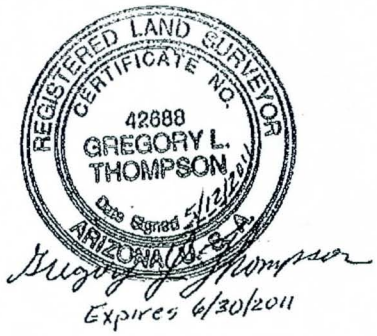
This Survey Report is the result of a survey conducted for Flood Control District of Maricopa County to provide on the ground field survey, drainage structure and bridge data.

The survey was conducted during the month of May 2011. It began with the gathering of research data on existing NGS control points in area of the project. These points form the basis of the survey control for this project. A Virtual Reference Station (VRS) network was utilized in lieu of standard GPS base stations as a major component of the RTK system. GPS data gathered during this survey used this system and standard GPS base set up.

Field work consisting of control checks into existing NGS monuments, setting and referencing project control monuments was completed May 13, 2011. Members of the field crew were Dane Branfort, Hector Bejarano, and James Flemings. GPS equipment used for this survey was Trimble R8 receivers combined with Trimble TSC2 data collectors.

Surveyors Certificate

I, Gregory L Thompson, a Registered Land Surveyor in the State of Arizona, do hereby certify that the accompanying survey conducted May, 2011 was made under my direct supervision and the information contained hereon is true and accurate to the best of my belief.




WILSON & COMPANY

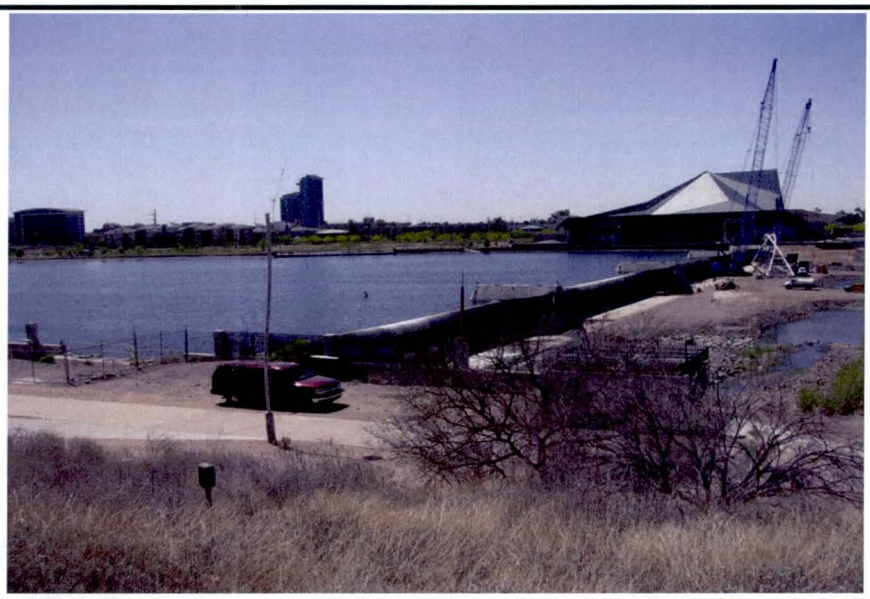
# G. Salt River Levee Photos

## G.1 Field Photos

## G.2 Field Photo Locations

Figure G-1: Field Photo Locations

# G.1 Field Photos



**Photograph #SR_001** **May 3, 2011**

Looking South at Tempe Town Lake West Inflatable Dam

**Photograph #SR_004** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_009** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_010** **May 3, 2011**

Looking West along the North Levee at top of Soil Cement

**Photograph #SR_011** **May 3, 2011**

Looking West along the North Levee at top of Gabions

**Photograph #SR_018** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_019** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_024** **May 3, 2011**

