APPENDIX I

MEMORANDUM: CENTRAL ARIZONA PROJECT – FLOOD VOLUME ASSESSMENT

Reata Wash
Flood Control Improvement Study

Contract No. 2014-168-COS

Memorandum: Central Arizona Project – Flood Volume Assessment

August 31, 2016

Prepared for:

CITY OF SCOTTSDALE
ARIZONA

Capital Project Management
7447 E. Indian School Rd. Suite 205
Scottsdale, AZ. 85251

Prepared By:

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

JE Fuller Hydrology & Geomorphology, Inc.
1 West Deer Valley Road, Suite 101
Phoenix, AZ 85027

Registered Professional Engineer (Civil)
CERTIFICATE NO.
34141
JON T.
AHERN
Date Signed 8/31/2016
ARIZONA, U. S. A.
EXPIRES: 9-30-17

In Association with:

WOOD/PATEL
MISSION: CLIENT SERVICE™

LOGANSIMPSON

FLOOR
associates
fam

Gannett Fleming

Technical Solutions

gci

Table of Contents

Section **Page**

List of Figures

List of Tables

Registered Professional Engineer (Civil)
CERTIFICATE NO.
34141
JON T.
AHERN
Date Signed 8/31/2016
ARIZONA, U. S. A.
EXPIRES: 9-30-17

1. Executive Summary

An assessment was conducted to compare the runoff volume from the Reata Wash Flood Control Improvement Study updated hydrologic modeling to historical design flood volumes for the Central Arizona Project (CAP) Reach 11 basins. The volume comparison assumed hydrologic models with full apex flows using historic elevations/volume data specific to the design volumes for CAP Reach 11, Dike 4, Basins 4 East and West. (See Figure 2–1).

Historic retention volumes and elevations for these basins were determined as noted in the Flood Analysis for Reach 11 Dikes (Reference #1). Due to the uncertainty of where these flows will go from storms larger than the 100-year event, upper Reata Pass area was assumed by the original design team (Reference #1) to contribute 100 percent to both Dike 3 (Basin 3) and Dike 4 (East and West Basins) for all flood events. Therefore, the proposed Reata Wash Flood Control improvements should not have an adverse impact on the volume/water surface elevations reported for Dike 4 (East and West Basins).

The volume of runoff from the Reata Wash Flood Control Improvement Study updated hydrologic model, included volume adjustments for un-modeled Dike 4 contributing area. This volume will attain an approximate elevation of 1,528.4 feet using the volume/elevation relationship in Figure 5–1 for Basin 4 East. When the Reata Wash Flood Control Improvement Study elevations are compared to the Dike 4 West Basin elevations reported in the original design documents of 1527.5 feet (Reference #1), 1528.1 feet (Reference #2) and 1529.0 feet (Reference #3 and #4), they are nearly identical.

Sediment volume was not considered as part for the overall basin volume comparison due to the maintenance agreement between the United States Bureau of Reclamation (USBR) and WestWorld (Reference #2). In the agreement, the City of Scottsdale (City) assumes responsibility for not allowing sediment to accumulate in Basin 4 West.

2. Overview

The Central Arizona Project (CAP) is a 336-mile long system of aqueducts, tunnels, pumping plants, and pipelines that carry water across Arizona. A portion of the CAP aqueduct crosses the City within the study limits. This segment of the CAP is protected on the upstream side by Reach 11 dikes (see Figure 7–2). The Reach 11 Dikes consist of a series of four separate dikes totaling approximately 15 miles in length. The dikes parallel the CAP along the northern side of the aqueduct from Cave Creek Road to 3.2 miles east of Loop 101. Dikes are typically bisected by elevated roadway crossings. Near the Reata Wash Flood Control Improvement Study area, Dikes 2 and 3 are segmented by Scottsdale Road and Dikes 3 and 4 are segmented by the historical Pima Road Alignment (now Loop 101). Within Dikes 3 and 4 are areas allocated to retain rainfall runoff volumes for the contributing drainage area. Dike 3 includes Basin 3, incorporating the Tournament Players Club Stadium and Champions golf courses. Dike 4 includes Basin 4 East and West incorporating WestWorld and McDowell Mountain Golf Club (see Figure 2–1).

This memorandum is intended to provide the following:

- A brief design history of CAP Reach 11.
- An overview of readily available publications pertaining to Reach 11, Basin 3 and Basins 4 East and West.
- A summary of the CAP's published volume capacity for Reach 11, Basin 3 and Basin 4 East and West retention areas along the upstream side of the CAP.
- A comparison of the volumes associated with Reata Wash Flood Control Improvement Study's 100-year peak discharge at Basin 4 West.

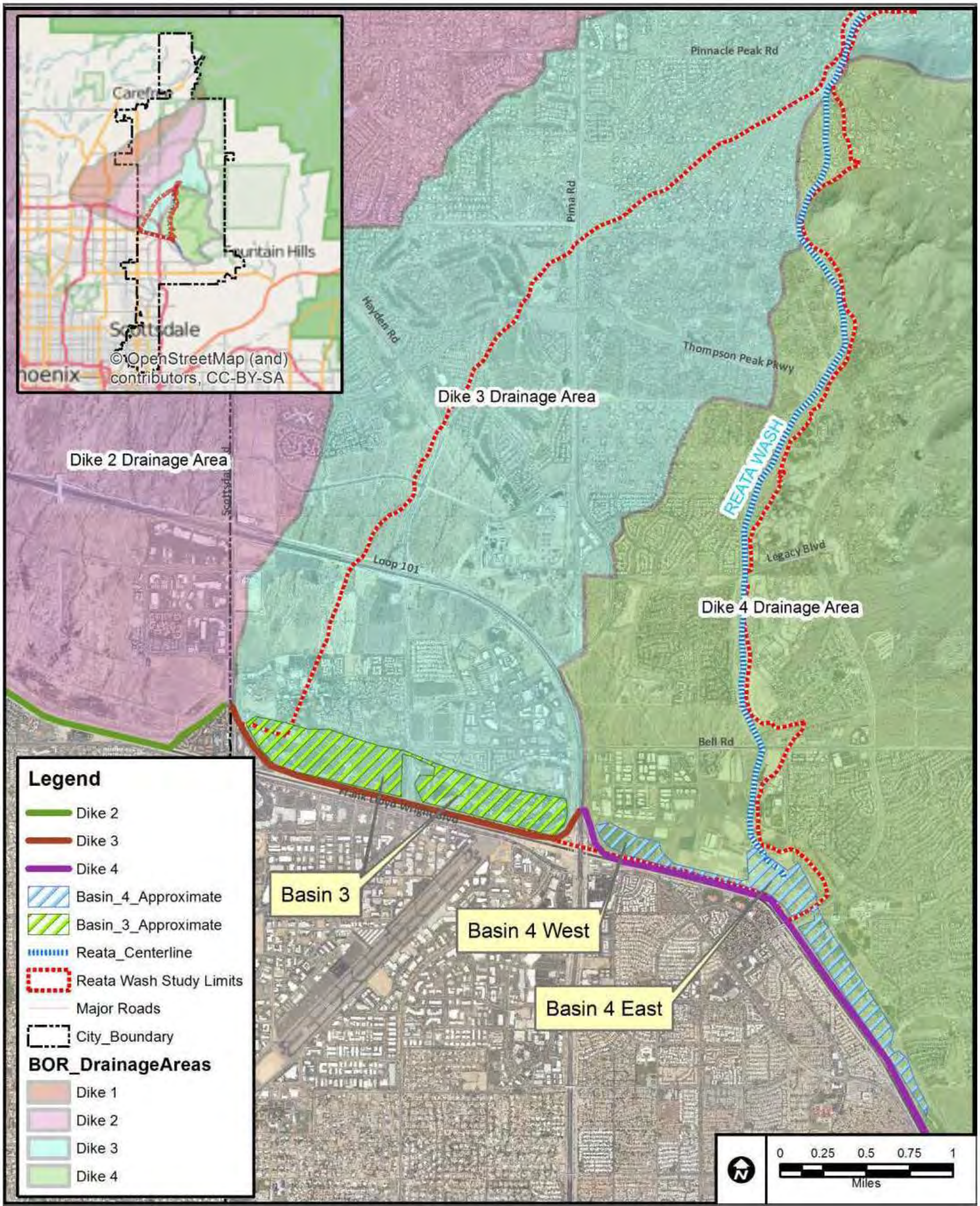


Figure 2–1 General Study Area Location

3. Project History

The following history, pertaining to Basin 4 East and West, was paraphrased from “Final Environmental Assessment, Golf Course, Thompson Peak Parkway and Desert Greenbelt Flood Control Facilities”, City of Scottsdale, January 1998.

The Paradise Valley Flood Detention Basin drainage basin area from McDowell Mountains on the east to Cave Buttes dam on the west was constructed by USBR primarily to protect the CAP facility. The USBR designated area east of Pima Road adjacent to the north side of the CAP canal (Reach 11, Dike 4) is to be developed for public recreational use. The Federal Water Project Recreation Act (PL 89-72) authorizes USBR to make project lands available to local units of government for public recreational purposes. In July 1982, USBR entered into a Cost Sharing and Land Use Agreement with the City that defines the terms of the City's use of this area for public recreational use. Under the agreement, the City is permitted to enter into subagreements and concession agreements subject to USBR's approval. The City later entered into a Use and Management Agreement with Capital Realty Corporation of Scottsdale (CRCS) to develop and manage various public recreational facilities according to a management plan for the area.

A Management and Facilities Operations Plan for development of the property was prepared to implement CRCS's Use and Management Agreement with the City. The management plan, originally approved by USBR and the City in December 1986, also includes a master plan that was updated and approved in July 1995.

On December 31, 1996, the City entered into a Concession Agreement with CRCS to construct a golf course (McDowell Mountain Golf Club). With USBR’s approval, the agreement would allow CRCS to build and operate a golf course on 210 acres of the 356 acres of USBR land covered under the 1982 Land Use and Cost Sharing Agreement. USBR's agreement with the City specifies that under this management scenario the City shall remain responsible for proper management of WestWorld/McDowell Mountain Golf Club facility.

4. Reach 11 Published Volumes

Table 4–1 lists the published Peak/Elevation/Volume values reported in various referenced documents. As seen in Table 4–1 and on Figure 5–1, while the peak discharge determined in the Reata Wash Flood Control Improvement Study updated hydrologic model increased, the runoff volume decreased.

Table 4–1 Basin 4 East Retention Volume at Dike 4 (100-year Event)

(1)Study	Study Date	Peak Discharge (cfs)	Volume (ac-ft)	Elevation (feet)	Notes
Flood Analysis for Reach 11 Dikes (Reference #1)	1990	15,700	2,320	1,525.5 (2)(1527.5)	Elevation estimated from elevation/volume relationship in Figure 7–3 for with project on City datum
Hayden/Rhodes Aqueduct Reach 11, Guidelines (Part of Reference #5)	October 1995	Data not provided	2,320	1,526.0 (2)(1,528.1)	Basin Elevation includes 100-year flood assuming the 50-year sediment volume of 1080 ac-ft in-place.
Ward Model – Existing Conditions (Reference #3)	May 20, 1996	Data not provided	(3)1,809-2,587 (4) (2,714)	1,529.0	Elevation includes sediment storage volume of 1080 ac-ft
Ward Model – With Reata Channel (Reference #4)	June 1, 1996	Data not provided	(3)2,520 (4)(2,714)	1,529.0	Elevation includes sediment storage volume of 1080 ac-ft
Reata Wash Flood Control Improvement Study Hydrology	2015	17,345	(6)2,526	(5)1,528.4	See Table 4–1 Basin 4 East Retention Volume at Dike 4 (100-year Event)

Notes:

(1) Citations and selected hydrologic data from referenced documents is included in Section 7 of this memorandum. Complete reference documents are included with the Reata Wash Flood Control Improvement Study Data Collection Memorandum.

(2) City datum is 2.1 feet higher than the USBR's, therefore the Q_{100} water surface elevation is 1,528.1 feet, above mean sea level (msl), per the City's Datum.

(3) Variation assumed for different Reata Split assumptions. See Reference #3 and #4 for more detail.

(4) Total volume assumed Basin 4 West retention area overflows to Basin 4 East retention area.

(5) Elevations reported estimated from volumes and elevation/volume curves for Basin 4 (East and West). Figure 5–1

(6) Drainage Area for the Reata Study is 19.58 sq. mi and includes upstream of Bell Road only. Runoff volume of 1,663 ac-ft from Reata Study HEC-1 model output, 100-year, 24 hour duration with no diversion at Dobson Wash. Per Table 2 in Reference #3 total contributing area to Dike 4 (Basins 4 East and West) is equivalent to 29.74 sq mi. For comparative purposes 2,526 ac-ft was determined using simple drainage area/runoff volume ratio to account for un-modeled contributing areas.
Reata Study Runoff Volume + prorated volume from additional contributing area = Estimated total runoff volume from 100-year, 24-hour storm

$$1{,}663\ ac-ft+\left(\frac{1{,}663\ ac-ft}{19.58\ sq\ mi}\right)(29.74\ sq\ mi-19.58\ sq\ mi)=2{,}526\ ac-ft$$

Abbreviations:

cfs – cubic feet per second
ac-ft – acre feet
ft- feet
sq mi – square miles

5. Anticipated Reata Wash Flood Volume and Estimated Basin Elevation

The Reata Wash Flood Control Improvement Study hydrology was updated from the recent Draft Pinnacle Peak South (PPS) Area Drainage Master Study (ADMS) Hydrology and Hydraulics (H&H) Report, 2012, prepared in cooperation with the City and the Flood Control District of Maricopa County (FCDMC). The hydrology was updated for this study to include additional drainage basins and routing reaches along Reata Wash from Pinnacle Peak Road South to Bell Road. The total volume from the updated Reata Wash Flood Control Improvement Study hydrologic model 100-year, 24-hour storm event was 1,663 ac-ft (with a contributing area of 19.6 sq mi). The volume was adjusted as noted in Table 4–1 and plotted along a trend line for the elevation/volume graph created from "With Reata Pass Channel" data reported in Figure 7–3. Resultant elevations for the revised hydrology are plotted on Figure 5–1 and listed in Table 4–1.

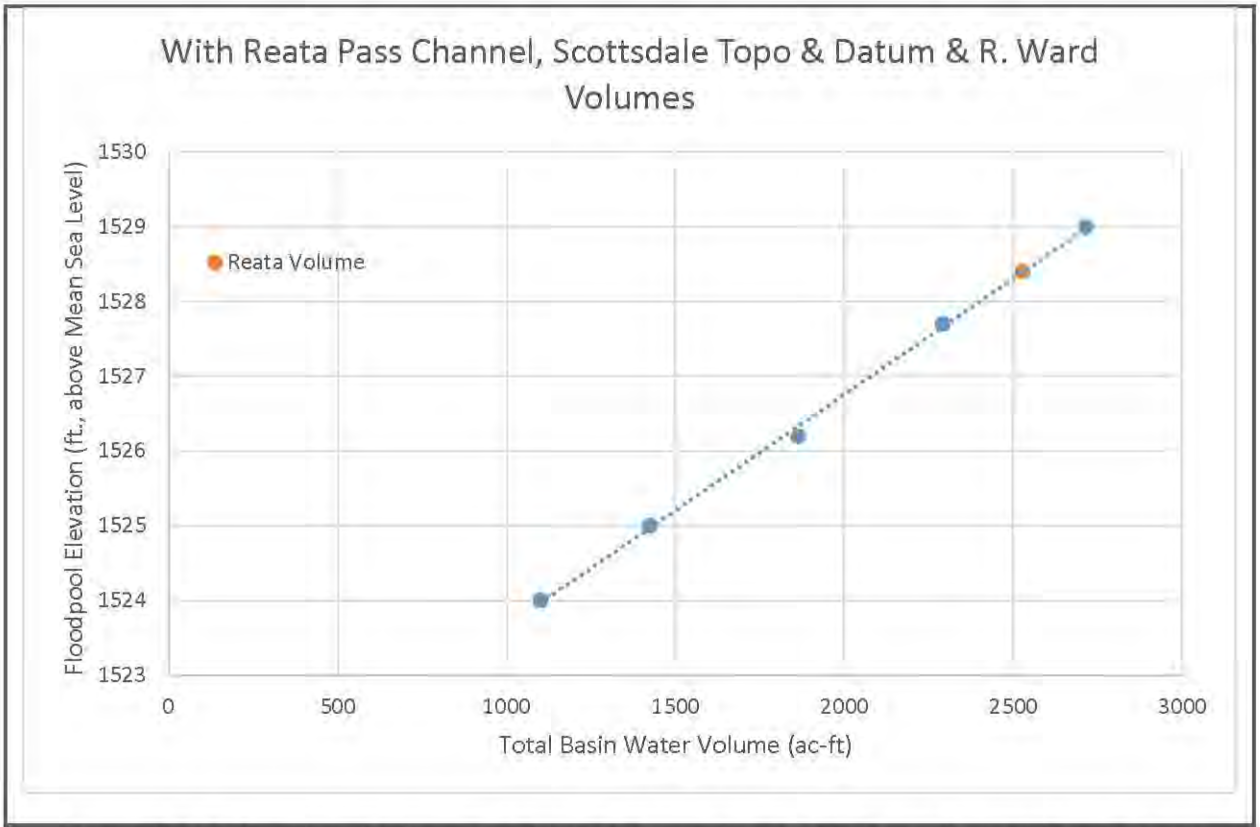


Figure 5–1 Elevation/Volume at Basin 4 Assuming 100% Contribution From Apex

6. Conclusion

The volume of runoff from the Reata Wash Flood Control Improvement Study updated hydrologic model, including volume adjustments for un-modeled Dike 4 contributing area, will attain an approximate elevation of 1,528.4 feet using the volume/elevation relationship in Figure 5–1 for Basin 4 East. When the Reata Wash Flood Control Improvement Study elevations are compared to the Dike 4 West Basin elevations reported in the original design documents of 1527.5 feet (Reference #1), 1528.1 feet (Reference #2) and 1529.0 feet (Reference #3 and #4), they are nearly identical to elevations determined for the Reata Wash Flood Control Improvement Study.

7. References

Below are excerpts and notes taken from various documents collected as part of the Data Collection effort for the Reata Wash Flood Control Improvement Study pertaining to Reach 11. Documents are generally ordered starting with the earliest and ending with the most recent.

REFERENCE #1

Report Reference

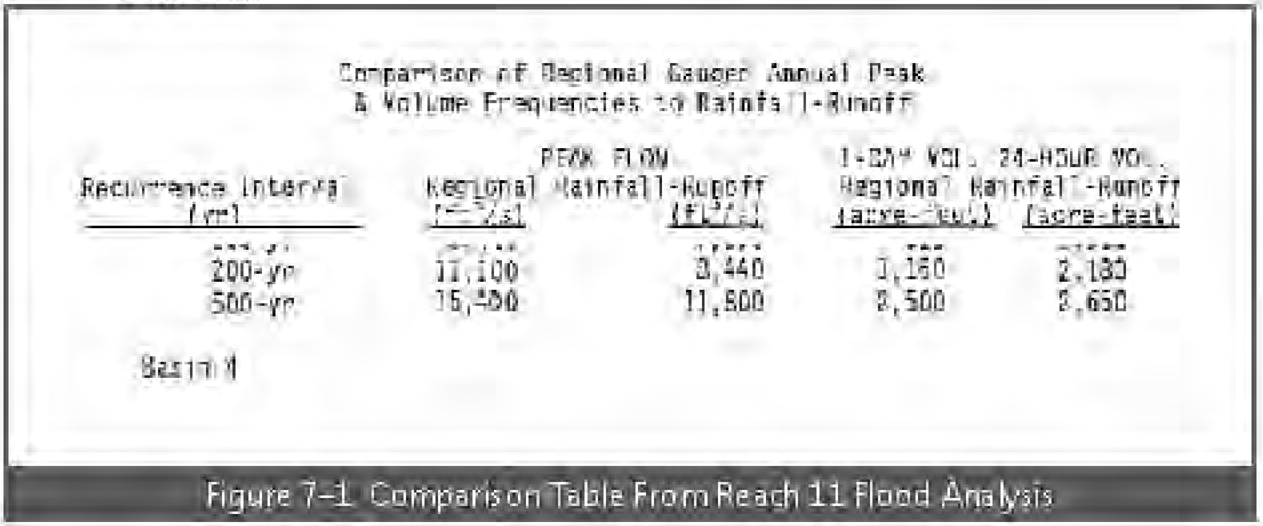
USBR and Arizona State Land Department (ASLD) documents 1990-1991 scanned from files at the City.

Report Summary

Provides back background data and letters regarding ASLD coordination and Reach 11 flood analysis.

The overall objectives of the study were:

- ASLD Letter dated June 10, 1991
    - Letter acknowledges the Reata Pass flows directed to retention basins east of Pima Road and outlines 4 recommended additional tasks to consider for future studies. The four tasks include redefinition of contributing area due to the potential shifting of alluvial fan channels, proposed flood channel and detention basin construction, ponding at a proposed freeway (Future Loop 101), and increased basin urbanization.
- Flood Analysis for Reach 11 Dikes, Hayden/Rhodes Aqueduct Central Arizona Project, USBR, Denver Office Flood Section, references memo dating March 27, 1990
    - Outlines peak discharges and storage volumes for multiple storm events along Reach 11, Dikes 1 to 4. (Figure 7–1)
    - Previous study used 6-hour storm duration. USBR study uses 24-hour storm duration.
    - One location where changes to the contributing drainage areas is likely to occur is below Reata Pass (Reata Wash south of Pinnacle Peak Road). Future drainage plans (Desert Green Belt project) call for the diversion of all flow from the 7 square mile Reata Pass area of Dike 3 into Dike 4 (See Figure 7–2) up to the 100-year flood flow. Due to the uncertainty of where these flows will go from storms larger than the 100-year event, this upper Reata Pass area is assumed to contribute 100 percent to both Dike 3 (Basin 3) and Dike 4 (East and West Basins) for all flood events.
    - Hydrologic analysis used: General Drainage Plan for North Scottsdale, AZ June 1989.
    - Final hydrologic models were not available as of the publication of the Flood Analysis Document.



Comparison of Regional Gauged Annual Peak
& Volume Frequencies to Rainfall-Runoff

Recurrence Interval (yr)	PEAK FLOW Regional (ft³/s)	PEAK FLOW Rainfall-Runoff (ft³/s)	1-DAY VOL. Regional (acre-feet)	24-HOUR VOL. Rainfall-Runoff (acre-feet)
200-yr	11,100	8,440	1,160	2,180
500-yr	15,400	11,800	2,500	3,650

Basin 4

Figure 7–1 Comparison Table From Reach 11 Flood Analysis

- USBR Reservoir Routing Criteria
    - Flood hydrograph routings through each of the dikes were completed using the 50-year sediment volumes in-place. The 50-year sediment volume has been provided by the Denver Sedimentation Section and is based on the frequency flood volumes determined in this study. The flood storage elevations have been adjusted assuming the 50-year sediment volumes occupies the bottom of the basin.

The document collected is missing all referenced figures and tables.

Relevance to Study

Original basin design hydrology was not located. This document provided a summary of the design documentation and notations within the memo stating that due to the uncertainty of where flow goes for larger storm events (above the 100-year), upper Reata Pass area is assumed to contribute 100 percent to both Dike 3 (Basin 3) and Dike 4 (East and West Basins) for all flood events.

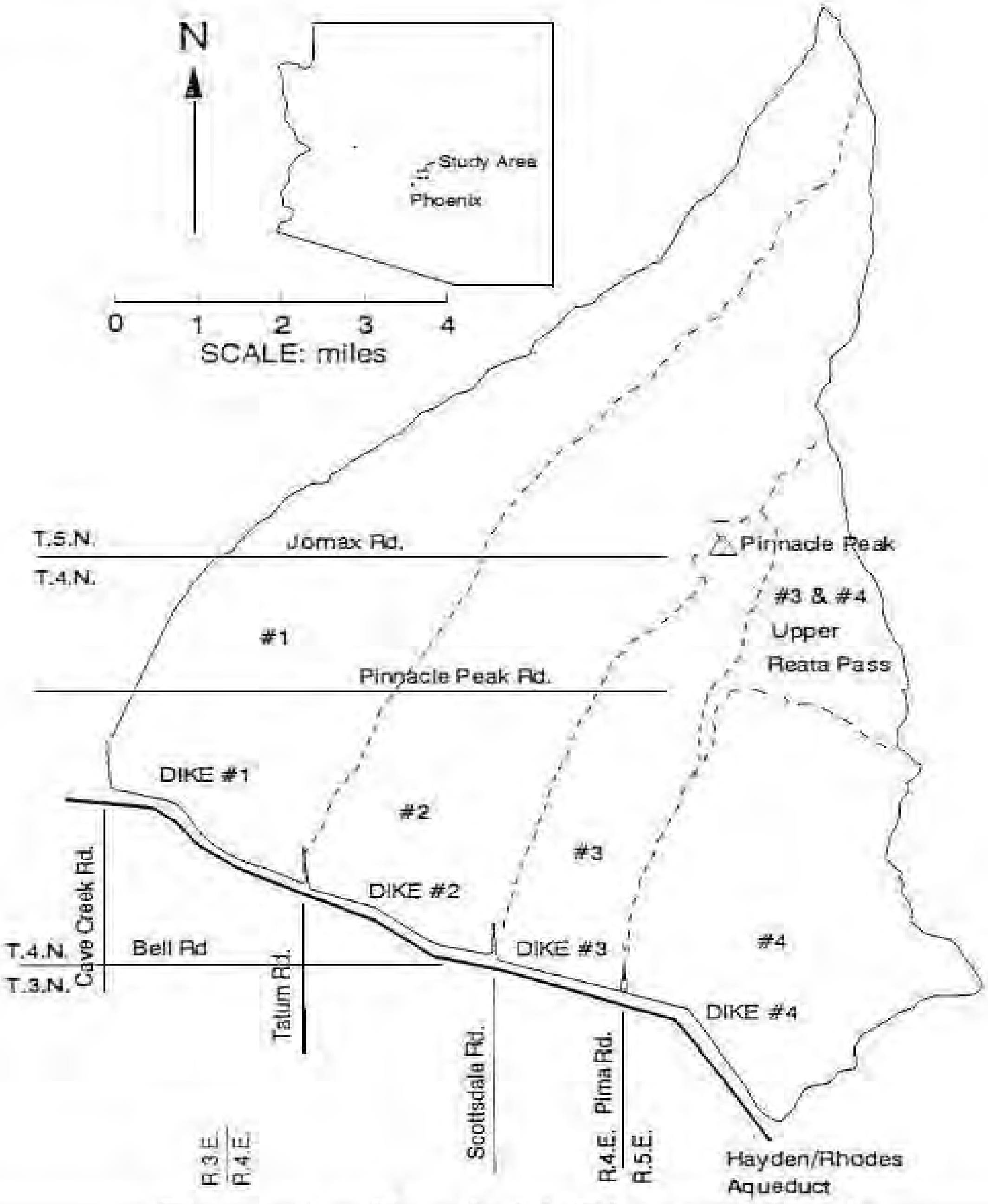


Figure 7–2 USBR Reach 11 Drainage Basins

REFERENCE #2

Report Reference

WestWorld Golf Course, Desert Greenbelt, Management – Operation Plan.

Report Summary

The overall objectives of the study were:

- Within the Preamble it states that the document is an agreement between the City (“Licensor”) and CRCS (“Licensee”).
- Addresses responsibility regarding control of flood waters, removal of sediment, environmental controls, construction and operation of the golf course, as well as methods to accomplish the work as outlined in the document.
- Basin 4 East was designed and constructed to accommodate storm water flows in excess of a 100-year flood. It is important to note that the USBR assumed that a 50-year sediment accumulation would be in place when a major storm occurred. Based on data published by the USBR, Dike 4 (Basin 4 East and West) can hold 10,700 ac-ft of water at elevation 1,542 feet. This would include 1,080 ac-ft or 1,742,400 cubic yards of sediment.
- At that time, the City entered into a concession agreement with CRCS to construct an 18-hole championship golf course (McDowell Mountain Golf Club) on the remaining 210 acres (see Figure 7–3 WestWorld Master Plan). The City has assumed responsibility to see that the basin is properly maintained (see notes below). A significant portion of this responsibility is to assure that sediment is not allowed to accumulate.
- Discusses maintenance requirement of the Golf Course operator to maintain storage volumes. Maintenance duties to include silt deposit removal a minimum of one time per year or as necessary.
- Discusses maintenance guidelines/precautions undertaken by the City for the “Desert Green Belt” project as it relates to the USBR Basins 4 East and West.
    - Channel design included two basins (upper and lower) to remove sediment/silt loads prior to entering McDowell Mountain Golf Club.
    - Stationary gauges will be placed in the upper basin (sediment basin) and sediment will be removed when a load of twelve (12) inches has been reached.
    - Stationary gauges will be placed in the lower basin (settling basin) and silt will be removed when a load of twelve (12) inches has been reached but in no case will the basin go for longer than one year without cleaning.

Relevance of Study

Reach 11, Basin 4 Management Plan allowing the City to utilize the 50-year sediment basin volume for stormwater storage volume. The City has assumed responsibility to see that the basin is properly maintained. A significant portion of this responsibility is to assure that sediment is not allowed to accumulate.

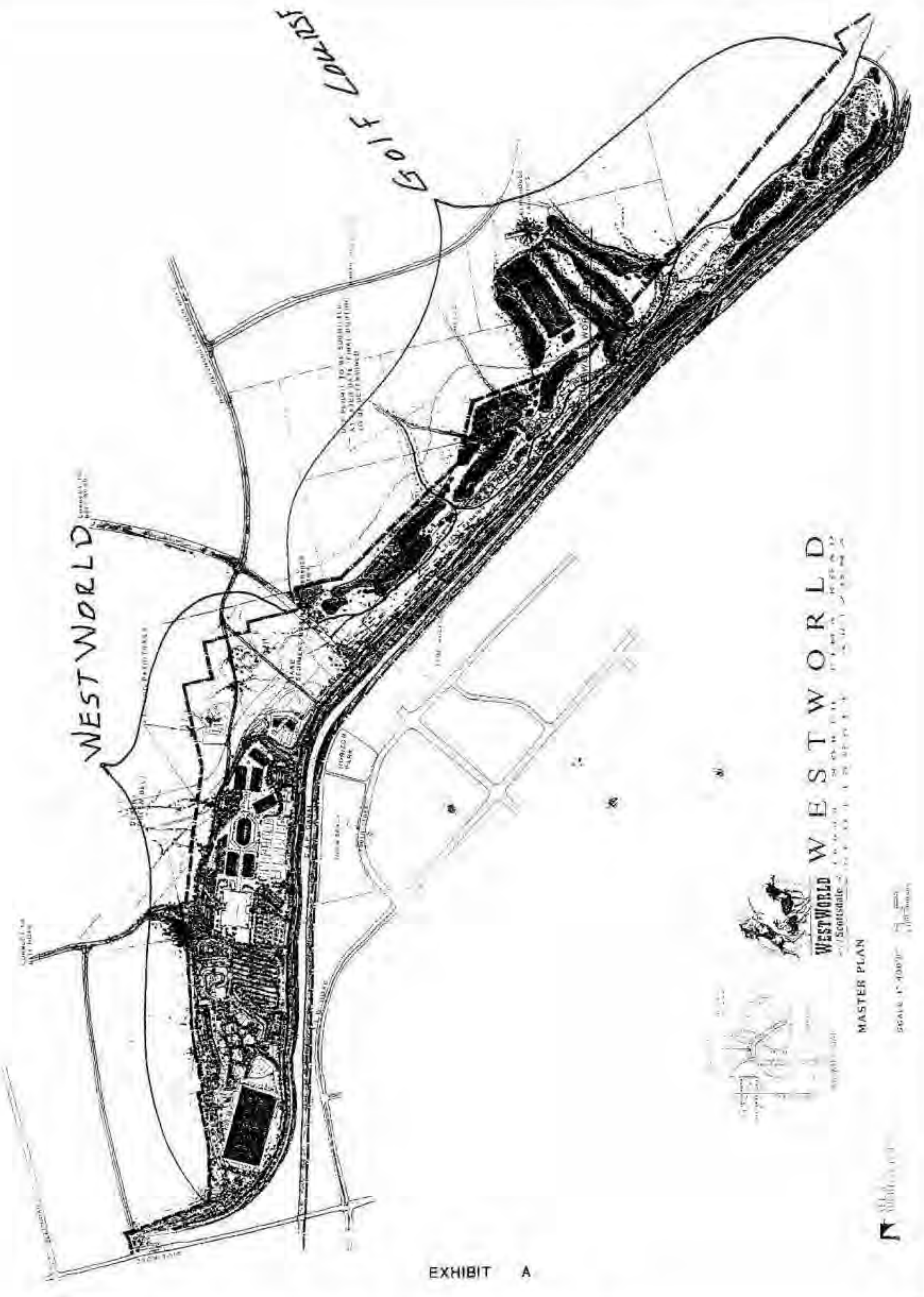


Figure 7–3 WestWorld Master Plan

REFERENCE #3

Report Reference

Letter from Bob Ward (Consulting Engineer) to the City of Scottsdale; Subject Floodpool Analysis, CAP Detention Basin No. 4. May 20, 1996.

Report Summary

The overall objectives of the study were:

- Assessed flood volumes for CAP detention Basin 4 for 5-year, 10-year, 25-year, 50-year, and 100-year storms.
- 6-hour storm duration and future land use conditions.
- Does not reflect the Thompson Peak Parkway crossing or regrading for the Golf Course (McDowell Mountain Golf Club).
- It was noted that the City recently completed new stage storage calculations for Dike 4 (May 1996).
- Differences between sediment/discharge inflow methodology account for the variation in results between Bob Ward's and the USBR's models.(Figure 7–4)

Relevance to Study

Study completed by Bob Ward for WestWorld of Scottsdale. Models focused on various scenarios for existing drainage patterns/Reata Pass Channel in-place and multiple storm events.

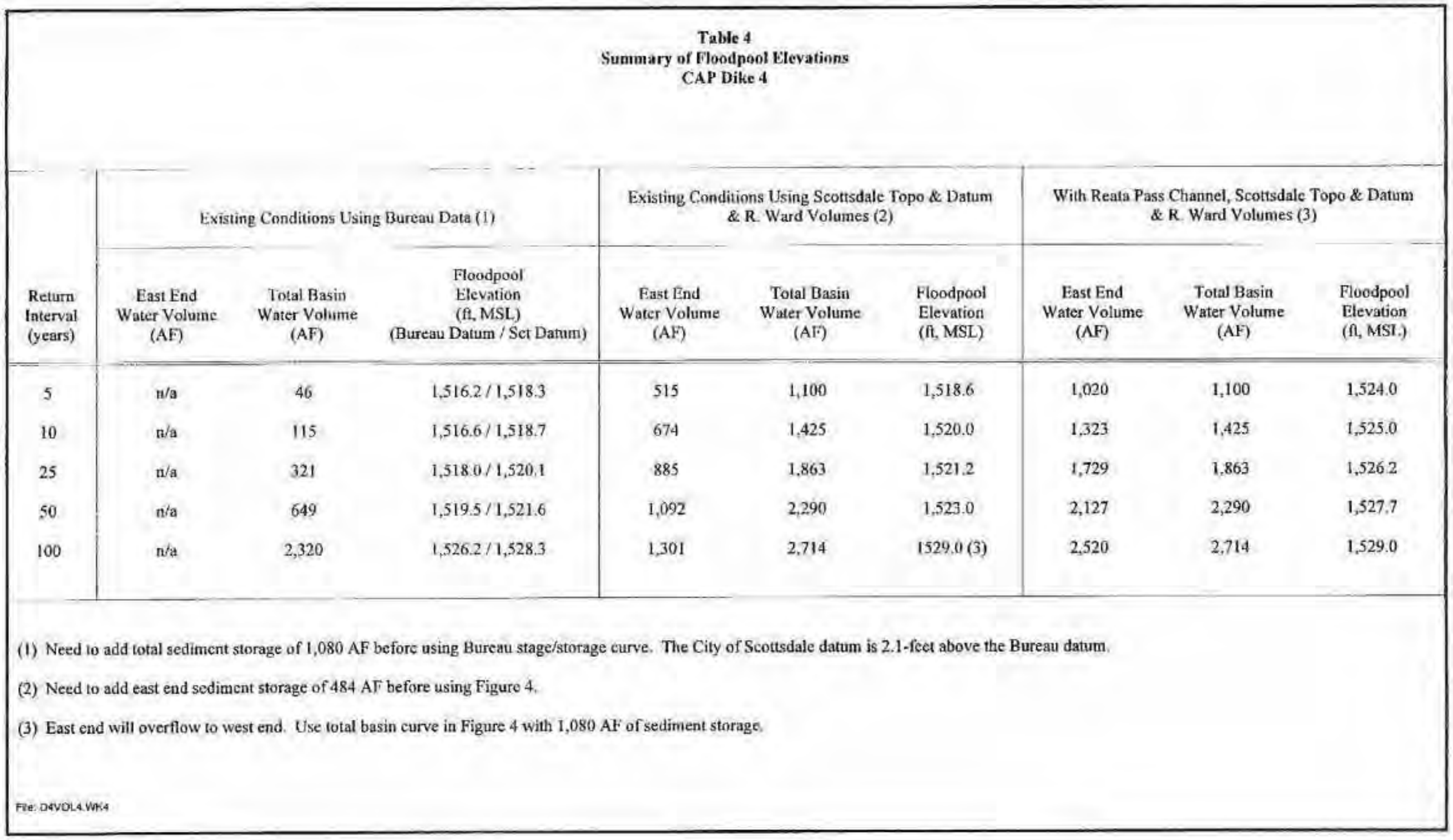


Table 4
Summary of Floodpool Elevations
CAP Dike 4

	Existing Conditions Using Bureau Data (1)			Existing Conditions Using Scottsdale Topo & Datum & R. Ward Volumes (2)			With Reata Pass Channel, Scottsdale Topo & Datum & R. Ward Volumes (3)		
Return Interval (years)	East End Water Volume (AF)	Total Basin Water Volume (AF)	Floodpool Elevation (ft, MSL) (Bureau Datum / Sct Datum)	East End Water Volume (AF)	Total Basin Water Volume (AF)	Floodpool Elevation (ft, MSL)	East End Water Volume (AF)	Total Basin Water Volume (AF)	Floodpool Elevation (ft, MSL)
5	n/a	46	1,516.2 / 1,518.3	515	1,100	1,518.6	1,020	1,100	1,524.0
10	n/a	115	1,516.6 / 1,518.7	674	1,425	1,520.0	1,323	1,425	1,525.0
25	n/a	321	1,518.0 / 1,520.1	885	1,863	1,521.2	1,729	1,863	1,526.2
50	n/a	649	1,519.5 / 1,521.6	1,092	2,290	1,523.0	2,127	2,290	1,527.7
100	n/a	2,320	1,526.2 / 1,528.3	1,301	2,714	1529.0 (3)	2,520	2,714	1,529.0

(1) Need to add total sediment storage of 1,080 AF before using Bureau stage/storage curve. The City of Scottsdale datum is 2.1-feet above the Bureau datum.

(2) Need to add east end sediment storage of 484 AF before using Figure 4.

(3) East end will overflow to west end. Use total basin curve in Figure 4 with 1,080 AF of sediment storage.

File: D4VOL4.WK4

Figure 7–4 Summary of Flood Detention Elevations

REFERENCE #4

Report reference

Letter from Bob Ward to the City of Scottsdale; Subject Updated Floodpool Analysis, CAP Detention Basin No. 4. June 1, 1996.

Report Summary

The overall objectives of the study were:

- Updated analysis from the May 20, 1996 letter to the City.
- Analysis included review on new topographic maps incorporating a portion of the Verde Canal.
- As a result of the review, it appears that the Verde Canal embankment, in conjunction with other manmade features shown on the topographic maps, can significantly influence the inflow patterns to the east and west end of Dike 4.
- Updated analysis only dealt with the "R. Ward Existing Conditions" analysis. Updated results table provided below (Figure 7–5).
- Bob Ward noted that the "with Reata Pass Channel" condition lies within the probability band defined by the flow ranges for the future land use conditions assuming the existing drainage patterns. This means, there is a reasonable chance that the existing watershed drainage pattern could direct as much water to the east end of Dike 4 as will occur after the Reata Pass Channel is constructed.

Relevance to Study

Updates the existing/with channel hydrology discussion from the previous Bob Ward letter dated May 20, 1996.

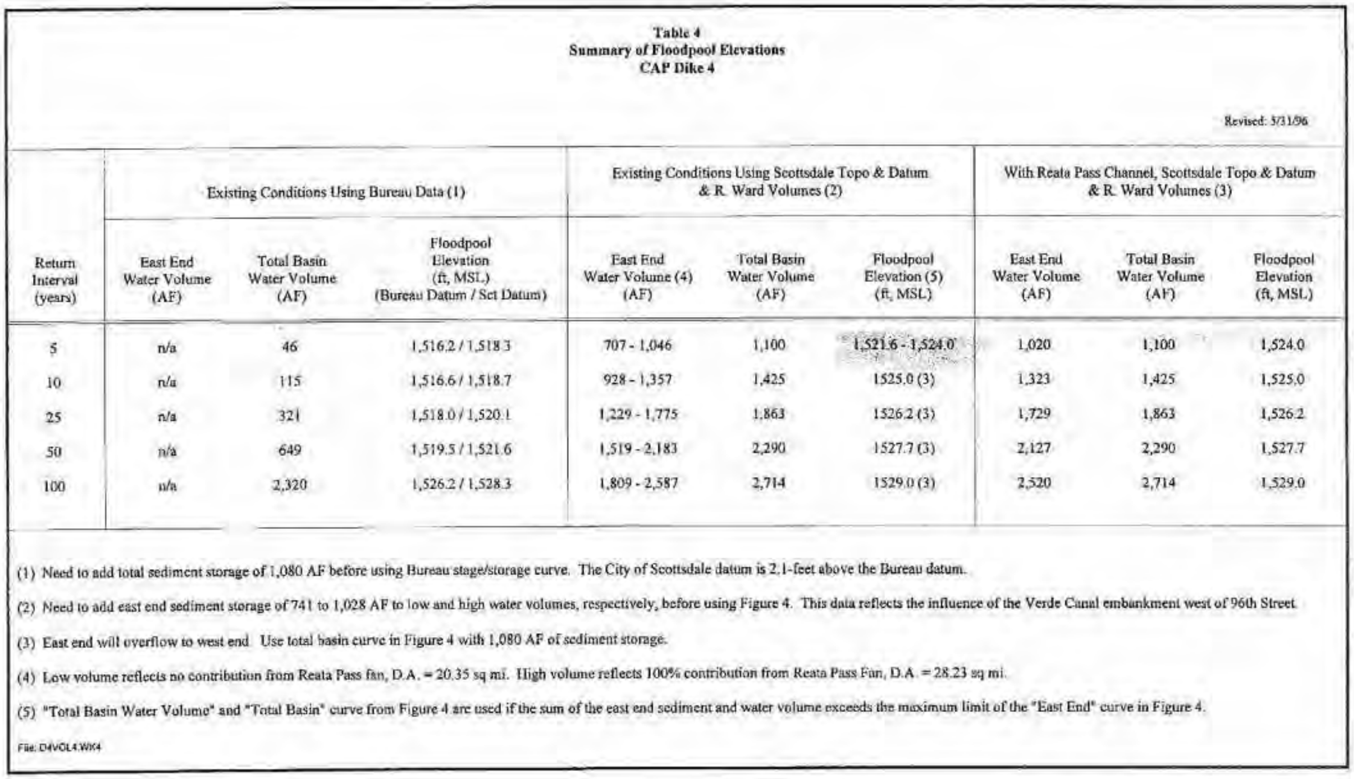


Table 4
Summary of Floodpool Elevations
CAP Dike 4

Revised: 5/31/96

Return Interval (years)	Existing Conditions Using Bureau Data (1)			Existing Conditions Using Scottsdale Topo & Datum & R. Ward Volumes (2)			With Reata Pass Channel, Scottsdale Topo & Datum & R. Ward Volumes (3)		
	East End Water Volume (AF)	Total Basin Water Volume (AF)	Floodpool Elevation (ft, MSL) (Bureau Datum / Sct Datum)	East End Water Volume (4) (AF)	Total Basin Water Volume (AF)	Floodpool Elevation (5) (ft, MSL)	East End Water Volume (AF)	Total Basin Water Volume (AF)	Floodpool Elevation (ft, MSL)
5	n/a	46	1,516.2 / 1,518.3	707 - 1,046	1,100	1,521.6 - 1,524.0	1,020	1,100	1,524.0
10	n/a	115	1,516.6 / 1,518.7	928 - 1,357	1,425	1525.0 (3)	1,323	1,425	1,525.0
25	n/a	321	1,518.0 / 1,520.1	1,229 - 1,775	1,863	1526.2 (3)	1,729	1,863	1,526.2
50	n/a	649	1,519.5 / 1,521.6	1,519 - 2,183	2,290	1527.7 (3)	2,127	2,290	1,527.7
100	n/a	2,320	1,526.2 / 1,528.3	1,809 - 2,587	2,714	1529.0 (3)	2,520	2,714	1,529.0

(1) Need to add total sediment storage of 1,080 AF before using Bureau stage/storage curve. The City of Scottsdale datum is 2.1-feet above the Bureau datum.

(2) Need to add east end sediment storage of 741 to 1,028 AF to low and high water volumes, respectively, before using Figure 4. This data reflects the influence of the Verde Canal embankment west of 96th Street.

(3) East end will overflow to west end. Use total basin curve in Figure 4 with 1,080 AF of sediment storage.

(4) Low volume reflects no contribution from Reata Pass fan, D.A. = 20.35 sq mi. High volume reflects 100% contribution from Reata Pass Fan, D.A. = 28.23 sq mi.

(5) "Total Basin Water Volume" and "Total Basin" curve from Figure 4 are used if the sum of the east end sediment and water volume exceeds the maximum limit of the "East End" curve in Figure 4.

File: D4VOL4.WK4

Figure 7–5 Updated Summary of Flood Detention Elevations

REFERENCE #5

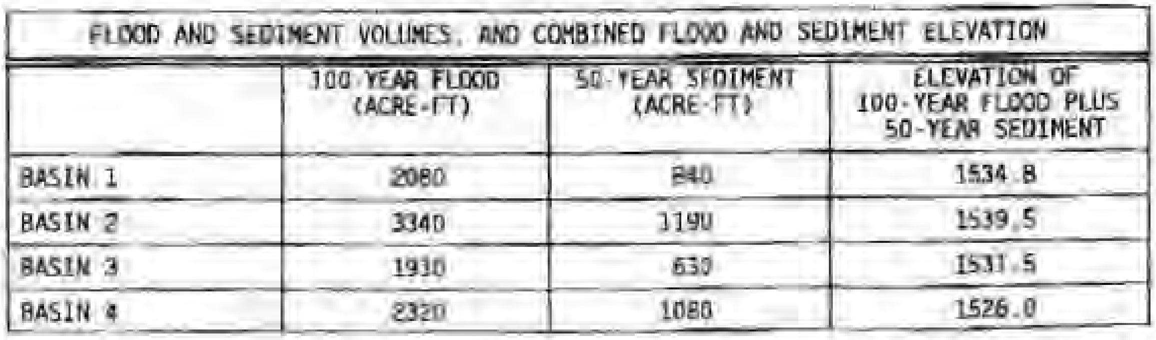
Report reference

City of Scottsdale Desert Greenbelt, Volume IV: Technical Addendum, Part 1 of 2, Reata Pass/Beardsley Wash Erosion Control and Channel Improvement Design, August 1997.

Report Summary

The overall objectives of the study were:

- Appendix D, Downstream Backwater Control for 100-year flood. Appear to be Guidelines set by USBR. Draft, Hayden/Rhodes Aqueduct, Reach 11, Guidelines for Road Crossing and Development within Drainage Basins, October 1995.
  - Decrease in the overall flood storage capacity of the dike basins is prohibited.
  - Based on compensatory volume determination.
  - Movement of Material within the flood detention basin will be allowed subject to approval by USBR and the Central Arizona Water Conservation District (CAWCD) based on the restrictions and/or guidelines noted below. Further detail provided in reference document.
    - Maintaining retention capacity below existing 100-year storm, 50-year sediment elevation. Movement of material from above the 100-year storm, 50-year sediment elevation to below that elevation will be allowed only if an equal volume is removed from below the 100-year storm, 50-year sediment elevation. See Figure 7–6.



FLOOD AND SEDIMENT VOLUMES, AND COMBINED FLOOD AND SEDIMENT ELEVATION

	100 YEAR FLOOD (ACRE-FT)	50-YEAR SEDIMENT (ACRE-FT)	ELEVATION OF 100-YEAR FLOOD PLUS 50-YEAR SEDIMENT
BASIN 1	2080	840	1534.8
BASIN 2	3340	1190	1539.5
BASIN 3	1910	630	1531.5
BASIN 4	2320	1080	1526.0

Figure 7–6 USBR Summary of Flood Detention Elevations

    - Discusses borrow material guidelines with in the flood detention basins.
    - Discusses content of imported borrow material.
    - Dividing basins or changing flow patterns within a basin. USBR and the CAWCD must review proposals for future crossings and land use development within detention basins. Projects which negatively impact the function and integrity of the dike and detention basins are not acceptable.

Relevance to Study

Technical document contained within the appendix appears to be guidelines set out by the USBR for management of the pool areas (areas of potential stormwater inundation) for retention basins within Reach 11.

REFERENCE #6

Report Reference

Final Environmental Assessment, Golf Course, Thompson Peak Parkway and Desert Greenbelt Flood Control Facilities, City of Scottsdale, January 1998.

Report Summary

The overall objectives of the study were:

- General environmental overview for Dike 4 area.
- More detailed information on USBR's hydraulic analysis is provided in the "Flood Analysis for Reach 11 Dikes, Hayden-Rhodes Aqueduct, Central Arizona Project", prepared by USBR Denver Office, Flood Section (1990). Reference noted on Pg3-32. Document was not located.

Relevance to Study

Document noted that the original Flood Analysis for Reach 11 dikes was not located when requested from the USBR.

REFERENCE #7

Report reference

US Department of the Interior, Bureau of Reclamation "Hydrologic Hazard Rainfall-Runoff Study, Hayden Rhodes Aqueduct, Arizona, Reaches 11, Dikes 1, 2, 3, And 4". December 2006.

Report Summary

The overall objectives of the study were:

- New and updated rainfall-runoff models were prepared as part of this hazard study (Figure 7–7).
- The new rainfall-runoff models were developed using all appropriate FCDMC guidelines.
- The new models were specifically designed for this project to run with much longer storm durations and larger return periods of rainfall than are typically used by the FCDMC studies but are required for USBR dam safety studies.
- The models were developed to include both existing and future land use conditions.
- No documentation exists in USBR files regarding the original design hydrology for these dikes.

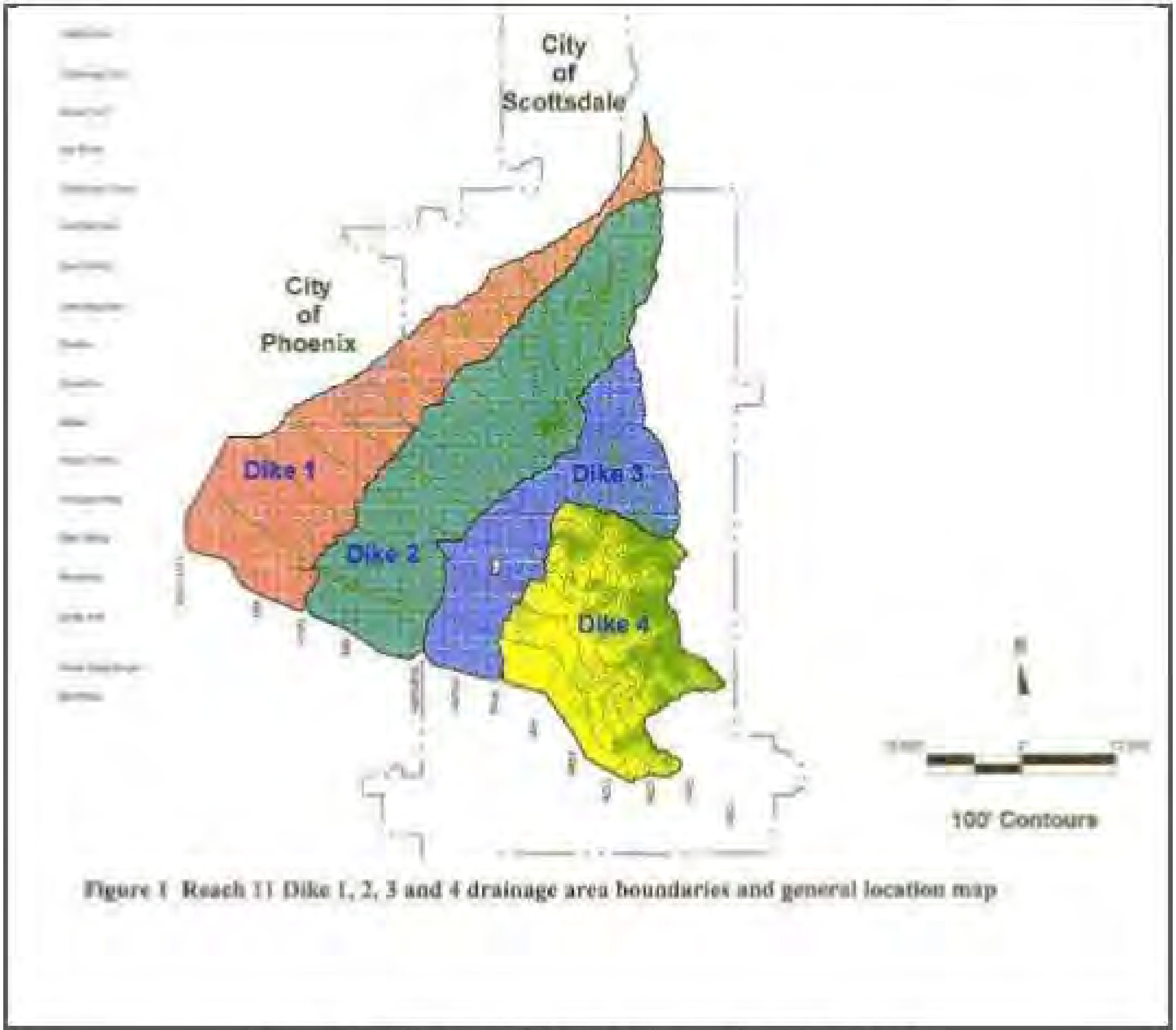


Figure 7–7 Reach 11 Dike/Drainage Area Locations

Relevance to Study

Updated hydrologic analysis to replace missing CAP design hydrology. These results will be compared to study hydrology to assess potential impacts with regard to USBR facilities at WestWorld.

APPENDIX J

MEMORANDUM: SEDIMENT AND STABLE CHANNEL ASSESSMENT: REVIEW OF HISTORICAL DOCUMENTATION

Reata Wash
Flood Control Improvement Study

Contract No. 2014-168-COS

Memorandum: Sediment and Stable Channel Assessment: Review of Historical Documentation

August 31, 2016

Prepared for:

Capital Project Management
7447 E. Indian School Rd. Suite 205
Scottsdale, AZ. 85251

Prepared By:

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

JE Fuller Hydrology & Geomorphology, Inc.
1 West Deer Valley Road, Suite 101
Phoenix, AZ 85027

In Association with:

WOOD/PATEL
MISSION: CLIENT SERVICE™

LOGAN SIMPSON

FLOOR
associates

Gannett Fleming

Technical Solutions

gci

CERTIFICATE NO.
34141
JON T.
AHERN
Date Signed 8/31/2016

EXPIRES: 9-30-17

Table of Contents

List of Figures

List of Tables

List of Appendices

Registered Professional Engineer (Civil)
CERTIFICATE NO.
34141
JON T.
AHERN
Date Signed 8/31/2016
ARIZONA, U. S. A.
EXPIRES: 9-30-17

1. Executive Summary

The Reata Wash Flood Control Improvement Study (RWFCIS) requires a sediment documentation review that includes historical sediment transport modeling assumptions and methodology, and provides recommendations for the study. The recommendations for sediment modeling assume full flow within the Reata Wash Corridor. Based on a review of the documents reported in Table 5–1 and current Flood Control District of Maricopa County (FCDMC) standards it is concluded that;

- The use of FCDMC standards defines the standard of practice for sediment transport modeling and scour calculations for projects within Maricopa County.
- FCDMC methods have provided reasonable results for sediment modeling within Maricopa County.

Given the conclusions listed above, it is recommended that FCDMC standards and methodologies be used for sedimentation and scour analyses for the Reata Wash Flood Control Improvement Study. To that end, sediment transport modeling and scour calculations compliant with current requirements outlined in the current version of the FCDMC Drainage Design Manual – Hydraulics (Chapter 11). In addition, it is recommended that the Reata Wash corridor sediment transport modeling utilize hydrographs updated as part of the RWFCIS, historic sediment sample data, and applicable sediment inflow data.

2. Overview

This memorandum documents the findings of the sediment transport modeling conducted in support of the City of Scottsdale's (City) Reata Wash Flood Control Improvement Study. The assessment was performed by staff from JE Fuller/Hydrology & Geomorphology, Inc. (JE Fuller), as a subconsultant to Wood, Patel & Associates (WPA), under Task 6 of City of Scottsdale Contract # 2014-168-COS. The scope of services for Task 6 calls for a review of past sediment transport modeling and reports to assess their applicability to the RWFCIS. Historical documents considered included:

- Photographs and aerial photography.
- Topographic mapping and geotechnical reports for existing wash corridor and levee.
- As-built drawings for flood control improvements.
- Historical rainfall data and hydrologic/hydraulic reports and modeling.
- Regulatory floodplains.
- High water marks associated with historic flood events.

The scope of services for Task 6 calls for a discussion of historical sediment modeling assumptions and methodology, as well recommendations for existing/design conditions sediment modeling assuming full flow within the Reata Wash Corridor.

3. Study Area

The Reata Wash Flood Control Improvement Study area is located within the city limits of Scottsdale, Arizona along the western flank of the McDowell Mountains, and northeast of the Loop 101 Freeway and the Central Arizona Project (CAP) Canal (Figure 3–1).

Figure 3–1 General Study Area Location

4. Review of Historical Documents

Historical documentation compiled and reviewed includes:

- Photographs and aerial photography
- Topographic mapping and geotechnical reports for existing wash corridor
- As-built drawings for flood control improvements.
- Historical rainfall data and hydrologic/hydraulic reports and modeling
- Regulatory floodplains
- Documented high water marks associated with historic flood events

In addition to the items noted above, Section 5 outlines significant sediment modeling elements from historical reports and studies conducted in the Reata Wash study area.

5. Previous Sediment Transport Modeling

Table 5–1 lists the relevant historical reports (arranged by date) and provides a summary of the sediment modeling and scour calculation techniques utilized for each study.

Table 5–1 Historical Sediment/Scour Modeling Documents

Study Document Number	Title	Modeling Assumptions and Methods
RW0072	Greiner, Inc., Scottsdale Desert Greenbelt Phase One Design: Reata Pass Wash Supplemental Conditional Letter of Map Revision (CLOMR), June 1, 1996	**Sediment Modeling Program: HEC-6(4)** **Sediment Modeling Assumptions/Document Highlights:** • Local Sediment Sampling • Yang's Streampower Method • 6-hour storm Input hydrographs • Accumulated 100-year storm event in a series • Additional study related to Yang Sediment Transport Relationship **Scour Calculations/Document Highlights:** • Safety factor of 1.5 for scour calculations to determine design scour elevations • Used thalweg as lowest channel bed elevation • Bend and anti-dune Trough (Bed form) per ADWR(1) "Design of Fluvial Systems" • Contraction, abutment and pier scour per FHWA(2) "Evaluating Scour at Bridges" • Low Flow incisement set at 1.5 feet within excavated channels per SLA, "Engineering Design of Fluvial Systems" • Apex confinement added 3 feet of scour to overall depth near apex

Table 5–1 Historical Sediment/Scour Modeling Documents

Study Document Number	Title	Modeling Assumptions and Methods
    RW0104 RW0105 RW0110 RW0106 RW0107	Simons, Li & Associates, Inc, City of Scottsdale Desert Greenbelt Project Multiple Volumes: Reata Pass/Beardsley Wash Channel Response Analysis with Ultimate Levee Encroachment, February 1997 Volumes: Volumes I (2/97) Volume II (1/97) Volume III (8/97) Volume IV Part 1 (8/97) Volume IV Part 2 (8/97)	**Sediment Modeling Program: HEC2-SR(3)** **Sediment Modeling Assumptions/Document Highlights:** • Local Sediment Sampling • Prepared discretized hydrographs for 100-year and the 10-year flood events **Scour Calculations/Document Highlights:** • Low Flow incisement set at 3 feet • Bed-form scour (ADWR(1) Eq 4.25) • Contraction scour at bridges and narrowing channel sections (Modified Laursen Equation 1960) • Bend Scour (ADWR(1) Eq. 5.25) • General Scour estimated using a single event 10-year HEC2-SR model run • Long-term degradation was estimated considering changes in sediment supply. Worse case used a 50% reduction in upstream sediment supply for the 100-year flood event. • Total Scour depth determined by multiplying a Safety factor of 1.3 to scour calculations then adding the long term degradation.

Notes:
(1) Arizona Department of Water Resources (ADWR), Design Manual for Engineering Analysis of Fluvial Systems, 1986. Prepared by Simons, Li & Associates, Inc.(SLA)
(2) Federal Highway Administration (FHWA)
(3) HEC2-SR is a quasi-dynamic sediment routing model developed by SLA.
(4) HEC-6, is a sediment routing model prepared by the Hydrologic Engineering Center (HEC).

6. Current Standards

Current FCDMC standards for sediment transport analysis are detailed within the FCDMC, Drainage Design Manual, Hydraulics 2013. Key components of the modeling procedures are presented below.

- Modeling using HEC-6, HEC-6T, or other FCDMC-approved software may provide useful results.
- When applying the modeling approach to evaluating the scour/deposition hazard, the maximum scour depth during the entire simulation time period must be used for the basis of design.
- When there is no historical flow record, a synthetic long-term hydrograph can be generated. The following is a potential group of events is often used for to represent a 100-year time span: one 100-year flood hydrograph, one 50-year flood hydrograph, two 25-year flood hydrographs, and six 10-year flood hydrographs. The sequence of various flood hydrographs is subject to engineering judgment.
- Site-specific bed material sediment data is needed for sediment transport modeling.

- The inflowing sediment load for various discharges for Reata Wash (Figure 3–1) may be estimated by (1) field measurement during a flood at the study reach upstream end (very unlikely in Maricopa County), (2) use of an appropriate sediment transport equation if the upstream supply reach is in an equilibrium condition, and (3) an iterative sediment transport modeling approach for the upstream supply reach if the supply reach is in equilibrium (trial of different sediment inflow loads for supply reach until the sediment outflow for the supply reach is equal to the sediment inflow).

An excerpt from FCDMC, Drainage Design Manual, Hydraulics 2013 Section 11.8 Estimation of Scour describing the modeling procedures is included in Appendix A.

7. Recommendations

Based on a review of the documents reported in Table 5–1 and current FCDMC standards it is concluded that;

- The use of FCDMC standards defines the standard of practice for sediment transport modeling and scour calculations for projects within Maricopa County.
- FCDMC methods have provided reasonable results for sediment modeling within Maricopa County.

Given the above conclusions, it is recommended that FCDMC standards and methodologies be utilized for sedimentation and scour analysis for the Reata Wash Flood Control Improvement Study. To that end, analysis would require preparation of sediment transport modeling and scour calculations compliant with current requirements outlined in Chapter 11: Sedimentation, within FCDMC, Drainage Design Manual, Hydraulics 2013. In addition, it is recommended that the Reata Wash corridor sediment transport modeling utilize updated study hydrographs, historic sediment sample data, and applicable sediment inflow data.

Results of new sediment transport and scour analyses performed for the RWFCIS are described in other memoranda and deliverables.

Appendix A **Supporting Documentation**

Flood Control District of Maricopa County, Drainage Design Manual, Hydraulics 2013. Section 11.8 Estimation of Scour.

11.7.3.8 Soil Erodibility Factor and Cover Management Factor

In the MUSLE method for the calculation of soil erosion, the soil erodibility factor K and the cover and management factor C must be determined. The FCDMC has developed preliminary figures for both of these factors as a rough estimate (Figure 11.23, Figure 11.24, Figure 11.25, and Figure 11.26). These tables serve as a good starting point and allow the automatic estimation of K and C values for a watershed. The automatic estimation of K and C values is implemented in the FCDMC's drainage design software (DDMSW). However, users should review the values in the tables and modify them based on more detailed information. The discussion on automation of K and C values and sediment yield can be found in the River Mechanics Manual for DDMSW (FCDMC, 2010). It should be mentioned that when there is impervious area in the watershed, the wash load should be estimated by multiplying the result with 1 minus the percentage of impervious area.

11.8 ESTIMATION OF SCOUR

11.8.1 Introduction

Scour is the lowering of the bed elevation of a watercourse, either locally or over some defined reach length of the watercourse, due to the hydraulics of flowing water. Scour is estimated as the sum of independent scour components that are due to factors along a defined reach of a watercourse, plus local scour at a specific location in a watercourse.

Scour estimates are often needed for the following drainage and flood control related purposes:

1. Estimation of the response of a watercourse due to altered management in the watershed. For example, scour in a natural watercourse may need to be evaluated due to urbanization that would alter the natural flood magnitude-frequency relations.
2. Estimation of the response of a watercourse due to alterations of the hydraulic conditions in the watercourse. Examples in this regard include floodplain encroachment, flood control modifications such as bank protection, and instream mining of sand and gravel.
3. Estimation of depth of toe-down for structural bank lining.
4. Estimation of depth of scour immediately at or downstream of hydraulic structures.
5. Estimation of potential scour depth for buried utility crossings of watercourses.
6. Estimation of scour depth for bridge piers, embankments, guide banks, and spur dikes.

The estimation of scour is critical to the evaluation of the watercourse stability at and near highway structures. Procedures to investigate watercourse stability are provided in HEC-20 (USDOT 2001c). Procedures to provide bridge scour countermeasures are provided in HEC-23 (USDOT, 2001a). The estimation of scour is an engineering application that requires both specific expertise and experience. Every application of scour technology is unique because of the wide variability of hydrologic, hydraulic and geologic/geomorphic factors. It is not possible to compile a comprehensive methodology in a drainage design manual that would be adequate to address all aspects of scour estimation. In addition, the knowledge of erosion and sedimentation is continually expanding because of the need to provide better technology in this field of engineering. Often, newer methodologies are presented in the engineering literature that should be considered and used, if appropriate. The following are general guidelines for estimating scour along with currently used methodologies that are considered applicable in Maricopa County.

11.8.2 Total Scour

Total scour, for a given application, should consider the following components of scour:

1. Long-term degradation of the bed of the watercourse.
2. General scour through a specific reach of the watercourse.
3. Scour induced due to a bend in the watercourse.
4. Scour associated with bedform movement through the watercourse.
5. Scour due to low-flow incisement.
6. Local scour due to bridge pier, bridge abutment, guide bank, etc.

