RESPONSE TO COMMENTS AND OBJECTIONS FILED ON ADWR'S JUNE 2009 SUBFLOW ZONE DELINEATION REPORT FOR THE SAN PEDRO RIVER WATERSHED

In re The General Adjudication of the

Gila River System and Source

Arizona Department of Water Resources

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CHAPTERS

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

On June 30, 2009, the Arizona Department of Water Resources ("Department" or "ADWR") published a report entitled "Subflow Zone Delineation Report for the San Pedro River Watershed" ("Sublow Zone Delineation Report"). Pursuant to Court order dated September 28, 2005 ("2005 Order"), ADWR filed this report in a judicial proceeding known as the Gila River Adjudication, which is pending in the Maricopa County Superior Court.[1] Using criteria and procedures set forth in the 2005 Order, the Subflow Zone Delineation Report presents a series of hydrogeologic maps that delineate the subflow zones for the San Pedro River, Babocomari River, and Aravaipa Creek, together with related information.[2]

1.2 OBJECTIONS AND COMMENTS

Upon filing the Subflow Zone Delineation Report with the Court, ADWR sent a notice to all water users who had filed claims to water rights ("claimants") in the San Pedro River Watershed, and claimants listed on the Gila River Adjudication Court-Approved Mailing List. The notice informed the claimants of the scope and availability of the report, as well as the right to file written objections to the report by December 28, 2009. Under the 2005 Order, objections were to be limited to ADWR's findings regarding the lateral extent of the subflow zone. Twenty-five objections or comments were filed on or before December 28, 2009, and one set of comments was filed after that date.[3]

[1] *In re the General Adjudication of all Rights to Use Water in the Gila River System and Source*, W-1, W-2, W-3, W-4 (Consolidated).
[2] A copy of the September 28, 2005 order is included in Appendix A-4 to the Subflow Zone Delineation Report.
[3] Freeport-McMoRan filed comments on December 31, 2009.

By Court order entered August 24, 2010, the Honorable Judge Eddward P. Ballinger, Jr. scheduled a March 15, 2011 hearing on the objections and comments that raised "substantive legal and technical issues," and referred the remaining objections and comments to the Special Master, George A. Schade, Jr., for determination. August 24, 2010 Order at 1. Judge Ballinger directed ADWR to submit a report that describes the objections or comments "with which ADWR agrees or does not take issue and providing information in response to a specific objection or comment." *Id.* at 2. At the request of ADWR, the original December 31, 2010 deadline for submitting this report was extended to January 31, 2011 by Court order dated December 8, 2010.

Table 1-1 lists the objectors whose comments and objections are addressed in this report and those objectors whose comments and objections are before the Special Master.[4] See August 24, 2010, December 8, 2010 and December 20, 2010 Orders, which are included in **Appendix A**. Copies of the comments and objections addressed in this report are included in **Appendix B**.

1.3 SCOPE OF REPORT

The comments and objections addressed in this report raise both technical and legal issues. The technical issues are summarized in Chapter 2 of this report, and ADWR's responses to those issues are set forth in subsequent chapters. The legal issues generally consist of challenges to the Court's 2005 Order, which directed ADWR to use certain criteria and procedures to determine the subflow zones within the San Pedro River Watershed. Two of the objectors asserted that the 2005 Order does not comply with certain decisions of the Arizona Supreme Court, and consequently the Subflow Zone Delineation Report should be rejected.[5] This report does not address those legal issues.

[4] In the Special Master's December 20, 2010 Minute Entry and Order, the Special Master also granted the December 1, 2010 motion to intervene filed by the San Carlos Apache Tribe.
[5] *See* objections and comments filed by ASARCO and Bella Vista Water Co. *et al*.

CHAPTER 2: TECHNICAL COMMENTS AND OBJECTIONS

2.1 CATEGORIES

Several technical comments and objections were filed to the Subflow Zone Delineation Report. These comments and objections generally address five categories of issues concerning the following:

- Predevelopment streamflow conditions;
- Geologic maps prepared by the Arizona Geological Survey (AZGS);
- Extent of the floodplain Holocene alluvium;
- Setbacks for side recharge; and
- Delineation of subflow zones.

Each of these categories is addressed below in separate chapters of the report.

2.2 SUMMARY OF TECHNICAL COMMENTS AND OBJECTIONS

The following seven parties filed substantive technical comments and objections to the Subflow Zone Delineation Report:

- ASARCO
- Bella Vista Water Co. *et al* (Sierra Vista Parties)
- Freeport McMoRan Corporation (Freeport)
- Gila River Indian Community (GRIC)
- Salt River Project (SRP)
- The Nature Conservancy (TNC)
- United States (US).

In addition, the City of Phoenix and the City of Tempe joined in SRP's objections.

The technical comments and objections filed by these parties are summarized in two tables. **Table 2-1** includes those comments and objections that disagree with certain

parts of the Subflow Zone Delineation Report, the party that filed the comment or objection, and the section of the report where the comment or objection is addressed. **Table 2-2** includes those comments that agree with certain parts of the Subflow Zone Delineation Report and the parties that filed the comments.

CHAPTER 3: PREDEVELOPMENT STREAMFLOW CONDITIONS

In this chapter, ADWR responds to comments from five parties who disagree with ADWR's analysis of predevelopment streamflow conditions. ADWR grouped their comments into six categories and addresses each category below:

- Multiple Years of Evidence (**Section 3.1**)
- Weighting Lines of Evidence (**Section 3.2**)
- Conflicting Evidence (**Section 3.3**)
- Historic Aerial Photography (**Section 3.4**)
- Historic Diversion Records (**Section 3.5**)
- Use of NRCS Soil Survey Maps (**Section 3.6**).

Table 2-2 summarizes areas where the parties agree with ADWR's predevelopment streamflow analysis, which are not discussed further here.

3.1 MULTIPLE YEARS OF EVIDENCE

In accordance with the 2005 Order, ASARCO (p. 12, n. 8) and the Sierra Vista Parties (p. 3) state that ADWR should have identified a single year or range of years to represent predevelopment streamflow rather than using multiple years, although neither party specified which years should have been used. The Sierra Vista Parties (p. 4) believe that ADWR's streamflow analysis overstates the subflow zone since looking at water uses over longer periods tends to make a water source appear more reliable and ignores the impacts of years where precipitation and snowmelt is unavailable.

In its 2005 Order, the Court directed ADWR to use predevelopment streamflow conditions to determine the lateral extent of the subflow zone within the San Pedro River Watershed. The Court defined predevelopment conditions as those that existed immediately prior to regular, discernable diversions or depletions by human activity and recognized that predevelopment periods may differ across the watershed due to the quality and availability of data. Although ADWR was directed to use predevelopment

streamflow conditions that existed during an identifiable chronological year or range of years, ADWR was also instructed to take a practical approach using the best available data while doing so with as much accuracy and reliability as possible.

Based on its review of available data, ADWR was unable to identify a specific year or range of years that would characterize predevelopment streamflows throughout the watershed. However, it did identify several independent lines of evidence that taken together were used to infer whether stream reaches likely had ephemeral or perennial/intermittent flow prior to development. ADWR only concluded that a stream reach had perennial or intermittent flow prior to development where at least two independent lines of evidence were found in its favor:

- Historic accounts
- Historic irrigation ditch diversions and ore mills
- Early streamflow data
- 1935 aerial photographs
- Recent streamflow data.

These lines of evidence take advantage of the best available data for several different time frames.

3.2 WEIGHTING LINES OF EVIDENCE

Freeport (pp. 7-8, 10) notes that the lines of evidence ADWR used to infer predevelopment streamflow conditions were not necessarily of equal value and should be weighted according to uncertainty. They specifically question the reliability of historic accounts and the use of March 1899 and March 1921 seepage runs.

ADWR understands that the lines of evidence it used to assess predevelopment streamflows are based on varying types of data. However, it believes its approach was reasonable and that attempting to weight each line of evidence would add more subjectivity to the analysis.

3.3 CONFLICTING EVIDENCE

Both ASARCO (p. 13, n. 9) and Freeport (p. 8) note that some of ADWR's evidence of predevelopment streamflow conflicts. Freeport suggests that ADWR address conflicting lines of evidence and assume that predevelopment flows were ephemeral where it was unable to reconcile differences clearly in favor of perennial or intermittent flows.

ADWR recognized that some historic accounts differed and other lines of evidence were inconclusive. ADWR only concluded that a stream reach had perennial or intermittent flow prior to development if *at least two* independent lines of evidence support that conclusion.

3.4 HISTORIC AERIAL PHOTOGRAPHY

Freeport (pp. 9-11) suggests that ADWR provide additional information on the 1935 aerial photographs used to infer predevelopment streamflows. Since some of ADWR's interpretations of this photography appear questionable, ADWR should not consider it a sole line of evidence.

Freeport's comments are based on Figure 3-14 of the Subflow Zone Delineation Report which shows examples of streamflow conditions inferred from the historic photographs. Better quality copies of the photographs are provided in **Appendix C** in digital format.[6] For comparison to ADWR's interpretation of the photographs (see Figure 3-21 of the Subflow Zone Delineation Report), river miles are plotted on these images. As stated above, ADWR only inferred that predevelopment streamflows were perennial or intermittent if at least two, independent lines of evidence were available. Analysis of historic aerial photography was not used as a sole line of evidence of streamflow conditions.

[6] For its analysis, ADWR reviewed both digital versions and hard copy prints of the aerial photographs.

3.5 HISTORIC DIVERSION RECORDS

SRP (p. 15) indicates that historic diversion records should be used to extend the predevelopment perennial/intermittent reach of Aravaipa Creek upstream of stream mile 36, where ADWR terminated it.

ADWR agrees that 1921 records from the Arizona Water Commissioner indicate that four diversions were located on Aravaipa Creek upstream of stream mile 36. However, ADWR's other lines of evidence do not support the conclusion that this reach of Aravaipa Creek was previously perennial or intermittent. Lacking other supporting evidence, ADWR concluded the reach above stream mile 36 was probably ephemeral.

3.6 USE OF NRCS SOIL SURVEY MAPS

GRIC (p. 5) states it is unclear that the Natural Resources Conservation Service (NRCS) has expertise in streamflow duration analysis superior to ADWR and questioned whether ADWR should defer to NRCS on this issue. In its 2005 Order, the Court instructed ADWR to exclude ephemeral streams shown on NRCS soil survey maps when delineating subflow zones in the watershed.

ADWR did not rely on NRCS soil survey maps in its analysis of predevelopment streamflow conditions. As described in **Section 3.1,** other independent lines of evidence were used for this analysis. AZGS did, however, review the NRCS soil maps during preparation of the surficial geology maps that ADWR utilized in the Subflow Zone Delineation Report. Comments on the AZGS maps are described in the next section.

CHAPTER 4: AZGS GEOLOGIC MAPS

In this chapter, ADWR responds to comments from four parties who disagree with the AZGS (2009) surficial geology maps that ADWR used to delineate floodplain Holocene alluvium (FHA) in the watershed. ADWR grouped their comments into seven categories and addresses each category below:

- Unit Labels and Colors (**Section 4.1**)
- Disturbed Areas (**Section 4.2**)
- Data Transfer to ADWR (**Section 4.3**)
- Cross Sections (**Section 4.4**)
- Unit Contacts (**Section 4.5**)
- Map Scale (**Section 4.6**)
- ADWR Grouping of Units (**Section 4.7**).

Table 2-2 summarizes areas where the parties agree with the AZGS geologic maps, which are not discussed further here.

4.1 UNIT LABELS AND COLORS

Freeport (p. 12) observes that map unit boundaries and labels are not always clear on the AZGS maps and the colors used for map units are sometimes inconsistent with map legends.

ADWR agrees that some minor deficiencies exist in the appearance of the final AZGS maps, but it does not believe that these had an affect on its delineation of subflow zones. ADWR used a Geographic Information System (GIS) database from AZGS for its analysis. Each geologic unit mapped by AZGS was stored in the database with a unique unit code. ADWR therefore avoided any ambiguity that may appear on hard copies of the AZGS maps.

4.2 DISTURBED AREAS

Two parties commented on the delineation of disturbed areas by AZGS. AZGS (2009, p. 42) defines disturbed areas as "heavily disturbed ground due to agriculture, extensive excavation or construction of earth dams." AZGS groups disturbed areas with "Other Units" that include plowed areas, colluvium, and Quaternary hillslope talus and colluvium. GRIC (p. 5) agrees that AZGS should have mapped these areas but should not have identified them as geologic units.

While ADWR agrees that disturbed areas are not geologic units per se, it followed the convention used by AZGS. Appendix D-2 of the Subflow Zone Delineation Report shows where AZGS mapped disturbed areas within and bordering FHA and which geologic units ADWR assumed originally underlay these areas for purposes of subflow zone delineation.

In Attachment 7 of its comments, SRP presents photographs of a man-made berm that extends into the floodplain of lower Aravaipa Creek. They note that AZGS incorrectly mapped this berm as late Holocene alluvium. ADWR agrees that the berm should have been mapped as a disturbed area and is likely underlain by FHA.

4.3 DATA TRANSFER TO ADWR

Freeport (pp. 11-12) asks ADWR to describe how geologic data from AZGS were transferred and used in the Subflow Zone Delineation Report.

ADWR relied on the same GIS database that AZGS used to produce its final surficial geology maps.[7] AZGS created the database by digitizing its delineation of geologic units compiled on 1:24,000 scale topographic maps. ADWR only modified these data by grouping geologic units of similar origin (*e.g.*, FHA vs. basin fill). No manual tracing was performed or electronic smoothing functions applied by ADWR.

[7] AZGS provided ADWR a personal geodatabase dated March 20, 2009 that was developed using ESRI ArcMap version 9.2 and stored in Microsoft Access 2003.

4.4 CROSS SECTIONS

SRP (p. 16) indicates that the geologic cross section prepared by AZGS and presented in the Subflow Zone Delineation Report does not represent actual surface and subsurface conditions in the watershed. According to SRP, the AZGS cross section erroneously shows basin fill exposed at ground surface between FHA units and does not properly depict the relationship between subsurface units.

ADWR brought this comment to AZGS' attention, which agreed that its original cross section inadvertently showed basin fill exposed at ground surface between certain FHA units. It has since provided ADWR with a revised cross section that both corrects this error and adds question marks at the base of the FHA units to depict their uncertainty with the subsurface conditions. However, neither AZGS nor ADWR agree that the original AZGS cross section improperly depicts the relationship between subsurface units.

For comparison, **Figure 4-1** shows the revised AZGS cross section and two alternatives:

- SRP's modification of the original AZGS cross section (Att. 2, fig. A) and
- A geologic cross section prepared by Hereford (1993) in the Lewis Springs area.

Hereford's study of the entrenchment and widening of the upper San Pedro River was recognized by Judge Goodfarb in his 1994 Subflow Order,[8] and Hereford's cross section depicts subsurface conditions that are more in line with the original and revised AZGS cross sections. It appears to ADWR that SRP used the cross sections it developed in the vicinity of TNC's San Pedro Preserve (Att. 2, fig. B) and near Hereford (Att. 2, fig, C) to modify the AZGS cross section. However, ADWR's review of the SRP cross sections suggests that SRP has either misinterpreted or overinterpreted subsurface conditions based on the limited geologic data it was able to derive from well driller logs. In several cases, the driller log data shown on SRP's cross sections do not support the relationships shown between subsurface units. In other cases, subsurface conditions are depicted on

[8] A copy of Judge Goodfarb's Subflow Order is included in Appendix A-1 to the Subflow Zone Delineation Report.

the SRP cross sections with no supporting driller log data and no indication of their uncertainty.

4.5 UNIT CONTACTS

The Sierra Vista Parties (p. 5) comment that the FHA boundary varies in accuracy causing the width of the subflow zone to be overstated. AZGS identified three levels of accuracy when mapping the contact between surficial geologic units:

- Well defined (± 25 feet accuracy)
- Subtle or gradational (± 50 feet accuracy)
- Approximate (± 250 feet accuracy).

On its generalized surficial geology maps, ADWR used solid, dashed and dotted lines, respectively, to depict these levels of accuracy at the contact between FHA and other mapping units. However, it did not carry these contact lines forward onto its subflow zone delineation maps. As such, the actual width of the subflow zones may be overstated (or understated) due to mapping uncertainty. As appropriate, ADWR recommends that the final subflow zone delineation maps for the watershed include various contact lines to reflect differing levels of accuracy.

4.6 MAP SCALE

Freeport (p. 12) notes that ADWR's reduction in the original scale of the AZGS maps from 1:24,000 to approximately 1:52,000 results in less accurate maps and is an odd scale to use.

The original scale of the AZGS maps was reduced so that the U.S. Geological Survey (USGS) quadrangles utilized by ADWR as base maps could readily be copied on 11-inch x 17-inch paper. The map scale ADWR used for display and printing did not affect its analysis and results. ADWR relied on GIS data from AZGS that are scalable and did not alter original units or their contact lines. However, future ADWR maps will

be drafted so that they can be reproduced at the original AZGS mapping scale of 1:24,000.

4.7 ADWR GROUPING OF UNITS

GRIC (p. 5) believes that ADWR's grouping of surficial geologic units into FHA, tributary Holocene alluvium, basin fill and bedrock is too simplistic since part of the tributary Holocene alluvium is FHA at depth. GRIC did not provide an alternative grouping of geologic units but indicated that at "some point the current surface Tributary Holocene Alluvium crosses the edge of the Holocene Trough and drapes over some area of the Trough."

ADWR addresses GRIC's assertion that a "Holocene Trough" exists and its use in delineating the full extent of FHA in **Section 5.4**. Also, as further described in Section 5.1, ADWR divided its basin fill unit into two subunits – Holocene basin fill and older basin fill to assist in determining the full extent of FHA.

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CHAPTER 5: EXTENT OF FLOODPLAIN HOLOCENE ALLUVIUM

In this chapter, ADWR responds to comments from four parties who disagree with its delineation of the extent of FHA since ADWR relied on surficial geologic maps that do not depict subsurface FHA. ADWR grouped their comments into five categories and addresses each category below:

- Fan Deposits and Active Floodplain Analysis (**Section 5.1**)
- Riparian Vegetation (**Section 5.2**)
- Borehole Geologic Logs and Aquifer Data (**Section 5.3**)
- Topographic Slope Change (**Section 5.4**)
- Distribution of Surficial Geologic Units (**Section 5.5**).

Based on these comments, **Section 5.6** describes two alternatives that ADWR recommends be considered to further delineate the full extent of FHA.

5.1 FAN DEPOSITS AND ACTIVE FLOODPLAIN ANALYSIS

Four parties comment that ADWR did not properly map the full (surface and subsurface) extent of FHA since it relied on surficial geology maps. GRIC (pp. 2-4), SRP (pp. 16-19), TNC (Exh. 2, p. 3) and the US (p. 4) state that areas exist where recent fan deposits (also referred to as alluvial fans, tributary Holocene alluvium and tributary surficial deposits) overly FHA and these areas should have been included by ADWR in its subflow zone. SRP (p. 18) and the US (p. 5) also believe that ADWR misinterpreted Goodfarb's 1994 Subflow Order regarding exclusion of floodplain alluvium of ephemeral streams from the subflow zone. GRIC (p. 4), SRP (pp. 27-28; Att. 2, fig. J) and the US (pp. 8-9) comment that ADWR's proposed methodology to address overlapping fan deposits (Appendix D-4 of the Subflow Zone Delineation Report) is arbitrary and speculative. Finally, GRIC (pp. 3-4), SRP (pp. 20-22), TNC (Exh. 2, p. 2) and the US (pp. 9-10) note that the boundary between FHA and fan deposits is subject to flood events

and channel migration so current outcrops of FHA are not a stable geologic unit, which is a key factor set forth in the 1994 Subflow Order and the 2005 Order.

SRP (p. 25) asserts that, "By definition, the active river channel contains saturated floodplain alluvium, which must be part of the subflow zone." In their objections, SRP (Att. 2, figs. D through I; Att. 3) and TNC (Exh. 2, figs. 11, 12) provide examples where the active channel of the San Pedro River has migrated overtime, is currently eroding fan deposits and is outside of ADWR's subflow zone. SRP (p. 24) also provides evidence that FHA underlying fan deposits can be saturated. In Attachment 6 of its comments, subsurface water level data from TNC's San Pedro River Reserve are contoured and plotted on AZGS surficial geology. Review of the contours suggests that subsurface water is flowing beneath fan deposits on the preserve in a direction parallel to the river.

ADWR understands that fan deposits likely overlie FHA where they border the floodplain or form fingers of material that extend out into the floodplain. The generalized geologic cross sections in **Figure 4-1** illustrate how fan deposits can overlap FHA near the floodplain boundary. ADWR agrees with the parties that its proposed methodology to address overlapping fan deposits has limitations, but ADWR does not agree with SRP (p. 29) that areas where FHA underlies fan deposits can be mapped with "little difficulty" or with SRP's suggested mapping methodology.

ADWR believes that one possible approach for better delineating the full extent of FHA is to map how the location of the active floodplain has changed over time. In areas where the active floodplain is now covered by fan deposits, the extent of FHA could be extended to include the areas of overlap. In order to locate where the active floodplain is now covered by fan deposits, ADWR conducted a systematic analysis of the active floodplains of the San Pedro and Babocomari Rivers and Aravaipa Creek.

ADWR's active floodplain analysis is described in **Appendix D** and was based on review of aerial imagery taken during 1935, the 1950s, the 1980s/1990s and 2007. As observed by SRP, along some stream reaches the active floodplain has been relatively dynamic and its location has migrated across the floodplain and/or changed appreciably in width since 1935. Along other reaches, the active floodplain has been more stable and its location has varied little over the period (**App. D, Att. 1**). For use in delineating subsurface FHA, ADWR prepared a series of quadrangle maps covering the stream

reaches that it determined had predevelopment perennial or intermittent flows. On these maps, the composite active floodplain boundary delineated from the aerial imagery was plotted on top of the generalized surficial geology that ADWR based on AZGS mapping (**App. D, Att. 2**). Review of the composite maps shows several areas where the historic (1930s to 2007) active floodplain is currently covered by fan deposits and other Holocene basin fill.[9] **Figure 5-1** provides examples of these areas of overlap where it is likely that FHA occurs in the subsurface. However, in many other areas, the fan deposits and Holocene basin fill remain outside of the historic active floodplain.

Other approaches were offered by the parties to better delineate the full extent of FHA and these are described below along with ADWR's confidence in their application.