Looking West along the North Levee at top of Soil Cement

**Photograph #SR_025** **May 3, 2011**

Looking East along the North Levee at top of Soil Cement

**Photograph #SR_031** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_032** **May 3, 2011**

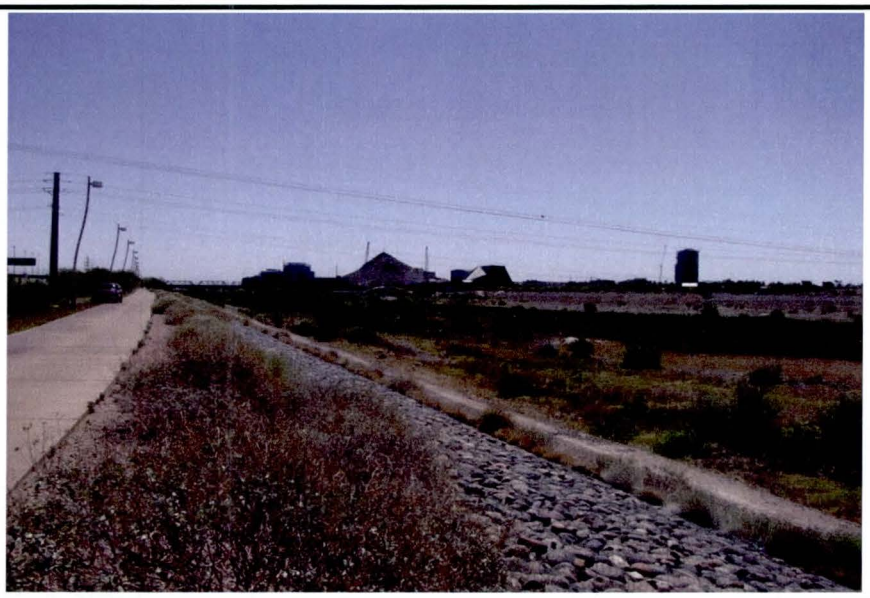
Looking West along the North Levee

**Photograph #SR_039** **May 3, 2011**

Looking West along the North Levee at top of Soil Cement

**Photograph #SR_040** **May 3, 2011**

Looking East along the North Levee at top of Soil Cement



**Photograph #SR_041** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_045** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_046** **May 3, 2011**

Looking at West at upstream face of Priest Drive

**Photograph #SR_047** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_061** **May 3, 2011**

Looking at East at downstream face of Priest Drive

**Photograph #SR_062** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_074** **May 3, 2011**

Looking at landside embankment West of Priest Drive

**Photograph #SR_081** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_082** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_083** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_087** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_088** **May 3, 2011**