Total scour, Z_t, is the sum of each of these individual components, Z_i, of scour. Total scour can be expressed as:

$$Z_t = FS(Z_{long\text{-}term} + Z_{general} + Z_{bend} + Z_{bedform} + Z_{low\text{-}flow}) + FS_{local} * Z_{local} \qquad (11.41)$$

where:

FS = the factor of safety (safety factor) for the long-term, general, bend, bedform, and low-flow incisement scour components, and

FS_{local} = the factor of safety for local scour such as pier scour, downstream scour for drop structure/grade control structures and other local scour components.

The factor of safety is often used for hydraulic engineering design to account for uncertainties in hydraulic engineering analyses. In general, a factor of safety of 1.3 for long-term, general, bend, bedform and low flow incisement scour should be used for the design of toe-down for bank protection. However, a lower value of the safety factor may be used under special circumstances with prior approval from the FCDMC and other jurisdictional agencies. The use of a higher safety factor, such as 1.5, may be justified where underestimation of scour could cause catastrophic failure that may result in loss of life or unacceptable economic consequences. The local scour safety factor, FS_{local}, may be less than 1.3 under special conditions, such as in the calculation of pier local scour when the debris width is added to the pier diameter or in the calculation of drop structure downstream scour when the result shows unreasonably large local scour. A safety factor of less than 1.3 may also be used for abutment scour because the abutment scour methodology often over-estimates the value.

In general, the recommended toe-down depth or utility burial depth is the total scour depth below the channel thalweg for areas inside the FEMA floodway or main channel banks (Figure 11.27). The thickened dash line in Figure 11.27 represents the toe-down or utility burial depth. The channel thalweg is the lowest point on a channel cross section. The velocity for computing the total scour depth within the floodway or main channel should be the main channel velocity or floodway velocity, whichever is larger. The toe-down depth or utility burial depth is the total scour depth below the adjacent ground for areas on the lateral-erosion line (Figure 11.27). The procedure for estimating the lateral-erosion line can be found in Section 11.9. For areas between the FEMA floodway line and the lateral erosion line, the toe-down depth or utility burial depth can be linearly interpolated as shown in Figure 11.27. For areas between the lateral erosion line and the FEMA floodplain line, the toe-down depth or utility burial depth can be linearly interpolated between the toe-down/burial depths at the lateral erosion line and the FEMA floodplain line. The toe-down/ burial depth at the FEMA floodplain line can be the total scour depth based on overbank velocity and flow depth. The overbank velocity may be obtained from an existing HEC-RAS model.

Figure 11.28 illustrates the recommended toe-down depth or utility burial depth for a very erosive condition where very erosive material is found in the channel bank and bed and large erosion and channel migration were observed in the past. Figure 11.29 and Figure 11.30 illustrate the recommended toe-down depth or utility burial depth for a situation where the lateral erosion line is outside the FEMA floodway line. It may be noted that areas outside the FEMA floodplain may be beyond the floodplain administrators' jurisdiction. Engineering judgment is highly recommended about the toe-down or burial depth for areas outside the FEMA floodplain but within the lateral erosion line.

The following is a discussion of each component of scour that should normally be considered when estimating total scour. FCDMC's DDMSW software can be used to estimate the scour components. The software can be downloaded from FCDMC's web site at (http://www.fcd.maricopa.gov).

FIGURE 11.27
TOE-DOWN AND UTILITY BURIAL DEPTH (EROSION, INSIDE FLOODPLAIN)
(LATERAL EROSION LINE IS INSIDE FLOODPLAIN LINE)

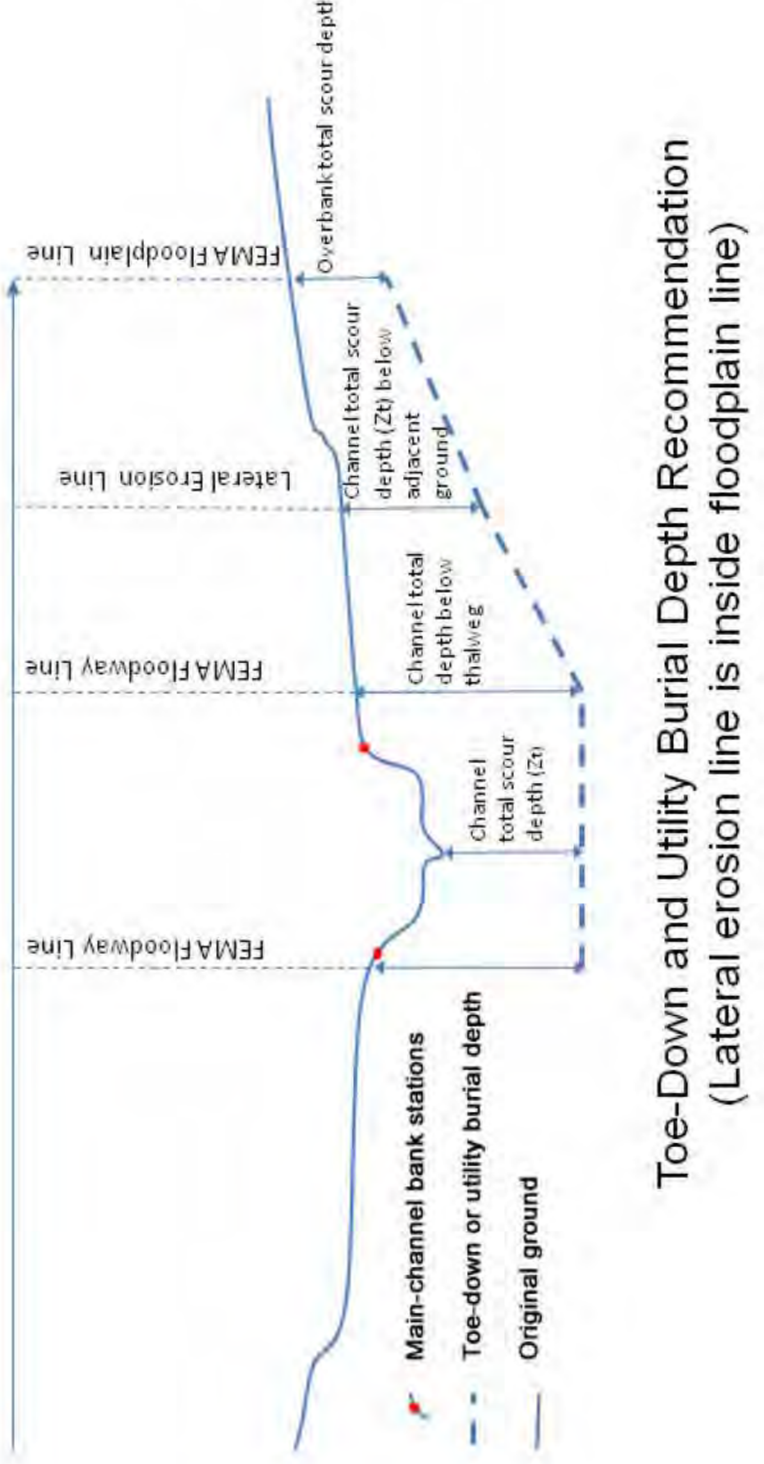


FIGURE 11.28

TOE-DOWN AND UTILITY BURIAL DEPTH (VERY EROSIVE, INSIDE FLOODPLAIN)

(A VERY EROSIVE CONDITION; LATERAL EROSION LINE IS INSIDE FLOODPLAIN LINE)

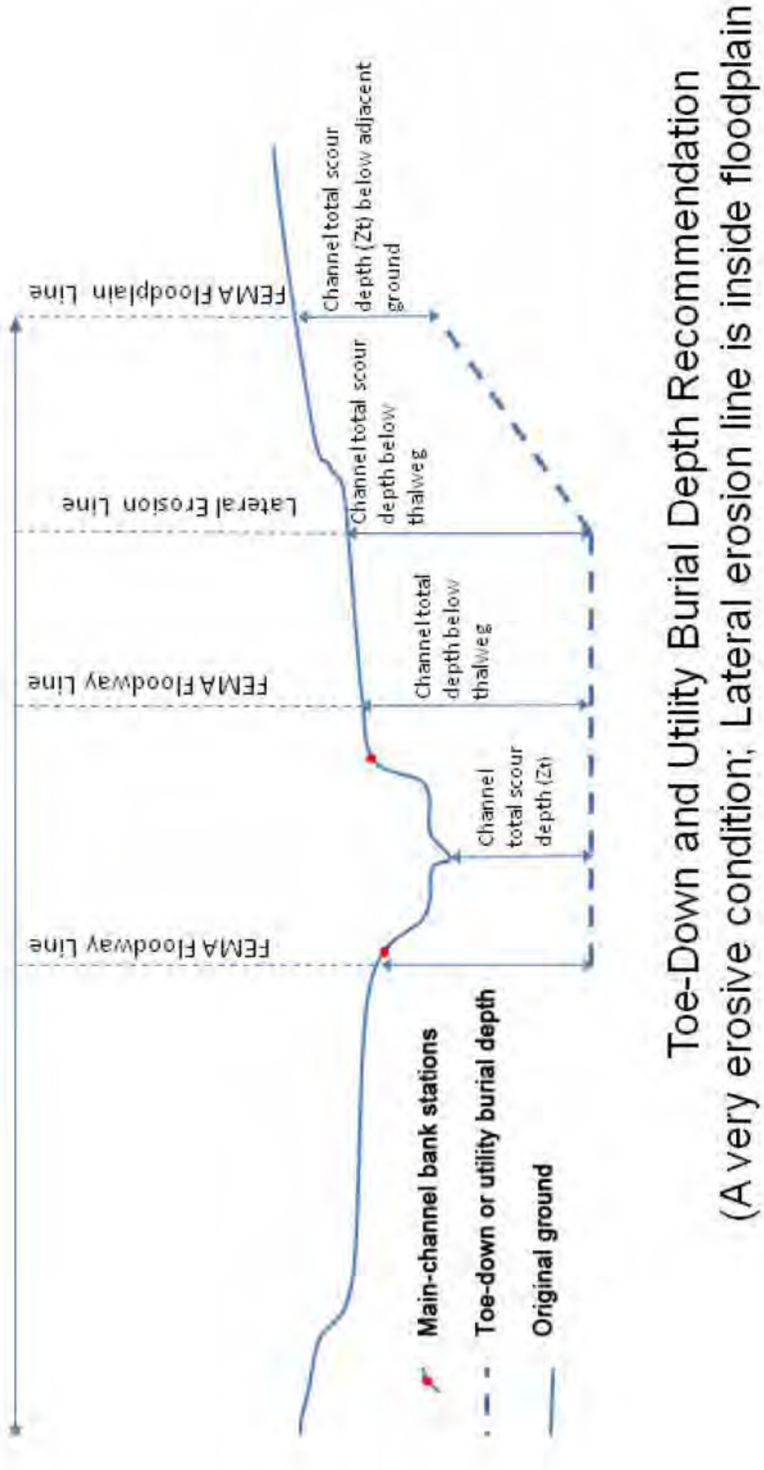


FIGURE 11.29
TOE-DOWN AND UTILITY BURIAL DEPTH (EROSION, OUTSIDE FLOODPLAIN)
(LATERAL EROSION LINE IS OUTSIDE FLOODPLAIN LINE)

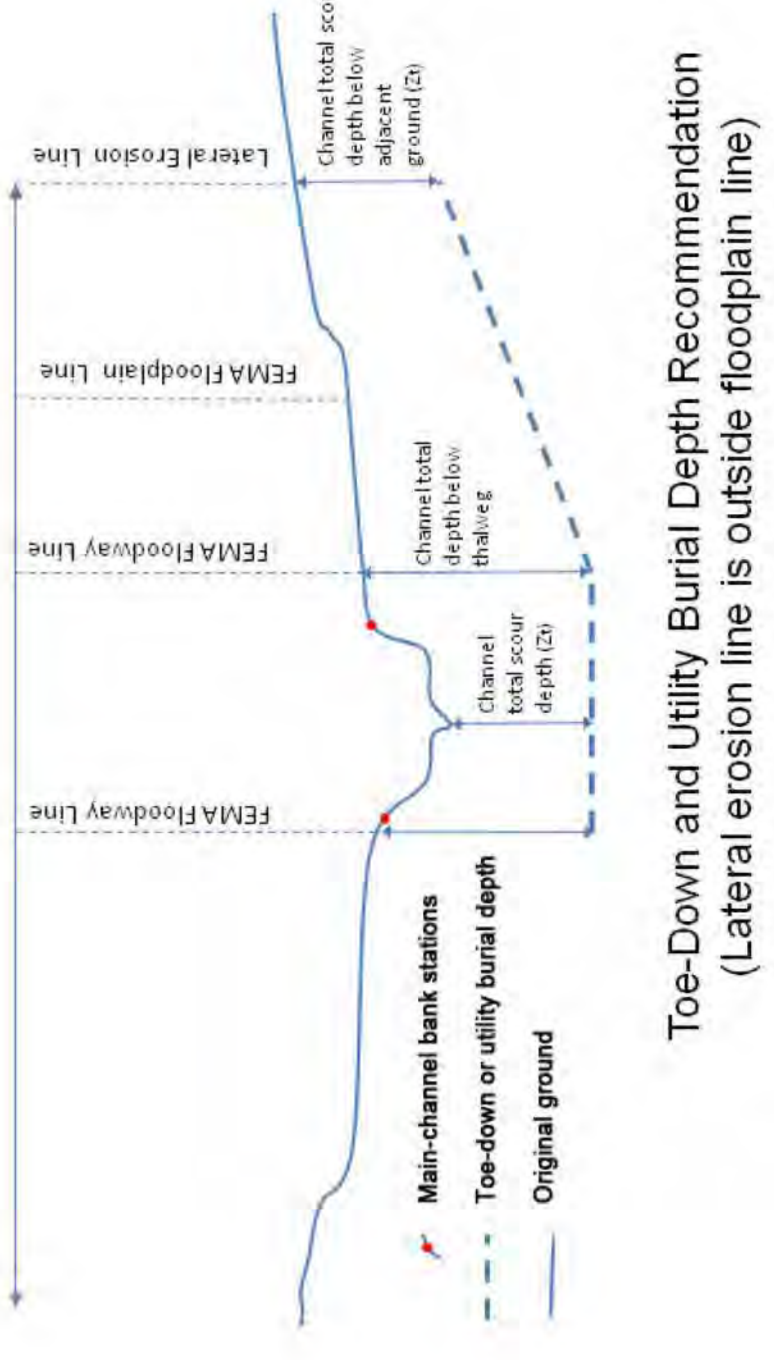
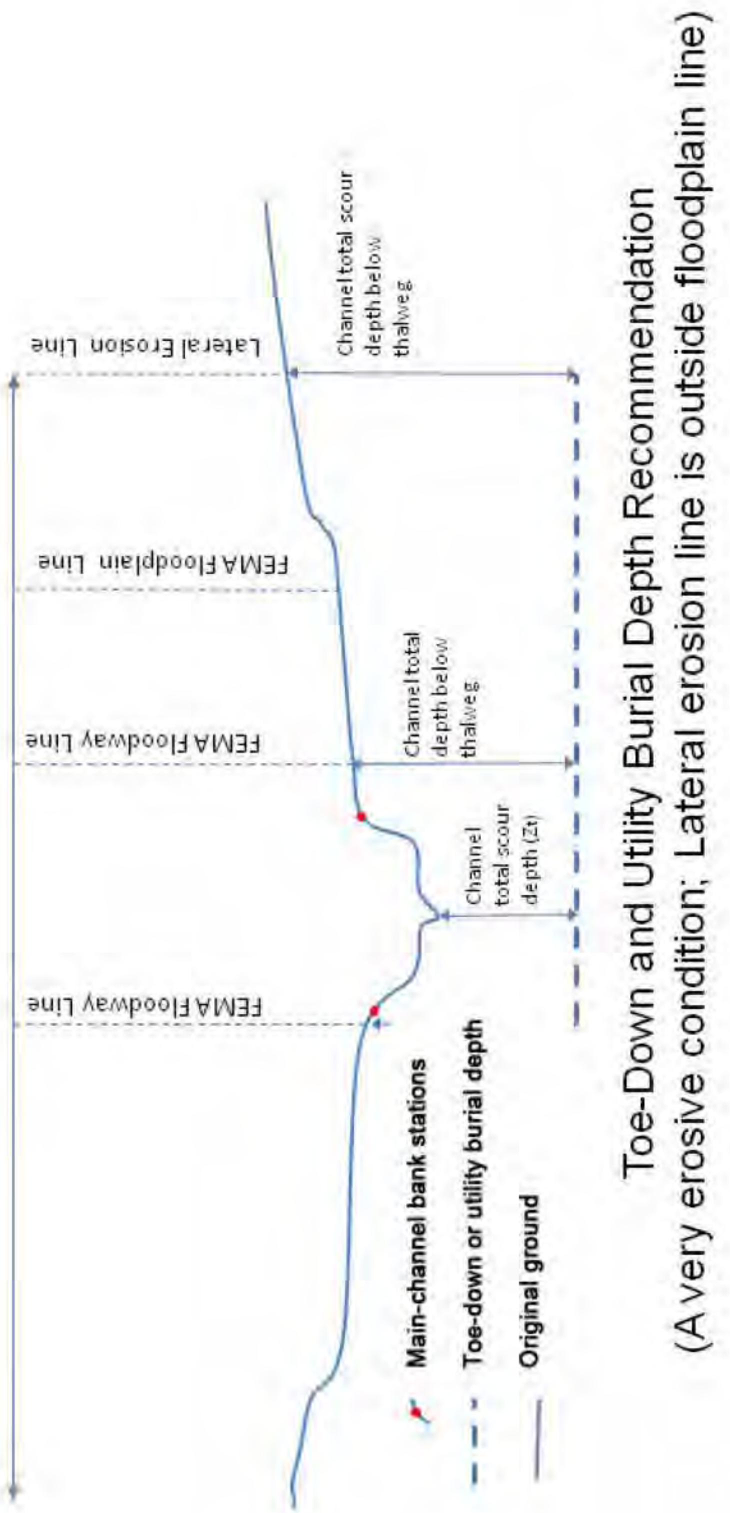


FIGURE 11.30
TOE-DOWN AND UTILITY BURIAL DEPTH (VERY EROSIVE, OUTSIDE FLOODPLAIN)
(A VERY EROSIVE CONDITION; LATERAL EROSION LINE IS OUTSIDE FLOODPLAIN LINE)



11.8.2.1 Long-Term Scour (Degradation)

Long-term degradation can be estimated by the following methods:

1. A trend analysis of historic elevation data.
2. Simulation by use of sediment transport modeling such as HEC-6 (USACE, 1991), HEC-6T (MBH, 2002), FLUVIAL-12 (Chang, 2006), or other sediment transport modeling software subject to the FCDMC's approval prior to the modeling.
3. Application of equilibrium slope analyses.
4. Level I Analysis from Arizona State Standard 5-96 (ADWR, 1996).

Trend Analysis

A trend analysis of historic bed elevation data is limited by the availability of adequate, long-term data for the watercourse. Therefore, such an analysis may be possible only for some of the major watercourses in Maricopa County. In addition, factors such as instream gravel mining and channelization of the watercourse may complicate such historic analyses.

Sediment Transport Modeling

Simulation modeling such as HEC-6, HEC-6T, FLUVIAL-12 or other FCDMC-approved software may provide useful results. The simulation results may be highly sensitive to hydrologic input (flood magnitude-frequency relations, flow duration, shape of hydrograph, etc.). Simulation modeling may only be appropriate for regional studies of major watercourses, especially those for which structural flood control alternatives are being considered. Whenever data are available, site-specific calibration should be performed to determine the parameters in the model such that it can reproduce the historical scour/deposition. Sensitivity analyses should be performed to analyze how the results respond to different input parameters. When applying the modeling approach to evaluating the scour/deposition hazard, the maximum scour or deposition during the entire simulation time period must be used for the basis of design. The flow hydrograph can be generated from historical flow records if they are available. Ideally, records for a period of one hundred years should be used. When there is no historical flow record, a synthetic long-term hydrograph can be generated. As indicated by Chang (2006), "In the time span of 100 years, one may expect statistically one flood event exceeding the 100-year flood, two events exceeding the 50-year flood, four events exceeding the 25-year flood, ten events exceeding the 10-yr flood, etc." Therefore, the following is a potential group of events that may be used for 100-year time span long-term simulation: one 100-year flood hydrograph, one 50-year flood hydrograph, two 25-year flood hydrographs, and six 10-year flood hydrographs. The sequence of flood events is subject to engineering judgment. A sensitivity analysis may be needed to help select the sequence of these events. The FCDMC, or jurisdictional agency, must approve the proposed synthetic long-term hydrograph before it is used in the model.

Site-specific bed material sediment data is needed for sediment transport modeling. The bed material sediment sampling approval should be based on Pemberton and Lara (1984).

The inflowing sediment load for various discharges for the study reach may be estimated by (1) field measurement at the study reach upstream end (very unlikely in Maricopa County), (2) use of an appropriate sediment transport equation if the upstream supply reach is in an equilibrium condition, and (3) an iterative sediment transport modeling approach for the upstream supply reach if the supply reach is in equilibrium (trial of different sediment inflow loads for supply reach until the sediment outflow for the supply reach is equal to the sediment inflow). However, when HEC-6T is used, the recirculation option may be used to automatically determine the inflowing sediment load.

An equilibrium condition for a channel reach is where the inflowing sediment load (volume or peak sediment discharge) for a channel reach is the same as the sediment outflow load (volume or peak sediment discharge). It corresponds to the case where there is no overall channel degradation or aggradation. If no significant channel degradation or aggradation is observed from aerial photos, topographic data comparison, and field visits, the channel may be considered in an equilibrium condition. When using the sediment transport modeling approach, if the immediate upstream supply reach is not in equilibrium, one should look further upstream until an equilibrium condition reach is located.

Equilibrium Slope Analysis

Equilibrium slope analysis is a method that can often be applied to estimate long-term degradation without extensive data or modeling effort. The equilibrium slope is the channel bed slope when the sediment inflow load and outflow load for the study reach are the same. It is the slope that corresponds to the equilibrium condition. When a channel reaches the equilibrium condition, there is no channel aggradation or degradation for the study reach. The application of this method requires that the study reach is not armored. It also requires the identification of a downstream bed elevation control (pivot point) at which the bed elevation is not expected to change. Such a control can be bedrock, caliche, a reach of armored channel bed, or a constructed facility such as a diversion dam, roadway crossing, and so forth. The dominant discharge should be used for equilibrium slope analysis. In Maricopa County, either a 5-year event or a 10-year event can be considered as the dominant discharge. A bankfull discharge may also be considered as the dominant discharge, or can be used as a basis for selection of either the 5-year or 10-year storm. Selection of appropriate bank stations is very important and should be carefully considered. Refer to Cruff (1999) for guidance in selection of bank stations for determining the dominant discharge, but keep in mind that the bank station positions may need to be adjusted for sediment transport numerical computation purposes.

Long-term degradation using equilibrium slope analysis (Simons, Li and Associates, 1985) is estimated by:

$$Z_{long\text{-}term} = L\,\Delta S \tag{11.42}$$

where:

$Z_{long\text{-}term}$ = the long-term scour, in feet,

L = the distance upstream of the pivot point in feet, and

ΔS = $S_0\text{-}S_{eq}$

where:

S_0 = the channel bed existing slope

S_{eq} = the channel bed equilibrium slope.

When the equilibrium slope is larger than the existing bed slope upstream from the pivot point, it would indicate aggradation rather than degradation. When it is an aggradation zone, the long-term scour depth may be considered zero as part of the total scour depth for structures design, because the long-term equilibrium status is dynamic and simply deducting aggradation depth from the total scour depth may under-estimate the total scour depth.

Application of long-term degradation is illustrated by the following:

> A natural watercourse has a slope of 22 feet per mile (0.0042 ft/ft). Proposed channelization of the watercourse will increase the unit discharge and the equilibrium slope is estimated to decrease to 15 feet per mile (0.0028 ft/ft). A drop structure is proposed at a distance of 2,000 feet upstream of a pivot point (armored channel cross section). The long-term degradation at the toe of the drop structure is estimated by:

$$\begin{aligned} Z_{long\text{-}term} &= (2000\,ft)(0.0042 - 0.0028\,ft/ft) \\ &= 2.8\,feet \end{aligned}$$

The key to long-term degradation by equilibrium slope analysis is the estimation of the equilibrium slope. The selection of an appropriate equilibrium slope equation depends upon the study reach's sediment flow condition. A clear water sediment flow condition occurs when there are upstream reservoirs, sand and gravel pits, or hydraulic structures that significantly reduce the sediment supply to the study reach. A sediment-laden condition occurs when there is no reservoir, sand or gravel pits, or hydraulic structures that significantly reduce the sediment supply. For a clear water condition in the study reach, the Schoklitsch bedload equation (Shulits, 1935; Pemberton and Lara, 1984) for zero bedload transport is recommended to estimate the equilibrium bed slope or the limiting bed slope. The Schoklitsch bedload equation is used to find the clear water condition equilibrium bed slope as follows:

$$S_{eq} = 0.00174\left(\frac{D^*B}{Q}\right)^{3/4} \tag{11.43}$$

where:

S_{eq} = equilibrium slope for clear water conditions, ft/ft;

Q = dominant discharge (usually a 10-year event), cfs;

D = mean particle size, which may be assumed to be the median particle size, D_{50}, mm;

D_{50} = particle size in a mixture in which 50% are smaller, mm;

B = channel bed width, ft.

For the sediment-laden condition where there is no upstream reservoir, sand or gravel pits, or hydraulic structures that will significantly reduce the sediment load to the study reach, the iterative method should be used based on Section 5.3.7 in Design Manual for Engineering Analysis of Fluvial Systems (Simons, Li and Associates, 1985). The requirement of this method is that the immediate upstream supply reach must be in an equilibrium condition where the inflowing sediment load and outflowing sediment load for the upstream supply reach are the same. This can be checked by historical and recent aerial photos, topographic maps, and field visits. If no significant aggradation or degradation is found in the supply reach, then the supply reach may be considered in equilibrium and an appropriate total bed material load equation such as the Zeller-Fullerton equation, Equation (11.44), (Zeller and Fullerton, 1983) can be used to estimate the sediment load from the supply reach. When the immediate upstream supply reach is not in equilibrium, one should consider a longer supply reach where the channel may reach equilibrium or look for an equilibrium segment further upstream. Once the supply reach has been verified that it is in an equilibrium condition, the Zeller-Fullerton (Zeller and Fullerton, 1983) total bed material load equation, Equation (11.44), can be used to estimate the sediment load for the supply reach, which is the sediment inflow to the study reach. The total bed material sediment discharge based on Zeller-Fullerton equation is:

$$Q_s = q_s W = 0.0064\left(\frac{n^{1.77} V_a^{4.32} G^{0.45}}{Y_h^{0.3} D_{50}^{0.61}}\right) W \tag{11.44}$$

where:

Q_s = total bed material discharge in cfs;

q_s = total bed material discharge in cfs per unit width;

W = flow average width = average width of flow, defined as the wetted area divided by flow depth (the flow depth can be the Manning's equation-based normal depth or maximum flow depth from HEC-RAS);

n = Manning's roughness coefficient;

V_a = average velocity, ft/s;

Y_h = hydraulic depth, ft;

D_{50} = median diameter, also defined as the diameter where 50% is finer by weight, mm;

G = gradation coefficient, where:

$$G = \frac{1}{2}\left(\frac{D_{84.1}}{D_{50}} + \frac{D_{50}}{D_{15.9}}\right) \qquad (11.45)$$

and $D_{84.1}$, D_{50} and $D_{15.9}$ are sediment diameters based on a percent finer by dry weight, mm.

After the supply total bed material sediment discharge is computed, one uses the Zeller-Fullerton equation to compute the total bed material sediment discharge for the study reach. If the sediment discharge for the study reach is equal to the supply sediment discharge, then the current channel bed slope for the study reach is the equilibrium slope. If not equal, one should vary the channel bed slope such that the sediment discharge for the study reach is equal to the supply reach sediment discharge. Once the sediment discharges are equal, the computed bed slope is the equilibrium slope. During this iteration process, Manning's equation or HEC-RAS may be used to compute the hydraulic variables.

When the immediate upstream supply reach is not in equilibrium, one should consider a longer upstream supply reach where the channel may reach equilibrium or look for an equilibrium segment further upstream.

Level I Analysis from Arizona State Standard 5-96

The equilibrium slope method requires locating an appropriate downstream pivotal point. When such a pivotal point does not exist, a simplified method based on ADWR (1996) may be used to estimate the long-term degradation as the last resort. The long-term degradation by ADWR (1996) Level I analysis is $0.02Q_{100}^{0.6}$ where Q_{100} is the 100-year peak flow in cubic feet per second. The long-term degradation is in feet. This equation should only be used when no downstream control structures exist.

Limits to Long-term Scour from Armoring

When computing the long-term scour, the potential for armoring should be considered. Armoring is the process in an alluvial watercourse where sediment transport removes bed material smaller than a certain size thus leaving a bed that is armored by the larger bed particle material. All alluvial channels experience the mechanics of armoring through the selective transport of finer bed material and leaving the coarser bed material. However, watercourses that continually receive inflow of bed material load in excess of transport capacity, or do not contain adequate quantities of the larger, armoring-size bed material, will not experience armoring. Also, armoring is flood magnitude dependent; that is, an armoring layer can develop over time due to a sequence of flood events, but a flood event sufficiently larger than those that formed the armor layer can penetrate the armor layer resulting in additional scour depth.

When the channel bed surface for a channel reach is entirely covered with cobbles/rocks, it is possible that this segment of the channel reach is already armored for the storm event under consideration and the long-term scour may be assumed to be zero. This armored bed may serve as the pivot point for upstream equilibrium slope analysis for clear-water long-term scour analysis. To verify if the surface cobbles/rocks have armored the river bed, one needs to compute the sediment critical particle size, d_c, by using Shields relationship. The channel bed surface may be considered armored or equivalently the long-term scour depth is taken as zero if the following two criteria are met. The first one is that the particle size for the majority of the bed surface is greater than d_c or $d_{10} > d_c$. The second criteria is that the median particle size of the bed surface material is greater than the required d_{50} computed by riprap design for a stable channel bed. The required d_{50} can be estimated by using the modified Isbash equation as set forth in Chapter 6, Loose Angular Riprap Sizing (d_{50}):

$$d_{50} = kV_a^2\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right) \qquad (11.46)$$

where:

d_{50} = the required median sediment particle diameter for which 50% of the material (by weight) finer, ft;

k = 0.0191 for a straight channel (bend angle less than 30 degrees; assuming low turbulent flows);

k = 0.0372 for a curved channel (bend angle more than 30 degrees; assuming high turbulent flows);

V_a = average velocity, ft/s;

γ_s = specific weight of stone, lb/ft^3; and

γ_w = specific weight of water, lb/ft^3.

If the entire channel bed is not covered with large cobbles/rocks, but a large amount of rocks are observed on the surface, it may be reasonable to assume that an armored layer may eventually develop at a certain depth below the bed surface. When the channel bed surface and sub-surface contains more than 10% coarse material, which can not be transported under dominant flow conditions, $d_{90}>d_c$, armoring will eventually develop at a certain depth below the surface (Pemberton and Lara, 1984). This depth may be assumed to be the long-term scour depth, Z_s, which can be estimated by Equation (11.25).

11.8.2.2 General Scour

General scour is one component of total scour that would occur during the passage of a design flood. The design flood may be a 100-year flood or other design events such as the Standard Project Flood (SPF) depending on the design purposes. This type of scour involves the removal of material from the bed and banks across all or most of the width of a channel. The scour is caused by increased velocities and shear stresses dictated by the local area geometry, such as at constrictions, and water surface controls. General scour can be estimated by using the empirical equations (Pemberton and Lara, 1984). It may be estimated by using a sediment transport model such as HEC-6 (USACE, 1991), HEC-6T or other FCDMC-approved models. When a sediment transport model such as HEC-6 or HEC-6T is used, the design flood hydrograph should be used. Since most one-dimensional sediment transport models are based on cross section averaged values and tend to under-estimate the general scour for the alluvial channels in the semi-arid areas, engineering judgement must be exercised to choose the most appropriate approach.

The empirical equations by the Bureau of Reclamation (page 29 - page 37 in Pemberton and Lara, 1984) for general scour due to passage of a design flood are the Neill equation, Lacey equation, and the Blench equation for zero-bed-transport.

In general, each equation should be applied as follows:

> Neill Equation. Neill's equation is applicable to areas of channel constriction, such as bridges or contraction structures. This approach also accounts for scour where bends are present in the contracted zone.
>
> Lacey Equation. This method is more applicable to a natural river system where there is not an upstream structure that captures sediment.
>
> Blench's Equation. This method is applicable to streams where the upstream sediment inflow is intercepted by basins or dams, creating clear water flow.
>
> Each of these approaches is discussed in detail in the following sections.

Neill Equation and HEC-18 Contraction Scour

For a bridge general scour estimate, the higher value between Neill's general scour equation, Equation (11.48), (Neill, 1973) and the HEC-18 contraction scour equation (USDOT, 2001b) should be used. If there is a bend, then the higher value between Neill's equation with an appropriate bend coefficient, Z, and the HEC-18 contraction scour equation with Zeller's bend scour equation, Equation (11.60), should be used.

The bend scour should be computed for the areas both at the bend and downstream of the bend because the secondary currents will still cause scour downstream of the bend. The distance from the bend at which the secondary currents will have decayed to a negligible magnitude can be found in Section 11.8.2.3.

The Neill equation is applicable to channel constriction cases where there is a bridge or contraction structure (Neill, 1973). Neill's equation is as follows:

$$Z_{general} = Zd_i\left[\frac{q_f}{q_i}\right]^m \tag{11.47}$$

where:

$Z_{general}$ = general scour depth, ft;

d_i = average depth at bankfull discharge in incised reach, ft (= hydraulic depth for bankfull discharge or dominant discharge);

q_f = design flood discharge per unit width (width can be defined as wetted cross sectional area divided by flow depth where flow depth can be the Manning's equation-based normal depth or maximum flow depth from HEC-RAS), cfs/ft;

q_i = bankfull discharge in incised reach per unit width (bankfull discharge can be from HEC-RAS main channel flow discharge between appropriate bank stations or taken as the 10-year event with the same definition as dominant discharge (Simons, Li and Associates, 1985); width can be defined as wetted cross section area divided by depth where flow depth can be the Manning's equation-based normal depth maximum flow depth from HEC-RAS, cfs/ft;

m = exponent varying from 0.67 for sand to 0.85 for coarse gravel; and

Z = multiplying factor (0.5 for a straight reach, 0.6 for a moderate bend, and 0.7 for a severe bend).

The HEC-18 contraction scour equations (USDOT, 2001b) are used to predict the depth of the contraction scour component in a contracted section. The equations for the clear-water condition and the live-bed condition are different. The following equation for critical velocity can be used to determine if the flow upstream of the bridge is clear-water or live-bed (USDOT, 2001b). The equation has the form:

$$V_c = 11.17 y_a^{1/6} D_{50}^{1/3} \tag{11.48}$$

where:

V_c = critical velocity, ft/s;

y_a = average depth of flow upstream of the bridge, ft (= hydraulic depth); and

D_{50} = particle size in a mixture in which 50% are smaller, ft.

The D_{50} is taken as an average of the bed material size in the reach of the stream upstream of the contraction.

When V_c < mean velocity, the live-bed equation should be used. Conversely, when $V_c \geq$ mean velocity, use the clear-water equation.

Live-bed Contraction Scour

The live-bed contraction scour equation is the modified Laursen equation (USDOT, 2001b) given as:

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W_1}{W_2}\right)^{k_1} \tag{11.49}$$

and

$$y_s = y_2 - y_0 \tag{11.50}$$

where:

y_s = average contraction scour depth, ft;

y_0 = existing depth of flow (the hydraulic depth) in the contracted section before scour, ft;

y_1 = average depth of flow (hydraulic depth) in the upstream main channel, ft;

y_2 = average depth of flow (hydraulic depth) in the contracted section, ft;

Q_1 = flow in the upstream channel transporting sediment, cfs;

Q_2 = flow in the contracted channel section, cfs;

W_1 = bottom width of the upstream main channel that is transporting bed material, ft;

W_2 = bottom width of the main channel in the contracted section less pier widths, ft;

k_1 = exponent determined from Table 11.9.

Please note that Q_1 may be smaller than, larger than or equal to Q_2, since there are varied flow conditions, and Q_1 is defined as the flow that is carrying sediment. This means that in some cases wide shallow overbank areas will not be counted in Q_1, but may be counted in Q_2 if the entire flow is pushed through the contracted section.

TABLE 11.9
VALUES OF K_1
(USDOT, 2001b)

$(V^*)/\omega$	k_1	**Mode of Bed Material Transport**
<0.5	0.59	Mostly contract bed material discharge
0.5 to 2.0	0.64	Some suspended bed material discharge
>2.0	0.69	Mostly suspended bed material discharge

The variables for Table 11.9 are defined as follows:

V^* = shear velocity in the upstream section, ft/s given by $(gy_1S_1)^{0.5}$;

g = gravitational acceleration, 32.2 ft/s^2;

S_1 = slope of the energy grade line of main channel, ft/ft;

ω = fall velocity in m/s of bed material from Figure 11.31 based on using D_{50} as D_s in mm, or in ft/s from regression equations developed by FCDMC as follows:

$$\omega = 3.28*10^a$$

where:

for 40° C:

$$a = -0.82901 + 0.74363(\log_{10}D_{50}) - 0.30037(\log_{10}D_{50})^2 + 0.049991(\log_{10}D_{50})^3 \quad (11.51)$$

for 20° C:

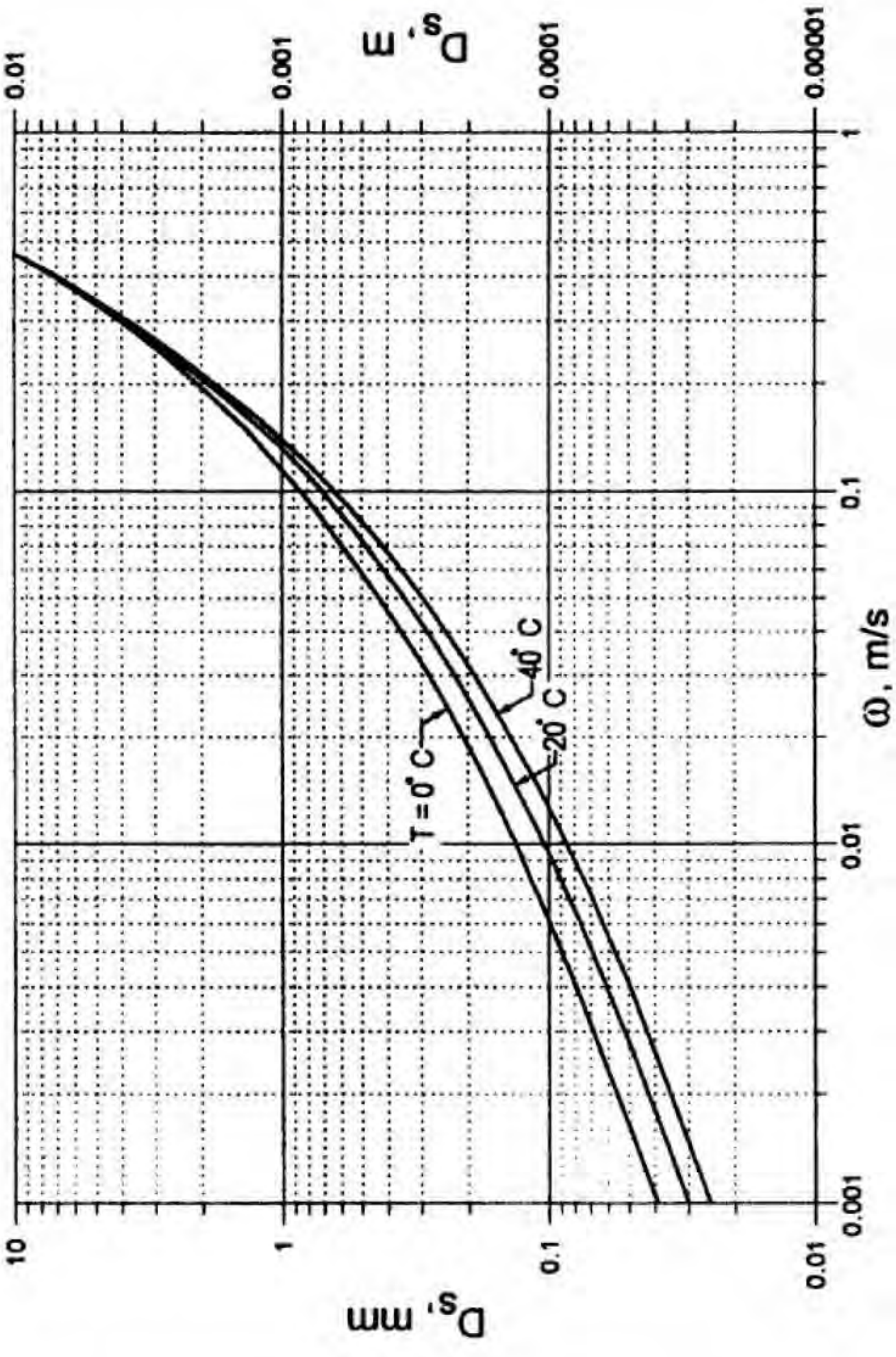
$$a = -0.84779 + 0.785215(\log_{10}D_{50}) - 0.33025(\log_{10}D_{50})^2 + 0.052387(\log_{10}D_{50})^3 \quad (11.52)$$

for 0° C:

$$a = -0.90682 + 0.936036(\log_{10}D_{50}) - 0.38413(\log_{10}D_{50})^2 + 0.012187(\log_{10}D_{50})^3 \quad (11.53)$$

D_{50} = particle size in a mixture in which 50% are smaller, mm.

FIGURE 11.31
FALL VELOCITY
(USDOT, 2001b)



where: D_s is representative of sand-sized particles.

Clear-water Contraction Scour

The clear-water contraction scour per USDOT, 2001b, is defined by:

$$y_s = y_2 - y_0 \tag{11.54}$$

$$y_2 = \left(\frac{0.0077Q^2}{D_m^{2/3}W^2}\right)^{3/7} \tag{11.55}$$

where:

y_s = average contraction scour depth, ft;

y_2 = average equilibrium depth (hydraulic depth) in the contracted section after contraction scour, ft;

Q = discharge through the contraction or on the set-back overbank area at the contraction associated with the width W, cfs;

D_m = diameter of the smallest nontransportable particle in the bed material ($1.25D_{50}$) in the contracted section, ft;

D_{50} = median diameter of bed material, also defined as the diameter where 50% is finer by weight, ft;

W = bottom width of the contracted section less pier width, ft; and

y_0 = average existing depth (hydraulic depth) in the contracted section, ft.

Lacey Equation

The Lacey equation is more applicable to a natural river system (Blench, 1969) where there are no upstream structures that capture sediment:

$$Z_{general} = Z\left(0.47\left[\frac{Q}{f}\right]^{1/3}\right) \tag{11.56}$$

where:

$Z_{general}$ = 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 may be approximated by D_{50}, (diameter where 50% is finer by dry weight) mm; and

Z = multiplying factor (0.25 for a straight reach, 0.5 for a moderate bend, 0.75 for a severe bend, 1.0 for right angle bends, and 1.25 for a vertical rock bank or wall).

The bend scour should be computed for the areas both at the bend and downstream of the bend because the secondary currents will still cause scour downstream of the bend. The distance from the bend at which the secondary currents will have decayed to a negligible magnitude can be found in Section 11.8.2.3.

Blench's Equation

The Blench equation, as presented in Pemberton and Lara (1984), is more applicable to clear-water flow conditions when there is a reservoir, sand and gravel pit, or hydraulic structure upstream that will significantly reduce the sediment supply.

Blench's equation is as follows:

$$Z_{general} = Z\frac{q_f^{2/3}}{F_{b0}^{1/3}} \tag{11.57}$$

where:

$Z_{general}$ = general scour depth, ft;

q_f = design flood discharge per unit width (= design flood discharge divided by flow average width; the flow average width can be defined as wetted cross sectional area divided by flow depth where flow depth can be the Manning's equation-based normal depth or maximum flow depth from HEC-RAS), cfs/ft;

Z = multiplying factor (0.6 for a straight channel reach and 1.25 for a vertical rock bank or wall. If there is a bend, the bend scour equation by Zeller should be used to compute the bend scour; see Bend Scour Section 11.8.2.3); and

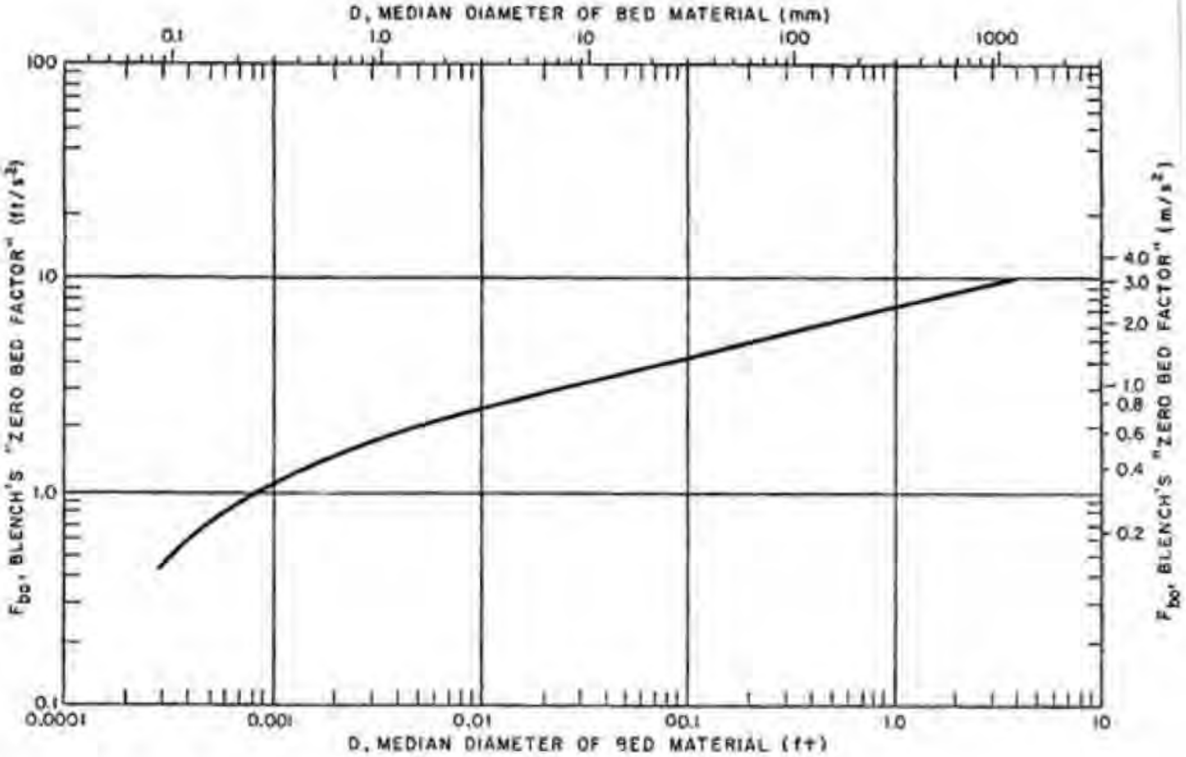
F_{b0} = Blench's zero bed factor from Figure 11.32 or from the equation developed by the FCDMC, which is:

$$F_{b0} = \begin{cases} 0.5672\ln(D_{50}) + 5.0302 & if D_{50} \le 0.0411 ft \\ 1.3698\ln(D_{50}) + 7.589 & if D_{50} > 0.0411 ft \end{cases} \tag{11.58}$$

where:

D_{50} = median diameter, also defined as the diameter where 50% is finer by weight, ft.

FIGURE 11.32
CHART FOR ESTIMATING F_{b0}FOR THE BLENCH EQUATION
(Pemberton and Lara, 1984)



11.8.2.3 Bend Scour

Bend scour may need to be estimated if it is not included as a component of general scour. For sand-bed watercourses, Zeller (1981) presents a bend scour equation. General scour by the Neil equation, or Lacey equation may include a bend scour component if certain coefficients (factor Z) are selected (Pemberton and Lara, 1984). However, if the Blench general equation is used, Zeller's bend scour equation should be applied. The higher value between Neill's equation (with an appropriate bend coefficient Z) and the HEC-18 contraction scour equation with Zeller's bend scour equation should be used. Zeller's bend scour equation for sand-bed watercourses (Simons, Li and Associates, 1985) is:

$$Z_{bend} = \frac{0.0685 y V_a^{0.8}}{y_h^{0.4} S_e^{0.3}}\left[2.1\left(\frac{\sin^2(\alpha/2)}{\cos(\alpha)}\right)^{0.2} - 1\right] \tag{11.59}$$

where:

Z_{bend} = bend scour depth, ft;

= 0 when $r_c/T \geq 10.0$ or $\alpha \leq 17.8^o$;

= computed value when $0.5 < r_c/T < 10.0$ or $17.8^o < \alpha < 60^o$;

= computed value at $\alpha = 60^o$ when $r_c/T \leq 0.5$ or $\alpha \geq 60^o$;

r_c = centerline of channel radius of curvature, ft;

T = channel top width, ft;

V_a = average velocity of flow immediately upstream of bend, ft/s;

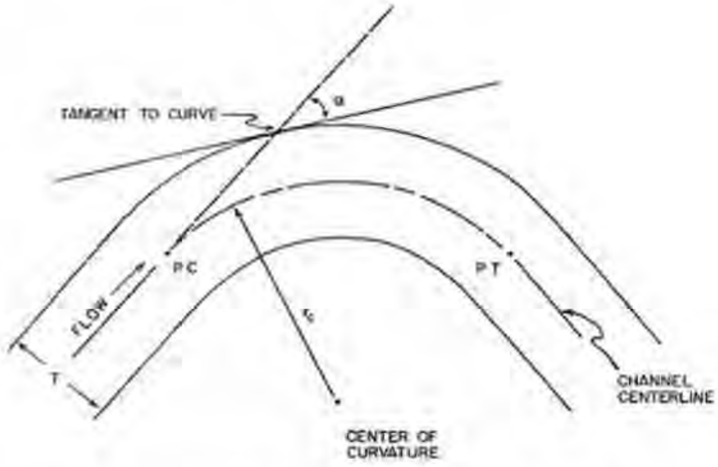
y = maximum depth of flow immediately upstream of bend, (ft) (= normal depth from Manning's or maximum channel depth from HEC-RAS);

y_h = hydraulic depth of flow immediately upstream of bend, ft;

S_e = energy slope immediately upstream of bend, ft/ft; and

α = angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (see Figure 11.33), degrees.

FIGURE 11.33
SKETCH OF CHANNEL BEND
(Simons, Li and Associates, 1985)



PT = Downstream point of tangency to the centerline radius of curvature.
PC = Upstream point of curvature at the centerline radius of curvature.

The bend scour equation should be applied to the entire channel reach through the bend. It should also be applied to a certain distance downstream from the end of the bend because secondary currents will still cause scour in the downstream reach. The distance from the end of a bend at which the secondary currents will have decayed to a negligible magnitude can be estimated per Simons, Li and Associates, 1985, as:

$$X = 2.3\left(\frac{C}{\sqrt{g}}\right)Y \tag{11.60}$$

where:

X = distance from the end of channel curvature (point of tangency, PT) to the downstream point at which secondary currents have dissipated feet;

C = Chezy coefficient = $\frac{1.486}{n}R^{1/6}$
where R is the hydraulic radius;

g = gravitational acceleration, 32.2 feet/second^2; and

Y = depth of flow (to be conservative, use maximum depth of flow, including superelevation and exclusive of scour, within the bend), feet.

This equation may also be used to determine the distance when the Neill equation and the Lacey equation include the bend scour.

11.8.2.4 Bedform Scour

Bedforms develop in alluvial channels in response to the hydraulics of the flowing water and they are part of the mechanics of sediment transport. Bedforms are of various configurations and typically they consist of alternating "mounds" and "troughs," and being mobile, they move longitudinally along the bed of the watercourse. A bedform trough is a component of total scour and should be accounted for under appropriate conditions. The component of scour that is associated with bedforms is equal to one-half of the bedform amplitude (vertical distance from top of mound to bottom of trough) as shown in the following equation:

$$Z_{bedform} = 0.5d_h \tag{11.61}$$

where:

$Z_{bedform}$ = bedform scour depth, ft;

d_h = dune or antidune height (measured from mound top to trough bottom), ft.

Dunes form during lower regime flow, typically at Froude Numbers, F_r, less than 0.7. The Froude Number is defined as $V_a / \sqrt{g y_h}$ where V_a is the average channel velocity, g is gravitational acceleration (32.2 feet/second^2); and y_h is the hydraulic depth. Antidunes form during the upper regime flow where F_r is greater than or equal to 1.0 and may form during the transition from lower to upper regime flows. In the transition region where F_r is between 0.7 and 1.0, the larger of either dune or antidune height should be used.

The dune height equation for lower regime flow where $F_r < 0.7$ is shown per Gyr and Hoyer, 2006 and Zanke, 1976, as:

$$0.15 < \frac{d_h}{y_h} < 0.3 \tag{11.62}$$

where:

d_h = dune measured from mound top to trough bottom, ft;

y_h = hydraulic depth of flow, ft.

Since a range is given for dune height in the above equation, engineering judgment should be exercised to judiciously select a dune height within the given range.

The anti-dune height equation (based on Kennedy, 1961) for upper regime flow where $F_r > 1.0$ is shown per Simons, Li & Associates, 1985, as:

$$d_h = 0.027 V_a^2 \tag{11.63}$$

where:

d_h = antidune height measured from mound top to trough bottom, ft;

V_a = average channel velocity, ft/s.

When $1.0 \geq F_r \geq 0.7$, the higher value between the dune height equation and anti-dune height equation should be used.

11.8.2.5 Low-Flow Incisement Scour

The normal irregularities in the bed of a watercourse (both natural and man-made) result in the formation of a low-flow channel. The channel is formed by the predominance of a low-flow condition or due to low-flows that persist after a flood. The magnitude of low-flow incisement may best be estimated by a representative field assessment. In the absence of field data, or for planning and design purposes, low-flow incisement should be estimated as no less than 1 foot and possibly in excess of 2 feet. A lower value can be used for small and minor watercourses and a higher value should be used for regional watercourses. When there is channelization where the channel bed is graded, the low flow channel depth may be estimated by assuming a small peak discharge (2-year event) for a simple chart that relates the depth to the channel-forming discharge (Figures 5-10 in USACE, 1994). If the low-flow channel is very stable and the toe-down or total scour is measured from the channel thalweg (lowest elevation in the entire cross section), this scour component may be ignored in the total scour computation. However, engineering judgment must be carefully exercised to avoid over-estimation or under-estimation of low-flow channel depths.

11.8.2.6 Local Scour

Local scour is a component of total scour that is caused by flow acceleration and vortices due to flow obstruction and impingement. Most local scour and deposition is caused by man-made structures such as culvert outlets (Photograph 11.11 and Photograph 11.12), bridge piers/abutments, bridge guide banks, grade controls, drop structures, sand/gravel mining pits, and other structures.

PHOTOGRAPH 11.11
LOCAL SCOUR AT UNPROTECTED CULVERT OUTLET.

Generally, local scour depths are much larger than long-term degradation or general scour. However, if there are major changes in watercourse conditions, such as a water storage facility built upstream or downstream or severe straightening of the watercourse, long term bed elevation changes can be the larger element in the total scour estimate.

Bridge local scour and culvert outlet local scour are discussed in the following sections. The estimation of bridge guide bank scour is similar to the bridge abutment scour estimation procedure (USDOT, 2001b). When estimating the bank protection scour or abutment scour and if the bank protection or abutment is close to piers, scour hole influence zones should be computed. The scour due to influence zones at the bank protection or abutment should be added to the total scour. A certain minimum distance, based on engineering judgment, between the piers and abutments should be preserved to minimize the scour impact to each other.

Local scour downstream of a hydraulic structure can be estimated by empirical equations from Schoklitsch (1932), Veronese (1937), and Zimmerman and Maniak (1967). Pemberton and Lara (1984) or the original references should be consulted and engineering judgment should be exercised when selecting or applying any of these equations.

PHOTOGRAPH 11.12
CULVERT CAUSES BACKWATER RESULTING IN UPSTREAM AGGRADATION.

For a submerged structure, the local scour depth can be estimated by the Simons, Li & Associates (1986) equations. These equations are a function of grade control structure face slope, drop height and other hydraulic parameters, but are independent of bed material grain size. These equations may overestimate scour depth for coarse bed material watercourses. Simons, Li & Associates (1986) should be consulted when using these equations.

In this chapter, the scour caused by sand and gravel mining operations is classified as local scour. There are two types of erosion caused by sand and gravel mining. One is erosion that starts from the pit's upstream brink point and moves upstream, which is called headcut. Another is erosion that starts from the pit's downstream brink point and moves downstream, which is called tailcut. The estimation of headcut and tailcut may be done by both empirical equations and sediment transport modeling. The available empirical equations are the methodology developed for the Arizona Department of Transportation (ADOT) by Li, et al. in 1989. However, it has been found that the methodology provides a reasonable estimate for headcut scour depth at the knickpoint but may under-estimate the headcut distance (FCDMC, 2006). Sediment transport modeling can be performed to estimate the headcut and tailcut by using HEC-6, HEC-6T, FLUVIAL-12 or other FCDMC-approved models. However, since most models are one-dimensional, when the pit width is much smaller than the river width, the model input file may need to be set up in a way that flow can be confined in a corridor that is equivalent to the pit width.

Local Scour at Bridge Piers

Local scour at bridge piers is calculated with the CSU equation (USDOT, 2001b). The basic pier scour equation is discussed here. Other equations for more complicated pier conditions can be found in USDOT (2001b). The basic pier scour equation is:

$$\frac{Z_{local}}{a} = 2.0K_1K_2K_3K_4\left(\frac{y_1}{a}\right)^{0.35}Fr^{0.43} \tag{11.64}$$

where:

Z_{local} = local scour depth for piers, ft;

y_1 = flow depth directly upstream of the pier, ft (= normal depth from Manning's equation; maximum channel depth from HEC-RAS);

K_1 = correction factor for pier nose shape from Table 11.10 and Figure 11.34;

K_2 = correction factor for angle of attack of flow from Table 11.11 and discussion below;

K_3 = correction factor for bed condition from Table 11.12 (note: if the bed form scour is already computed based on bed form trough depth, then K_3 should be set to 1.0 to avoid double-counting of the bed condition scour);

K_4 = correction factor for armoring by bed material size, see discussion below;

a = pier width, ft;

L = length of pier, ft;

g = gravitational acceleration, 32.2 ft/s^2;

Fr = Froude Number directly upstream of the pier = $V_1/(gy_1)^{1/2}$; and

V_1 = mean velocity of flow directly upstream of the pier, ft/s.

TABLE 11.10
CORRECTION FACTOR, K_1, FOR PIER NOSE SHAPE
(USDOT, 2001b)

Shape of Pier Nose	K_1
(a) Square nose	1.1
(b) Round nose	1.0
(c) Circular cylinder	1.0
(d) Group cylinders	1.0
(e) Sharp nose	0.9

FIGURE 11.34
PIER NOSE SHAPE
(USDOT, 2001b)

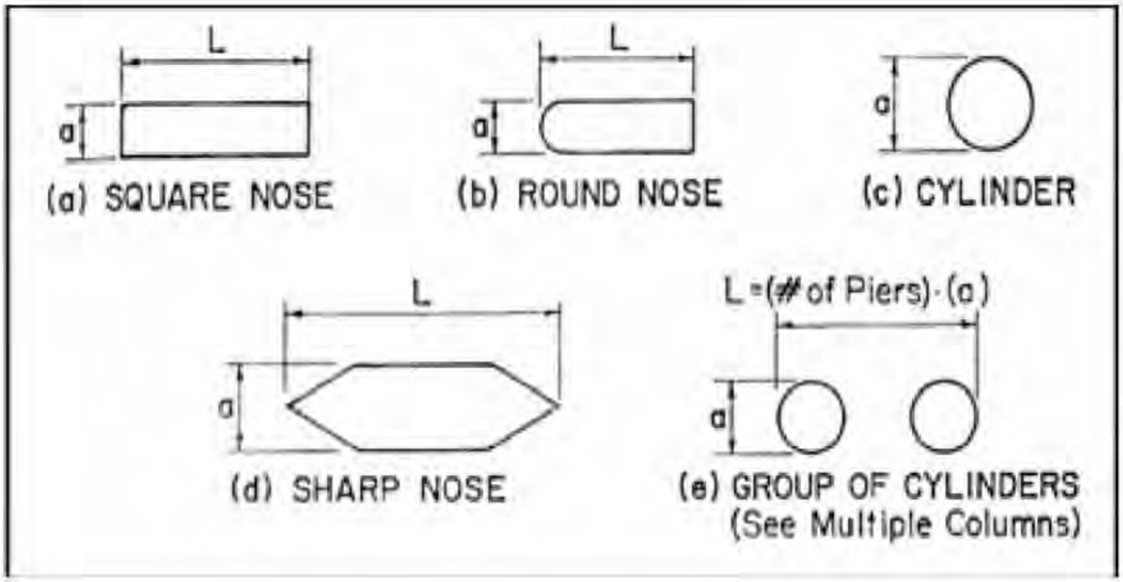


TABLE 11.11
CORRECTION FACTOR, K_2, FOR FLOW ANGLE OF ATTACK
(USDOT, 2001b)

Angle (degree)	L/a=4	L/a=8	L/a=12
1	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
Angle = skew angle of flow L = length of pier, ft a = pier width, ft			

The following formula can also be used to estimate the K_2 factor:

$$K_2 = \left(\cos\theta + \frac{L}{a}\sin\theta\right)^{0.65} \tag{11.65}$$

where:

θ = angle of attack, degrees. If $L/a > 12$, use $L/a = 12$.

TABLE 11.12
CORRECTION FACTOR, K_3, FOR BED FORM CONDITION
(USDOT, 2001b)

Bed Condition	Dune Height (ft)	K_3
Clear-Water Scour	N/A	1.1
Plane bed and Antidune flow	N/A	1.1
Small Dunes	$3 > H \geq 0.6$	1.1
Medium Dunes	$9 > H \geq 3$	1.2 to 1.1
Large Dunes	$H \geq 9$	1.3

The following formulas are to be used to estimate the K_4 factor:

if $D_{50} < 2\ mm$ or $D_{95} < 20\ mm$, then $K_4 = 1$, or

if $D_{50} \geq 2\ mm$ and $D_{95} \geq 20\ mm$, then:

$$K_4 = 0.4(V_R)^{0.15} \quad (11.66)$$

where:

$$V_R = \frac{V_1 - V_{icD_{50}}}{V_{cD_{50}} - V_{icD_{95}}} > 0 \quad (11.67)$$

where:

V_1 = velocity of the approach flow just upstream of the pier, ft/s;

V_{icD_x} = approach velocity ft/s required to initiate scour at the pier for the grain size D_x, ft;

D_x = grain size for which x percent of the bed material is finer, ft; and

x = 50 or 95.

The approach velocity is calculated with the equation:

$$V_{icD_x} = 0.645\left(\frac{D_x}{a}\right)^{0.053} V_{cD_x} \quad (11.68)$$

where:

V_{cD_x} = critical velocity (m/s or ft/s) for incipient motion for the grain size D_x, ft; and

V_{cD_x} = $11.17 y_1^{1/6} D_x^{1/3}$

where:

y_1 = depth of flow just upstream of the pier, excluding local scour, ft (normal depth from Manning's equation; maximum channel depth from HEC-RAS); and

D_x = grain size for which x percent of the bed material is finer, ft.

While K_4 provides a good fit with the field data, the velocity ratio terms are so formed that if D_{50} is held constant and D_{95} increases, the value of K_4 increases rather than decreases. For field data an increase in D_{95} was always accompanied with an increase in D_{50}. The minimum value of K_4 is 0.4.

Local Scour at Abutments

Froehlich's equation is used to estimate the local scour at bridge abutments when the ratio of the length of the abutment (normal to flow) to flow depth $L/y_a \leq 25$ (USDOT, 2001b). It has the form:

$$\frac{Z_{local}}{y_a} = 2.27K_1K_2\left[\frac{L'}{y_a}\right]^{0.43}Fr^{0.61} + 1 \tag{11.69}$$

where:

Z_{local} = local scour depth for abutments, ft;

y_a = average depth of flow on the floodplain (A_e/L), ft;

K_1 = coefficient for abutment shape from Figure 11.35 and Table 11.13;

K_2 = coefficient factor for angle of embankment to flow;

K_2 = $(\theta/90)^{0.13}$ (see Figure 11.36 for the definition of θ);

$\theta < 90°$ if embankment points downstream;

$\theta > 90°$ if embankment points upstream;

L' = length of active flow obstructed by the embankment, ft, see Figure 11.37;

L = length of embankment projected normal to the flow, ft, see Figure 11.37;

Fr = Froude number of approach of the abutment = $V_e/(gy_a)^{1/2}$;

V_e = Q_e/A_e, ft/s;

A_e = flow area of the approach cross section obstructed by the embankment, ft^2;

Q_e = flow obstructed by the abutment and approach embankment, cfs; and

g = gravitational acceleration, 32.2 ft/s^2.

The HIRE equation is used when the ratio of the length of the abutment (normal to flow) to flow depth $L/y_a > 25$, (USDOT, 2001b). It has the form:

$$\frac{Z_{local}}{y_1} = 4Fr^{0.33}\frac{K_1}{0.55}K_2 \tag{11.70}$$

where:

Z_{local} = local scour depth, ft;

y_1 = depth of flow at the abutment on the overbank or in the main channel, ft;

K_1 = coefficient for abutment shape from Figure 11.35 and Table 11.13;

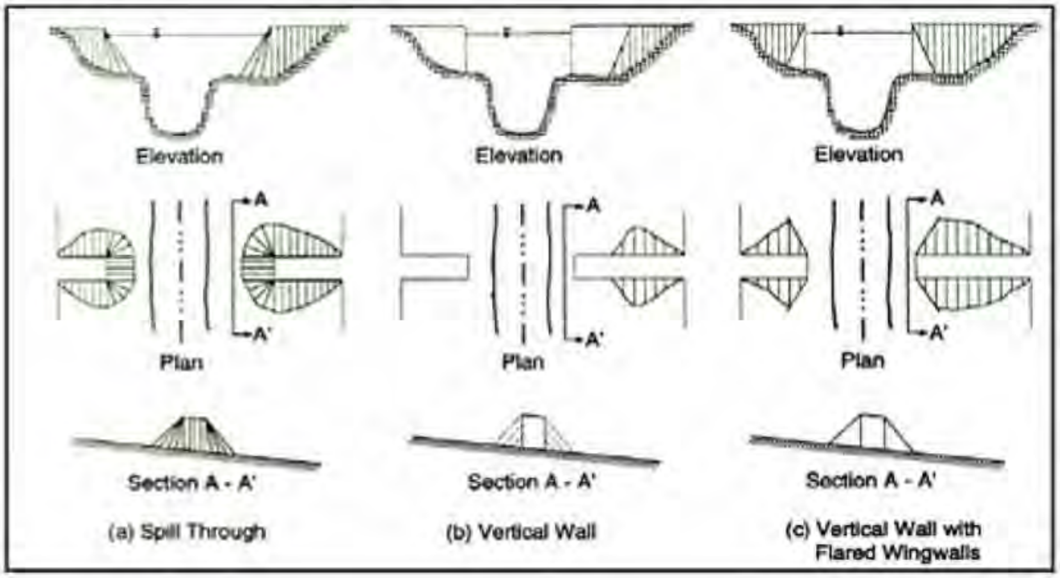
K_2 = $(\theta/90)^{0.13}$ (see Figure 11.36 for the definition of θ);

$\theta < 90°$ if embankment points downstream;

$\theta > 90°$ if embankment points upstream; and

Fr = Froude number based on the velocity and depth adjacent to and upstream of the abutment.