5.2 RIPARIAN VEGETATION

Two parties suggest that the current distribution of riparian vegetation can be used to delineate FHA in the subsurface. SRP (p. 23, Att. 5) notes that ADWR ignored dense communities of riparian vegetation located outside of its mapped subflow zone, and TNC (Exh. 2, p. 8) indicates that the pattern of riparian vegetation together with the distribution of pre-Holocene outcrops and local topography is a strong indicator of subsurface FHA. In his 1994 Subflow Order (p. 56), Judge Goodfarb noted that:

> To the extent that phreatophication exists or can be documented in the areas adjacent to the principal channel, it does mark that portion of the area of the 'subflow' zone. If it extends to the lateral edge of the saturated floodplain Holocene alluvium, then it is a vital marker. However, even phreatophytes cannot tell the difference between floodplain alluvium and tributary aquifer alluvium and, therefore, can be a false marker. The boundaries of riparian zones are helpful and certainly within the 'subflow' zone if they do not extend over the top of tributary aquifer or basin fill.

Judge Goodfarb further notes that delineating riparian areas in their predevelopment state would not be an easy task.

[9] ADWR revised its generalized surficial geology maps by dividing the basin fill unit into two subunits - Holocene basin fill and older basin fill. This revision was made to account for younger basin fill that is potentially also underlain by FHA. The other generalized units (FHA, tributary Holocene alluvium, bedrock, and disturbed areas) were unchanged from the Subflow Zone Delineation Report.

To test the approach suggested by SRP and TNC, ADWR plotted riparian areas and wetlands recently mapped by the U.S. Fish and Wildlife Service (USFWS) on top of ADWR's generalized surficial geology maps. USFWS (2009, pp. 7, 24) defines riparian areas and wetlands as follows:[10]

> Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland.
>
> Wetlands (are) lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.

ADWR downloaded GIS data for riparian areas and wetlands in the San Pedro River Watershed from the USFWS National Wetlands Mapper website (http://www.fws.gov/wetlands/Data/DataDownload.html). Metadata on the website indicate that USFWS based its mapping on 1:24,000-scale aerial photographs primarily taken in 2001. The last four miles of the lower San Pedro River and about five miles in the middle Babocomari River were mapped using 2005 and 1996 aerial photographs, respectively.

Appendix E presents a series of quadrangle maps that show the relationship between the riparian areas and wetlands mapped by USFWS and AZGS surficial geology.[11] **Figure 5-2** provides examples where riparian vegetation may or may not be a useful indicator of subsurface FHA. Ideally, if riparian vegetation were a useful tool in delineating subsurface FHA, it should primarily grow on outcrops of FHA as well as fan deposits and Holocene basin fill near the floodplain potentially underlain by FHA.

[10] This definition is consistent with the definition of "riparian area" in A.R.S. § 45-101(b) relied upon by Judge Goodfarb (1994 Subflow Order, p. 54).

[11] For comparison to SRP's riparian vegetation maps, which only show dense cottonwood-willow and mesquite woodland, ADWR used USFWS data to differentiate cottonwood-willow and mesquite forest from wetlands and other riparian areas. The latter include salt cedar, sacaton grass and riparian scrub-shrub.

Review of the maps in **Appendix E** shows that this is indeed the case along the lower San Pedro River, particularly below approximately river mile 60. In this area, the cottonwood-willow and mesquite forest is relatively wide and occurs on outcrops of both FHA and adjacent tributary Holocene alluvium and Holocene basin fill. However, above approximately river mile 60, the cottonwood-willow and mesquite forest is relatively narrow and typically confined to existing FHA outcrops. SRP's approach would not assist in identifying subsurface FHA in this area. Along the middle and upper San Pedro River, other riparian vegetation is frequently found growing along tributaries far outside of the floodplain and in some places directly on older (pre-Holocene) basin fill. Since FHA cannot underlie pre-Holocene deposits, the growth of riparian vegetation in these areas suggests it may not be as clear an indicator of subsurface geology as suggested by SRP and TNC.

Growth of riparian vegetation on fan deposits and Holocene basin fill does not necessarily indicate the presence of subsurface FHA, as recognized by Judge Goodfarb. Even if it did, the maps in **Appendix E** show that along the middle and upper San Pedro River, current riparian areas and wetlands are often highly irregular in shape with vegetation occurring in patches and strips and sometimes only on one side of the river. Areas currently covered by riparian vegetation would have to be used to infer areas that may have previously had this vegetation, which would add more uncertainty to the analysis. Based on these factors, ADWR has *low confidence* in using riparian vegetation to delineate subsurface FHA.

5.3 BOREHOLE GEOLOGIC LOGS AND AQUIFER DATA

Two parties suggest that borehole geologic logs and/or aquifer data could be used to infer where FHA occurs in the subsurface. TNC (Exh. 2, p. 3) states that geologic logs and pumping tests allow the true extent of FHA to be delineated. The US (p. 6; Exh. 1, Att. B) believes that where the boundary of FHA is in doubt, the general direction of groundwater flow should be determined, either by measurement or inferred from existing data and experience in similar areas.

Although ADWR agrees that reliable borehole and aquifer data are valuable in understanding hydrogeologic conditions, such site specific data are lacking along most stream reaches in the watershed and are impractical to collect considering the extent of the watershed. The data most readily available (well driller logs) are often incomplete and/or inconclusive.

It is instructive to review the well driller logs that TNC (Exh. 2, Tables 1-3) presents to infer subsurface geologic conditions in the vicinity of three properties it owns along the San Pedro River north of Benson – the San Pedro River Preserve, H&E Farm and Three Links Farm properties (Exh. 2, fig. 2). On 24 of these well driller logs, TNC highlights where clay was encountered during drilling to indicate where it believes that older basin fill is first encountered in the subsurface. On the other 27 well driller logs, TNC does not provide an indication of the older basin fill contact even though at least nine of these logs show substantial clay layers were encountered and several others logs indicate an excess of 100 feet of coarser material. In summarizing their findings, TNC (Exh. 2, p. 7) states "data from geologic and drillers logs from wells on and near the three Conservancy properties described in this report indicates that the floodplain Holocene alluvium is on the order of 100 feet thick and extends beneath the thin veneer of surficial tributary alluvium…" TNC provides no other interpretation of these logs to substantiate the potential subsurface contact between overlying fan deposits and underlying FHA. It is unclear to ADWR how these logs would be used to verify the extent of FHA underlying fan deposits and Holocene basin fill.

TNC also provides maps (Exh. 2, figs. 3, 7 and 9) which show where numerous monitor wells have been drilled on their San Pedro River properties in addition to existing production wells. ADWR does not understand why the geologic logs for these monitoring wells were not included in TNC's comments and compared to their interpretation of well driller logs described above. In Figures 4 and 5 of Exhibit 2, TNC does provide detailed (2-foot contour interval) water level altitude maps for the south and north parcels of its San Pedro River Preserve that appear to have been drawn using data from over 30 wells and piezometers. SRP presents a similar figure in Attachment 6 of its comments for the south parcel of the preserve showing how the water level contours compare to the SRP and ADWR subflow zone delineations. As described above, ADWR

agrees that such aquifer data are valuable in evaluating hydrogeologic conditions. However, this level of data is typically not available throughout the watershed and would be impractical for ADWR and most parties to collect.

5.4 TOPOGRAPHIC SLOPE CHANGE

Three parties suggest that topographic maps and aerial photographs can be used to identify changes in topographic slope which would better define the boundary of FHA deposition. GRIC (p. 3) believes that topographic breaks occur at the edge of what GRIC terms a "Holocene Trough" that laterally confines FHA in the subsurface and forms a stable boundary for sediment movement along major streams in the watershed. SRP (p. 28) and TNC (Exh. 2, pp. 3, 8) believe that topographic breaks, together with the distribution of surficial geologic units, can be used to delineate the edge of subsurface FHA.

As described by GRIC, the Holocene Trough is analogous to the ancestral floodplain of a river. ADWR attempted to identify this feature by constructing a series of cross sections along the major streams in the watershed. Each cross section was oriented perpendicular to the active floodplain and displays the generalized surficial geologic units mapped by AZGS.[12] If this were a viable means of delineating subsurface FHA, the cross sections should show a distinct change in slope where the edge of the Holocene Trough is crossed and tributary Holocene alluvium or Holocene basin fill occurs at ground surface. The cross sections would not be helpful where older basin fill and bedrock border FHA outcrops since FHA cannot occur beneath these geologic units. **Figure 4-1** shows the potential relationship between topographic slope and the surface and subsurface extent of geologic units in the watershed, and **Appendix F** presents ADWR's cross sections.

ADWR constructed its cross sections using 10-meter digital elevation model (DEM) data downloaded from the USGS National Elevation Dataset (http://ned.usgs.gov/). More detailed (1-meter) topography was available from the

[12] For ease of viewing, cross sections for the San Pedro and Babocomari Rivers were generated looking downstream while the Aravaipa Creek cross sections look up upstream.

University of Arizona based on 2003 Light Detection and Ranging (LIDAR) imagery, but only for the portion of the watershed covered by the San Pedro Riparian Conservation Area. ADWR compared the DEM and LIDAR topography and found good agreement in the areas outside of the active floodplain where the edge of the Holocene Trough should be located.[13] Based on this comparison, ADWR used DEM data for generating representative cross sections throughout the watershed.

ADWR generated a separate cross section along each mile of the San Pedro River (157 miles), Babocomari River (29 miles) and Aravaipa Creek (53 miles).[14] To allow slope changes such as a Holocene Trough to be more easily identified, the cross sections were plotted at a vertical exaggeration of 15 times. For comparison, the cross sections also display ADWR's composite active floodplain boundary (**Section 5.1**) and the riparian areas and wetlands mapped by the USFWS (**Section 5.2**).

Using the cross sections in **Appendix F**, ADWR attempted to identify slope breaks that could signify the edge of a Holocene Trough and subsurface FHA. The following observations were made.

<u>San Pedro River</u>

- Only 5 of the 158 San Pedro River cross sections show FHA outcrops bordered on both sides of the floodplain by older basin fill or bedrock. These cross sections are located along the upper reach of the river, at and above river mile 116. Since FHA cannot underlay older basin fill and bedrock, identification of potential subsurface FHA is not required in such areas.
- All of the remaining San Pedro River cross sections show FHA outcrops bordered on at least one side by tributary Holocene alluvium or Holocene basin fill. In these areas, FHA could occur in the subsurface.
- Many of the cross sections below river mile 80 show a distinct change in slope on both sides of the floodplain which may indicate a Holocene Trough (*e.g.*, river

[13] The 10-meter DEM data were derived from 1:24,000-scale USGS topographic maps and consist of a grid of elevation values posted every 10 meters. The 1-meter DEM data were collected by an aircraft-mounted laser and consist of a grid of elevation values posted every one meter.
[14] Cross sections were also generated at the mouths of these three streams (river mile 0) for a total of 242 cross sections.

miles 8, 39 and 71). The topographic breaks typically occur where outcrops of older basin fill border outcrops of tributary Holocene alluvium or Holocene basin fill. Although less frequent, some cross sections along this reach of the river only show a clear topographic break on one side of the floodplain (*e.g.*, river miles 18 and 48).

- Above river mile 80, topographic breaks are generally less obvious in the cross sections and more often occur on only one side of the river (*e.g.*, river miles 88 and 115) or sometimes on neither side (*e.g.*, river miles 93 and 153).

Babocomari River

- About one third of the 30 Babocomari River cross sections show FHA outcrops bordered on both sides of the floodplain by older basin fill or bedrock. These cross sections cover portions of the lower and upper reaches of the river. Subsurface FHA is not present in such areas.
- The other Babocomari River cross sections show FHA outcrops bordered on at least one side by tributary Holocene alluvium or Holocene basin fill, so subsurface FHA may exist. However, about half of these cross sections show little or no clear indication of topographic breaks that would indicate a Holocene Trough (*e.g.*, river miles 5 and 22). The remaining cross sections show some evidence of a topographic break typically at or near the surface contact between older basin fill and tributary Holocene alluvium or Holocene basin fill (*e.g.*, river miles 10 and 23).

Aravaipa Creek

- The 54 Aravaipa Creek cross sections show that along most of the creek's lower reach (below river mile 28), FHA outcrops are bordered by older basin fill or relatively steep bedrock canyon walls so subsurface FHA is not expected to be present.
- Along the upper reach of the creek, tributary Holocene alluvium or Holocene basin fill typically border FHA outcrops on at least one side of the floodplain. About one-third of the cross sections in this area show little or no evidence of a

Holocene Trough (*e.g.*, river miles 38 and 50). The remaining cross sections do show a topographic break that may indicate a Holocene Trough on one or both sides of the creek (*e.g.*, river miles 30 and 44, respectively). These topographic breaks typically occur at or near the surface contact between older basin fill and tributary Holocene alluvium or Holocene basin fill.

As described above, several cross sections along the major streams in the watershed either do not show clear changes in slope that could signify a Holocene Trough and subsurface FHA, or the topographic breaks occur only on one side of the floodplain. Where slope changes are observed, they typically occur at or near the surface contact between older basin fill and tributary Holocene alluvium or Holocene basin fill. **Figures 5-3a, 5-3b and 5-3c** provide examples where the cross sections may or may not indicate the presence of a Holocene Trough along the San Pedro River, Babocomari River and Aravaipa Creek, respectively. ADWR has *low confidence* in using slope change by itself to identify subsurface FHA and believes that the distribution of surficial geologic units, discussed in **Section 5.5**, could be more useful.

5.5 DISTRIBUTION OF SURFICIAL GEOLOGIC UNITS

Three parties comment that the distribution of surficial geologic units along the floodplain could also be used to better delineate the full extent of FHA. GRIC (p. 4) suggests the relatively simple approach of drawing a smooth line connecting outcrops of geologic units clearly older than Holocene where they occur closest to the stream of interest. During the proceedings before Judge Goodfarb, these outcrops were termed "inliers."[15] SRP (pp. 28-29; Att. 2, fig. L) and TNC (pp. 3, 8; Exh. 2, fig. 13) believe that the patterns of pre-Holocene outcrops together with topographic breaks (**Section 5.4**) are a good indicator of the subsurface edge of FHA.

[15] Stetson Engineers, Inc. (1993), consultant for the US, used the term inlier to describe "where basin fill is exposed within the floodplain alluvium" (p. 15) and presented a map (fig. 6) showing how its proposed subflow zone for the St. David to Pomerene area takes inliers into account. In his 1994 Subflow Order (p. 36), Judge Goodfarb indicated that the subflow zone "must be outside of and not include those tributary alluvial deposits known as "inliers" as indicated in figure 6 of the Stetson Report."

ADWR evaluated this approach by selecting two reaches of the San Pedro River where distinct outcrops of older basin fill border the floodplain and then attempted to draw a smooth line connecting the outcrops. **Figure 5-4** presents the results for the Benson and Mammoth/Dudleyville areas. In each area, ADWR delineated the potential extent of FHA based on the presence of inliers as well as the general shape of fan deposits covering the floodplain. ADWR used three line types to indicate its relative level of confidence in these delineations:

- Solid line (*high confidence*) - where fingers of fan deposits clearly overlie the floodplain and where outcrops of older basin fill or bedrock border outcrops of FHA;
- Dashed line (*moderate confidence*) – where inliers are relatively close to the floodplain and occur in a frequent and consistent pattern; and
- Dotted line (*low confidence*) – where inliers are relatively far from the floodplain and occur infrequently and in an inconsistent pattern.

ADWR understands that the use of inliers to delineate the subsurface extent of FHA presumes there is no subsurface older basin fill between the inlier and exposed FHA. It follows that the further away from the floodplain one goes before encountering an inlier, the greater the possibility that older basin fill is simply covered by fan deposits and not exposed at ground surface. In some areas, tributary Holocene alluvium extends to the edge of the area AZGS mapped with no inliers in between for guidance. However, to assume that no FHA underlies fan deposits outside of the active floodplain is unreasonable and inconsistent with water level data TNC collected at its San Pedro River Preserve (SRP, Att. 6). The latter clearly show that subsurface water is flowing beneath some fan deposits in a direction parallel to the river. Moreover, the fact that outcrops of older basin fill often form patterns that parallel the floodplain suggests they were previously eroded by the river, and areas between the inliers and the active floodplain may contain subsurface FHA. The distribution of surficial geologic units alone is not dispositive.

5.6 ALTERNATIVES

This chapter describes five approaches for better delineating the full extent of FHA in the watershed based on comments received by the parties. ADWR has the *highest confidence* in mapping areas where the historic active floodplain is now covered by fan deposits (**Section 5.1**) and identifying where fingers of fan deposits clearly overlie the floodplain (**Section 5.5**). It has *moderate confidence* in extending the FHA outward to inliers that are relatively close to the floodplain and occur in a frequent and consistent pattern, and *lower confidence* in using inliers which are farther from the floodplain and occur infrequently and in an inconsistent pattern (**Section 5.5**). ADWR has *lowest confidence* in using riparian vegetation (**Section 5.2**) or topographic slope changes (**Section 5.4**). Reliable subsurface geologic and aquifer data would provide the greatest confidence in delineating the full extent of FHA, but these data are not readily available and would be impractical to collect on a watershed scale (**Section 5.3**).

ADWR suggests two alternatives that the Court can consider for delineating the full extent of FHA in the watershed. As indicated in **Table 5-1,** each alternative has tradeoffs and different levels of relative confidence. In Alternative A, the extent of FHA would be constrained to current outcrops of FHA combined with areas where the historic active floodplain is now covered by fan deposits and where fingers of fan deposits clearly overlie the floodplain. Under this alternative, confidence is high that only FHA deposits would be delineated, but confidence is low that all FHA deposits would be included. Confidence is also low that the FHA delineated would represent a stable geologic unit. It is likely under this alternative that some subsurface FHA would be excluded.

In Alternative B, the extent of FHA would be expanded from Alternative A to include potential subsurface FHA deposits located between the active floodplain and inliers. Under this alternative, confidence is high that no FHA would be excluded and the FHA delineated would represent a stable geologic unit. However, confidence is low that only FHA deposits would be included. In this case, it is possible that non-FHA deposits would be included.

CHAPTER 6: SETBACKS FOR SIDE RECHARGE

In its 2005 Order, the Court directed ADWR to exclude tributary aquifers, areas of basin fill recharge and the alluvial plains of ephemeral streams. In this chapter, ADWR responds to comments from three parties who disagree with ADWR's application of setbacks to account for side recharge from tributary and basin fill aquifers. ADWR grouped their comments into three categories and addresses each category below:

- Prescribed Setbacks (**Section 6.1**)
- Effect of Tributary Size (**Section 6.2**)
- Local Groundwater Flow Conditions (**Section 6.3**).

ADWR's conclusion regarding the use of setbacks is presented in **Section 6.4**.

6.1 PRESCRIBED SETBACKS

To delineate subflow zones in the watershed, ADWR applied a 100-foot setback where FHA was bordered by basin fill and a 200-foot setback where it was bordered by tributary Holocene alluvium. Judge Goodfarb prescribed these setbacks in his 1994 Subflow Order (pp. 57-58, 65):

> [W]here there are connecting tributary aquifers or floodplain alluvium of ephemeral streams, the boundary of the "subflow" zone must be at least 200 feet inside of that connecting zone so that the hydrostatic pressure effect of the side recharge of this tributary aquifer is negligible and the dominant direction of flow is the stream direction…[W]here there is a basin-fill connection between saturated zones of the floodplain Holocene alluvium and a saturated zone of basin fill, the boundary of the "subflow" zone must be 100 feet inside of the connecting zone so that the hydrostatic pressure effect of the basin-fill's side discharge is overcome and the predominant direction of flow of all of the "subflow" zone is the same as the stream's directional flow.
>
> * * *

> That part of the floodplain alluvium which qualifies as a "subflow" zone must also be where the pressure of side recharge from adjacent tributary aquifers or basin fill is so reduced that it has no significant effect on the flow direction of the floodplain alluvium. (i.e., a 200-foot setback from connecting tributary aquifers and a 100-foot setback from the basin-fill deposits).

Judge Goodfarb did not prescribe setbacks where FHA was bordered by bedrock but his 1994 Subflow Order (p. 30) recognized the existence of bedrock canyon streams which were defined as "perennial or intermittent streams located in canyons bounded by consolidated tributary aquifers or impermeable bedrock."

SRP (pp. 22-23) and the US (Exh. 1, p. 2) note that ADWR routinely applied 200-foot setbacks in numerous locations where a tributary aquifer or inflow from ephemeral stream alluvium do not exist. The US (Exh. 1, p. 4) also notes that ADWR should not have applied setbacks where the San Pedro River flows through two bedrock areas in the northern part of the Lewis Springs quadrangle map since it reduced the width of the subflow zone or eliminated it entirely.

The 100- and 200-foot setbacks required by Judge Goodfarb were based on the testimony of Stephen G. Erb, the former ADWR adjudications manager, together with evidence of different rates of permeability and transmissivity of different geologic units, as well as certain exhibits received at trial (1994 Subflow Order, p. 58). ADWR applied 100-foot setbacks where basin fill borders FHA and 200-foot setbacks where tributary Holocene alluvium borders it. ADWR considered outcrops of tributary Holocene alluvium a practical marker of where connecting tributary aquifers and floodplain alluvium of ephemeral streams may contribute side recharge. ADWR agrees with the US that it should not have applied setbacks in the two bedrock areas within the Lewis Springs quadrangle map as these stream reaches could be viewed as flowing through bedrock canyons.

6.2 EFFECT OF TRIBUTARY SIZE

Both SRP (p. 23) and the US (Exh. 1, pp. 2-4) believe that different setbacks should be applied for large and small tributaries bordering the floodplain. A 200-foot

setback would be appropriate at the mouths of large tributaries, but for small tributaries and where basin fill borders the floodplain, the setback should be 100-feet. To distinguish large from small tributaries, SRP's consultant did the following (p. 30):

> Identified named washes from topographic maps and determined how far their alluvial fans extended upstream and downstream on the floodplain along the saturated floodplain line. The [AZGS] mapping and topography were used to make this determination. In many places, alluvial fans overlap and, in those cases, professional judgment was used to make the determination.

SRP (pp. 30-31) indicates that further adjustment of these setbacks may be necessary where their application causes "the river channel, as identified by [AZGS], to be outside of the subflow zone." The US (Exh. 4, p. 4) indicates that the 200-foot setback "should only apply for large tributaries that have groundwater flow in the tributary Holocene alluvium at the edge of the San Pedro River floodplain year round. It is only in these areas that the groundwater flow in the tributary alluvium is expected to be perpendicular to that of the San Pedro River subflow as defined by the Court." Unlike SRP, the US does not offer a ready means of identifying these large tributaries.

While ADWR agrees that larger setbacks may be hydrologically reasonable for larger tributaries, neither SRP nor the US provide hydrogeologic evidence that supports their suggested use of 200-foot setbacks only for large tributaries and 100-foot setbacks for the other washes. In addition, Judge Goodfarb does not discuss such an approach in his 1994 Subflow Order.

6.3 LOCAL GROUNDWATER FLOW CONDITIONS

TNC (Exh. 2, p. 4) suggests that more appropriate setbacks could be developed based on local water level data and subsurface flow directions. Based on its water level contour maps for the San Pedro River Preserve (Exh. 2, fig. 4 and 5), TNC (Exh. 2, p. 7) concludes that subsurface flow within the FHA is in the same approximate direction, and side recharge has no significant affect on flow direction.