Looking at landside embankment West of Priest Drive

**Photograph #SR_091** **May 3, 2011**

Looking East along the North Levee

**Photograph #SR_095** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_096** **May 3, 2011**

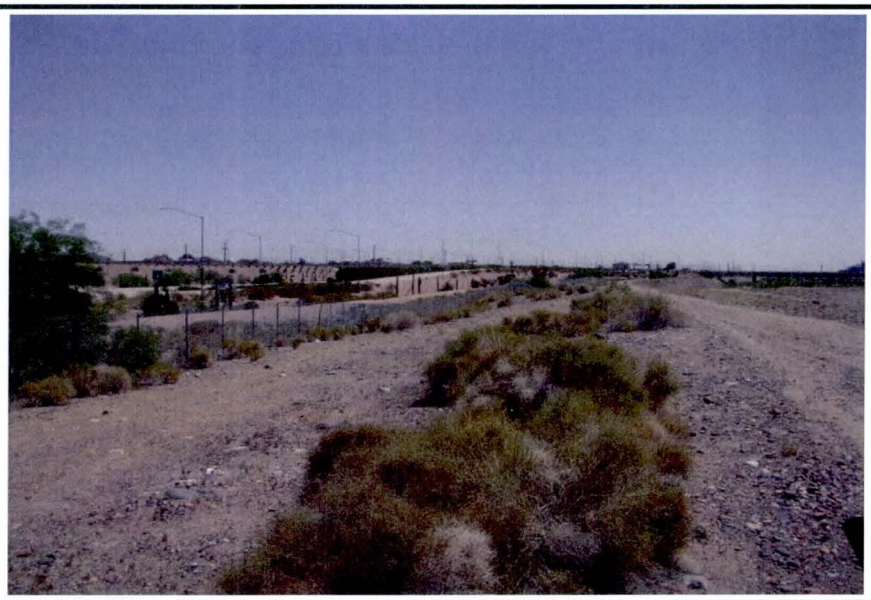
Looking East along the North Levee

**Photograph #SR_100** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_102** **May 3, 2011**

Looking West at landside area



**Photograph #SR_103** **May 3, 2011**

Looking East at landside area

**Photograph #SR_104** **May 3, 2011**

Looking at box culvert through levee (Cross Cut Canal)

**Photograph #SR_105** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_109** **May 3, 2011**

Looking West along the North Levee

**Photograph #SR_112** **May 3, 2011**

Looking at interior drainage ponding area east of Cross Cut Canal

**Photograph #SR_114** **May 3, 2011**

Looking from top of headwall at Cross Cut Canal

**Photograph #SR_115** **May 3, 2011**

Looking at interior drainage ponding area West of Cross Cut Canal

**Photograph #SR_120** **May 3, 2011**

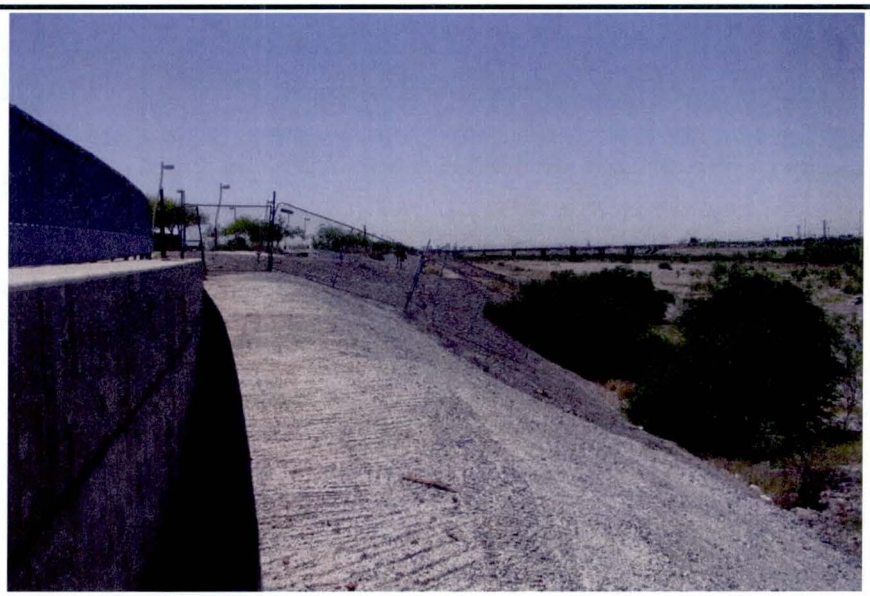
Looking East along the North Levee

**Photograph #SR_124** **May 3, 2011**

Looking at West at upstream face of SR143

**Photograph #SR_144** **May 3, 2011**

Looking East along channel from below SR 143 Bridge



**Photograph #SR_151** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_159** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_163** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_164** **May 3, 2011**

Looking West at landside area (South Levee)

**Photograph #SR_165** **May 3, 2011**

Looking East at landside area (South Levee)

**Photograph #SR_167** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_173** **May 3, 2011**

Looking East at landside area (South Levee)

**Photograph #SR_174** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_179** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_180** **May 3, 2011**

Looking West at landside area (South Levee)

**Photograph #SR_181** **May 3, 2011**

Looking East at landside area (South Levee)