FIGURE 11.35
COMMON ABUTMENT SHAPES
(USDOT, 2001b)



(a) Spill Through
(b) Vertical Wall
(c) Vertical Wall with Flared Wingwalls

TABLE 11.13
ABUTMENT SHAPE COEFFICIENTS
(USDOT), 2001b)

Description	K_1
Vertical-wall abutment	1.00
Vertical-wall abutment with wing walls	0.82
Spill-through abutment	0.55

FIGURE 11.36
ABUTMENT SKEW; FOR ABUTMENTS ANGLES UPSTREAM
(USDOT, 2001b)

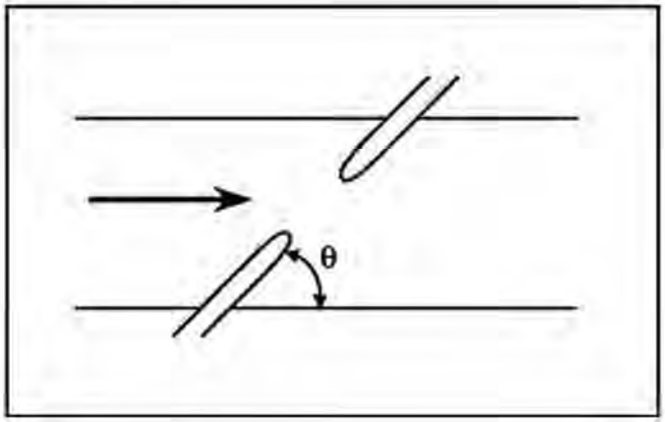
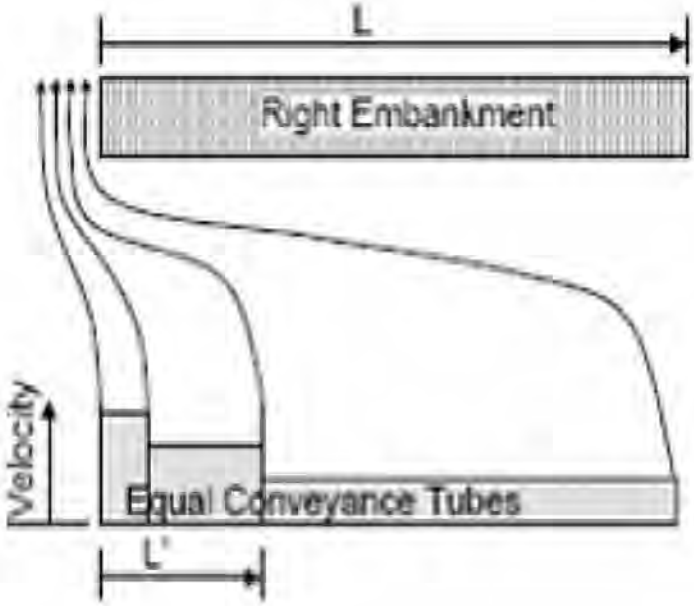


FIGURE 11.37
LENGTHS OF EMBANKMENT
(USDOT, 2001b)



Local Scour at Guide Banks

Local scour at guide banks can be estimated by the local scour at abutment equations (USDOT, 2001b). When the ratio, L/y_a, between the embankment projected length, L, normal to the flow and floodplain average depth, y_a, is less than or equal to 25, Froehlich's abutment equation can be used for guide bank local scour estimation. Assuming the guide banks are similar to spill through abutments and the abutment angle is 90 degrees, K_1 becomes 0.55 and K_2 becomes 1.0. Thus, Froehlich's abutment scour equation (if $L/y_a \le 25$) can be simplified as:

$$\frac{Z_{local}}{y_a} = 1.248\left[\frac{L'}{y_a}\right]^{0.43} Fr^{0.61} + 1 \qquad (11.71)$$

where:

Z_{local} = local scour depth, ft;

y_a = average depth of flow on the floodplain (A_e/L), ft;

L' = length of active flow obstructed by the embankment, ft, see Figure 11.37;

L = length of embankment projected normal to the flow, ft, see Figure 11.37;

Fr = Froude number of approach to the abutment = $V_e/(gy_a)^{1/2}$;

V_e = Q_e/A_e ft/s;

A_e = flow area of the approach cross section obstructed by the embankment, ft^2;

Q_e = flow obstructed by the abutment and approach embankment, cfs; and

g = gravitational acceleration, 32.2 ft/s^2.

When the ratio, L/y_a, between the embankment projected length, L, normal to the flow and floodplain average depth, y_a, is greater than 25, the HIRE equation becomes:

$$\frac{Z_{local}}{y_1} = 4.0Fr^{0.33} \tag{11.72}$$

where:

Z_{local} = local scour depth, ft;

y_1 = depth of flow at the abutment on the overbank or in the main channel, ft; and

Fr = Froude number based on the velocity and depth y_1 adjacent to and upstream of the guide bank.

Local Scour at Culvert Outlets

The equation to calculate the local scour at a culvert outlet in cohesionless soil has the form (USDOT, 2006):

$$\left(\frac{Z_{local}}{R_c}, \frac{W_{local}}{R_c}, \frac{L_{local}}{R_c}, \frac{V_{local}}{R_c^3}\right) = C_s C_h\left(\frac{\alpha}{\sigma^{1/3}}\right)\left(\frac{Q}{\sqrt{g}R_c^{2.5}}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta} \tag{11.73}$$

where:

Z_{local} = depth of scour, ft;

W_{local} = width of scour, ft;

L_{local} = length of scour, ft;

V_{local} = volume of scour, ft;

R_c = hydraulic radius at the end of the culvert (assuming full flow), ft;

Q = discharge, cfs;

g = acceleration of gravity, 32.2 ft/s^2;

t = time of scour in minutes (30 minutes recommended);

t_o = base time (316 minutes);

σ = $(D_{84}/D_{16})^{0.5}$, material standard deviation;

D_{16} = median sediment particle diameter for which 16% of the material (by weight) is finer, ft;

D_{84} = median sediment particle diameter for which 84% of the material (by weight) is finer, ft;

α, β, θ are coefficients, see Table 11.14;

C_s = slope correction coefficient, see Table 11.15; and

C_h = drop height adjustment coefficient, see Table 11.16.

If the soil is cohesive in nature the above equation should not be used. The equation in Section 5.2 (pages 5-6) of USDOT (2006) should be used.

TABLE 11.14
COEFFICIENTS FOR CULVERT OUTLET SCOUR IN COHESIONLESS SOILS
(USDOT, 2006)

	α	β	θ
Depth, Z_{local}	2.27	0.39	0.06
Width, W_{local}	6.94	0.53	0.08
Length, L_{local}	17.1	0.47	0.1
Volume, V_{local}	127.08	1.24	0.18

Table 11.15
Coefficient, C_S, for Culvert Slope
(USDOT, 2006)

Slope %	Depth	Width	Length	Volume
0	1	1	1	1
2	1.03	1.28	1.17	1.3
5	1.08	1.28	1.17	1.3
>7	1.12	1.28	1.17	1.3

Table 11.16
Coefficient, C_H, for Outlets above the Bed
(USDOT, 2006)

H_d[1]	Depth, Z_{local}	Width, W_{local}	Length, L_{local}	Volume, V_{local}
0	1	1	1	1
1	1.22	1.51	0.73	1.28
2	1.26	1.54	0.73	1.47
4	1.34	1.66	0.73	1.55

[1] H_d is the height above bed in pipe diameters.

Local Scour at Grade Controls or Drop Structures

The equations for scour below a structure are those of Schoklitsch, Veronese, and Zimmerman and Maniak (Pemberton and Lara, 1984).

Schoklitsch Equation

The Schoklitsch equation was developed to calculate scour depth below a structure with a free overfall of water on an unprotected river bed. It can also be used for evaluating local scour below a sharp-crested spillway, drop structure or grade control structure. It has the form:

$$Z_{loc} = \frac{3.15 H^{0.2} q^{0.57}}{D_{90}^{0.32}} - y_m \qquad (11.74)$$

where:

Z_{local} = depth of scour, ft;

H = vertical distance between the water level upstream and downstream of the structure, ft;

q = design discharge per unit width (= design discharge divided by average flow width; the average flow width can be defined as wetted cross section area divided by flow depth where flow depth can be the Manning's equation-based normal depth or maximum flow depth from HEC-RAS), cfs/ft;

D_{90} = particle size for which 90% is finer than, mm; and

y_m = downstream mean water depth, (hydraulic depth) ft.

Veronese Equation

The Veronese equation for computing the scour depth below a low head stilling basin design is in the form:

$$Z_{local} = 1.32 H_T^{0.225} q^{0.54} - y_m \tag{11.75}$$

where:

Z_{local} = depth of scour, ft;

H_T = the head from upstream reservoir to tailwater level, ft;

q = design discharge per unit width (= design discharge divided by average flow width; the average flow width can be defined as wetted cross section area divided by flow depth where flow depth can be the Manning's equation-based normal depth or maximum flow depth from HEC-RAS), cfs/ft; and

y_m = downstream mean water depth (hydraulic depth), ft.

Zimmerman and Maniak Equation

The Zimmerman and Maniak equation for scour depth below a stilling basin or at the end of an apron is in the form:

$$Z_{local} = 1.95\left(\frac{q^{0.82}}{D_{85}{}^{0.23}}\right)\left(\frac{y_m}{q^{2/3}}\right)^{0.93} - y_m \tag{11.76}$$

where:

y_{loc} = local scour depth below streambed, ft;

q = design discharge per unit width (= design discharge divided by average flow width; the average flow width can be defined as wetted cross section area divided by flow depth where flow depth can be the Manning's equation-based normal depth or maximum flow depth from HEC-RAS), cfs/ft; and

D_{85} = particle size for which 85% is finer than, mm; and

y_m = downstream mean water depth (hydraulic depth), ft.

11.9 ESTIMATING LATERAL-EROSION HAZARD ZONES

This section presents a methodology for estimating the 100-year lateral-erosion or lateral-migration hazard zones for straight or meandering natural channels in Maricopa County, Arizona. The terms lateral-erosion and lateral-migration are interchangeable in this section.

A typical natural channel has a main-channel and overbank areas (Figure 11.38). A main-channel usually has well-defined channel banks. There may be low flow channels within the main-channel. Both the main-channel and any low-flow channels may be meandering. The methodology should be applied to the main-channel instead of the low-flow channel.

FIGURE 11.38
TYPICAL CROSS SECTION FOR A NATURAL CHANNEL

APPENDIX K

MEMORANDUM: SEDIMENT AND STABLE CHANNEL ASSESSMENT: SEDIMENT YIELD

Reata Wash
Flood Control Improvement Study

Contract No. 2014-168-COS

Memorandum: Sediment and Stable Channel Assessment: Sediment Yield

August 31, 2016

Prepared for:

Capital Project Management
7447 E. Indian School Rd. Suite 205
Scottsdale, AZ. 85251

Prepared By:

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

JE Fuller Hydrology & Geomorphology, Inc.
1 West Deer Valley Road, Suite 101
Phoenix, AZ 85027

Registered Professional Engineer (Civil)
Certificate No.
26846
JONATHAN E.
FULLER
Date Signed 8/31/2016
ARIZONA, U.S.A.
EXPIRES: 3.31.17

In Association with:

WOOD/PATEL
MISSION: CLIENT SERVICE™

LOGANSIMPSON

FLOOR
associates
hrm

Gannett Fleming

Technical Solutions

gci

Table of Contents

Section **Page**

List of Figures

Registered Professional Engineer (Civil)
CERTIFICATE NO.
26846
JONATHAN E.
FULLER
Date Signed 8/31/2016
ARIZONA, U.S.A.

EXPIRES: 3-31-17

1. Executive Summary

A review of existing sediment yield studies was conducted including recommendations regarding their applicability to the study. Sediment yield is the volume of soil material and sediment transported from a watershed through its stream network. Sediment yield is an important design parameter for flood control structures because sediment deposition in dams, reservoirs, or floodways reduces the storage or transport capacity. Reduced capacity of flood control structures increases the likelihood of a overtopping during flood events, increasing the probability of injuries, damage to downstream property and the structure itself, and even loss of human life.

Previous sediment yield estimates were identified during the data collection phase of the Reata Wash Flood Control Improvement Study. These estimates are appropriate for concept-level Reata Wash Flood Control Improvement Study evaluation. However, if the study progresses to full design, new sediment yield estimates should be developed to address changes in methodology that are site-specific to the particular design elements of the proposed channel, reflect current watershed and site conditions, and are appropriate for use in both design and evaluation of Federal Emergency Management Agency (FEMA) floodplains.

Therefore, it is recommended that new sediment yield be performed if the Reata Wash Flood Control Improvement Study proceeds to full design.

2. Overview

The Reata Pass Alluvial Fan is located within the city limits of Scottsdale, Arizona along the western flank of the McDowell Mountains, and northeast of the Loop 101 Freeway and the Central Arizona Project (CAP) Canal (Figure 2–1). The Reata Pass Alluvial Fan landform is moderately large, but the active parts of fan landform are significantly smaller, and are limited to the portions of the landform near the hydrographic apexes. Large portions of the fan landform were mapped as an active alluvial fan by the FEMA, although more careful consideration and recent analyses indicate that only portions of the fan landform are in fact active. The Reata Wash Flood Control Improvement Study investigates the feasibility of constructing flood control structures to safely contain and convey flood waters over the fan surface and remove the FEMA-designated floodplain.

This memorandum documents the findings of the sediment yield review conducted in support of the City of Scottsdale's (City) Reata Wash Flood Control Improvement Study. The review was performed by staff from JE Fuller, Inc. (JE Fuller), as a subconsultant to Wood, Patel & Associates (WPA).

Figure 2–1 General Location Map for the Reata Pass Alluvial Fan Landform

3. Definition and Significance of Sediment Yield

Sediment yield is the volume of soil material and sediment transported from a watershed to and through its stream network. Sediment yield is an important design parameter for flood control structures because sediment deposition in dams, reservoirs, or floodways reduces the storage or transport capacity. Reduced capacity of flood control structures increases the likelihood of overtopping during flood events, increasing the probability of injuries, damage to, downstream property and flood control structures, and even loss of human life. Specifically, sediment yield could impact the design and function of the Reata Wash Flood Control Improvement Study in the following ways:

- Capacity. Structural flood control measures contain and/or convey both flood water and sediment. Floods in the arid southwest can carry up to 20% (by volume)[1] sediment in addition to flood water. The sediment load carried along with the flood water increases the depth, velocity, and other aspects of the flood flow. Flood control basins and channels must be designed to hold the additional volume of the sediment load.
- Performance. How the sediment load is accounted for in the design affects how the flood control measures will perform. For example, if the sediment load is not trapped upstream of a constructed channel network, then the channels must be designed either to keep the sediment load moving without deposition, include features that will trap and store the sediment, or be designed with excess capacity to account for sediment deposition. If the natural sediment load is removed before flows enter a constructed channel network, then the impacts of sediment-deprived water on scour and erosion must be factored into the design.
- Maintenance. Sediment deposited in a flood control feature must be removed before it affects the flood control structure performance. The need for periodic sediment maintenance affects the annual operating costs of structural flood control measures, and also affects the design due to the need for access by maintenance equipment.
- Regulatory Issues. Because a significant portion of the study area is currently mapped as an active alluvial fan, FEMA will require consideration of sedimentation impacts on any proposed structural flood control measures before they will revise the effective floodplain maps. In addition, many potential funding partners, such as the Flood Control District of Maricopa County (FCDMC), the United States Army Corps of Engineers (USACE), or FEMA, will require a site specific evaluation of sediment yield (and sediment transport) as part of the final project design.

4. Sources of Sediment Inflow

There are three primary sources of sediment yield for the Reata Wash Flood Control Improvement Study. The first is from the upper watershed, as measured at the apex of the Reata Pass Alluvial Fan located near Pinnacle Peak Road (see Figure 4–1). This sediment load will consist of sands, gravels, and cobbles (the bed material load) as well as finer-grained sediments normally carried in suspension in flood waters (the suspended and wash load). The second source of sediment yield is from tributaries that enter the study area downstream of the alluvial fan apex. These include some small unnamed watersheds that drain the foothills of the McDowell Mountains near the apex, North and South Beardsley Washes which drain the western slopes of the McDowell Mountains, and the watersheds now captured by the Thompson Peak Channel. Each

---

[1] Graf, WL, 1987, Fluvial Processes in Dryland Rivers, Springer-Verlag Press, New York.

of these tributaries deliver not only flood water, but also significant volumes of sediment that must be accounted for in the Reata Wash Flood Control Improvement Study design. The sediment delivered from these tributaries is similar in composition to that of the sediment associated with the fan apex, although the volume will be different as a function of the watershed size, physiography, geology, and hydrology. The third source of sediment yield to the study area is from the many channels and upland surfaces within the Reata Pass Alluvial Fan landform. Flow along the alluvial channels of the Reata Pass Alluvial Fan has the capacity to erode the stream beds and banks. This sediment is then added to the load delivered to downstream reaches. The sediment sizes delivered from the channels within the Reata Wash Flood Control Improvement Study will be a function of the channel design, but are most likely to include predominantly sand and gravel sized material.

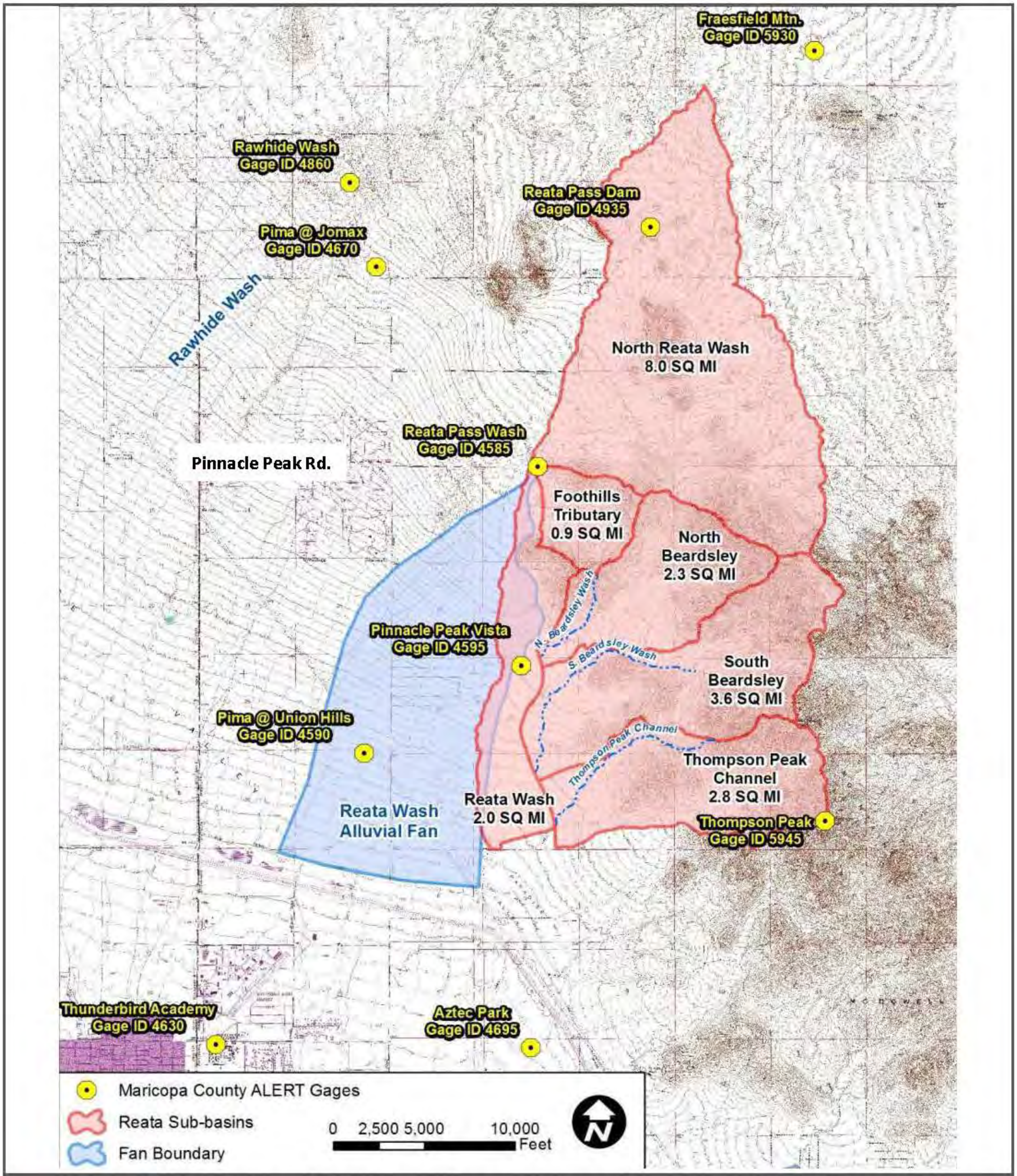
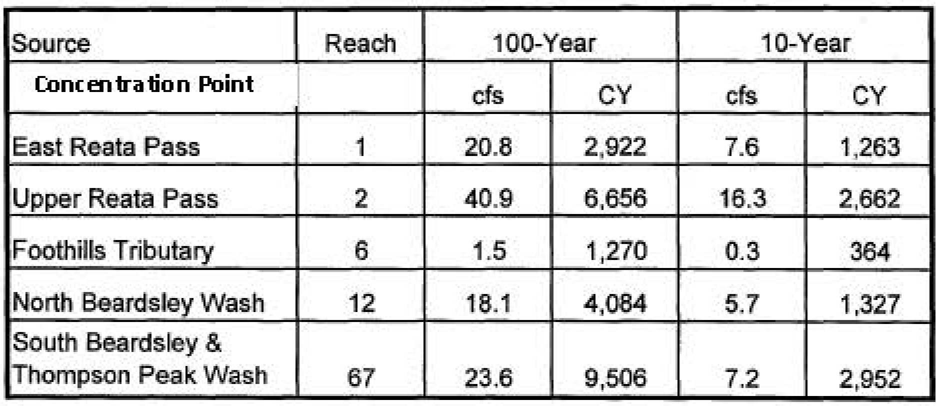


Figure 4–1 Reata Pass Alluvial Fan Tributary Drainage Areas & FCDMC Gage Locations

5. Sediment Yield Estimates

A review of previous estimates of sediment yield was conducted relative to their applicability to the Reata Wash Flood Control Improvement Study. The following estimates of sediment yield were identified during the data collection effort conducted for this study:

- Simons Li & Associates, 1997, City of Scottsdale Desert Greenbelt Project Volume III: Reata Pass/Beardsley Wash Erosion Sedimentation Control and Channel Improvement Design[2]: This report identified sediment inflows (a.k.a., sediment load) at five concentration points for the 10- and 100-year events (see Figure 5–1). The estimates computed for the Simons Li & Associate's study used slightly different methodologies than currently required in some local design manuals, and also used concentration points near, but not necessarily along the study alignment. However, the estimates are directly relevant to the Reata Wash Flood Control Improvement Study, if only for comparison to a (future) site specific sediment yield assessment for the proposed project.



Source	Reach	100-Year		10-Year	
Concentration Point		cfs	CY	cfs	CY
East Reata Pass	1	20.8	2,922	7.6	1,263
Upper Reata Pass	2	40.9	6,656	16.3	2,662
Foothills Tributary	6	1.5	1,270	0.3	364
North Beardsley Wash	12	18.1	4,084	5.7	1,327
South Beardsley & Thompson Peak Wash	67	23.6	9,506	7.2	2,952

Figure 5–1 Reproduction of Sediment Inflow Estimates from Table 4.2 in SLA, 1997.

- Stantech Consulting, 1998, PR3B – System Design & Operation Memorandum and Appendix A.[3]: This memorandum summarizes sediment yield estimates made in previous studies by PACE, Robert Ward, George V. Sabol Consulting Engineers, and Win Hjalmarson for the Desert Greenbelt Studies (see Figure 5–2). Sediment yield estimates for average annual and 100-year events were provided at several concentration points that are located within the Reata Wash Flood Control Improvement Study area. Stantech used methodologies that, while appropriate and commonly used elsewhere, are not currently recommended in the FCDMC guidelines. Nevertheless, the Stantech estimates would be useful for comparison to future site specific sediment yield assessments.

---

[2] Document RW0110 in the Reata Wash Flood Control Improvement Study Data Collection Report.

[3] Document RW0100 in the Reata Wash Flood Control Improvement Study Data Collection Report. The same information is also reported in Document RW0096 (Stantech, 1999).

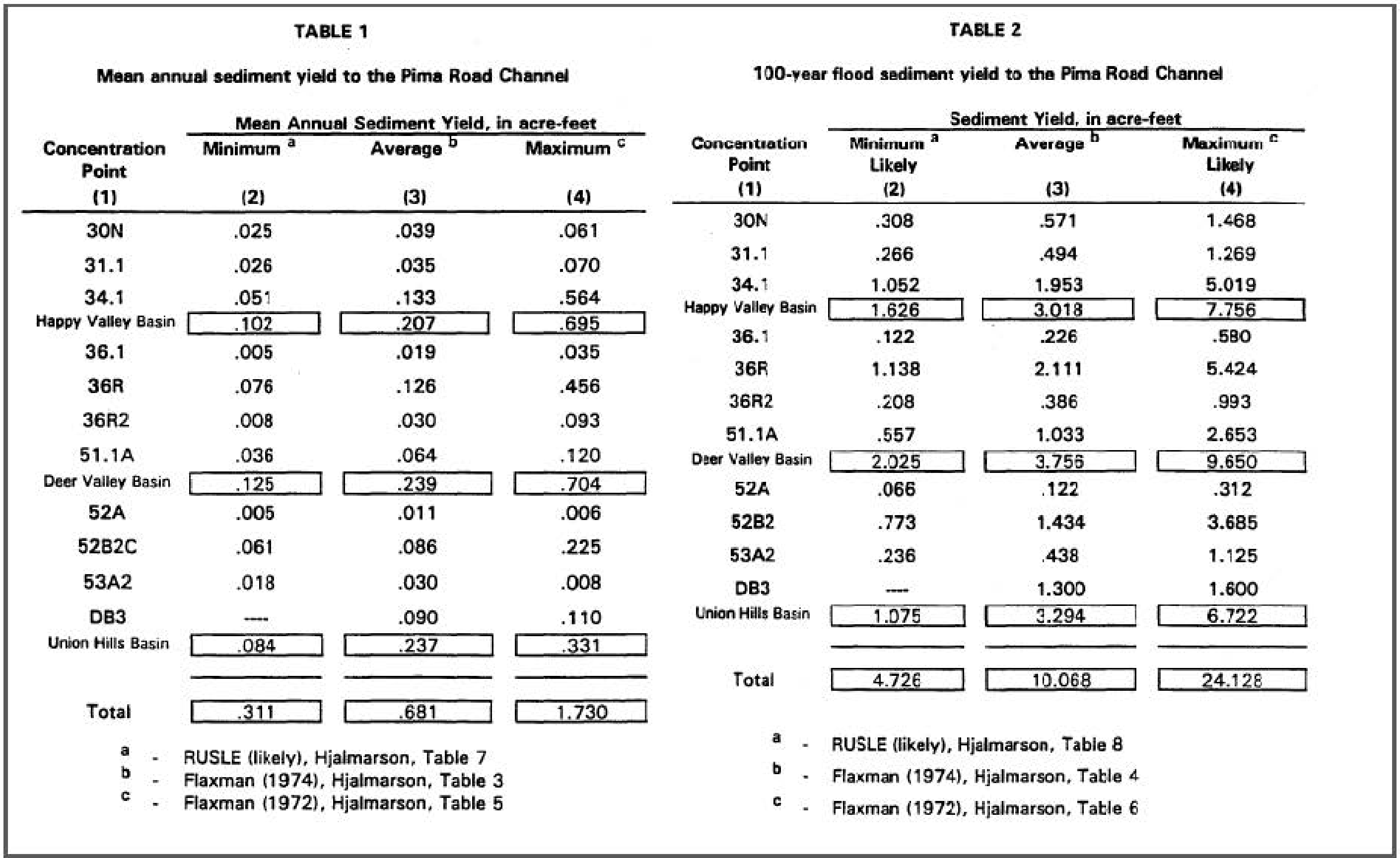


TABLE 1

Mean annual sediment yield to the Pima Road Channel

Concentration Point (1)	Mean Annual Sediment Yield, in acre-feet: Minimum [a] (2)	Average [b] (3)	Maximum [c] (4)
30N	.025	.039	.061
31.1	.026	.035	.070
34.1	.051	.133	.564
Happy Valley Basin	.102	.207	.695
36.1	.005	.019	.035
36R	.076	.126	.456
36R2	.008	.030	.093
51.1A	.036	.064	.120
Deer Valley Basin	.125	.239	.704
52A	.005	.011	.006
52B2C	.061	.086	.225
53A2	.018	.030	.008
DB3	----	.090	.110
Union Hills Basin	.084	.237	.331
Total	.311	.681	1.730

a - RUSLE (likely), Hjalmarson, Table 7
b - Flaxman (1974), Hjalmarson, Table 3
c - Flaxman (1972), Hjalmarson, Table 5

TABLE 2

100-year flood sediment yield to the Pima Road Channel

Concentration Point (1)	Sediment Yield, in acre-feet: Minimum [a] Likely (2)	Average [b] (3)	Maximum [c] Likely (4)
30N	.308	.571	1.468
31.1	.266	.494	1.269
34.1	1.052	1.953	5.019
Happy Valley Basin	1.626	3.018	7.756
36.1	.122	.226	.580
36R	1.138	2.111	5.424
36R2	.208	.386	.993
51.1A	.557	1.033	2.653
Deer Valley Basin	2.025	3.756	9.650
52A	.066	.122	.312
52B2	.773	1.434	3.685
53A2	.236	.438	1.125
DB3	----	1.300	1.600
Union Hills Basin	1.075	3.294	6.722
Total	4.726	10.068	24.128

a - RUSLE (likely), Hjalmarson, Table 8
b - Flaxman (1974), Hjalmarson, Table 4
c - Flaxman (1972), Hjalmarson, Table 6

Figure 5–2 Reproduction of Sediment Yield Estimates Tables from Stantech, 1998.

6. Sediment Yield Studies from Adjacent and Nearby Watersheds

In addition to previous sediment yield studies for locations within the Reata Wash Flood Control Improvement Study area, there are many sediment yield studies that have been conducted in the North Scottsdale or Maricopa County area that would provide some context, verification and comparison for a site-specific sediment yield study for the area of interest. Table 11.7 in the current FCDMC Drainage Design Manual for Maricopa County – Hydraulics (2013) lists previous estimates of average annual sediment yield for 20 different watersheds in the arid southwest considered to be representative of conditions in Maricopa County. Those estimates range from 0.03 to 0.96 acre-feet/square mile/year, with a median of 0.24 acre-feet/square mile/year for the Arizona sites. Those data were plotted as shown in Figure 6–1, which indicates the wide variability of sediment yield depending on site-specific factors.

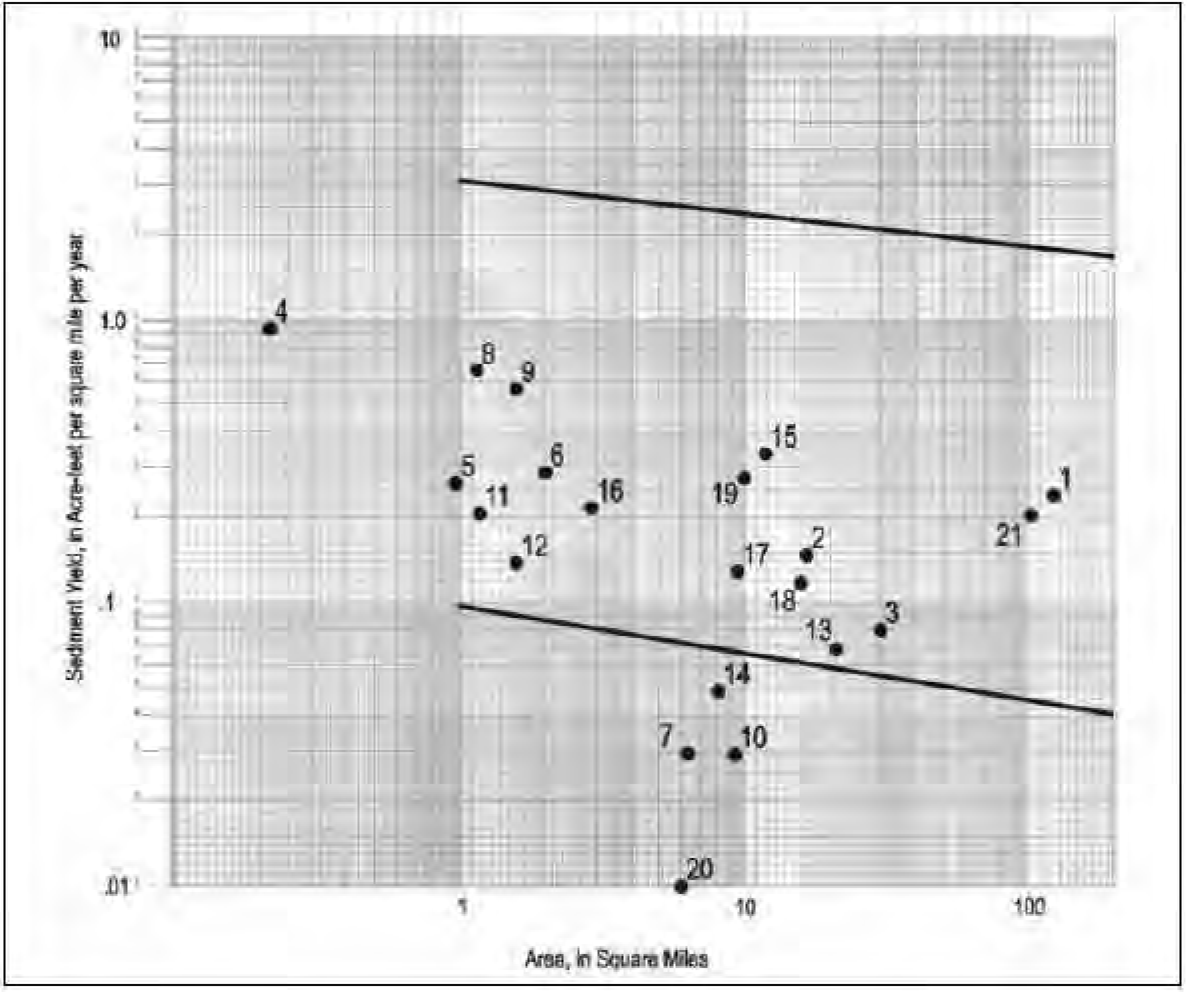


Figure 6–1 Reproduction of Figure 11.21 from the FCDMC Drainage Design Manual Showing Sediment Yield Estimates.

In addition, JE Fuller has computed sediment yield estimates for many watersheds in Maricopa County over the past several decades on behalf of many public agencies. JE Fuller's estimates are somewhat more clustered than the values indicated in the figure above, but are within the range indicated by the envelope lines in Figure 6–1.

7. Conclusions and Recommendations

A number of previous sediment yield estimates for the Reata Wash Flood Control Improvement Study area were identified during the data collection phase of the study. While these estimates are appropriate for a concept-level evaluation of the proposed Reata Wash Flood Control Improvement Study, they should be updated and evaluated in detail if the study proceeds to full design for the following reasons:

- Methodology. Some of the estimates are based on methodologies that are not included in the current FCDMC guidelines. If FCDMC participation in the project is desired, then it is highly likely that the FCDMC will require use of only the methodologies that are listed in the current version of their guidelines.

- Site-Specific. While some of the previous estimates include locations within the Reata Wash Flood Control Improvement Study area, they are not necessarily located at the concentration points currently identified. Thus, at least some update of the previous estimates will be required to assure that the correct watershed areas, basin or channel configurations are used.
- Current Conditions. There have been changes in rainfall estimates (National Ocean and Atmospheric Administration (NOAA) Atlas 2 vs. 14) and the extent of urbanization since some of the previous estimates were calculated. Updates would be required to address these types of changes.
- Focus/Intent. The previous estimates were developed to support channelization and basin designs. Some repurposing of the estimates is required to address potential FEMA concerns regarding issues associated with active alluvial fan flooding that are likely to arise if the effective Flood Insurance Rate Maps are to be revised.

Therefore, it is recommended that new sediment yield analyses be performed if the Reata Wash Flood Control Improvement Study proceeds to full design. For the current Concept Design Plan (15% Level Design) it is recommended that sediment yield based on a 0.24 acre/square mile/year value be used in conjunction with the proposed sediment basin within the Central Arizona Project floodplain area.

APPENDIX L

MEMORANDUM: SEDIMENT AND STABLE CHANNEL ASSESSMENT:

GEOMORPHIC ASSESSMENT

Reata Wash
Flood Control Improvement Study

Contract No. 2014-168-COS

Memorandum: Sediment and Stable Channel Assessment: Geomorphic Assessment

August 31, 2016

Prepared for:

CITY OF SCOTTSDALE
ARIZONA

Capital Project Management
7447 E. Indian School Rd. Suite 205
Scottsdale, AZ. 85251

Prepared By:

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

JE Fuller Hydrology & Geomorphology, Inc.
1 West Deer Valley Road, Suite 101
Phoenix, AZ 85027

26848
JONATHAN E.
FULLER
Date Signed 8/31/2016
EXPIRES: 3-31-17

In Association with:

WOOD/PATEL
MISSION: CLIENT SERVICE™

LOGANSIMPSON

FLOOR
associates

Gannett Fleming

Technical Solutions

gci

Table of Contents

List of Figures

List of Tables

Registered Professional Engineer (Civil)
Certificate No.
26846
JONATHAN E.
FULLER
Date Signed 8/31/2016
Arizona, U.S.A.

EXPIRES: 3-31-17

1. Executive Summary

A geomorphic assessment of the Reata Wash Flood Control Improvement Study area was conducted to document existing channel conditions and likely flood and sedimentation problems, and to better understand the geologic features and landforms within the watershed, as well as the geomorphic processes taking place within the channel and overbank areas. The geomorphic assessment indicates the following:

- Most of the Reata Pass Alluvial Fan landform is an ***inactive*** alluvial fan, characterized by relatively stable tributary and distributary[1] flow paths.
- The active portion of the Reata Pass Alluvial Fan landform is located in the area between Pinnacle Peak Road and the Deer Valley Road alignment along the Reata Wash corridor, and between Pinnacle Peak Road and Thompson Peak Parkway along the Dobson Wash corridor.
- Urban development has significantly altered the natural runoff patterns on the Reata Pass Alluvial Fan landform. Development also altered (i.e., reduced) the potential for flow path uncertainty (aka, alluvial fan flooding) downstream of the Deer Valley Road alignment. The obstructions created by walls, homes, roads, and grading generally reduce the potential for natural avulsions[2] that create flow path uncertainty on active alluvial fans.
- Prior to development, the Reata Wash corridor was characterized primarily by stable and unstable distributary channels, all of which were confined within a relatively narrow area constrained by older, stable, inactive alluvial fan surfaces.

Field observations document that Reata Wash transports large quantities of sediment and up to boulder-sized sediment during floods. Currently, as documented by historical aerial photographs, analysis of topographic maps, and detailed geologic mapping, the channels in the Reata Wash corridor are dominated by erosional, rather than depositional, processes, i.e., it is not an aggrading landform.

2. Introduction & Overview

Reata Pass Wash flows onto a moderately large alluvial fan landform located adjacent to the western slopes of the McDowell Mountains in Scottsdale, Arizona. Large portions of the fan landform were mapped as an active alluvial fan by the Federal Emergency Management Agency (FEMA), although more careful consideration and recent analyses indicate that only portions of the fan landform are in fact active. Most of the landform is inactive, subject to sheet flooding and stable distributary flow, or has stable tributary drainage paths on older inactive fan surfaces. The upper portion[3] of the Reata Pass Alluvial Fan landform (Figure 2–1, Figure 2–2), near its hydrographic apex[4], is potentially subject to active alluvial fan flooding

---

[1] A distributary flow pattern is one in which the channels split in the downstream direction, creating more possible flow paths as one moves downstream. In contrast, a tributary channel pattern occurs where multiple stream channels combine to create a single, usually larger, channel.

[2] An avulsion is a sudden relocation of a channel or flow path from one part of a floodplain or an alluvial fan to another location where flow did not previously occur.

[3] The upper portion of the fan, or upper fan, is the most active portion of the alluvial fan landform, as described later in this memorandum.

[4] The hydrographic apex of an active alluvial fan is the location where the main channel loses the capacity to contain flooding, where the channel pattern changes from tributary to distributary channels, and where flow path uncertainty begins.

during large floods. However, during the 60-year period of record of aerial photographs, even this portion of the fan has been relatively inactive, primarily due to the lack of large floods.

This memorandum documents the findings of the reconnaissance-level geomorphic assessment conducted in support of the City of Scottsdale's (City) Reata Wash Flood Control Improvement Study. The assessment was performed by staff from JE Fuller/Hydrology & Geomorphology, Inc. (JE Fuller), as a subconsultant to Wood, Patel & Associates. Inc. (WPA), under Task 6 of City Contract # 2014-168-COS. A geomorphic assessment of the Reata Wash Flood Control Improvement Study area was conducted to document existing channel conditions and likely flood and sedimentation problems, and to better understand the geologic features and landforms within the watershed, as well as the geomorphic processes taking place within the channel and overbank areas. The geomorphic assessment focused on the active portion of the fan landform near the hydrographic apex and the potential Reata Wash channelization corridor.

Figure 2–1 General Location Map for the Reata Pass Alluvial Fan Landform and the Reata Wash Flood Control Improvement Study

2.1 Site Location

The Reata Pass Alluvial Fan is located within the city limits of Scottsdale, Arizona along the western flank of the McDowell Mountains, and northeast of the Loop 101 Freeway and the Central Arizona Project (CAP) Canal (Figure 2–1). The Reata Pass Alluvial Fan landform is moderately large, but the active parts of fan landform are significantly smaller, and are limited to the portions of the landform near the hydrographic apexes. As seen in Figure 2–2, the primary hydrographic apex of Reata Pass Alluvial Fan is location just south of Pinnacle Peak Road. At the apex, flow splits in two main directions: (1) to the south, which is locally referred to as Reata Wash, and (2) to the southwest, which is locally referred to as Dobson Wash.

The watershed area above the primary hydrographic apex located at Pinnacle Peak Road is approximately 8.0 square miles (Figure 2–2, Figure 2–3). The total watershed area more than doubles in size downstream of the primary hydrographic apex from runoff due to tributary watersheds draining the McDowell Mountains, as well as from runoff caused by precipitation falling directly on the Reata Pass fan landform itself and on adjacent piedmont[5] areas to the west. These downstream watersheds include Beardsley Wash (north and south channels), and the Thompson Peak Channel. Channels on the Rawhide Wash Alluvial Fan landform once intermingled with the channels on the Reata Pass Alluvial Fan landform in their lower, inactive piedmont areas, but are now mostly hydrologically disconnected due to the effects of urbanization (See Figure 2–3 for locations of geographic features). The mountain watershed areas upstream of the fan landform have steep slopes, are mostly undeveloped, and are underlain by bedrock or very shallow granitic soils. The piedmont areas are more gently sloping and are underlain by highly permeable, deep, granitic soils, and are now mostly developed as residential and commercial sites, with several large golf courses. The lower portions of the Reata Pass Alluvial Fan landform were developed recently and consist primarily of master planned communities (see Figure 3–5). The upper piedmont consists of large lot development with little or no original drainage infrastructure.

The Reata Wash corridor is a relatively well-defined ephemeral wash, with a braided or distributary channel system confined between more stable, topographically higher piedmont surfaces. The stream channels in the Dobson Wash corridor are much less defined, and are strongly distributary, and rapidly transition to urban sheet flooding conditions. Historically, there were two secondary hydrographic apexes located along the Reata Wash alignment (Figure 2–2 – indicated by yellow stars). The upstream-most secondary apex is located at what is now the E. Cross Canyon Way Road alignment. The other secondary apex is located further downstream (south) at what is now the E. Havasupai Drive alignment. Both of these secondary apexes were associated with small, confined channel fans, which transitioned rapidly into stable distributary channel systems with no significant risk of avulsion or long-term aggradation.

---

[5] A piedmont is the sloping landform located between a mountain front and the centerline of the valley adjacent to the mountains. A piedmont landform is composed of sediment material eroded from the mountains and deposited on the valley floor.

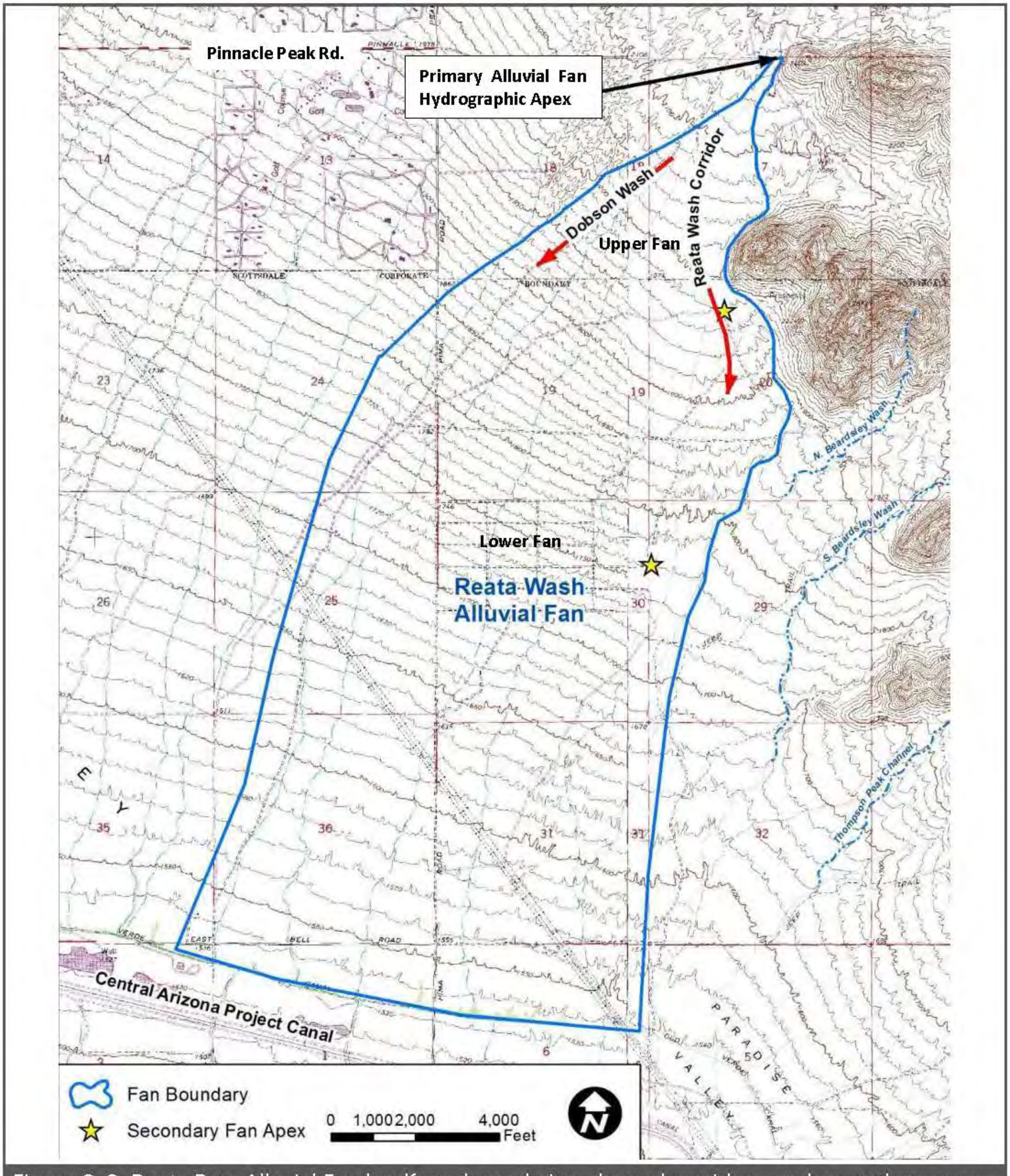


Figure 2–2 Reata Pass Alluvial Fan landform boundaries, channel corridors, and secondary apexes

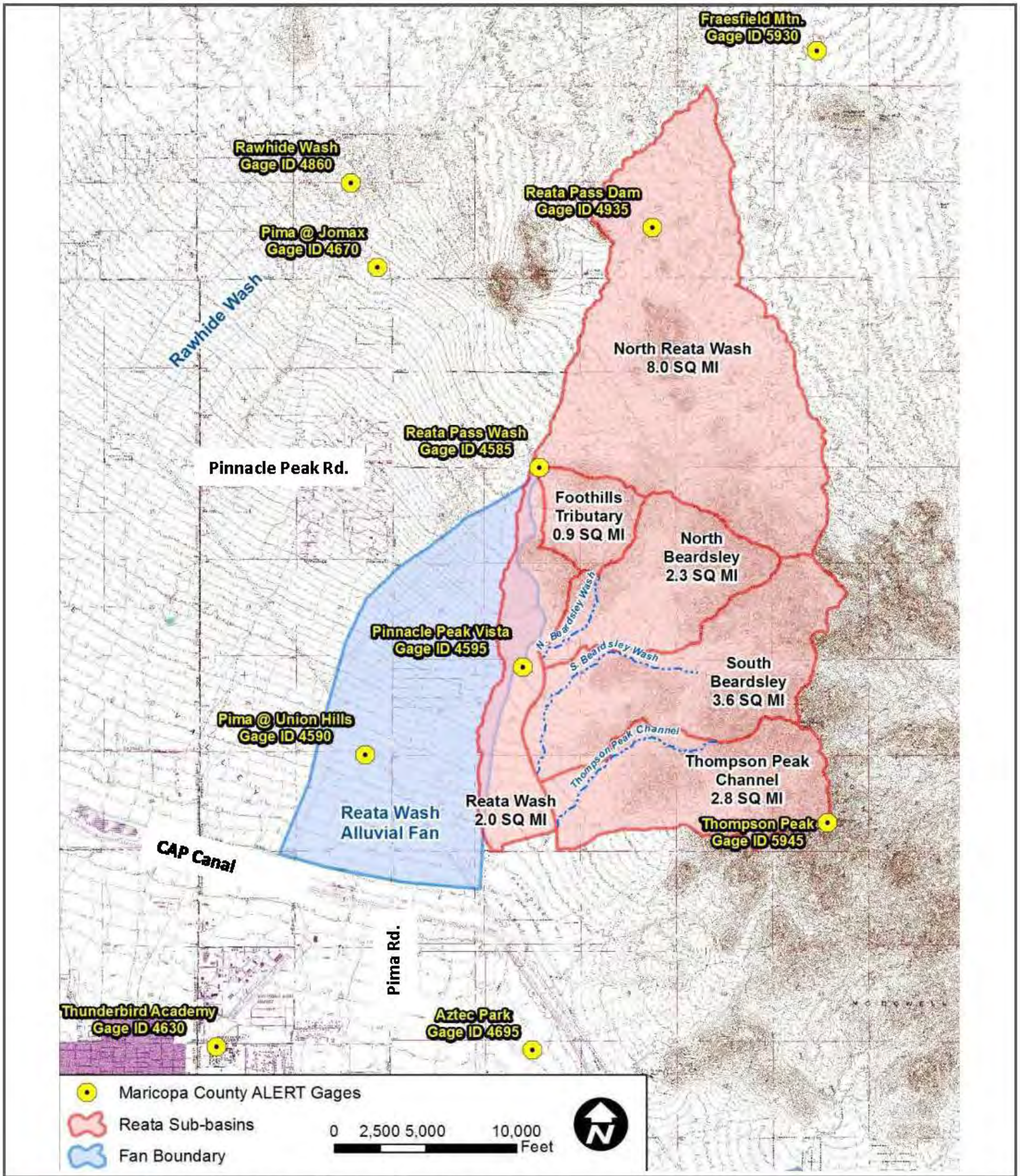


Figure 2–3 Reata Pass Alluvial Fan tributary drainage areas & FCDMC gage locations

3. Geomorphic Characteristics of the Reata Pass Alluvial Fan

The geomorphic history and character of the Reata Pass Alluvial Fan landform was assessed using detailed soils maps published by the Natural Resources Conservation Service (NRCS), geologic maps published by the Arizona Geological Survey (AZGS), interpretation of recent and historical aerials photography, interpretation of topographic mapping, and field reconnaissance.

3.1 NRCS Soils Mapping

NRCS soil survey information for the Reata Pass Alluvial Fan study area was obtained from the Soil Survey of the Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona (Camp, 1986) and is shown on Figure 3–1. Soil survey units are labeled individually in Figure 3–1, but are also grouped by color into the major landform types designated by the NRCS.

The Reata Pass Alluvial Fan landform surface was mapped as six soil units. At the primary hydrographic apex near Pinnacle Peak Road, both the Reata Wash and Dobson Wash branches are underlain by NRCS Unit No. 8 (Arizo cobbly sandy loam). According to the NRCS, the Arizo soils unit is “characterized by excessively drained (i.e., highly permeable) soils on floodplain” where “runoff is slow, and the hazard of water erosion is severe.” The NRCS Unit No. 8 underlies the main channels of the Reata Wash branch downstream to just upstream of the Legacy Boulevard alignment, but does not extend outside the main channel corridor, and does not have a fan shape (i.e., it does not widen in the downstream direction). This indicates that the active channel corridor is linear (i.e., riverine, rather than fan-like).

Just downstream of the primary hydrographic apex on the Dobson Wash branch, the area is mapped as NRCS Unit No. 6 (Anthony-Arizo complex), which the NRCS describes as found on floodplains and drainageways. The NRCS Unit No. 6 is mapped with a fan shape along the Dobson Wash corridor, which widens in the downstream direction as the channelized flow near the primary apex transitions to distributary and sheet flooding. The NRCS Unit No. 6 could be interpreted as a transitional unit from active alluvial fan flooding to shallow sheet flooding, as the fan surface becomes less active and flood hazards diminish due to attenuation over the widening inundation surface. NRCS Unit No. 6 terminates just downstream of the Deer Valley Road alignment, just within the northern DC Ranch community limits.

The Tres Hermanos-Anthony complex (NRCS #121) lies between the Arizo (#8) on the east and the Anthony-Arizo (#6) units, and occupies much of the upper Reata Pass Alluvial Fan landform surface. The NRCS describes this soil unit as found on inactive fan and stream terraces, and includes their (inactive) riverine floodplains within the terraces. The NRCS further describes Unit No. 121 as having “slow” runoff with “slight” water erosion hazard, indicating relatively high clay and carbonate content. The NRCS Unit No. 121 is indicative of inactive alluvial fan surfaces.

NRCS Soil Unit No. 90, the Momoli gravelly sandy loam occupies most of the middle part of the Reata Pass Alluvial Fan landform, and lies downstream of the soil units described above. The NRCS describes Unit No. 90 as a “deep well drained soil” located on “fan terraces,” with “slow” runoff and “slight” water erosion hazards. NRCS Soil Unit No. 91, the Momoli-Carrizo complex, borders the eastern side of the Reata Pass Alluvial Fan landform, and is similar in composition (gravelly, sandy loam) and classification (fan terrace) to Unit No. 90. Fan terraces are equivalent to inactive alluvial fan surfaces.

NRCS Soil Unit No. 55 is mapped at the extreme southwest portion of the Reata Pass Alluvial Fan landform outlined in Figure 3–1. This loam and sandy loam unit is described by the NRCS as being found on alluvial fans and floodplains, but is described as “none” in their frequency of flooding category. More likely, the NRCS designation should be for an alluvial plain, a landform often found in the sheet flooding zone at the toe of an alluvial fan landform. This interpretation is more consistent with the NRCS soil texture (loam), as well as the AZGS map units and topographic features described below.

Bordering the alluvial fan landform on the east are several rock outcrop soil units (NRCS Unit No. 31) which are part of the McDowell Mountains.

Summary: The NRCS soil unit classifications indicates that only the upper portion of the Reata Pass Alluvial Fan landform is subject to active alluvial fan flooding (Units No. 8 and possibly 6). The other NRCS soil units were classified by the NRCS as relict or inactive alluvial fans (fan terraces). Therefore, the remainder of the landform is either inactive fan terraces, or shallow sheet flooding areas near the toe of the fan landform.

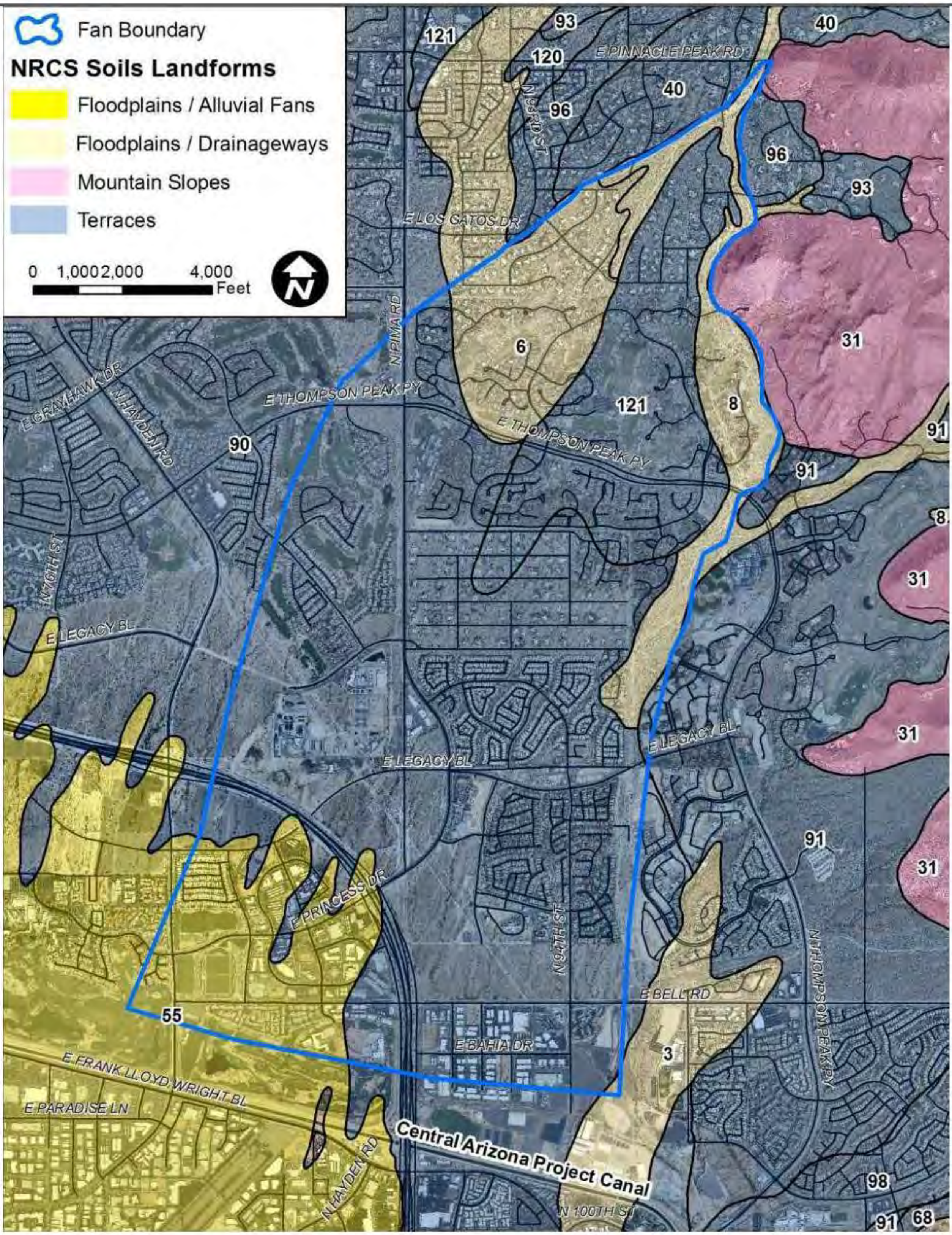


Figure 3–1 NRCS soils mapping of the Reata Pass Alluvial Fan landform

3.2 AZGS Surficial Geologic Mapping

Geologic mapping prepared by Richard and Spencer (1998) of the AZGS for the area near Reata Wash is shown in Figure 3–2. Aside from the bedrock units of the McDowell Mountains to the east of the alluvial fan landform, which are composed of early Proterozoic Quartzite (Xsq), the following three geologic units compose the fan itself, in order of increasing geologic age:

- Qy – Holocene Alluvium, Alluvial Fan Deposits and Drainageways (< 10,000 years)
- Qylf – Holocene Alluvium, Alluvial Fan and Alluvial Plains (< 10,000 years)
- Ql – Late Pleistocene Alluvium, Dissected Alluvial Fans and Fan Terraces (>10,000 years)
- Qm – Middle Pleistocene Alluvium, Fan Terraces and Relict Fans (>100,000 years)

Only the Holocene-aged units (Qy) should be considered as potential active alluvial fan surfaces. Surficial units that have been stable, i.e., not eroded or buried by recent sediment deposition or transport, for more than 10,000 years are highly unlikely to be subject to active alluvial fan processes such as flood inundation, channel avulsion or net sediment aggradation. As shown on Figure 3–2, the younger Qy units are found at the primary hydrographic apex near Pinnacle Peak Road, directly under the main channels along the Reata Wash corridor, and along the Dobson Wash channel alignment on the western side of the alluvial fan landform. The Qy units along the Reata Wash corridor are relatively narrow and are confined by older, more stable Ql and Qm units. Toward the downstream end of the Reata Pass Alluvial Fan landform, the Reata Wash corridor becomes somewhat distributary in character, although the distributary corridors are well-confined by older, more stable Ql and Qm units. The Ql and Qm unit are also higher in elevation than the Qy units, making them less subject to flooding.

The younger Qy units found along the Dobson Wash corridor to the west tend to be wider and more broadly distributed than along the Reata Wash corridor on the east. Detailed two-dimensional hydraulic modeling of the upper portion of the Reata Pass Alluvial Fan (Fuller, 2010) indicates that most of the frequent flows and the majority of the largest flows follow the Reata Wash corridor. That detailed hydraulic modeling confirms the AZGS mapping which indicates that the Dobson Wash corridor may be a recently abandoned, slightly older surface which is more subject to shallow sheet flooding or spillover flows from Reata Wash corridor (near the apex) than to active alluvial fan flooding.

Summary: The AZGS surficial mapping indicates that only a small part of the Reata Pass Alluvial Fan landform is subject to active alluvial fan flood processes. Most of the landform surface consists of an inactive alluvial fan or shallow sheet flooding areas. Flooding along the Reata Wash corridor is confined within a relatively narrow floodplain contained by older, stable inactive fan surfaces. Flooding along the Dobson Wash corridor is less contained, but is subject primarily to sheet flooding outside of the area directly influenced by the primary hydrographic apex.

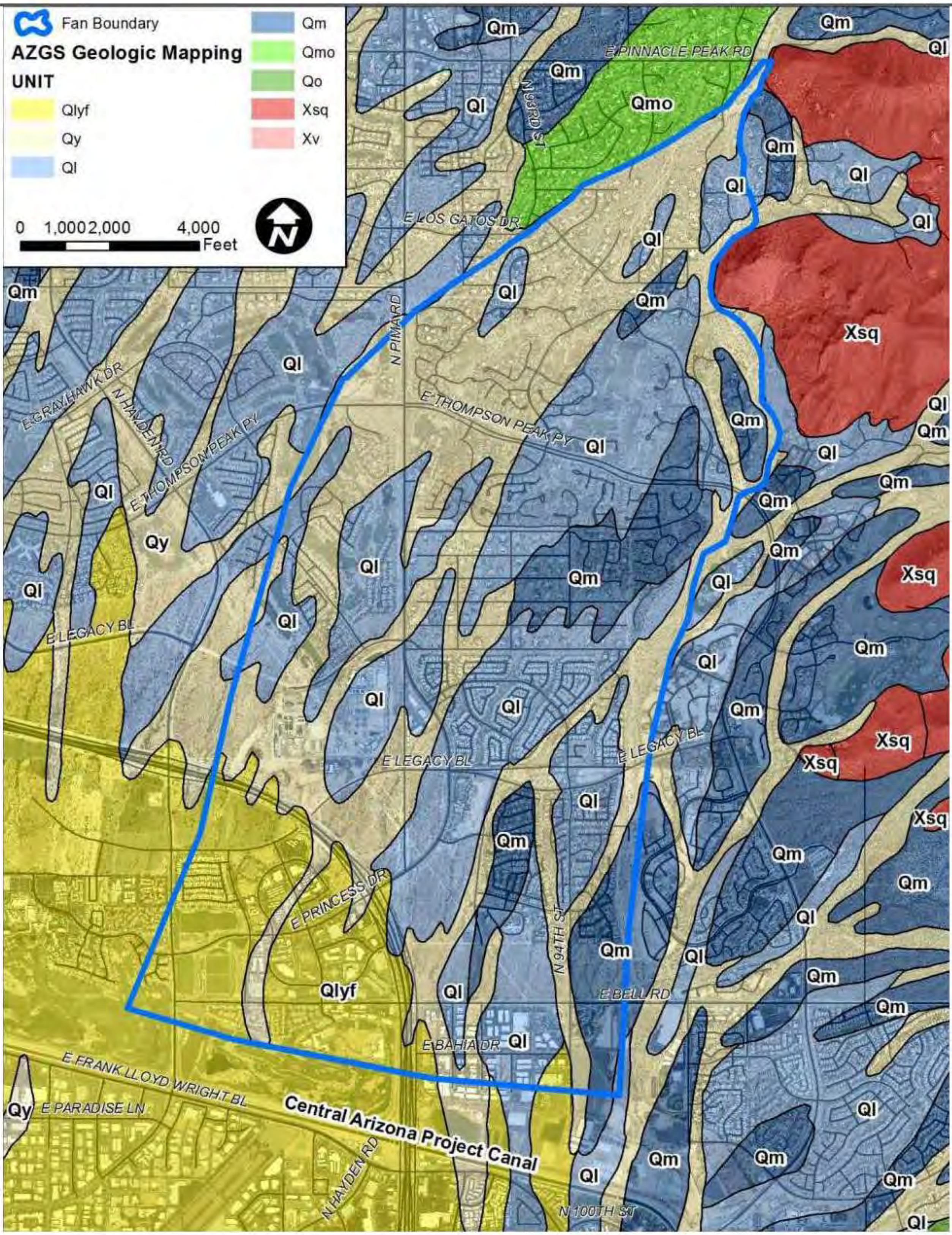


Figure 3–2 AZGS geologic mapping of the: Reata Pass Alluvial Fan landform

3.3 Interpretation of Topographic Mapping

Large scale topographic mapping of the Reata Pass Alluvial Fan landform from 7.5 minute USGS quadrangle maps is shown in Figure 2–2. Topographic information for the Reata Pass Alluvial Fan landform obtained from the USGS maps is summarized in Table 3–1.