ADWR does not understand how TNC uses Figures 4 and 5 in its comments to conclude that side recharge has no significant affect on flow direction beneath its preserve, since the contact between tributary and basin fill aquifers and saturated FHA are not delineated on their contour maps. ADWR agrees that more appropriate setbacks could be developed based on detailed subsurface water level data, however, these data are not readily available throughout the watershed. What are more readily available are regional water level contour maps as SRP presents for the Upper San Pedro Basin in Attachment 6 of their comments. However, the relatively small scale of such regional water level maps would not be useful in developing site specific setbacks.

6.4 CONCLUSION

Based on its review of the SRP, TNC and US comments regarding setbacks and upon further consideration, ADWR concludes that there are currently insufficient data to support application of site specific setbacks in the watershed. ADWR applied the setbacks presented by the 1994 Subflow Order.

CHAPTER 7: DELINEATION OF SUBFLOW ZONES

In this chapter, ADWR responds to comments from four parties who disagree with its delineation of subflow zones in the watershed. ADWR grouped their comments into three categories and addresses each category below:

- Combined Effect of Fan Deposits and Setbacks (**Section 7.1**)
- Alternative Subflow Zone Maps (**Section 7.2**)
- Mountain-Front Streams (**Section 7.3**).

Table 2-2 summarizes areas where the parties agree with ADWR's subflow zone delineations, which are not discussed further here.

7.1 COMBINED EFFECT OF FAN DEPOSITS AND SETBACKS

Three parties state that ADWR's failure to map the full extent of FHA together with its routine application of prescribed setbacks results in delineation of overly narrow and discontinuous subflow zones. The US (pp. 4, 6) believes it is unreasonable to allow temporary fan deposits to narrow the subflow zone, particularly where application of setbacks causes the subflow zone to disappear entirely and leaves large gaps along streams that ADWR determined had predevelopment perennial or intermittent flow. TNC (Exh. 2, p. 7) observes that by applying setbacks and only considering surface exposures of FHA, ADWR's subflow zone has several gaps and areas where the current river channel lies outside of it. SRP (pp. 15, 25-26) identified nearly 500 areas where the current river channel is excluded from ADWR's delineation of saturated FHA including a half mile reach of lower Aravaipa Creek where AZGS incorrectly mapped a man-made berm as late Holocene alluvium (**Section 4.2**).

ADWR understands that fan deposits likely overlie FHA where they border the floodplain or form fingers of material that extend out into the floodplain. As described in **Section 5.6**, ADWR evaluated five approaches for better delineating the full extent of

FHA and suggested two alternatives that could be considered by the Court. One of these methodologies could be used to revise ADWR's FHA maps.

ADWR concludes in **Section 6.4** that there are currently insufficient data to support application of site specific setbacks in the watershed and that application of the prescribed setbacks leads to anomalous results. Application of setbacks under Alternative A would further limit the width of the subflow zone and potentially create even more anomalies. Application of setbacks under Alternative B would eliminate the anomalies, but would potentially include non-FHA deposits.

7.2 ALTERNATIVE SUBFLOW ZONE MAPS

Three parties offer alternative subflow zone maps to those ADWR presents in Appendix E of the Subflow Zone Delineation Report. On Sheets 1 through 6 of Attachment 10, SRP's consultant (Leonard Rice Engineers or LRE) plots the lateral extent of both surface *and* subsurface FHA directly onto the AZGS surficial geology maps based on their interpretation of the geology maps and "aerial photography, topographic map analysis, drillers logs and field observation." On these same sheets, LRE then applies 100- and 200-foot setbacks to the lateral extent of FHA, as described in **Section 6.2,** and derives a final subflow zone. In Attachment 8 of their comments, SRP compares the LRE subflow zone for the San Pedro River to ADWR's 2009 subflow zone and the post-1880 subflow zone that Errol Montgomery, consultant for the groundwater users, presented as Exhibits 209-216 at trial in 1994. SRP makes a similar comparison between the LRE and ADWR subflow zones in Attachments 9 and 11, but this time it also includes the Babocomari River and Aravaipa Creek, and in Attachment 9 it also shows the location of large wells.[16] In Figure K of Attachment 2, LRE compares its current interpretation of the subflow zone to its 1994 interpretation and notes how well they agree.

In Figures 6, 8 and 10 of Exhibit 2, TNC's expert (Haney) delineates subflow zones for their three properties along the lower San Pedro River based chiefly on

[16] SRP (p. 27) points out that many large wells are located outside of ADWR's proposed subflow zone but within LRE's subflow zone. These wells would likely be subject to cone of depression tests and "require enormous amounts of additional time and money to be spent by ADWR, the parties and the Court."

"geologic logs, AZGS geologic mapping units, NRCS soil units, topography, and hydrogeologic data obtained during investigations and regular monitoring." Haney then compares these to ADWR's 2009 subflow zones.

Finally, in Attachment B of Exhibit 1, the US consultant (Stetson Engineers) proposes an alternative subflow zone for the San Pedro River along the northern portion of the Hereford USGS quadrangle map "based primarily on geology and topography" with "setbacks of 100 feet for basin fill and 200 feet for large tributaries…added to the floodplain Holocene alluvium boundary to create a new subflow boundary." Where the subflow zone is uncertain, the US consultant (Exh. 1, p. 3) suggests applying a "simple field test" involving "driving three well points or piezometers into the Holocene alluvium and carefully measuring the water levels and measurement point elevation." This test would be very costly and time consuming.

All of the alternative maps show continuous subflow zones that are considerably wider than those ADWR delineated in the Subflow Zone Delineation Report. This is not unexpected since ADWR applied uniform setbacks and did not attempt to delineate subsurface FHA. ADWR agrees with the US (Exh. 1, p. 4) that the "boundary of Holocene alluvium in the San Pedro River floodplain may be more difficult to define in some places rather than others due to limited basin fill or bedrock outcrops, and low topography." Final subflow zones would therefore be delineated with more confidence in some areas of the watershed than others.

7.3 MOUNTAIN-FRONT STREAMS

Two parties comment that ADWR should have mapped subflow zones along mountain-front streams in the watershed. SRP (pp. 14-15) disagrees with ADWR's criteria for excluding mountain-front streams noting that "streams may be excluded only if the stream is ephemeral under predevelopment conditions and there is not a connection of saturated floodplain Holocene alluvium between the ephemeral stream and a perennial or intermittent stream." SRP also asks that ADWR explain why it excluded at least two specific reaches (Redfield and Buehman canyons) from the Subflow Zone Delineation Report and suggests that whether there are appropriative rights to the isolated intermittent

or perennial reach of the stream should be a consideration (pp. 4, 15). GRIC (p. 4) believes that ADWR should have considered all streams in its analysis and notes that the Babocomari River and Aravaipa Creek, which ADWR did analyze, could also be viewed as mountain-front streams.

ADWR did not consider mountain-front streams in the Subflow Zone Delineation Report, noting the following factors:

- The reaches are relatively short and often isolated from major streams in the alluvial valleys;
- Access is often difficult or restricted due to their location within and/or at the base of mountains;
- Significant resources would be required to research and map their locations; and
- AZGS did not include these streams in its surficial geologic mapping.[17]

ADWR recognizes that subflow zones may exist along some mountain-front streams in the watershed and could develop a strategy for identifying and delineating these zones. However, in light of the resources that would be required, ADWR requests that the Court consider how this work should be prioritized with other ADWR efforts in the watershed.

[17] AZGS' contract with ADWR was limited to mapping surficial geologic units along the San Pedro and Babocomari Rivers and Aravaipa Creek.

TABLES

TABLE 1-1. PARTIES WHO FILED COMMENTS AND OBJECTIONS

PARTIES RAISING SUBSTANTIVE LEGAL AND TECHNICAL COMMENTS	OTHER PARTIES[1]
ASARCO	Apache Powder Company
Bella Vista Water Company, Pueblo Del Sol Water Company, and the City of Sierra Vista (Sierra Vista Parties)	Richard Donahue
	Howard L. Ludd
Freeport-McMoRan Corporation (Freeport)	Paul Kartchner
Gila River Indian Community (GRIC)	Miller Brothers' Ranch [3]
City of Phoenix [2]	Miller Family Trust
Salt River Valley Water Users Association and Salt River Project Agricultural Improvement and Power District (SRP)	Quentin Miller [3]
	William Miller
City of Tempe [2]	Marsha Thompson [4]
The Nature Conservancy (TNC)	Kevin Trejo [4]
United States (US)	George L. White

Notes:

[1] Comments referred to the Special Master.

[2] Joined in SRP's comments.

[3] Filed three separate objection forms.

[4] Filed two separate objection forms.

TABLE 2-1. SUMMARY OF TECHNICAL COMMENTS AND OBJECTIONS WHICH DISAGREE WITH SUBFLOW ZONE DELINEATION REPORT

SECTION ADDRESSED IN REPORT	COMMENT	PARTIES[1]
3.0	***Predevelopment Streamflow Conditions***	
3.1	A single year or range of years should have been identified to represent predevelopment streamflows rather than multiple years.	ASARCO, Sierra Vista Parties
3.2	ADWR's lines of evidence for predevelopment streamflows were not necessarily of equal value and should be weighted according to uncertainty.	Freeport
3.3	Conflicting lines of evidence should be addressed.	ASARCO, Freeport
3.4	Additional information on the 1935 aerial photography used by ADWR should be provided and this imagery should not be considered a sole line of evidence.	Freeport
3.5	Historic diversion records should be used to extend the perennial/intermittent reach of Aravaipa Creek further upstream.	SRP
3.6	NRCS soil survey maps should not be relied on to exclude ephemeral reaches.	GRIC
4.0	***AZGS Geologic Maps***	
4.1	Map unit boundaries and labels are not always clear and colors used for map units are sometimes inconsistent with map legends.	Freeport
4.2	Disturbed areas should not be identified as geologic units.	GRIC, SRP
4.3	ADWR should describe how geologic data were transferred from AZGS.	Freeport
4.4	The AZGS geologic cross section used by ADWR does not represent actual surface and subsurface conditions in the watershed.	SRP
4.5	The varying accuracy of geologic contacts mapped by AZGS overstates the width of the subflow zone.	Sierra Vista Parties
4.6	ADWR's reduction in the scale of AZGS maps results in less accurate mapping of subflow zones and is an odd scale to use.	Freeport
4.7	ADWR's generalized grouping of AZGS geologic units is too simplistic.	GRIC
5.0	***Extent of Floodplain Holocene Alluvium***	
5.1	ADWR did not properly map the full extent of floodplain Holocene alluvium (FHA) since it relied on recent surficial geology, which is not stable, and its proposed methodology to address overlapping tributary Holocene alluvium (fan deposits) is flawed.	GRIC, SRP, TNC, US
5.2	The current distribution of riparian vegetation can be used to delineate FHA in the subsurface.	SRP and TNC
5.3	Borehole geologic logs and/or aquifer data can also be used to infer where FHA occurs in the subsurface.	TNC, US
5.4	Topographic maps and aerial photographs can be used to identify changes in topographic slope ("Holocene Trough") which define the boundaries of FHA deposition.	GRIC, SRP, TNC
5.5	Distribution of surficial geologic units along the floodplain could also be used to delineate the full extent of FHA.	GRIC, SRP, TNC
6.0	***Setbacks for Side Recharge***	
6.1	ADWR should not have routinely applied prescribed setbacks to account for side recharge from tributary and basin fill aquifers.	SRP, US
6.2.	Different setbacks should be applied for large and small tributaries.	SRP
6.3	More appropriate setbacks could be developed based on local water level data and subsurface flow directions.	TNC
7.0	***Delineation of Subflow Zones***	
7.1	ADWR's failure to map the full extent of FHA together with its routine application of prescribed setbacks for side recharge resulted in delineation of overly narrow and discontinuous subflow zones.	SRP, TNC, US
7.2	Alternative subflow zones were delineated and compared to ADWR's maps.	SRP, TNC
7.3	Subflow zones should have been mapped along mountain-front streams.	GRIC, SRP

Note:

[1] The cities of Phoenix and Tempe joined in the comments filed by SRP.

TABLE 2-2. SUMMARY OF TECHNICAL COMMENTS WHICH AGREE WITH SUBFLOW ZONE DELINEATION REPORT[1]

COMMENTS	PARTIES [2]
Predevelopment Streamflow Conditions	
Predevelopment conditions should be used to delineate the subflow zone.	SRP, US
Hydrologic criteria and procedures described in Chapter 2 are appropriate.	SRP, TNC
The description of hydrologic conditions in the San Pedro Watershed presented in Chapter 3 was thorough and accurate.	TNC
The general magnitude of phreatophyte evapotranspiration was properly estimated in Chapter 3.	SRP
Cultural depletions were properly summarized in Chapter 3.	SRP
ADWR properly concluded that the San Pedro River was perennial or intermittent during predevelopment times from the International Border to its confluence with the Gila River.	TNC, US
ADWR properly concluded that Aravaipa Creek and Babocomari River were perennial or intermittent during predevelopment times.	TNC, US
Predevelopment flows and water levels were properly analyzed in Chapter 3.	SRP
The delineation of predevelopment conditions is thorough, accurate and reliable.	US
AZGS Geologic Maps	
AZGS appropriately mapped the surficial geology along the San Pedro and Babocomari Rivers and Aravaipa Creek.	GRIC, SRP, TNC
Delineation of Subflow Zones	
Saturated floodplain Holocene alluvium should be used to delineate the subflow zone.	SRP, TNC
It is appropriate to assume that the entire lateral extent of floodplain Holocene alluvium is saturated.	SRP, TNC
Tributary aquifers, areas of basin fill recharge, and the alluvial plains of ephemeral streams should be excluded from the subflow zones.	SRP, TNC, US

Notes:

[1] This summary includes only those parties who explicitly agree with certain portions of the report.

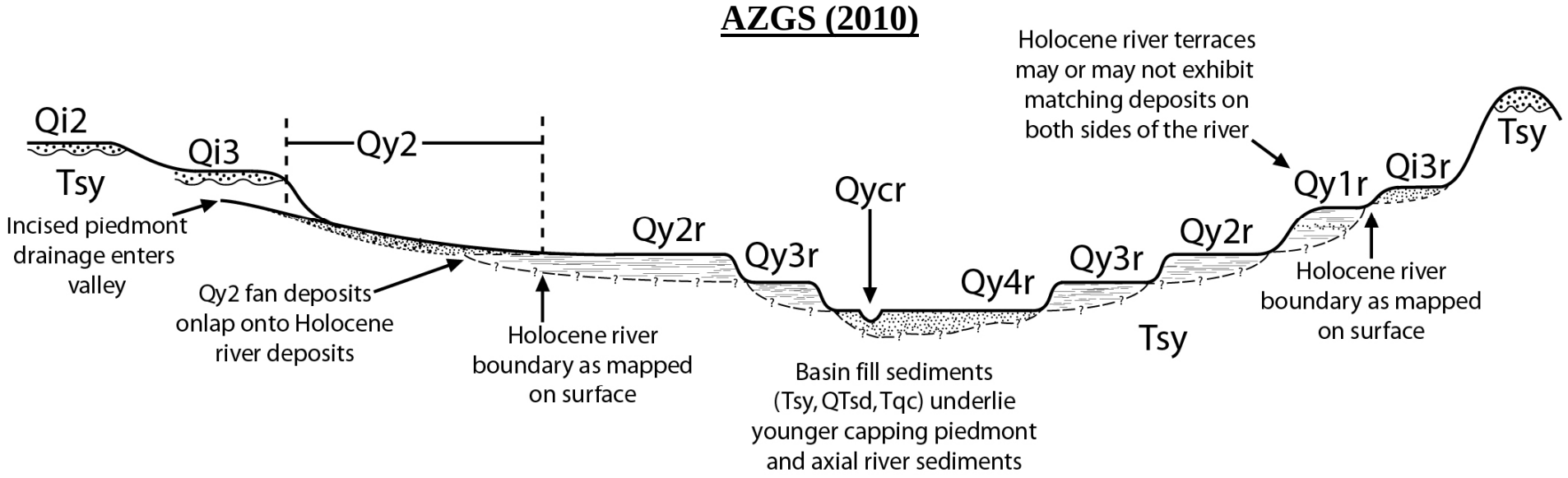
[2] The cities of Phoenix and Tempe joined in the comments filed by SRP.

TABLE 5-1. ALTERNATIVES FOR DELINEATING THE FULL EXTENT OF FLOODPLAIN HOLOCENE ALLUVIUM (FHA)

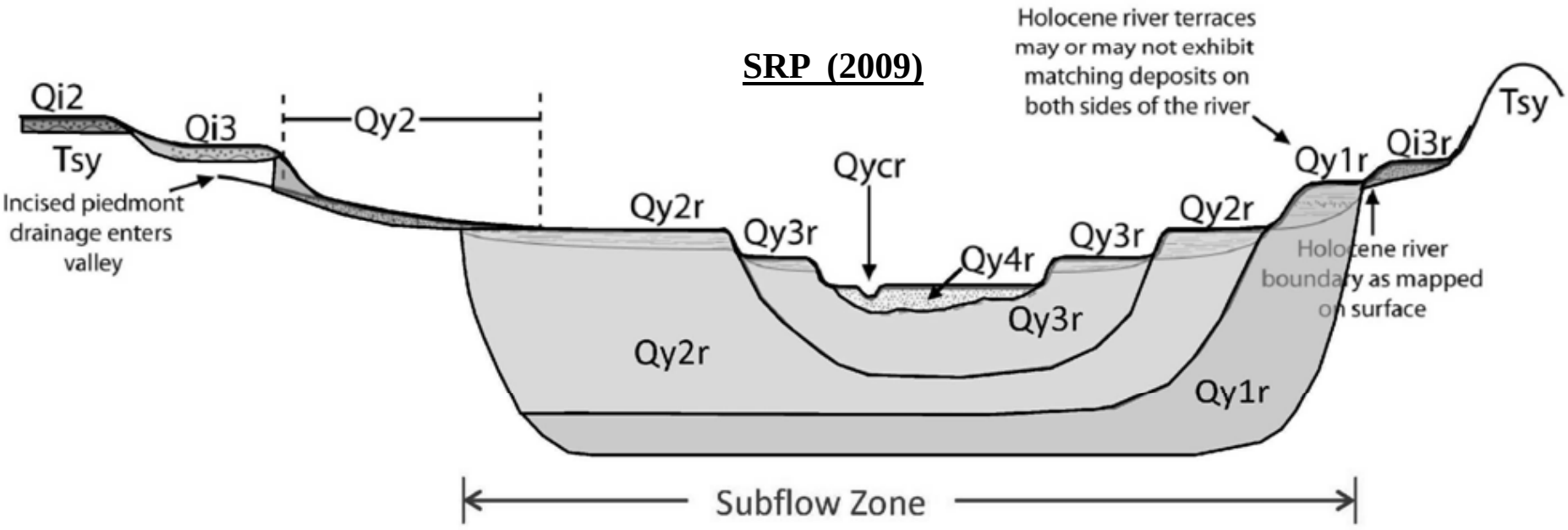
ALTERNATIVE	BASIS FOR DELINEATION	RELATIVE LEVELS OF CONFIDENCE		
		Delineation Only Includes FHA	Delineation Includes All Subsurface FHA	Delineation Represents a Stable Geologic Unit
A	Current outcrops of FHA combined with areas where fan deposits cover the historic active floodplain and form obvious fingers in the floodplain	High	Low	Low
B	Same as Alternative A plus potentially buried FHA located between the current floodplain and inliers	Low	High	High

FIGURES

AZGS (2010)



SRP (2009)



Key to AZGS and SRP Cross Sections

GEOLOGIC UNIT	UNIT NAME	AGE
Active\Modern Channel Deposits	Qycr	Holocene (10,000 years ago to present)
Stream Terraces	Qy4r (youngest)	Holocene
	Qy3r	
	Qy2r	
	Qy1r	
	Qi3r (oldest)	Pleistocene (2 million to 10,000 years ago)
Piedmont Deposits (Tributary Alluvium and Younger Basin Fill)	Qy2 (youngest)	Holocene
	Qi3	Pleistocene
	Qi2 (oldest)	
Older Basin Fill	QTsd (youngest)	Tertiary (2 million years ago and before)
	Tqc	
	Tsy (oldest)	

Hereford (1993)