**Photograph #SR_182** **May 3, 2011**

Looking at culvert outlet flapgate. Levee Station 222+05

**Photograph #SR_186** **May 3, 2011**

Looking at culvert outlet flapgate. Levee Station 218+15

**Photograph #SR_187** **May 3, 2011**

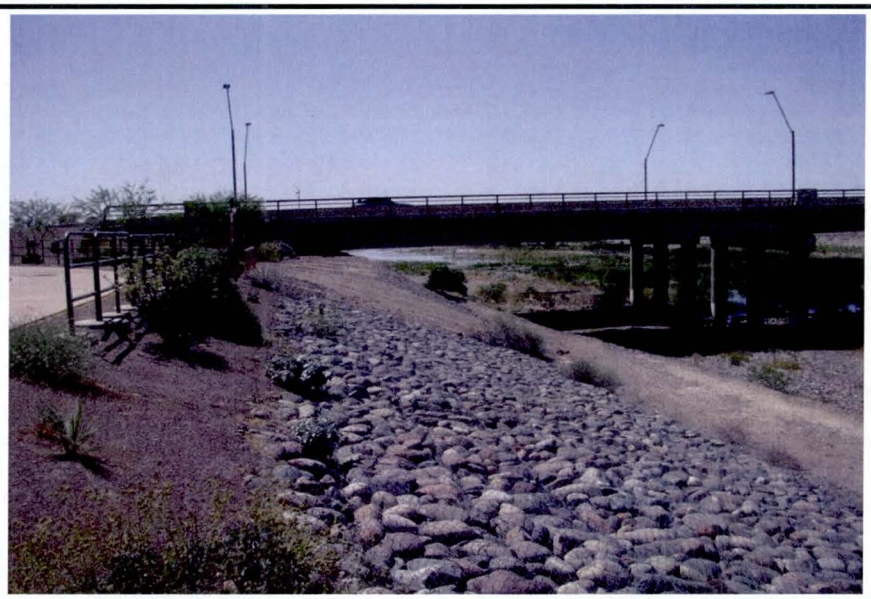
Looking West along the South Levee

**Photograph #SR_192** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_195** **May 3, 2011**

Looking East at landside area (South Levee)



**Photograph #SR_200** **May 3, 2011**

Looking at West at upstream face of Priest Drive

**Photograph #SR_205** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_206** **May 3, 2011**

Looking at West at downstream face of Priest Drive

**Photograph #SR_212** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_214** **May 3, 2011**

Looking at culvert outlet flapgate. Levee Station 210+25

**Photograph #SR_219** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_225** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_226** **May 3, 2011**