Table 3–1 Watershed and Alluvial Fan Landform Characteristics, Reata Wash Flood Control Improvement Study Area

Item	Value	Source
Watershed area		
• Upstream of primary apex	8.1 square miles	USGS Quads
• At CAP (fan toe)	24 square miles	
Watershed slope		
• 3.2 miles upstream to apex	3.4 %	USGS Quads
Fan slope		
• Apex to 1.92 miles downstream	3.3 %	USGS Quads
• 1.92 miles to 4.65 miles downstream	2.0 %	
Fan Profile Shape	Concave	USGS Quads
Max Elevation in Drainage Area	3880 feet (1)	USGS Quads
Elevation at apex	2185 feet (1)	USGS Quads
Minimum Elevation in fan	1520 feet (1)	USGS Quads

Notes:
(1) Elevations in feet above mean sea level.

Some of the key information derived from the topographic mapping with respect to the geomorphic assessment include the following:

- Drainage Area. The watershed area at the primary hydrographic apex (8.1 mi^2) near Pinnacle Peak Road is relatively small compared to the total watershed area at the toe of the fan (~24 mi^2). In fact, drainage area of the fan landform below the primary hydrographic apex (~6.2 mi^2) is only slightly smaller than the watershed above the apex, and slightly less than the total drainage area of the tributaries (~10 mi^2) that drain the McDowell Mountains and join Reata Wash downstream of the primary apex. Therefore, it is likely that flooding and sediment supply generated from the drainage areas located above the primary apex have diminishing significance with distance down the fan.

- Slope. The slope of the Reata Pass Alluvial Fan landform is relatively steep compared to other piedmont surfaces in Maricopa County. Therefore, above average flow velocities and sediment transport rates should be expected along confined flow corridors.

- Fan Shape. The convexity[6] of an active alluvial fan may be correlated to the potential for channel avulsions, as well as the rate of sediment deposition and fan aggradation. Highly active fans often have highly convex shapes. The low convexity of the Reata Pass Alluvial Fan is not indicative of a highly active alluvial fan. The convexity varies significantly within the landform boundaries, as described below:
    - Near the primary hydrographic apex, the highest convexity is located along the Reata Wash corridor, which is the most constrained by older, inactive surfaces. The Dobson Wash corridor has relatively low convexity, but is more strongly distributary and has a larger younger surface area (Figure 3–1, Figure 3–2) than the Reata Wash corridor.
    - The highest degree of convexity on the entire landform occurs in the vicinity of the secondary hydrographic apex in Section 20 (Figure 2–2) in an inactive area underlain by middle to late Pleistocene aged surfaces (Figure 3–2).
    - Near the toe of the landform, the topographic contours are not convex, an indication that this portion of the geomorphic surface is an alluvial plain.

  These patterns of convexity may suggest that much of the "fan" shape of the Reata Pass Alluvial Fan landform is a remnant of its geologic past, rather than an artifact of recent active alluvial fan floodplain and sediment aggradation (i.e., it is not a very active alluvial fan).
- Contour Crenulations[7]. Active alluvial fans are typically crossed by smooth contours. Inactive alluvial fans typically have highly crenulated (i.e., curvy) contours. Crenulated contours are caused by channel erosion as the surface ages and develops an interior drainage network. The crenulated contour patterns observed on the Reata Pass Alluvial Fan landform are consistent with the surface age designations mapped by the AZGS (Figure 3–2), which indicate that most of the landform is underlain by older, stable, inactive fan surfaces.

---

[6] The convexity of an alluvial fan landform refers to what degree the surface of the fan is curved outward like the exterior of a sphere, where the interior of the surface is topographically higher than its margins. A highly convex fan bends outward significantly, creating topographic contours that bend in a semi-circular pattern. A fan with low convexity has topographic contours that are relatively straight, indicating a laterally planar surface.

[7] Contour crenulation measures the smoothness vs. curviness of a topographic contour. A smooth topographic contour indicates a landform surface with few incised channels or topographic rises, which is indicative of geologically young, recently deposited surfaces. A curvy (or crenulated) topographic contour indicates a landform with numerous incised channels indicative of older, eroding (non-depositional) surfaces. Active alluvial fans experience recent deposition which creates smooth surfaces that have smooth, non-crenulated contours.

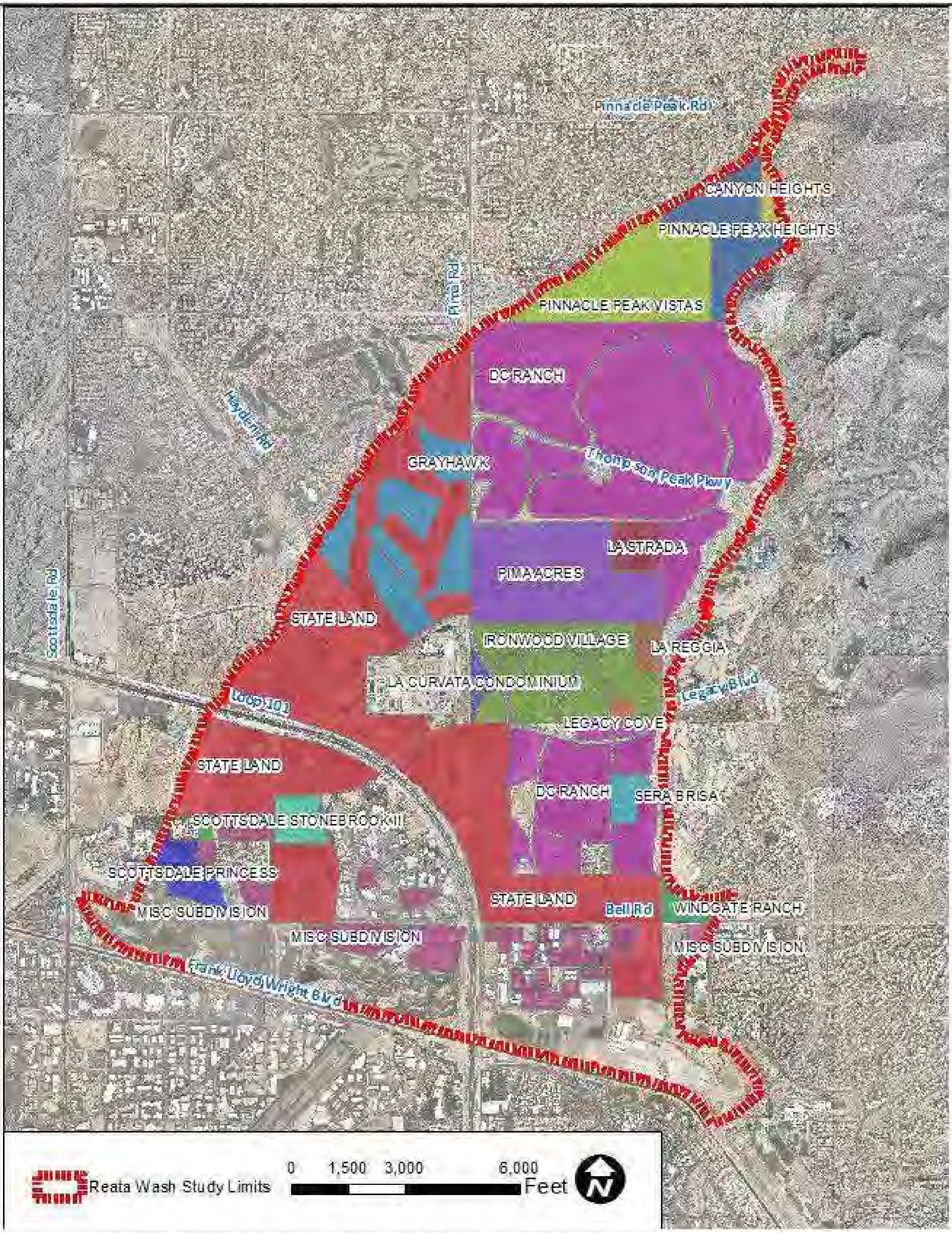


Figure 3–3 Location of Subdivisions in the Vicinity of the Reata Pass Alluvial Fan Landform

3.4 Interpretation of Aerial Photography

The geomorphic character of the Reata Pass Alluvial Fan landform was also assessed by examining recent and historical aerial photographs. The following observations were made based on inspection of aerial photographs for the study area that date back to 1962 (Figure 3–4 to Figure 3–5):

- Development. The most striking feature of the Reata Pass Alluvial Fan landform observed when older and more recent aerial photographs are compared is the degree to which the piedmont surface has been urbanized in just the last few decades (Figure 3–3, Figure 3–4 and Figure 3–4). Except at the primary hydrographic apex, the natural geomorphic characteristics of the piedmont are almost completely obscured by development. Even near the primary hydrographic apex, the degree of residential development is relatively high, though less dense than elsewhere on the fan landform. The high degree of urbanization, e.g., homes, subdivisions, commercial and industrial property, local and major roads, bridges, walls, fences, storm drains, culverts, landscaping, trails, utilities, and other features, radically alter how flood water and sediment can be conveyed over the piedmont surface compared to pre-development conditions. Therefore, clues to the natural, pre-development geomorphic characteristics of the Reata Pass Alluvial Fan landform must be obtained from the earliest aerial photography.
- Channel Pattern. As observed on the pre-development aerial photographs, the channel patterns on the Reata Pass Alluvial Fan are distributary at the primary hydrographic apex, but transition to a tributary drainage pattern in the vicinity of the Deer Valley Road alignment upstream of DC Ranch. Distributary channels can be indicative of active alluvial fans, but tributary channels are almost always a characteristic of inactive fan areas. The occurrence of distributary and tributary channel areas are highly correlative with the AZGS surficial geology mapping shown in Figure 3–2.
- Channel Size. The pre-development aerials show that the individual channel widths decrease in the downstream direction along the Dobson Wash corridor between the primary hydrographic apex and the toe of the fan landform. The decrease in channel size indicates that the peak discharges conveyed over the fan surface decreased significantly due to flow attenuation (infiltration and floodplain storage). Along the Reata Wash corridor, the decrease in channel width is less pronounced, and is impacted by the inflow of tributaries from west slopes of the McDowell Mountains.
- Lower Beardsley Wash. The pre-development aerials also indicate that Lower Beardsley Wash did not join the Reata Wash channel corridor upstream of Bell Road prior to urbanization of the Reata Pass Alluvial Fan area. Prior to development, Lower Beardsley Wash (and the Thompson Peak Channel watershed) began to intermingle with the Reata Pass Fan drainages downstream of Bell Road, outside of the current project limits. See Figure 2–3 for tributary channel locations.
- Dobson Wash. In 1962, the Dobson Wash corridor appears to be more prominent, i.e., conveys more of the runoff from the primary hydrographic apex, than the Reata Wash corridor. The current shift of flow toward the Reata Wash corridor may be due to stream capture processes along the steeper Reata Wash flow path. See Figure 2–2 for the location of Dobson Wash.

Figure 3–4 Reata Pass Alluvial Fan Before & After Development, 1962-2009, Apex Area

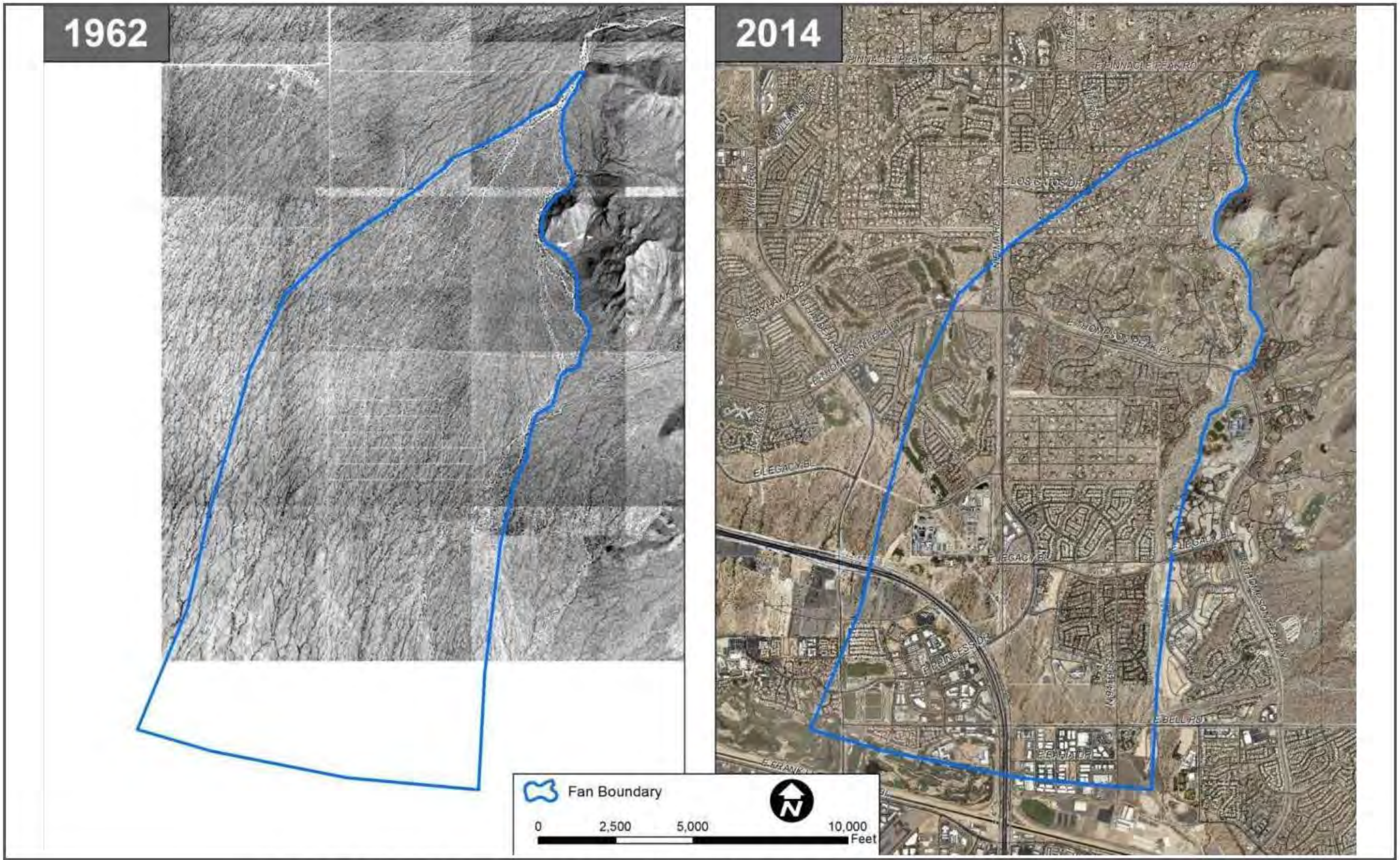


Figure 3–5 Reata Pass Alluvial Fan Before & After Development, 1962-2014, Apex Area

3.5 Field Reconnaissance

Field reconnaissance trips to the study area were conducted to supplement the information obtained from the map and aerial photographic exercises, and to compare conditions observed on the Reata Pass Alluvial Fan during past studies by JE Fuller (2010). The following field observations were made in support of the geomorphic assessment:

- Erosion. Overall, the Reata Pass Alluvial Fan landform appears to be dominated by erosional, rather than depositional processes. Evidence of scour was observed in many places and in many forms, particularly where the flow channels intersected the built environment, such as at road crossings. Even in the most active portions of the fan landform near the primary hydrographic apex, there was more evidence of scour and transport than of net sediment deposition.
- Sediment Transport. The channels on the Reata Pass Alluvial Fan landform have the capacity to move moderately large volumes of sediment, probably due to the steep slope of the landform and the resulting high flow velocities during large floods. Although the dominant materials in transport are sand and gravel sized clasts, evidence of transport of cobble-sized materials was observed throughout the study area, even near the toe of the landform and in channels in the inactive portions of the alluvial fan. There appear to be two primary sources for the cobble-sized materials transported by floods: (1) Steep tributaries draining the McDowell Mountains. These materials were observed in the tributaries themselves and in the vicinity of their confluence with the Reata Pass Alluvial Fan channel systems, but were typically not transported far from the confluences. (2) Exposure due to vertical scour of the fan surface by degrading channels. Long-term scour of some channels has exposed coarse sediment layers, causing cobble-sized material to be eroded from channel banks and deposited in the main channels. Many of these deposits are imbricated[8] indicating that the channels can at least rearrange the exposed coarse sediments, if not fully transport them downstream.
- Sediment Deposition. Evidence of sediment deposition was generally local, rather than systemic, with deposits observed upstream of obstructions, such as undersized culverts, and in ineffective flow areas. No instances of older surfaces being buried by progressive sediment aggradation, as is often seen on active alluvial fans, were observed in the study area.
- Scour. Evidence of long-term scour was observed at most at-grade road crossings, downstream of culverts, and at grade control structures.
- Culvert Clogging. Culverts designed to convey flow from within to outside the engineered channel corridor to meet Clean Water Act (CWA) Section 404 permitting requirements were clogged by sediment, indicating that the culverts were not functioning as designed. The cause of the clogging was not assessed in detailed for this study, but could be related to lack of maintenance, deliberate plugging by local residents, or inadequate design. To the extent that the proposed Reata Wash channelization plan includes such features, particular care should be made to improve the long-term function of such “bleed-off” culverts.

---

[8] Imbrication is an overlapping, parallel alignment of sediment (like tilted dominoes) caused by flowing water.

4. Preliminary Alluvial Fan Hazard Assessment

A geomorphic assessment is a major component of a FEMA floodplain delineation on any alluvial fan landform. FEMA requires that a three-stage assessment process be applied. A preliminary three-stage assessment for the Reata Pass Alluvial Fan is outlined below based on the geomorphic data summarized in this memorandum. A more detailed assessment would be required prior to submittal to FEMA to support a revision of the effective FEMA floodplain maps.

4.1 Preliminary Stage 1 alluvial Fan flooding assessment

In Stage 1 of a FEMA alluvial fan floodplain assessment, the study area is evaluated to determine if it has the characteristics of an alluvial fan landform. The most probable pre-development landform classification for the Reata Pass Alluvial Fan using FEMA's Stage 1 categories is described below, and consists of the following three elements:

- Composition. The landform is composed of alluvium (sediment material transported by the streams that formed the landform.
- Morphology. The landform has the shape of a fan, either partially or fully extended.
- Location. The landform is located at a topographic break where the primary watercourse loses capacity.

The Reata Pass Alluvial Fan landform is shown to be composed of alluvium, as indicated by the NRCS detailed soils mapping (Figure 3–1) and AZGS surficial geology mapping (Figure 3–2). As shown in Figure 2–2, the landform has the radial contours characteristic of a partially extended fan. Additionally, the site is located at the topographic break formed where the Reata Pass Wash loses confinement and splits into the Reata Wash and Dobson Wash corridors downstream of Pinnacle Peak Road. Therefore, the landform is properly classified as an alluvial fan landform.

4.2 Preliminary Stage 2 Alluvial Fan Flooding Assessment

In Stage 2 of a FEMA alluvial fan floodplain assessment, the alluvial fan landform is evaluated to determine if it is (or portions are) active or inactive. Inactive alluvial fan floodplains can be mapped using traditional riverine mapping tools. Active alluvial fan floodplain delineations are performed using more complex mapping techniques that can account for flow path uncertainty and sediment impacts.

The AZGS and NRCS mapping, as well as the historical aerial photographs clearly indicate that only portions of the Reata Pass Alluvial Fan landform are subject to active alluvial fan flooding. Most of the land area currently mapped as part of the Reata Pass FEMA floodplain (Figure 4–1) are incorrectly mapped as active alluvial fans. Even a cursory comparison of Figure 4–1 with the surficial geology and soils mapping in Figure 3–1 and Figure 3–2 reveals the inconsistency of the effective FEMA floodplain delineations. Most of the Reata Pass Alluvial Fan landform is subject to riverine flooding, stable distributary flooding, and/or sheet flooding, all of which can be effectively mapped using hydraulic modeling tools such as FLO2D. In addition, the study area is not subject to debris flows and would be minimally impacted by wildfire, two factors which can contribute to active alluvial fan flooding. Finally, it is highly likely that a detailed modeling study would conclude that the dense urbanization of the study area would eliminate much of the potential for flow path uncertainty that may have existed prior to development.

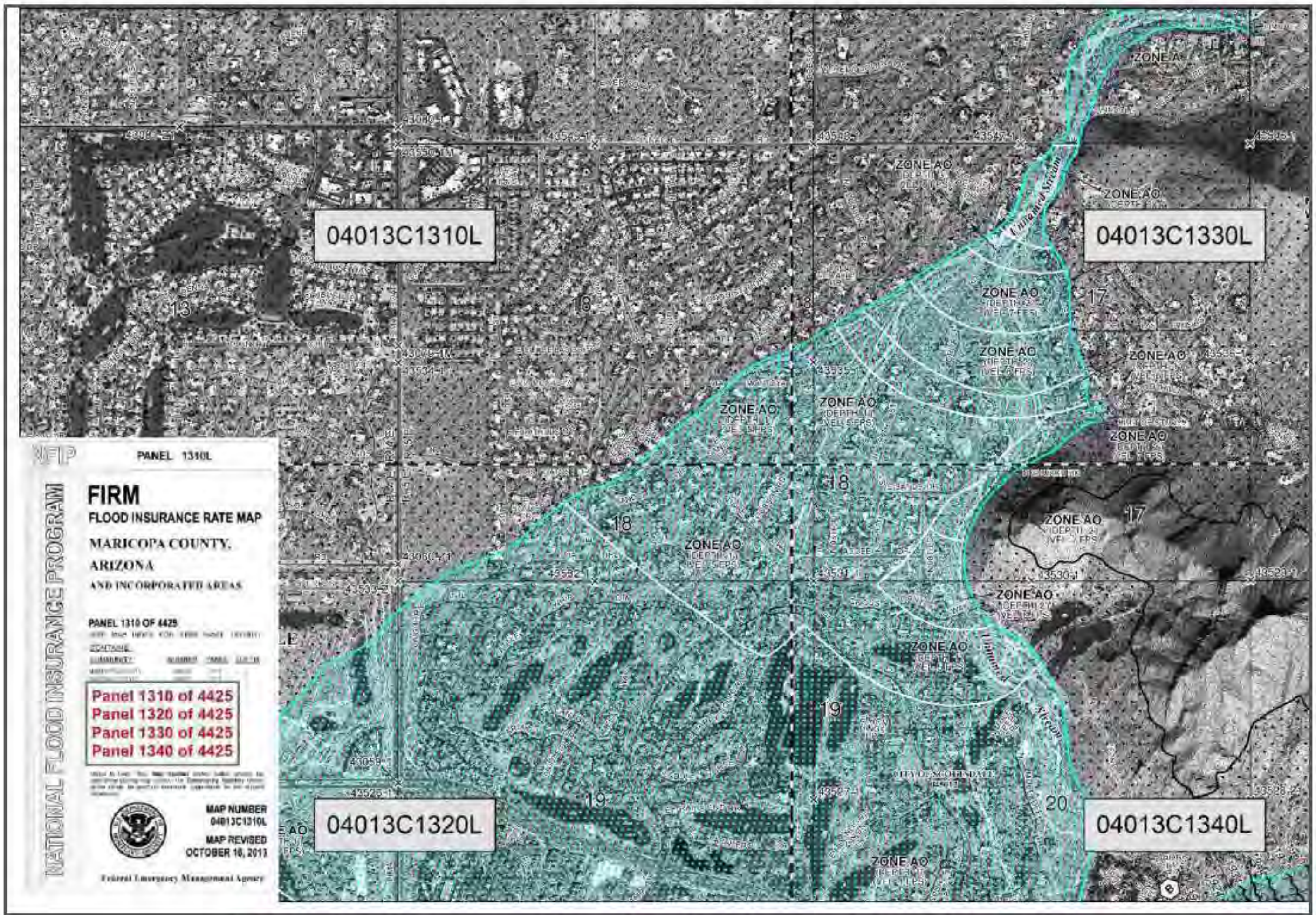


Figure 4–1 Reata Pass Alluvial Fan FEMA Floodplain Map (FIRM)

5. Development History

The development history of the Reata Pass Alluvial Fan was previously reviewed and evaluated by JE Fuller (2010) as part of the Flood Control District of Maricopa County's (FCDMC) revision of their Piedmont Flood Hazard Assessment Manual. The key findings of that study, with respect to the Reata Pass Alluvial Fan included the following:

- Development on the fan began after 1962. Around 1962, unpaved roads were graded in a small part of the fan near the Pima Acres subdivision, but no homes were built. The remainder of the fan was undeveloped or used for cattle grazing.
- Significant development of the fan surface did not begin until the 1990's. At that time, development occurred very rapidly.
- Flood control measures constructed with development included elevation of finished floors (generally applied for large residential lots), and channelization along the Reata Wash corridor.
- Despite the lack of specific engineering measures to address active alluvial fan flooding, no significant damages to structures have been reported since the area was urbanized. However, as discussed

below, there have been no recorded floods that exceeded a 10-year frequency during the period of record since development began in the late 1970's and early 1980's.

The City of Scottsdale and some Homeowners Associations report periodic issues with sediment maintenance at at-grade crossings and undersized culverts.

6. Historical Hydrologic & Flood Data

There are five FCDMC precipitation gages and one streamflow gage located in the vicinity of the Reata Pass Alluvial Fan. These gages include the combined rain and stream gage located at the Pinnacle Peak Road crossing of Reata Wash at the primary hydrographic apex (Table 6–1 and Figure 2–3). The gage near the apex has been in continuous operation since May 2001. The oldest gage in the vicinity was installed in 1989 (Thompson Peak). The largest measured rainfall totals at the FCDMC gages are listed in Table 6–1. The following conclusions can be drawn from the FCDMC gage records:

- Flood Discharge Measurements. No floods in the period since gages were installed near the Reata study area have occurred that were close to a 100-year event.
    - Very few large magnitude, low frequency floods have occurred.
    - No flood flows greater than a 10-year event have occurred on Reata Pass Wash since the gage was installed in 2001.
- Rainfall Measurements. No 100-year rainstorms have been recorded at any gage in the immediate vicinity of the Reata study area since the first gage was installed in 1989. The largest measured rainstorm (October 2003; 44-year event) did not produce a significant flood at the hydrographic apex (34 cubic feet per second; < 2-year event).[9]

There are anecdotal accounts of a significant flood at the hydrographic apex in August 1996 (< 10 yr.), or in years prior to development, although the historical aerial photographs do not indicate that any major avulsions or fan aggradation has occurred in the active portions of the alluvial fan landform during the period of record since 1962.

---

[9] Note that a 100-year rainfall does not necessarily produce a 100-year flood (or a 10-year flood from a 10-year rainfall). The flood magnitude generated by a specific rainstorm is a function of the duration and intensity of the rainstorm, but also by how wet the watershed was prior to the storm (antecedent moisture), recent changes in watershed vegetation due to drought or wildfire, and many other factors.

Table 6–1 Rainfall and Runoff Measurements for Selected Significant Storms near Reata Pass Alluvial Fan

Date of Storm	Reata Wash Stream & Precip (ID:4588/4585) (at primary hydrographic apex) Gages Installed 5/15/2001			Pinnacle Peak Vista Precip (ID: 4595) (mid-piedmont) Gage Installed 4/21/1998		Reata Wash Dam Precip (ID: 4935) (Watershed above primary apex) Gage Installed 8/26/1993		Pima Road Precip (ID: 4590) (Lower piedmont) Gage Installed: 10/22/1997		Thompson Peak Precip (ID: 5945) (Upper watershed of lower tributaries) Gage Installed: 7/27/1989	
	Rainfall Depth (Inches)	Stream Flow (Q in cubic feet per second)	Recurrence Interval (years)[1]	Rainfall Depth (Inches)	Recurrence Interval (years)[1]	Rainfall Depth (Inches)	Recurrence Interval (years)[1]	Rainfall Depth (Inches)	Recurrence Interval (years)[1]	Rainfall Depth (Inches)	Recurrence Interval (years)[1]
9/8/2014	2.24 (6 hour)	1197	19 < 10	1.93 (24 hour)	< 2	2.20 (6 hour)	14	2.32 (6 hour)	25	1.97 (24 hour)	< 2
11/30/2007	1.93 (24 hour)	314	< 2 < 5	2.56 (24 hour)	8	1.77 (24 hour)	< 2	1.81 (24 hour)	< 2	1.54 (24 hour)	< 2
12/07/2007	0.47 (24 hour)	57	< 2 < 2	2.56 (24 hour)	< 2	0.75 (24 hour)	< 2	0.43 (24 hour)	< 2	0.51 (24 hour)	< 2
7/31/2007	0.16 (24 hour)	314	< 2 < 5	0.12 (24 hour)	< 2	1.34 (24 hour)	< 2	1.57 (1 hour)	14	0.00 (24 hour)	< 2
09/03/2006	0.91 (15 minutes)	649	12 5	0.83 (24 hour)	< 2	0.94 (24 hour)	< 2	0.87 (24 hour)	< 2	0.91 (24 hour)	< 2
07/31/2005	1.61 (1 hour)	63	5 < 2	0.75 (24 hour)	< 2	0.39 (24 hour)	< 2	0.31 (24 hour)	< 2	0.51 (24 hour)	< 2
03/05/2004	2.28 (24 hour)	238	4 < 5	1.38 (24 hour)	< 2	1.61 (24 hour)	< 2	0.98 (24 hour)	< 2	1.22 (24 hour)	< 2
10/10/2003	1.26 (24 hour)	34	< 2 < 2	1.89 (1 hour) 2.20 (6 hour)	44 21	0.91 (24 hour)	< 2	1.73 (24 hour)	< 2	1.38 (24 hour)	< 2
08/29/1996	no data	(1,780)	no data	no data	no data	1.54 (1 hour)	10	no data	no data	0.24 (24 hour)	< 2
11/15/1993	no data	no data	no data	no data	no data	2.64 (24 hour)	5	no data	no data	0.67 (24 hour)	< 2
10/6/1993	no data	no data	no data	no data	no data	2.09 (24 hour)	2	no data	no data	1.30 (24 hour)	< 2
8/22/1992	no data	no data	no data	no data	no data	no data	no data	no data	no data	2.76 (6 hour)	55

Notes:

* Recurrence interval is a measure of the frequency of the event measure (e.g., a 100-year flood has recurrence interval of 100 years)

Sources: http://alert.fcd.maricopa.gov/alert

http://alert.fcd.maricopa.gov/alert/Rain/Master/4935.pdf http://alert.fcd.maricopa.gov/alert/Rain/Master/4585.pdf http://alert.fcd.maricopa.gov/alert/Rain/Master/4595.pdf http://alert.fcd.maricopa.gov/alert/Rain/Master/4670.pdf http://alert.fcd.maricopa.gov/alert/Rain/Master/5945.pdf

Notes:
(1) Recurrence interval is a measure of the frequency of the event measure (e.g., a 100-year flood has recurrence interval of 100 years)
Sources: http://alert.fcd.maricopa.gov/alert
http://alert.fcd.maricopa.gov/alert/Rain/Master/4935.pdf
http://alert.fcd.maricopa.gov/alert/Rain/Master/4585.pdf
http://alert.fcd.maricopa.gov/alert/Rain/Master/4595.pdf
http://alert.fcd.maricopa.gov/alert/Rain/Master/4670.pdf
http://alert.fcd.maricopa.gov/alert/Rain/Master/5945.pdf

7. Conclusions

A geomorphic assessment of the Reata Wash Flood Control Improvement Study area was conducted to document existing channel conditions and likely flood and sedimentation problems, and to better understand the geologic features and landforms within the watershed, as well as the geomorphic processes taking place within the channel and overbank areas. The following conclusions are made based on the geomorphic assessment with respect to the Reata Wash Flood Control Improvement Study:

- Most of the Reata Pass Alluvial Fan landform is an ***inactive*** alluvial fan, characterized by relatively stable tributary and distributary flow paths. Flooding on the channels of inactive alluvial fans can be adequately assessed using traditional one- or two-dimensional hydrologic and hydraulic modeling tools such as HEC-RAS and FLO-2D. Given the relatively steep slope of the Reata Pass Alluvial Fan landform, high flow velocities, scour depths, and sediment transport rates should be expected along the main channels during large floods. The inactive portions of the alluvial fan landform will be dominated by erosional processes, although localized sediment deposition may occur near obstructions or constrictions. No part of the Reata Pass Alluvial Fan landform is subject to debris flows or debris flooding.
- The active portion of the Reata Pass Alluvial Fan landform is located in the area between Pinnacle Peak Road and the Deer Valley Road alignment along the Reata Wash corridor, and between Pinnacle Peak Road and Thompson Peak Parkway along the Dobson Wash corridor. Active alluvial fans have the potential to experience channel avulsions (sudden channel relocations) and net sediment deposition (aggradation) during floods and over the long-term. Channels designed in such areas should account for high sediment loads, potential sediment surplus, and changing topographic elevations where sediment is deposited.
- Development has significantly altered the natural runoff patterns on the Reata Pass Alluvial Fan landform, including the potential for flow path uncertainty (aka, alluvial fan flooding) downstream of the Deer Valley Road alignment. The response of the fan landform during the period of urbanization may be used as an indication of the likely response to the proposed Reata Wash Flood Control Improvement Study channelization. That is, the record indicates that this response over most of the Reata Pass Alluvial Fan landform has been relatively mild during a period that lacked large floods, and consisted primarily of street and sediment maintenance issues. The response during a larger, more rare, event like the 100-year flood would likely be more significant, particularly near the hydrographic apex.
- Prior to development, the Reata Wash corridor was characterized primarily by stable and unstable distributary channels, all of which were confined within a relatively narrow area constrained by older, stable, inactive alluvial fan surfaces. Therefore, the type of channelization proposed for RWFCIS (i.e., open channels, full containment of the 100-year flood, natural channel beds) over the inactive portions of the alluvial fan landform will not be substantively different than the natural channelization of the flow corridors by older, topographically higher geomorphic surfaces.

Reata Wash transports large quantities of sediment and up to boulder-sized clasts during large floods. Currently, the channels in the Reata Wash corridor are dominated by erosional, rather than depositional, processes, i.e., it is not an aggrading landform. Therefore, the flood control improvements recommended by the Reata Wash Flood Control Improvement Study should be designed to convey and/or store high volumes of sediment, including cobble-sized sediment clasts.

APPENDIX M

MEMORANDUM: SEDIMENT AND STABLE CHANNEL ASSESSMENT: SEDIMENT TRANSPORT AND LOCAL SCOUR ASSESSMENT

Reata Wash
Flood Control Improvement Study

Contract No. 2014-168-COS

Memorandum: Sediment and Stable Channel Assessment: Sediment Transport and Local Scour Assessment

August 31, 2016

Prepared for:

Capital Project Management
7447 E. Indian School Rd. Suite 205
Scottsdale, AZ. 85251

Prepared By:
JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC
JE Fuller Hydrology & Geomorphology, Inc.
1 West Deer Valley Road, Suite 101
Phoenix, AZ 85027

In Association with:

WOOD/PATEL
MISSION: CLIENT SERVICE™

LOGANSIMPSON

FLOOR
associates

Gannett Fleming

Technical Solutions

gci

Registered Professional Engineer (Civil)
Certificate No.
34141
JON T.
AHERN
Date Signed 8/31/2016
ARIZONA, U.S.A.
EXPIRES: 9-30-17

Table of Contents

Section

List of Figures

List of Tables

List of Appendices

Registered Professional Engineer (Civil)
CERTIFICATE NO.
34141
JON T.
AHERN
Date Signed 8/31/2016
ARIZONA, U. S. A.

EXPIRES: 9-30-17

1. Executive Summary

The Reata Wash Flood Control Improvement Study includes a sediment documentation review that discusses historical sediment transport modeling assumptions and methodology and provides recommendations for existing/design conditions sediment modeling within the Reata Wash corridor. Scour depths were also estimated along the Reata Wash Corridor. The purposes of this assessment were to evaluate the potential for sediment degradation or erosion and to incorporate the results into the evaluation of the existing bank protection, grade controls and bridge structures along the corridor. Assessment of the suitability of the existing bank protection was documented in the "Memorandum: Existing Condition Hydraulic Capacity" prepared by Wood, Patel & Associates, Inc. The engineering standards used for this analysis are consistent with those outlined in Chapter 11: Sedimentation, within Flood Control District of Maricopa County (FCDMC), Drainage Design Manual (DDM), Hydraulics 2013.

2. Overview

This memorandum documents the findings of the with-project sediment transport analysis and the local scour and erosion assessment at critical locations in support of the City of Scottsdale's (City) Reata Wash Flood Control Improvement Study. The assessment was performed by staff from JE Fuller/Hydrology & Geomorphology, Inc. (JE Fuller), as a subconsultant to Wood, Patel & Associates, Inc. (WPA). The assessment includes:

- Preparation of a with-project sediment transport model assuming full implementation of a build alternative. The sediment transport analysis will be performed utilizing a series of storm events. The intent of the analysis is to examine long-term trends of scour and deposition as well as to make an estimate of sediment delivery to the Reach 11 Dike 4 West Basin assuming implementation of improvements.
- Local scour and erosion was evaluated along the Reata Wash corridor at critical locations as determined by the project team (e.g. crossings, levees, grade control structures, channel inflow locations, etc.), assuming implementation of a build alternative.

FCDMC Standards and methodologies will be utilized for sedimentation transport modeling and scour analysis as outlined in Chapter 11: Sedimentation, within FCDMC DDM Hydraulics 2013.

3. Study Area

The Reata Wash Flood Control Improvement Study is located within the city limits of Scottsdale, Arizona along the western flank of the McDowell Mountains, and northeast of the Loop 101 Freeway and the Central Arizona Project (CAP) Canal (see Figure 3–1).

Figure 3–1 General Study Area Location

4. Sediment Transport Methodology

The sediment transport methodology used for the Reata Wash Flood Control Improvement Study was based on the following types of information, modeling assumptions, and data input, as described in the following paragraphs:

- Hydrology
- Hydraulic Cross Sections
- Non-Conveyance Areas
- Roughness Estimates
- Sediment Transport Parameters
- Grain Size Distributions
- Flow Regime Considerations

The sediment transport modeling was performed using the HEC-6T computer model.

4.1 Hydrology

Inflow flow rates used in the sediment transport model were based on the hydrology data prepared of the Reata Wash Flood Control Improvement Study. The modeled response to a sequence of 50 consecutive individual storms ranging from 2-year to 100-year events[1] were used to approximate the long-term bed changes[2] along the Reata Wash corridor. The sequence of events was randomly constructed, and the number of each recurrence interval event to be included was determined based on the probability of each event.

Each hydrograph and sequence included in the HEC-6T model is depicted in Figure 4–1. Additional data on the long-term flood series and the resulting channel response is included in Appendix A.

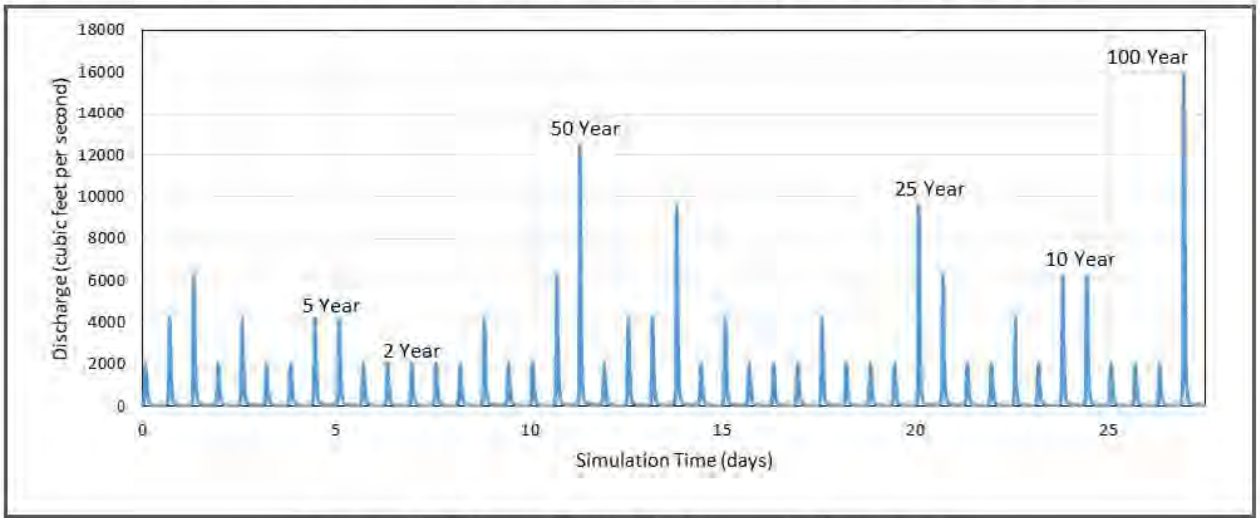


Figure 4–1 Long Term Hydrograph Sequence

---

[1] Event refers to the common hydrologic storm in both the frequency and the duration. For analysis purposes the frequency is called out as 2-year, 5-year up to 100-year and the durations is consistently set as 24-hour.

[2] Bed changes refers to the bottom of the channel cross section either lowering due to degradation or rising due to deposition during the model simulation time interval.

4.2 Hydraulic Cross Sections

The HEC-6T model computes hydraulic conditions, e.g. depth, velocity, top width, etc., at each hydraulic cross section coded into the model. A single hydraulic cross section describes the ground surface geometry at a line drawn across the wash corridor. Hydraulic cross sections located at intervals along the Reata Wash corridor describe variation in channel geometry and slope. This information can be used to characterize the flow carrying capability of the wash. To evaluate the Reata Wash corridor, a base hydraulic model was developed from the concept-level HEC-RAS model (dated November 19, 2015) created by WPA for the Reata Wash Flood Control Improvement Study. The HEC-RAS model included hydraulic cross section geometry that reflected the preferred study level concept improvements along the Reata Wash corridor. The model included a total of 306 hydraulic cross sections spanning a total distance of approximately 5.5 miles, from Reach 11 Dike 4 West Basin north to a point 1,600 feet north of Pinnacle Peak Road (see Figure 4–2). The average distance between hydraulic cross sections was approximately 100 feet. Prior to importing the HEC-RAS hydraulic cross section data into the HEC-6T model, hydraulic cross section stations were rounded to the nearest significant digit and non-conveyance[3] areas were eliminated from the hydraulic cross section geometry.

---

[3] Non conveyance areas or "ineffective areas" within the hydraulic cross section where the velocity is assumed to be zero. Such areas do not transport sediment, and therefore are commonly coded out of the model input.

Figure 4–2 Hydraulic Cross Sections and Reach Overview

The HEC-RAS cross sections used represented the build alternative channel configuration. HEC-RAS model data and cross-section geometry are provided in Appendix B.

Table 4–1 General Channel Configuration Notes

Hydraulic Cross Section Identification #	Channel Configuration Notes
30600 - 30200	Natural channel
30100 - 29211	Natural channel including minor adjustments to contain design flood event.
29168 - 21300	Lined constructed channel or various configuration
21200 - 5982	Natural channel including minor adjustments to contain design flood event.
5900 - 1600	Constructed trapezoidal channel with protected banks

4.3 Non Conveyance Areas (Ineffective Flow)

Non-Conveyance Areas (Ineffective Flow) located within the Reata Wash corridor modeling using HEC-6T were eliminated from the input code. HEC-6T does not compute sediment transport ineffective flow areas or for portions of the cross section outside of the channel bank stations. The ineffective flow areas defined in the HEC-6T model are consistent with the corresponding HEC-RAS model and channel geometry.

4.4 Hydraulic Structures

The following four major hydraulic conveyance structures are located in the Reata Wash Flood Control Improvement Study reach:

- Box culvert at Pinnacle Peak Road
- Bridge structure at Thompson Peak Parkway
- Bridge structure at Legacy Boulevard
- Parallel bridges at Bell Road

In addition, there are number of existing grade control structures along the Reata Wash Flood Control Improvement Study corridor. The HEC-6T model does not have the capability to explicitly model hydraulic structures. Therefore, HEC-RAS model coding for these four structures was converted to regular channel cross sections that reflect the channel geometry of the culvert or bridge opening. Then, the hydraulic results from HEC-RAS (including the structure) were compared to a fixed-bed HEC-6T analysis (discussed in Section 4.9) to assure that the HEC-6T channel geometry was adequately simulating the hydraulic conditions as modelled in HEC-RAS. The HEC-6T channel geometry was adjusted as needed (e.g., roughness, ineffective flow limits, channel bottom elevation) to assure that the velocity profile that agreed with the HEC-RAS results.

4.5 Roughness Estimation

The initial Manning's roughness coefficients (n-value) used in the HEC-6T model were taken directly from the HEC-RAS build alternative hydraulic model prepared by WPA. Table 4–2 below lists the n-values used for the build alternative analysis. The values shown below served as a starting point for the initial model runs. However, n-values at some cross sections were adjusted during fixed-bed hydraulic calibration process.

Table 4–2 Manning's n-values

Hydraulic Cross Section Identification #	n-values		
	Left Overbank (East)	Main Channel	Right Overbank (West)
30600 - 30200	0.050	0.040	0.050
30100 - 29400	0.050	0.048	0.050
29300	0.050	0.049	0.050
29250	0.05	0.016	0.05
29211	0.05	0.035	0.05
29168	0.05	0.016	0.05
29150	0.05	0.048	0.05
29100 - 27900	0.05	0.018	0.05
27800 - 21300	0.05	0.048	0.05
21200 - 18500	0.05	0.035	0.05
18400 - 18345	0.04	0.035	0.04
18300 - 11582	0.045	0.040	0.045
11567	0.04	0.035	0.04
11562 - 11540	0.015	0.015	0.015
11492 - 11000	0.04	0.035	0.04
10900 - 8900	0.045	0.040	0.045
8800 - 8033	0.04	0.035	0.04
7900 - 6700	0.045	0.04	0.045
6600 - 6025	0.04	0.035	0.04
5982 – 5900	0.04	0.03	0.04
5800 - 1600	0.04	0.035	0.04

4.6 Sediment Transport Parameters

HEC-6T sediment transport modeling was performed using the Yang excess stream power sediment transport equation. The Yang Equation was developed for sands and gravels, and it has been shown to adequately approximate sediment transport in alluvial systems in Arizona. In addition, the default HEC-6T cross section smoothing command was disabled, and the movable bed limits (the part of the cross section in which sediment can be moved) was defined for each cross section based on field data. For most cross section, the movable bed limit was set equal to the cross section bank stations. A maximum allowable scour depth of 10 feet[4] was also defined for each cross section. For cross sections with non-erodible beds, e.g., roadway dip crossings, grade controls, and lined channel segments, the maximum allowable scour depth was set to zero.

Sediment inflow data were incorporated in to the HEC-6T model using historic model data prepared as part of the sediment transport modeling prepared by Greiner, Inc. for the Scottsdale Desert Greenbelt Phase One Design, as described in the Reata Pass Wash Supplemental Conditional Letter of Map Revision (CLOMR), June 1, 1996. Upstream sediment data, as well as local inflow for North and South Beardsley Washes were also used in the HEC-6T modeling. Sediment input data are included in Appendix A.

4.7 Grain Size Distribution

Five reaches with distinct sediment grain size differences were identified within the Reata Wash Flood Control Improvement Study reach, based on sediment samples from historical studies. Sediment input data and gradation curves are included in Appendix A. See Figure 4–3 for the five sediment reach locations.

---

[4] Erodible limit set to 10 feet to assure initial model stability. Erodibility limits were adjusted as needed for subsequent model runs.

Figure 4–3 Sediment Grain Size Reaches Used in the HEC-6T Models

4.8 Flow Regime Considerations

Hydraulic modeling of Reata Wash indicated the presence of mixed flow regimes[5], and that much of the study reach is dominated by supercritical flow[6] due to the steep channel slopes. While HEC-6T does not compute supercritical flow profiles by default, the model is capable of correcting velocity for supercritical conditions when necessary. Because of the steep channel slopes and indications of supercritical velocities observed in the initial model runs, the option available in HEC-6T to correct for supercritical flow was used. The option includes a toggle that enables the model to adjust the velocity and normal depth when supercritical conditions are detected. When this toggle is switched to the 'OFF' position only subcritical flow data[7] are used in the sediment computations.

4.9 HEC-6T Model Results

4.9.1 Calibration model

The HEC-6T model was calibrated and/or verified using several steps. First, the HEC-RAS interface was used to fine-tune the model geometry before conversion to the HEC-6T format. Second, verification of hydraulic results was performed by comparing HEC-RAS subcritical and mixed flow output with HEC-6T output. To facilitate this comparison, HEC-6T modeling were generated for the no-bed-change condition (no scour and no deposition) for comparison with the (fixed-bed) HEC-RAS model output. The comparison was made for the zero sediment inflow condition and subcritical flow regimes, as well as a separate comparison for mixed flow regime results. The verification comparison was made for a range of steady state discharges (4,000 cubic feet per second (cfs), 8,000 cfs, 12,000 cfs, and 15,618 cfs) for both models. Key hydraulic parameters relevant to sediment transport (e.g., velocity, depth) were compared. Depth was calculated as the difference between the water surface elevation and the minimum channel elevation. An iterative process was performed to ensure that abrupt changes in velocity were minimized. This was accomplished by adjusting channel Manning's n-values, ineffective flow boundaries, cross section elevations, and removing select cross sections. Several cross sections were removed from the model at Legacy Boulevard and upstream of Bell Road as these locations were shown to produce significant model instability.

4.9.2 Build Alternative Concept Improvements Model

A long-term simulation was performed to assess the potential for scour and deposition within the Reata Wash corridor over 50 years, as opposed to the channel response during a single flood. The results of the analysis were used to estimate long-term scour along Reata Wash. The build alternative concept improvements model run simulates the concept condition of Reata Wash, including the full containment at all cross sections and inflow changes at confluence locations with North and South Beardsley wash.

Tables in Appendix B include the results of the long term assessment. The HEC-6T model results indicate that the Reata Wash corridor is largely degradation, with notable scour zones observed above Bell Road and at the transition between the build alternative concept improvements lined channel section and natural channel near cross section 21300.

---

[5] A mixed flow regime is one where a stream has reaches of subcritical and reaches of supercritical flow.

[6] Supercritical flow is characterized by high velocities, steep channel slopes, turbulent water, and high rates of sediment transport and scour.

[7] Subcritical flow is characterized by lower velocities, less steep channel slopes, less turbulent water, and generally lower rates of sediment transport and scour.

5. Scour Components

The estimation of total scour to assess the bank protection toe-down depths incorporates long term scour/sediment transport, short term general scour, bend scour, anti-dune, low flow and other local scour components at bridges, grade controls and other hydraulic structures within the Reata Wash corridor.

5.1 General Scour

General scour components are based on the Lacey Equation with a modifier of 0.25. General scour was calculated using guidance in the US Bureau of Reclamation report "Computing Degradation and Local Scour." Due to the lack of stagnant impoundment, live-bed scour conditions were assumed and the Lacey equation used to calculate the general scour depth. The Lacey equation is empirically based and incorporates median bed sediment size, design discharge, and a curvature factor to determine the general scour depth.

5.2 Bend Scour

Bend scour components are based on using the Lacey Equation with a modifier of 0.5. Note that the general scour component is not included when bend scour components are applied. The bend scour component is only applied to the outside of a channel bend.

5.3 Bedform

Bedform scour was calculated based upon the methodology presented in the FCDMC DDM Hydraulics 2013. Variables for the calculations were derived from the project HEC-RAS model run under "mixed-flow" conditions. These variables included Froude number, channel velocity, and channel hydraulic depth. The generally low flow velocities and Froude numbers caused dune, rather than anti-dune, scour conditions to dominate through the project area. Bedform scour depths were generally less than 1 foot, but as high as 2.5 feet at some cross sections.

5.4 Low-flow

Low-flow channel incisement was estimate using the results of a qualitative geomorphic analysis as described in Section 5.2 of the Arizona Department of Water Resources, Design Manual for Engineering Analysis of Fluvial Systems, 1985. Preliminary values of 1 feet of low flow incisement were used for existing channel segments in the upper reaches where channel modification is considered minimal (upstream of Bell Road) and 2 feet below Bell Road where significant modifications will be needed to contain the existing flows.

5.5 Local Scour

Local scour component occurs at hydraulic structures. Estimates of local scour were based on methods outlined in the U.S. Army Corps of Engineers HEC-18 Manual for contraction, pier and abutment scour. Local scour at drop structures was estimated using FCDMC guidelines and the Schoklitsch Equation.

- HEC-18 local scour components are reported for Thompson Peak Parkway and Bell Road.
- Drop scour components are reported for existing grade control/structure and downstream of Legacy Boulevard and Pinnacle Peak Road.

5.6 Reach Definitions

The HEC-6T and scour computation results are reported by reaches, as well as at individual cross sections. Reaches were initially defined between existing structures (e.g., grade controls, bridges/culvert, at-grade crossings etc.), and then were further refined using a table of hydraulic modeling parameters such as channel flow capacity, channel top width, velocity, depth, etc., and grouping hydraulic cross sections into reaches of similar hydraulic properties. Scour components were then averaged within each reach for general and bed-form scour. All other scour components were applied at each cross section. See Figure 4–2 for a depiction of the reaches defined for the Reata Wash Flood Control Improvement Study.

6. Total Scour Depths

Total scour depth was computed as the sum of all scour components multiplied by a safety factor, following the practice outlined in the FCDMC Hydraulic Design Manual. The total scour depth estimated along the Reata Corridor ranged from 4.3 feet to 16.4 feet. Using a safety factor of 1.3, the toe-down of the bank protection would extend from 5.6 feet to 21.4 feet below the minimum channel elevation.

Total Scour (Zt) is determined by the following equation;

$$Z_t = FS\left(Z_{Long-term} + Z_{general} + Z_{bend} + Z_{bedform} + Z_{low-flow}\right) + \quad {}^{*}FS_{local}Z_{local}$$

where:

FS = the factor of safety (safety factor) for the long-term, general, bend, bedform, and low-flow incisement scour components, and

FS_{local} = the factor of safety for local scour such as pier scour, downstream scour for drop structure/grade control structures and other local scour components.

Total scour depths, not including local scour at hydraulic structures, are reported in Table 6–1 at each hydraulic cross section within the Reata Wash Flood Control Improvement Study corridor. The total scour estimates are used to assess the adequacy of the existing bank protection along the corridor.

Table 6–1 Total Scour Summary Table

(1)Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth (feet)	General Scour Depth (feet)	(2)Bend Scour Depth		Bedform Scour Depth (feet)	Low Flow Depth (feet)	Factor of Safety	Total Scour Depth	
				East Side (feet)	West Side (feet)				East Side (feet)	West Side (feet)
21200	7	9.19	2.65	4.14	0	1.45	1	1.3	20.51	18.57
21100	7	9.85	2.65	4.14	0	1.45	1	1.3	21.38	19.44
21000	7	6.59	2.65	4.14	0	1.45	1	1.3	17.14	15.2
20900	7	5.33	2.65	4.14	0	1.45	1	1.3	15.5	13.56
20800	7	3.47	2.65	0	0	1.45	1	1.3	11.14	11.14
20700	7	4.34	2.65	0	0	1.45	1	1.3	12.27	12.27
20600	7	3.37	2.65	0	0	1.45	1	1.3	11.01	11.01
20500	7	2.41	2.65	0	0	1.45	1	1.3	9.77	9.77
20400	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
20300	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
20200	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
20100	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
20000	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19900	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19800	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19700	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19600	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19500	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19400	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19300	7	0.57	2.65	4.15	0	1.45	1	1.3	9.32	7.37
19200	7	0.48	2.65	0	0	1.45	1	1.3	7.25	7.25
19100	7	0.48	2.65	0	0	1.45	1	1.3	7.25	7.25

Table 6–1 Total Scour Summary Table

(1)Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	(2)Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
19000	8	0.48	2.31	0	0	1.42	1	1.3	6.77	6.77
18900	8	0.48	2.31	0	0	1.42	1	1.3	6.77	6.77
18800	8	0.48	2.31	0	0	1.42	1	1.3	6.77	6.77
18700	8	0.48	2.31	0	0	1.42	1	1.3	6.77	6.77
18600	9	0.48	2.31	0	0	1.2	1	1.3	6.48	6.48
18500	9	0.48	2.31	0	0	1.2	1	1.3	6.48	6.48
18400	9	0.48	2.31	0	0	1.2	1	1.3	6.48	6.48
18345	9	0.48	2.31	0	0	1.2	1	1.3	6.48	6.48
18322	9	Thompson	Peak	Parkway						
18300	9	0.48	2.31	0	0	1.2	1	1.3	6.48	6.48
18200	10	0	2.32	0	0	1.31	1	1.3	6.02	6.02
18100	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
18000	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17900	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17800	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17700	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17600	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17500	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17400	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17300	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17200	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17100	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
17000	10	1.75	2.32	0	0	1.31	1	1.3	8.3	8.3
16900	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16800	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22

Table 6–1 Total Scour Summary Table

[1]Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	[2]Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
16700	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16600	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16500	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16400	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16300	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16200	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16100	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
16000	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
15900	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
15800	10	0.15	2.32	0	0	1.31	1	1.3	6.22	6.22
15700	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
15600	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
15500	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
15400	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
15300	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
15200	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
15100	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
14965.2	11	0.27	2.33	0	0	0.98	1	1.3	5.95	5.95
14900	11	0.79	2.33	0	0	0.98	1	1.3	6.63	6.63
14800	11	0.79	2.33	0	0	0.98	1	1.3	6.63	6.63
14700	11	0.79	2.33	0	0	0.98	1	1.3	6.63	6.63
14600	12	0.79	2.32	0	0	1.02	1	1.3	6.66	6.66
14500	12	0.79	2.32	0	0	1.02	1	1.3	6.66	6.66
14400	12	0.79	2.32	0	0	1.02	1	1.3	6.66	6.66
14300	12	0.79	2.32	0	0	1.02	1	1.3	6.66	6.66

Table 6–1 Total Scour Summary Table

(1)Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	(2)Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
14200	12	0.79	2.32	0	0	1.02	1	1.3	6.66	6.66
14100	12	0.79	2.32	0	3.25	1.02	1	1.3	6.66	7.87
14000	12	0.79	2.32	0	3.25	1.02	1	1.3	6.66	7.87
13900	12	0.79	2.32	0	3.25	1.02	1	1.3	6.66	7.87
13835.1	12	0.79	2.32	0	3.25	1.02	1	1.3	6.66	7.87
13700	12	2.24	2.32	0	3.25	1.02	1	1.3	8.55	9.76
13600	12	2.24	2.32	0	3.25	1.02	1	1.3	8.55	9.76
13500	12	2.24	2.32	0	3.25	1.02	1	1.3	8.55	9.76
13400	12	2.24	2.32	0	3.25	1.02	1	1.3	8.55	9.76
13300	12	2.24	2.32	0	3.25	1.02	1	1.3	8.55	9.76
13200	12	2.24	2.32	0	3.25	1.02	1	1.3	8.55	9.76
13100	13	2.24	2.4	0	3.25	1.73	1	1.3	9.59	10.69
13000	13	2.24	2.4	0	3.25	1.73	1	1.3	9.59	10.69
12900	13	2.24	2.4	0	0	1.73	1	1.3	9.59	9.59
12800	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
12700	13	0.06	2.4	0	0	1.73	1	1.3	6.75	6.75
12600	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
12545.2	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
12400	13	0.1	2.4	0	0	1.73	1	1.3	6.8	6.8
12289.2	13	0.1	2.4	0	0	1.73	1	1.3	6.8	6.8
12200	13	1.56	2.4	0	0	1.73	1	1.3	8.7	8.7
12100	13	0.88	2.4	0	0	1.73	1	1.3	7.81	7.81
12033.1	13	0.88	2.4	0	0	1.73	1	1.3	7.81	7.81
11900	13	0.63	2.4	0	0	1.73	1	1.3	7.49	7.49
11777	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67

Table 6–1 Total Scour Summary Table

[1]Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	[2]Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
11665.3	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11614.7	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11600.4	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11582	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11567.5	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11562	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11545.5	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11540	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11516.1	13	Legacy Boulevard								
11492.3	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11376.9	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11316.7	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11271.2	13	0	2.4	0	0	1.73	1	1.3	6.67	6.67
11130.6	14	2.56	2.8	0	0	1.37	1	1.3	10.05	10.05
11000	14	2.56	2.8	0	0	1.37	1	1.3	10.05	10.05
10900	14	2.56	2.8	0	0	1.37	1	1.3	10.05	10.05
10800	14	2.56	2.8	0	0	1.37	1	1.3	10.05	10.05
10700	14	2.56	2.8	0	0	1.37	1	1.3	10.05	10.05
10600	14	0.53	2.8	0	0	1.37	1	1.3	7.42	7.42
10500	14	0.53	2.8	0	0	1.37	1	1.3	7.42	7.42
10400	14	0.53	2.8	0	0	1.37	1	1.3	7.42	7.42
10300	14	0.53	2.8	0	0	1.37	1	1.3	7.42	7.42
10200	14	0.53	2.8	0	0	1.37	1	1.3	7.42	7.42
10100	15	0.54	2.8	0	0	1.65	1	1.3	7.79	7.79
10000	15	0.54	2.8	0	0	1.65	1	1.3	7.79	7.79

Table 6–1 Total Scour Summary Table

(1)Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	(2)Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
9900	15	0.54	2.8	0	0	1.65	1	1.3	7.79	7.79
9800	15	2.17	2.8	0	0	1.65	1	1.3	9.91	9.91
9700	15	2.17	2.8	0	0	1.65	1	1.3	9.91	9.91
9600	16	2.17	2.34	0	0	1.1	1	1.3	8.6	8.6
9500	16	2.17	2.34	0	0	1.1	1	1.3	8.6	8.6
9400	16	2.17	2.34	0	0	1.1	1	1.3	8.6	8.6
9300	16	2.17	2.34	0	0	1.1	1	1.3	8.6	8.6
9200	16	2.17	2.34	0	0	1.1	1	1.3	8.6	8.6
9100	16	2.17	2.34	0	0	1.1	1	1.3	8.6	8.6
9000	16	2.17	2.34	0	0	1.1	1	1.3	8.6	8.6
8900	16	2.17	2.8	0	0	1.28	1	1.3	9.42	9.42
8800	17	1.32	2.8	0	0	1.27	1	1.3	8.32	8.32
8700	17	1.32	2.8	0	0	1.27	1	1.3	8.32	8.32
8600	17	1.32	2.8	0	0	1.27	1	1.3	8.32	8.32
8500	17	1.32	2.8	0	0	1.27	1	1.3	8.32	8.32
8364.13	17	1.32	2.8	0	0	1.27	1	1.3	8.32	8.32
8300	17	2.58	2.8	0	0	1.27	1	1.3	9.95	9.95
8200	17	2.58	2.8	0	4.15	1.27	1	1.3	9.95	11.7
8100	17	2.58	2.8	0	4.15	1.27	1	1.3	9.95	11.7
8032.6	17	2.58	2.8	0	4.15	1.27	1	1.3	9.95	11.7
7900	18	2.62	2.82	0	4.15	1.54	1	1.3	10.38	12.11
7800	18	2.62	2.82	0	4.15	1.54	1	1.3	10.38	12.11
7700	18	0	2.82	0	4.15	1.54	1	1.3	6.97	8.7
7600	18	1.76	2.82	0	4.15	1.54	1	1.3	9.26	10.98
7500	18	1.76	2.82	0	4.15	1.54	1	1.3	9.26	10.98

Table 6–1 Total Scour Summary Table

(1)Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	(2)Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
7361.78	18	1.76	2.82	0	4.15	1.54	1	1.3	9.26	10.98
7300	18	1.96	2.82	0	4.15	1.54	1	1.3	9.51	11.24
7200	18	1.96	2.82	0	4.15	1.54	1	1.3	9.51	11.24
7100	18	0	2.82	0	4.15	1.54	1	1.3	6.97	8.7
7000	18	5.87	2.82	0	4.15	1.54	1	1.3	14.6	16.33
6900	18	5.87	2.82	0	4.15	1.54	1	1.3	14.6	16.33
6800	18	5.87	2.82	0	0	1.54	1	1.3	14.6	14.6
6700	18	5.87	2.82	0	0	1.54	1	1.3	14.6	14.6
6600	18	5.87	2.82	0	0	1.54	1	1.3	14.6	14.6
6500	19	0	2.38	0	0	1.83	1	1.3	6.77	6.77
6400	19	5.38	2.38	0	0	1.83	1	1.3	13.76	13.76
6300	19	5.38	2.38	3.43	0	1.83	1	1.3	15.13	13.76
6200	19	5.38	2.38	3.43	0	1.83	1	1.3	15.13	13.76
6126.11	19	5.38	2.38	3.43	0	1.83	1	1.3	15.13	13.76
6084.06	19	5.38	2.38	3.43	0	1.83	1	1.3	15.13	13.76
6060	19	Bell Road								
6041.11	19	5.38	2.38	3.43	0	1.83	1	1.3	15.13	13.76
6024.98	19	5.38	2.38	3.43	0	1.83	1	1.3	15.13	13.76
6000	19	Bell Road								
5981.62	19	5.38	2.38	3.43	0	1.83	2	1.3	16.43	15.06
5900	19	1.79	2.38	3.43	0	1.83	2	1.3	11.76	10.4
5800	19	1.79	2.38	3.43	0	1.83	2	1.3	11.76	10.4
5700	19	1.79	2.38	3.43	0	1.83	2	1.3	11.76	10.4
5600	19	1.79	2.38	0	0	1.83	2	1.3	10.4	10.4
5500	19	1.79	2.38	0	0	1.83	2	1.3	10.4	10.4

Table 6–1 Total Scour Summary Table

(1)Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	(2)Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
5400	19	1.79	2.38	0	0	1.83	2	1.3	10.4	10.4
5300	19	1.79	2.38	0	0	1.83	2	1.3	10.4	10.4
5200	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
5100	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
5000	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4900	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4800	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4700	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4600	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4500	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4400	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4300	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4200	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4100	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
4000	19	0.34	2.38	0	0	1.83	2	1.3	8.51	8.51
3900	19	0.34	2.38	0	3.43	1.83	2	1.3	8.51	9.88
3800	19	0.34	2.38	0	3.43	1.83	2	1.3	8.51	9.88
3700	19	0.34	2.38	0	3.43	1.83	2	1.3	8.51	9.88
3600	19	0.34	2.38	0	3.43	1.83	2	1.3	8.51	9.88
3500	19	0.34	2.38	0	3.43	1.83	2	1.3	8.51	9.88
3400	19	0.34	2.38	0	3.43	1.83	2	1.3	8.51	9.88
3300	20	0.08	2.34	0	3.43	0.76	2	1.3	6.73	8.15
3200	20	0.08	2.34	0	3.43	0.76	2	1.3	6.73	8.15
3100	20	0.08	2.34	0	3.43	0.76	2	1.3	6.73	8.15
3000	21	0.72	2.34	0	3.43	2.52	2	1.3	9.85	11.27

Table 6–1 Total Scour Summary Table

[1]Hydraulic Cross Section Identification #	Reach	Long-Term Scour Depth	General Scour Depth	[2]Bend Scour Depth		Bedform Scour Depth	Low Flow Depth	Factor of Safety	Total Scour Depth	
				East Side	West Side				East Side	West Side
		(feet)	(feet)	(feet)	(feet)	(feet)	(feet)		(feet)	(feet)
2900	21	0.72	2.34	0	3.43	2.52	2	1.3	9.85	11.27
2800	21	0.72	2.34	0	3.43	2.52	2	1.3	9.85	11.27
2700	21	0.72	2.34	0	3.43	2.52	2	1.3	9.85	11.27
2600	21	0.72	2.34	0	3.43	2.52	2	1.3	9.85	11.27
2500	22	0	2.34	0	3.43	1.1	2	1.3	7.08	8.49
2400	22	0	2.34	0	3.43	1.1	2	1.3	7.08	8.49
2300	22	0	2.34	0	3.43	1.1	2	1.3	7.08	8.49
2200	22	0	2.34	0	3.43	1.1	2	1.3	7.08	8.49
2100	22	0	2.34	0	0	1.1	2	1.3	7.08	7.08
2000	22	0	2.34	0	0	1.1	2	1.3	7.08	7.08
1900	22	0	2.34	0	0	1.1	2	1.3	7.08	7.08
1800	22	0	2.34	0	0	1.1	2	1.3	7.08	7.08
1700	22	0	2.34	0	0	1.1	2	1.3	7.08	7.08
1600	22	0	2.34	0	0	1.1	2	1.3	7.08	7.08

Notes:
(1) HEC-RAS cross section from November 11, 2015. HEC-RAS cross sections incorporated in the HEC-6T model.
(2) The higher of the bend scour or general scour included in the total scour depth.