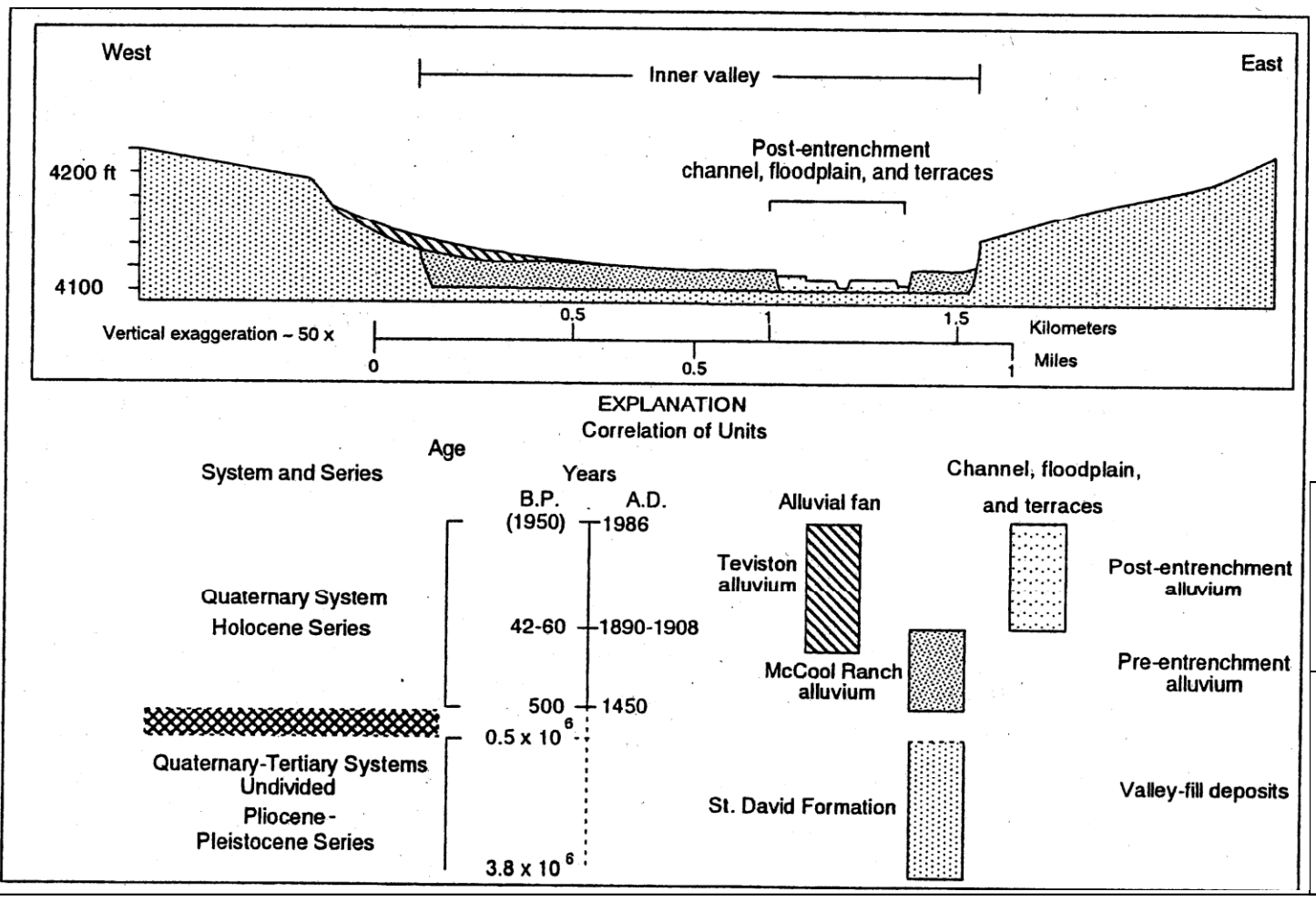


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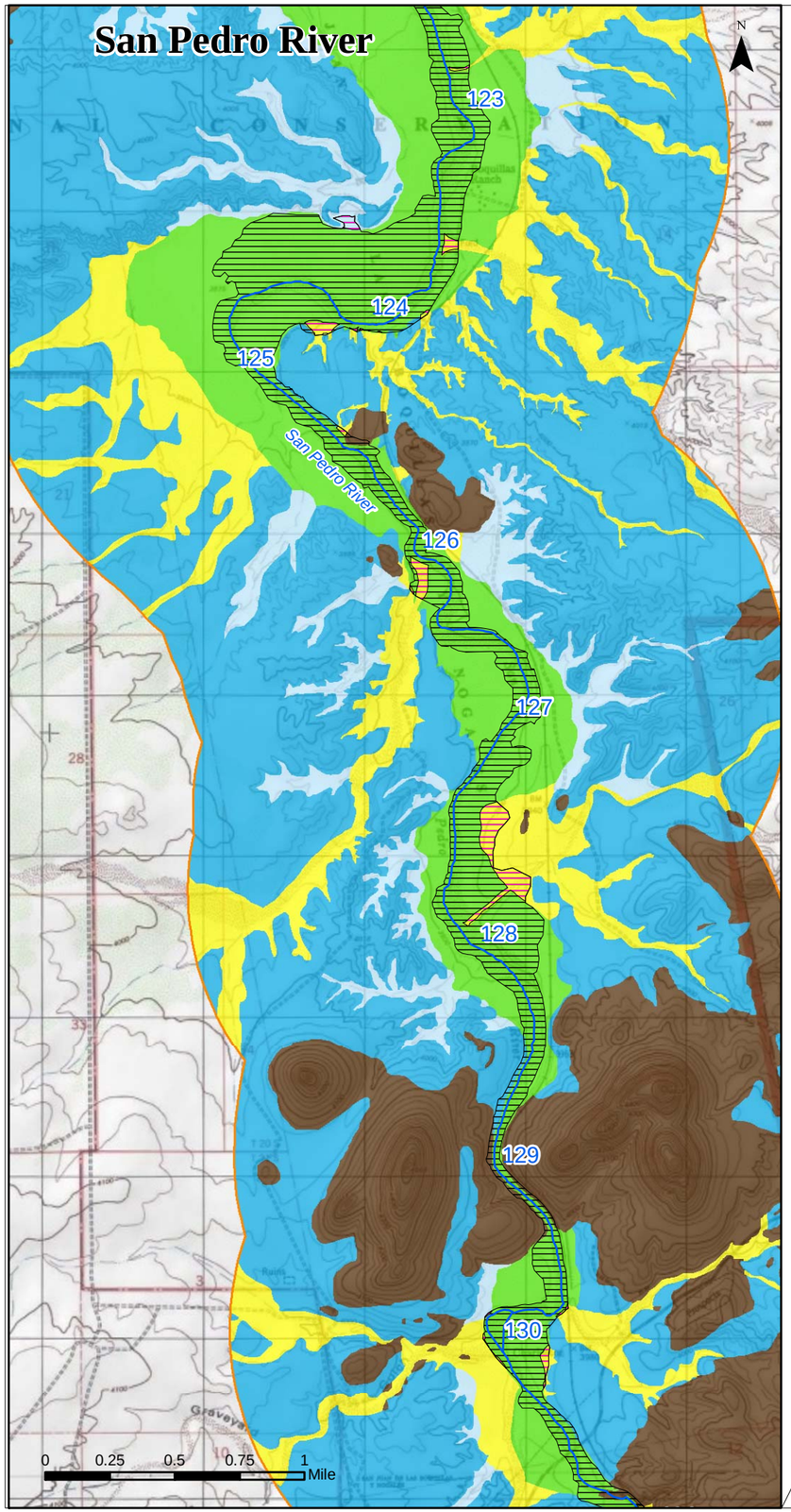
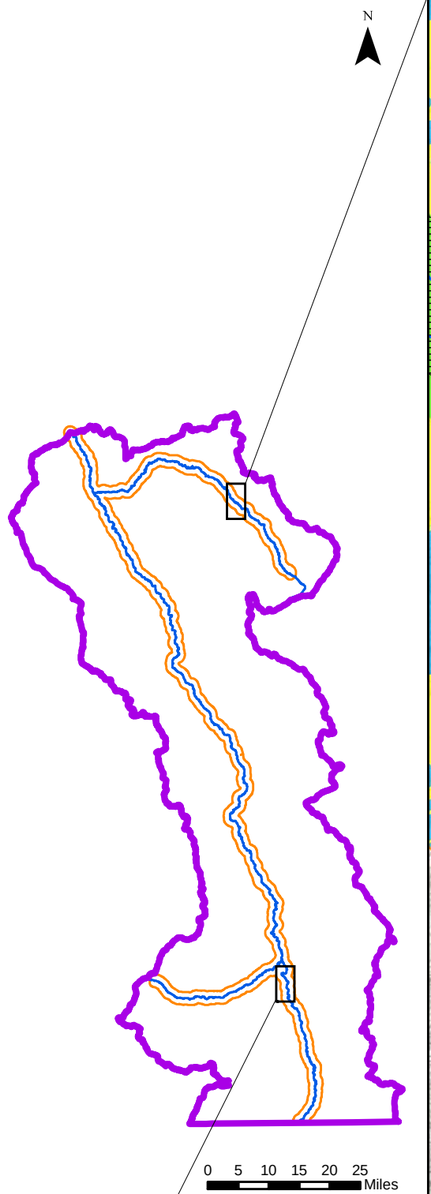
Figure 4-1

Comparison of Generalized Geologic Cross Sections along the San Pedro River

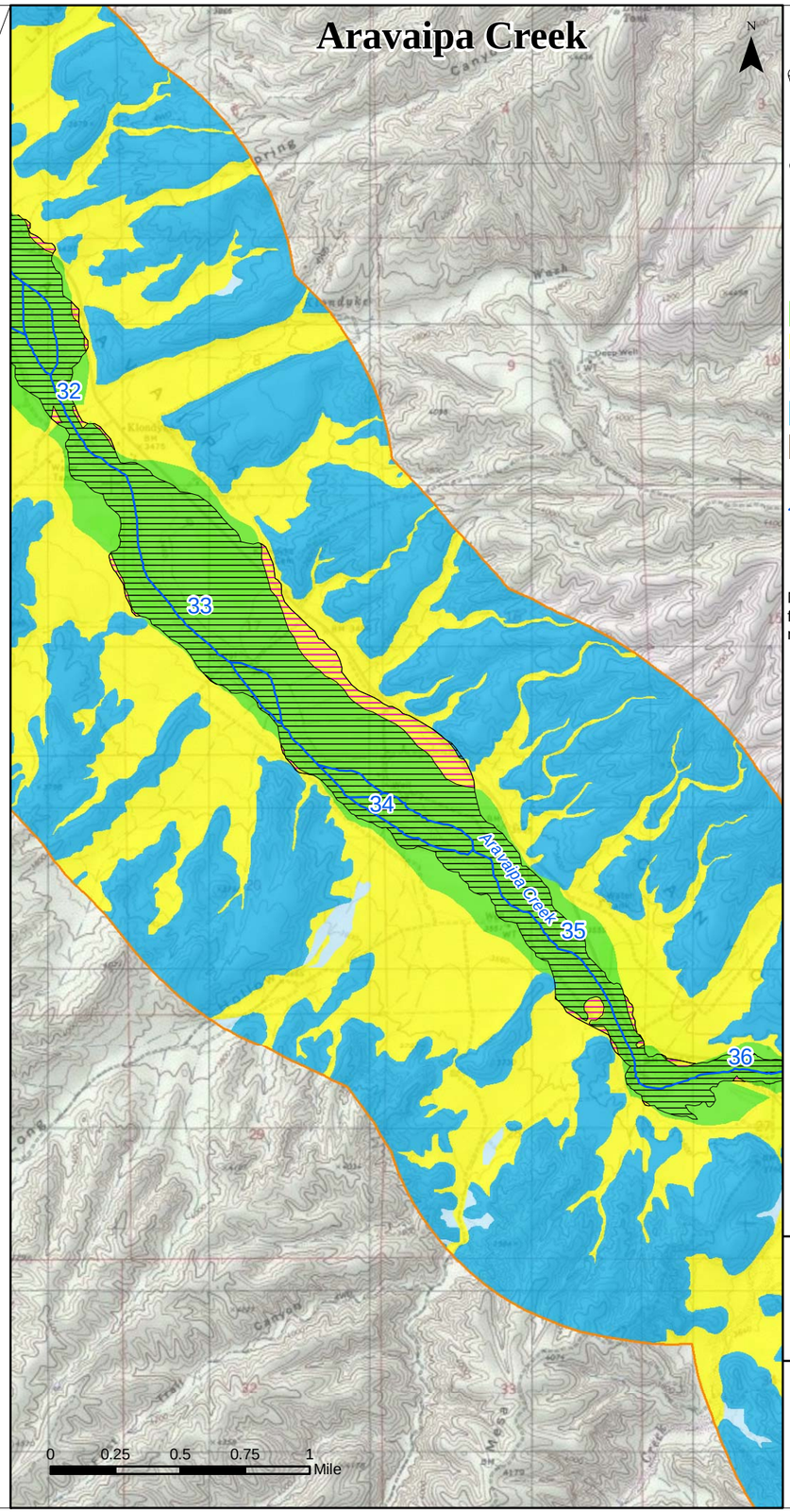
Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

San Pedro River





Aravaipa Creek



Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Portion of Historic Composite Active Floodplain Boundary Currently Covered by Fan Deposits
- Area Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock

- Major Stream and River Mile Locations
- San Pedro Watershed

Note: Appendix D describes ADWR's active floodplain analysis and presents a series of maps that cover major streams in the watershed.

Base Map: USGS 1:24,000 Topo

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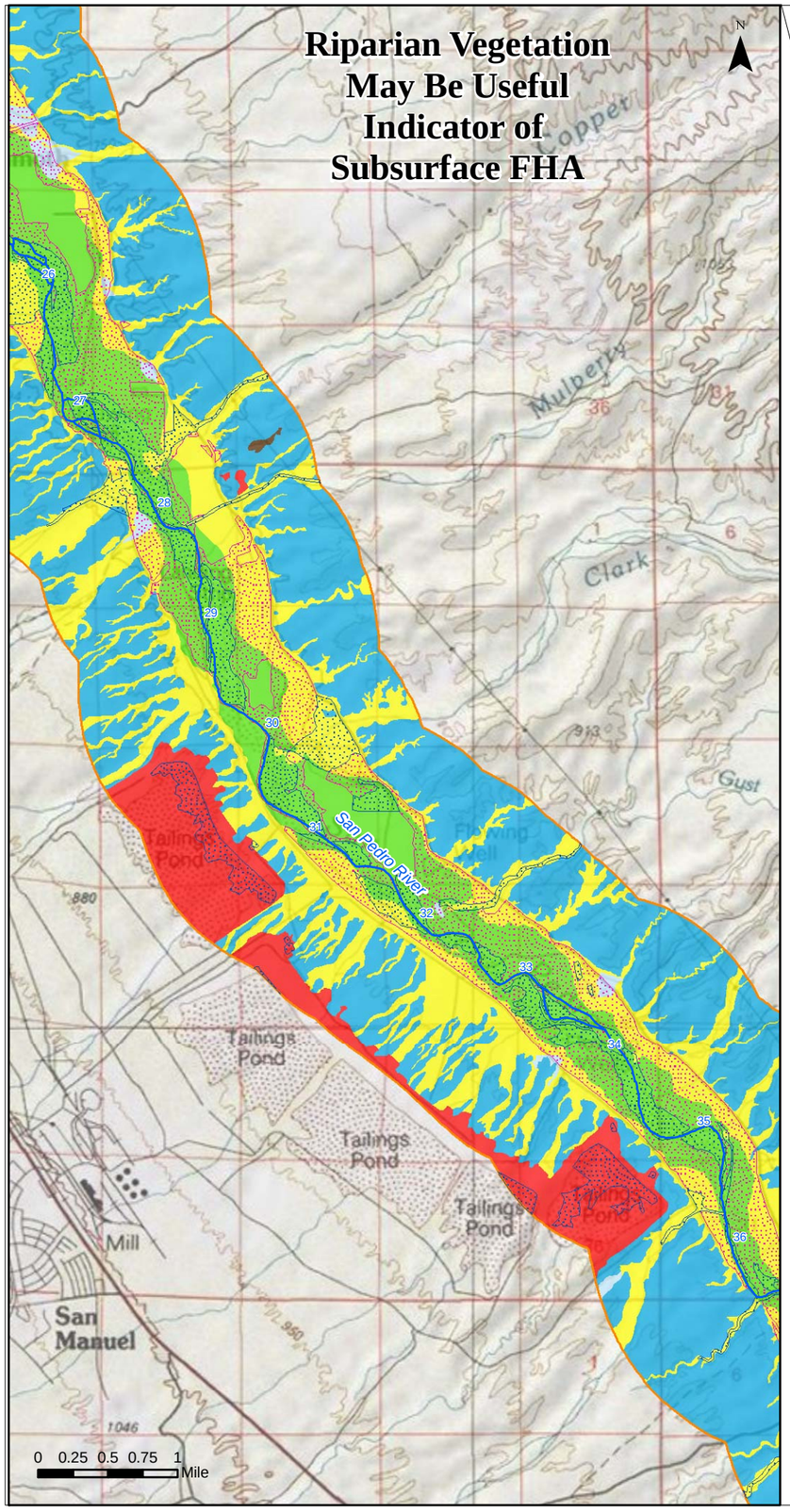
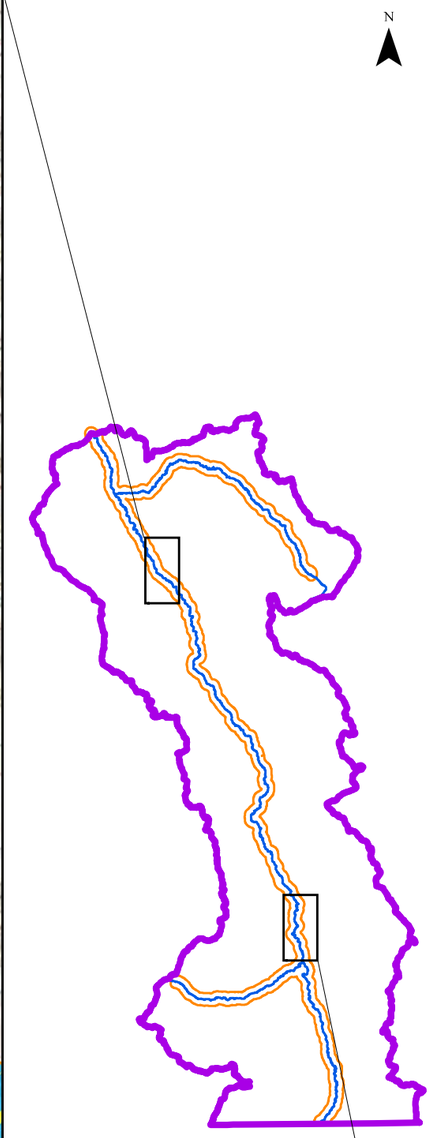
Figure 5-1
Examples Where the Historic Active Floodplain Is Currently Covered by Fan Deposits

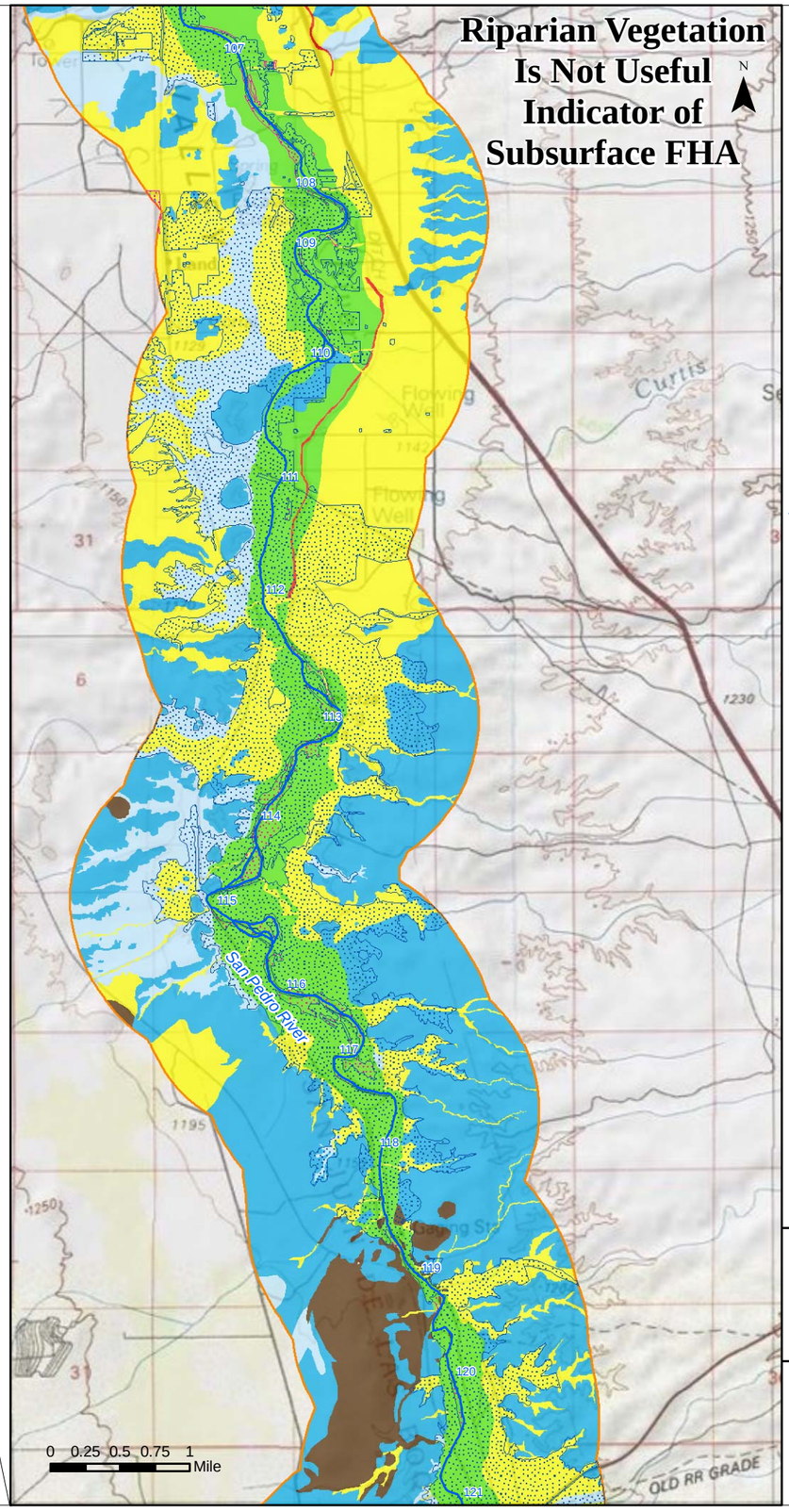
Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

Riparian Vegetation May Be Useful Indicator of Subsurface FHA





Riparian Vegetation Is Not Useful Indicator of Subsurface FHA



Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
  *Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.
- Area Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Major Stream and River Mile Locations
- San Pedro Watershed

Note: Appendix E presents a series of riparian vegetation maps that cover the San Pedro River and lower reaches of the Babocomari River and Aravaipa Creek. Vegetation mapping completed by U.S. Fish and Wildlife Service.