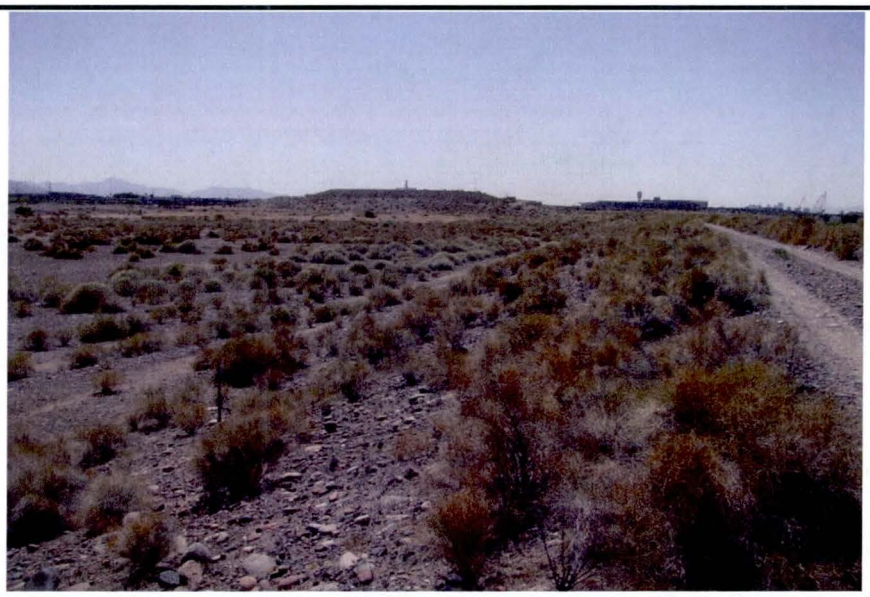
Looking West along the South Levee

**Photograph #SR_227** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_228** **May 3, 2011**

Looking at Gabion Mats



**Photograph #SR_229** **May 3, 2011**

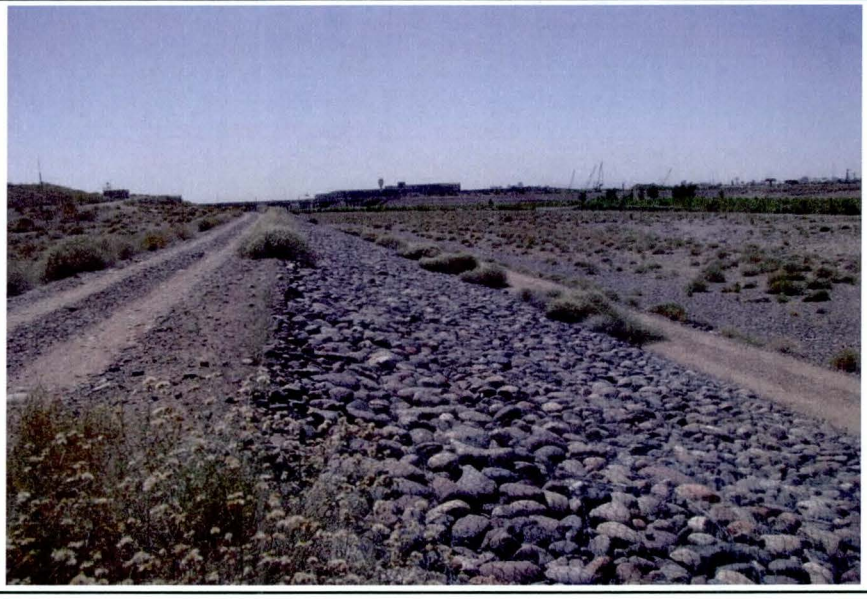
Looking West at landside area (South Levee)

**Photograph #SR_230** **May 3, 2011**

Looking East at landside area (South Levee)

**Photograph #SR_231** **May 3, 2011**

Looking East along the South Levee



**Photograph #SR_236** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_237** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_238** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_239** **May 3, 2011**

Looking West at landside area (South Levee)

**Photograph #SR_240** **May 3, 2011**

Looking East at landside area (South Levee)

**Photograph #SR_242** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_246** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_247** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_248** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_249** **May 3, 2011**

Looking West at landside area (South Levee)

**Photograph #SR_254** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_259** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_260** **May 3, 2011**

Looking at culvert outlet flapgate. Levee Station 165+00

**Photograph #SR_262** **May 3, 2011**

Looking West along the South Levee

**Photograph #SR_263** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_264** **May 3, 2011**

Looking East along the South Levee

**Photograph #SR_268** **May 3, 2011**

Looking at the upstream face of SR143 Bridge

**Photograph #SR_269** **May 3, 2011**

Looking at the upstream face of SR143 Bridge

## G.2 Field Photo Locations

Flood Control District of Maricopa County

**LEVEE CERTIFICATION REPORT, SALT RIVER LEVEE SYSTEM ID#31 BETWEEN TEMPE TOWN LAKE AND STATE ROUTE 143**

**Legend**

☆ General Photo Locations

200 100 0 200
Feet

*June, 2011*

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC
1 WEST DEER VALLEY ROAD
SUITE 101
PHOENIX, AZ 85027
623-889-0166 (O)
480-839-2193 (F)

**FIGURE G-1:**
**PHOTO LOCATIONS**

# H. Data Disk Refer to Addendum #1 Disk

## As-Built and Design Plans

Priest Drive Bridge Plans
Stage Route 143 Bridge Plans
State rough 153 Bridge Plans
As Built Plans for Salt River Channelization Hohokam University to Sky Harbor

## Field Photos

## General Support Documents

SRHMP Hydraulic Reports and Files

## HECRAS

HEC-RAS Evaluation Model (SR_Levee_ID33.prj)

## Survey Report and Files