Local scour was assessed at bridge, culverts and grade control structures as noted in Section 5.5. See Table 6–2 and 6-3.

Table 6–2 Local Scour at Grade Control and Channel Drops

(1)Hydraulic Cross Section Identification #	Adjacent Hydraulic Cross Section	Reach	Scour Component Depth	(2) Length of Scour Hole	Notes
			(feet)	(feet)	
18200	18100	10	NA	NA	Existing Grade Control
14965.19	14900	11	1.73	21	Existing Grade Control
13835.07	13700	12	3.01	36	Existing Grade Control
12800	12700	13	1.60	19	Existing Grade Control
12545.24	12400	13	1.08	13	Existing Grade Control
12289.17	12200	13	6.01	72	Existing Grade Control
12033.11	11900	13	3.99	48	Existing Grade Control
11777	11665.28	13	5.92	71	Existing Grade Control
11492.27	11376.89	13	3.16	38	Legacy Boulevard Bridge
8364.13	8300	17	8.99	108	Existing Grade Control
8032.6	7900	17	8.18	98	Existing Grade Control
7700	7600	18	6.22	75	Existing Grade Control
7361.78	7300	18	5.96	72	Existing Grade Control
7100	7000	18	11.25	135	Existing Grade Control
6500	6400	19	16.24	195	Existing Grade Control

Notes:
(1) HEC-RAS cross section from November 11, 2015. HEC-RAS cross sections incorporated in the HEC-6T model.
(2) Drop Scour determined using Schoklitsch Equation.

Table 6–3 Local Scour at Bridges

Structure	(1)Pier Scour Depth	(2)Abutment Scour Depth	(3)Contraction Scour Depth	Bend Scour Depth at Structure	Notes
	(feet)	(feet)	(feet)	(feet)	
Bell Road	10.4	Nee Note	0/0/0	8.6	Applied bend scour modifier of 1.25 to Lacey equation for upstream abutment protection Pier scour does not influence depth of bank protection
Legacy Boulevard	0	0	0	0	Existing Abutments and Piers protected by concrete floor
Thompson Peak Parkway	15	0	1/0/1	0	Pier scour does not influence depth of bank protection

Notes:
(1) Pier Scour using HEC18 Pier Scour Equation
(2) Abutment Scour per HEC18
(3) Contraction Scour Checked for Left/Channel/Right

7. Conclusion

Based on recommendations presented in the Sediment and Stable Channel Assessment: Review of Historic Documentation Memorandum, a concept level sediment transport model was prepared to estimate the long term channel response of the build alternative concept improvements for the Reata Corridor. The following observations are presented based on the concept level sediment transport modeling and scour evaluation results;

- Scour depths appear reasonable for a relatively well-defined ephemeral wash, with a braided or distributary channel system.
- The build alternative channel will like remain in a sediment deficit condition throughout its length, therefore FEMA should have no concerns about overtopping due to deposition.
- Existing bridge structures at Bell Road, Legacy Boulevard and Thompson Peak Parkway pass the 100-year design flows pass the 100 Year Base Flood Peak Discharge. Adequacy of the existing bank protection was addressed by WPA under separate cover.
- No assessment of sediment leaving the system was conducted for the potential Dobson Wash flow release. Effects of sediment leaving the system are likely and will need to be evaluated.

Given the above conclusions and observations, it is recommended that a detailed sediment transport and scour evaluation be conducted if study progresses to full design. FCDMC standards and methodologies should continue to be followed for sedimentation and scour analysis.

Appendix A Back up data

Hydrologic Data for HEC-6T model

Sediment Data

Scour Summary Sheets

HEC-6T Maximum Bed Elevation Change Summary

General Scour – Lacey

Bend Scour – Lacey

Bend Scour Curve Data

Bedform Scour

Sediment Sample Reaches

Local Scour at Channel Drops

Local Scour at Structures (Hydraulic Design Data from HEC-RAS)

Bell Road

Thompson Peak Parkway

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion Q-Record (Water discharge entering the model)		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Field 1	Field 2	Field 3
66	48	39	0	0	2-year	18	9	39
108	64	53	0.025	0.6		44	11	53
758	436	161	0.05	1.2		322	275	161
2027	1891	1911	0.075	1.8		136	-20	1911
1290	1020	812	0.1	2.4		270	208	812
589	341	236	0.125	3		248	105	236
282	156	102	0.15	3.6		126	54	102
171	84	62	0.175	4.2		87	22	62
105	56	43	0.2	4.8		49	13	43
71	43	34	0.225	5.4		28	9	34
54	36	30	0.25	6		18	6	30
46	33	27	0.275	6.6		13	6	27
41	30	25	0.3	7.2		11	5	25
38	27	22	0.325	7.8		11	5	22
35	25	20	0.35	8.4		10	5	20
33	23	19	0.375	9		10	4	19
30	21	18	0.4	9.6		9	3	18
28	20	16	0.425	10.2		8	4	16
26	18	15	0.45	10.8		8	3	15
25	17	14	0.475	11.4		8	3	14
23	17	14	0.5	12		6	3	14
23	17	14	0.525	12.6		6	3	14
20	16	14	0.55	13.2		4	2	14
17	14	12	0.575	13.8		3	2	12
14	10	8	0.6	14.4		4	2	8
80	60	50	0.625	15	5-year	20	10	50
107	79	67	0.65	15.6		28	12	67
958	457	170	0.675	16.2		501	287	170
4149	3434	3164	0.7	16.8		715	270	3164
2391	1609	1359	0.725	17.4		782	250	1359
994	545	330	0.75	18		449	215	330
456	222	131	0.775	18.6		234	91	131
242	115	80	0.8	19.2		127	35	80
154	75	55	0.825	19.8		79	20	55
103	57	44	0.85	20.4		46	13	44
76	48	39	0.875	21		28	9	39
62	43	35	0.9	21.6		19	8	35
54	39	32	0.925	22.2		15	7	32
48	35	29	0.95	22.8		13	6	29
45	32	26	0.975	23.4		13	6	26
42	30	25	1	24		12	5	25
38	28	24	1.025	24.6		10	4	24
36	26	21	1.05	25.2		10	5	21
34	23	19	1.075	25.8		11	4	19

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
32	22	18	1.1	26.4		10	4	18
31	22	18	1.125	27		9	4	18
29	21	18	1.15	27.6		8	3	18
28	21	18	1.175	28.2		7	3	18
23	18	16	1.2	28.8		5	2	16
20	13	10	1.225	29.4		7	3	10
93	70	60	1.25	30	10-year	23	10	60
124	92	81	1.275	30.6		32	11	81
1167	468	316	1.3	31.2		699	152	316
6193	4819	4387	1.325	31.8		1374	432	4387
3138	2099	1660	1.35	32.4		1039	439	1660
1262	696	363	1.375	33		566	333	363
543	254	137	1.4	33.6		289	117	137
271	130	86	1.425	34.2		141	44	86
176	86	63	1.45	34.8		90	23	63
119	66	53	1.475	35.4		53	13	53
89	57	47	1.5	36		32	10	47
74	51	42	1.525	36.6		23	9	42
65	46	38	1.55	37.2		19	8	38
58	42	35	1.575	37.8		16	7	35
53	38	31	1.6	38.4		15	7	31
49	36	29	1.625	39		13	7	29
45	33	28	1.65	39.6		12	5	28
42	31	25	1.675	40.2		11	6	25
39	28	23	1.7	40.8		11	5	23
37	26	22	1.725	41.4		11	4	22
36	26	21	1.75	42		10	5	21
35	25	21	1.775	42.6		10	4	21
33	25	21	1.8	43.2		8	4	21
28	22	19	1.825	43.8		6	3	19
24	16	12	1.85	44.4		8	4	12
66	48	39	1.875	45	year	18	9	39
108	64	53	1.9	45.6		44	11	53
758	436	161	1.925	46.2		322	275	161
2027	1891	1911	1.95	46.8		136	-20	1911
1290	1020	812	1.975	47.4		270	208	812
589	341	236	2	48		248	105	236
282	156	102	2.025	48.6		126	54	102
171	84	62	2.05	49.2		87	22	62
105	56	43	2.075	49.8		49	13	43
71	43	34	2.1	50.4		28	9	34
54	36	30	2.125	51		18	6	30
46	33	27	2.15	51.6		13	6	27
41	30	25	2.175	52.2		11	5	25

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
38	27	22	2.2	52.8	2-	11	5	22
35	25	20	2.225	53.4		10	5	20
33	23	19	2.25	54		10	4	19
30	21	18	2.275	54.6		9	3	18
28	20	16	2.3	55.2		8	4	16
26	18	15	2.325	55.8		8	3	15
25	17	14	2.35	56.4		8	3	14
23	17	14	2.375	57		6	3	14
23	17	14	2.4	57.6		6	3	14
20	16	14	2.425	58.2		4	2	14
17	14	12	2.45	58.8		3	2	12
14	10	8	2.475	59.4		4	2	8
80	60	50	2.5	60	5-year	20	10	50
107	79	67	2.525	60.6		28	12	67
958	457	170	2.55	61.2		501	287	170
4149	3434	3164	2.575	61.8		715	270	3164
2391	1609	1359	2.6	62.4		782	250	1359
994	545	330	2.625	63		449	215	330
456	222	131	2.65	63.6		234	91	131
242	115	80	2.675	64.2		127	35	80
154	75	55	2.7	64.8		79	20	55
103	57	44	2.725	65.4		46	13	44
76	48	39	2.75	66		28	9	39
62	43	35	2.775	66.6		19	8	35
54	39	32	2.8	67.2		15	7	32
48	35	29	2.825	67.8		13	6	29
45	32	26	2.85	68.4		13	6	26
42	30	25	2.875	69		12	5	25
38	28	24	2.9	69.6		10	4	24
36	26	21	2.925	70.2		10	5	21
34	23	19	2.95	70.8		11	4	19
32	22	18	2.975	71.4		10	4	18
31	22	18	3	72		9	4	18
29	21	18	3.025	72.6		8	3	18
28	21	18	3.05	73.2		7	3	18
23	18	16	3.075	73.8		5	2	16
20	13	10	3.1	74.4		7	3	10
66	48	39	3.125	75		18	9	39
108	64	53	3.15	75.6		44	11	53
758	436	161	3.175	76.2		322	275	161
2027	1891	1911	3.2	76.8		136	-20	1911
1290	1020	812	3.225	77.4		270	208	812
589	341	236	3.25	78		248	105	236
282	156	102	3.275	78.6		126	54	102

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
171	84	62	3.3	79.2	2-year	87	22	62
105	56	43	3.325	79.8		49	13	43
71	43	34	3.35	80.4		28	9	34
54	36	30	3.375	81		18	6	30
46	33	27	3.4	81.6		13	6	27
41	30	25	3.425	82.2		11	5	25
38	27	22	3.45	82.8		11	5	22
35	25	20	3.475	83.4		10	5	20
33	23	19	3.5	84		10	4	19
30	21	18	3.525	84.6		9	3	18
28	20	16	3.55	85.2		8	4	16
26	18	15	3.575	85.8		8	3	15
25	17	14	3.6	86.4		8	3	14
23	17	14	3.625	87		6	3	14
23	17	14	3.65	87.6		6	3	14
20	16	14	3.675	88.2		4	2	14
17	14	12	3.7	88.8		3	2	12
14	10	8	3.725	89.4		4	2	8
66	48	39	3.75	90	2-year	18	9	39
108	64	53	3.775	90.6		44	11	53
758	436	161	3.8	91.2		322	275	161
2027	1891	1911	3.825	91.8		136	-20	1911
1290	1020	812	3.85	92.4		270	208	812
589	341	236	3.875	93		248	105	236
282	156	102	3.9	93.6		126	54	102
171	84	62	3.925	94.2		87	22	62
105	56	43	3.95	94.8		49	13	43
71	43	34	3.975	95.4		28	9	34
54	36	30	4	96		18	6	30
46	33	27	4.025	96.6		13	6	27
41	30	25	4.05	97.2		11	5	25
38	27	22	4.075	97.8		11	5	22
35	25	20	4.1	98.4		10	5	20
33	23	19	4.125	99		10	4	19
30	21	18	4.15	99.6		9	3	18
28	20	16	4.175	100.2		8	4	16
26	18	15	4.2	100.8		8	3	15
25	17	14	4.225	101.4		8	3	14
23	17	14	4.25	102		6	3	14
23	17	14	4.275	102.6		6	3	14
20	16	14	4.3	103.2		4	2	14
17	14	12	4.325	103.8		3	2	12
14	10	8	4.35	104.4		4	2	8
80	60	50	4.375	105		20	10	50

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
107	79	67	4.4	105.6	5-year	28	12	67
958	457	170	4.425	106.2		501	287	170
4149	3434	3164	4.45	106.8		715	270	3164
2391	1609	1359	4.475	107.4		782	250	1359
994	545	330	4.5	108		449	215	330
456	222	131	4.525	108.6		234	91	131
242	115	80	4.55	109.2		127	35	80
154	75	55	4.575	109.8		79	20	55
103	57	44	4.6	110.4		46	13	44
76	48	39	4.625	111		28	9	39
62	43	35	4.65	111.6		19	8	35
54	39	32	4.675	112.2		15	7	32
48	35	29	4.7	112.8		13	6	29
45	32	26	4.725	113.4		13	6	26
42	30	25	4.75	114		12	5	25
38	28	24	4.775	114.6		10	4	24
36	26	21	4.8	115.2		10	5	21
34	23	19	4.825	115.8		11	4	19
32	22	18	4.85	116.4		10	4	18
31	22	18	4.875	117		9	4	18
29	21	18	4.9	117.6		8	3	18
28	21	18	4.925	118.2		7	3	18
23	18	16	4.95	118.8		5	2	16
20	13	10	4.975	119.4		7	3	10
80	60	50	5	120	5-year	20	10	50
107	79	67	5.025	120.6		28	12	67
958	457	170	5.05	121.2		501	287	170
4149	3434	3164	5.075	121.8		715	270	3164
2391	1609	1359	5.1	122.4		782	250	1359
994	545	330	5.125	123		449	215	330
456	222	131	5.15	123.6		234	91	131
242	115	80	5.175	124.2		127	35	80
154	75	55	5.2	124.8		79	20	55
103	57	44	5.225	125.4		46	13	44
76	48	39	5.25	126		28	9	39
62	43	35	5.275	126.6		19	8	35
54	39	32	5.3	127.2		15	7	32
48	35	29	5.325	127.8		13	6	29
45	32	26	5.35	128.4		13	6	26
42	30	25	5.375	129		12	5	25
38	28	24	5.4	129.6		10	4	24
36	26	21	5.425	130.2		10	5	21
34	23	19	5.45	130.8		11	4	19
32	22	18	5.475	131.4		10	4	18

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
31	22	18	5.5	132		9	4	18
29	21	18	5.525	132.6		8	3	18
28	21	18	5.55	133.2		7	3	18
23	18	16	5.575	133.8		5	2	16
20	13	10	5.6	134.4		7	3	10
66	48	39	5.625	135	2-year	18	9	39
108	64	53	5.65	135.6		44	11	53
758	436	161	5.675	136.2		322	275	161
2027	1891	1911	5.7	136.8		136	-20	1911
1290	1020	812	5.725	137.4		270	208	812
589	341	236	5.75	138		248	105	236
282	156	102	5.775	138.6		126	54	102
171	84	62	5.8	139.2		87	22	62
105	56	43	5.825	139.8		49	13	43
71	43	34	5.85	140.4		28	9	34
54	36	30	5.875	141		18	6	30
46	33	27	5.9	141.6		13	6	27
41	30	25	5.925	142.2		11	5	25
38	27	22	5.95	142.8		11	5	22
35	25	20	5.975	143.4		10	5	20
33	23	19	6	144		10	4	19
30	21	18	6.025	144.6		9	3	18
28	20	16	6.05	145.2		8	4	16
26	18	15	6.075	145.8		8	3	15
25	17	14	6.1	146.4		8	3	14
23	17	14	6.125	147		6	3	14
23	17	14	6.15	147.6		6	3	14
20	16	14	6.175	148.2		4	2	14
17	14	12	6.2	148.8		3	2	12
14	10	8	6.225	149.4		4	2	8
66	48	39	6.25	150	-year	18	9	39
108	64	53	6.275	150.6		44	11	53
758	436	161	6.3	151.2		322	275	161
2027	1891	1911	6.325	151.8		136	-20	1911
1290	1020	812	6.35	152.4		270	208	812
589	341	236	6.375	153		248	105	236
282	156	102	6.4	153.6		126	54	102
171	84	62	6.425	154.2		87	22	62
105	56	43	6.45	154.8		49	13	43
71	43	34	6.475	155.4		28	9	34
54	36	30	6.5	156		18	6	30
46	33	27	6.525	156.6		13	6	27
41	30	25	6.55	157.2		11	5	25
38	27	22	6.575	157.8		11	5	22

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
35	25	20	6.6	158.4	2	10	5	20
33	23	19	6.625	159		10	4	19
30	21	18	6.65	159.6		9	3	18
28	20	16	6.675	160.2		8	4	16
26	18	15	6.7	160.8		8	3	15
25	17	14	6.725	161.4		8	3	14
23	17	14	6.75	162		6	3	14
23	17	14	6.775	162.6		6	3	14
20	16	14	6.8	163.2		4	2	14
17	14	12	6.825	163.8		3	2	12
14	10	8	6.85	164.4		4	2	8
66	48	39	6.875	165		18	9	39
108	64	53	6.9	165.6		44	11	53
758	436	161	6.925	166.2		322	275	161
2027	1891	1911	6.95	166.8		136	-20	1911
1290	1020	812	6.975	167.4		270	208	812
589	341	236	7	168		248	105	236
282	156	102	7.025	168.6		126	54	102
171	84	62	7.05	169.2		87	22	62
105	56	43	7.075	169.8		49	13	43
71	43	34	7.1	170.4		28	9	34
54	36	30	7.125	171	2-year	18	6	30
46	33	27	7.15	171.6		13	6	27
41	30	25	7.175	172.2		11	5	25
38	27	22	7.2	172.8		11	5	22
35	25	20	7.225	173.4		10	5	20
33	23	19	7.25	174		10	4	19
30	21	18	7.275	174.6		9	3	18
28	20	16	7.3	175.2		8	4	16
26	18	15	7.325	175.8		8	3	15
25	17	14	7.35	176.4		8	3	14
23	17	14	7.375	177		6	3	14
23	17	14	7.4	177.6		6	3	14
20	16	14	7.425	178.2		4	2	14
17	14	12	7.45	178.8		3	2	12
14	10	8	7.475	179.4		4	2	8
66	48	39	7.5	180		18	9	39
108	64	53	7.525	180.6		44	11	53
758	436	161	7.55	181.2		322	275	161
2027	1891	1911	7.575	181.8		136	-20	1911
1290	1020	812	7.6	182.4		270	208	812
589	341	236	7.625	183		248	105	236
282	156	102	7.65	183.6		126	54	102
171	84	62	7.675	184.2		87	22	62

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
105	56	43	7.7	184.8	2-year	49	13	43
71	43	34	7.725	185.4		28	9	34
54	36	30	7.75	186		18	6	30
46	33	27	7.775	186.6		13	6	27
41	30	25	7.8	187.2		11	5	25
38	27	22	7.825	187.8		11	5	22
35	25	20	7.85	188.4		10	5	20
33	23	19	7.875	189		10	4	19
30	21	18	7.9	189.6		9	3	18
28	20	16	7.925	190.2		8	4	16
26	18	15	7.95	190.8		8	3	15
25	17	14	7.975	191.4		8	3	14
23	17	14	8	192		6	3	14
23	17	14	8.025	192.6		6	3	14
20	16	14	8.05	193.2		4	2	14
17	14	12	8.075	193.8		3	2	12
14	10	8	8.1	194.4		4	2	8
66	48	39	8.125	195	2-year	18	9	39
108	64	53	8.15	195.6		44	11	53
758	436	161	8.175	196.2		322	275	161
2027	1891	1911	8.2	196.8		136	-20	1911
1290	1020	812	8.225	197.4		270	208	812
589	341	236	8.25	198		248	105	236
282	156	102	8.275	198.6		126	54	102
171	84	62	8.3	199.2		87	22	62
105	56	43	8.325	199.8		49	13	43
71	43	34	8.35	200.4		28	9	34
54	36	30	8.375	201		18	6	30
46	33	27	8.4	201.6		13	6	27
41	30	25	8.425	202.2		11	5	25
38	27	22	8.45	202.8		11	5	22
35	25	20	8.475	203.4		10	5	20
33	23	19	8.5	204		10	4	19
30	21	18	8.525	204.6		9	3	18
28	20	16	8.55	205.2		8	4	16
26	18	15	8.575	205.8		8	3	15
25	17	14	8.6	206.4		8	3	14
23	17	14	8.625	207		6	3	14
23	17	14	8.65	207.6		6	3	14
20	16	14	8.675	208.2		4	2	14
17	14	12	8.7	208.8		3	2	12
14	10	8	8.725	209.4		4	2	8
80	60	50	8.75	210		20	10	50
107	79	67	8.775	210.6		28	12	67

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
958	457	170	8.8	211.2	5-year	501	287	170
4149	3434	3164	8.825	211.8		715	270	3164
2391	1609	1359	8.85	212.4		782	250	1359
994	545	330	8.875	213		449	215	330
456	222	131	8.9	213.6		234	91	131
242	115	80	8.925	214.2		127	35	80
154	75	55	8.95	214.8		79	20	55
103	57	44	8.975	215.4		46	13	44
76	48	39	9	216		28	9	39
62	43	35	9.025	216.6		19	8	35
54	39	32	9.05	217.2		15	7	32
48	35	29	9.075	217.8		13	6	29
45	32	26	9.1	218.4		13	6	26
42	30	25	9.125	219		12	5	25
38	28	24	9.15	219.6		10	4	24
36	26	21	9.175	220.2		10	5	21
34	23	19	9.2	220.8		11	4	19
32	22	18	9.225	221.4		10	4	18
31	22	18	9.25	222		9	4	18
29	21	18	9.275	222.6		8	3	18
28	21	18	9.3	223.2		7	3	18
23	18	16	9.325	223.8		5	2	16
20	13	10	9.35	224.4		7	3	10
66	48	39	9.375	225	2-year	18	9	39
108	64	53	9.4	225.6		44	11	53
758	436	161	9.425	226.2		322	275	161
2027	1891	1911	9.45	226.8		136	-20	1911
1290	1020	812	9.475	227.4		270	208	812
589	341	236	9.5	228		248	105	236
282	156	102	9.525	228.6		126	54	102
171	84	62	9.55	229.2		87	22	62
105	56	43	9.575	229.8		49	13	43
71	43	34	9.6	230.4		28	9	34
54	36	30	9.625	231		18	6	30
46	33	27	9.65	231.6		13	6	27
41	30	25	9.675	232.2		11	5	25
38	27	22	9.7	232.8		11	5	22
35	25	20	9.725	233.4		10	5	20
33	23	19	9.75	234		10	4	19
30	21	18	9.775	234.6		9	3	18
28	20	16	9.8	235.2		8	4	16
26	18	15	9.825	235.8		8	3	15
25	17	14	9.85	236.4		8	3	14
23	17	14	9.875	237		6	3	14

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
23	17	14	9.9	237.6		6	3	14
20	16	14	9.925	238.2		4	2	14
17	14	12	9.95	238.8		3	2	12
14	10	8	9.975	239.4		4	2	8
66	48	39	10	240	2-year	18	9	39
108	64	53	10.025	240.6		44	11	53
758	436	161	10.05	241.2		322	275	161
2027	1891	1911	10.075	241.8		136	-20	1911
1290	1020	812	10.1	242.4		270	208	812
589	341	236	10.125	243		248	105	236
282	156	102	10.15	243.6		126	54	102
171	84	62	10.175	244.2		87	22	62
105	56	43	10.2	244.8		49	13	43
71	43	34	10.225	245.4		28	9	34
54	36	30	10.25	246		18	6	30
46	33	27	10.275	246.6		13	6	27
41	30	25	10.3	247.2		11	5	25
38	27	22	10.325	247.8		11	5	22
35	25	20	10.35	248.4		10	5	20
33	23	19	10.375	249		10	4	19
30	21	18	10.4	249.6		9	3	18
28	20	16	10.425	250.2		8	4	16
26	18	15	10.45	250.8		8	3	15
25	17	14	10.475	251.4		8	3	14
23	17	14	10.5	252		6	3	14
23	17	14	10.525	252.6		6	3	14
20	16	14	10.55	253.2		4	2	14
17	14	12	10.575	253.8		3	2	12
14	10	8	10.6	254.4		4	2	8
93	70	60	10.625	255	10-year	23	10	60
124	92	81	10.65	255.6		32	11	81
1167	468	316	10.675	256.2		699	152	316
6193	4819	4387	10.7	256.8		1374	432	4387
3138	2099	1660	10.725	257.4		1039	439	1660
1262	696	363	10.75	258		566	333	363
543	254	137	10.775	258.6		289	117	137
271	130	86	10.8	259.2		141	44	86
176	86	63	10.825	259.8		90	23	63
119	66	53	10.85	260.4		53	13	53
89	57	47	10.875	261		32	10	47
74	51	42	10.9	261.6		23	9	42
65	46	38	10.925	262.2		19	8	38
58	42	35	10.95	262.8		16	7	35
53	38	31	10.975	263.4		15	7	31

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model)		
						Field 1	Field 2	Field 3
49	36	29	11	264		13	7	29
45	33	28	11.025	264.6		12	5	28
42	31	25	11.05	265.2		11	6	25
39	28	23	11.075	265.8		11	5	23
37	26	22	11.1	266.4		11	4	22
36	26	21	11.125	267		10	5	21
35	25	21	11.15	267.6		10	4	21
33	25	21	11.175	268.2		8	4	21
28	22	19	11.2	268.8		6	3	19
24	16	12	11.225	269.4		8	4	12
124	98	85	11.25	270	50-year	26	13	85
162	127	112	11.275	270.6		35	15	112
819	798	578	11.3	271.2		21	220	578
12370	8992	8025	11.325	271.8		3378	967	8025
5830	3411	2813	11.35	272.4		2419	598	2813
2004	1018	588	11.375	273		986	430	588
773	336	197	11.4	273.6		437	139	197
385	176	116	11.425	274.2		209	60	116
236	118	87	11.45	274.8		118	31	87
167	93	72	11.475	275.4		74	21	72
128	79	64	11.5	276		49	15	64
105	71	58	11.525	276.6		34	13	58
93	65	53	11.55	277.2		28	12	53
82	59	49	11.575	277.8		23	10	49
75	54	44	11.6	278.4		21	10	44
70	50	41	11.625	279		20	9	41
63	47	39	11.65	279.6		16	8	39
59	44	35	11.675	280.2		15	9	35
58	42	32	11.7	280.8		16	10	32
58	39	30	11.725	281.4		19	9	30
56	37	30	11.75	282		19	7	30
52	36	30	11.775	282.6		16	6	30
49	35	30	11.8	283.2		14	5	30
40	31	27	11.825	283.8		9	4	27
33	22	16	11.85	284.4		11	6	16
66	48	39	11.875	285		18	9	39
108	64	53	11.9	285.6		44	11	53
758	436	161	11.925	286.2		322	275	161
2027	1891	1911	11.95	286.8		136	-20	1911
1290	1020	812	11.975	287.4		270	208	812
589	341	236	12	288		248	105	236
282	156	102	12.025	288.6		126	54	102
171	84	62	12.05	289.2		87	22	62
105	56	43	12.075	289.8		49	13	43

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model)		
						Field 1	Field 2	Field 3
71	43	34	12.1	290.4	2-year	28	9	34
54	36	30	12.125	291		18	6	30
46	33	27	12.15	291.6		13	6	27
41	30	25	12.175	292.2		11	5	25
38	27	22	12.2	292.8		11	5	22
35	25	20	12.225	293.4		10	5	20
33	23	19	12.25	294		10	4	19
30	21	18	12.275	294.6		9	3	18
28	20	16	12.3	295.2		8	4	16
26	18	15	12.325	295.8		8	3	15
25	17	14	12.35	296.4		8	3	14
23	17	14	12.375	297		6	3	14
23	17	14	12.4	297.6		6	3	14
20	16	14	12.425	298.2		4	2	14
17	14	12	12.45	298.8		3	2	12
14	10	8	12.475	299.4		4	2	8
80	60	50	12.5	300	5-year	20	10	50
107	79	67	12.525	300.6		28	12	67
958	457	170	12.55	301.2		501	287	170
4149	3434	3164	12.575	301.8		715	270	3164
2391	1609	1359	12.6	302.4		782	250	1359
994	545	330	12.625	303		449	215	330
456	222	131	12.65	303.6		234	91	131
242	115	80	12.675	304.2		127	35	80
154	75	55	12.7	304.8		79	20	55
103	57	44	12.725	305.4		46	13	44
76	48	39	12.75	306		28	9	39
62	43	35	12.775	306.6		19	8	35
54	39	32	12.8	307.2		15	7	32
48	35	29	12.825	307.8		13	6	29
45	32	26	12.85	308.4		13	6	26
42	30	25	12.875	309		12	5	25
38	28	24	12.9	309.6		10	4	24
36	26	21	12.925	310.2		10	5	21
34	23	19	12.95	310.8		11	4	19
32	22	18	12.975	311.4		10	4	18
31	22	18	13	312		9	4	18
29	21	18	13.025	312.6		8	3	18
28	21	18	13.05	313.2		7	3	18
23	18	16	13.075	313.8		5	2	16
20	13	10	13.1	314.4		7	3	10
80	60	50	13.125	315		20	10	50
107	79	67	13.15	315.6		28	12	67
958	457	170	13.175	316.2		501	287	170

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
4149	3434	3164	13.2	316.8	5-year	715	270	3164
2391	1609	1359	13.225	317.4		782	250	1359
994	545	330	13.25	318		449	215	330
456	222	131	13.275	318.6		234	91	131
242	115	80	13.3	319.2		127	35	80
154	75	55	13.325	319.8		79	20	55
103	57	44	13.35	320.4		46	13	44
76	48	39	13.375	321		28	9	39
62	43	35	13.4	321.6		19	8	35
54	39	32	13.425	322.2		15	7	32
48	35	29	13.45	322.8		13	6	29
45	32	26	13.475	323.4		13	6	26
42	30	25	13.5	324		12	5	25
38	28	24	13.525	324.6		10	4	24
36	26	21	13.55	325.2		10	5	21
34	23	19	13.575	325.8		11	4	19
32	22	18	13.6	326.4		10	4	18
31	22	18	13.625	327		9	4	18
29	21	18	13.65	327.6		8	3	18
28	21	18	13.675	328.2		7	3	18
23	18	16	13.7	328.8		5	2	16
20	13	10	13.725	329.4		7	3	10
110	85	75	13.75	330	25-year	25	10	75
144	111	101	13.775	330.6		33	10	101
879	533	580	13.8	331.2		346	-47	580
9499	6952	6256	13.825	331.8		2547	696	6256
4713	2994	2133	13.85	332.4		1719	861	2133
1711	920	448	13.875	333		791	472	448
682	308	164	13.9	333.6		374	144	164
332	156	102	13.925	334.2		176	54	102
209	104	76	13.95	334.8		105	28	76
145	81	62	13.975	335.4		64	19	62
110	69	55	14	336		41	14	55
91	62	51	14.025	336.6		29	11	51
80	57	46	14.05	337.2		23	11	46
71	52	42	14.075	337.8		19	10	42
65	50	47	14.1	338.4		15	3	47
61	55	53	14.125	339		6	2	53
55	53	45	14.15	339.6		2	8	45
51	44	34	14.175	340.2		7	10	34
48	36	29	14.2	340.8		12	7	29
45	33	27	14.225	341.4		12	6	27
43	31	26	14.25	342		12	5	26
42	31	26	14.275	342.6		11	5	26

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
41	31	26	14.3	343.2		10	5	26
35	27	23	14.325	343.8		8	4	23
30	19	14	14.35	344.4		11	5	14
66	48	39	14.375	345	2-year	18	9	39
108	64	53	14.4	345.6		44	11	53
758	436	161	14.425	346.2		322	275	161
2027	1891	1911	14.45	346.8		136	-20	1911
1290	1020	812	14.475	347.4		270	208	812
589	341	236	14.5	348		248	105	236
282	156	102	14.525	348.6		126	54	102
171	84	62	14.55	349.2		87	22	62
105	56	43	14.575	349.8		49	13	43
71	43	34	14.6	350.4		28	9	34
54	36	30	14.625	351		18	6	30
46	33	27	14.65	351.6		13	6	27
41	30	25	14.675	352.2		11	5	25
38	27	22	14.7	352.8		11	5	22
35	25	20	14.725	353.4		10	5	20
33	23	19	14.75	354		10	4	19
30	21	18	14.775	354.6		9	3	18
28	20	16	14.8	355.2		8	4	16
26	18	15	14.825	355.8		8	3	15
25	17	14	14.85	356.4		8	3	14
23	17	14	14.875	357		6	3	14
23	17	14	14.9	357.6		6	3	14
20	16	14	14.925	358.2		4	2	14
17	14	12	14.95	358.8		3	2	12
14	10	8	14.975	359.4		4	2	8
80	60	50	15	360	5-year	20	10	50
107	79	67	15.025	360.6		28	12	67
958	457	170	15.05	361.2		501	287	170
4149	3434	3164	15.075	361.8		715	270	3164
2391	1609	1359	15.1	362.4		782	250	1359
994	545	330	15.125	363		449	215	330
456	222	131	15.15	363.6		234	91	131
242	115	80	15.175	364.2		127	35	80
154	75	55	15.2	364.8		79	20	55
103	57	44	15.225	365.4		46	13	44
76	48	39	15.25	366		28	9	39
62	43	35	15.275	366.6		19	8	35
54	39	32	15.3	367.2		15	7	32
48	35	29	15.325	367.8		13	6	29
45	32	26	15.35	368.4		13	6	26
42	30	25	15.375	369		12	5	25

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
38	28	24	15.4	369.6		10	4	24
36	26	21	15.425	370.2		10	5	21
34	23	19	15.45	370.8		11	4	19
32	22	18	15.475	371.4		10	4	18
31	22	18	15.5	372		9	4	18
29	21	18	15.525	372.6		8	3	18
28	21	18	15.55	373.2		7	3	18
23	18	16	15.575	373.8		5	2	16
20	13	10	15.6	374.4		7	3	10
66	48	39	15.625	375	2-year	18	9	39
108	64	53	15.65	375.6		44	11	53
758	436	161	15.675	376.2		322	275	161
2027	1891	1911	15.7	376.8		136	-20	1911
1290	1020	812	15.725	377.4		270	208	812
589	341	236	15.75	378		248	105	236
282	156	102	15.775	378.6		126	54	102
171	84	62	15.8	379.2		87	22	62
105	56	43	15.825	379.8		49	13	43
71	43	34	15.85	380.4		28	9	34
54	36	30	15.875	381		18	6	30
46	33	27	15.9	381.6		13	6	27
41	30	25	15.925	382.2		11	5	25
38	27	22	15.95	382.8		11	5	22
35	25	20	15.975	383.4		10	5	20
33	23	19	16	384		10	4	19
30	21	18	16.025	384.6		9	3	18
28	20	16	16.05	385.2		8	4	16
26	18	15	16.075	385.8		8	3	15
25	17	14	16.1	386.4		8	3	14
23	17	14	16.125	387		6	3	14
23	17	14	16.15	387.6		6	3	14
20	16	14	16.175	388.2		4	2	14
17	14	12	16.2	388.8		3	2	12
14	10	8	16.225	389.4		4	2	8
66	48	39	16.25	390		18	9	39
108	64	53	16.275	390.6		44	11	53
758	436	161	16.3	391.2		322	275	161
2027	1891	1911	16.325	391.8		136	-20	1911
1290	1020	812	16.35	392.4		270	208	812
589	341	236	16.375	393		248	105	236
282	156	102	16.4	393.6		126	54	102
171	84	62	16.425	394.2		87	22	62
105	56	43	16.45	394.8		49	13	43
71	43	34	16.475	395.4		28	9	34

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model) Field 1	Field 2	Field 3
54	36	30	16.5	396	2-year	18	6	30
46	33	27	16.525	396.6		13	6	27
41	30	25	16.55	397.2		11	5	25
38	27	22	16.575	397.8		11	5	22
35	25	20	16.6	398.4		10	5	20
33	23	19	16.625	399		10	4	19
30	21	18	16.65	399.6		9	3	18
28	20	16	16.675	400.2		8	4	16
26	18	15	16.7	400.8		8	3	15
25	17	14	16.725	401.4		8	3	14
23	17	14	16.75	402		6	3	14
23	17	14	16.775	402.6		6	3	14
20	16	14	16.8	403.2		4	2	14
17	14	12	16.825	403.8		3	2	12
14	10	8	16.85	404.4		4	2	8
66	48	39	16.875	405	2-year	18	9	39
108	64	53	16.9	405.6		44	11	53
758	436	161	16.925	406.2		322	275	161
2027	1891	1911	16.95	406.8		136	-20	1911
1290	1020	812	16.975	407.4		270	208	812
589	341	236	17	408		248	105	236
282	156	102	17.025	408.6		126	54	102
171	84	62	17.05	409.2		87	22	62
105	56	43	17.075	409.8		49	13	43
71	43	34	17.1	410.4		28	9	34
54	36	30	17.125	411		18	6	30
46	33	27	17.15	411.6		13	6	27
41	30	25	17.175	412.2		11	5	25
38	27	22	17.2	412.8		11	5	22
35	25	20	17.225	413.4		10	5	20
33	23	19	17.25	414		10	4	19
30	21	18	17.275	414.6		9	3	18
28	20	16	17.3	415.2		8	4	16
26	18	15	17.325	415.8		8	3	15
25	17	14	17.35	416.4		8	3	14
23	17	14	17.375	417		6	3	14
23	17	14	17.4	417.6		6	3	14
20	16	14	17.425	418.2		4	2	14
17	14	12	17.45	418.8		3	2	12
14	10	8	17.475	419.4		4	2	8
80	60	50	17.5	420		20	10	50
107	79	67	17.525	420.6		28	12	67
958	457	170	17.55	421.2		501	287	170
4149	3434	3164	17.575	421.8		715	270	3164

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
2391	1609	1359	17.6	422.4	5-year	782	250	1359
994	545	330	17.625	423		449	215	330
456	222	131	17.65	423.6		234	91	131
242	115	80	17.675	424.2		127	35	80
154	75	55	17.7	424.8		79	20	55
103	57	44	17.725	425.4		46	13	44
76	48	39	17.75	426		28	9	39
62	43	35	17.775	426.6		19	8	35
54	39	32	17.8	427.2		15	7	32
48	35	29	17.825	427.8		13	6	29
45	32	26	17.85	428.4		13	6	26
42	30	25	17.875	429		12	5	25
38	28	24	17.9	429.6		10	4	24
36	26	21	17.925	430.2		10	5	21
34	23	19	17.95	430.8		11	4	19
32	22	18	17.975	431.4		10	4	18
31	22	18	18	432		9	4	18
29	21	18	18.025	432.6		8	3	18
28	21	18	18.05	433.2		7	3	18
23	18	16	18.075	433.8		5	2	16
20	13	10	18.1	434.4		7	3	10
66	48	39	18.125	435	2-year	18	9	39
108	64	53	18.15	435.6		44	11	53
758	436	161	18.175	436.2		322	275	161
2027	1891	1911	18.2	436.8		136	-20	1911
1290	1020	812	18.225	437.4		270	208	812
589	341	236	18.25	438		248	105	236
282	156	102	18.275	438.6		126	54	102
171	84	62	18.3	439.2		87	22	62
105	56	43	18.325	439.8		49	13	43
71	43	34	18.35	440.4		28	9	34
54	36	30	18.375	441		18	6	30
46	33	27	18.4	441.6		13	6	27
41	30	25	18.425	442.2		11	5	25
38	27	22	18.45	442.8		11	5	22
35	25	20	18.475	443.4		10	5	20
33	23	19	18.5	444		10	4	19
30	21	18	18.525	444.6		9	3	18
28	20	16	18.55	445.2		8	4	16
26	18	15	18.575	445.8		8	3	15
25	17	14	18.6	446.4		8	3	14
23	17	14	18.625	447		6	3	14
23	17	14	18.65	447.6		6	3	14
20	16	14	18.675	448.2		4	2	14

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
17	14	12	18.7	448.8		3	2	12
14	10	8	18.725	449.4		4	2	8
66	48	39	18.75	450	2-year	18	9	39
108	64	53	18.775	450.6		44	11	53
758	436	161	18.8	451.2		322	275	161
2027	1891	1911	18.825	451.8		136	-20	1911
1290	1020	812	18.85	452.4		270	208	812
589	341	236	18.875	453		248	105	236
282	156	102	18.9	453.6		126	54	102
171	84	62	18.925	454.2		87	22	62
105	56	43	18.95	454.8		49	13	43
71	43	34	18.975	455.4		28	9	34
54	36	30	19	456		18	6	30
46	33	27	19.025	456.6		13	6	27
41	30	25	19.05	457.2		11	5	25
38	27	22	19.075	457.8		11	5	22
35	25	20	19.1	458.4		10	5	20
33	23	19	19.125	459		10	4	19
30	21	18	19.15	459.6		9	3	18
28	20	16	19.175	460.2		8	4	16
26	18	15	19.2	460.8		8	3	15
25	17	14	19.225	461.4		8	3	14
23	17	14	19.25	462		6	3	14
23	17	14	19.275	462.6		6	3	14
20	16	14	19.3	463.2		4	2	14
17	14	12	19.325	463.8		3	2	12
14	10	8	19.35	464.4		4	2	8
66	48	39	19.375	465	2-year	18	9	39
108	64	53	19.4	465.6		44	11	53
758	436	161	19.425	466.2		322	275	161
2027	1891	1911	19.45	466.8		136	-20	1911
1290	1020	812	19.475	467.4		270	208	812
589	341	236	19.5	468		248	105	236
282	156	102	19.525	468.6		126	54	102
171	84	62	19.55	469.2		87	22	62
105	56	43	19.575	469.8		49	13	43
71	43	34	19.6	470.4		28	9	34
54	36	30	19.625	471		18	6	30
46	33	27	19.65	471.6		13	6	27
41	30	25	19.675	472.2		11	5	25
38	27	22	19.7	472.8		11	5	22
35	25	20	19.725	473.4		10	5	20
33	23	19	19.75	474		10	4	19
30	21	18	19.775	474.6		9	3	18

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model)		
						Field 1	Field 2	Field 3
28	20	16	19.8	475.2		8	4	16
26	18	15	19.825	475.8		8	3	15
25	17	14	19.85	476.4		8	3	14
23	17	14	19.875	477		6	3	14
23	17	14	19.9	477.6		6	3	14
20	16	14	19.925	478.2		4	2	14
17	14	12	19.95	478.8		3	2	12
14	10	8	19.975	479.4		4	2	8
110	85	75	20	480	25-year	25	10	75
144	111	101	20.025	480.6		33	10	101
879	533	580	20.05	481.2		346	-47	580
9499	6952	6256	20.075	481.8		2547	696	6256
4713	2994	2133	20.1	482.4		1719	861	2133
1711	920	448	20.125	483		791	472	448
682	308	164	20.15	483.6		374	144	164
332	156	102	20.175	484.2		176	54	102
209	104	76	20.2	484.8		105	28	76
145	81	62	20.225	485.4		64	19	62
110	69	55	20.25	486		41	14	55
91	62	51	20.275	486.6		29	11	51
80	57	46	20.3	487.2		23	11	46
71	52	42	20.325	487.8		19	10	42
65	50	47	20.35	488.4		15	3	47
61	55	53	20.375	489		6	2	53
55	53	45	20.4	489.6		2	8	45
51	44	34	20.425	490.2		7	10	34
48	36	29	20.45	490.8		12	7	29
45	33	27	20.475	491.4		12	6	27
43	31	26	20.5	492		12	5	26
42	31	26	20.525	492.6		11	5	26
41	31	26	20.55	493.2		10	5	26
35	27	23	20.575	493.8		8	4	23
30	19	14	20.6	494.4		11	5	14
93	70	60	20.625	495	ar	23	10	60
124	92	81	20.65	495.6		32	11	81
1167	468	316	20.675	496.2		699	152	316
6193	4819	4387	20.7	496.8		1374	432	4387
3138	2099	1660	20.725	497.4		1039	439	1660
1262	696	363	20.75	498		566	333	363
543	254	137	20.775	498.6		289	117	137
271	130	86	20.8	499.2		141	44	86
176	86	63	20.825	499.8		90	23	63
119	66	53	20.85	500.4		53	13	53
89	57	47	20.875	501		32	10	47

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model) Field 1	Field 2	Field 3
74	51	42	20.9	501.6	10-ye	23	9	42
65	46	38	20.925	502.2		19	8	38
58	42	35	20.95	502.8		16	7	35
53	38	31	20.975	503.4		15	7	31
49	36	29	21	504		13	7	29
45	33	28	21.025	504.6		12	5	28
42	31	25	21.05	505.2		11	6	25
39	28	23	21.075	505.8		11	5	23
37	26	22	21.1	506.4		11	4	22
36	26	21	21.125	507		10	5	21
35	25	21	21.15	507.6		10	4	21
33	25	21	21.175	508.2		8	4	21
28	22	19	21.2	508.8		6	3	19
24	16	12	21.225	509.4		8	4	12
66	48	39	21.25	510	2-year	18	9	39
108	64	53	21.275	510.6		44	11	53
758	436	161	21.3	511.2		322	275	161
2027	1891	1911	21.325	511.8		136	-20	1911
1290	1020	812	21.35	512.4		270	208	812
589	341	236	21.375	513		248	105	236
282	156	102	21.4	513.6		126	54	102
171	84	62	21.425	514.2		87	22	62
105	56	43	21.45	514.8		49	13	43
71	43	34	21.475	515.4		28	9	34
54	36	30	21.5	516		18	6	30
46	33	27	21.525	516.6		13	6	27
41	30	25	21.55	517.2		11	5	25
38	27	22	21.575	517.8		11	5	22
35	25	20	21.6	518.4		10	5	20
33	23	19	21.625	519		10	4	19
30	21	18	21.65	519.6		9	3	18
28	20	16	21.675	520.2		8	4	16
26	18	15	21.7	520.8		8	3	15
25	17	14	21.725	521.4		8	3	14
23	17	14	21.75	522		6	3	14
23	17	14	21.775	522.6		6	3	14
20	16	14	21.8	523.2		4	2	14
17	14	12	21.825	523.8		3	2	12
14	10	8	21.85	524.4		4	2	8
66	48	39	21.875	525		18	9	39
108	64	53	21.9	525.6		44	11	53
758	436	161	21.925	526.2		322	275	161
2027	1891	1911	21.95	526.8		136	-20	1911
1290	1020	812	21.975	527.4		270	208	812

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
589	341	236	22	528	2-year	248	105	236
282	156	102	22.025	528.6		126	54	102
171	84	62	22.05	529.2		87	22	62
105	56	43	22.075	529.8		49	13	43
71	43	34	22.1	530.4		28	9	34
54	36	30	22.125	531		18	6	30
46	33	27	22.15	531.6		13	6	27
41	30	25	22.175	532.2		11	5	25
38	27	22	22.2	532.8		11	5	22
35	25	20	22.225	533.4		10	5	20
33	23	19	22.25	534		10	4	19
30	21	18	22.275	534.6		9	3	18
28	20	16	22.3	535.2		8	4	16
26	18	15	22.325	535.8		8	3	15
25	17	14	22.35	536.4		8	3	14
23	17	14	22.375	537		6	3	14
23	17	14	22.4	537.6		6	3	14
20	16	14	22.425	538.2		4	2	14
17	14	12	22.45	538.8		3	2	12
14	10	8	22.475	539.4		4	2	8
80	60	50	22.5	540	5-year	20	10	50
107	79	67	22.525	540.6		28	12	67
958	457	170	22.55	541.2		501	287	170
4149	3434	3164	22.575	541.8		715	270	3164
2391	1609	1359	22.6	542.4		782	250	1359
994	545	330	22.625	543		449	215	330
456	222	131	22.65	543.6		234	91	131
242	115	80	22.675	544.2		127	35	80
154	75	55	22.7	544.8		79	20	55
103	57	44	22.725	545.4		46	13	44
76	48	39	22.75	546		28	9	39
62	43	35	22.775	546.6		19	8	35
54	39	32	22.8	547.2		15	7	32
48	35	29	22.825	547.8		13	6	29
45	32	26	22.85	548.4		13	6	26
42	30	25	22.875	549		12	5	25
38	28	24	22.9	549.6		10	4	24
36	26	21	22.925	550.2		10	5	21
34	23	19	22.95	550.8		11	4	19
32	22	18	22.975	551.4		10	4	18
31	22	18	23	552		9	4	18
29	21	18	23.025	552.6		8	3	18
28	21	18	23.05	553.2		7	3	18
23	18	16	23.075	553.8		5	2	16

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model)		
						Field 1	Field 2	Field 3
20	13	10	23.1	554.4		7	3	10
66	48	39	23.125	555	2-year	18	9	39
108	64	53	23.15	555.6		44	11	53
758	436	161	23.175	556.2		322	275	161
2027	1891	1911	23.2	556.8		136	-20	1911
1290	1020	812	23.225	557.4		270	208	812
589	341	236	23.25	558		248	105	236
282	156	102	23.275	558.6		126	54	102
171	84	62	23.3	559.2		87	22	62
105	56	43	23.325	559.8		49	13	43
71	43	34	23.35	560.4		28	9	34
54	36	30	23.375	561		18	6	30
46	33	27	23.4	561.6		13	6	27
41	30	25	23.425	562.2		11	5	25
38	27	22	23.45	562.8		11	5	22
35	25	20	23.475	563.4		10	5	20
33	23	19	23.5	564		10	4	19
30	21	18	23.525	564.6		9	3	18
28	20	16	23.55	565.2		8	4	16
26	18	15	23.575	565.8		8	3	15
25	17	14	23.6	566.4		8	3	14
23	17	14	23.625	567		6	3	14
23	17	14	23.65	567.6		6	3	14
20	16	14	23.675	568.2		4	2	14
17	14	12	23.7	568.8		3	2	12
14	10	8	23.725	569.4		4	2	8
93	70	60	23.75	570	10-year	23	10	60
124	92	81	23.775	570.6		32	11	81
1167	468	316	23.8	571.2		699	152	316
6193	4819	4387	23.825	571.8		1374	432	4387
3138	2099	1660	23.85	572.4		1039	439	1660
1262	696	363	23.875	573		566	333	363
543	254	137	23.9	573.6		289	117	137
271	130	86	23.925	574.2		141	44	86
176	86	63	23.95	574.8		90	23	63
119	66	53	23.975	575.4		53	13	53
89	57	47	24	576		32	10	47
74	51	42	24.025	576.6		23	9	42
65	46	38	24.05	577.2		19	8	38
58	42	35	24.075	577.8		16	7	35
53	38	31	24.1	578.4		15	7	31
49	36	29	24.125	579		13	7	29
45	33	28	24.15	579.6		12	5	28
42	31	25	24.175	580.2		11	6	25

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model)		
						Field 1	Field 2	Field 3
39	28	23	24.2	580.8		11	5	23
37	26	22	24.225	581.4		11	4	22
36	26	21	24.25	582		10	5	21
35	25	21	24.275	582.6		10	4	21
33	25	21	24.3	583.2		8	4	21
28	22	19	24.325	583.8		6	3	19
24	16	12	24.35	584.4		8	4	12
93	70	60	24.375	585	10-year	23	10	60
124	92	81	24.4	585.6		32	11	81
1167	468	316	24.425	586.2		699	152	316
6193	4819	4387	24.45	586.8		1374	432	4387
3138	2099	1660	24.475	587.4		1039	439	1660
1262	696	363	24.5	588		566	333	363
543	254	137	24.525	588.6		289	117	137
271	130	86	24.55	589.2		141	44	86
176	86	63	24.575	589.8		90	23	63
119	66	53	24.6	590.4		53	13	53
89	57	47	24.625	591		32	10	47
74	51	42	24.65	591.6		23	9	42
65	46	38	24.675	592.2		19	8	38
58	42	35	24.7	592.8		16	7	35
53	38	31	24.725	593.4		15	7	31
49	36	29	24.75	594		13	7	29
45	33	28	24.775	594.6		12	5	28
42	31	25	24.8	595.2		11	6	25
39	28	23	24.825	595.8		11	5	23
37	26	22	24.85	596.4		11	4	22
36	26	21	24.875	597		10	5	21
35	25	21	24.9	597.6		10	4	21
33	25	21	24.925	598.2		8	4	21
28	22	19	24.95	598.8		6	3	19
24	16	12	24.975	599.4		8	4	12
66	48	39	25	600		18	9	39
108	64	53	25.025	600.6		44	11	53
758	436	161	25.05	601.2		322	275	161
2027	1891	1911	25.075	601.8		136	-20	1911
1290	1020	812	25.1	602.4		270	208	812
589	341	236	25.125	603		248	105	236
282	156	102	25.15	603.6		126	54	102
171	84	62	25.175	604.2		87	22	62
105	56	43	25.2	604.8		49	13	43
71	43	34	25.225	605.4		28	9	34
54	36	30	25.25	606	ear	18	6	30
46	33	27	25.275	606.6		13	6	27

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						**HEC-6 Model Conversion**		
CP64	CP60	CP59	Days	Hours	Event	Q-Record (Water discharge entering the model)		
cubic feet per second	cubic feet per second	cubic feet per second				Field 1	Field 2	Field 3
41	30	25	25.3	607.2	2-ye	11	5	25
38	27	22	25.325	607.8		11	5	22
35	25	20	25.35	608.4		10	5	20
33	23	19	25.375	609		10	4	19
30	21	18	25.4	609.6		9	3	18
28	20	16	25.425	610.2		8	4	16
26	18	15	25.45	610.8		8	3	15
25	17	14	25.475	611.4		8	3	14
23	17	14	25.5	612		6	3	14
23	17	14	25.525	612.6		6	3	14
20	16	14	25.55	613.2		4	2	14
17	14	12	25.575	613.8		3	2	12
14	10	8	25.6	614.4		4	2	8
66	48	39	25.625	615		18	9	39
108	64	53	25.65	615.6		44	11	53
758	436	161	25.675	616.2		322	275	161
2027	1891	1911	25.7	616.8		136	-20	1911
1290	1020	812	25.725	617.4		270	208	812
589	341	236	25.75	618		248	105	236
282	156	102	25.775	618.6		126	54	102
171	84	62	25.8	619.2		87	22	62
105	56	43	25.825	619.8		49	13	43
71	43	34	25.85	620.4		28	9	34
54	36	30	25.875	621	2-year	18	6	30
46	33	27	25.9	621.6		13	6	27
41	30	25	25.925	622.2		11	5	25
38	27	22	25.95	622.8		11	5	22
35	25	20	25.975	623.4		10	5	20
33	23	19	26	624		10	4	19
30	21	18	26.025	624.6		9	3	18
28	20	16	26.05	625.2		8	4	16
26	18	15	26.075	625.8		8	3	15
25	17	14	26.1	626.4		8	3	14
23	17	14	26.125	627		6	3	14
23	17	14	26.15	627.6		6	3	14
20	16	14	26.175	628.2		4	2	14
17	14	12	26.2	628.8		3	2	12
14	10	8	26.225	629.4		4	2	8
66	48	39	26.25	630		18	9	39
108	64	53	26.275	630.6		44	11	53
758	436	161	26.3	631.2		322	275	161
2027	1891	1911	26.325	631.8		136	-20	1911
1290	1020	812	26.35	632.4		270	208	812
589	341	236	26.375	633		248	105	236

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Hydrograph data from Reata Wash HEC-1 Model reduced for use in HEC-6T Model

HEC-1 Model Concentration						HEC-6 Model Conversion		
CP64 cubic feet per second	CP60 cubic feet per second	CP59 cubic feet per second	Days	Hours	Event	Q-Record (Water discharge entering the model) Field 1	Field 2	Field 3
282	156	102	26.4	633.6	2-year	126	54	102
171	84	62	26.425	634.2		87	22	62
105	56	43	26.45	634.8		49	13	43
71	43	34	26.475	635.4		28	9	34
54	36	30	26.5	636		18	6	30
46	33	27	26.525	636.6		13	6	27
41	30	25	26.55	637.2		11	5	25
38	27	22	26.575	637.8		11	5	22
35	25	20	26.6	638.4		10	5	20
33	23	19	26.625	639		10	4	19
30	21	18	26.65	639.6		9	3	18
28	20	16	26.675	640.2		8	4	16
26	18	15	26.7	640.8		8	3	15
25	17	14	26.725	641.4		8	3	14
23	17	14	26.75	642		6	3	14
23	17	14	26.775	642.6		6	3	14
20	16	14	26.8	643.2		4	2	14
17	14	12	26.825	643.8		3	2	12
14	10	8	26.85	644.4		4	2	8
143	112	96	26.875	645	100-year	31	16	96
186	144	129	26.9	645.6		42	15	129
1368	1063	721	26.925	646.2		305	342	721
15618	12119	11274	26.95	646.8		3499	845	11274
10530	3985	3280	26.975	647.4		6545	705	3280
3064	1074	615	27	648		1990	459	615
1082	339	228	27.025	648.6		743	111	228
476	192	135	27.05	649.2		284	57	135
263	131	99	27.075	649.8		132	32	99
188	103	82	27.1	650.4		85	21	82
143	89	72	27.125	651		54	17	72
119	80	66	27.15	651.6		39	14	66
106	74	60	27.175	652.2		32	14	60
96	67	55	27.2	652.8		29	12	55
87	61	49	27.225	653.4		26	12	49
81	56	46	27.25	654		25	10	46
74	53	44	27.275	654.6		21	9	44
68	49	40	27.3	655.2		19	9	40
63	44	36	27.325	655.8		19	8	36
59	41	34	27.35	656.4		18	7	34
55	40	34	27.375	657		15	6	34
54	40	34	27.4	657.6		14	6	34
53	40	34	27.425	658.2		13	6	34
49	35	31	27.45	658.8		14	4	31
39	25	18	27.475	659.4		14	7	18

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Sediment Sample Data

		Group SM-1				Group SM-2								Group SM-3					Group SM-4					Group SM-5			
		East Branch				Pinnacle to North Beardsley								North Beardsley to Union Hills					Union Hills to Bell					Downstream of Bell			
Seive	Size (mm)	S3-7	S3-6	AGRAbkt	Composite	RP-1	RP-3	RP-4	RP-5	RP-6	RTP-1	RTP-3	Composite	RTP-5	RTP-6	RTP-9	RTP-12	Composite	RTP-14	RTP-16	RTP-19	SLA UH	Composite	RTP-14	RTP-19	SLA UH	Composite
3.5	88.9	100	100	100	100.0	100	100	100	100	100	100	100	100.0	100	100	100		100.0	100	100	100	100	100.0	97.9	100	100	99.3
3	76.2	100	100	100	100.0	100	100	100	100	100	100	100	100.0	100	95.7	100	86.7	100.0	100	100	100	100	100.0	91.6	100	100	97.2
2.5	63.5	100	100	100	100.0	100	100	100	100	100	100	100	100.0	100				94.0		100	100	100	100.0			100	94.0
2	50.8	100	100	100	100.0	100	100	100	100	100	100	100	100.0	100	88.2	95.8	72.3	89.1	93.8	100	100	100	98.5	89.5	84.9	100	91.5
1.5	38.1	100	100	100	100.0	100	100	100	100	100	100	100	100.0	95.6	76.3	92.7	68.2	83.2	91.4	100	97.3	100	97.2	83.3	80.9	90.9	85.0
1	25.4	100	100	99.5	99.9	100	100	100	100	100	100	98.9	99.8	87.1	69.9	85.5	57.9	75.1	90.1	98.7	96	97.3	95.5	74.9	73.9	75.9	74.9
0.75	19.05	100	100	98.5	99.6	100	100	100	100	100	100	98.9	99.8	81.2	64.5	79.2	53.8	69.7	90.1	98.7	94.7	96	94.9	69.7	69.9	67.8	69.1
0.5	12.7	100	99	96.9	98.5	100	98.8	100	100	100	100	96.8	99.4	72.9	54.8	70.9	46.7	61.3	86.4	96.1	92	93.3	92.0	61.3	59.8	55.7	58.9
0.375	9.525	99	96.9	94.4	96.8	96.1	97.6	96.3	98.6	100	98	94.7	97.3	68.2	49.4	64.7	42.6	56.2	84	93.5	89.3	90.7	89.4	56.1	52.8	49.7	52.9
0.25	6.35	95.9	90.7	84.2	90.7	90.8	90.4	93.8	95.9	93.7	92.8	82.1	91.4	60	40.8	55.3	35.4	47.9	77.8	87	81.3	86.7	83.2	47.7	42.8	41.6	44.0
4	4.75	89.8	82.5	74.5	82.8	82.9	83.1	90.1	91.9	86.1	87.7	71.6	84.8	54.1	36.5	50.2	32.3	43.3	74.1	83.1	76	81.3	78.6	41.4	35.7	36.6	37.9
8	2.36	60.2	56.7	50.9	56.1	61.8	65.1	72.8	79.7	62	65.3	49.5	65.2	43.5	26.8	36.7	23.1	32.5	58	68.8	57.3	68	63.0	29.9	21.7	24.5	25.4
10	2	52	49.5	43.8	49.0	55.3	59	67.9	75.7	54.4	58.1	43.2	59.1	38.8	23.6	33.5	21	29.2	53.1	63.6	53.3	62.7	58.2	26.8	19.7	21.5	22.7
16	1.18	32.7	27.8	25.4	29.2	40.8	44.6	53.1	60.8	36.7	37.7	29.5	43.3	29.4	17.1	24.2	14.9	21.4	42	50.6	40	48	45.2	19.5	12.7	12.5	14.9
30	0.6	14.3	11.3	10.6	12.2	26.3	27.7	34.6	39.2	21.5	20.3	15.8	26.5	18.8	10.7	13.8	7.7	12.8	28.4	36.4	26.7	33.3	31.2	11.1	5.6	5.4	7.4
40	0.425	9.2	7.2	6	7.4	19.7	21.7	27.2	29.7	15.2	14.2	11.6	19.9	14.1	7.4	9.7	5.6	9.2	22.2	28.6	22.7	26.7	25.1	7.9	3.6	2.4	4.6
50	0.3	5.1	4.1	3.4	4.2	14.5	15.7	18.5	21.6	11.4	9.1	8.4	14.2	10.6	5.3	6.5	3.6	6.5	17.3	22.1	17.3	20	19.2	5.9	1.6	1.4	3.0
100	0.15	2	1	0.9	1.2	5.3	6	7.4	8.1	3.8	1.9	3.2	5.1	4.7	2	2.4	1.5	2.7	7.4	10.4	8	9.3	8.8	1.7	0.6	0.4	0.9
200	0.075	0	0	0	0.0	0	0	0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0.0

Note:
See RW0105 for additional sediment sample data and sample locations.