Base Map: USGS 1:24,000 Topo

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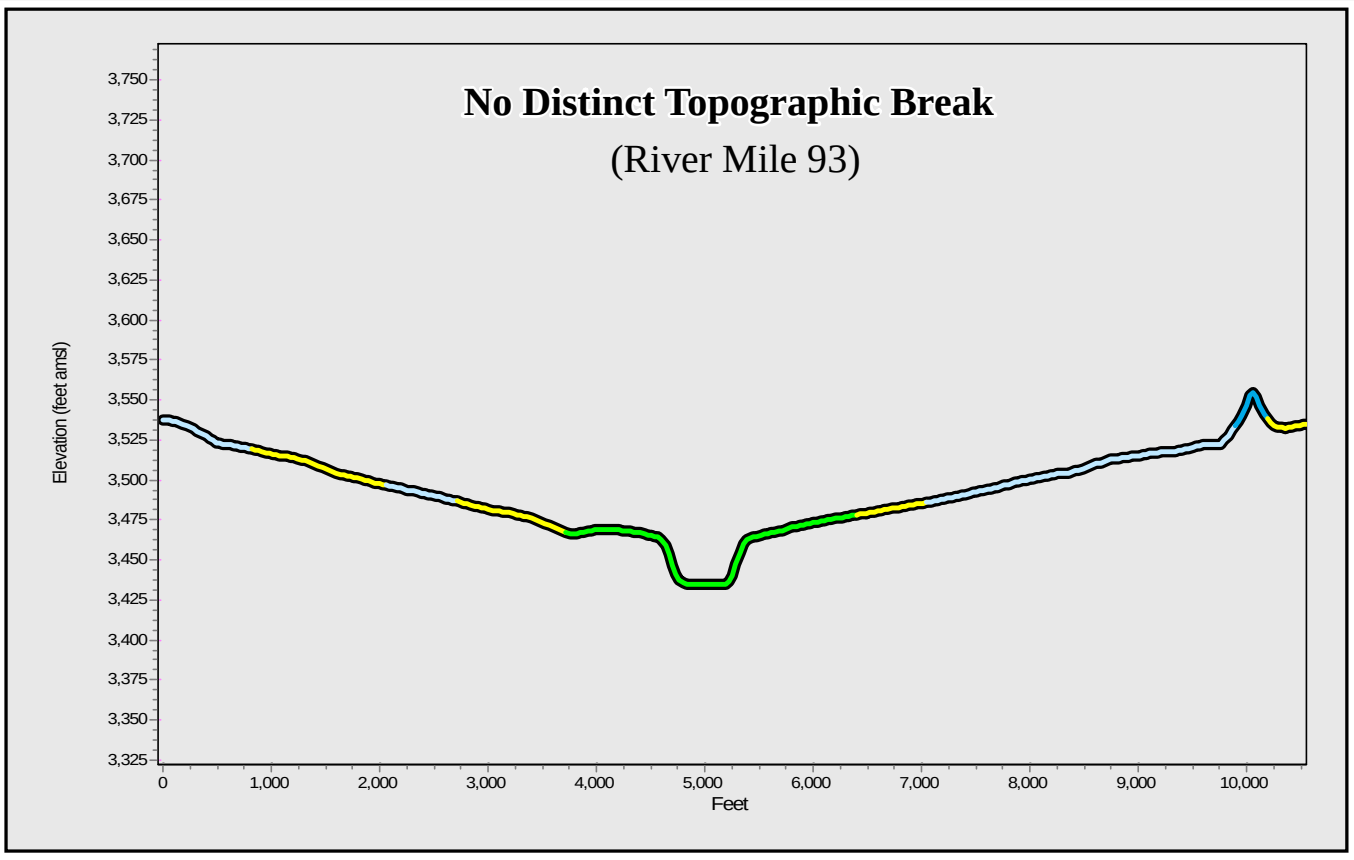
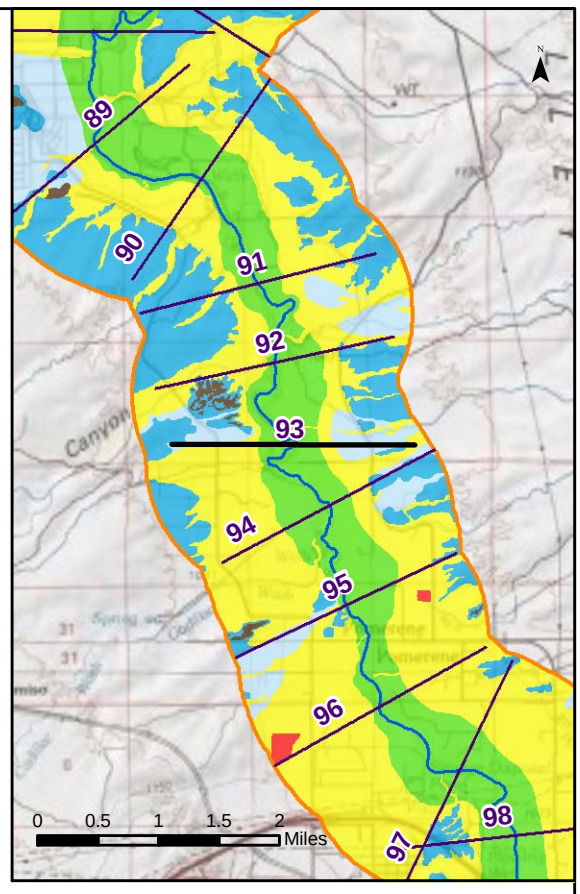
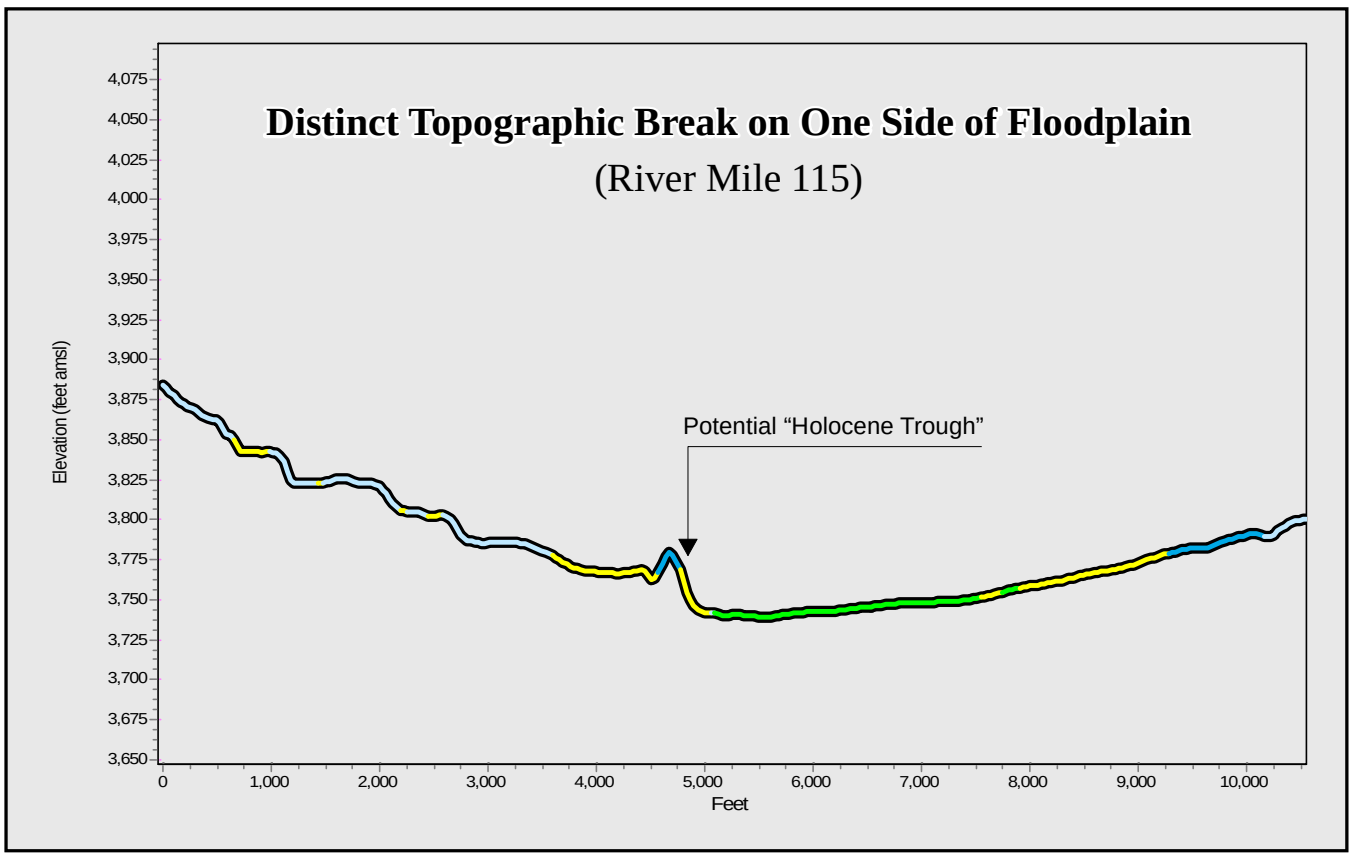
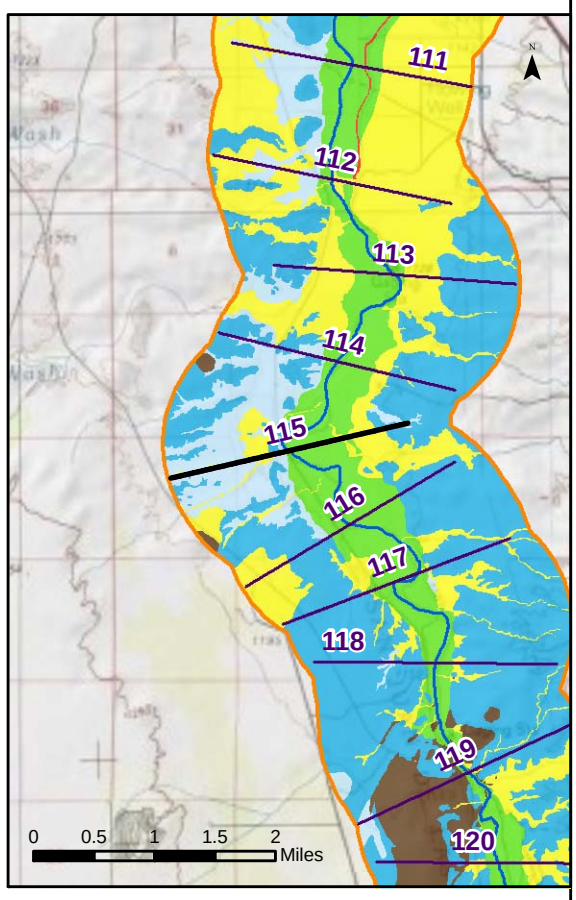
Figure 5-2
Use of Riparian Vegetation as an Indicator of Subsurface Floodplain Holocene Alluvium

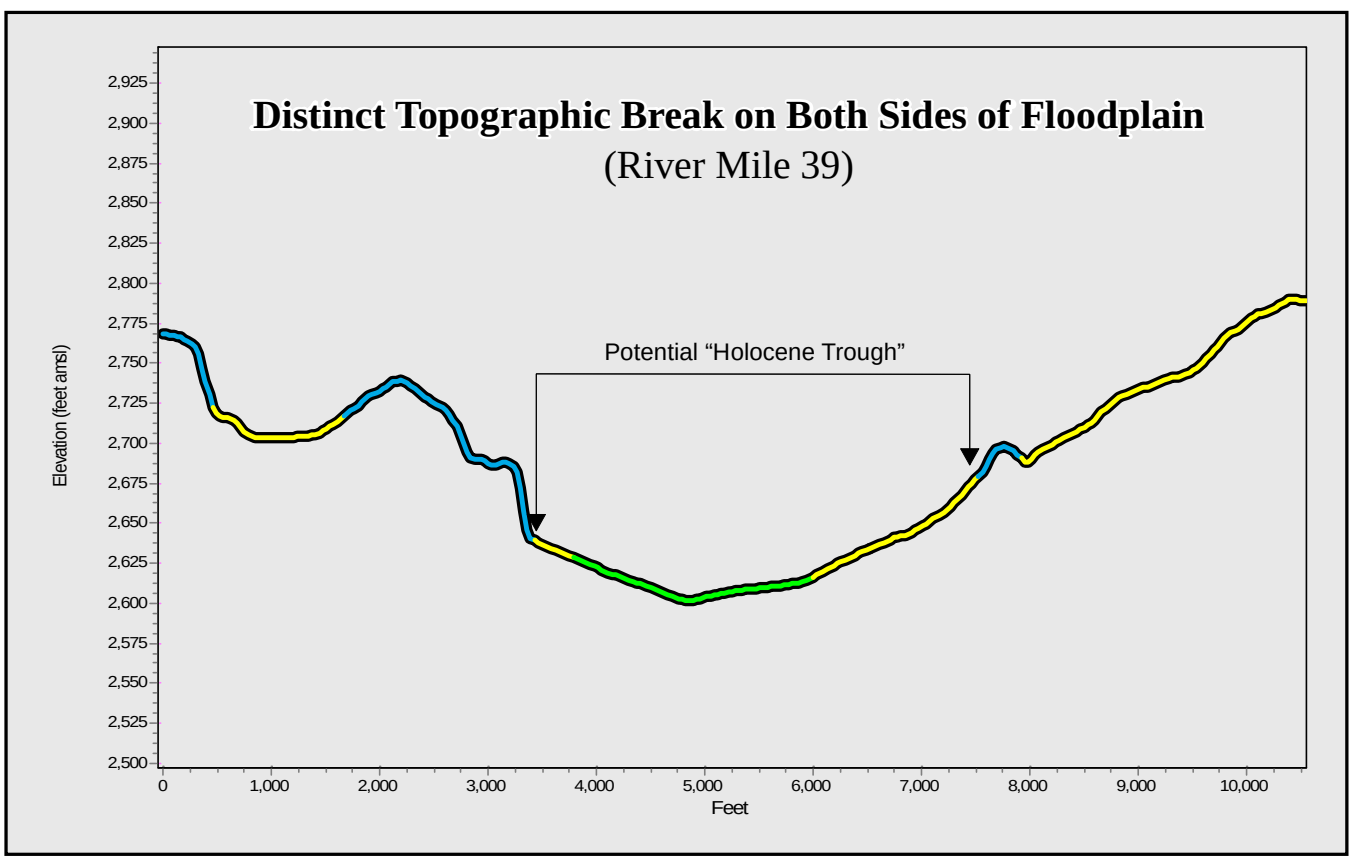
Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

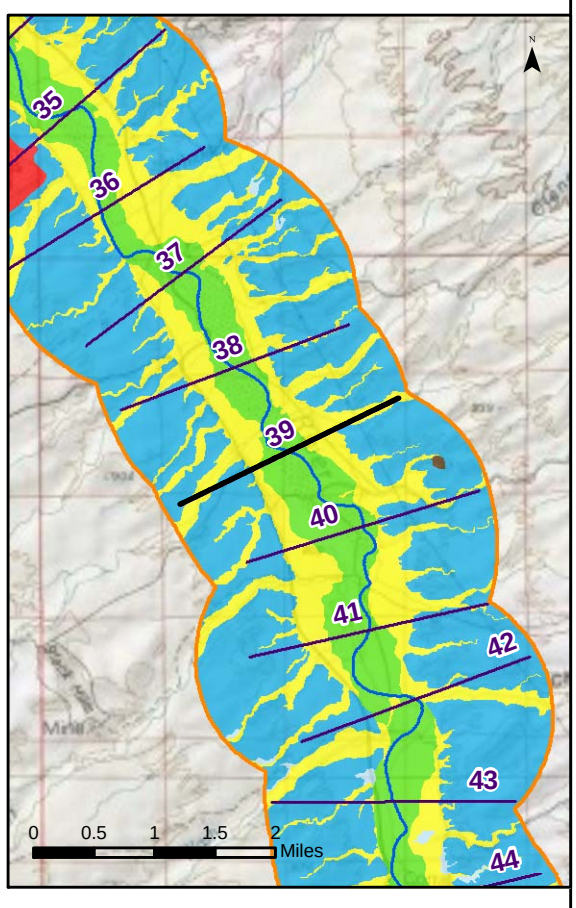


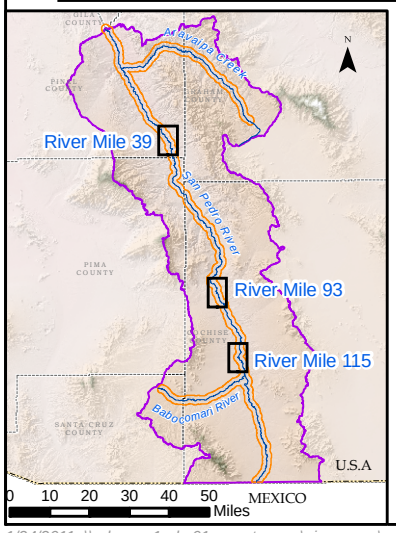












All Cross Sections at 15 X Vertical Exaggeration

Legend

Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- Major Stream and River Mile Location
- San Pedro River Watershed

Note: Appendix F includes a separate cross section along each mile of the San Pedro River (158 total)

Base Map: USGS 1:24,000 Topo

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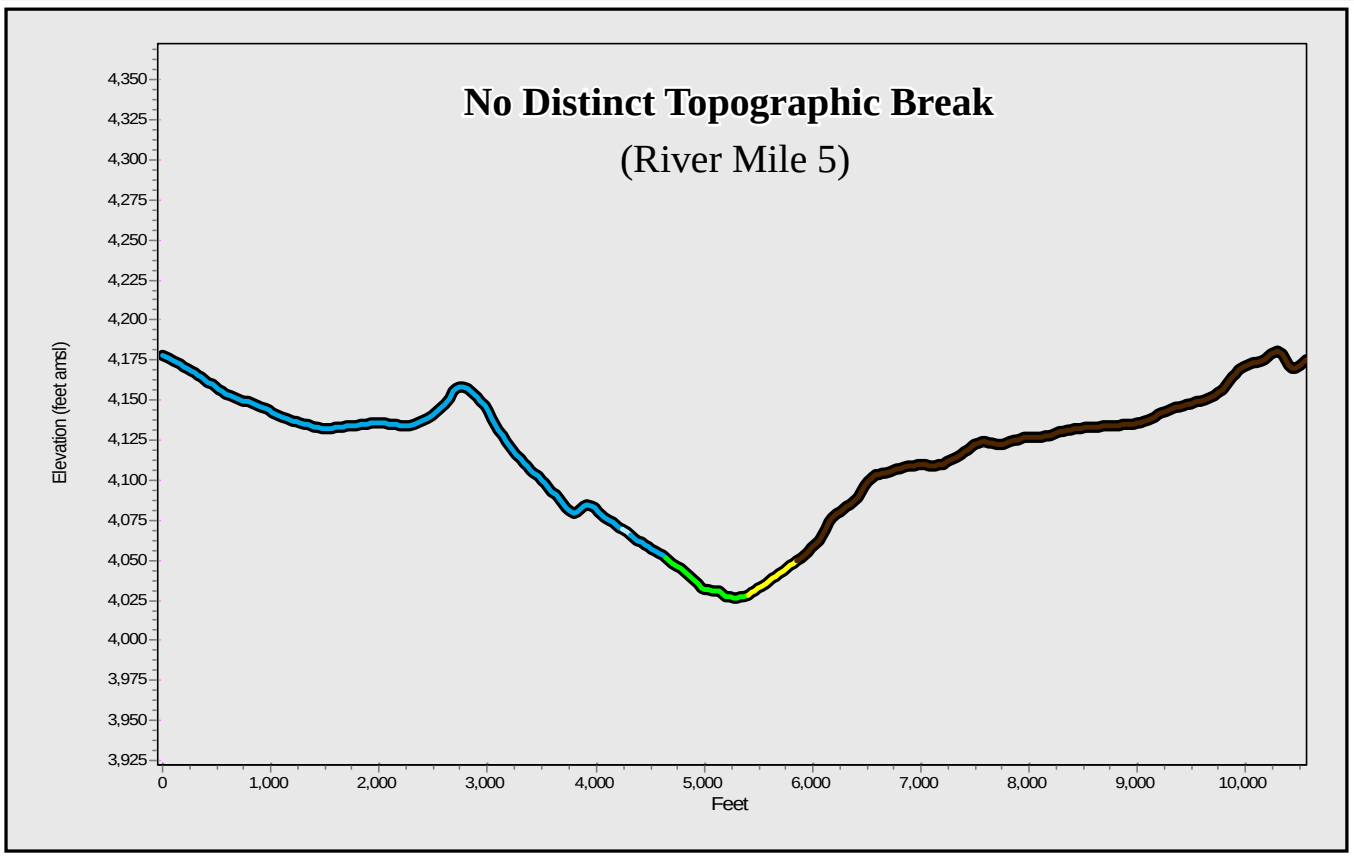
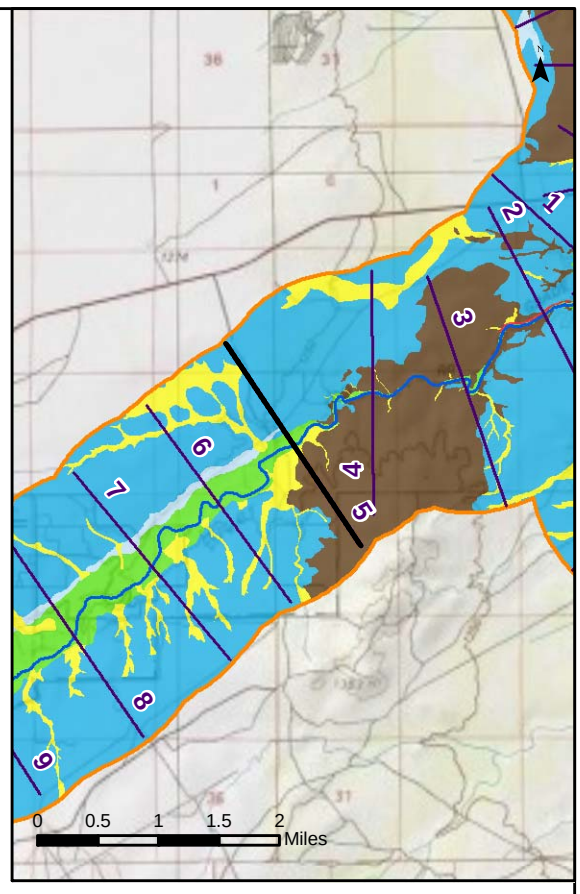
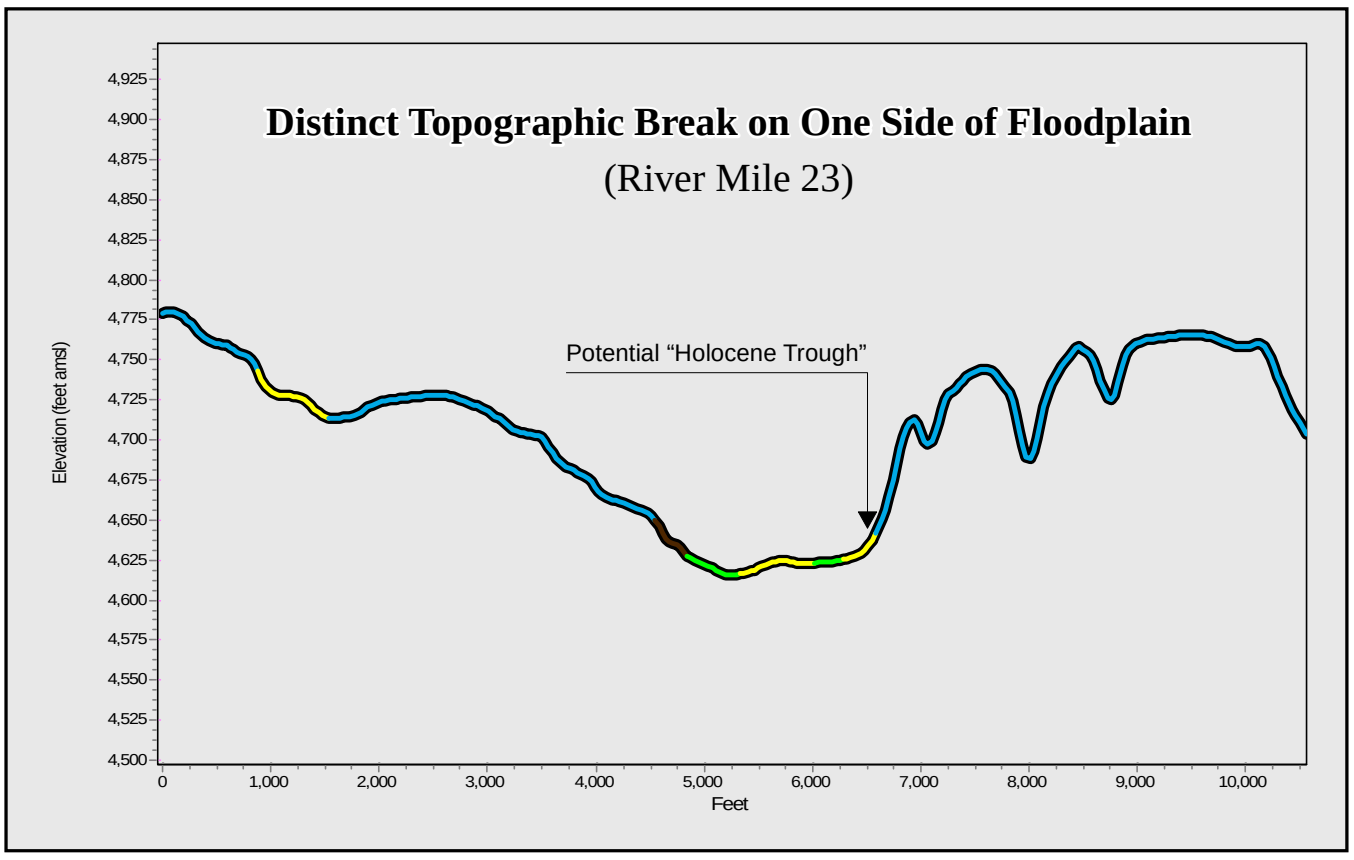
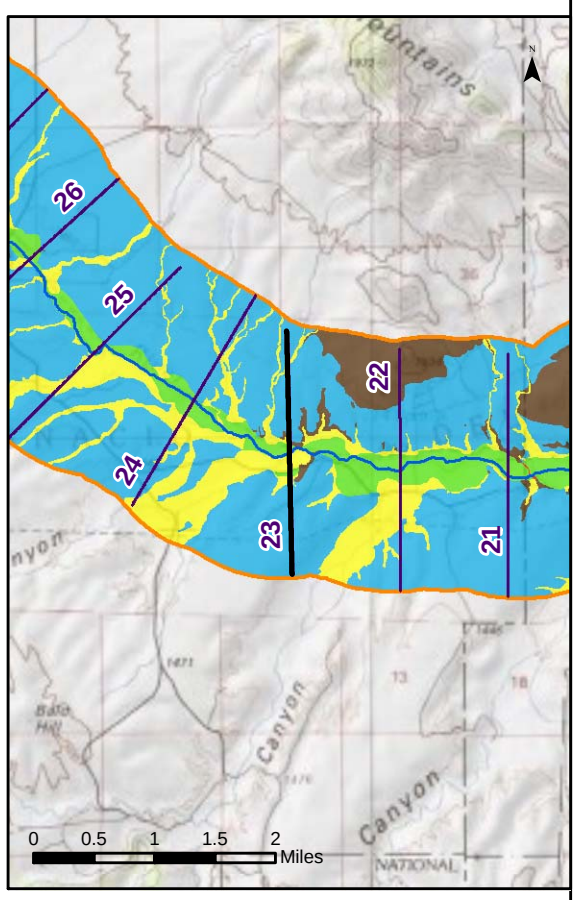
Figure 5-3a
Example Cross Sections of the San Pedro River