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

HEC-6T Maximum Bed Elevation Change Summary

Hydraulic Cross Section Identification #	Bed Elevation	Minimum Bed Elevation	Reach	Hydraulic Cross Section maxium bed elevation change	Reach Average long term bed change
	(feet)	(feet)		feet	feet
1600	1504.2	1504.20	22	0.00	0.02
1700	1504	1504.00	22	0.00	0.02
1800	1503.6	1503.60	22	0.00	0.02
1900	1503.6	1503.60	22	0.00	0.02
2000	1503.6	1503.60	22	0.00	0.02
2100	1503.6	1503.60	22	0.00	0.02
2200	1503.5	1503.50	22	0.00	0.02
2300	1503.6	1503.60	22	0.00	0.02
2400	1504.1	1504.14	22	0.04	0.02
2500	1504.6	1504.73	22	0.13	0.02
2600	1506.8	1506.77	21	-0.03	-0.72
2700	1510.4	1509.60	21	-0.80	-0.72
2800	1513.2	1512.49	21	-0.71	-0.72
2900	1515.2	1514.37	21	-0.83	-0.72
3000	1516.7	1515.47	21	-1.23	-0.72
3100	1518.5	1518.25	20	-0.25	-0.08
3200	1519.5	1519.50	20	0.00	-0.08
3300	1520.5	1520.51	20	0.01	-0.08
3400	1521.5	1521.49	19	-0.01	-0.34
3500	1523.8	1523.29	19	-0.51	-0.34
3600	1524.3	1524.31	19	0.01	-0.34
3700	1526.5	1525.99	19	-0.51	-0.34
3800	1526.6	1526.63	19	0.03	-0.34
3900	1529	1528.58	19	-0.42	-0.34
4000	1529.9	1529.92	19	0.02	-0.34
4100	1532.1	1531.60	19	-0.50	-0.34
4200	1533	1532.94	19	-0.06	-0.34
4300	1535.1	1534.28	19	-0.82	-0.34
4400	1535.6	1535.56	19	-0.04	-0.34
4500	1537.7	1536.79	19	-0.91	-0.34
4600	1539	1538.09	19	-0.91	-0.34
4700	1540	1539.37	19	-0.63	-0.34
4800	1540.8	1540.67	19	-0.13	-0.34
4900	1542	1542.00	19	0.00	-0.34
5000	1543	1543.02	19	0.02	-0.34
5100	1545.4	1544.78	19	-0.62	-0.34
5200	1546.7	1546.22	19	-0.48	-0.34
5300	1549	1547.68	19	-1.32	-1.79
5400	1551	1549.18	19	-1.82	-1.79
5500	1552.5	1550.69	19	-1.81	-1.79
5600	1554	1552.25	19	-1.75	-1.79
5700	1555	1553.80	19	-1.20	-1.79
5800	1557	1555.42	19	-1.58	-1.79
5900	1560	1556.96	19	-3.04	-1.79

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

HEC-6T Maximum Bed Elevation Change Summary

Hydraulic Cross Section Identification #	Bed Elevation	Minimum Bed Elevation	Reach	Hydraulic Cross Section maxium bed elevation change	Reach Average long term bed change
6200	1568.6	1564.46	19	-4.14	-5.38
6300	1570.4	1565.83	19	-4.57	-5.38
6400	1572.8	1566.13	19	-6.67	-5.38
6500	1574.3	1574.30	19	0.00	0.00
6700	1578	1573.98	18	-4.02	-5.87
6800	1579.2	1574.27	18	-4.93	-5.87
6900	1580.7	1574.22	18	-6.48	-5.87
7000	1583.9	1575.86	18	-8.04	-5.87
7100	1585.7	1585.70	18	0.00	0.00
7200	1587	1586.04	18	-0.96	-1.96
7300	1589.5	1586.54	18	-2.96	-1.96
7500	1594.7	1593.45	18	-1.25	-1.76
7600	1596.2	1593.93	18	-2.27	-1.76
7700	1597.9	1597.90	18	0.00	0.00
7800	1599.9	1599.10	18	-0.80	-2.62
7900	1601.5	1599.11	18	-2.39	-2.62
8100	1604.6	1603.78	17	-0.82	-2.58
8200	1607.1	1604.83	17	-2.27	-2.58
8300	1610	1605.35	17	-4.65	-2.58
8500	1613.8	1613.35	17	-0.45	-1.32
8600	1614.9	1613.98	17	-0.92	-1.32
8700	1616.5	1615.53	17	-0.97	-1.32
8800	1619.1	1617.27	17	-1.83	-1.32
8900	1621.4	1619.88	16	-1.52	-2.17
9000	1623.7	1622.32	16	-1.38	-2.17
9100	1624.9	1622.68	16	-2.22	-2.17
9200	1628.1	1626.21	16	-1.89	-2.17
9300	1629.2	1626.99	16	-2.21	-2.17
9400	1632	1629.37	16	-2.63	-2.17
9500	1634	1631.45	16	-2.55	-2.17
9600	1637	1634.08	16	-2.92	-2.17
9700	1639	1636.77	15	-2.23	-2.17
9800	1639.8	1638.42	15	-1.38	-2.17
9900	1640.8	1640.23	15	-0.57	-0.54
10000	1641.7	1641.56	15	-0.14	-0.54
10100	1644.7	1643.79	15	-0.91	-0.54
10200	1645.7	1645.65	14	-0.05	-0.53
10300	1647.5	1647.31	14	-0.19	-0.53
10400	1651.4	1650.45	14	-0.95	-0.53
10500	1653.8	1653.05	14	-0.75	-0.53
10600	1655.5	1654.79	14	-0.71	-0.53
10700	1657.7	1656.24	14	-1.46	-2.56
10800	1658.9	1656.66	14	-2.24	-2.56
10900	1663.2	1658.91	14	-4.29	-2.56
11000	1665.8	1661.65	14	-4.15	-2.56

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

HEC-6T Maximum Bed Elevation Change Summary

Hydraulic Cross Section Identification #	Bed Elevation	Minimum Bed Elevation	Reach	Hydraulic Cross Section maxium bed elevation change	Reach Average long term bed change
11777	1677.5	1677.50	13	0.00	0.00
11900	1680.4	1679.77	13	-0.63	-0.63
12100	1685.6	1684.72	13	-0.88	-0.88
12200	1687.4	1685.84	13	-1.56	-1.56
12400	1693.1	1693.00	13	-0.10	-0.10
12600	1697.6	1697.60	13	0.00	0.00
12700	1699.7	1699.64	13	-0.06	-0.06
12800	1702.2	1702.21	13	0.01	0.01
12900	1706	1704.70	13	-1.30	-2.24
13000	1707.6	1706.10	13	-1.50	-2.24
13100	1710.5	1707.91	13	-2.59	-2.24
13200	1713.5	1710.53	12	-2.97	-2.24
13300	1715.8	1713.37	12	-2.43	-2.24
13400	1717.7	1715.14	12	-2.56	-2.24
13500	1719.9	1717.58	12	-2.32	-2.24
13600	1723.4	1720.90	12	-2.50	-2.24
13700	1725.3	1723.29	12	-2.01	-2.24
13900	1730.7	1730.30	12	-0.40	-0.79
14000	1733	1732.00	12	-1.00	-0.79
14100	1735.1	1734.62	12	-0.48	-0.79
14200	1737.2	1736.65	12	-0.55	-0.79
14300	1739.4	1738.57	12	-0.83	-0.79
14400	1741.8	1740.95	12	-0.85	-0.79
14500	1744.8	1743.77	12	-1.03	-0.79
14600	1746.4	1745.75	12	-0.65	-0.79
14700	1749.3	1747.94	11	-1.36	-0.79
14800	1751.7	1750.55	11	-1.15	-0.79
14900	1753.8	1753.41	11	-0.39	-0.79
15100	1758.3	1758.32	11	0.02	-0.27
15200	1760.2	1760.14	11	-0.06	-0.27
15300	1762.8	1762.56	11	-0.24	-0.27
15400	1764.5	1764.39	11	-0.11	-0.27
15500	1768.2	1767.38	11	-0.82	-0.27
15600	1770.4	1770.13	11	-0.27	-0.27
15700	1773.7	1773.31	11	-0.39	-0.27
15800	1775.7	1775.68	10	-0.02	-0.15
15900	1778.5	1778.35	10	-0.15	-0.15
16000	1780.2	1780.24	10	0.04	-0.15
16100	1782.5	1782.45	10	-0.05	-0.15
16200	1785.2	1785.22	10	0.02	-0.15
16300	1787.8	1787.48	10	-0.32	-0.15
16400	1790.2	1789.78	10	-0.42	-0.15
16500	1792.8	1792.32	10	-0.48	-0.15
16600	1795.1	1795.08	10	-0.02	-0.15
16700	1798.1	1797.88	10	-0.22	-0.15

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

HEC-6T Maximum Bed Elevation Change Summary

Hydraulic Cross Section Identification #	Bed Elevation	Minimum Bed Elevation	Reach	Hydraulic Cross Section maxium bed elevation change	Reach Average long term bed change
16800	1799.5	1799.55	10	0.05	-0.15
16900	1802.9	1802.63	10	-0.27	-0.15
17000	1807	1805.35	10	-1.65	-1.75
17100	1810.1	1808.36	10	-1.74	-1.75
17200	1812.6	1811.23	10	-1.37	-1.75
17300	1814.8	1813.44	10	-1.36	-1.75
17400	1817.3	1815.36	10	-1.94	-1.75
17500	1819.2	1816.69	10	-2.51	-1.75
17600	1821.6	1818.94	10	-2.66	-1.75
17700	1824.1	1821.73	10	-2.37	-1.75
17800	1826.3	1824.00	10	-2.30	-1.75
17900	1828.2	1826.45	10	-1.75	-1.75
18000	1830.7	1829.29	10	-1.41	-1.75
18100	1832.6	1832.64	10	0.04	-1.75
18200	1834.2	1834.20	10	0.00	0.00
18500	1842.6	1842.39	9	-0.21	-0.48
18600	1844.5	1844.55	9	0.05	-0.48
18700	1848.2	1847.67	8	-0.53	-0.48
18800	1850.3	1849.73	8	-0.57	-0.48
18900	1852.2	1852.19	8	-0.01	-0.48
19000	1855.6	1854.94	8	-0.66	-0.48
19100	1857.5	1856.53	7	-0.97	-0.48
19200	1861.1	1860.18	7	-0.92	-0.48
19300	1863.6	1862.22	7	-1.38	-0.57
19400	1866	1864.48	7	-1.52	-0.57
19500	1868.2	1867.49	7	-0.71	-0.57
19600	1869.6	1869.53	7	-0.07	-0.57
19700	1871.1	1871.14	7	0.04	-0.57
19800	1874.1	1874.06	7	-0.04	-0.57
19900	1877.7	1877.62	7	-0.08	-0.57
20000	1881.3	1881.15	7	-0.15	-0.57
20100	1883.4	1882.76	7	-0.64	-0.57
20200	1886.6	1885.90	7	-0.70	-0.57
20300	1889.7	1888.88	7	-0.82	-0.57
20400	1891.9	1891.12	7	-0.78	-0.57
20500	1895.7	1893.29	7	-2.41	-2.41
20600	1899.3	1895.93	7	-3.37	-3.37
20700	1902	1897.66	7	-4.34	-4.34
20800	1905.5	1902.03	7	-3.47	-3.47
20900	1908.9	1903.57	7	-5.33	-5.33
21000	1912.4	1905.81	7	-6.59	-6.59
21100	1915.1	1905.25	7	-9.85	-9.85
21200	1917.1	1907.91	7	-9.19	-9.19

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

General Scour Calculations using Lacey Equation

Calc'd by: JTA — Checked: KSA
Date: 6/15/2016 — Date: 6/15/2016

(3)Hydraulic Cross Section Identification #	Reach	(1)Q	(2)D50	Z Factor	Scour Component Per Cross Section	Averaged Scour Component Per Reach	Comments
		cubic feet per second	millimeters		feet	feet	
21200	7	11901	0.350	0.25	2.65	2.65	
21100	7	11901	0.350	0.25	2.65	2.65	
21000	7	11901	0.350	0.25	2.65	2.65	
20900	7	11901	0.350	0.25	2.65	2.65	
20800	7	11901	0.350	0.25	2.65	2.65	
20700	7	11901	0.350	0.25	2.65	2.65	
20600	7	11901	0.350	0.25	2.65	2.65	
20500	7	11901	0.350	0.25	2.65	2.65	
20400	7	11901	0.350	0.25	2.65	2.65	
20300	7	11901	0.350	0.25	2.65	2.65	
20200	7	11901	0.350	0.25	2.65	2.65	
20100	7	11901	0.350	0.25	2.65	2.65	
20000	7	11901	0.350	0.25	2.65	2.65	
19900	7	11901	0.350	0.25	2.65	2.65	
19800	7	11901	0.350	0.25	2.65	2.65	
19700	7	11901	0.350	0.25	2.65	2.65	
19600	7	11901	0.350	0.25	2.65	2.65	
19500	7	11901	0.350	0.25	2.65	2.65	
19400	7	11901	0.350	0.25	2.65	2.65	
19300	7	11901	0.350	0.25	2.65	2.65	
19200	7	11901	0.350	0.25	2.65	2.65	
19100	7	11901	0.350	0.25	2.65	2.65	
19000	8	11901	0.800	0.25	2.31	2.31	
18900	8	11901	0.800	0.25	2.31	2.31	
18800	8	11901	0.800	0.25	2.31	2.31	
18700	8	11901	0.800	0.25	2.31	2.31	
18600	9	11901	0.800	0.25	2.31	2.31	
18500	9	11901	0.800	0.25	2.31	2.31	
18400	9	11901	0.800	0.25	2.31	2.31	
18345	9	11901	0.800	0.25	2.31	2.31	
18322	9	Bridge	0.800	0.25		2.31	
18300	9	11901	0.800	0.25	2.31	2.31	
18200	10	11901	0.800	0.25	2.31	2.32	
18100	10	11901	0.800	0.25	2.31	2.32	
18000	10	11901	0.800	0.25	2.31	2.32	
17900	10	11901	0.800	0.25	2.31	2.32	
17800	10	11901	0.800	0.25	2.31	2.32	
17700	10	11901	0.800	0.25	2.31	2.32	
17600	10	11901	0.800	0.25	2.31	2.32	
17500	10	11901	0.800	0.25	2.31	2.32	
17400	10	11901	0.800	0.25	2.31	2.32	
17300	10	11901	0.800	0.25	2.31	2.32	
17200	10	12338	0.800	0.25	2.33	2.32	
17100	10	12338	0.800	0.25	2.33	2.32	
17000	10	12338	0.800	0.25	2.33	2.32	
16900	10	12338	0.800	0.25	2.33	2.32	
16800	10	12338	0.800	0.25	2.33	2.32	
16700	10	12338	0.800	0.25	2.33	2.32	
16600	10	12338	0.800	0.25	2.33	2.32	
16500	10	12338	0.800	0.25	2.33	2.32	
16400	10	12338	0.800	0.25	2.33	2.32	
16300	10	12338	0.800	0.25	2.33	2.32	
16200	10	12338	0.800	0.25	2.33	2.32	
16100	10	12338	0.800	0.25	2.33	2.32	

(3)Hydraulic Cross Section Identification #	Reach	(1)Q	(2)D50	Z Factor	Scour Component Per Cross Section	Averaged Scour Component Per Reach	Comments
		cubic feet per second	millimeters		feet	feet	
16000	10	12338	0.800	0.25	2.33	2.32	
15900	10	12338	0.800	0.25	2.33	2.32	
15800	10	12338	0.800	0.25	2.33	2.32	
15700	11	12338	0.800	0.25	2.33	2.33	
15600	11	12338	0.800	0.25	2.33	2.33	
15500	11	12338	0.800	0.25	2.33	2.33	
15400	11	12338	0.800	0.25	2.33	2.33	
15300	11	12338	0.800	0.25	2.33	2.33	
15200	11	12338	0.800	0.25	2.33	2.33	
15100	11	12338	0.800	0.25	2.33	2.33	
14965.19	11	12182	0.800	0.25	2.32	2.33	
14900	11	12182	0.800	0.25	2.32	2.33	
14800	11	12182	0.800	0.25	2.32	2.33	
14700	11	12182	0.800	0.25	2.32	2.33	
14600	12	12182	0.800	0.25	2.32	2.32	
14500	12	12182	0.800	0.25	2.32	2.32	
14400	12	12182	0.800	0.25	2.32	2.32	
14300	12	12182	0.800	0.25	2.32	2.32	
14200	12	12182	0.800	0.25	2.32	2.32	
14100	12	12182	0.800	0.25	2.32	2.32	
14000	12	12182	0.800	0.25	2.32	2.32	
13900	12	12182	0.800	0.25	2.32	2.32	
13835.07	12	12182	0.800	0.25	2.32	2.32	
13700	12	12182	0.800	0.25	2.32	2.32	
13600	12	12182	0.800	0.25	2.32	2.32	
13500	12	12182	0.800	0.25	2.32	2.32	
13400	12	12182	0.800	0.25	2.32	2.32	
13300	12	12026	0.800	0.25	2.31	2.32	
13200	12	12026	0.800	0.25	2.31	2.32	
13100	13	12026	0.800	0.25	2.31	2.40	
13000	13	12026	0.800	0.25	2.31	2.40	
12900	13	12026	0.800	0.25	2.31	2.40	
12800	13	12026	0.800	0.25	2.31	2.40	
12700	13	12026	0.800	0.25	2.31	2.40	
12600	13	12026	0.800	0.25	2.31	2.40	
12545.24	13	12026	0.800	0.25	2.31	2.40	
12400	13	12026	0.800	0.25	2.31	2.40	
12289.17	13	12026	0.800	0.25	2.31	2.40	
12200	13	12026	0.800	0.25	2.31	2.40	
12100	13	12026	0.800	0.25	2.31	2.40	
12033.11	13	12026	0.800	0.25	2.31	2.40	
11900	13	12026	0.800	0.25	2.31	2.40	
11777	13	12026	0.800	0.25	2.31	2.40	
11665.28	13	11870	0.800	0.25	2.30	2.40	
11614.66	13	11870	0.800	0.25	2.30	2.40	
11600.41	13	11870	0.800	0.25	2.30	2.40	
11582.03	13	11870	0.800	0.25	2.30	2.40	
11567.48	13	11870	0.800	0.25	2.30	2.40	
11561.97	13	11870	0.800	0.25	2.30	2.40	
11545.46	13	11870	0.800	0.25	2.30	2.40	
11539.95	13	11870	0.250	0.25	2.80	2.40	
11516.11	13	Culvert	0.250	0.25		2.40	
11492.27	13	11870	0.250	0.25	2.80	2.40	
11376.89	13	11870	0.250	0.25	2.80	2.40	
11316.65	13	11870	0.250	0.25	2.80	2.40	
11271.2	13	11870	0.250	0.25	2.80	2.40	
11130.61	14	11870	0.250	0.25	2.80	2.80	
11000	14	11870	0.250	0.25	2.80	2.80	
10900	14	11870	0.250	0.25	2.80	2.80	
10800	14	11870	0.250	0.25	2.80	2.80	
10700	14	11870	0.250	0.25	2.80	2.80	
10600	14	11870	0.250	0.25	2.80	2.80	

(3)Hydraulic Cross Section Identification #	Reach	(1)Q	(2)D50	Z Factor	Scour Component Per Cross Section	Averaged Scour Component Per Reach	Comments
		cubic feet per second	millimeters		feet	feet	
10500	14	11870	0.250	0.25	2.80	2.80	
10400	14	11870	0.250	0.25	2.80	2.80	
10300	14	11870	0.250	0.25	2.80	2.80	
10200	14	11870	0.250	0.25	2.80	2.80	
10100	15	11870	0.250	0.25	2.80	2.80	
10000	15	11870	0.250	0.25	2.80	2.80	
9900	15	11870	0.250	0.25	2.80	2.80	
9800	15	11870	0.250	0.25	2.80	2.80	
9700	15	11870	0.250	0.25	2.80	2.80	
9600	16	11870	0.250	0.25	2.80	2.34	
9500	16	11870	0.250	0.25	2.80	2.34	
9400	16	11870	0.250	0.25	2.80	2.34	
9300	16	11870	0.250	0.25	2.80	2.34	
9200	16	11870	0.250	0.25	2.80	2.34	
9100	16	11870	0.250	0.25	2.80	2.34	
9000	16	11870	0.250	0.25	2.80	2.34	
8900	16	11870	0.250	0.25	2.80	2.80	
8800	17	11870	0.250	0.25	2.80	2.80	
8700	17	11870	0.250	0.25	2.80	2.80	
8600	17	11870	0.250	0.25	2.80	2.80	
8500	17	11870	0.250	0.25	2.80	2.80	
8364.13	17	11870	0.250	0.25	2.80	2.80	
8300	17	11870	0.250	0.25	2.80	2.80	
8200	17	11870	0.250	0.25	2.80	2.80	
8100	17	11870	0.250	0.25	2.80	2.80	
8032.6	17	11870	0.250	0.25	2.80	2.80	
7900	18	11870	0.250	0.25	2.80	2.82	
7800	18	11870	0.250	0.25	2.80	2.82	
7700	18	11870	0.250	0.25	2.80	2.82	
7600	18	11870	0.250	0.25	2.80	2.82	
7500	18	11870	0.250	0.25	2.80	2.82	
7361.78	18	11870	0.250	0.25	2.80	2.82	
7300	18	11870	0.250	0.25	2.80	2.82	
7200	18	11870	0.250	0.25	2.80	2.82	
7100	18	11870	0.250	0.25	2.80	2.82	
7000	18	11870	0.250	0.25	2.80	2.82	
6900	18	11870	0.250	0.25	2.80	2.82	
6800	18	11870	0.250	0.25	2.80	2.82	
6700	18	11870	0.250	0.25	2.80	2.82	
6600	18	15842	0.250	0.25	3.08	2.82	
6500	19	15842	0.250	0.25	3.08	2.38	
6400	19	15842	0.250	0.25	3.08	2.38	
6300	19	15842	1.300	0.25	2.34	2.38	
6200	19	15842	1.300	0.25	2.34	2.38	
6126.11	19	15842	1.300	0.25	2.34	2.38	
6084.06	19	15842	1.300	0.25	2.34	2.38	
6060	19	Bridge	1.300	0.25		2.38	
6041.11	19	15842	1.300	0.25	2.34	2.38	
6024.98	19	15842	1.300	0.25	2.34	2.38	
6000	19	Bridge	1.300	0.25		2.38	
5981.62	19	15842	1.300	0.25	2.34	2.38	
5900	19	15842	1.300	0.25	2.34	2.38	
5800	19	15842	1.300	0.25	2.34	2.38	
5700	19	15842	1.300	0.25	2.34	2.38	
5600	19	15842	1.300	0.25	2.34	2.38	
5500	19	15842	1.300	0.25	2.34	2.38	
5400	19	15842	1.300	0.25	2.34	2.38	
5300	19	15842	1.300	0.25	2.34	2.38	
5200	19	15842	1.300	0.25	2.34	2.38	
5100	19	15842	1.300	0.25	2.34	2.38	
5000	19	15842	1.300	0.25	2.34	2.38	
4900	19	15842	1.300	0.25	2.34	2.38	

[3]Hydraulic Cross Section Identification #	Reach	[1]Q cubic feet per second	[2]D50 millimeters	Z Factor	Scour Component Per Cross Section feet	Averaged Scour Component Per Reach feet	Comments
4800	19	15842	1.300	0.25	2.34	2.38	
4700	19	15842	1.300	0.25	2.34	2.38	
4600	19	15842	1.300	0.25	2.34	2.38	
4500	19	15842	1.300	0.25	2.34	2.38	
4400	19	15842	1.300	0.25	2.34	2.38	
4300	19	15842	1.300	0.25	2.34	2.38	
4200	19	15842	1.300	0.25	2.34	2.38	
4100	19	15842	1.300	0.25	2.34	2.38	
4000	19	15842	1.300	0.25	2.34	2.38	
3900	19	15842	1.300	0.25	2.34	2.38	
3800	19	15842	1.300	0.25	2.34	2.38	
3700	19	15842	1.300	0.25	2.34	2.38	
3600	19	15842	1.300	0.25	2.34	2.38	
3500	19	15842	1.300	0.25	2.34	2.38	
3400	19	15842	1.300	0.25	2.34	2.38	
3300	20	15842	1.300	0.25	2.34	2.34	
3200	20	15842	1.300	0.25	2.34	2.34	
3100	20	15842	1.300	0.25	2.34	2.34	
3000	21	15842	1.300	0.25	2.34	2.34	
2900	21	15842	1.300	0.25	2.34	2.34	
2800	21	15842	1.300	0.25	2.34	2.34	
2700	21	15842	1.300	0.25	2.34	2.34	
2600	21	15842	1.300	0.25	2.34	2.34	
2500	22	15842	1.300	0.25	2.34	2.34	
2400	22	15842	1.300	0.25	2.34	2.34	
2300	22	15842	1.300	0.25	2.34	2.34	
2200	22	15842	1.300	0.25	2.34	2.34	
2100	22	15842	1.300	0.25	2.34	2.34	
2000	22	15842	1.300	0.25	2.34	2.34	
1900	22	15842	1.300	0.25	2.34	2.34	
1800	22	15842	1.300	0.25	2.34	2.34	
1700	22	15842	1.300	0.25	2.34	2.34	
1600	22	15842	1.300	0.25	2.34	2.34	

Notes:

(1) - Q100 per project Hydrology

(2) - D50 from SLA 1997 sediment gradation curves

(3) - HEC-RAS cross section from November 11, 2015. HEC-RAS cross sections incorporated in the HEC-6T model.

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Bend Scour Calculations using Lacey Equation

Calc'd by: JTA
Date: 6/15/2016

Checked: KSA
Date: 6/15/2016

(4)Hydraulic Cross Section Identification #	Reach	(1)Q	(2)D50	Z Factor	Scour Component Per Cross Section	Curve Letter	Averaged Scour Component Per Bend East	Averaged Scour Component Per Bend West	(3)Downstream Length	Comments
		cubic feet per second	millimeters		feet		feet	feet	feet	
21200	7	11901	1.500	0.50	4.15	B	4.14			
21100	7	11901	1.500	0.50	4.15	B	4.14			
21000	7	11901	1.500	0.50	4.15	B	4.14		107	Approximate PT Location
20900	7	11901	1.500		0.00		4.14			
20800	7	11901	1.500		0.00					
20700	7	11901	1.500		0.00					
20600	7	11901	1.500		0.00					
20500	7	11901	1.500		0.00					
20400	7	11901	1.500	0.50	4.15	C	4.15			Approximate PC Location
20300	7	11901	1.500	0.50	4.15	C	4.15			
20200	7	11901	1.500	0.50	4.15	C	4.15			
20100	7	11901	1.500	0.50	4.15	C	4.15			
20000	7	11901	1.500	0.50	4.15	C	4.15			
19900	7	11901	1.500	0.50	4.15	C	4.15			
19800	7	11901	1.500	0.50	4.15	C	4.15			
19700	7	11901	1.500	0.50	4.15	C	4.15			
19600	7	11901	1.500	0.50	4.15	C	4.15			
19500	7	11901	1.500	0.50	4.15	C	4.15			
19400	7	11901	1.500	0.50	4.15	C	4.15		117	Approximate PT Location
19300	7	11901	1.500		0.00		4.15			
19200	7	11901	1.500		0.00					
19100	7	11901	1.500		0.00					
19000	8	11901	6.820		0.00					
18900	8	11901	6.820		0.00					
18800	8	11901	6.820		0.00					
18700	8	11901	6.820		0.00					
18600	9	11901	6.820		0.00					
18500	9	11901	6.820		0.00					
18400	9	11901	6.820		0.00					
18345	9	11901	6.820		0.00					
18322	9	Bridge	6.820							
18300	9	11901	6.820		0.00					
18200	10	11901	6.820		0.00					
18100	10	11901	6.820		0.00					
18000	10	11901	6.820		0.00					
17900	10	11901	6.820		0.00					
17800	10	11901	6.820		0.00					
17700	10	11901	6.820		0.00					
17600	10	11901	6.820		0.00					
17500	10	11901	6.820		0.00					
17400	10	11901	6.820		0.00					
17300	10	11901	6.820		0.00					
17200	10	12338	6.820		0.00					
17100	10	12338	6.820		0.00					
17000	10	12338	6.820		0.00					
16900	10	12338	6.820		0.00					
16800	10	12338	6.820		0.00					
16700	10	12338	6.820		0.00					
16600	10	12338	6.820		0.00					
16500	10	12338	6.820		0.00					
16400	10	12338	6.820		0.00					
16300	10	12338	6.820		0.00					
16200	10	12338	6.820		0.00					
16100	10	12338	6.820		0.00					

(4)Hydraulic Cross Section Identification #	Reach	(1)Q	(2)D50	Z Factor	Scour Component Per Cross Section	Curve Letter	Averaged Scour Component Per Bend		(3)Downstream Length	Comments
							East	West		
		cubic feet per second	millimeters		feet		feet	feet	feet	
16000	10	12338	6.820		0.00					
15900	10	12338	6.820		0.00					
15800	10	12338	6.820		0.00					
15700	11	12338	6.820		0.00					
15600	11	12338	6.820		0.00					
15500	11	12338	6.820		0.00					
15400	11	12338	6.820		0.00					
15300	11	12338	6.820		0.00					
15200	11	12338	6.820		0.00					
15100	11	12338	6.820		0.00					
14965.19	11	12182	6.820		0.00					
14900	11	12182	6.820		0.00					
14800	11	12182	6.820		0.00					
14700	11	12182	6.820		0.00					
14600	12	12182	6.820		0.00					
14500	12	12182	6.820		0.00					
14400	12	12182	6.820		0.00					
14300	12	12182	6.820		0.00					
14200	12	12182	6.820		0.00					
14100	12	12182	6.820	0.50	3.25	D		3.25		Approximate PC Location
14000	12	12182	6.820	0.50	3.25	D		3.25		
13900	12	12182	6.820	0.50	3.25	D		3.25		
13835.07	12	12182	6.820	0.50	3.25	D		3.25		
13700	12	12182	6.820	0.50	3.25	D		3.25		
13600	12	12182	6.820	0.50	3.25	D		3.25		
13500	12	12182	6.820	0.50	3.25	D		3.25		
13400	12	12182	6.820	0.50	3.25	D		3.25		
13300	12	12026	6.820	0.50	3.24	D		3.25		
13200	12	12026	6.820	0.50	3.24	D		3.25		
13100	13	12026	6.820	0.50	3.24	D		3.25	118	Approximate PT Location
13000	13	12026	6.820		0.00			3.25		
12900	13	12026	6.820		0.00					
12800	13	12026	6.820		0.00					
12700	13	12026	6.820		0.00					
12600	13	12026	6.820		0.00					
12545.24	13	12026	6.820		0.00					
12400	13	12026	6.820		0.00					
12289.17	13	12026	6.820		0.00					
12200	13	12026	6.820		0.00					
12100	13	12026	6.820		0.00					
12033.11	13	12026	6.820		0.00					
11900	13	12026	6.820		0.00					
11777	13	12026	6.820		0.00					
11665.28	13	11870	6.820		0.00					
11614.66	13	11870	6.820		0.00					
11600.41	13	11870	6.820		0.00					
11582.03	13	11870	6.820		0.00					
11567.48	13	11870	6.820		0.00					
11561.97	13	11870	6.820		0.00					
11545.46	13	11870	6.820		0.00					
11539.95	13	11870	1.500		0.00					
11516.11	13	Culvert	1.500							
11492.27	13	11870	1.500		0.00					
11376.89	13	11870	1.500		0.00					
11316.65	13	11870	1.500		0.00					
11271.2	13	11870	1.500		0.00					
11130.61	14	11870	1.500		0.00					
11000	14	11870	1.500		0.00					
10900	14	11870	1.500		0.00					
10800	14	11870	1.500		0.00					
10700	14	11870	1.500		0.00					
10600	14	11870	1.500		0.00					
10500	14	11870	1.500		0.00					

(4)Hydraulic Cross Section Identification #	Reach	(1)Q	(2)D50	Z Factor	Scour Component Per Cross Section	Curve Letter	Averaged Scour Component Per Bend		(3)Downstream Length	Comments
							East	West		
		cubic feet per second	millimeters		feet		feet	feet	feet	
10400	14	11870	1.500		0.00					
10300	14	11870	1.500		0.00					
10200	14	11870	1.500		0.00					
10100	15	11870	1.500		0.00					
10000	15	11870	1.500		0.00					
9900	15	11870	1.500		0.00					
9800	15	11870	1.500		0.00					
9700	15	11870	1.500		0.00					
9600	16	11870	1.500		0.00					
9500	16	11870	1.500		0.00					
9400	16	11870	1.500		0.00					
9300	16	11870	1.500		0.00					
9200	16	11870	1.500		0.00					
9100	16	11870	1.500		0.00					
9000	16	11870	1.500		0.00					
8900	16	11870	1.500		0.00					
8800	17	11870	1.500		0.00					
8700	17	11870	1.500		0.00					
8600	17	11870	1.500		0.00					
8500	17	11870	1.500		0.00					
8364.13	17	11870	1.500		0.00					
8300	17	11870	1.500		0.00					
8200	17	11870	1.500	0.50	4.15	E		4.15		Approximate PC Location
8100	17	11870	1.500	0.50	4.15	E		4.15		
8032.6	17	11870	1.500	0.50	4.15	E		4.15		
7900	18	11870	1.500	0.50	4.15	E		4.15		
7800	18	11870	1.500	0.50	4.15	E		4.15		
7700	18	11870	1.500	0.50	4.15	E		4.15		
7600	18	11870	1.500	0.50	4.15	E		4.15		
7500	18	11870	1.500	0.50	4.15	E		4.15		
7361.78	18	11870	1.500	0.50	4.15	E		4.15		
7300	18	11870	1.500	0.50	4.15	E		4.15		
7200	18	11870	1.500	0.50	4.15	E		4.15		
7100	18	11870	1.500	0.50	4.15	E		4.15		
7000	18	11870	1.500	0.50	4.15	E		4.15	116	Approximate PT Location
6900	18	11870	1.500		0.00			4.15		
6800	18	11870	1.500		0.00					
6700	18	11870	1.500		0.00					
6600	18	15842	1.500		0.00					
6500	19	15842	1.500		0.00					
6400	19	15842	1.500		0.00					
6300	19	15842	8.400	0.50	3.43	F	3.43			Approximate PC Location
6200	19	15842	8.400	0.50	3.43	F	3.43			
6126.11	19	15842	8.400	0.50	3.43	F	3.43			
6084.06	19	15842	8.400	0.50	3.43	F	3.43			
6060	19	Bridge	8.400	0.50		F	3.43			
6041.11	19	15842	8.400	0.50	3.43	F	3.43			
6024.98	19	15842	8.400	0.50	3.43	F	3.43			
6000	19	Bridge	8.400	0.50		F	3.43			
5981.62	19	15842	8.400	0.50	3.43	F	3.43			
5900	19	15842	8.400	0.50	3.43	F	3.43			
5800	19	15842	8.400	0.50	3.43	F	3.43		76	Approximate PT Location
5700	19	15842	8.400		0.00		3.43			
5600	19	15842	8.400		0.00					
5500	19	15842	8.400		0.00					
5400	19	15842	8.400		0.00					
5300	19	15842	8.400		0.00					
5200	19	15842	8.400		0.00					
5100	19	15842	8.400		0.00					
5000	19	15842	8.400		0.00					
4900	19	15842	8.400		0.00					
4800	19	15842	8.400		0.00					
4700	19	15842	8.400		0.00					

(4)Hydraulic Cross Section Identification #	Reach	(1)Q	(2)D50	Z Factor	Scour Component Per Cross Section	Curve Letter	Averaged Scour Component Per Bend		(3)Downstream Length	Comments
							East	West		
		cubic feet per second	millimeters		feet		feet	feet	feet	
4600	19	15842	8.400		0.00					
4500	19	15842	8.400		0.00					
4400	19	15842	8.400		0.00					
4300	19	15842	8.400		0.00					
4200	19	15842	8.400		0.00					
4100	19	15842	8.400		0.00					
4000	19	15842	8.400		0.00					
3900	19	15842	8.400	0.50	3.43	G		3.43		Approximate PC Location
3800	19	15842	8.400	0.50	3.43	G		3.43		
3700	19	15842	8.400	0.50	3.43	G		3.43		
3600	19	15842	8.400	0.50	3.43	G		3.43		
3500	19	15842	8.400	0.50	3.43	G		3.43		
3400	19	15842	8.400	0.50	3.43	G		3.43		
3300	20	15842	8.400	0.50	3.43	G		3.43		
3200	20	15842	8.400	0.50	3.43	G		3.43		
3100	20	15842	8.400	0.50	3.43	G		3.43		
3000	21	15842	8.400	0.50	3.43	G		3.43		
2900	21	15842	8.400	0.50	3.43	G		3.43		
2800	21	15842	8.400	0.50	3.43	G		3.43		
2700	21	15842	8.400	0.50	3.43	G		3.43		
2600	21	15842	8.400	0.50	3.43	G		3.43		
2500	22	15842	8.400	0.50	3.43	G		3.43	317	Approximate PT Location
2400	22	15842	8.400		0.00			3.43		
2300	22	15842	8.400		0.00			3.43		
2200	22	15842	8.400		0.00			3.43		
2100	22	15842	8.400		0.00					
2000	22	15842	8.400		0.00					
1900	22	15842	8.400		0.00					
1800	22	15842	8.400		0.00					
1700	22	15842	8.400		0.00					
1600	22	15842	8.400		0.00					

Notes:
(1) - Q100 per project Hydrology
(2) - D50 from SLA 1997 sediment gradation curves
(3) - Extended downstream from the PT by length L
(4) - HEC-RAS cross section from November 11, 2015. HEC-RAS cross sections incorporated in the HEC-6T model.

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Curve Data and Bend Scour Limits

Calc'd by: JTA Checked: KSA
Date: 6/10/2016 Date: 6/15/2016

Curve Letter	(1)Curve Data		Radius of Curvature	alpha	Channel Side e/w	HEC-RAS Station nearest PT	(2)Downstream Length X	Applied Bend Scour Limits		Comments
	PC	PT						Upstream PC	Downstream PT-X	
			feet	degrees			feet	feet	feet	
A	23300	22300	1000.000	32.83	w	22300.00	145	233+00	221+55	
B	22300	21040	1000.000	30.61	e	21000.00	107	223+00	209+33	
C	20400	19460	1300.000	37.33	e	19400.00	117	204+00	193+43	
D	14100	13180	2000.000	30.34	w	13100.00	118	141+00	130+62	
E	8100	7070	2000.000	24.80	w	7000.00	116	81+00	69+54	
F	6200	5860	400.000	47.29	e	5800.00	76	62+00	57+84	
G	3900	2530	1400.000	31.93	w	2500.00	317	39+00	22+13	

Notes:
(1) - From ACAD centerline data
(2) - Downstream length deteermined per FCDMC DDM Hydraulics Equation 11.60.

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Bedform Scour

Calc'd by: JTA
Date: 6/10/2016

Checked: KSA
Date: 6/15/2016

(3)Hydraulic Cross Section Identification #	Reach	Hydraulic Depth	Froude No.	Channel Velocity	Controlling:	Dune Height	Anti-Dune Height	Scour Component Per Cross Section	Averaged Scour Component Per Reach	Notes
		(ft)		ft/s		(ft)	(ft)	(ft)	(ft)	
21200	7	3.27	1.78	19.59	Anti-Dune	0.65	3.27	1.64	1.45	
21100	7	2.58	1.85	19.25	Anti-Dune	0.52	2.58	1.29	1.45	
21000	7	2.96	1.56	17.33	Anti-Dune	0.59	2.96	1.48	1.45	
20900	7	3.15	1.66	18.61	Anti-Dune	0.63	3.15	1.58	1.45	
20800	7	2.43	2.07	18.93	Anti-Dune	0.49	2.43	1.22	1.45	
20700	7	3.1	1.5	15.26	Anti-Dune	0.62	3.10	1.55	1.45	
20600	7	2.52	1.67	16.15	Anti-Dune	0.50	2.52	1.26	1.45	
20500	7	2.7	1.65	15.45	Anti-Dune	0.54	2.70	1.35	1.45	
20400	7	2.8	1.5	14.7	Anti-Dune	0.56	2.80	1.40	1.45	
20300	7	2.84	1.49	15.3	Anti-Dune	0.57	2.84	1.42	1.45	
20200	7	2.99	1.28	14.99	Anti-Dune	0.60	2.99	1.50	1.45	
20100	7	3.89	1.29	15.67	Anti-Dune	0.78	3.89	1.95	1.45	
20000	7	1.63	2.91	21.38	Anti-Dune	0.33	1.63	0.82	1.45	
19900	7	2.78	1.31	13.14	Anti-Dune	0.56	2.78	1.39	1.45	
19800	7	2.71	1.4	14.46	Anti-Dune	0.54	2.71	1.36	1.45	
19700	7	3.32	1.13	12.8	Anti-Dune	0.66	3.32	1.66	1.45	
19600	7	2.95	1.22	14.27	Anti-Dune	0.59	2.95	1.48	1.45	
19500	7	2.7	1.14	13.53	Anti-Dune	0.54	2.70	1.35	1.45	
19400	7	2.5	1.53	16.82	Anti-Dune	0.50	2.50	1.25	1.45	
19300	7	2.9	1.37	14.74	Anti-Dune	0.58	2.90	1.45	1.45	
19200	7	3.24	1.35	14.8	Anti-Dune	0.65	3.24	1.62	1.45	
19100	7	3.69	0.9	12.08	Anti-Dune	0.74	3.69	1.85	1.45	
19000	8	2.95	1.21	16.84	Anti-Dune	0.59	2.95	1.48	1.42	
18900	8	2.82	1.39	18.98	Anti-Dune	0.56	2.82	1.41	1.42	
18800	8	3.13	1.53	20.54	Anti-Dune	0.63	3.13	1.57	1.42	
18700	8	2.44	1.96	22.96	Anti-Dune	0.49	2.44	1.22	1.42	
18600	9	2.53	1.47	16.61	Anti-Dune	0.51	2.53	1.27	1.20	
18500	9	2.7	1.64	17.34	Anti-Dune	0.54	2.70	1.35	1.20	
18400	9	2.93	1.27	14.35	Anti-Dune	0.59	2.93	1.47	1.20	
18345	9	4.5	0.65	8.89	Dune	0.90	2.13	0.45	1.20	
18322	9								1.20	
18300	9	2.91	1.36	15.32	Anti-Dune	0.58	2.91	1.46	1.20	
18200	10	2.5	1.61	14.46	Anti-Dune	0.50	2.50	1.25	1.31	
18100	10	3.16	1.16	11.95	Anti-Dune	0.63	3.16	1.58	1.31	
18000	10	3.49	1.25	13.2	Anti-Dune	0.70	3.49	1.75	1.31	
17900	10	3.09	1.27	12.71	Anti-Dune	0.62	3.09	1.55	1.31	
17800	10	3.24	1.13	11.69	Anti-Dune	0.65	3.24	1.62	1.31	
17700	10	3	1.3	12.88	Anti-Dune	0.60	3.00	1.50	1.31	
17600	10	3.52	0.96	10.98	Anti-Dune	0.70	3.26	1.63	1.31	
17500	10	2.2	1.23	13.65	Anti-Dune	0.44	2.20	1.10	1.31	
17400	10	2.38	1.4	13.8	Anti-Dune	0.48	2.38	1.19	1.31	
17300	10	2.99	1.24	13.59	Anti-Dune	0.60	2.99	1.50	1.31	
17200	10	2.21	1.59	14.74	Anti-Dune	0.44	2.21	1.11	1.31	
17100	10	2.83	1.1	11.93	Anti-Dune	0.57	2.83	1.42	1.31	
17000	10	1.97	1.69	15.03	Anti-Dune	0.39	1.97	0.99	1.31	
16900	10	2.44	1.11	9.99	Anti-Dune	0.49	2.44	1.22	1.31	
16800	10	2.2	1.33	11.5	Anti-Dune	0.44	2.20	1.10	1.31	
16700	10	2.26	1.21	11.07	Anti-Dune	0.45	2.26	1.13	1.31	
16600	10	2.07	1.33	12.13	Anti-Dune	0.41	2.07	1.04	1.31	
16500	10	2.36	1.07	10.71	Anti-Dune	0.47	2.36	1.18	1.31	
16400	10	2.04	1.32	12.08	Anti-Dune	0.41	2.04	1.02	1.31	
16300	10	2.38	1.16	11.36	Anti-Dune	0.48	2.38	1.19	1.31	

[3]Hydraulic Cross Section Identification #	Reach	Hydraulic Depth (ft)	Froude No.	Channel Velocity ft/s	Controlling :	Dune Height (ft)	Anti-Dune Height (ft)	Scour Component Per Cross Section (ft)	Averaged Scour Component Per Reach (ft)	Notes
16200	10	2.55	1.25	12.12	Anti-Dune	0.51	2.55	1.28	1.31	
16100	10	2.7	1.13	11.98	Anti-Dune	0.54	2.70	1.35	1.31	
16000	10	2.5	1.29	11.72	Anti-Dune	0.50	2.50	1.25	1.31	
15900	10	2.84	1.13	10.97	Anti-Dune	0.57	2.84	1.42	1.31	
15800	10	2.59	1.25	11.61	Anti-Dune	0.52	2.59	1.30	1.31	
15700	11	2.24	1.27	10.76	Anti-Dune	0.45	2.24	1.12	0.98	
15600	11	2.14	1.26	10.63	Anti-Dune	0.43	2.14	1.07	0.98	
15500	11	2.07	1.2	9.87	Anti-Dune	0.41	2.07	1.04	0.98	
15400	11	2.18	1.02	8.64	Anti-Dune	0.44	2.02	1.01	0.98	
15300	11	1.82	1.3	10	Anti-Dune	0.36	1.82	0.91	0.98	
15200	11	1.98	1.03	8.27	Anti-Dune	0.40	1.85	0.92	0.98	
15100	11	1.75	1.25	9.42	Anti-Dune	0.35	1.75	0.88	0.98	
14965.19	11	1.92	1.04	8.02	Anti-Dune	0.38	1.74	0.87	0.98	
14900	11	1.83	1.18	8.88	Anti-Dune	0.37	1.83	0.92	0.98	
14800	11	2.03	1.01	8.35	Anti-Dune	0.41	1.88	0.94	0.98	
14700	11	2.23	1.23	10.5	Anti-Dune	0.45	2.23	1.12	0.98	
14600	12	1.97	1.19	10.6	Anti-Dune	0.39	1.97	0.99	1.02	
14500	12	1.9	1.14	10.19	Anti-Dune	0.38	1.90	0.95	1.02	
14400	12	2	1.11	10.55	Anti-Dune	0.40	2.00	1.00	1.02	
14300	12	1.69	1.22	11.43	Anti-Dune	0.34	1.69	0.85	1.02	
14200	12	1.69	1.2	10.66	Anti-Dune	0.34	1.69	0.85	1.02	
14100	12	1.68	1.3	10.34	Anti-Dune	0.34	1.68	0.84	1.02	
14000	12	1.87	1.07	8.56	Anti-Dune	0.37	1.87	0.94	1.02	
13900	12	1.79	1.2	9.43	Anti-Dune	0.36	1.79	0.90	1.02	
13835.07	12	1.92	1.06	8.38	Anti-Dune	0.38	1.90	0.95	1.02	
13700	12	2.06	1.07	8.79	Anti-Dune	0.41	2.06	1.03	1.02	
13600	12	2.13	1.13	9.53	Anti-Dune	0.43	2.13	1.07	1.02	
13500	12	2.19	1.16	9.96	Anti-Dune	0.44	2.19	1.10	1.02	
13400	12	2.41	1.07	9.59	Anti-Dune	0.48	2.41	1.21	1.02	
13300	12	2.55	1.04	9.69	Anti-Dune	0.51	2.54	1.27	1.02	
13200	12	2.59	1.15	10.65	Anti-Dune	0.52	2.59	1.30	1.02	
13100	13	2.9	1.19	12.17	Anti-Dune	0.58	2.90	1.45	1.73	
13000	13	3.58	1	11.39	Anti-Dune	0.72	3.50	1.75	1.73	
12900	13	3.44	1.18	13.22	Anti-Dune	0.69	3.44	1.72	1.73	
12800	13	3.77	1.05	12.54	Anti-Dune	0.75	3.77	1.89	1.73	
12700	13	3.39	1.37	15.56	Anti-Dune	0.68	3.39	1.70	1.73	
12600	13	2.74	1.89	19.92	Anti-Dune	0.55	2.74	1.37	1.73	
12545.24	13	3.53	1.24	13.42	Anti-Dune	0.71	3.53	1.77	1.73	
12400	13	3.81	1.15	13.21	Anti-Dune	0.76	3.81	1.91	1.73	
12289.17	13	3.74	1.18	13.6	Anti-Dune	0.75	3.74	1.87	1.73	
12200	13	3.6	1.35	15.04	Anti-Dune	0.72	3.60	1.80	1.73	
12100	13	3.68	1.27	14.38	Anti-Dune	0.74	3.68	1.84	1.73	
12033.11	13	3.62	1.31	14.77	Anti-Dune	0.72	3.62	1.81	1.73	
11900	13	3.86	1.21	14.18	Anti-Dune	0.77	3.86	1.93	1.73	
11777	13	3.79	1.27	14.79	Anti-Dune	0.76	3.79	1.90	1.73	
11665.28	13	3.51	1.39	15.16	Anti-Dune	0.70	3.51	1.76	1.73	
11614.66	13	3.9	1.25	14.25	Anti-Dune	0.78	3.90	1.95	1.73	
11600.41	13	3.92	1.24	14.15	Anti-Dune	0.78	3.92	1.96	1.73	
11582.03	13	3.64	1.37	15.15	Anti-Dune	0.73	3.64	1.82	1.73	
11567.48	13	3.55	1.48	16.24	Anti-Dune	0.71	3.55	1.78	1.73	
11561.97	13	3.57	1.45	16.06	Anti-Dune	0.71	3.57	1.79	1.73	
11545.46	13	7.91	0.42	6.93	Dune	1.58	1.30	0.79	1.73	
11539.95	13	8.34	0.46	7.55	Dune	1.67	1.54	0.83	1.73	
11516.11	13								1.73	
11492.27	13	5.9	0.77	10.72	Anti-Dune	1.18	3.10	1.55	1.73	
11376.89	13	5.36	0.8	11.52	Anti-Dune	1.07	3.58	1.79	1.73	
11316.65	13	4.71	0.96	13.15	Anti-Dune	0.94	4.67	2.33	1.73	
11271.2	13	4.82	0.85	11.85	Anti-Dune	0.96	3.79	1.90	1.73	
11130.61	14	3.6	0.83	9.59	Anti-Dune	0.72	2.48	1.24	1.37	
11000	14	2.98	1.03	10.24	Anti-Dune	0.60	2.83	1.42	1.37	

(3)Hydraulic Cross Section Identification #	Reach	Hydraulic Depth (ft)	Froude No.	Channel Velocity ft/s	Controlling :	Dune Height (ft)	Anti-Dune Height (ft)	Scour Component Per Cross Section (ft)	Averaged Scour Component Per Reach (ft)	Notes
10900	14	2.41	1.41	12.63	Anti-Dune	0.48	2.41	1.21	1.37	
10800	14	2.83	1.08	10.56	Anti-Dune	0.57	2.83	1.42	1.37	
10700	14	2.7	1.17	11.11	Anti-Dune	0.54	2.70	1.35	1.37	
10600	14	2.73	1.18	11.26	Anti-Dune	0.55	2.73	1.37	1.37	
10500	14	2.81	1.12	10.93	Anti-Dune	0.56	2.81	1.41	1.37	
10400	14	2.69	1.27	11.98	Anti-Dune	0.54	2.69	1.35	1.37	
10300	14	2.96	1.11	11.04	Anti-Dune	0.59	2.96	1.48	1.37	
10200	14	2.98	1.17	11.76	Anti-Dune	0.60	2.98	1.49	1.37	
10100	15	3.66	0.89	10.67	Anti-Dune	0.73	3.07	1.54	1.65	
10000	15	3.59	0.88	11.33	Anti-Dune	0.72	3.47	1.73	1.65	
9900	15	3.73	0.94	12.46	Anti-Dune	0.75	3.73	1.87	1.65	
9800	15	2.88	1.38	14.71	Anti-Dune	0.58	2.88	1.44	1.65	
9700	15	3.35	1.03	11.18	Anti-Dune	0.67	3.35	1.68	1.65	
9600	16	2.6	1.36	12.63	Anti-Dune	0.52	2.60	1.30	1.10	
9500	16	2.85	1.11	10.86	Anti-Dune	0.57	2.85	1.43	1.10	
9400	16	2.43	1.29	11.57	Anti-Dune	0.49	2.43	1.22	1.10	
9300	16	2.76	1	9.49	Anti-Dune	0.55	2.43	1.22	1.10	
9200	16	2.4	1.15	10.72	Anti-Dune	0.48	2.40	1.20	1.10	
9100	16	2.36	1.19	10.74	Anti-Dune	0.47	2.36	1.18	1.10	
9000	16	2.66	0.94	9.5	Anti-Dune	0.53	2.44	1.22	1.10	
8900	16	2.87	1.19	12.26	Anti-Dune	0.57	2.87	1.44	1.28	
8800	17	3.3	0.87	11.25	Anti-Dune	0.66	3.30	1.65	1.27	
8700	17	2.32	1.13	14.43	Anti-Dune	0.46	2.32	1.16	1.27	
8600	17	2.42	1.23	14.93	Anti-Dune	0.48	2.42	1.21	1.27	
8500	17	2.37	1.35	15.03	Anti-Dune	0.47	2.37	1.19	1.27	
8364.13	17	2.52	1.12	14.11	Anti-Dune	0.50	2.52	1.26	1.27	
8300	17	2.49	1.33	16.37	Anti-Dune	0.50	2.49	1.25	1.27	
8200	17	2.28	1.52	16.94	Anti-Dune	0.46	2.28	1.14	1.27	
8100	17	2.61	1.31	15.54	Anti-Dune	0.52	2.61	1.31	1.27	
8032.6	17	2.59	1.43	16.25	Anti-Dune	0.52	2.59	1.30	1.27	
7900	18	2.88	1.23	12.95	Anti-Dune	0.58	2.88	1.44	1.54	
7800	18	3.35	0.99	11.41	Anti-Dune	0.67	3.35	1.68	1.54	
7700	18	3.04	1.21	13.17	Anti-Dune	0.61	3.04	1.52	1.54	
7600	18	3.33	1.07	11.33	Anti-Dune	0.67	3.33	1.67	1.54	
7500	18	3.56	1	11.21	Anti-Dune	0.71	3.39	1.70	1.54	
7361.78	18	3.23	1.22	12.81	Anti-Dune	0.65	3.23	1.62	1.54	
7300	18	3.29	1.22	13.45	Anti-Dune	0.66	3.29	1.65	1.54	
7200	18	3.87	0.89	11.8	Anti-Dune	0.77	3.76	1.88	1.54	
7100	18	3.22	1.19	14.07	Anti-Dune	0.64	3.22	1.61	1.54	
7000	18	2.78	1.46	14.36	Anti-Dune	0.56	2.78	1.39	1.54	
6900	18	2.96	1.01	10.89	Anti-Dune	0.59	2.96	1.48	1.54	
6800	18	2.63	1.05	11.12	Anti-Dune	0.53	2.63	1.32	1.54	
6700	18	2.4	0.98	10.58	Anti-Dune	0.48	2.40	1.20	1.54	
6600	18	2.77	1.01	11.75	Anti-Dune	0.55	2.77	1.39	1.54	
6500	19	2.4	1.29	13.54	Anti-Dune	0.48	2.40	1.20	1.83	
6400	19	2.59	1.1	11.42	Anti-Dune	0.52	2.59	1.30	1.83	
6300	19	2.6	1.85	17.93	Anti-Dune	0.52	2.60	1.30	1.83	
6200	19	4.56	1.01	12.24	Anti-Dune	0.91	4.05	2.02	1.83	
6126.11	19	6.1	0.72	10.15	Anti-Dune	1.22	2.78	1.39	1.83	
6084.06	19	6.61	0.66	9.64	Dune	1.32	2.51	0.66	1.83	
6060	19								1.83	
6041.11	19	6.13	0.75	10.49	Anti-Dune	1.23	2.97	1.49	1.83	
6024.98	19	6.28	0.73	10.33	Anti-Dune	1.26	2.88	1.44	1.83	
6000	19								1.83	
5981.62	19	4.58	1.21	14.65	Anti-Dune	0.92	4.58	2.29	1.83	
5900	19	2.74	2.55	23.91	Anti-Dune	0.55	2.74	1.37	1.83	
5800	19	3.45	1.76	18.6	Anti-Dune	0.69	3.45	1.73	1.83	
5700	19	4.21	1.28	14.89	Anti-Dune	0.84	4.21	2.11	1.83	
5600	19	4.9	1.01	12.62	Anti-Dune	0.98	4.30	2.15	1.83	
5500	19	4.37	1.21	14.36	Anti-Dune	0.87	4.37	2.19	1.83	

(3)Hydraulic Cross Section Identification #	Reach	Hydraulic Depth	Froude No.	Channel Velocity	Controlling :	Dune Height	Anti-Dune Height	Scour Component Per Cross Section	Averaged Scour Component Per Reach	Notes
		(ft)		ft/s		(ft)	(ft)	(ft)	(ft)	
5400	19	4.54	1.14	13.73	Anti-Dune	0.91	4.54	2.27	1.83	
5300	19	4.1	1.34	15.39	Anti-Dune	0.82	4.10	2.05	1.83	
5200	19	3.94	1.43	16.07	Anti-Dune	0.79	3.94	1.97	1.83	
5100	19	4.89	1	12.61	Anti-Dune	0.98	4.29	2.15	1.83	
5000	19	3.83	1.5	16.62	Anti-Dune	0.77	3.83	1.92	1.83	
4900	19	4.9	1	12.62	Anti-Dune	0.98	4.30	2.15	1.83	
4800	19	5.38	0.86	11.34	Anti-Dune	1.08	3.47	1.74	1.83	
4700	19	5.12	0.93	12	Anti-Dune	1.02	3.89	1.94	1.83	
4600	19	4.9	1	12.62	Anti-Dune	0.98	4.30	2.15	1.83	
4500	19	4.57	1.13	13.66	Anti-Dune	0.91	4.57	2.29	1.83	
4400	19	5.95	0.73	10.1	Anti-Dune	1.19	2.75	1.38	1.83	
4300	19	4.9	1	12.62	Anti-Dune	0.98	4.30	2.15	1.83	
4200	19	3.97	1.41	15.96	Anti-Dune	0.79	3.97	1.99	1.83	
4100	19	4.9	1	12.62	Anti-Dune	0.98	4.30	2.15	1.83	
4000	19	3.92	1.44	16.2	Anti-Dune	0.78	3.92	1.96	1.83	
3900	19	4.9	1.01	12.62	Anti-Dune	0.98	4.30	2.15	1.83	
3800	19	6.52	0.63	9.08	Dune	1.30	2.23	0.65	1.83	
3700	19	4.98	1	12.7	Anti-Dune	1.00	4.35	2.18	1.83	
3600	19	3.88	1.46	16.35	Anti-Dune	0.78	3.88	1.94	1.83	
3500	19	4.9	1.01	12.62	Anti-Dune	0.98	4.30	2.15	1.83	
3400	19	3.87	1.47	16.42	Anti-Dune	0.77	3.87	1.94	1.83	
3300	20	6.81	0.58	8.63	Dune	1.36	2.01	0.68	0.76	
3200	20	7.58	0.49	7.6	Dune	1.52	1.56	0.76	0.76	
3100	20	8.39	0.41	6.74	Dune	1.68	1.23	0.84	0.76	
3000	21	6.61	1	14.6	Anti-Dune	1.32	5.76	2.88	2.52	
2900	21	5.33	1.39	18.15	Anti-Dune	1.07	5.33	2.67	2.52	
2800	21	3.88	1.74	19.44	Anti-Dune	0.78	3.88	1.94	2.52	
2700	21	5.93	1.01	13.91	Anti-Dune	1.19	5.22	2.61	2.52	
2600	21	5.01	1.57	19.99	Anti-Dune	1.00	5.01	2.51	2.52	
2500	22	9.61	0.47	8.23	Dune	1.92	1.83	0.96	1.10	
2400	22	9.65	0.48	8.41	Dune	1.93	1.91	0.97	1.10	
2300	22	8.74	0.67	11.25	Dune	1.75	3.42	0.87	1.10	
2200	22	9.32	0.49	8.54	Dune	1.86	1.97	0.93	1.10	
2100	22	9.58	0.48	8.39	Dune	1.92	1.90	0.96	1.10	
2000	22	9.2	0.51	8.73	Dune	1.84	2.06	0.92	1.10	
1900	22	9.08	0.5	8.51	Dune	1.82	1.96	0.91	1.10	
1800	22	9.08	0.55	9.41	Dune	1.82	2.39	0.91	1.10	
1700	22	8.01	0.67	10.68	Dune	1.60	3.08	0.80	1.10	
1600	22	6.38	1.01	14.41	Anti-Dune	1.28	5.61	2.80	1.10	

Notes:
(1) - HEC-RAS cross section from November 11, 2015. HEC-RAS cross sections incorporated in the HEC-6T model.
Dune height coefficient set at 2.0
Maximum anti-dune height no deeper than hydraulic depth

Project: **Reata Wash Flood Control Improvement Study**
Location: **City of Scottsdale**

Local Scour at Grade Control/Drops

Calc'd by: RS
Date: 4/24/2016

Checked: JTA
Date: 4/24/2016

(4)Hydraulic Cross Section Identification #	(3)Downstream HEC-RAS/HEC-6T Cross Section	Reach	Drop Height H	Unit Disharge, q			D_{90}	Downstream Hydraulic Depth ym	(1)Scour Component	(2) Length of Scour Hole	Notes
				Discharge	Wetted Area	Max Depth					
			feet	cubic feet per second	square feet	feet	millemiter	feet	feet	feet	
6500	6400	19	6.7	14837.02	1095.44	3.41	10.00	3.36	16.2	195	Existing Grade Control
7100	7000	18	8.0	10701.24	760.58	4.36	50.00	3.02	11.2	135	Existing Grade Control
7361.78	7300	18	3.0	11330.21	884.24	3.44	50.00	3.75	6.0	72	Existing Grade Control
7700	7600	18	2.3	11311.63	859.03	3.67	50.00	3.48	6.2	75	Existing Grade Control
8032.6	7900	17	2.4	9165.47	564.1	4.02	50.00	3.44	8.2	98	Existing Grade Control
8364.13	8300	17	4.6	8480.15	601.08	4.89	50.00	4.67	9.0	108	Existing Grade Control
11492.27	11376.89	13	1.0	11847.85	1105.26	5.95	50.00	6.46	3.2	38	Legacy Road Bridge
11777	11665.28	13	1.1	11378.37	769.54	4.18	50.00	3.71	5.9	71	Existing Grade Control
12033.11	11900	13	0.6	11591.79	785.05	3.94	50.00	4.25	4.0	48	Existing Grade Control
12289.17	12200	13	1.6	11683.7	859.38	4.15	50.00	3.85	6.0	72	Existing Grade Control
12545.24	12400	13	0.1	7787.71	580.34	3.62	50.00	4.12	1.1	13	Existing Grade Control
12800	12700	13	0.1	11373.67	907.02	4.45	50.00	4.03	1.6	19	Existing Grade Control
13835.07	13700	12	2.0	11906.45	1421.08	1.95	50.00	2.08	3.0	36	Existing Grade Control
14965.19	14900	11	0.4	8673.17	1081.73	1.85	50.00	1.76	1.7	21	Existing Grade Control
18200	18100	10	0.0	11901	823.16	2.5	50.00	3.29	NA	NA	Existing Grade Control

Notes:
(1) Drop Scour determined using Schoklitsch Equation
(2) Downstream length equivalent to 12 times scour depth
(3) - HEC-RAS cross section rounded to the nearest decimal in HEC-6T model. Some cross sections removed for model stability.
(4) - HEC-RAS cross section from November 11, 2015. HEC-RAS cross sections incorporated in the HEC-6T model.