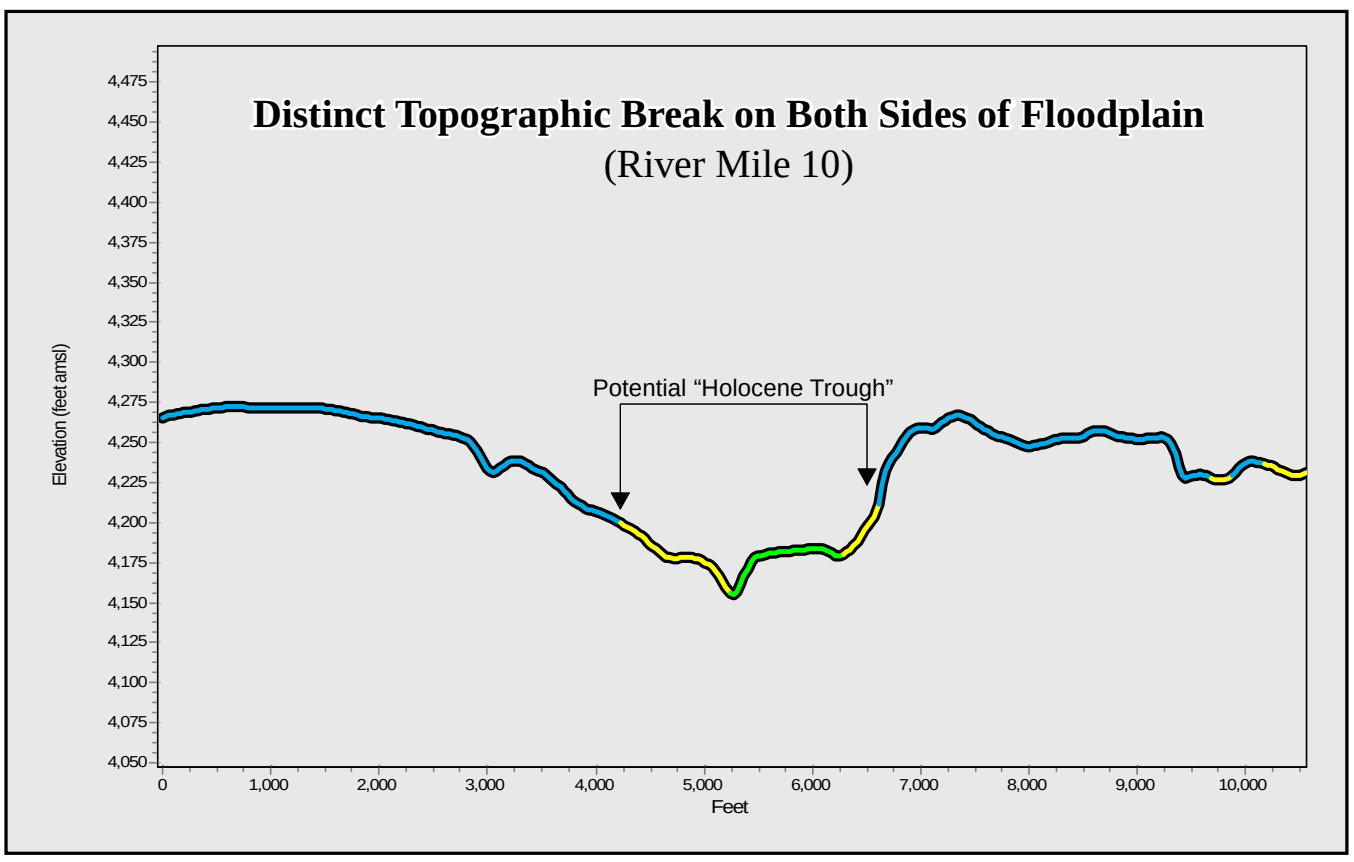
Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

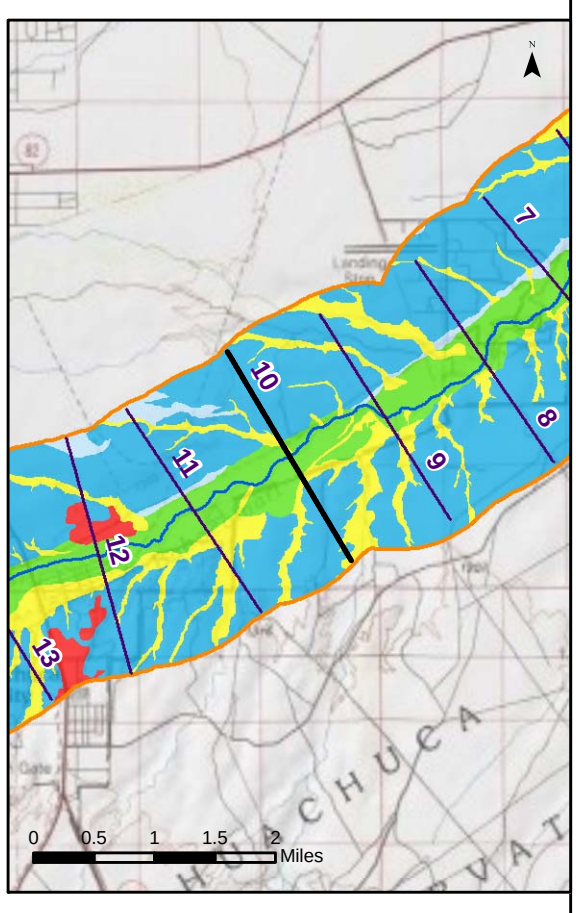


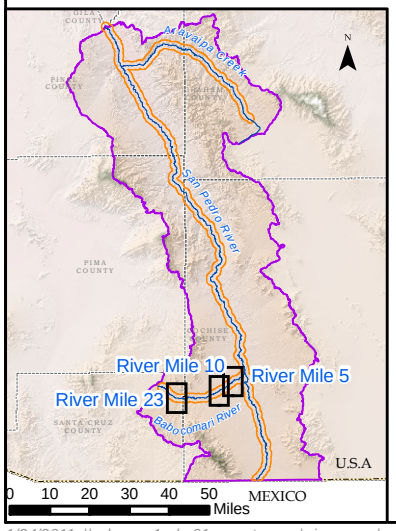












All Cross Sections at 15 X Vertical Exaggeration

Legend

Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- Major Stream and River Mile Location
- San Pedro River Watershed

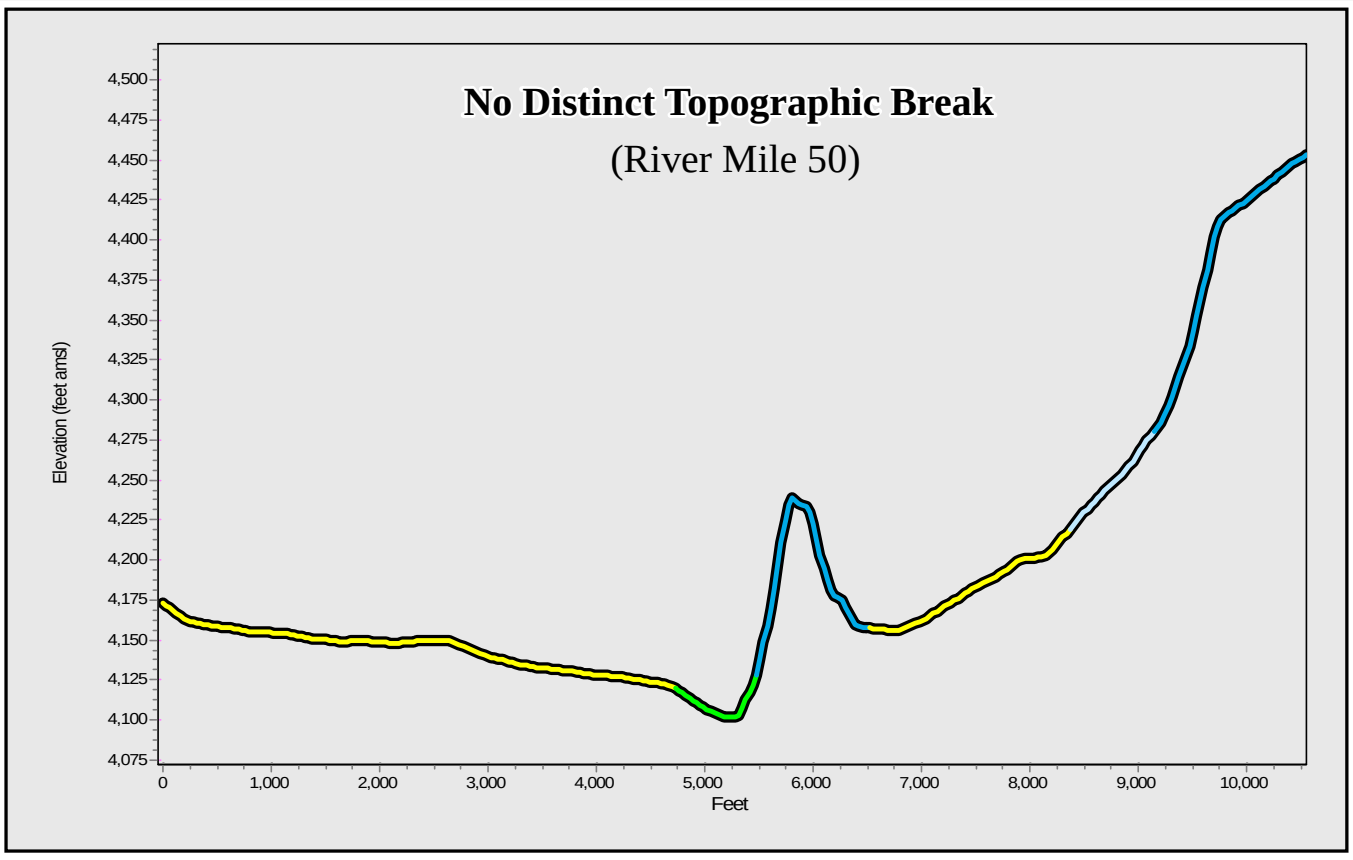
Note: Appendix F includes a separate cross section along each mile of the Babocomari River (30 total)

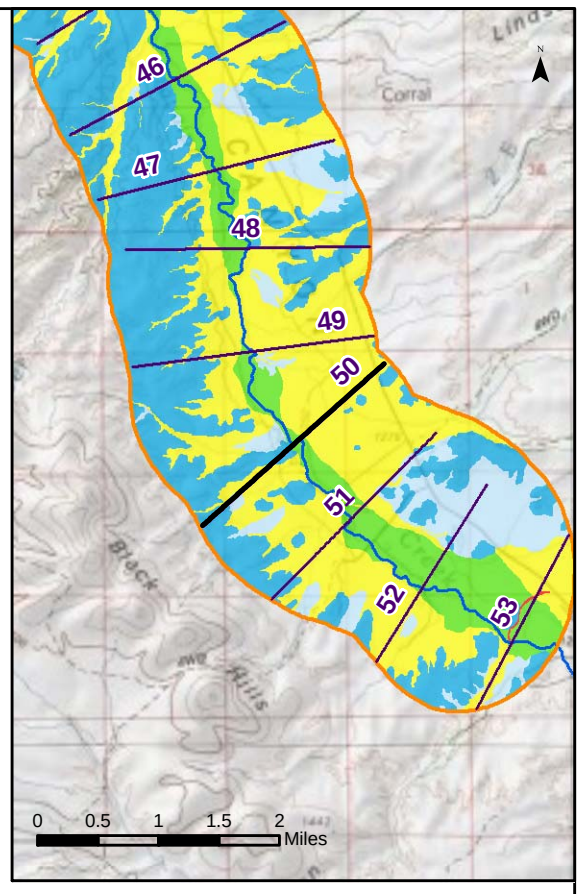
Base Map: USGS 1:24,000 Topo

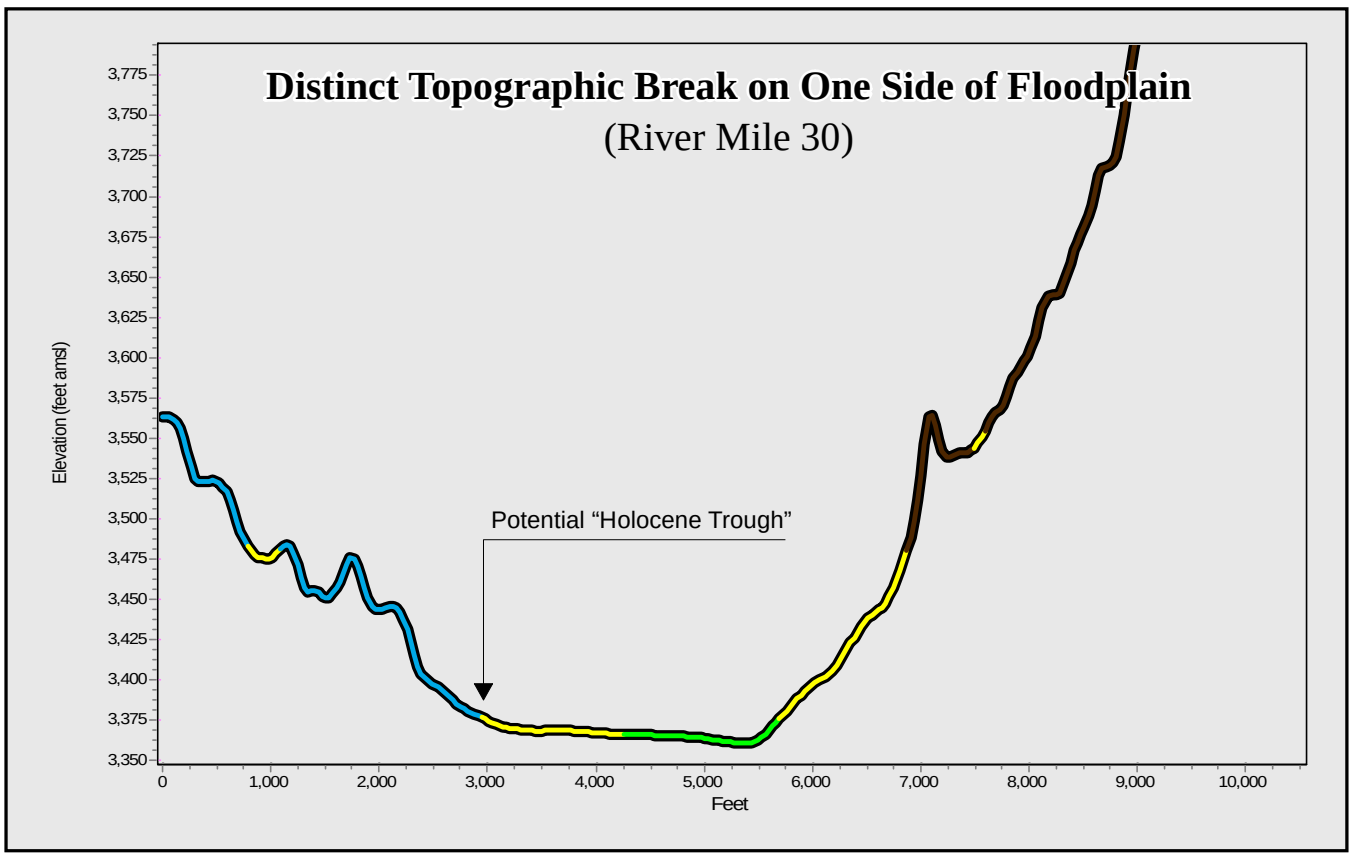
ARIZONA DEPARTMENT OF WATER RESOURCES

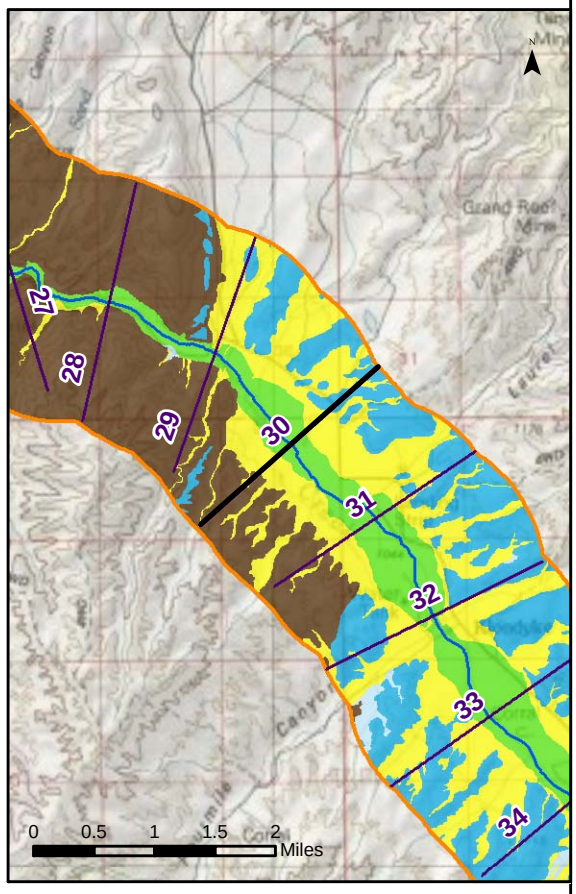
Figure 5-3b
Example Cross Sections of the Babocomari River

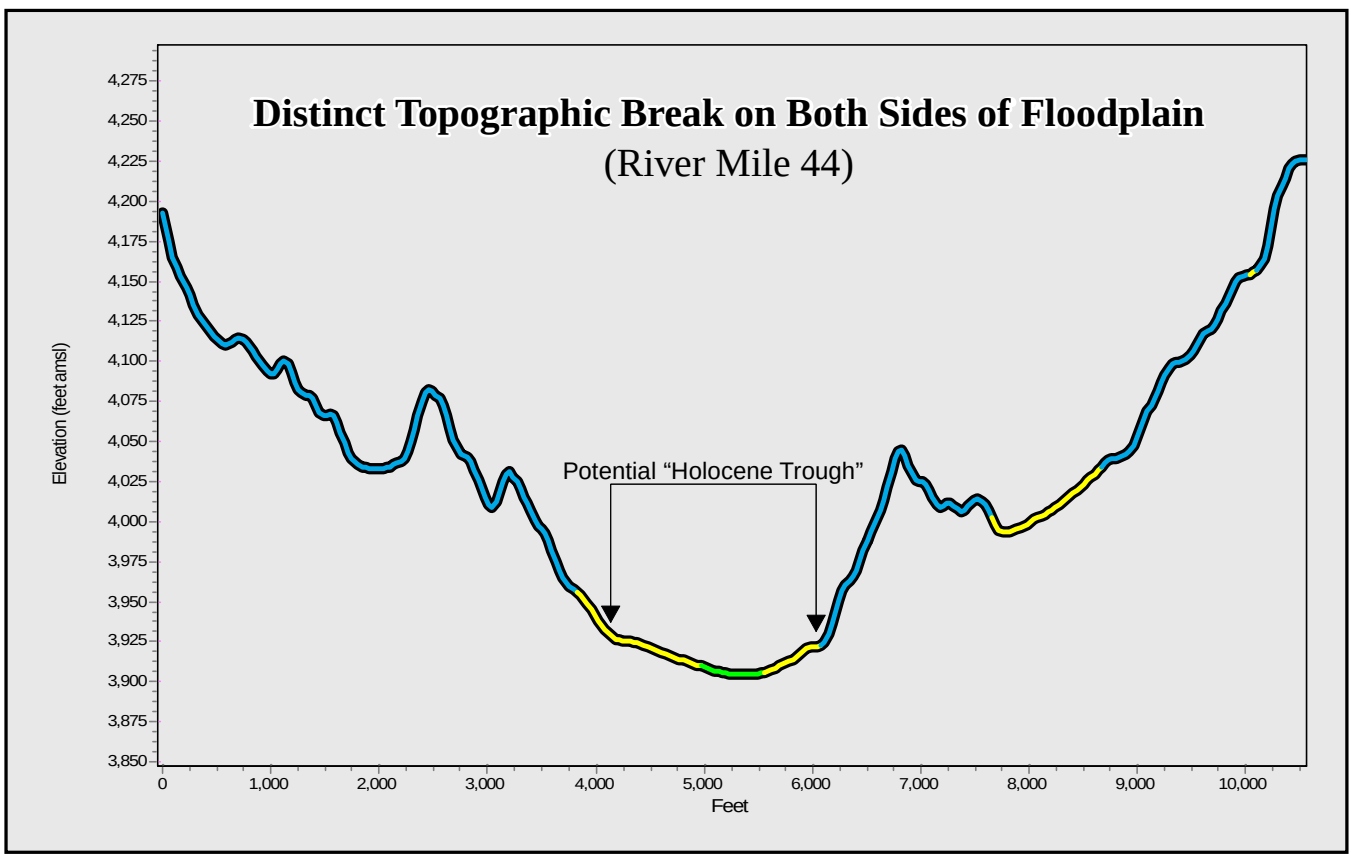
Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

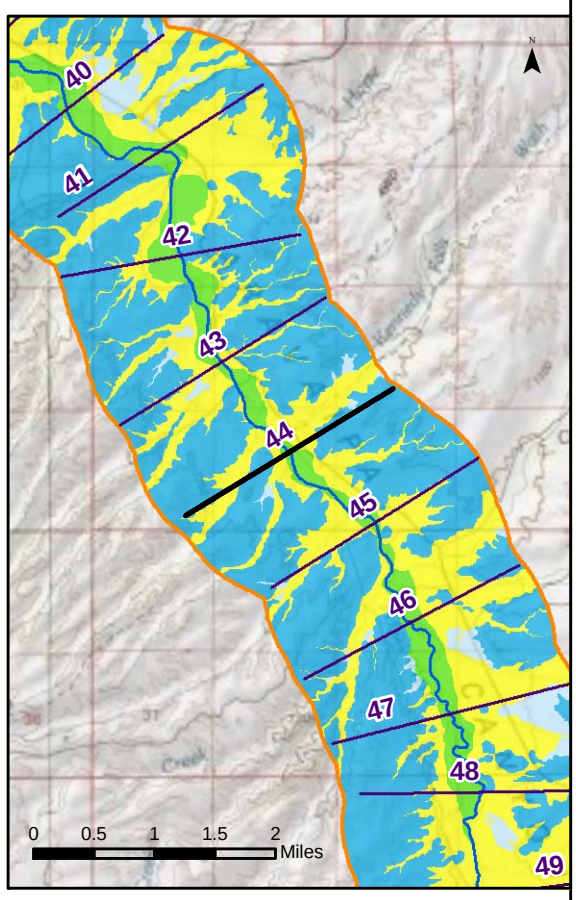


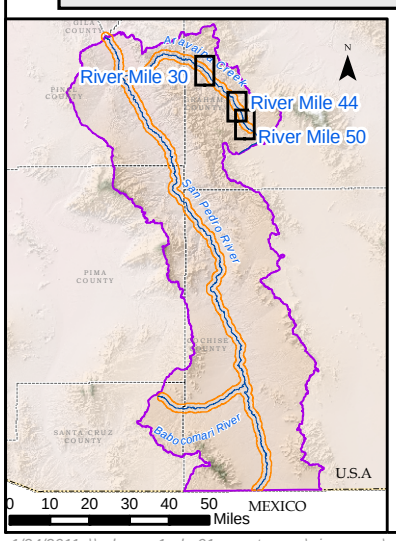












All Cross Sections at 15 X Vertical Exaggeration

Legend

Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- Major Stream and River Mile Location
- San Pedro River Watershed

Note: Appendix F includes a separate cross section along each mile of Aravaipa Creek (54 total)

Base Map: USGS 1:24,000 Topo

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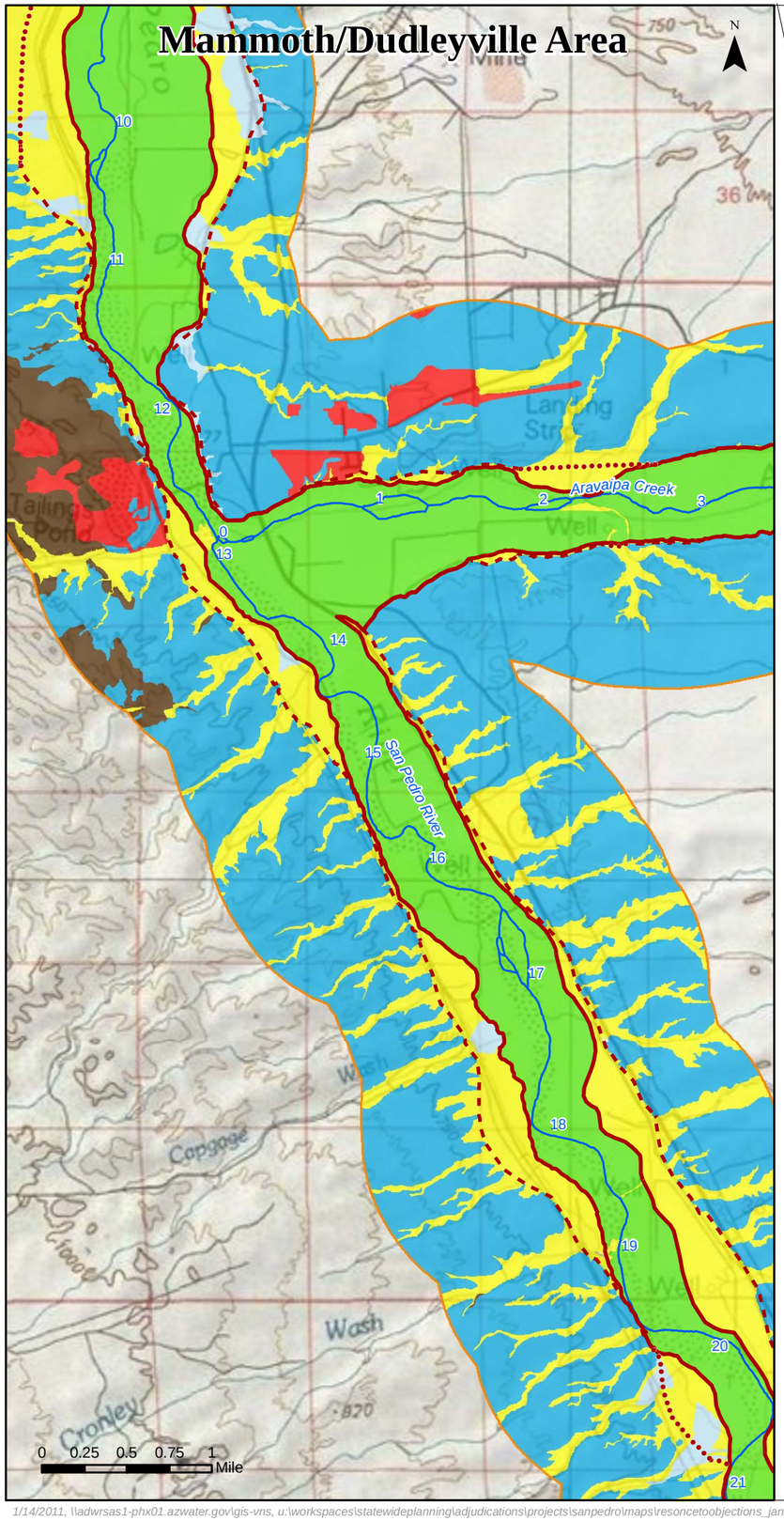
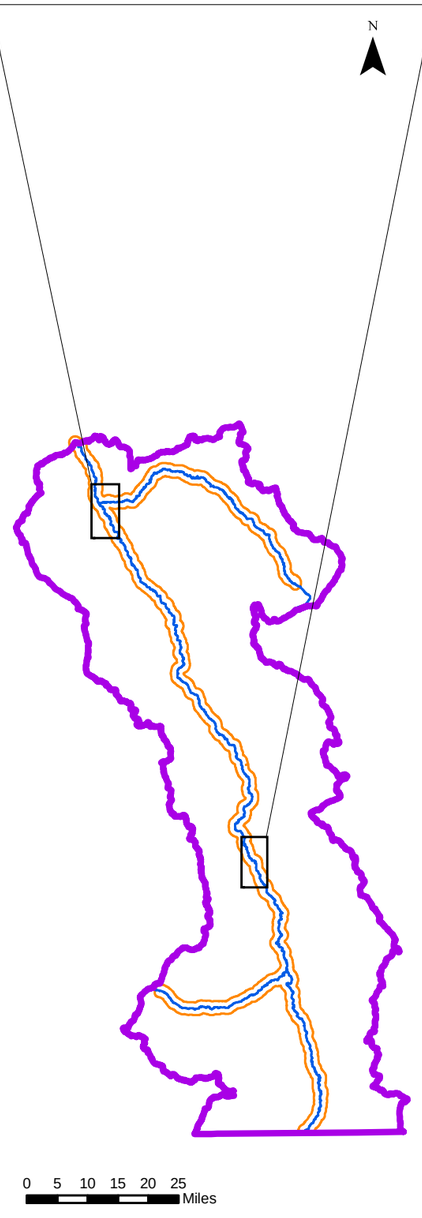
Figure 5-3c
Example Cross Sections of the Aravaipa Creek

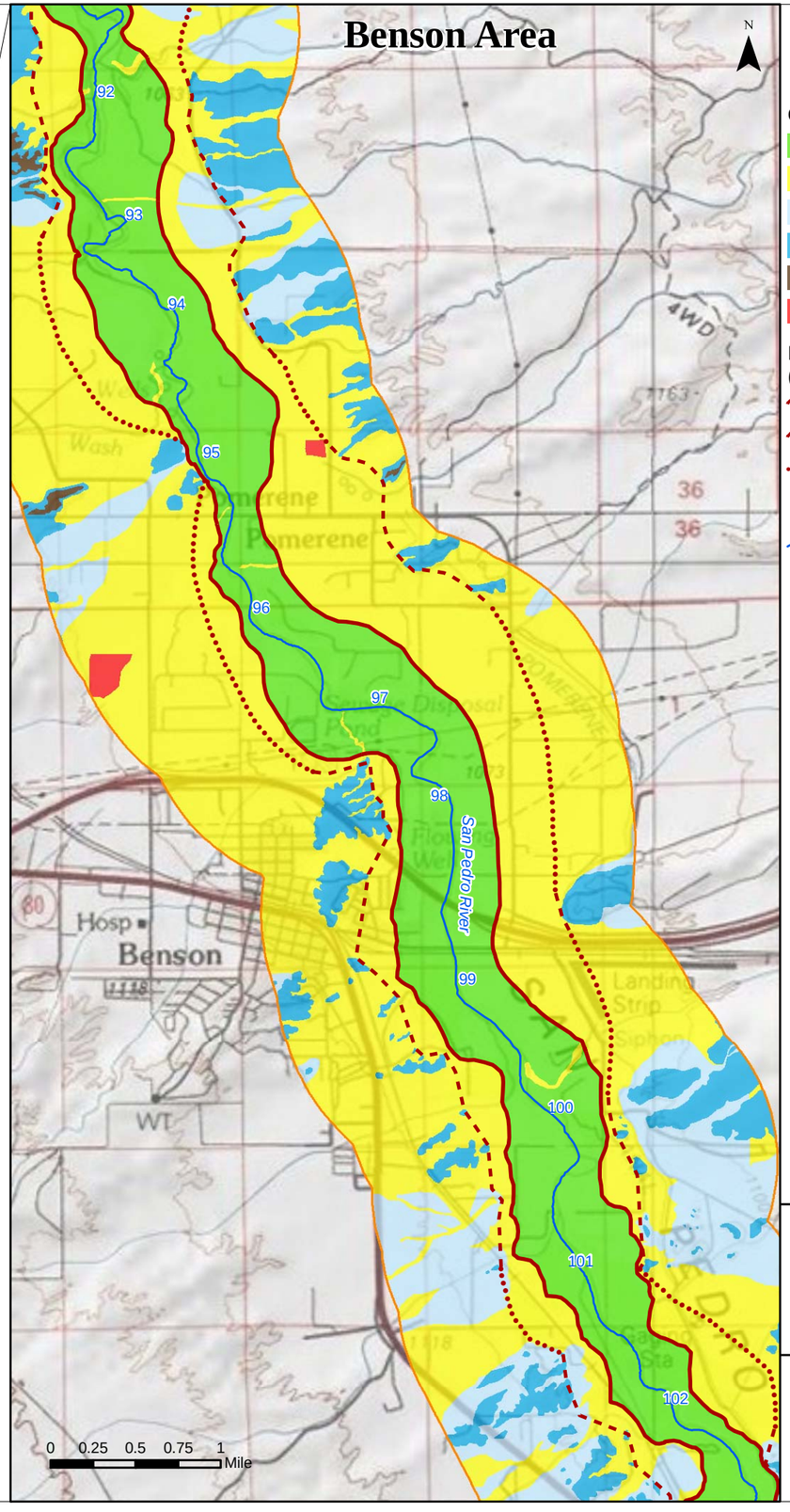
Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

Mammoth/Dudleyville Area





Benson Area



Legend

Area Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Potential Extent of FHA (Relative Levels of Confidence)

- High Confidence
- Moderate Confidence
- Low Confidence

Major Stream and River Mile Locations

San Pedro Watershed

Base Map: USGS 1:24,000 Topo

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Figure 5-4
Use of Geologic Outcrop Patterns to Map Fan Deposits Potentially Underlain by Floodplain Holocene Alluvium

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

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APPENDIX A

Court Orders

August 24, 2010

SUPERIOR COURT OF ARIZONA
MARICOPA COUNTY

08/16/2010 CLERK OF THE COURT
FORM V000

HONORABLE EDDWARD BALLINGER, JR. R.Tomlinson
Deputy

W-1, W-2, W-3, W-4(Consolidated) **COPY**

FILED: 08/24/2010

In Re the General Adjudication
of All Rights to Use Water in
The Gila River System and Source

In Re ADWR's Subflow Zone Delineation
Report for the San Pedro River Watershed

ORDER

On June 30, 2009, the Arizona Department of Water Resources ("ADWR") filed its Subflow Zone Delineation Report for the San Pedro River Watershed. The report was prepared pursuant to the Court's order dated September 28, 2005. The order provided claimants 180 days to file objections and comments to the report.

The Court has reviewed the twenty-six objections and comments filed. The papers filed by ASARCO LLC, Freeport-McMoRan Corporation, Salt River Project, Bella Vista Water Co., Inc., Pueblo Del Sol Water Company, and the City of Sierra Vista (collectively, the "Sierra Vista Parties"), The Nature Conservancy, and the United States present substantive legal and technical issues. The Court will hear these objections and comments in a hearing to be held on **March 15, 2011, at 2:30 p.m.** before:

The Honorable Eddward P. Ballinger, Jr.
Superior Court of Arizona
Juvenile Court Center - Durango Facility
3131 West Durango, Courtroom 6
Phoenix, AZ 85009-6292
602.506.8551

IT IS ORDERED that the affidavits or sworn declarations of expert witnesses submitted with the objections and comments of the foregoing parties shall be considered

to be direct testimony. At the hearing, the testimony of the affiants and of the representatives of ADWR shall be limited to cross-examination except for new information in response to ADWR's report due on December 31, 2010.

IT IS FURTHER ORDERED directing ADWR to submit a report on or before **December 31, 2010**, identifying the objections or comments of the foregoing parties with which ADWR agrees or does not take issue and providing information in response to a specific objection or comment.

IT IS FURTHER ORDERED referring to the Special Master the task of proceeding in the best manner to organize and determine the remaining objections and comments.

A. Proceedings before the Special Master may include consideration of disclosures and discovery, including matters arising under Arizona Rules of Civil Procedure 26 and 26.1, briefing of issues, and conducting hearings and conferences. The Special Master is empowered with all the powers enumerated in Arizona Rule of Civil Procedure 53.

B. The Special Master shall submit findings of fact, conclusions of law, and recommendations in a report to the Court (the "Special Master's Report").

C. Objections and comments to the Special Master's Report may be filed within seventy-five (75) days after the report is filed with the Court. Responses to objections and comments shall be filed within sixty (60) days thereafter, with replies to be filed not later than forty (40) days after the response due date. Filing times are exclusive of the additional period authorized by Arizona Rule of Civil Procedure 6(e).

IT IS FURTHER ORDERED signing this entry as an order of the Court.

/s/ Eddward P. Ballinger, Jr.
EDDWARD P. BALLINGER, JR.
Judge of the Superior Court

A copy of this order is mailed to all parties on the Court approved mailing list for the Gila River Adjudication, W-1, W-2, W-3, W-4 (Consolidated), dated July 29, 2010.

December 8, 2010

SUPERIOR COURT OF ARIZONA
MARICOPA COUNTY

12/07/2010 CLERK OF THE COURT
FORM V000

HONORABLE EDDWARD BALLINGER, JR. R.Tomlinson
Deputy

W-1, W-2, W-3, W-4(Consolidated)

Contested Case No. W1-103

FILED: 12/08/2010

In Re: The General Adjudication
of All Rights to Use Water in
The Gila River System and Source

In Re: Arizona Department of Water Resources'
Request for Additional Time

MINUTE ENTRY

After reviewing the Arizona Department of Water Resources' ("ADWR" or the "Department") request for additional time to file its responses to the comments and objections filed with respect to the Department's Subflow Zone Delineation Report for the San Pedro River Watershed ("SP Subflow Report"), the Court finds good cause exists to grant the requested relief.

Accordingly,

IT IS ORDERED granting ADWR until **January 31, 2011**, to file it responses to comments and objections filed with respect to the SP Subflow Report.

IT IS FURTHER ORDERED that in addition to the comments and objections listed in the Court's August 24, 2010 order, the Court will consider the comments filed by the Gila River Indian Community at the hearing to be held on March 15, 2011.

A copy of this order is mailed to all parties on the Court-approved mailing list for the Gila River Adjudication, W-1, W-2, W-3, W-4 (Consolidated), dated July 29, 2010.

December 20, 2010

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA
IN AND FOR THE COUNTY OF MARICOPA

IN CHAMBERS (X) IN OPEN COURT ( )

SPECIAL MASTER GEORGE A. SCHADE, JR.
Presiding

IN RE THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE

DATE: December 20, 2010

CIVIL NO. W1-103

MINUTE ENTRY AND ORDER FOLLOWING THE CONFERENCE HELD ON DECEMBER 14, 2010

CONTESTED CASE NAME: *In re Subflow Technical Report, San Pedro River Watershed*.

HSR INVOLVED: None.

DESCRIPTIVE SUMMARY: The Special Master provides an opportunity for the objectors to supplement their objections on or before January 31, 2011, grants the motion of the San Carlos Apache Tribe to intervene, and adds several parties to the Court approved mailing list of this contested case.

NUMBER OF PAGES: 5.

DATE OF FILING: December 20, 2010.

The Special Master held a conference on December 14, 2010, in Sierra Vista, Arizona. After considering comments and motions, the Special Master enters this order.

I. MINUTE ENTRY: ATTENDANCE AND DISCUSSION

The following attorneys attended the conference in person or by telephone: Gregory L. Adams representing ASARCO LLC; Harlan C. Agnew representing Pima County, Arizona; William H. Anger representing the Cities of Avondale, Chandler, Glendale, Mesa, and Scottsdale; David A. Brown representing various claimants; Charles L. Cahoy representing the City of Tempe; M. James Callahan representing the City of

Phoenix; Stephen C. Cann representing The Nature Conservancy; Cynthia M. Chandley representing Freeport-McMoRan Corporation; Theresa M. Craig representing the Arizona Attorney General's Office; Susan B. Montgomery representing the Pascua Yaqui Tribe and Yavapai-Apache Nation; Margaret B. LaBianca representing BHP Copper Inc.; R. Lee Leininger representing the United States; Mark A. McGinnis and Patrick B. Sigl representing the Salt River Project; Thomas L. Murphy representing the Gila River Indian Community; Joe P. Sparks and Laurel A. Hermann representing the San Carlos Apache Tribe and Tonto Apache Tribe; Lee A. Storey representing the City of Flagstaff; and William P. Sullivan representing the Bella Vista Water Company, Inc., Pueblo Del Sol Water Company, and City of Sierra Vista. Court reporter Denise R. Vaishville attended.

At the beginning of the conference, none of the objectors whose objections were referred to the Special Master were in attendance. Messrs. Agnew, Anger, and Brown, and Mss. LaBianca, Montgomery, and Storey requested to be placed on the Court approved mailing list of this case. The Special Master stated that the requests would be granted, but without a motion to intervene, placement on the mailing list will not grant these parties the status of intervenors. The Special Master stated that the motion of the San Carlos Apache Tribe to intervene would be granted.

Messrs. Adams, McGinnis, Sparks, and Sullivan discussed with the Special Master ways to proceed in this case. It was argued that the current contents of the objections will not facilitate meaningful or substantive briefing.

After the conference was adjourned, it was learned that objector Ms. Carmen J. Miller had arrived late and was present. The conference was resumed on the record. Ms. Miller explained procedural aspects of the objections she filed. The Special Master informed her that all the objectors would be given the opportunity to supplement their objections, and thereafter, the Special Master would determine the merits of the objections as they relate to this phase of the case.

II. ORDER

On August 24, 2010, Judge Eddward P. Ballinger, Jr. referred to the Special Master the task of proceeding in the best manner to organize and determine the twenty objections Richard Donahue, Howard L. Judd, Paul B. Kartchner, Quentin H. Miller and Carmen J. Miller, Marsha L. Thompson, Kevin J. Trejo, and George L. White and Richard B. White filed to the Subflow Zone Delineation Report for the San Pedro River Watershed (June 2009) prepared by the Arizona Department of Water Resources ("ADWR").

On July 16, 2004, the Special Master filed his report concerning the initial phase of this contested case. The report recommended the implementation of a schedule of action. Recommendation No. 36 set the schedule as follows:

> The Court should implement the following schedule in the San Pedro River Watershed:
>
> A. After the Court considers the Special Master's report recommending the procedures and processes to delineate the subflow zone within the San Pedro River Watershed and a cone of depression test,

ADWR is directed to prepare a map delineating the subflow zone for the entire San Pedro River Watershed. ADWR shall submit this map and related information in a technical report whose scope shall be limited to delineating the subflow zone and shall not set forth ADWR's proposed water right attributes for any individual water right claim or use.

B. Upon filing the technical report with the Court, ADWR shall send a notice to all claimants in the San Pedro River Watershed and to the persons listed in the Gila River Adjudication Court-Approved Mailing List informing them of the scope and availability of the report and of a claimant's right to file written objections to the report and of the deadline for filing objections.