Project: Reata Wash Flood Control Improvement Study
Location: City of Scottsdale

Sediment Samples by Reach

Calc'd by: RS Checked: JTA
Date: 9/2/2015 Date: 9/2/2015

HEC-RAS Cross Section	Reach	Q	D16	D50	D50	D84	D90	D95	Sediment Sample
		cubic feet per second	millimeter	millimeter	feet	millimeter	millimeter	millimeter	
30600	2	13015	0.74	2	0.007	5	6.3	8	SM-1
30500	2	13015	0.74	2	0.007	5	6.3	8	SM-1
30400	2	13015	0.74	2	0.007	5	6.3	8	SM-1
30300	2	13015	0.74	2	0.007	5	6.3	8	SM-1
30200	2	13015	0.74	2	0.007	5	6.3	8	SM-1
30100	3	13015	0.74	2	0.007	5	6.3	8	SM-1
30000	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29900	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29800	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29700	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29600	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29500	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29400	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29300	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29250	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29210.84	3	13015	0.74	2	0.007	5	6.3	8	SM-1
29180	4	Culvert	0.74	2	0.007	5	6.3	8	SM-1
29168.47	4	13015	0.74	2	0.007	5	6.3	8	SM-1
29150	4	10880	0.74	2	0.007	5	6.3	8	SM-1
29100	4	10880	0.74	2	0.007	5	6.3	8	SM-1
29000	4	10880	0.74	2	0.007	5	6.3	8	SM-1
28900	4	10880	0.74	2	0.007	5	6.3	8	SM-1
28800	4	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28700	4	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28600	4	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28500	4	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28400	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28300	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28200	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28100	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
28000	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27900	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27800	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27700	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27600	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27500	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27400	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27300	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27200	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27100	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
27000	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26900	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26885	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26800	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26700	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26600	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26500	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26400	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26300	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26200	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2

26100	5	10880	0.35	1.5	0.005	4.7	6	7.9	SM-2
26000	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25900	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25800	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25700	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25600	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25576	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25500	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25400	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25300	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25200	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25100	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
25000	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24900	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24800	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24700	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24600	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24500	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24400	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24300	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24200	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24100	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
24000	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23900	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23800	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23700	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23600	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23500	5	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23400	6	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23300	6	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23200	6	11340	0.35	1.5	0.005	4.7	6	7.9	SM-2
23100	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
23000	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22900	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22800	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22700	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22600	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22500	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22400	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22300	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22200	6	11254	0.35	1.5	0.005	4.7	6	7.9	SM-2
22100	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
22000	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21900	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21800	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21700	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21600	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21500	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21400	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21300	6	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21200	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21100	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
21000	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20900	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20800	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20700	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20600	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20500	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20400	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20300	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20200	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20100	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
20000	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2

19900	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19800	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19700	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19600	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19500	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19400	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19300	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19200	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19100	7	11901	0.35	1.5	0.005	4.7	6	7.9	SM-2
19000	8	11901	0.8	6.82	0.022	39	49	64	SM-3
18900	8	11901	0.8	6.82	0.022	39	49	64	SM-3
18800	8	11901	0.8	6.82	0.022	39	49	64	SM-3
18700	8	11901	0.8	6.82	0.022	39	49	64	SM-3
18600	9	11901	0.8	6.82	0.022	39	49	64	SM-3
18500	9	11901	0.8	6.82	0.022	39	49	64	SM-3
18400	9	11901	0.8	6.82	0.022	39	49	64	SM-3
18345	9	11901	0.8	6.82	0.022	39	49	64	SM-3
18322	9	Bridge	0.8	6.82	0.022	39	49	64	SM-3
18300	9	11901	0.8	6.82	0.022	39	49	64	SM-3
18200	10	11901	0.8	6.82	0.022	39	49	64	SM-3
18100	10	11901	0.8	6.82	0.022	39	49	64	SM-3
18000	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17900	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17800	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17700	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17600	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17500	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17400	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17300	10	11901	0.8	6.82	0.022	39	49	64	SM-3
17200	10	12338	0.8	6.82	0.022	39	49	64	SM-3
17100	10	12338	0.8	6.82	0.022	39	49	64	SM-3
17000	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16900	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16800	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16700	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16600	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16500	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16400	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16300	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16200	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16100	10	12338	0.8	6.82	0.022	39	49	64	SM-3
16000	10	12338	0.8	6.82	0.022	39	49	64	SM-3
15900	10	12338	0.8	6.82	0.022	39	49	64	SM-3
15800	10	12338	0.8	6.82	0.022	39	49	64	SM-3
15700	11	12338	0.8	6.82	0.022	39	49	64	SM-3
15600	11	12338	0.8	6.82	0.022	39	49	64	SM-3
15500	11	12338	0.8	6.82	0.022	39	49	64	SM-3
15400	11	12338	0.8	6.82	0.022	39	49	64	SM-3
15300	11	12338	0.8	6.82	0.022	39	49	64	SM-3
15200	11	12338	0.8	6.82	0.022	39	49	64	SM-3
15100	11	12338	0.8	6.82	0.022	39	49	64	SM-3
14965.19	11	12182	0.8	6.82	0.022	39	49	64	SM-3
14900	11	12182	0.8	6.82	0.022	39	49	64	SM-3
14800	11	12182	0.8	6.82	0.022	39	49	64	SM-3
14700	11	12182	0.8	6.82	0.022	39	49	64	SM-3
14600	12	12182	0.8	6.82	0.022	39	49	64	SM-3
14500	12	12182	0.8	6.82	0.022	39	49	64	SM-3
14400	12	12182	0.8	6.82	0.022	39	49	64	SM-3
14300	12	12182	0.8	6.82	0.022	39	49	64	SM-3
14200	12	12182	0.8	6.82	0.022	39	49	64	SM-3
14100	12	12182	0.8	6.82	0.022	39	49	64	SM-3
14000	12	12182	0.8	6.82	0.022	39	49	64	SM-3
13900	12	12182	0.8	6.82	0.022	39	49	64	SM-3

13835.07	12	12182	0.8	6.82	0.022	39	49	64	SM-3
13700	12	12182	0.8	6.82	0.022	39	49	64	SM-3
13600	12	12182	0.8	6.82	0.022	39	49	64	SM-3
13500	12	12182	0.8	6.82	0.022	39	49	64	SM-3
13400	12	12182	0.8	6.82	0.022	39	49	64	SM-3
13300	12	12026	0.8	6.82	0.022	39	49	64	SM-3
13200	12	12026	0.8	6.82	0.022	39	49	64	SM-3
13100	13	12026	0.8	6.82	0.022	39	49	64	SM-3
13000	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12900	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12800	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12700	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12600	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12545.24	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12400	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12289.17	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12200	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12100	13	12026	0.8	6.82	0.022	39	49	64	SM-3
12033.11	13	12026	0.8	6.82	0.022	39	49	64	SM-3
11900	13	12026	0.8	6.82	0.022	39	49	64	SM-3
11777	13	12026	0.8	6.82	0.022	39	49	64	SM-3
11665.28	13	11870	0.8	6.82	0.022	39	49	64	SM-3
11614.66	13	11870	0.8	6.82	0.022	39	49	64	SM-3
11600.41	13	11870	0.8	6.82	0.022	39	49	64	SM-3
11582.03	13	11870	0.8	6.82	0.022	39	49	64	SM-3
11567.48	13	11870	0.8	6.82	0.022	39	49	64	SM-3
11561.97	13	11870	0.8	6.82	0.022	39	49	64	SM-3
11545.46	13	11870	0.8	6.82	0.022	39	49	64	SM-3
11539.95	13	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
11516.11	13	Culvert	0.25	1.5	0.005	6.5	10	21.5	SM-4
11492.27	13	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
11376.89	13	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
11316.65	13	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
11271.2	13	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
11130.61	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
11000	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10900	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10800	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10700	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10600	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10500	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10400	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10300	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10200	14	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10100	15	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
10000	15	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9900	15	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9800	15	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9700	15	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9600	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9500	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9400	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9300	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9200	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9100	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
9000	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8900	16	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8800	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8700	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8600	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8500	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8364.13	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8300	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4

8200	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8100	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
8032.6	17	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7900	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7800	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7700	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7600	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7500	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7361.78	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7300	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7200	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7100	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
7000	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
6900	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
6800	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
6700	18	11870	0.25	1.5	0.005	6.5	10	21.5	SM-4
6600	18	15842	0.25	1.5	0.005	6.5	10	21.5	SM-4
6500	19	15842	0.25	1.5	0.005	6.5	10	21.5	SM-4
6400	19	15842	0.25	1.5	0.005	6.5	10	21.5	SM-4
6300	19	15842	1.3	8.4	0.028	37	47	64	SM-5
6200	19	15842	1.3	8.4	0.028	37	47	64	SM-5
6126.11	19	15842	1.3	8.4	0.028	37	47	64	SM-5
6084.06	19	15842	1.3	8.4	0.028	37	47	64	SM-5
6060	19	Bridge	1.3	8.4	0.028	37	47	64	SM-5
6041.11	19	15842	1.3	8.4	0.028	37	47	64	SM-5
6024.98	19	15842	1.3	8.4	0.028	37	47	64	SM-5
6000	19	Bridge	1.3	8.4	0.028	37	47	64	SM-5
5981.62	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5900	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5800	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5700	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5600	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5500	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5400	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5300	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5200	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5100	19	15842	1.3	8.4	0.028	37	47	64	SM-5
5000	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4900	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4800	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4700	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4600	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4500	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4400	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4300	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4200	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4100	19	15842	1.3	8.4	0.028	37	47	64	SM-5
4000	19	15842	1.3	8.4	0.028	37	47	64	SM-5
3900	19	15842	1.3	8.4	0.028	37	47	64	SM-5
3800	19	15842	1.3	8.4	0.028	37	47	64	SM-5
3700	19	15842	1.3	8.4	0.028	37	47	64	SM-5
3600	19	15842	1.3	8.4	0.028	37	47	64	SM-5
3500	19	15842	1.3	8.4	0.028	37	47	64	SM-5
3400	19	15842	1.3	8.4	0.028	37	47	64	SM-5
3300	20	15842	1.3	8.4	0.028	37	47	64	SM-5
3200	20	15842	1.3	8.4	0.028	37	47	64	SM-5
3100	20	15842	1.3	8.4	0.028	37	47	64	SM-5
3000	21	15842	1.3	8.4	0.028	37	47	64	SM-5
2900	21	15842	1.3	8.4	0.028	37	47	64	SM-5
2800	21	15842	1.3	8.4	0.028	37	47	64	SM-5
2700	21	15842	1.3	8.4	0.028	37	47	64	SM-5
2600	21	15842	1.3	8.4	0.028	37	47	64	SM-5
2500	22	15842	1.3	8.4	0.028	37	47	64	SM-5

2400	22	15842	1.3	8.4	0.028	37	47	64	SM-5
2300	22	15842	1.3	8.4	0.028	37	47	64	SM-5
2200	22	15842	1.3	8.4	0.028	37	47	64	SM-5
2100	22	15842	1.3	8.4	0.028	37	47	64	SM-5
2000	22	15842	1.3	8.4	0.028	37	47	64	SM-5
1900	22	15842	1.3	8.4	0.028	37	47	64	SM-5
1800	22	15842	1.3	8.4	0.028	37	47	64	SM-5
1700	22	15842	1.3	8.4	0.028	37	47	64	SM-5
1600	22	15842	1.3	8.4	0.028	37	47	64	SM-5

Bell Road

Hydraulic Design Data

Contraction Scour

	Left	Channel	Right
Input Data			
Average Depth (ft):	0.06	4.56	
Approach Velocity (ft/s):	0.60	12.24	
Br Average Depth (ft):		6.19	
BR Opening Flow (cfs):		15842.00	
BR Top WD (ft):		234.93	
Grain Size D50 (mm):		8.40	
Approach Flow (cfs):	0.02	15841.98	
Approach Top WD (ft):	0.49	283.55	
K1 Coefficient:	0.590	0.640	
Results			
Scour Depth Ys (ft):		0.00	
Critical Velocity (ft/s):		4.35	
Equation:		Live	

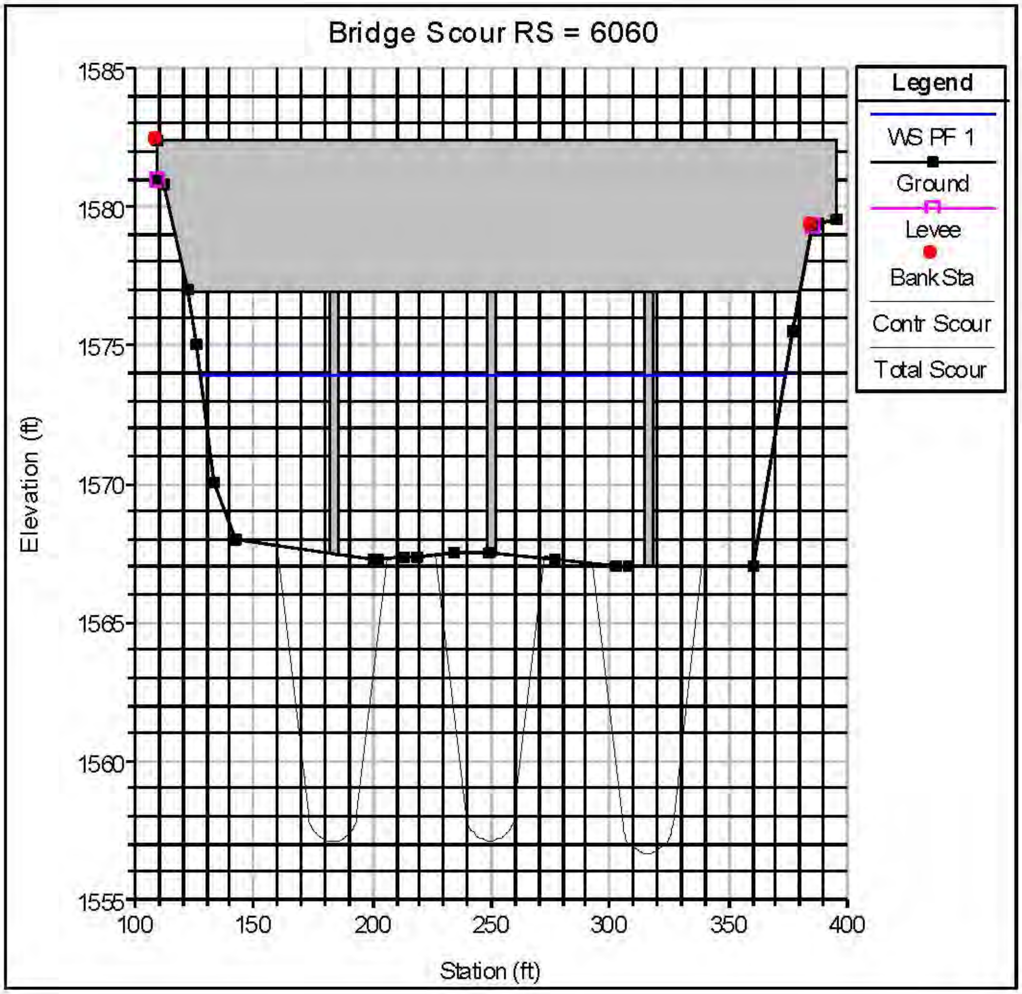
Pier Scour

All piers have the same scour depth

Input Data	
Pier Shape:	Circulare cylinder
Pier Width (ft):	4.00
Grain Size D50 (mm):	8.40000
Depth Upstream (ft):	7.32
Velocity Upstream (ft/s):	10.20
K1 Nose Shape:	1.00
Pier Angle:	15.00
Pier Length (ft):	4.00
K2 Angle Coef:	1.14
K3 Bed Cond Coef:	1.10
Grain Size D90 (mm):	47.00000
K4 Armouring Coef:	1.00
Set K1 value to 1.0 because angle > 5 degrees	
Results	
Scour Depth Ys (ft):	10.40
Froude #:	0.66
Equation:	CSU equation

Abutment Scour

	Left	Right
Input Data		
Station at Toe (ft):	142.00	360.00
Toe Sta at appr (ft):	145.25	610.61
Abutment Length (ft):	102.11	0.00
Depth at Toe (ft):	6.56	7.52
K1 Shape Coef:	0.55 - Spill-through abutment	
Degree of Skew (degrees):	90.00	90.00
K2 Skew Coef:	1.00	1.00
Projected Length L' (ft):	.1	.1
Avg Depth Obstructed Ya (ft):	.1	.1
Flow Obstructed Qe (cfs):	.1	.1
Area Obstructed Ae (sq ft):	.1	.1
Results		
Scour Depth Ys (ft):	0.19	0.19
Qe/Ae = Ve:	1.00	1.00
Froude #:	0.56	0.56
Equation:	Froehlich	Froehlich



Downstream looking upstream at Bell Road Bridge

Upstream face of Bell Road Bridge

Thompson Peak Parkway

Hydraulic Design Data

Contraction Scour

	Left	Channel	Right
Input Data			
Average Depth (ft):	0.92	3.46	0.72
Approach Velocity (ft/s):	5.01	17.34	4.25
Br Average Depth (ft):	2.90	4.98	2.07
BR Opening Flow (cfs):	2571.75	8734.16	595.09
BR Top WD (ft):	118.38	148.52	46.46
Grain Size D50 (mm):	6.82	6.82	6.82
Approach Flow (cfs):	292.74	11559.08	49.18
Approach Top WD (ft):	63.63	192.68	16.13
K1 Coefficient:	0.640	0.640	0.640
Results			
Scour Depth Ys (ft):	1.08	0.00	1.03
Critical Velocity (ft/s):	3.11	3.88	2.98
Equation:	Live	Live	Live

Pier Scour

All piers have the same scour depth

Input Data

Pier Shape:	Square nose
Pier Width (ft):	8.00
Grain Size D50 (mm):	6.82000
Depth Upstream (ft):	5.74
Velocity Upstream (ft/s):	9.00
K1 Nose Shape:	1.00
Pier Angle:	15.00
Pier Length (ft):	8.00
K2 Angle Coef:	1.14
K3 Bed Cond Coef:	1.10
Grain Size D90 (mm):	49.00000
K4 Armouring Coef:	1.00

Set K1 value to 1.0 because angle > 5 degrees

Results

Scour Depth Ys (ft):	14.96
Froude #:	0.66
Equation:	CSU equation

Abutment Scour

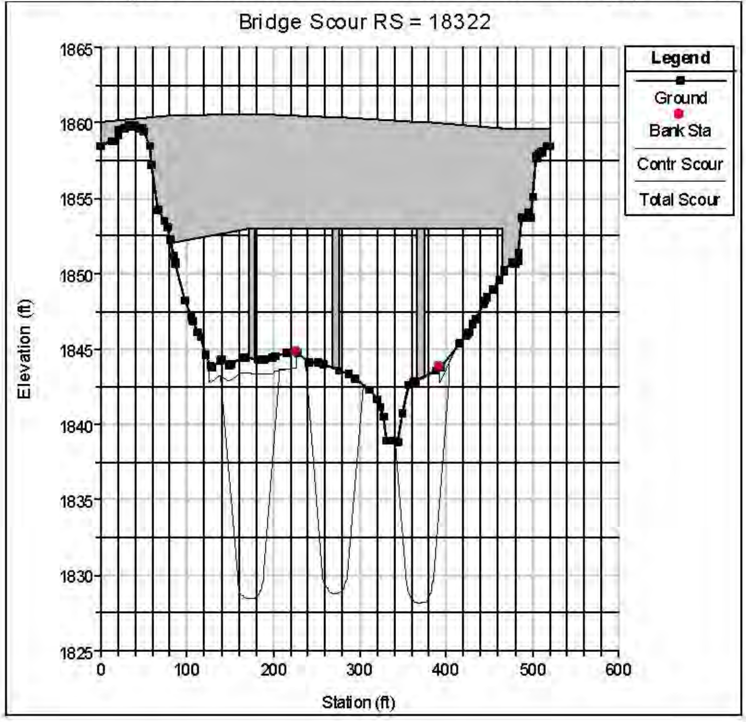
	Left	Right
Input Data		
Station at Toe (ft):	127	392
Toe Sta at appr (ft):	235	427
Abutment Length (ft):	63.92	16.52
Depth at Toe (ft):	4.41	4.62
K1 Shape Coef: 0.55 - Spill-through abutment		
Degree of Skew (degrees):	90.00	90.00
K2 Skew Coef:	1.00	1.00
Projected Length L' (ft):	.1	.1
Avg Depth Obstructed Ya (ft):	.1	.1
Flow Obstructed Qe (cfs):	.1	.1
Area Obstructed Ae (sq ft):	.1	.1
Results		
Scour Depth Ys (ft):	0.19	0.19
Qe/Ae = Ve:	1.00	1.00
Froude #:	0.56	0.56
Equation:	Froehlich	Froehlich

Combined Scour Depths

Pier Scour + Contraction Scour (ft):

Left Bank:	16.04
Channel:	14.96

Left abutment scour + contraction scour (ft):	1.27
Right abutment scour + contraction scour (ft):	0.19




12 09 2015 11 04

Downstream looking upstream at Thompson Peak Parkway Bridge


JUL/17/2015

Looking at upstream face of Thompson Peak Parkway Bridge

Appendix B Model Data

HEC-RAS

Summary Tables

Electronic Model

HEC-6T

Electronic Model and output files

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1

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)	
4264-010-CL	30600	PF 1	13015.00	2220.11	2225.67	2225.67	2226.99	0.016627	9.26	1428.88	549.16	0.99
4264-010-CL	30500	PF 1	13015.00	2215.87	2221.87	2222.61	2224.38	0.041204	12.72	1025.91	470.31	1.51
4264-010-CL	30400	PF 1	13015.00	2213.08	2218.92	2219.30	2220.71	0.029420	10.87	1223.27	563.85	1.28
4264-010-CL	30300	PF 1	13015.00	2210.78	2215.08	2215.66	2217.19	0.042023	11.77	1127.25	602.12	1.49
4264-010-CL	30200	PF 1	13015.00	2207.14	2212.83	2212.90	2214.32	0.018689	9.81	1340.05	507.17	1.05
4264-010-CL	30100	PF 1	13015.00	2197.00	2202.52	2205.11	2210.50	0.064871	22.68	573.91	115.05	1.79
4264-010-CL	30000	PF 1	13015.00	2194.00	2199.96	2201.23	2204.89	0.035625	17.82	730.24	134.18	1.35
4264-010-CL	29900	PF 1	13015.00	2191.00	2198.56	2198.63	2201.99	0.018923	14.87	875.36	130.53	1.01
4264-010-CL	29800	PF 1	13015.00	2188.00	2194.23	2195.54	2199.31	0.035155	18.08	719.66	127.90	1.34
4264-010-CL	29700	PF 1	13015.00	2185.00	2190.43	2191.79	2195.53	0.040954	18.12	718.20	143.50	1.43
4264-010-CL	29600	PF 1	13015.00	2182.00	2189.64	2189.64	2193.12	0.018482	14.97	869.31	124.01	1.00
4264-010-CL	29500	PF 1	13015.00	2179.00	2186.84	2187.40	2191.00	0.022664	16.38	794.39	116.75	1.11
4264-010-CL	29400	PF 1	13015.00	2177.00	2185.66	2185.66	2189.30	0.017891	15.32	849.50	115.23	0.99
4264-010-CL	29300	PF 1	13015.00	2176.00	2182.89	2183.65	2187.04	0.028204	16.34	796.82	136.39	1.18
4264-010-CL	29250	PF 1	13015.00	2175.70	2181.50	2182.78	2186.51	0.004229	17.97	724.26	138.51	1.38
4264-010-CL	29210.84	PF 1	13015.00	2173.94	2180.28	2181.86	2186.11	0.023037	19.38	671.55	123.20	1.46
4264-010-CL	29180		Culvert									
4264-010-CL	29168.47	PF 1	13015.00	2172.96	2181.22	2181.22	2184.85	0.002097	15.29	851.12	116.53	1.00
4264-010-CL	29150	PF 1	10880.00	2165.50	2181.50	2173.43	2182.20	0.001494	6.72	1652.23	126.68	0.31
4264-010-CL	29100	PF 1	10880.00	2164.00	2175.65	2175.65	2181.53	0.008861	19.45	559.32	48.00	1.00
4264-010-CL	29000	PF 1	10880.00	2161.00	2170.39	2172.67	2179.44	0.015146	24.13	450.83	48.00	1.39
4264-010-CL	28900	PF 1	10880.00	2158.00	2166.51	2170.05	2177.53	0.019458	26.64	408.41	48.00	1.61
4264-010-CL	28800	PF 1	10880.00	2155.00	2163.07	2166.65	2175.32	0.022296	28.09	387.26	48.00	1.74
4264-010-CL	28700	PF 1	10880.00	2152.00	2159.80	2163.65	2172.91	0.024319	29.06	374.41	48.00	1.83
4264-010-CL	28600	PF 1	10880.00	2149.00	2156.63	2160.65	2170.35	0.025792	29.73	365.99	48.00	1.90
4264-010-CL	28500	PF 1	10880.00	2146.00	2153.51	2157.65	2167.67	0.026874	30.20	360.22	48.00	1.94
4264-010-CL	28400	PF 1	10880.00	2143.00	2150.42	2154.65	2164.91	0.027673	30.55	356.18	48.00	1.98
4264-010-CL	28300	PF 1	10880.00	2140.00	2147.36	2151.66	2162.09	0.028268	30.80	353.27	48.00	2.00
4264-010-CL	28200	PF 1	10880.00	2137.00	2144.31	2148.65	2159.23	0.028729	30.99	351.08	48.00	2.02
4264-010-CL	28100	PF 1	10880.00	2134.00	2141.29	2145.65	2156.32	0.029031	31.11	349.68	48.00	2.03
4264-010-CL	28000	PF 1	10880.00	2131.00	2138.26	2142.65	2153.39	0.029275	31.21	348.55	48.00	2.04
4264-010-CL	27900	PF 1	10880.00	2128.00	2135.24	2139.65	2150.45	0.029461	31.29	347.71	48.00	2.05
4264-010-CL	27800	PF 1	10880.00	2125.00	2128.93	2132.76	2144.34	0.192018	31.50	345.35	95.72	2.92
4264-010-CL	27700	PF 1	10880.00	2122.00	2128.20	2129.76	2133.80	0.040451	18.98	573.34	104.82	1.43
4264-010-CL	27600	PF 1	10880.00	2119.00	2126.12	2126.76	2130.20	0.025190	16.22	670.79	108.47	1.15
4264-010-CL	27500	PF 1	10880.00	2116.00	2122.72	2123.76	2127.38	0.030675	17.32	628.28	106.89	1.26
4264-010-CL	27400	PF 1	10880.00	2113.00	2119.80	2120.76	2124.34	0.029451	17.08	636.83	107.21	1.24
4264-010-CL	27300	PF 1	10880.00	2110.00	2116.77	2117.76	2121.35	0.029927	17.18	633.45	107.09	1.24
4264-010-CL	27200	PF 1	10880.00	2107.00	2113.76	2114.76	2118.36	0.030080	17.20	632.38	107.05	1.25
4264-010-CL	27100	PF 1	10880.00	2104.00	2110.76	2111.76	2115.36	0.030080	17.20	632.38	107.05	1.25
4264-010-CL	27000	PF 1	10880.00	2101.00	2107.76	2108.76	2112.36	0.030080	17.20	632.38	107.05	1.25
4264-010-CL	26900	PF 1	10880.00	2098.00	2104.76	2105.76	2109.36	0.030080	17.20	632.38	107.05	1.25
4264-010-CL	26885	PF 1	10880.00	2093.00	2097.72	2100.76	2108.03	0.102948	25.76	422.35	98.89	2.20
4264-010-CL	26800	PF 1	10880.00	2090.00	2096.39	2097.76	2101.62	0.036629	18.36	592.44	105.54	1.37
4264-010-CL	26700	PF 1	10880.00	2087.00	2094.03	2094.76	2098.23	0.026273	16.45	661.46	108.13	1.17
4264-010-CL	26600	PF 1	10880.00	2084.00	2090.74	2091.76	2095.37	0.030393	17.26	630.21	106.97	1.25
4264-010-CL	26500	PF 1	10880.00	2081.00	2087.79	2088.76	2092.35	0.029715	17.14	634.94	107.14	1.24
4264-010-CL	26400	PF 1	10880.00	2078.00	2084.77	2085.76	2089.35	0.029964	17.18	633.19	107.08	1.25
4264-010-CL	26300	PF 1	10880.00	2075.00	2081.76	2082.76	2086.36	0.030042	17.20	632.64	107.06	1.25
4264-010-CL	26200	PF 1	10880.00	2072.00	2078.76	2079.76	2083.36	0.030042	17.20	632.64	107.06	1.25
4264-010-CL	26100	PF 1	10880.00	2069.00	2075.76	2076.76	2080.36	0.030042	17.20	632.64	107.06	1.25
4264-010-CL	26000	PF 1	11340.00	2066.00	2073.27	2073.96	2077.50	0.025476	16.51	686.96	109.07	1.16
4264-010-CL	25900	PF 1	11340.00	2063.00	2069.90	2070.96	2074.67	0.030429	17.51	647.52	107.61	1.26
4264-010-CL	25800	PF 1	11340.00	2060.00	2066.96	2067.96	2071.64	0.029640	17.36	653.21	107.82	1.24
4264-010-CL	25700	PF 1	11340.00	2057.00	2063.94	2064.96	2068.65	0.029951	17.42	650.94	107.74	1.25
4264-010-CL	25600	PF 1	11340.00	2054.00	2060.93	2061.96	2065.65	0.030060	17.44	650.15	107.71	1.25
4264-010-CL	25576	PF 1	11340.00	2047.00	2051.57	2054.96	2063.62	0.125279	27.86	407.09	98.27	2.41
4264-010-CL	25500	PF 1	11340.00	2044.00	2050.09	2051.96	2056.42	0.046790	20.19	561.59	104.37	1.53
4264-010-CL	25400	PF 1	11340.00	2041.00	2048.36	2048.96	2052.47	0.024379	16.27	697.12	109.44	1.14
4264-010-CL	25300	PF 1	11340.00	2038.00	2044.89	2045.96	2049.68	0.030670	17.56	645.83	107.55	1.26
4264-010-CL	25200	PF 1	11340.00	2035.00	2041.97	2042.96	2046.63	0.029441	17.32	654.67	107.88	1.24
4264-010-CL	25100	PF 1	11340.00	2032.00	2038.94	2039.96	2043.65	0.029914	17.41	651.21	107.75	1.25
4264-010-CL	25000	PF 1	11340.00	2029.00	2035.93	2036.96	2040.65	0.030088	17.45	649.96	107.70	1.25
4264-010-CL	24900	PF 1	11340.00	2026.00	2032.93	2033.96	2037.65	0.030088	17.45	649.96	107.70	1.25
4264-010-CL	24800	PF 1	11340.00	2023.00	2029.93	2030.96	2034.65	0.030088	17.45	649.96	107.70	1.25
4264-010-CL	24700	PF 1	11340.00	2020.00	2026.93	2027.96	2031.65	0.030088	17.45	649.96	107.70	1.25
4264-010-CL	24600	PF 1	11340.00	2017.00	2023.93	2024.96	2028.65	0.030088	17.45	649.96	107.70	1.25
4264-010-CL	24500	PF 1	11340.00	2014.00	2020.93	2021.96	2025.65	0.030088	17.45	649.96	107.70	1.25
4264-010-CL	24400	PF 1	11340.00	2011.50	2019.29	2019.46	2022.89	0.020019	15.23	744.59	111.16	1.04
4264-010-CL	24300	PF 1	11340.00	2009.00	2016.18	2016.96	2020.53	0.026580	16.74	677.32	108.71	1.18
4264-010-CL	24200	PF 1	11340.00	2006.50	2013.97	2014.46	2017.94	0.023167	15.99	709.09	109.88	1.11
4264-010-CL	24100	PF 1	11340.00	2004.00	2011.28	2011.96	2015.49	0.025341	16.48	688.19	109.11	1.16
4264-010-CL	24000	PF 1	11340.00	2001.50	2008.86	2009.46	2012.97	0.024420	16.28	696.74	109.43	1.14
4264-010-CL	23900	PF 1	11340.00	1999.00	2006.30	2006.96	2010.49	0.025080	16.42	690.56	109.20	1.15
4264-010-CL	23800	PF 1	11340.00	1996.50	2003.83	2004.46	2007.98	0.024782	16.36	693.32	109.30	1.14

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

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)	
4264-010-CL	23700	PF 1	11340.00	1994.00	2001.30	2001.96	2005.49	0.025030	16.41	691.03	109.22	1.15
4264-010-CL	23600	PF 1	11340.00	1991.50	2000.65	1999.46	2003.12	0.011436	12.61	899.12	116.59	0.80
4264-010-CL	23500	PF 1	11340.00	1990.00	1997.94	1997.94	2001.39	0.018713	14.89	761.62	111.77	1.01
4264-010-CL	23400	PF 1	11340.00	1988.00	1995.71	1995.96	1999.40	0.020765	15.42	735.52	110.83	1.05
4264-010-CL	23300	PF 1	11340.00	1986.00	1993.94	1993.96	1997.39	0.018774	14.91	760.79	111.74	1.01
4264-010-CL	23200	PF 1	11340.00	1984.00	1991.72	1991.96	1995.40	0.020636	15.39	737.06	110.89	1.05
4264-010-CL	23100	PF 1	11254.00	1981.00	1987.73	1988.91	1992.70	0.032751	17.90	628.72	106.91	1.30
4264-010-CL	23000	PF 1	11254.00	1978.00	1985.03	1985.91	1989.53	0.028129	17.02	661.31	108.12	1.21
4264-010-CL	22900	PF 1	11254.00	1974.00	1980.33	1981.91	1986.05	0.040515	19.21	585.97	105.30	1.43
4264-010-CL	22800	PF 1	11254.00	1971.00	1978.17	1978.90	1982.40	0.025987	16.50	681.89	110.13	1.17
4264-010-CL	22700	PF 1	11254.00	1967.00	1973.33	1974.91	1979.05	0.040461	19.20	586.22	105.31	1.43
4264-010-CL	22600	PF 1	11254.00	1963.50	1970.23	1971.41	1975.20	0.032771	17.90	628.59	106.91	1.30
4264-010-CL	22500	PF 1	11254.00	1960.00	1966.60	1967.90	1971.80	0.034954	18.29	615.30	106.41	1.34
4264-010-CL	22400	PF 1	11254.00	1956.00	1962.36	1963.91	1968.02	0.039860	19.10	589.13	105.42	1.42
4264-010-CL	22300	PF 1	11254.00	1952.00	1958.35	1959.91	1964.03	0.040069	19.14	588.12	105.38	1.43
4264-010-CL	22200	PF 1	11254.00	1948.00	1954.35	1955.91	1960.03	0.039992	19.12	588.49	105.39	1.43
4264-010-CL	22100	PF 1	11901.00	1944.00	1950.82	1952.24	1956.21	0.034978	18.64	638.40	107.27	1.35
4264-010-CL	22000	PF 1	11901.00	1940.00	1946.57	1948.30	1952.44	0.039725	19.45	612.01	106.28	1.43
4264-010-CL	21900	PF 1	11901.00	1937.00	1944.46	1945.19	1948.85	0.025682	16.82	707.56	109.82	1.17
4264-010-CL	21800	PF 1	11901.00	1934.00	1941.11	1942.19	1946.01	0.030331	17.78	669.37	108.42	1.26
4264-010-CL	21700	PF 1	11901.00	1931.00	1938.15	1939.18	1942.99	0.029720	17.66	673.93	108.59	1.25
4264-010-CL	21600	PF 1	11901.00	1928.00	1935.13	1936.19	1940.00	0.029954	17.71	672.17	108.52	1.25
4264-010-CL	21500	PF 1	11901.00	1925.00	1932.13	1933.18	1937.00	0.030036	17.72	671.56	108.50	1.26
4264-010-CL	21400	PF 1	11901.00	1923.00	1931.19	1931.19	1934.72	0.018555	15.08	788.96	112.75	1.00
4264-010-CL	21300	PF 1	11901.00	1921.00	1928.94	1929.19	1932.74	0.020674	15.64	760.83	111.74	1.06
4264-010-CL	21200	PF 1	11901.00	1917.08	1923.49	1925.27	1929.40	0.036846	19.59	625.01	225.23	1.78
4264-010-CL	21100	PF 1	11901.00	1915.11	1919.85	1921.54	1925.43	0.040760	19.25	669.73	260.06	1.85
4264-010-CL	21000	PF 1	11901.00	1912.39	1917.37	1918.67	1921.73	0.027756	17.33	775.89	261.73	1.56
4264-010-CL	20900	PF 1	11901.00	1908.90	1913.87	1915.39	1918.73	0.031322	18.61	735.80	302.43	1.66
4264-010-CL	20800	PF 1	11901.00	1905.55	1909.02	1910.69	1914.57	0.056219	18.93	636.14	261.38	2.07
4264-010-CL	20700	PF 1	11901.00	1902.02	1906.58	1907.60	1910.18	0.027372	15.26	787.44	254.05	1.50
4264-010-CL	20600	PF 1	11901.00	1899.35	1903.29	1904.46	1907.08	0.035001	16.15	802.50	320.68	1.67
4264-010-CL	20500	PF 1	11901.00	1895.74	1899.85	1900.95	1903.56	0.034879	15.45	770.77	285.69	1.65
4264-010-CL	20400	PF 1	11901.00	1891.92	1896.99	1898.10	1900.33	0.028100	14.70	818.59	292.08	1.50
4264-010-CL	20300	PF 1	11901.00	1889.65	1894.16	1895.14	1897.58	0.026636	15.30	846.90	297.71	1.49
4264-010-CL	20200	PF 1	11901.00	1886.61	1892.00	1893.18	1895.42	0.017980	14.99	853.47	285.69	1.28
4264-010-CL	20100	PF 1	11901.00	1883.38	1889.79	1890.78	1893.57	0.018066	15.67	783.02	427.30	1.29
4264-010-CL	20000	PF 1	11901.00	1881.30	1883.97	1885.61	1889.58	0.127560	21.38	660.79	406.37	2.91
4264-010-CL	19900	PF 1	11901.00	1877.74	1882.07	1882.55	1884.33	0.020946	13.14	1064.96	383.21	1.31
4264-010-CL	19800	PF 1	11901.00	1874.11	1879.13	1879.95	1882.04	0.023627	14.46	947.46	350.86	1.40
4264-010-CL	19700	PF 1	11901.00	1871.10	1877.79	1878.15	1880.03	0.014429	12.80	1080.99	398.74	1.13
4264-010-CL	19600	PF 1	11901.00	1869.56	1875.76	1876.47	1878.44	0.016551	14.27	1051.57	411.70	1.22
4264-010-CL	19500	PF 1	11901.00	1868.18	1874.31	1875.00	1876.86	0.014277	13.53	1058.90	391.69	1.14
4264-010-CL	19400	PF 1	11901.00	1866.03	1871.49	1872.57	1874.87	0.026987	16.82	970.50	388.72	1.53
4264-010-CL	19300	PF 1	11901.00	1863.64	1869.49	1870.21	1872.26	0.021823	14.74	995.77	343.36	1.37
4264-010-CL	19200	PF 1	11901.00	1861.06	1866.66	1867.67	1870.04	0.021361	14.80	823.09	262.79	1.35
4264-010-CL	19100	PF 1	11901.00	1857.52	1866.45	1866.45	1868.65	0.008351	12.08	1085.12	294.15	0.90
4264-010-CL	19000	PF 1	11901.00	1855.58	1864.17	1865.13	1867.45	0.014757	16.84	1092.14	370.39	1.21
4264-010-CL	18900	PF 1	11901.00	1852.15	1861.44	1862.94	1865.65	0.019843	18.98	946.13	335.36	1.39
4264-010-CL	18800	PF 1	11901.00	1850.34	1858.68	1860.12	1863.41	0.024287	20.54	868.89	277.35	1.53
4264-010-CL	18700	PF 1	11901.00	1848.20	1854.15	1855.95	1860.11	0.043425	22.96	771.11	316.08	1.96
4264-010-CL	18600	PF 1	11901.00	1844.48	1852.18	1853.55	1856.40	0.024459	16.61	770.70	305.13	1.47
4264-010-CL	18500	PF 1	11901.00	1842.56	1849.03	1850.12	1853.57	0.031932	17.34	736.77	272.44	1.64
4264-010-CL	18400	PF 1	11901.00	1840.18	1847.84	1848.61	1850.70	0.018302	14.35	950.86	324.86	1.27
4264-010-CL	18345	PF 1	11901.00	1838.78	1848.37	1847.30	1849.41	0.004414	9.00	1557.86	349.73	0.66
4264-010-CL	18322		Bridge									
4264-010-CL	18300	PF 1	11901.00	1837.67	1845.73	1846.31	1848.25	0.020429	13.84	1007.75	317.65	1.19
4264-010-CL	18200	PF 1	11901.00	1834.23	1841.72	1842.73	1845.14	0.048969	14.83	802.35	328.49	1.67
4264-010-CL	18100	PF 1	11901.00	1832.60	1839.54	1839.88	1841.71	0.020894	11.86	1011.06	318.23	1.15
4264-010-CL	18000	PF 1	11901.00	1830.72	1836.69	1837.26	1839.41	0.024379	13.23	899.23	258.42	1.25
4264-010-CL	17900	PF 1	11901.00	1828.18	1834.33	1834.85	1836.82	0.025980	12.68	938.62	303.10	1.27
4264-010-CL	17800	PF 1	11901.00	1826.34	1832.28	1832.60	1834.41	0.020466	11.71	1016.94	313.99	1.14
4264-010-CL	17700	PF 1	11901.00	1824.08	1829.46	1830.05	1832.03	0.027079	12.87	926.66	318.38	1.30
4264-010-CL	17600	PF 1	11901.00	1821.57	1828.12	1828.13	1829.94	0.013686	10.98	1134.08	363.44	0.96
4264-010-CL	17500	PF 1	11901.00	1819.18	1825.48	1826.23	1828.12	0.022867	13.64	1033.51	470.63	1.23
4264-010-CL	17400	PF 1	11901.00	1817.31	1822.68	1823.51	1825.43	0.031946	13.80	946.55	398.03	1.40
4264-010-CL	17300	PF 1	11901.00	1814.84	1820.09	1820.92	1822.64	0.023460	13.59	981.20	327.89	1.24
4264-010-CL	17200	PF 1	12338.00	1812.56	1816.60	1817.51	1819.49	0.042837	14.74	949.22	440.40	1.59
4264-010-CL	17100	PF 1	12338.00	1810.08	1814.71	1814.97	1816.48	0.018309	11.93	1232.61	435.63	1.10
4264-010-CL	17000	PF 1	12338.00	1806.97	1810.67	1811.59	1813.54	0.049433	15.03	946.36	479.43	1.69
4264-010-CL	16900	PF 1	12338.00	1802.94	1808.56	1808.69	1810.00	0.021393	9.99	1292.62	529.55	1.11
4264-010-CL	16800	PF 1	12338.00	1799.46	1805.51	1805.93	1807.39	0.031369	11.50	1139.71	518.07	1.33
4264-010-CL	16700	PF 1	12338.00	1798.06	1802.88	1803.20	1804.53	0.025100	11.07	1237.82	548.58	1.21
4264-010-CL	16600	PF 1	12338.00	1795.14	1799.52	1800.10	1801.70	0.030613	12.13	1088.60	524.94	1.33
4264-010-CL	16500	PF 1	12338.00	1792.83	1797.60	1797.87	1799.20	0.018296	10.71	1304.68	552.65	1.07

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

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)	
4264-010-CL	16400	PF 1	12338.00	1790.16	1794.83	1795.40	1796.86	0.029770	12.08	1148.54	563.66	1.32
4264-010-CL	16300	PF 1	12338.00	1787.76	1792.60	1792.88	1794.19	0.021947	11.36	1286.41	541.54	1.16
4264-010-CL	16200	PF 1	12338.00	1785.16	1789.64	1790.16	1791.76	0.025662	12.12	1093.38	448.63	1.25
4264-010-CL	16100	PF 1	12338.00	1782.55	1787.59	1787.94	1789.47	0.019492	11.98	1204.85	445.77	1.13
4264-010-CL	16000	PF 1	12338.00	1780.21	1784.98	1785.46	1787.11	0.028584	11.72	1058.80	423.07	1.29
4264-010-CL	15900	PF 1	12338.00	1778.54	1782.75	1783.00	1784.60	0.020878	10.97	1140.26	402.15	1.13
4264-010-CL	15800	PF 1	12338.00	1775.69	1780.17	1780.63	1782.24	0.026258	11.61	1074.40	419.72	1.25
4264-010-CL	15700	PF 1	12338.00	1773.65	1777.61	1778.00	1779.41	0.028812	10.76	1146.41	512.91	1.27
4264-010-CL	15600	PF 1	12338.00	1770.37	1774.84	1775.18	1776.53	0.028263	10.63	1199.26	560.18	1.26
4264-010-CL	15500	PF 1	12338.00	1768.18	1772.26	1772.51	1773.75	0.026246	9.87	1262.03	609.03	1.20
4264-010-CL	15400	PF 1	12338.00	1764.45	1770.54	1770.56	1771.68	0.018646	8.64	1445.61	663.54	1.02
4264-010-CL	15300	PF 1	12338.00	1762.83	1767.71	1768.08	1769.26	0.032597	10.00	1236.54	680.51	1.30
4264-010-CL	15200	PF 1	12338.00	1760.15	1765.55	1765.59	1766.62	0.019837	8.27	1492.58	755.38	1.03
4264-010-CL	15100	PF 1	12338.00	1758.33	1762.81	1763.10	1764.18	0.030083	9.42	1320.34	755.77	1.25
4264-010-CL	14965.19	PF 1	12182.00	1755.32	1760.26	1760.26	1761.26	0.020631	8.02	1517.49	790.71	1.04
4264-010-CL	14900	PF 1	12182.00	1753.81	1758.46	1758.65	1759.70	0.027055	8.88	1363.20	744.31	1.18
4264-010-CL	14800	PF 1	12182.00	1751.69	1756.35	1756.37	1757.43	0.018642	8.35	1475.06	770.02	1.01
4264-010-CL	14700	PF 1	12182.00	1749.33	1753.44	1753.93	1755.15	0.026874	10.50	1166.61	584.95	1.23
4264-010-CL	14600	PF 1	12182.00	1746.37	1750.98	1751.28	1752.55	0.024340	10.60	1259.10	637.75	1.19
4264-010-CL	14500	PF 1	12182.00	1744.85	1748.72	1749.03	1750.16	0.022670	10.19	1338.96	703.18	1.14
4264-010-CL	14400	PF 1	12182.00	1741.82	1746.52	1746.85	1748.01	0.020283	10.55	1335.48	668.53	1.11
4264-010-CL	14300	PF 1	12182.00	1739.41	1744.12	1744.59	1745.75	0.025129	11.43	1339.29	790.70	1.22
4264-010-CL	14200	PF 1	12182.00	1737.16	1741.81	1742.16	1743.18	0.024788	10.66	1401.19	829.38	1.20
4264-010-CL	14100	PF 1	12182.00	1735.08	1739.01	1739.29	1740.40	0.031574	10.34	1334.12	796.25	1.30
4264-010-CL	14000	PF 1	12182.00	1733.04	1736.96	1736.96	1737.93	0.021141	8.56	1564.21	834.55	1.07
4264-010-CL	13900	PF 1	12182.00	1730.73	1734.34	1734.52	1735.53	0.026928	9.43	1408.78	788.67	1.20
4264-010-CL	13835.07	PF 1	12182.00	1728.47	1732.88	1732.96	1733.96	0.020958	8.38	1467.96	764.43	1.06
4264-010-CL	13700	PF 1	12182.00	1725.25	1729.92	1730.02	1731.11	0.021134	8.79	1393.17	676.05	1.07
4264-010-CL	13600	PF 1	12182.00	1723.39	1727.52	1727.71	1728.91	0.022760	9.53	1300.97	609.46	1.13
4264-010-CL	13500	PF 1	12182.00	1719.92	1725.04	1725.28	1726.57	0.023743	9.96	1240.75	565.46	1.16
4264-010-CL	13400	PF 1	12182.00	1717.68	1723.19	1723.28	1724.59	0.019717	9.59	1293.91	537.54	1.07
4264-010-CL	13300	PF 1	12026.00	1715.78	1721.24	1721.33	1722.68	0.018323	9.69	1264.06	495.97	1.04
4264-010-CL	13200	PF 1	12026.00	1713.53	1718.88	1719.14	1720.63	0.022434	10.65	1139.80	440.50	1.15
4264-010-CL	13100	PF 1	12026.00	1710.53	1716.15	1716.58	1718.35	0.022205	12.17	1039.34	358.38	1.19
4264-010-CL	13000	PF 1	12026.00	1707.62	1714.65	1714.70	1716.55	0.014840	11.39	1120.58	312.84	1.00
4264-010-CL	12900	PF 1	12026.00	1705.97	1712.21	1712.68	1714.74	0.020765	13.22	973.21	282.64	1.18
4264-010-CL	12800	PF 1	12026.00	1702.17	1710.55	1710.81	1712.89	0.015704	12.54	1018.41	270.29	1.05
4264-010-CL	12700	PF 1	12026.00	1699.71	1706.97	1708.05	1710.70	0.027760	15.56	791.59	233.29	1.37
4264-010-CL	12600	PF 1	12026.00	1697.60	1701.77	1703.22	1706.78	0.055190	19.92	705.84	257.48	1.89
4264-010-CL	12545.24	PF 1	12026.00	1696.40	1701.56	1702.03	1704.17	0.023566	13.42	936.44	265.34	1.24
4264-010-CL	12400	PF 1	12026.00	1693.12	1698.41	1698.83	1701.08	0.019243	13.21	931.23	244.70	1.15
4264-010-CL	12289.17	PF 1	12026.00	1690.57	1696.07	1696.57	1698.88	0.020280	13.60	912.89	243.92	1.18
4264-010-CL	12200	PF 1	12026.00	1687.43	1693.27	1694.16	1696.72	0.027417	15.04	820.10	228.07	1.35
4264-010-CL	12100	PF 1	12026.00	1685.62	1690.92	1691.63	1694.06	0.024063	14.38	860.25	233.77	1.27
4264-010-CL	12033.11	PF 1	12026.00	1683.38	1689.09	1689.90	1692.38	0.025517	14.77	842.78	232.73	1.31
4264-010-CL	11900	PF 1	12026.00	1680.42	1686.19	1686.81	1689.21	0.021252	14.18	882.11	228.30	1.21
4264-010-CL	11777	PF 1	12026.00	1677.50	1683.16	1683.93	1686.43	0.023588	14.79	850.65	224.52	1.27
4264-010-CL	11665.28	PF 1	11870.00	1674.76	1679.93	1680.85	1683.48	0.029084	15.16	793.30	226.03	1.39
4264-010-CL	11614.66	PF 1	11870.00	1672.74	1678.92	1679.59	1682.07	0.023361	14.25	839.46	215.41	1.25
4264-010-CL	11600.41	PF 1	11870.00	1672.29	1678.51	1679.14	1681.59	0.022497	14.15	852.36	217.38	1.24
4264-010-CL	11582.03	PF 1	11870.00	1671.63	1677.31	1678.20	1680.82	0.028449	15.15	799.55	219.83	1.37
4264-010-CL	11567.48	PF 1	11870.00	1672.33	1676.09	1677.20	1680.09	0.024994	16.24	751.66	211.52	1.48
4264-010-CL	11561.97	PF 1	11870.00	1672.33	1676.12	1677.19	1680.03	0.004456	16.06	756.46	211.66	1.45
4264-010-CL	11545.46	PF 1	11870.00	1668.58	1677.20	1673.48	1677.92	0.000277	6.93	1778.42	224.82	0.42
4264-010-CL	11539.95	PF 1	11870.00	1668.57	1677.02	1673.58	1677.90	0.000338	7.55	1586.93	190.22	0.46
4264-010-CL	11516.11		Culvert									
4264-010-CL	11492.27	PF 1	11870.00	1668.34	1674.29		1676.08	0.005908	10.72	1114.58	188.76	0.77
4264-010-CL	11376.89	PF 1	11870.00	1666.90	1673.80	1673.12	1675.70	0.006121	11.52	1131.19	211.11	0.80
4264-010-CL	11316.65	PF 1	11870.00	1666.71	1672.73	1672.73	1675.21	0.009248	13.15	992.20	210.55	0.96
4264-010-CL	11271.2	PF 1	11870.00	1666.35	1672.63	1672.11	1674.54	0.006996	11.85	1138.99	236.51	0.85
4264-010-CL	11130.61	PF 1	11870.00	1665.98	1671.98		1673.36	0.007807	9.59	1301.27	361.59	0.83
4264-010-CL	11000	PF 1	11870.00	1665.85	1670.56	1670.56	1672.05	0.012978	10.24	1223.45	410.83	1.03
4264-010-CL	10900	PF 1	11870.00	1663.18	1667.53	1668.16	1669.96	0.034621	12.63	956.57	397.26	1.41
4264-010-CL	10800	PF 1	11870.00	1658.90	1665.51	1665.69	1667.21	0.019342	10.56	1146.95	405.58	1.08
4264-010-CL	10700	PF 1	11870.00	1657.70	1663.22	1663.50	1665.10	0.022878	11.11	1087.43	403.33	1.17
4264-010-CL	10600	PF 1	11870.00	1655.47	1660.86	1661.17	1662.79	0.023266	11.26	1074.37	393.40	1.18
4264-010-CL	10500	PF 1	11870.00	1653.85	1658.74	1658.99	1660.57	0.020687	10.93	1107.45	393.54	1.12
4264-010-CL	10400	PF 1	11870.00	1651.44	1656.01	1656.46	1658.20	0.026646	11.98	1007.53	374.17	1.27
4264-010-CL	10300	PF 1	11870.00	1647.53	1653.96	1654.16	1655.81	0.020011	11.04	1098.73	371.46	1.11
4264-010-CL	10200	PF 1	11870.00	1645.71	1651.60	1651.95	1653.69	0.022030	11.76	1036.31	347.53	1.17
4264-010-CL	10100	PF 1	11870.00	1644.68	1650.29	1650.16	1651.94	0.011151	10.67	1214.20	331.97	0.89
4264-010-CL	10000	PF 1	11870.00	1641.70	1649.07	1649.07	1650.84	0.010624	11.33	1218.03	338.89	0.88
4264-010-CL	9900	PF 1	11870.00	1640.80	1647.79	1647.89	1649.70	0.011850	12.46	1182.48	317.31	0.94
4264-010-CL	9800	PF 1	11870.00	1639.81	1644.96	1645.70	1647.84	0.029286	14.71	919.75	319.63	1.38
4264-010-CL	9700	PF 1	11870.00	1639.00	1643.82	1643.82	1645.50	0.016003	11.18	1168.22	348.29	1.03

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

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)	
4264-010-CL	9600	PF 1	11870.00	1636.96	1640.82	1641.41	1643.25	0.031094	12.63	956.20	367.94	1.36
4264-010-CL	9500	PF 1	11870.00	1634.00	1638.82	1639.00	1640.58	0.020049	10.86	1125.96	394.41	1.11
4264-010-CL	9400	PF 1	11870.00	1632.04	1636.13	1636.57	1638.18	0.028540	11.57	1040.80	427.83	1.29
4264-010-CL	9300	PF 1	11870.00	1629.23	1634.65	1634.65	1636.04	0.016424	9.49	1257.59	454.89	1.00
4264-010-CL	9200	PF 1	11870.00	1628.06	1632.35	1632.67	1634.11	0.022423	10.72	1137.51	474.55	1.15
4264-010-CL	9100	PF 1	11870.00	1624.94	1630.01	1630.35	1631.78	0.024140	10.74	1129.48	479.38	1.19
4264-010-CL	9000	PF 1	11870.00	1623.73	1628.74	1628.74	1630.10	0.014218	9.50	1307.89	492.03	0.94
4264-010-CL	8900	PF 1	11870.00	1621.37	1626.00	1626.44	1628.27	0.022253	12.26	999.37	348.33	1.19
4264-010-CL	8800	PF 1	11870.00	1619.06	1625.47	1625.47	1627.30	0.007882	11.25	1204.70	365.52	0.87
4264-010-CL	8700	PF 1	11870.00	1616.49	1623.26	1624.25	1626.18	0.013353	14.43	1019.36	438.69	1.13
4264-010-CL	8600	PF 1	11870.00	1614.87	1621.84	1622.82	1624.67	0.016589	14.93	1039.98	430.57	1.23
4264-010-CL	8500	PF 1	11870.00	1613.79	1619.80	1620.74	1622.80	0.021075	15.03	960.43	406.03	1.35
4264-010-CL	8364.13	PF 1	11870.00	1611.45	1617.98	1618.63	1620.35	0.013424	14.11	1163.26	461.60	1.12
4264-010-CL	8300	PF 1	11870.00	1609.97	1616.27	1617.23	1619.27	0.019180	16.37	1025.26	411.38	1.33
4264-010-CL	8200	PF 1	11870.00	1607.14	1613.45	1614.50	1616.97	0.026689	16.94	912.06	400.06	1.52
4264-010-CL	8100	PF 1	11870.00	1604.59	1611.55	1612.41	1614.59	0.018842	15.54	979.81	375.01	1.31
4264-010-CL	8032.6	PF 1	11870.00	1603.79	1609.77	1610.83	1613.16	0.023001	16.25	904.80	348.77	1.43
4264-010-CL	7900	PF 1	11870.00	1601.53	1607.26	1607.92	1609.82	0.023498	12.95	951.83	330.57	1.23
4264-010-CL	7800	PF 1	11870.00	1599.88	1605.98	1606.10	1607.81	0.014215	11.41	1156.18	345.04	0.99
4264-010-CL	7700	PF 1	11870.00	1597.86	1603.39	1603.97	1605.98	0.022250	13.17	952.73	313.70	1.21
4264-010-CL	7600	PF 1	11870.00	1596.17	1601.84	1602.01	1603.82	0.017750	11.33	1060.01	318.24	1.07
4264-010-CL	7500	PF 1	11870.00	1594.68	1600.28	1600.33	1602.17	0.014989	11.21	1101.11	309.06	1.00
4264-010-CL	7361.78	PF 1	11870.00	1592.05	1597.11	1597.60	1599.58	0.022941	12.81	955.86	295.61	1.22
4264-010-CL	7300	PF 1	11870.00	1589.54	1595.56	1596.11	1598.15	0.022655	13.45	950.42	289.22	1.22
4264-010-CL	7200	PF 1	11870.00	1586.99	1594.69	1594.69	1596.68	0.010412	11.80	1139.46	294.44	0.89
4264-010-CL	7100	PF 1	11870.00	1585.73	1592.35	1593.05	1595.19	0.020186	14.07	944.89	293.72	1.19
4264-010-CL	7000	PF 1	11870.00	1583.87	1589.46	1590.30	1592.57	0.034333	14.36	855.52	307.66	1.46
4264-010-CL	6900	PF 1	11870.00	1580.67	1588.21	1588.36	1589.94	0.015597	10.89	1182.05	399.17	1.01
4264-010-CL	6800	PF 1	11870.00	1579.16	1586.40	1586.70	1588.28	0.017211	11.12	1124.76	427.52	1.05
4264-010-CL	6700	PF 1	11870.00	1577.99	1584.96	1585.26	1586.62	0.014700	10.58	1237.69	515.94	0.98
4264-010-CL	6600	PF 1	15842.00	1576.91	1583.50	1583.81	1585.35	0.011281	11.75	1621.06	584.55	1.01
4264-010-CL	6500	PF 1	15842.00	1574.28	1581.11	1581.91	1583.80	0.019934	13.54	1297.17	551.03	1.29
4264-010-CL	6400	PF 1	15842.00	1572.84	1579.95	1580.31	1581.89	0.014500	11.42	1498.01	578.82	1.10
4264-010-CL	6300	PF 1	15842.00	1570.36	1574.77	1576.11	1579.30	0.043000	17.93	957.57	368.07	1.85
4264-010-CL	6200	PF 1	15842.00	1568.63	1574.79	1574.79	1577.11	0.011050	12.24	1293.79	284.04	1.01
4264-010-CL	6126.11	PF 1	15842.00	1567.70	1574.41	1573.19	1576.01	0.005174	10.15	1560.63	255.70	0.72
4264-010-CL	6084.06	PF 1	15842.00	1567.00	1574.33	1572.68	1575.77	0.004229	9.64	1642.92	248.54	0.66
4264-010-CL	6060		Bridge									
4264-010-CL	6041.11	PF 1	15842.00	1566.96	1573.57	1572.43	1575.27	0.005572	10.49	1510.55	246.36	0.75
4264-010-CL	6024.98	PF 1	15842.00	1566.80	1573.52	1572.29	1575.18	0.005206	10.33	1533.61	244.21	0.73
4264-010-CL	6000		Bridge									
4264-010-CL	5981.62	PF 1	15842.00	1565.98	1570.78	1571.42	1574.12	0.011654	14.65	1081.43	236.20	1.21
4264-010-CL	5900	PF 1	15842.00	1560.00	1562.84	1565.22	1571.72	0.061184	23.91	662.48	242.02	2.55
4264-010-CL	5800	PF 1	15842.00	1557.00	1560.61	1562.22	1565.99	0.037044	18.60	851.49	246.66	1.76
4264-010-CL	5700	PF 1	15842.00	1555.00	1559.45	1560.22	1562.89	0.018224	14.89	1064.02	252.67	1.28
4264-010-CL	5600	PF 1	15842.00	1554.00	1559.22	1559.22	1561.69	0.010724	12.62	1255.05	256.29	1.01
4264-010-CL	5500	PF 1	15842.00	1552.50	1557.12	1557.72	1560.32	0.016146	14.36	1103.56	252.72	1.21
4264-010-CL	5400	PF 1	15842.00	1551.00	1555.82	1556.22	1558.75	0.014015	13.73	1153.69	253.91	1.14
4264-010-CL	5300	PF 1	15842.00	1549.00	1553.33	1554.22	1557.00	0.020164	15.39	1029.35	250.95	1.34
4264-010-CL	5200	PF 1	15842.00	1546.65	1550.80	1551.87	1554.81	0.023164	16.07	985.67	249.91	1.43
4264-010-CL	5100	PF 1	15842.00	1545.40	1550.61	1550.61	1553.08	0.010720	12.61	1256.17	256.82	1.00
4264-010-CL	5000	PF 1	15842.00	1543.00	1547.02	1548.22	1551.31	0.025782	16.62	953.26	249.13	1.50
4264-010-CL	4900	PF 1	15842.00	1542.00	1547.22	1547.22	1549.69	0.010716	12.62	1255.33	256.30	1.00
4264-010-CL	4800	PF 1	15842.00	1540.80	1546.57	1546.02	1548.56	0.007637	11.34	1397.06	259.60	0.86
4264-010-CL	4700	PF 1	15842.00	1540.00	1545.47	1545.22	1547.71	0.009126	12.00	1320.57	257.82	0.93
4264-010-CL	4600	PF 1	15842.00	1539.00	1544.22	1544.22	1546.69	0.010717	12.62	1255.30	256.30	1.00
4264-010-CL	4500	PF 1	15842.00	1537.70	1542.54	1542.92	1545.44	0.013778	13.66	1159.89	254.05	1.13
4264-010-CL	4400	PF 1	15842.00	1535.60	1542.02	1540.82	1543.61	0.005296	10.10	1569.13	263.54	0.73
4264-010-CL	4300	PF 1	15842.00	1535.10	1540.32	1540.32	1542.79	0.010715	12.62	1255.36	256.30	1.00
4264-010-CL	4200	PF 1	15842.00	1533.00	1537.18	1538.22	1541.14	0.022668	15.96	992.35	250.07	1.41
4264-010-CL	4100	PF 1	15842.00	1532.10	1537.32	1537.32	1539.79	0.010717	12.62	1255.30	256.30	1.00
4264-010-CL	4000	PF 1	15842.00	1529.90	1534.02	1535.12	1538.09	0.023745	16.20	978.07	249.72	1.44
4264-010-CL	3900	PF 1	15842.00	1529.00	1534.22	1534.22	1536.69	0.010722	12.62	1255.11	256.29	1.01
4264-010-CL	3800	PF 1	15842.00	1526.60	1533.69	1531.82	1534.97	0.003795	9.08	1744.94	267.51	0.63
4264-010-CL	3700	PF 1	15842.00	1526.50	1531.75	1531.75	1534.25	0.010656	12.70	1247.28	250.64	1.00
4264-010-CL	3600	PF 1	15842.00	1524.30	1528.39	1529.52	1532.53	0.024457	16.35	969.09	249.51	1.46
4264-010-CL	3500	PF 1	15842.00	1523.80	1529.02	1529.02	1531.49	0.010728	12.62	1254.89	256.29	1.01
4264-010-CL	3400	PF 1	15842.00	1521.50	1525.57	1526.72	1529.75	0.024805	16.42	964.82	249.41	1.47
4264-010-CL	3300	PF 1	15842.00	1520.50	1527.92	1525.72	1529.08	0.003244	8.63	1834.78	269.52	0.58
4264-010-CL	3200	PF 1	15842.00	1519.50	1527.84		1528.74	0.002178	7.60	2085.19	275.04	0.49
4264-010-CL	3100	PF 1	15842.00	1518.50	1527.79		1528.50	0.001503	6.74	2349.98	280.21	0.41
4264-010-CL	3000	PF 1	15842.00	1516.69	1524.62	1524.62	1527.93	0.009810	14.60	1084.78	164.02	1.00
4264-010-CL	2900	PF 1	15842.00	1515.16	1521.28	1522.61	1526.39	0.020020	18.15	872.81	163.66	1.39
4264-010-CL	2800	PF 1	15842.00	1513.20	1517.87	1519.61	1523.74	0.034614	19.44	814.90	209.88	1.74
4264-010-CL	2700	PF 1	15842.00	1510.37	1518.37	1518.40	1521.38	0.010160	13.91	1138.63	192.10	1.01

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

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)	
4264-010-CL	2600	PF 1	15842.00	1506.79	1513.32	1515.25	1519.52	0.026237	19.99	792.69	158.11	1.57
4264-010-CL	2500	PF 1	15842.00	1504.64	1517.33	1512.92	1518.38	0.001912	8.23	1925.98	200.44	0.47
4264-010-CL	2400	PF 1	15842.00	1504.13	1517.08		1518.18	0.001965	8.41	1883.26	195.20	0.48
4264-010-CL	2300	PF 1	15842.00	1503.56	1515.84		1517.81	0.004456	11.25	1408.66	161.08	0.67
4264-010-CL	2200	PF 1	15842.00	1503.55	1516.13		1517.26	0.002123	8.54	1855.22	198.99	0.49
4264-010-CL	2100	PF 1	15842.00	1503.56	1515.95		1517.05	0.001976	8.39	1887.40	196.95	0.48
4264-010-CL	2000	PF 1	15842.00	1503.56	1515.64		1516.83	0.002250	8.73	1813.78	197.06	0.51
4264-010-CL	1900	PF 1	15842.00	1503.56	1515.46		1516.59	0.002168	8.51	1861.08	204.91	0.50
4264-010-CL	1800	PF 1	15842.00	1503.56	1514.95		1516.32	0.002672	9.41	1683.86	185.48	0.55
4264-010-CL	1700	PF 1	15842.00	1504.05	1514.19	1512.03	1515.96	0.004025	10.68	1482.91	185.21	0.67
4264-010-CL	1600	PF 1	15842.00	1504.19	1511.99	1511.99	1515.21	0.009892	14.41	1099.40	172.44	1.01

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1

Reach	River Sta	Profile	Top W Left	Top W Chnl	Top W Right	Top Width	Top W Act Left	Top W Act Chan	Top W Act Right	Top Wdth Act
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
4264-010-CL	30600	PF 1	12.64	511.85	24.67	549.16	12.64	511.85	24.67	549.16
4264-010-CL	30500	PF 1	4.21	463.45	2.65	470.31	4.21	463.45	2.65	470.31
4264-010-CL	30400	PF 1	26.84	515.93	21.08	563.85	26.84	515.93	21.08	563.85
4264-010-CL	30300	PF 1	22.89	557.42	21.81	602.12	22.89	557.42	21.81	602.12
4264-010-CL	30200	PF 1	9.43	486.37	11.37	507.17	9.43	486.37	11.37	507.17
4264-010-CL	30100	PF 1		115.05		115.05		115.05		115.05
4264-010-CL	30000	PF 1		134.18		134.18		134.18		134.18
4264-010-CL	29900	PF 1		130.53		130.53		130.53		130.53
4264-010-CL	29800	PF 1		127.90		127.90		127.90		127.90
4264-010-CL	29700	PF 1		143.50		143.50		143.50		143.50
4264-010-CL	29600	PF 1		124.01		124.01		124.01		124.01
4264-010-CL	29500	PF 1		116.75		116.75		116.75		116.75
4264-010-CL	29400	PF 1		115.23		115.23		115.23		115.23
4264-010-CL	29300	PF 1	2.08	134.31		136.39	2.08	134.31		136.39
4264-010-CL	29250	PF 1		138.51		138.51		138.51		138.51
4264-010-CL	29210.84	PF 1		123.20		123.20		123.20		123.20
4264-010-CL	29180		Culvert							
4264-010-CL	29168.47	PF 1		116.53		116.53		116.53		116.53
4264-010-CL	29150	PF 1	16.59	110.09		126.68	16.59	110.09		126.68
4264-010-CL	29100	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	29000	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28900	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28800	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28700	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28600	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28500	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28400	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28300	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28200	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28100	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	28000	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	27900	PF 1		48.00		48.00		48.00		48.00
4264-010-CL	27800	PF 1		95.72		95.72		95.72		95.72
4264-010-CL	27700	PF 1		104.82		104.82		104.82		104.82
4264-010-CL	27600	PF 1		108.47		108.47		108.47		108.47
4264-010-CL	27500	PF 1		106.89		106.89		106.89		106.89
4264-010-CL	27400	PF 1		107.21		107.21		107.21		107.21
4264-010-CL	27300	PF 1		107.09		107.09		107.09		107.09
4264-010-CL	27200	PF 1		107.05		107.05		107.05		107.05
4264-010-CL	27100	PF 1		107.05		107.05		107.05		107.05
4264-010-CL	27000	PF 1		107.05		107.05		107.05		107.05
4264-010-CL	26900	PF 1		107.05		107.05		107.05		107.05
4264-010-CL	26885	PF 1		98.89		98.89		98.89		98.89
4264-010-CL	26800	PF 1		105.54		105.54		105.54		105.54
4264-010-CL	26700	PF 1		108.13		108.13		108.13		108.13
4264-010-CL	26600	PF 1		106.97		106.97		106.97		106.97
4264-010-CL	26500	PF 1		107.14		107.14		107.14		107.14
4264-010-CL	26400	PF 1		107.08		107.08		107.08		107.08
4264-010-CL	26300	PF 1		107.06		107.06		107.06		107.06
4264-010-CL	26200	PF 1		107.06		107.06		107.06		107.06
4264-010-CL	26100	PF 1		107.06		107.06		107.06		107.06
4264-010-CL	26000	PF 1		109.07		109.07		109.07		109.07
4264-010-CL	25900	PF 1		107.61		107.61		107.61		107.61
4264-010-CL	25800	PF 1		107.82		107.82		107.82		107.82
4264-010-CL	25700	PF 1		107.74		107.74		107.74		107.74
4264-010-CL	25600	PF 1		107.71		107.71		107.71		107.71
4264-010-CL	25576	PF 1		98.27		98.27		98.27		98.27
4264-010-CL	25500	PF 1		104.37		104.37		104.37		104.37
4264-010-CL	25400	PF 1		109.44		109.44		109.44		109.44
4264-010-CL	25300	PF 1		107.55		107.55		107.55		107.55
4264-010-CL	25200	PF 1		107.88		107.88		107.88		107.88
4264-010-CL	25100	PF 1		107.75		107.75		107.75		107.75
4264-010-CL	25000	PF 1		107.70		107.70		107.70		107.70
4264-010-CL	24900	PF 1		107.70		107.70		107.70		107.70
4264-010-CL	24800	PF 1		107.70		107.70		107.70		107.70
4264-010-CL	24700	PF 1		107.70		107.70		107.70		107.70
4264-010-CL	24600	PF 1		107.70		107.70		107.70		107.70
4264-010-CL	24500	PF 1		107.70		107.70		107.70		107.70
4264-010-CL	24400	PF 1		111.16		111.16		111.16		111.16
4264-010-CL	24300	PF 1		108.71		108.71		108.71		108.71
4264-010-CL	24200	PF 1		109.88		109.88		109.88		109.88
4264-010-CL	24100	PF 1		109.11		109.11		109.11		109.11
4264-010-CL	24000	PF 1		109.43		109.43		109.43		109.43
4264-010-CL	23900	PF 1		109.20		109.20		109.20		109.20
4264-010-CL	23800	PF 1		109.30		109.30		109.30		109.30
4264-010-CL	23700	PF 1		109.22		109.22		109.22		109.22
4264-010-CL	23600	PF 1		116.59		116.59		116.59		116.59
4264-010-CL	23500	PF 1		111.77		111.77		111.77		111.77

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

Reach	River Sta	Profile	Top W Left	Top W Chnl	Top W Right	Top Width	Top W Act Left	Top W Act Chan	Top W Act Right	Top Wdth Act
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
4264-010-CL	23400	PF 1		110.83		110.83		110.83		110.83
4264-010-CL	23300	PF 1		111.74		111.74		111.74		111.74
4264-010-CL	23200	PF 1		110.89		110.89		110.89		110.89
4264-010-CL	23100	PF 1		106.91		106.91		106.91		106.91
4264-010-CL	23000	PF 1		108.12		108.12		108.12		108.12
4264-010-CL	22900	PF 1		105.30		105.30		105.30		105.30
4264-010-CL	22800	PF 1		110.13		110.13		110.13		110.13
4264-010-CL	22700	PF 1		105.31		105.31		105.31		105.31
4264-010-CL	22600	PF 1		106.91		106.91		106.91		106.91
4264-010-CL	22500	PF 1		106.41		106.41		106.41		106.41
4264-010-CL	22400	PF 1		105.42		105.42		105.42		105.42
4264-010-CL	22300	PF 1		105.38		105.38		105.38		105.38
4264-010-CL	22200	PF 1		105.39		105.39		105.39		105.39
4264-010-CL	22100	PF 1		107.27		107.27		107.27		107.27
4264-010-CL	22000	PF 1		106.28		106.28		106.28		106.28
4264-010-CL	21900	PF 1		109.82		109.82		109.82		109.82
4264-010-CL	21800	PF 1		108.42		108.42		108.42		108.42
4264-010-CL	21700	PF 1		108.59		108.59		108.59		108.59
4264-010-CL	21600	PF 1		108.52		108.52		108.52		108.52
4264-010-CL	21500	PF 1		108.50		108.50		108.50		108.50
4264-010-CL	21400	PF 1		112.75		112.75		112.75		112.75
4264-010-CL	21300	PF 1		111.74		111.74		111.74		111.74
4264-010-CL	21200	PF 1	12.48	160.59	52.16	225.23	12.48	160.59	17.82	190.89
4264-010-CL	21100	PF 1	14.20	177.21	68.65	260.06	14.20	177.21	68.65	260.06
4264-010-CL	21000	PF 1	9.21	164.77	87.75	261.73	9.21	164.77	87.75	261.73
4264-010-CL	20900	PF 1	11.76	143.51	147.17	302.43	11.76	143.51	78.42	233.68
4264-010-CL	20800	PF 1	14.54	242.17	4.67	261.38	14.54	242.17	4.67	261.38
4264-010-CL	20700	PF 1	4.14	242.02	7.89	254.05	4.14	242.02	7.89	254.05
4264-010-CL	20600	PF 1	54.48	231.26	34.94	320.68	54.48	231.26	32.84	318.58
4264-010-CL	20500	PF 1	1.69	282.12	1.88	285.69	1.69	282.12	1.88	285.69
4264-010-CL	20400	PF 1	10.24	270.80	11.04	292.08	10.24	270.80	11.04	292.08
4264-010-CL	20300	PF 1	14.12	218.83	64.76	297.71	14.12	218.83	64.76	297.71
4264-010-CL	20200	PF 1	17.24	181.16	87.29	285.69	17.24	181.16	87.29	285.69
4264-010-CL	20100	PF 1	16.33	164.34	246.63	427.30	16.33	164.34	20.49	201.17
4264-010-CL	20000	PF 1	1.38	203.90	201.09	406.37	1.38	203.90	201.09	406.37
4264-010-CL	19900	PF 1	12.38	218.84	152.00	383.21	12.38	218.84	152.00	383.21
4264-010-CL	19800	PF 1	13.98	215.47	121.42	350.86	12.24	215.47	121.42	349.13
4264-010-CL	19700	PF 1	81.25	195.77	121.73	398.74	7.88	195.77	121.73	325.37
4264-010-CL	19600	PF 1	85.94	160.04	165.72	411.70	31.11	160.04	165.72	356.87
4264-010-CL	19500	PF 1	129.64	176.68	85.37	391.69	129.64	176.68	85.37	391.69
4264-010-CL	19400	PF 1	128.35	133.58	126.79	388.72	128.35	133.58	126.79	388.72
4264-010-CL	19300	PF 1	103.58	169.46	70.33	343.36	103.58	169.46	70.33	343.36
4264-010-CL	19200	PF 1	2.40	215.63	44.76	262.79	2.40	215.63	35.96	253.99
4264-010-CL	19100	PF 1	44.45	171.89	77.81	294.15	44.45	171.89	77.81	294.15
4264-010-CL	19000	PF 1	11.73	83.23	275.44	370.39	11.73	83.23	275.44	370.39
4264-010-CL	18900	PF 1	4.99	78.21	252.16	335.36	4.99	78.21	252.16	335.36
4264-010-CL	18800	PF 1	7.95	69.21	200.19	277.35	7.95	69.21	200.19	277.35
4264-010-CL	18700	PF 1		82.65	233.43	316.08		82.65	233.43	316.08
4264-010-CL	18600	PF 1	34.12	176.73	94.28	305.13	34.12	176.73	94.28	305.13
4264-010-CL	18500	PF 1	63.63	192.68	16.13	272.44	63.63	192.68	16.13	272.44
4264-010-CL	18400	PF 1	117.47	179.23	28.16	324.86	117.47	179.23	28.16	324.86
4264-010-CL	18345	PF 1	131.11	164.52	54.10	349.73	131.11	164.52	54.10	349.73
4264-010-CL	18322		Bridge							
4264-010-CL	18300	PF 1	114.83	156.74	46.08	317.65	114.83	156.74	46.08	317.65
4264-010-CL	18200	PF 1		328.49		328.49		328.49		328.49
4264-010-CL	18100	PF 1		301.64	16.59	318.23		301.64	16.59	318.23
4264-010-CL	18000	PF 1		258.42		258.42		258.42		258.42
4264-010-CL	17900	PF 1		303.10		303.10		303.10		303.10
4264-010-CL	17800	PF 1	0.85	308.45	4.69	313.99	0.85	308.45	4.69	313.99
4264-010-CL	17700	PF 1	10.75	301.52	6.12	318.38	1.07	301.52	6.12	308.70
4264-010-CL	17600	PF 1	10.63	258.12	94.68	363.44	10.63	258.12	53.93	322.68
4264-010-CL	17500	PF 1	7.74	205.25	257.63	470.63	7.74	205.25	257.63	470.63
4264-010-CL	17400	PF 1		261.31	136.72	398.03		261.31	136.72	398.03
4264-010-CL	17300	PF 1	11.07	196.52	120.30	327.89	10.86	196.52	120.30	327.68
4264-010-CL	17200	PF 1	127.02	227.29	86.09	440.40	116.86	227.29	86.09	430.24
4264-010-CL	17100	PF 1	197.84	189.76	48.03	435.63	197.84	189.76	48.03	435.63
4264-010-CL	17000	PF 1	181.67	211.78	85.97	479.43	181.67	211.78	85.97	479.43
4264-010-CL	16900	PF 1	68.92	370.33	90.30	529.55	68.92	370.33	90.30	529.55
4264-010-CL	16800	PF 1	88.06	358.00	72.02	518.07	88.06	358.00	72.02	518.07
4264-010-CL	16700	PF 1	91.94	306.76	149.88	548.58	91.94	306.76	149.88	548.58
4264-010-CL	16600	PF 1	32.77	375.09	117.07	524.94	32.77	375.09	117.07	524.94
4264-010-CL	16500	PF 1	42.91	320.51	189.23	552.65	42.91	320.51	189.23	552.65
4264-010-CL	16400	PF 1	55.16	334.30	174.21	563.66	55.16	334.30	174.21	563.66
4264-010-CL	16300	PF 1	109.03	226.60	205.91	541.54	109.03	226.60	203.94	539.57
4264-010-CL	16200	PF 1	69.78	308.09	70.76	448.63	69.78	308.09	51.30	429.17
4264-010-CL	16100	PF 1	113.03	221.78	110.95	445.77	113.03	221.78	110.95	445.77
4264-010-CL	16000	PF 1	6.17	409.79	7.12	423.07	6.17	409.79	7.12	423.07
4264-010-CL	15900	PF 1	9.17	377.92	15.06	402.15	9.17	377.92	15.06	402.15

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

Reach	River Sta	Profile	Top W Left	Top W Chnl	Top W Right	Top Width	Top W Act Left	Top W Act Chan	Top W Act Right	Top Wdth Act
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
4264-010-CL	15800	PF 1	10.12	392.35	17.26	419.72	10.12	392.35	11.89	414.36
4264-010-CL	15700	PF 1		512.91		512.91		512.91		512.91
4264-010-CL	15600	PF 1	6.69	472.64	80.86	560.18	6.69	472.64	80.86	560.18
4264-010-CL	15500	PF 1	18.49	580.47	10.07	609.03	18.49	580.47	10.07	609.03
4264-010-CL	15400	PF 1	1.52	625.44	36.57	663.54	1.52	625.44	36.57	663.54
4264-010-CL	15300	PF 1		673.54	6.97	680.51		673.54	6.97	680.51
4264-010-CL	15200	PF 1	9.78	745.60		755.38	9.78	745.60		755.38
4264-010-CL	15100	PF 1		729.13	26.65	755.77		729.13	26.65	755.77
4264-010-CL	14965.19	PF 1	12.25	585.30	193.16	790.71	12.25	585.30	193.16	790.71
4264-010-CL	14900	PF 1	6.37	594.54	143.40	744.31	6.37	594.54	143.40	744.31
4264-010-CL	14800	PF 1	52.62	682.92	34.48	770.02	7.59	682.92	34.48	724.98
4264-010-CL	14700	PF 1	61.79	507.80	15.36	584.95		507.80	15.36	523.16
4264-010-CL	14600	PF 1	192.12	370.31	75.32	637.75	192.12	370.31	75.32	637.75
4264-010-CL	14500	PF 1	268.14	405.08	29.95	703.18	268.14	405.08	29.95	703.18
4264-010-CL	14400	PF 1	319.17	327.32	22.05	668.53	319.17	327.32	22.05	668.53
4264-010-CL	14300	PF 1	468.88	287.86	33.96	790.70	468.88	287.86	33.96	790.70
4264-010-CL	14200	PF 1	530.50	297.43	1.45	829.38	530.50	297.43	1.45	829.38
4264-010-CL	14100	PF 1	391.61	374.65	29.99	796.25	391.61	374.65	29.99	796.25
4264-010-CL	14000	PF 1	438.76	393.54	2.25	834.55	438.76	393.54	2.25	834.55
4264-010-CL	13900	PF 1	390.75	395.88	2.04	788.67	390.75	395.88	2.04	788.67
4264-010-CL	13835.07	PF 1	27.97	729.91	6.55	764.43	27.97	729.91	6.55	764.43
4264-010-CL	13700	PF 1	14.35	661.70		676.05	14.35	661.70		676.05
4264-010-CL	13600	PF 1	13.51	563.96	32.00	609.46	13.51	563.96	32.00	609.46
4264-010-CL	13500	PF 1	9.94	525.76	29.77	565.46	9.94	525.76	29.77	565.46
4264-010-CL	13400	PF 1	12.26	494.87	30.41	537.54	12.26	494.87	30.41	537.54
4264-010-CL	13300	PF 1	20.18	453.82	21.97	495.97	20.18	453.82	21.97	495.97
4264-010-CL	13200	PF 1	12.83	420.75	6.92	440.50	12.83	420.75	6.92	440.50
4264-010-CL	13100	PF 1	31.90	283.80	42.68	358.38	31.90	283.80	42.68	358.38
4264-010-CL	13000	PF 1	40.29	239.92	32.62	312.84	40.29	239.92	32.62	312.84
4264-010-CL	12900	PF 1	50.31	209.06	23.26	282.64	50.31	209.06	23.26	282.64
4264-010-CL	12800	PF 1	50.68	203.93	15.68	270.29	50.68	203.93	15.68	270.29
4264-010-CL	12700	PF 1	33.40	190.25	9.64	233.29	33.40	190.25	9.64	233.29
4264-010-CL	12600	PF 1	31.81	110.16	115.52	257.48	31.81	110.16	115.52	257.48
4264-010-CL	12545.24	PF 1	11.82	160.36	93.16	265.34	11.82	160.36	93.16	265.34
4264-010-CL	12400	PF 1	16.48	216.29	11.93	244.70	16.48	216.29	11.93	244.70
4264-010-CL	12289.17	PF 1	27.58	207.26	9.08	243.92	27.58	207.26	9.08	243.92
4264-010-CL	12200	PF 1	17.19	202.98	7.91	228.07	17.19	202.98	7.91	228.07
4264-010-CL	12100	PF 1	14.87	205.58	13.33	233.77	14.87	205.58	13.33	233.77
4264-010-CL	12033.11	PF 1	24.54	199.17	9.02	232.73	24.54	199.17	9.02	232.73
4264-010-CL	11900	PF 1	24.67	191.18	12.45	228.30	24.67	191.18	12.45	228.30
4264-010-CL	11777	PF 1	22.32	184.10	18.10	224.52	22.32	184.10	18.10	224.52
4264-010-CL	11665.28	PF 1	2.54	209.30	14.19	226.03	2.54	209.30	14.19	226.03
4264-010-CL	11614.66	PF 1	1.92	206.53	6.96	215.41	1.92	206.53	6.96	215.41
4264-010-CL	11600.41	PF 1	3.60	203.09	10.68	217.38	3.60	203.09	10.68	217.38
4264-010-CL	11582.03	PF 1	3.66	202.17	13.99	219.83	3.66	202.17	13.99	219.83
4264-010-CL	11567.48	PF 1	11.76	188.00	11.76	211.52	11.76	188.00	11.76	211.52
4264-010-CL	11561.97	PF 1	11.83	188.00	11.83	211.66	11.83	188.00	11.83	211.66
4264-010-CL	11545.46	PF 1	18.41	188.00	18.41	224.82	18.41	188.00	18.41	224.82
4264-010-CL	11539.95	PF 1	2.13	185.62	2.48	190.22	2.13	185.62	2.48	190.22
4264-010-CL	11516.11		Culvert							
4264-010-CL	11492.27	PF 1	1.44	185.63	1.69	188.76	1.44	185.63	1.69	188.76
4264-010-CL	11376.89	PF 1	42.66	141.85	26.60	211.11	42.66	141.85	26.60	211.11
4264-010-CL	11316.65	PF 1	32.96	140.19	37.40	210.55	32.96	140.19	37.40	210.55
4264-010-CL	11271.2	PF 1	33.05	133.65	69.81	236.51	33.05	133.65	69.81	236.51
4264-010-CL	11130.61	PF 1	15.70	286.35	59.54	361.59	15.70	286.35	59.54	361.59
4264-010-CL	11000	PF 1	20.15	292.85	97.83	410.83	20.15	292.85	97.83	410.83
4264-010-CL	10900	PF 1	12.96	366.48	17.81	397.26	12.96	366.48	17.81	397.26
4264-010-CL	10800	PF 1	17.72	369.99	17.87	405.58	17.72	369.99	17.87	405.58
4264-010-CL	10700	PF 1	13.26	373.30	16.78	403.33	13.26	373.30	16.78	403.33
4264-010-CL	10600	PF 1	15.42	360.87	17.10	393.40	15.42	360.87	17.10	393.40
4264-010-CL	10500	PF 1	14.43	361.00	18.11	393.54	14.43	361.00	18.11	393.54
4264-010-CL	10400	PF 1	12.51	346.99	14.67	374.17	12.51	346.99	14.67	374.17
4264-010-CL	10300	PF 1	12.52	334.29	24.65	371.46	12.52	334.29	24.65	371.46
4264-010-CL	10200	PF 1	8.20	306.48	32.85	347.53	8.20	306.48	32.85	347.53
4264-010-CL	10100	PF 1	83.27	224.24	24.47	331.97	83.27	224.24	24.47	331.97
4264-010-CL	10000	PF 1	134.08	175.17	29.64	338.89	134.08	175.17	29.64	338.89
4264-010-CL	9900	PF 1	179.94	123.12	14.26	317.31	179.94	123.12	14.26	317.31
4264-010-CL	9800	PF 1	133.54	173.79	12.30	319.63	133.54	173.79	12.30	319.63
4264-010-CL	9700	PF 1	142.90	190.15	15.24	348.29	142.90	190.15	15.24	348.29
4264-010-CL	9600	PF 1	11.87	340.58	15.49	367.94	11.87	340.58	15.49	367.94
4264-010-CL	9500	PF 1	36.57	339.74	18.10	394.41	36.57	339.74	18.10	394.41
4264-010-CL	9400	PF 1	8.29	401.37	18.17	427.83	8.29	401.37	18.17	427.83
4264-010-CL	9300	PF 1	6.56	441.83	6.50	454.89	6.56	441.83	6.50	454.89
4264-010-CL	9200	PF 1	64.85	406.17	3.52	474.55	64.85	406.17	3.52	474.55
4264-010-CL	9100	PF 1	42.62	427.06	9.70	479.38	42.62	427.06	9.70	479.38
4264-010-CL	9000	PF 1	100.47	385.86	5.70	492.03	100.47	385.86	5.70	492.03
4264-010-CL	8900	PF 1	56.67	280.87	10.79	348.33	56.67	280.87	10.79	348.33
4264-010-CL	8800	PF 1	164.96	188.28	12.28	365.52	164.96	188.28	12.28	365.52

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

Reach	River Sta	Profile	Top W Left	Top W Chnl	Top W Right	Top Width	Top W Act Left	Top W Act Chan	Top W Act Right	Top Wdth Act
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
4264-010-CL	8700	PF 1	289.37	144.74	4.58	438.69	289.37	144.74	4.58	438.69
4264-010-CL	8600	PF 1	288.18	136.58	5.81	430.57	288.18	136.58	5.81	430.57
4264-010-CL	8500	PF 1	229.31	168.78	7.94	406.03	229.31	168.78	7.94	406.03
4264-010-CL	8364.13	PF 1	329.60	122.89	9.11	461.60	329.60	122.89	9.11	461.60
4264-010-CL	8300	PF 1	293.77	100.04	17.57	411.38	293.77	100.04	17.57	411.38
4264-010-CL	8200	PF 1	260.25	133.12	6.70	400.06	260.25	133.12	6.70	400.06
4264-010-CL	8100	PF 1	222.51	133.32	19.18	375.01	222.51	133.32	19.18	375.01
4264-010-CL	8032.6	PF 1	198.12	140.26	10.39	348.77	198.12	140.26	10.39	348.77
4264-010-CL	7900	PF 1	58.57	261.24	10.76	330.57	58.57	261.24	10.76	330.57
4264-010-CL	7800	PF 1	106.74	216.95	21.35	345.04	106.74	216.95	21.35	345.04
4264-010-CL	7700	PF 1	42.73	233.95	37.03	313.70	42.73	233.95	37.03	313.70
4264-010-CL	7600	PF 1	6.43	298.46	13.35	318.24	6.43	298.46	13.35	318.24
4264-010-CL	7500	PF 1	27.84	260.13	21.09	309.06	27.84	260.13	21.09	309.06
4264-010-CL	7361.78	PF 1	27.26	257.07	11.28	295.61	27.26	257.07	11.28	295.61
4264-010-CL	7300	PF 1	19.04	204.92	65.26	289.22	19.04	204.92	65.26	289.22
4264-010-CL	7200	PF 1	43.84	164.60	85.99	294.44	43.84	164.60	85.99	294.44
4264-010-CL	7100	PF 1	54.52	174.50	64.70	293.72	54.52	174.50	64.70	293.72
4264-010-CL	7000	PF 1	15.86	262.41	29.39	307.66	15.86	262.41	29.39	307.66
4264-010-CL	6900	PF 1	90.40	276.75	32.02	399.17	90.40	276.75	32.02	399.17
4264-010-CL	6800	PF 1	125.93	301.59		427.52	125.93	301.59		427.52
4264-010-CL	6700	PF 1	221.09	294.86		515.94	221.09	294.86		515.94
4264-010-CL	6600	PF 1	315.84	264.71	4.00	584.55	315.84	264.71	4.00	584.55
4264-010-CL	6500	PF 1	228.02	321.62	1.39	551.03	217.36	321.62	1.39	540.37
4264-010-CL	6400	PF 1	184.85	391.52	2.45	578.82	184.85	391.52	2.45	578.82
4264-010-CL	6300	PF 1	114.59	253.48		368.07	114.59	253.48		368.07
4264-010-CL	6200	PF 1	0.49	283.55		284.04	0.49	283.55		284.04
4264-010-CL	6126.11	PF 1	0.93	254.77		255.70	0.93	254.77		255.70
4264-010-CL	6084.06	PF 1		248.54		248.54		248.54		248.54
4264-010-CL	6060		Bridge							
4264-010-CL	6041.11	PF 1		246.36		246.36		246.36		246.36
4264-010-CL	6024.98	PF 1		244.21		244.21		244.21		244.21
4264-010-CL	6000		Bridge							
4264-010-CL	5981.62	PF 1		236.20		236.20		236.20		236.20
4264-010-CL	5900	PF 1		242.02		242.02		242.02		242.02
4264-010-CL	5800	PF 1		246.66		246.66		246.66		246.66
4264-010-CL	5700	PF 1		252.67		252.67		252.67		252.67
4264-010-CL	5600	PF 1		256.29		256.29		256.29		256.29
4264-010-CL	5500	PF 1		252.72		252.72		252.72		252.72
4264-010-CL	5400	PF 1		253.91		253.91		253.91		253.91
4264-010-CL	5300	PF 1		250.95		250.95		250.95		250.95
4264-010-CL	5200	PF 1		249.91		249.91		249.91		249.91
4264-010-CL	5100	PF 1		256.82		256.82		256.82		256.82
4264-010-CL	5000	PF 1		249.13		249.13		249.13		249.13
4264-010-CL	4900	PF 1		256.30		256.30		256.30		256.30
4264-010-CL	4800	PF 1		259.60		259.60		259.60		259.60
4264-010-CL	4700	PF 1		257.82		257.82		257.82		257.82
4264-010-CL	4600	PF 1		256.30		256.30		256.30		256.30
4264-010-CL	4500	PF 1		254.05		254.05		254.05		254.05
4264-010-CL	4400	PF 1		263.54		263.54		263.54		263.54
4264-010-CL	4300	PF 1		256.30		256.30		256.30		256.30
4264-010-CL	4200	PF 1		250.07		250.07		250.07		250.07
4264-010-CL	4100	PF 1		256.30		256.30		256.30		256.30
4264-010-CL	4000	PF 1		249.72		249.72		249.72		249.72
4264-010-CL	3900	PF 1		256.29		256.29		256.29		256.29
4264-010-CL	3800	PF 1		267.51		267.51		267.51		267.51
4264-010-CL	3700	PF 1		250.64		250.64		250.64		250.64
4264-010-CL	3600	PF 1		249.51		249.51		249.51		249.51
4264-010-CL	3500	PF 1		256.29		256.29		256.29		256.29
4264-010-CL	3400	PF 1		249.41		249.41		249.41		249.41
4264-010-CL	3300	PF 1		269.52		269.52		269.52		269.52
4264-010-CL	3200	PF 1		275.04		275.04		275.04		275.04
4264-010-CL	3100	PF 1		280.21		280.21		280.21		280.21
4264-010-CL	3000	PF 1		164.02		164.02		164.02		164.02
4264-010-CL	2900	PF 1		163.66		163.66		163.66		163.66
4264-010-CL	2800	PF 1		209.88		209.88		209.88		209.88
4264-010-CL	2700	PF 1		192.10		192.10		192.10		192.10
4264-010-CL	2600	PF 1		158.11		158.11		158.11		158.11
4264-010-CL	2500	PF 1		200.44		200.44		200.44		200.44
4264-010-CL	2400	PF 1		195.20		195.20		195.20		195.20
4264-010-CL	2300	PF 1		161.08		161.08		161.08		161.08
4264-010-CL	2200	PF 1		198.99		198.99		198.99		198.99
4264-010-CL	2100	PF 1		196.95		196.95		196.95		196.95
4264-010-CL	2000	PF 1		197.06		197.06		197.06		197.06
4264-010-CL	1900	PF 1		204.91		204.91		204.91		204.91
4264-010-CL	1800	PF 1		185.48		185.48		185.48		185.48
4264-010-CL	1700	PF 1		185.21		185.21		185.21		185.21
4264-010-CL	1600	PF 1		172.44		172.44		172.44		172.44

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1

Reach	River Sta	Profile	Length Left	Length Chnl	Length Rght	Length Wtd.	Q Channel	Area Channel	Invert Slope	Hydr Radius	Hydr Radius C
			(ft)	(ft)	(ft)	(ft)	(cfs)	(sq ft)		(ft)	(ft)
4264-010-CL	30600	PF 1	100.00	100.00	100.00	100.00	12816.70	1383.89	0.0424	2.59	2.69
4264-010-CL	30500	PF 1	100.00	100.00	100.00	100.00	12988.50	1020.95	0.0279	2.17	2.19
4264-010-CL	30400	PF 1	100.00	100.00	100.00	100.00	12566.50	1155.93	0.0230	2.16	2.23
4264-010-CL	30300	PF 1	100.00	100.00	100.00	100.00	12664.14	1076.19	0.0364	1.86	1.92
4264-010-CL	30200	PF 1	100.00	100.00	100.00	100.00	12897.58	1314.96	0.1014	2.62	2.68
4264-010-CL	30100	PF 1	100.00	100.00	100.00	100.00	13015.00	573.91	0.0300	4.88	4.88
4264-010-CL	30000	PF 1	100.00	100.00	100.00	100.00	13015.00	730.24	0.0300	5.33	5.33
4264-010-CL	29900	PF 1	100.00	100.00	100.00	100.00	13015.00	875.36	0.0300	6.52	6.52
4264-010-CL	29800	PF 1	100.00	100.00	100.00	100.00	13015.00	719.66	0.0300	5.50	5.50
4264-010-CL	29700	PF 1	100.00	100.00	100.00	100.00	13015.00	718.20	0.0300	4.92	4.92
4264-010-CL	29600	PF 1	100.00	100.00	100.00	100.00	13015.00	869.31	0.0300	6.71	6.71
4264-010-CL	29500	PF 1	100.00	100.00	100.00	100.00	13015.00	794.39	0.0200	6.59	6.59
4264-010-CL	29400	PF 1	100.00	100.00	100.00	100.00	13015.00	849.50	0.0100	7.12	7.12
4264-010-CL	29300	PF 1	50.00	50.00	50.00	50.00	13013.95	796.29	0.0060	5.66	5.75
4264-010-CL	29250	PF 1	39.16	39.16	39.16	39.16	13015.00	724.26	0.0449	5.13	5.13
4264-010-CL	29210.84	PF 1	42.37	42.37	42.37	42.37	13015.00	671.55	0.0231	5.22	5.22
4264-010-CL	29180		Culvert								
4264-010-CL	29168.47	PF 1	18.44	18.44	18.44	18.44	13015.00	851.12	0.4046	6.82	6.82
4264-010-CL	29150	PF 1	50.00	50.00	50.00	50.00	10784.03	1604.86	0.0300	11.73	13.31
4264-010-CL	29100	PF 1	100.00	100.00	100.00	100.00	10880.00	559.32	0.0300	3.96	3.96
4264-010-CL	29000	PF 1	100.00	100.00	100.00	100.00	10880.00	450.83	0.0300	3.66	3.66
4264-010-CL	28900	PF 1	100.00	100.00	100.00	100.00	10880.00	408.41	0.0300	3.52	3.52
4264-010-CL	28800	PF 1	100.00	100.00	100.00	100.00	10880.00	387.26	0.0300	3.44	3.44
4264-010-CL	28700	PF 1	100.00	100.00	100.00	100.00	10880.00	374.41	0.0300	3.39	3.39
4264-010-CL	28600	PF 1	100.00	100.00	100.00	100.00	10880.00	365.99	0.0300	3.36	3.36
4264-010-CL	28500	PF 1	100.00	100.00	100.00	100.00	10880.00	360.22	0.0300	3.33	3.33
4264-010-CL	28400	PF 1	100.00	100.00	100.00	100.00	10880.00	356.18	0.0300	3.32	3.32
4264-010-CL	28300	PF 1	100.00	100.00	100.00	100.00	10880.00	353.27	0.0300	3.31	3.31
4264-010-CL	28200	PF 1	100.00	100.00	100.00	100.00	10880.00	351.08	0.0300	3.30	3.30
4264-010-CL	28100	PF 1	100.00	100.00	100.00	100.00	10880.00	349.68	0.0300	3.29	3.29
4264-010-CL	28000	PF 1	100.00	100.00	100.00	100.00	10880.00	348.55	0.0300	3.29	3.29
4264-010-CL	27900	PF 1	100.00	100.00	100.00	100.00	10880.00	347.71	0.0300	3.28	3.28
4264-010-CL	27800	PF 1	100.00	100.00	100.00	100.00	10880.00	345.35	0.0300	3.54	3.54
4264-010-CL	27700	PF 1	100.00	100.00	100.00	100.00	10880.00	573.34	0.0300	5.32	5.32
4264-010-CL	27600	PF 1	100.00	100.00	100.00	100.00	10880.00	670.79	0.0300	6.00	6.00
4264-010-CL	27500	PF 1	100.00	100.00	100.00	100.00	10880.00	628.28	0.0300	5.71	5.71
4264-010-CL	27400	PF 1	100.00	100.00	100.00	100.00	10880.00	636.83	0.0300	5.77	5.77
4264-010-CL	27300	PF 1	100.00	100.00	100.00	100.00	10880.00	633.45	0.0300	5.74	5.74
4264-010-CL	27200	PF 1	100.00	100.00	100.00	100.00	10880.00	632.38	0.0300	5.74	5.74
4264-010-CL	27100	PF 1	100.00	100.00	100.00	100.00	10880.00	632.38	0.0300	5.74	5.74
4264-010-CL	27000	PF 1	100.00	100.00	100.00	100.00	10880.00	632.38	0.0300	5.74	5.74
4264-010-CL	26900	PF 1	15.00	15.00	15.00	15.00	10880.00	632.38	0.3333	5.74	5.74
4264-010-CL	26885	PF 1	85.00	85.00	85.00	85.00	10880.00	422.35	0.0353	4.18	4.18
4264-010-CL	26800	PF 1	100.00	100.00	100.00	100.00	10880.00	592.44	0.0300	5.46	5.46
4264-010-CL	26700	PF 1	100.00	100.00	100.00	100.00	10880.00	661.46	0.0300	5.94	5.94
4264-010-CL	26600	PF 1	99.93	99.93	99.93	99.93	10880.00	630.21	0.0300	5.72	5.72
4264-010-CL	26500	PF 1	100.00	100.00	100.00	100.00	10880.00	634.94	0.0300	5.75	5.75
4264-010-CL	26400	PF 1	100.00	100.00	100.00	100.00	10880.00	633.19	0.0300	5.74	5.74
4264-010-CL	26300	PF 1	100.00	100.00	100.00	100.00	10880.00	632.64	0.0300	5.74	5.74
4264-010-CL	26200	PF 1	100.00	100.00	100.00	100.00	10880.00	632.64	0.0300	5.74	5.74
4264-010-CL	26100	PF 1	100.00	100.00	100.00	100.00	10880.00	632.64	0.0300	5.74	5.74
4264-010-CL	26000	PF 1	100.00	100.00	100.00	100.00	11340.00	686.96	0.0300	6.11	6.11
4264-010-CL	25900	PF 1	100.00	100.00	100.00	100.00	11340.00	647.52	0.0300	5.84	5.84
4264-010-CL	25800	PF 1	100.00	100.00	100.00	100.00	11340.00	653.21	0.0300	5.88	5.88
4264-010-CL	25700	PF 1	100.00	100.00	100.00	100.00	11340.00	650.94	0.0300	5.86	5.86
4264-010-CL	25600	PF 1	24.00	24.00	24.00	24.00	11340.00	650.15	0.2917	5.86	5.86
4264-010-CL	25576	PF 1	76.00	76.00	76.00	76.00	11340.00	407.09	0.0395	4.05	4.05
4264-010-CL	25500	PF 1	100.00	100.00	100.00	100.00	11340.00	561.59	0.0300	5.24	5.24
4264-010-CL	25400	PF 1	100.00	100.00	100.00	100.00	11340.00	697.12	0.0300	6.17	6.17
4264-010-CL	25300	PF 1	100.00	100.00	100.00	100.00	11340.00	645.83	0.0300	5.83	5.83
4264-010-CL	25200	PF 1	100.00	100.00	100.00	100.00	11340.00	654.67	0.0300	5.89	5.89
4264-010-CL	25100	PF 1	100.00	100.00	100.00	100.00	11340.00	651.21	0.0300	5.87	5.87
4264-010-CL	25000	PF 1	100.00	100.00	100.00	100.00	11340.00	649.96	0.0300	5.86	5.86
4264-010-CL	24900	PF 1	100.00	100.00	100.00	100.00	11340.00	649.96	0.0300	5.86	5.86
4264-010-CL	24800	PF 1	100.00	100.00	100.00	100.00	11340.00	649.96	0.0300	5.86	5.86
4264-010-CL	24700	PF 1	100.00	100.00	100.00	100.00	11340.00	649.96	0.0300	5.86	5.86
4264-010-CL	24600	PF 1	100.00	100.00	100.00	100.00	11340.00	649.96	0.0300	5.86	5.86
4264-010-CL	24500	PF 1	100.00	100.00	100.00	100.00	11340.00	649.96	0.0250	5.86	5.86
4264-010-CL	24400	PF 1	100.00	100.00	100.00	100.00	11340.00	744.59	0.0250	6.48	6.48
4264-010-CL	24300	PF 1	100.00	100.00	100.00	100.00	11340.00	677.32	0.0250	6.04	6.04
4264-010-CL	24200	PF 1	100.00	100.00	100.00	100.00	11340.00	709.09	0.0250	6.25	6.25
4264-010-CL	24100	PF 1	100.00	100.00	100.00	100.00	11340.00	688.19	0.0250	6.11	6.11
4264-010-CL	24000	PF 1	100.00	100.00	100.00	100.00	11340.00	696.74	0.0250	6.17	6.17
4264-010-CL	23900	PF 1	100.00	100.00	100.00	100.00	11340.00	690.56	0.0250	6.13	6.13
4264-010-CL	23800	PF 1	100.00	100.00	100.00	100.00	11340.00	693.32	0.0250	6.15	6.15
4264-010-CL	23700	PF 1	100.00	100.00	100.00	100.00	11340.00	691.03	0.0250	6.13	6.13

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

Reach	River Sta	Profile	Length Left	Length Chnl	Length Rght	Length Wtd.	Q Channel	Area Channel	Invert Slope	Hydr Radius	Hydr Radius C
			(ft)	(ft)	(ft)	(ft)	(cfs)	(sq ft)		(ft)	(ft)
4264-010-CL	23600	PF 1	100.00	100.00	100.00	100.00	11340.00	899.12	0.0150	7.44	7.44
4264-010-CL	23500	PF 1	100.00	100.00	100.00	100.00	11340.00	761.62	0.0200	6.59	6.59
4264-010-CL	23400	PF 1	100.00	100.00	100.00	100.00	11340.00	735.52	0.0200	6.43	6.43
4264-010-CL	23300	PF 1	100.00	100.00	100.00	100.00	11340.00	760.79	0.0200	6.59	6.59
4264-010-CL	23200	PF 1	100.00	100.00	100.00	100.00	11340.00	737.06	0.0300	6.44	6.44
4264-010-CL	23100	PF 1	100.00	100.00	100.00	100.00	11254.00	628.72	0.0300	5.71	5.71
4264-010-CL	23000	PF 1	100.00	100.00	100.00	100.00	11254.00	661.31	0.0400	5.93	5.93
4264-010-CL	22900	PF 1	100.00	100.00	100.00	100.00	11254.00	585.97	0.0300	5.41	5.41
4264-010-CL	22800	PF 1	100.00	100.00	100.00	100.00	11254.00	681.89	0.0400	6.01	6.01
4264-010-CL	22700	PF 1	100.00	100.00	100.00	100.00	11254.00	586.22	0.0350	5.41	5.41
4264-010-CL	22600	PF 1	100.00	100.00	100.00	100.00	11254.00	628.59	0.0350	5.71	5.71
4264-010-CL	22500	PF 1	100.00	100.00	100.00	100.00	11254.00	615.30	0.0400	5.62	5.62
4264-010-CL	22400	PF 1	100.00	100.00	100.00	100.00	11254.00	589.13	0.0400	5.43	5.43
4264-010-CL	22300	PF 1	100.00	100.00	100.00	100.00	11254.00	588.12	0.0400	5.43	5.43
4264-010-CL	22200	PF 1	100.00	100.00	100.00	100.00	11254.00	588.49	0.0400	5.43	5.43
4264-010-CL	22100	PF 1	100.00	100.00	100.00	100.00	11901.00	638.40	0.0400	5.78	5.78
4264-010-CL	22000	PF 1	100.00	100.00	100.00	100.00	11901.00	612.01	0.0300	5.60	5.60
4264-010-CL	21900	PF 1	100.00	100.00	100.00	100.00	11901.00	707.56	0.0300	6.24	6.24
4264-010-CL	21800	PF 1	100.00	100.00	100.00	100.00	11901.00	669.37	0.0300	5.99	5.99
4264-010-CL	21700	PF 1	100.00	100.00	100.00	100.00	11901.00	673.93	0.0300	6.02	6.02
4264-010-CL	21600	PF 1	100.00	100.00	100.00	100.00	11901.00	672.17	0.0300	6.01	6.01
4264-010-CL	21500	PF 1	100.00	100.00	100.00		11901.00	671.56	0.0200	6.00	6.00
4264-010-CL	21400	PF 1	100.00	100.00	100.00	100.00	11901.00	788.96	0.0200	6.77	6.77
4264-010-CL	21300	PF 1	100.00	100.00	100.00	100.00	11901.00	760.83	0.0392	6.59	6.59
4264-010-CL	21200	PF 1	100.00	100.00	100.00	100.00	11788.59	601.87	0.0197	3.26	3.73
4264-010-CL	21100	PF 1	100.00	100.00	100.00	100.00	11504.85	597.65	0.0272	2.57	3.37
4264-010-CL	21000	PF 1	100.00	100.00	100.00	100.00	11006.66	635.24	0.0349	2.95	3.83
4264-010-CL	20900	PF 1	100.00	100.00	100.00	100.00	10452.03	561.52	0.0335	3.13	3.90
4264-010-CL	20800	PF 1	100.00	100.00	100.00	100.00	11856.09	626.19	0.0353	2.43	2.58
4264-010-CL	20700	PF 1	100.00	100.00	100.00	100.00	11854.55	776.81	0.0267	3.08	3.20
4264-010-CL	20600	PF 1	100.00	100.00	100.00	100.00	10845.53	671.60	0.0361	2.51	2.90
4264-010-CL	20500	PF 1	100.00	100.00	100.00	100.00	11899.26	769.97	0.0382	2.69	2.72
4264-010-CL	20400	PF 1	100.00	100.00	100.00	100.00	11860.03	806.54	0.0227	2.79	2.97
4264-010-CL	20300	PF 1	100.00	100.00	100.00	100.00	11034.86	721.04	0.0304	2.83	3.28
4264-010-CL	20200	PF 1	100.00	100.00	100.00	100.00	11637.07	776.34	0.0323	2.97	4.27
4264-010-CL	20100	PF 1	100.00	100.00	100.00	100.00	11794.14	752.76	0.0208	3.87	4.55
4264-010-CL	20000	PF 1	100.00	100.00	100.00	100.00	7326.38	342.72	0.0356	1.62	1.67
4264-010-CL	19900	PF 1	100.00	100.00	100.00	100.00	9028.02	686.94	0.0363	2.77	3.13
4264-010-CL	19800	PF 1	100.00	100.00	100.00	100.00	10303.92	712.71	0.0301	2.71	3.30
4264-010-CL	19700	PF 1	100.00	100.00	100.00	100.00	10006.94	781.64	0.0154	3.31	3.98
4264-010-CL	19600	PF 1	100.00	100.00	100.00	100.00	9679.09	678.29	0.0138	2.94	4.22
4264-010-CL	19500	PF 1	100.00	100.00	100.00	100.00	10461.98	773.51	0.0215	2.69	4.35
4264-010-CL	19400	PF 1	100.00	100.00	100.00	100.00	8464.77	503.16	0.0239	2.49	3.75
4264-010-CL	19300	PF 1	100.00	100.00	100.00	100.00	9046.49	613.53	0.0258	2.89	3.60
4264-010-CL	19200	PF 1	100.00	100.00	100.00	100.00	11824.93	799.23	0.0354	3.22	3.68
4264-010-CL	19100	PF 1	100.00	100.00	100.00	100.00	11531.08	954.62	0.0194	3.66	5.49
4264-010-CL	19000	PF 1	100.00	100.00	100.00	100.00	8429.30	500.53	0.0343	2.93	5.90
4264-010-CL	18900	PF 1	100.00	100.00	100.00	100.00	8552.75	450.72	0.0181	2.80	5.65
4264-010-CL	18800	PF 1	100.00	100.00	100.00	100.00	7970.69	388.12	0.0214	3.11	5.47
4264-010-CL	18700	PF 1	100.00	100.00	100.00	100.00	8051.10	350.62	0.0372	2.43	4.18
4264-010-CL	18600	PF 1	100.00	100.00	100.00	100.00	11695.09	704.15	0.0192	2.51	3.96
4264-010-CL	18500	PF 1	100.00	100.00	100.00	100.00	11559.08	666.80	0.0238	2.70	3.45
4264-010-CL	18400	PF 1	100.00	100.00	100.00	100.00	10212.67	711.54	0.0140	2.92	3.95
4264-010-CL	18345	PF 1	3.00	3.00	3.00	3.00	8499.05	944.10	0.0000	4.43	5.70
4264-010-CL	18322		Bridge								
4264-010-CL	18300	PF 1	100.00	100.00	100.00	100.00	9189.84	663.93	0.0344	3.16	4.21
4264-010-CL	18200	PF 1	100.00	100.00	100.00	100.00	11901.00	802.35	0.0163	2.42	2.42
4264-010-CL	18100	PF 1	100.00	100.00	100.00	100.00	11861.27	1000.07	0.0188	3.15	3.28
4264-010-CL	18000	PF 1	100.00	100.00	100.00	100.00	11901.00	899.23	0.0254	3.45	3.45
4264-010-CL	17900	PF 1	100.00	100.00	100.00	100.00	11901.00	938.62	0.0184	3.08	3.08
4264-010-CL	17800	PF 1	100.00	100.00	100.00	100.00	11899.73	1016.04	0.0226	3.22	3.27
4264-010-CL	17700	PF 1	100.00	100.00	100.00	100.00	11891.98	923.75	0.0251	2.99	3.06
4264-010-CL	17600	PF 1	100.00	100.00	100.00	100.00	11438.93	1041.47	0.0239	3.50	4.02
4264-010-CL	17500	PF 1	100.00	100.00	100.00	100.00	10696.00	783.89	0.0187	2.19	3.79
4264-010-CL	17400	PF 1	100.00	100.00	100.00	100.00	10857.90	786.98	0.0247	2.37	3.00
4264-010-CL	17300	PF 1	100.00	100.00	100.00	100.00	9925.74	730.40	0.0228	2.98	3.69
4264-010-CL	17200	PF 1	100.00	100.00	100.00	100.00	8928.35	605.86	0.0248	2.20	2.65
4264-010-CL	17100	PF 1	100.00	100.00	100.00	100.00	8311.53	696.77	0.0311	2.81	3.66
4264-010-CL	17000	PF 1	100.00	100.00	100.00	100.00	7848.90	522.30	0.0403	1.96	2.45
4264-010-CL	16900	PF 1	100.00	100.00	100.00	100.00	9256.36	926.84	0.0348	2.43	2.49
4264-010-CL	16800	PF 1	100.00	100.00	100.00	100.00	9596.24	834.54	0.0140	2.18	2.31
4264-010-CL	16700	PF 1	100.00	100.00	100.00	100.00	8810.79	795.98	0.0292	2.24	2.58
4264-010-CL	16600	PF 1	100.00	100.00	100.00	100.00	11683.94	962.95	0.0231	2.06	2.55
4264-010-CL	16500	PF 1	100.00	100.00	100.00	100.00	10716.99	1000.94	0.0267	2.35	3.11
4264-010-CL	16400	PF 1	100.00	100.00	100.00	100.00	10501.89	869.36	0.0240	2.03	2.59
4264-010-CL	16300	PF 1	100.00	100.00	100.00	100.00	7665.14	674.58	0.0260	2.38	2.97

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

Reach	River Sta	Profile	Length Left	Length Chnl	Length Rght	Length Wtd.	Q Channel	Area Channel	Invert Slope	Hydr Radius	Hydr Radius C
			(ft)	(ft)	(ft)	(ft)	(cfs)	(sq ft)		(ft)	(ft)
4264-010-CL	16200	PF 1	100.00	100.00	100.00	100.00	10892.09	898.44	0.0261	2.54	2.91
4264-010-CL	16100	PF 1	100.00	100.00	100.00	100.00	9356.65	780.79	0.0234	2.69	3.51
4264-010-CL	16000	PF 1	100.00	100.00	100.00	100.00	12290.10	1048.50	0.0167	2.49	2.55
4264-010-CL	15900	PF 1	100.00	100.00	100.00	100.00	12157.31	1108.15	0.0285	2.82	2.92
4264-010-CL	15800	PF 1	100.00	100.00	100.00	100.00	12237.50	1054.38	0.0204	2.58	2.68
4264-010-CL	15700	PF 1	100.00	100.00	100.00	100.00	12338.00	1146.41	0.0328	2.23	2.23
4264-010-CL	15600	PF 1	100.00	100.00	100.00	100.00	11180.90	1051.88	0.0219	2.13	2.22
4264-010-CL	15500	PF 1	100.00	100.00	100.00	100.00	12052.90	1221.31	0.0373	2.07	2.10
4264-010-CL	15400	PF 1	100.00	100.00	100.00	100.00	12081.16	1397.55	0.0162	2.17	2.22
4264-010-CL	15300	PF 1	100.00	100.00	100.00	100.00	12312.58	1231.30	0.0268	1.81	1.82
4264-010-CL	15200	PF 1	100.00	100.00	100.00	100.00	12336.99	1491.59	0.0182	1.96	1.99
4264-010-CL	15100	PF 1	134.81	134.81	134.81	134.81	12194.23	1294.59	0.0223	1.74	1.77
4264-010-CL	14965.19	PF 1	65.19	65.19	65.19	65.19	8673.17	1081.73	0.0232	1.91	1.84
4264-010-CL	14900	PF 1	100.00	100.00	100.00	100.00	9284.04	1045.25	0.0212	1.82	1.75
4264-010-CL	14800	PF 1	100.00	100.00	100.00	100.00	12084.74	1447.10	0.0236	2.03	2.11
4264-010-CL	14700	PF 1	100.00	100.00	100.00	100.00	12126.50	1154.54	0.0296	2.22	2.27
4264-010-CL	14600	PF 1	100.00	100.00	100.00	100.00	9730.65	917.90	0.0152	1.97	2.47
4264-010-CL	14500	PF 1	100.00	100.00	100.00	100.00	10174.56	998.51	0.0303	1.90	2.46
4264-010-CL	14400	PF 1	100.00	100.00	100.00	100.00	9749.06	924.36	0.0241	1.99	2.81
4264-010-CL	14300	PF 1	100.00	100.00	100.00	100.00	8935.76	781.51	0.0225	1.69	2.71
4264-010-CL	14200	PF 1	100.00	100.00	100.00	100.00	7825.82	734.00	0.0208	1.68	2.46
4264-010-CL	14100	PF 1	100.00	100.00	100.00		7612.64	736.01	0.0204	1.67	1.96
4264-010-CL	14000	PF 1	100.00	100.00	100.00	100.00	6723.02	785.68	0.0231	1.87	1.99
4264-010-CL	13900	PF 1	64.93	64.93	64.93	64.93	7190.70	762.67	0.0348	1.78	1.92
4264-010-CL	13835.07	PF 1	135.07	135.07	135.07	135.07	11906.45	1421.08	0.0238	1.92	1.94
4264-010-CL	13700	PF 1	100.00	100.00	100.00	100.00	12079.21	1374.81	0.0186	2.06	2.08
4264-010-CL	13600	PF 1	100.00	100.00	100.00	100.00	11925.07	1251.81	0.0347	2.13	2.22
4264-010-CL	13500	PF 1	100.00	100.00	100.00	100.00	12046.21	1209.42	0.0224	2.19	2.30
4264-010-CL	13400	PF 1	100.00	100.00	100.00	100.00	11869.13	1237.78	0.0190	2.40	2.49
4264-010-CL	13300	PF 1	100.00	100.00	100.00	100.00	11806.75	1218.18	0.0225	2.54	2.68
4264-010-CL	13200	PF 1	100.00	100.00	100.00	100.00	11916.73	1119.10	0.0300	2.57	2.65
4264-010-CL	13100	PF 1	100.00	100.00	100.00	100.00	11308.47	929.26	0.0291	2.89	3.26
4264-010-CL	13000	PF 1	100.00	100.00	100.00	100.00	10962.45	962.67	0.0165	3.56	3.99
4264-010-CL	12900	PF 1	100.00	100.00	100.00	100.00	10773.58	814.76	0.0380	3.43	3.88
4264-010-CL	12800	PF 1	100.00	100.00	100.00	100.00	11373.67	907.02	0.0246	3.75	4.42
4264-010-CL	12700	PF 1	100.00	100.00	100.00	100.00	11933.65	767.12	0.0211	3.36	3.98
4264-010-CL	12600	PF 1	54.76	54.76	54.76	54.76	7569.12	380.05	0.0219	2.72	3.45
4264-010-CL	12545.24	PF 1	145.24	145.24	145.24	145.24	7787.71	580.34	0.0226	3.50	3.61
4264-010-CL	12400	PF 1	110.83	110.83	110.83	110.83	11775.28	891.36	0.0230	3.77	4.10
4264-010-CL	12289.17	PF 1	89.17	89.17	89.17	89.17	11683.70	859.38	0.0352	3.71	4.12
4264-010-CL	12200	PF 1	100.00	100.00	100.00	100.00	11744.64	781.01	0.0181	3.56	3.82
4264-010-CL	12100	PF 1	66.89	66.89	66.89	66.89	11677.76	812.27	0.0335	3.66	3.94
4264-010-CL	12033.11	PF 1	133.11	133.11	133.11	133.11	11591.79	785.05	0.0222	3.60	3.93
4264-010-CL	11900	PF 1	123.00	123.00	123.00	123.00	11515.46	811.93	0.0237	3.84	4.24
4264-010-CL	11777	PF 1	111.72	111.72	111.72	111.72	11378.37	769.54	0.0245	3.77	4.17
4264-010-CL	11665.28	PF 1	50.00	50.00	50.00	50.00	11785.40	777.34	0.0404	3.49	3.70
4264-010-CL	11614.66	PF 1	14.50	20.43	39.00	20.51	11824.40	829.66	0.0220	3.82	3.98
4264-010-CL	11600.41	PF 1	19.00	28.61	52.00	28.86	11715.09	827.75	0.0231	3.85	4.05
4264-010-CL	11582.03	PF 1	14.55	25.12	44.50	25.33	11603.99	765.77	-0.0279	3.57	3.76
4264-010-CL	11567.48	PF 1	5.00	5.00	5.00	5.00	11486.64	707.41	0.0000	3.53	3.76
4264-010-CL	11561.97	PF 1	15.00	15.00	15.00	15.00	11431.35	711.68	0.2500	3.55	3.79
4264-010-CL	11545.46	PF 1	5.00	5.00	5.00	5.00	11221.95	1619.80	0.0020	7.78	8.62
4264-010-CL	11539.95	PF 1	41.00	41.00	41.00	41.00	11832.00	1567.51	0.0056	7.81	8.44
4264-010-CL	11516.11		Culvert								
4264-010-CL	11492.27	PF 1	97.00	60.00	25.00	60.47	11847.85	1105.26	0.0240	5.63	5.95
4264-010-CL	11376.89	PF 1	72.00	58.00	43.00	57.98	10563.70	916.82	0.0033	5.32	6.46
4264-010-CL	11316.65	PF 1	67.00	61.00	54.00	60.60	10653.17	810.28	0.0059	4.69	5.78
4264-010-CL	11271.2	PF 1	150.00	138.93	130.00	138.45	9648.22	814.44	0.0027	4.79	6.09
4264-010-CL	11130.61	PF 1	130.61	130.61	130.61	130.61	11295.72	1177.87	0.0010	3.58	4.09
4264-010-CL	11000	PF 1	100.00	100.00	100.00	100.00	9271.02	905.23	0.0267	2.97	3.08
4264-010-CL	10900	PF 1	100.00	100.00	100.00	100.00	11466.78	907.75	0.0428	2.40	2.47
4264-010-CL	10800	PF 1	100.00	100.00	100.00	100.00	11512.67	1089.77	0.0120	2.81	2.92
4264-010-CL	10700	PF 1	100.00	100.00	100.00	100.00	11560.50	1040.97	0.0223	2.68	2.78
4264-010-CL	10600	PF 1	100.00	100.00	100.00	100.00	11430.08	1015.08	0.0162	2.72	2.80
4264-010-CL	10500	PF 1	100.00	100.00	100.00	100.00	11585.50	1060.15	0.0241	2.80	2.93
4264-010-CL	10400	PF 1	100.00	100.00	100.00	100.00	11581.93	966.62	0.0391	2.68	2.78
4264-010-CL	10300	PF 1	100.00	100.00	100.00	100.00	11253.70	1019.44	0.0182	2.95	3.04
4264-010-CL	10200	PF 1	100.00	100.00	100.00	100.00	11241.46	956.13	0.0103	2.97	3.11
4264-010-CL	10100	PF 1	100.00	100.00	100.00	100.00	10743.20	1007.03	0.0298	3.65	4.48
4264-010-CL	10000	PF 1	100.00	100.00	100.00	100.00	10118.68	893.30	0.0090	3.58	5.09
4264-010-CL	9900	PF 1	100.00	100.00	100.00	100.00	8327.31	668.47	0.0099	3.71	5.41
4264-010-CL	9800	PF 1	100.00	100.00	100.00		9004.93	612.31	0.0081	2.87	3.52
4264-010-CL	9700	PF 1	100.00	100.00	100.00	100.00	7814.32	698.79	0.0204	3.34	3.67
4264-010-CL	9600	PF 1	100.00	100.00	100.00	100.00	11519.29	912.38	0.0296	2.59	2.68
4264-010-CL	9500	PF 1	100.00	100.00	100.00	100.00	10963.77	1009.32	0.0196	2.85	2.97
4264-010-CL	9400	PF 1	100.00	100.00	100.00	100.00	11633.10	1005.56	0.0281	2.43	2.50

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

Reach	River Sta	Profile	Length Left	Length Chnl	Length Rght	Length Wtd.	Q Channel	Area Channel	Invert Slope	Hydr Radius	Hydr Radius C
			(ft)	(ft)	(ft)	(ft)	(cfs)	(sq ft)		(ft)	(ft)
4264-010-CL	9300	PF 1	100.00	100.00	100.00	100.00	11824.52	1245.88	0.0117	2.76	2.81
4264-010-CL	9200	PF 1	100.00	100.00	100.00	100.00	11679.04	1088.96	0.0312	2.39	2.68
4264-010-CL	9100	PF 1	100.00	100.00	100.00	100.00	11672.20	1086.51	0.0121	2.35	2.54
4264-010-CL	9000	PF 1	100.00	100.00	100.00	100.00	11533.73	1214.56	0.0236	2.65	3.14
4264-010-CL	8900	PF 1	100.00	100.00	100.00	100.00	11352.44	925.85	0.0231	2.86	3.29
4264-010-CL	8800	PF 1	100.00	100.00	100.00	100.00	10951.53	973.53	0.0257	3.28	5.16
4264-010-CL	8700	PF 1	100.00	100.00	100.00	100.00	10603.43	734.97	0.0162	2.31	5.04
4264-010-CL	8600	PF 1	100.00	100.00	100.00	100.00	9267.08	620.79	0.0108	2.40	4.51
4264-010-CL	8500	PF 1	135.87	135.87	135.87	135.87	9690.56	644.95	0.0172	2.36	3.81
4264-010-CL	8364.13	PF 1	64.13	64.13	64.13	64.13	8480.15	601.08	0.0231	2.51	4.86
4264-010-CL	8300	PF 1	100.00	100.00	100.00	100.00	7648.46	467.34	0.0283	2.48	4.64
4264-010-CL	8200	PF 1	100.00	100.00	100.00	100.00	8654.17	510.93	0.0255	2.27	3.82
4264-010-CL	8100	PF 1	67.40	67.40	67.40	67.40	9062.21	583.34	0.0119	2.60	4.35
4264-010-CL	8032.6	PF 1	132.60	132.60	132.60	132.60	9165.47	564.10	0.0170	2.59	4.01
4264-010-CL	7900	PF 1	100.00	100.00	100.00	100.00	11639.92	898.74	0.0165	2.87	3.43
4264-010-CL	7800	PF 1	100.00	100.00	100.00	100.00	10274.77	900.58	0.0202	3.34	4.13
4264-010-CL	7700	PF 1	100.00	100.00	100.00	100.00	11311.63	859.03	0.0169	3.03	3.66
4264-010-CL	7600	PF 1	100.00	100.00	100.00	100.00	11764.16	1037.87	0.0149	3.32	3.47
4264-010-CL	7500	PF 1	138.22	138.22	138.22	138.22	11286.34	1007.22	0.0190	3.55	3.87
4264-010-CL	7361.78	PF 1	61.78	61.78	61.78	61.78	11330.21	884.24	0.0406	3.22	3.44
4264-010-CL	7300	PF 1	100.00	100.00	100.00	100.00	10336.58	768.24	0.0255	3.27	3.73
4264-010-CL	7200	PF 1	100.00	100.00	100.00	100.00	10709.03	907.50	0.0126	3.86	5.49
4264-010-CL	7100	PF 1	100.00	100.00	100.00	100.00	10701.24	760.58	0.0186	3.21	4.35
4264-010-CL	7000	PF 1	100.00	100.00	100.00	100.00	11378.80	792.19	0.0320	2.77	3.01
4264-010-CL	6900	PF 1	100.00	100.00	100.00	100.00	10895.02	1000.15	0.0151	2.95	3.60
4264-010-CL	6800	PF 1	100.00	100.00	100.00	100.00	11614.11	1044.77	0.0117	2.62	3.44
4264-010-CL	6700	PF 1	100.00	100.00	100.00	100.00	11271.19	1065.56	0.0108	2.39	3.60
4264-010-CL	6600	PF 1	100.00	100.00	100.00	100.00	13107.04	1115.93	0.0263	2.76	4.20
4264-010-CL	6500	PF 1	100.00	100.00	100.00	100.00	14837.02	1095.44	0.0144	2.40	3.40
4264-010-CL	6400	PF 1	100.00	100.00	100.00	100.00	15017.99	1315.07	0.0248	2.57	3.34
4264-010-CL	6300	PF 1	100.00	100.00	100.00		13225.78	737.55	0.0173	2.60	2.91
4264-010-CL	6200	PF 1	92.00	74.00	57.00	74.00	15841.98	1293.76	0.0126	4.54	4.55
4264-010-CL	6126.11	PF 1	40.00	40.00	40.00	40.00	15841.81	1560.42	0.0175	6.04	6.06
4264-010-CL	6084.06	PF 1	1.00	1.00	1.00	1.00	15842.00	1642.92	0.0000	6.53	6.53
4264-010-CL	6060		Bridge								
4264-010-CL	6041.11	PF 1	16.00	16.00	16.00	16.00	15842.00	1510.55	0.0100	6.02	6.02
4264-010-CL	6024.98	PF 1	2.00	2.00	2.00	2.00	15842.00	1533.61	0.0000	6.19	6.19
4264-010-CL	6000		Bridge								
4264-010-CL	5981.62	PF 1	81.62	81.62	81.62	81.62	15842.00	1081.43	0.0733	4.53	4.53
4264-010-CL	5900	PF 1	100.00	100.00	100.00	100.00	15842.00	662.48	0.0300	2.73	2.73
4264-010-CL	5800	PF 1	100.00	100.00	100.00	100.00	15842.00	851.49	0.0200	3.44	3.44
4264-010-CL	5700	PF 1	100.00	100.00	100.00		15842.00	1064.02	0.0100	4.19	4.19
4264-010-CL	5600	PF 1	100.00	100.00	100.00	100.00	15842.00	1255.05	0.0150	4.86	4.86
4264-010-CL	5500	PF 1	100.00	100.00	100.00	100.00	15842.00	1103.56	0.0150	4.34	4.34
4264-010-CL	5400	PF 1	100.00	100.00	100.00	100.00	15842.00	1153.69	0.0200	4.52	4.52
4264-010-CL	5300	PF 1	100.00	100.00	100.00	100.00	15842.00	1029.35	0.0235	4.08	4.08
4264-010-CL	5200	PF 1	100.00	100.00	100.00	100.00	15842.00	985.67	0.0125	3.92	3.92
4264-010-CL	5100	PF 1	100.00	100.00	100.00	100.00	15842.00	1256.17	0.0240	4.86	4.86
4264-010-CL	5000	PF 1	100.00	100.00	100.00	100.00	15842.00	953.26	0.0100	3.81	3.81
4264-010-CL	4900	PF 1	100.00	100.00	100.00	100.00	15842.00	1255.33	0.0120	4.87	4.87
4264-010-CL	4800	PF 1	100.00	100.00	100.00	100.00	15842.00	1397.06	0.0080	5.34	5.34
4264-010-CL	4700	PF 1	100.00	100.00	100.00	100.00	15842.00	1320.57	0.0100	5.09	5.09
4264-010-CL	4600	PF 1	100.00	100.00	100.00	100.00	15842.00	1255.30	0.0130	4.87	4.87
4264-010-CL	4500	PF 1	100.00	100.00	100.00	100.00	15842.00	1159.89	0.0210	4.54	4.54
4264-010-CL	4400	PF 1	100.00	100.00	100.00	100.00	15842.00	1569.13	0.0050	5.91	5.91
4264-010-CL	4300	PF 1	100.00	100.00	100.00	100.00	15842.00	1255.36	0.0210	4.87	4.87
4264-010-CL	4200	PF 1	100.00	100.00	100.00		15842.00	992.35	0.0090	3.95	3.95
4264-010-CL	4100	PF 1	100.00	100.00	100.00	100.00	15842.00	1255.30	0.0220	4.87	4.87
4264-010-CL	4000	PF 1	100.00	100.00	100.00		15842.00	978.07	0.0090	3.90	3.90
4264-010-CL	3900	PF 1	100.00	100.00	100.00	100.00	15842.00	1255.11	0.0240	4.87	4.87
4264-010-CL	3800	PF 1	100.00	100.00	100.00	100.00	15842.00	1744.94	0.0010	6.47	6.47
4264-010-CL	3700	PF 1	100.00	100.00	100.00	100.00	15842.00	1247.28	0.0220	4.93	4.93
4264-010-CL	3600	PF 1	100.00	100.00	100.00	100.00	15842.00	969.09	0.0050	3.86	3.86
4264-010-CL	3500	PF 1	100.00	100.00	100.00	100.00	15842.00	1254.89	0.0230	4.86	4.86
4264-010-CL	3400	PF 1	100.00	100.00	100.00	100.00	15842.00	964.82	0.0100	3.85	3.85
4264-010-CL	3300	PF 1	100.00	100.00	100.00	100.00	15842.00	1834.78	0.0100	6.75	6.75
4264-010-CL	3200	PF 1	100.00	100.00	100.00	100.00	15842.00	2085.19	0.0100	7.51	7.51
4264-010-CL	3100	PF 1	100.00	100.00	100.00	100.00	15842.00	2349.98	0.0181	8.29	8.29
4264-010-CL	3000	PF 1	100.00	100.00	100.00	100.00	15842.00	1084.78	0.0153	6.47	6.47
4264-010-CL	2900	PF 1	100.00	100.00	100.00	100.00	15842.00	872.81	0.0196	5.25	5.25
4264-010-CL	2800	PF 1	100.00	100.00	100.00	100.00	15842.00	814.90	0.0283	3.86	3.86
4264-010-CL	2700	PF 1	100.00	100.00	100.00	100.00	15842.00	1138.63	0.0358	5.86	5.86
4264-010-CL	2600	PF 1	100.00	100.00	100.00	100.00	15842.00	792.69	0.0215	4.95	4.95
4264-010-CL	2500	PF 1	100.00	100.00	100.00	100.00	15842.00	1925.98	0.0051	9.33	9.33
4264-010-CL	2400	PF 1	100.00	100.00	100.00	100.00	15842.00	1883.26	0.0057	9.45	9.45
4264-010-CL	2300	PF 1	100.00	100.00	100.00	100.00	15842.00	1408.66	0.0001	7.90	7.90

HEC-RAS Plan: Rch2 River: REATA WASH Reach: 4264-010-CL Profile: PF 1 (Continued)

Reach	River Sta	Profile	Length Left	Length Chnl	Length Rght	Length Wtd.	Q Channel	Area Channel	Invert Slope	Hydr Radius	Hydr Radius C
			(ft)	(ft)	(ft)	(ft)	(cfs)	(sq ft)		(ft)	(ft)
4264-010-CL	2200	PF 1	100.00	100.00	100.00	100.00	15842.00	1855.22	-0.0001	9.12	9.12
4264-010-CL	2100	PF 1	100.00	100.00	100.00	100.00	15842.00	1887.40	0.0000	9.38	9.38
4264-010-CL	2000	PF 1	100.00	100.00	100.00	100.00	15842.00	1813.78	0.0000	9.03	9.03
4264-010-CL	1900	PF 1	100.00	100.00	100.00	100.00	15842.00	1861.08	0.0000	8.93	8.93
4264-010-CL	1800	PF 1	100.00	100.00	100.00	100.00	15842.00	1683.86	-0.0049	8.88	8.88
4264-010-CL	1700	PF 1	100.00	100.00	100.00	100.00	15842.00	1482.91	-0.0014	7.90	7.90
4264-010-CL	1600	PF 1					15842.00	1099.40		6.30	6.30