C. Any claimant in the San Pedro River Watershed may file objections to ADWR's technical report within one hundred and twenty days [modified by Judge Ballinger to 180 days] of the date on which the report is filed. **Objections shall be limited to ADWR's findings regarding the lateral extent of the subflow zone** (emphasis added).

D. After considering the objections, the Court will approve a map that delineates the subflow zone within the San Pedro River Watershed.

E. Using the cone of depression test adopted by the Court, ADWR will analyze all wells located outside the lateral limits of the subflow zone to determine if a well's cone of depression reaches an adjacent subflow zone, and if continuing pumping will cause a loss of such subflow as to affect the quantity of the stream. ADWR will examine all water right claims to determine *de minimis* water rights in the San Pedro River Watershed in accordance with the Court's September 26, 2002, order. ADWR will investigate and supplement, as needed, its findings reported in the Final San Pedro River Watershed HSR.

F. ADWR will publish a Supplemental Final San Pedro River Watershed HSR reporting its findings and proposed water right attributes on a claim by claim basis, in accordance with A.R.S. § 45-256(B), including wells withdrawing subflow, cone of depression analyses, *de minimis* water rights, and all other new or updated information.

G. ADWR shall send a notice of the filing of the Supplemental Final San Pedro River Watershed HSR to all claimants in the Gila River Adjudication, who may file objections within one hundred and eighty days of the date on which the report was filed.[1]

In his order dated September 28, 2005, Judge Ballinger considered Recommendation No. 36 and ruled in pertinent part as follows:

---

[1] Rept. of the Special Master on ADWR's Subflow Technical Report, San Pedro River Watershed at 97-8 (July 16, 2004). The report is available at http://www.superiorcourt.maricopa.gov/SuperiorCourt/Adjudications/_schade/W1-103FinalRep071604.pdf.

> The Court does not challenge the Special Master's analysis of the applicable statutory authority governing the filing of objections, but it will accommodate the desire of claimants requesting a one hundred eighty (180) day period for report. The Court agrees with the remainder of the Special Master's recommendations regarding the implementation of procedures.[2]

Judge Ballinger "approved and adopted [Recommendation No. 36] to the extent consistent with" his order.[3] The only modification to Recommendation No. 36 that he adopted was enlarging the time in section C to file objections from 120 to 180 days.

ADWR's Subflow Zone Delineation Report (2009) describes this schedule in Chapter 1: Introduction, Section 1.4 Notice and Objections, on page 1-7.

The Special Master has reviewed the objections. He stated in his order setting the conference held on December 14, 2010, as follows:

> "The majority describe existing wells, some history, and current or planned water uses. Many do not provide supporting technical information. Several objections describe the artesian nature of a well or wells. One objection may be outside the scope of this phase of this case."[4]

The Special Master finds that the contents of the objections referred to him do not address "ADWR's findings regarding the lateral extent of the subflow zone." Some counsel at the conference expressed this position.

The Special Master stated that the objectors would be allowed an opportunity to supplement their objections in order to comply with the requisite scope of objections in this phase. The Special Master points out to the objectors that they will have an opportunity at a future time to file objections that relate to the water right attributes of their wells. We are proceeding through section C of Recommendation No. 36. Reference is again made to sections F and G that provide as follows:

> F. ADWR will publish a Supplemental Final San Pedro River Watershed HSR reporting its findings and proposed water right attributes on a claim by claim basis, in accordance with A.R.S. § 45-256(B), including wells withdrawing subflow, cone of depression analyses, *de minimis* water rights, and all other new or updated information.
>
> G. ADWR shall send a notice of the filing of the Supplemental Final San Pedro River Watershed HSR to all claimants in the Gila River Adjudication, who may file objections within one hundred and eighty days of the date on which the report was filed.

---

2 Order at 40-1 (Sept. 28, 2005). The order is available at http://www.superiorcourt.maricopa.gov/SuperiorCourt/Adjudications/_ballinger/Subfloword92805.pdf.

3 *Id*. at 42.

4 Special Master's Order at 2 (Sept. 3, 2010). Its text is available at http://www.superiorcourt.maricopa.gov/SuperiorCourt/Adjudications/_schade/W1-103ord090310.pdf.

IT IS ORDERED:

1. Allowing objectors Richard Donahue, Howard L. Judd, Paul B. Kartchner, Quentin H. Miller and Carmen J. Miller, Marsha L. Thompson, Kevin J. Trejo, and George L. White and Richard B. White the opportunity to supplement and file their objections on or before **Monday, January 31, 2011**. Objections shall be limited to ADWR's findings regarding the lateral extent of the subflow zone. Supplements shall be filed with the Clerk of the Maricopa County Superior Court. Thereafter, the Special Master will determine whether to hear, grant, or dismiss the objections.

2. Granting the motion of the San Carlos Apache Tribe to intervene.

3. Granting the requests of Arizona Public Service Company, BHP Copper Inc., Cities of Chandler, Flagstaff, Glendale, Mesa, and Scottsdale, Pascua Yaqui Tribe, Pima County, Arizona, Yavapai-Apache Nation, and the various claimants represented by Brown & Brown Law Offices, P.C. to be added to the Court approved mailing list of this case. An updated mailing list will be posted on the Special Master's web site at http://www.superiorcourt.maricopa.gov/SuperiorCourt/Adjudications/.

Absent a granted request to intervene, placement of a party on the mailing list does not grant the status of an intervenor. The placement entitles these parties to receive copies of documents filed with the Clerk of the Maricopa County Superior Court and other documents that may be distributed by means of the mailing list. All parties shall use the mailing list to distribute copies of any documents they file in this case. And,

4. Mr. Harlan C. Agnew and Mr. Stephen C. Cann shall be added to the Court approved mailing list used for the proceeding before Judge Ballinger.

DATED: December 20, 2010.

/s/ George A. Schade, Jr.
GEORGE A. SCHADE, JR.
Special Master

On December 20, 2010, the original of the foregoing was delivered to the Clerk of the Maricopa County Superior Court for filing and distributing a copy to all persons listed on the Court approved mailing list for Contested Case No. W1-103 dated September 3, 2010, and all parties named in this minute entry and order.

/s/ George A. Schade, Jr.
George A. Schade, Jr.

APPENDIX B

Comments and Objections

ASARCO

RECEIVED
DEC 28 2009
LEGAL
DEPT OF WATER RESOURCES

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Attorneys for ASARCO LLC

SUPERIOR COURT OF ARIZONA

MARICOPA COUNTY

IN RE THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE	Civil Nos. W-1, W-2, W-3 and W-4 Contested Case No. W1-103 **ASARCO LLC'S OBJECTIONS TO THE ARIZONA DEPARTMENT OF WATER RESOURCES' SUBFLOW ZONE DELINEATION REPORT FOR THE SAN PEDRO RIVER WATERSHED DATED JUNE 30, 2009** (Assigned to the Hon. Eddward P. Ballinger, Jr.)

DESCRIPTIVE SUMMARY: ASARCO LLC files its objections to the Arizona Department of Water Resources' Subflow Zone Delineation Report for the San Pedro Rive Watershed dated June 30, 2009.

STATEMENT OF CLAIMANT NUMBERS: ASARCO LLC – Nos. 39-U8-62699 et al.

NUMBER OF PAGES: 16

DATE OF FILING: December 23, 2009

ASARCO LLC ("ASARCO") hereby objects to the Arizona Department of Water Resources' Subflow Zone Delineation Report for the San Pedro River Watershed, dated June 30, 2009 ("Subflow Report"). The Subflow Report fails to satisfy the standards established by *In re General Adjudication of All Rights to Use Water in Gila River Sys. & Source*, 198 Ariz. 330, 9 P.3d 1069 (2000), *cert denied*, 533 U.S. 941 (2001) ("*Gila IV*"), and must be rejected.

I. BACKGROUND

A. The Department's Subflow Report

The Supreme Court affirmed "in all respects" the Superior Court's Order (July 6, 1994) ("1994 Order") establishing criteria to determine whether underground water is appropriable as "subflow." *Gila IV*, 198 Ariz. at 344 ¶ 48, 9 P.3d at 1083. Following the Supreme Court's decision, this Court directed the Department of Water Resources ("Department") to prepare a report "identifying and describing the procedures and processes it proposes to use to establish the limits of the subflow zone within the San Pedro River watershed." Minute Entry at 1 (filed Jan. 22, 2002) ("January 22, 2002 Minute Entry"). The Department issued that report on March 22, 2002. *See* Subflow Technical Report San Pedro River Watershed (March 22, 2002) ("2002 Report").

The approach proposed in the 2002 Report deviated from the Supreme Court's directives.[1] ASARCO and other claimants objected to the Department's 2002 Report, and briefed issues regarding the Department's proposed procedures before the Special Master and this Court. *See* Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed; Motion for Approval

[1] The Supreme Court's directives are discussed in detail *infra* at II.A. The Department proposed to proceed with an assumption that the entire lateral extent of the floodplain Holocene alluvium is saturated, 2002 Report at 17; it proposed to use "predevelopment conditions" to determine the subflow zone, 2002 Report at 5-7; and it proposed to assume that the relevant *Gila IV* factors are subsumed within the scope of the lateral extent of the saturated floodplain Holocene alluvium, 2002 Report at 17.

of Report; and Notice of Subsequent Proceedings (July 16, 2004); Order Re: Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed and Motion for Approval of Report at 41-42 (Sept. 28, 2005) ("2005 Order"). ASARCO argued before the Special Master and this Court that the Department must adhere to all the Supreme Court's directives enumerated in *Gila IV* for delineating the subflow zone.[2] This Court, however, approved, and directed the Department to proceed with, the use of assumptions and procedures that are inconsistent with *Gila IV*. *See infra* at II.A., II.B., II.C.; *see also* 2005 Order at 8-24.

This Court directed the Department to prepare a technical report delineating the subflow zone for the San Pedro Watershed. *See* 2005 Order at 41-42. The 2005 Order authorized claimants to object to and comment on the Department's Subflow Report within 180 days of the filing of that Report. *Id.* at 42. The Department filed the Subflow Report on June 30, 2009.

ASARCO disagrees with this Court's determinations in the 2005 Order. This Court's instructions to the Department resulted in a report that does not comply with the Supreme Court's directives regarding subflow. ASARCO restates many of the arguments it made previously before this Court to ensure that those arguments are preserved for appeal.

B. Legal Principles Governing the Determination of Subflow

Underground waters are presumed to be percolating and, therefore, not subject to appropriation. *See Maricopa County Mun. Water Conservation Dist. v. Southwest Cotton Co.*, 39 Ariz. 65, 85, 4 P.2d 369, 376 (1931) ("*Southwest Cotton*"); *In re General*

[2] *See* ASARCO Incorporated's and Arizona Water Company's Objections to the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed (June 17, 2002); ASARCO Incorporated's and Arizona Water Company's and Tucson Electric Power Company's Supplemental Brief on Subflow-Related Issues (March 3, 2004); Objections of ASARCO Incorporated and Arizona Water Company to the Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed; Motion for Approval of Report; and Notice of Subsequent Proceedings (Oct. 1, 2004).

Adjudication of All Rights to Use Water in Gila River Sys. & Source, 175 Ariz. 382, 392, 857 P.2d 1236, 1246 (1993) ("*Gila II*"); *Gila IV*, 198 Ariz. at 335 ¶ 6, 9 P.3d at 1074. Subflow is a "narrow concept," *Gila II*, 175 Ariz. at 393, 857 P.2d at 1247, generally defined as "'those waters which slowly find their way through the sand and gravel constituting the bed of the stream, or the lands under or immediately adjacent to the stream, and are themselves a part of the surface stream.'" *Gila IV*, 198 Ariz. at 334 ¶ 4, 9 P.3d at 1073 (citing *Southwest Cotton*, 39 Ariz. at 96, 4 P.3d at 380).

One who asserts that underground water is part of a stream's subflow must prove that fact by clear and convincing evidence. *Gila IV*, 198 Ariz. at 335 ¶ 6, 9 P.3d at 1074. The Department's "determination that a well is pumping appropriable subflow constitutes clear and convincing evidence." *Id.* The Supreme Court, recognizing the significance of the Department's determination, emphasized that "it is critical that any test used for determining the boundaries of a subflow zone be as *accurate and reliable as possible*." *Id.* (emphasis added).

Inherent in the use of a technical test to satisfy the clear and convincing evidence standard is the requirement that the test be conducted properly. *See Anonymous v. Anonymous*, 10 Ariz. App. 496, 499-500, 460 P.2d 32, 35-36 (1969). Accordingly, the Department's determinations represent clear and convincing evidence *only if* the Department employs the "proper test" and relies on "appropriate criteria." *See Gila IV*, 198 Ariz. at 355 ¶ 6, 9 P.3d at 1074.

The Supreme Court explained why proceeding with a defective subflow test in this Adjudication is unacceptable:

> The 50%/90 day rule was formulated to instruct DWR in the preparation of hydrographic survey reports, and merely creates a rebuttable presumption that wells meeting the test are pumping subflow. Nonetheless, *if the test is defective, its use would adversely affect the adjudication.* It would plant errors in every hydrographic survey report, which would have to be litigated according to the procedures set out in the Rules

> for Proceeding Before the Special Master, Rules 6.00-16.00. This would exacerbate an already lengthy and costly process. Perhaps even more significantly, *use of a flawed test for identifying wells pumping subflow could cause significant injustice*. Many surface owners unable to mount a challenge could effectively lose their right to pump percolating groundwater, simply because their wells were improperly presumed to be pumping appropriable subflow. Considering the time, expense, and importance of accurate hydrographic survey reports, and the complex lawsuits over their correctness, it would be *a senseless waste* to use a flawed presumption for identifying wells pumping subflow.

Gila II, 175 Ariz. at 388-89, 857 P.2d at 1242-43 (emphasis added). The Supreme Court later cautioned that:

> [U]se of an inaccurate test to determine whether a well is pumping subflow would not satisfy the clear and convincing evidentiary standard and would improperly shift the burden to the groundwater user to show that its well is not pumping subflow.

Gila IV, 198 Ariz. at 335 ¶ 6, 9 P.3d at 1074 (emphasis added).

For the reasons discussed below, the Department's Subflow Report fails to meet the standards established by the Supreme Court and must be rejected.

II. DISCUSSION

The Department described its process for delineating the subflow zone for the San Pedro Watershed as follows:

> ADWR delineated the subflow zones by first identifying those stream reaches that it determined had perennial or intermittent streamflow at predevelopment, and then applied the lateral extent of the floodplain Holocene alluvium. To map the subflow zone, the lateral extent of the floodplain Holocene alluvium was adjusted by 100- and 200-foot setbacks to account for side recharge from saturated basin fill and tributary alluvium, respectively . . . .

Subflow Report at 6-1. The Department's process, as approved by this Court, truncates the analysis required by the Supreme Court and elevates expediency of the process over accuracy and reliability of the outcome. *See Gila IV*, 198 Ariz. at 335 ¶ 6, 9 P.3d at 1074.

A. The Department's Subflow Report Fails to Consider All the Relevant Criteria for Delineating the Subflow Zone

The Supreme Court did not authorize the delineation of the subflow zone using the methodology approved by this Court and employed by the Department. *Compare Gila IV*, 198 Ariz. at 344 ¶ 48, 9 P.3d at 1083 *with* Subflow Report at 6-1 *and* 2005 Order at 9-11. In affirming the 1994 Order, the Supreme Court stated:

> The subflow zone is defined as the saturated floodplain Holocene alluvium. *DWR, in turn, will determine the specific parameters of that zone in a particular area by evaluating all of the applicable and measurable criteria set forth in the trial court's order and any other relevant factors.*

Gila IV, 198 Ariz. at 344 ¶ 48, 9 P.3d at 1083 (emphasis added). The Supreme Court expressly included in its opinion the "applicable and measurable criteria" for delineating the subflow zone listed in the 1994 Order:

> 1. A "subflow" zone is adjacent [to] and beneath a perennial or intermittent stream and not an ephemeral stream.
>
> 2. There must be a hydraulic connection to the stream from the saturated "subflow" zone.
>
> 3. Even though there may be a hydraulic connection between the stream and its floodplain alluvium to an adjacent tributary aquifer or basin-fill aquifer, neither of the latter two or any part of them may be part of the "subflow" zone.
>
> 4. That part of the floodplain alluvium which qualifies as a "subflow," beneath and adjacent to the stream, must be that part of the geologic unit where the flow direction, the water level elevations, the gradations of the water level elevations and the chemical composition of the water in that particular reach of the stream are substantially the same as the water level, elevation and gradient of the stream.
>
> 5. That part of the floodplain alluvium which qualifies as a "subflow" zone must also be where the pressure of side recharge from adjacent tributary aquifers or basin fill is so reduced that it has no significant effect on the flow direction of the floodplain alluvium. . . .
>
> 6. Riparian vegetation may be useful in marking the lateral limits of the "subflow" zone[,] particularly where there is

> observable seasonal and/or diurnal variations in stream flow caused by transpiration. However, riparian vegetation on alluvium of a tributary aquifer or basin fill cannot extend the limits of the "subflow" zone outside of the lateral limits of the saturated floodplain Holocene alluvium.
>
> 7. All wells located in the lateral limits of the "subflow" zone are subject to the jurisdiction of this adjudication no matter how deep or where these perforations are located. However, if the well owners prove that perforations are below an impervious formation which preclude[s] "drawdown" from the floodplain alluvium, then that well will be treated as outside the "subflow" zone.
>
> 8. No well located outside the lateral limits of the "subflow" zone will be included in the jurisdiction of the adjudication unless the "cone of depression" caused by its pumping has now extended to a point where it reaches an adjacent "subflow" zone, and by continual pumping will cause a loss of such "subflow" as to affect the quantity of the stream.

Id. 198 Ariz. at 338 ¶ 18, 9 P.3d at 1077 (quoting 1994 Order at 64-66). The Court also included the further explanation of the criteria applicable to delineating the subflow zone found in the 1994 Order:

> Also, in order to fulfill the definition of "subflow," the geologic unit must be saturated because of the need for a hydraulic connection between the stream and the "subflow." Further definition requires "subflow" to be a part of the surrounding floodplain of the stream basin. Those parts of the alluvial plain which it may be a part of or which it is connected to must be the alluvial plain of a perennial or intermittent stream and *not* an ephemeral stream or a part of the alluvial plain of a tributary aquifer even if there is an alluvial connection. Where the alluvial plain of tributary aquifers or ephemeral streams connects to the floodplain Holocene alluvium of the stream itself and provides tributary or basin fill recharge, that tributary aquifer must also be excluded because its flow direction is different and often perpendicular to the stream-flow direction.
>
> The evidence here shows that the only true geologic unit which is beneath and adjacent to the stream is the floodplain Holocene alluvium. *When it is saturated*, that part of the unit qualifies as the "subflow" zone, where the water which makes up the saturation flows substantially in the same direction as the stream, and the effect of any side discharge from tributary aquifers and basin fill is overcome or is

> negligible. Because low-flow streams like the San Pedro meander back and forth in a series of "S" curves within a wider principal or dynamic channel, flow direction must be the general overall direction of the stream. As [DWR expert] Steve Erb testified, as long as the subflow's direction is within 45 degrees of that general stream flow direction, the flow direction requirement is met.
>
> *If we add the following additional criteria, then even more certainty and reliability is provided. First,* the water level elevation of the "subflow" zone must be relatively the same as the stream flow's elevation. *Second,* the gradient of these elevations for any reach must be comparable with that of the levels of the stream flow. *Third,* there must be no significant difference in chemical composition that cannot be explained by some local pollution source which has a limited effect. *Fourth,* where there are connecting tributary aquifers or floodplain alluvium of ephemeral streams, the boundary of the "subflow" zone must be at least 200 feet inside of that connecting zone so that the hydrostatic pressure effect of the side recharge of this tributary aquifer is negligible and the dominant direction of flow is the stream direction. *Fifth,* where there is a basin-fill connection between saturated zones of the floodplain Holocene alluvium and a saturated zone of basin fill, the boundary of the "subflow" zone must be 100 feet inside of the connecting zone so that the hydrostatic pressure effect of the basin-fill's side discharge is overcome and the predominant direction of flow of all of the "subflow" zone is the same as the stream's directional flow . . . .

Gila IV, 198 Ariz. at 337-38 ¶ 17, 9 P.3d at 1076-77 (quoting 1994 Order at 56-58) (emphasis added).[3]

This Court previously rejected the notion that the Department could ignore one or more of the *Gila IV* factors in delineating the subflow zone. In clarifying its expectations regarding the scope of the Department's work, this Court stated:

> The Court has considered ADWR's position that the decision of the Arizona Supreme Court in "Gila IV" requires that the subflow zone be initially delineated by simply mapping the saturated lateral limits of the floodplain of this alluvium. Many claimants object to this procedure and assert that ADWR's current proposal is not legally sufficient. The Court notes that *the guidelines set forth in Gila IV direct ADWR to*

[3] Steve Erb, referred to by the Supreme Court as "DWR expert," was the Chief of the Adjudication Section for the Department when he testified before the Superior Court. *See* 1994 Order at 4.

> *use all criteria geologically and hydrologically appropriate for subflow determination in each watershed.* Even if ADWR is correct about the tasks mandated by Gila IV to determine the subflow zone, the work required to address the other considerations mentioned in Gila IV will serve to *confirm the accuracy* of ADWR's determinations. Therefore, in determining the subflow zone in the San Pedro River watershed ADWR shall use a methodology that addresses the appropriate use, if any, of *each of the criterion listed in Gila IV*, as well as any other relevant factors that will be helpful in insuring that ADWR's subflow zone determination is completed using all reasonable means to arrive at results that are as accurate as possible.

January 22, 2002 Minute Entry at 1-2 (emphasis added). This Court later reversed course and determined that the Department need consider only the saturated floodplain Holocene alluvium to determine the limits of the subflow zone. *See* 2005 Order at 8-11. This shift in position constitutes an erroneous departure from the Supreme Court's directives in *Gila IV*. *See Gila IV*, 198 Ariz. at 344 ¶ 48, 9 P.3d at 1083.

The Subflow Report does not contain the analysis required by *Gila IV*. It lacks any meaningful evaluation of conditions such as the underground water level gradient within the saturated floodplain Holocene alluvium; differences in water levels between the Holocene alluvium and the river; direction of underground water flow[4]; and water chemistry. These (and the other) factors have a significant, and determinative, effect on the delineation of the subflow zone. *See Gila IV*, 198 Ariz. at 338 ¶ 18, 9 P.3d at 1077 ("That part of the floodplain alluvium which qualifies as a "subflow" [zone], beneath and adjacent to the stream, *must be that part of the geologic unit* where the flow direction, the water level elevations, the gradations of the water level elevations and the chemical composition of the water in that particular reach of the stream are substantially the same as the water level, elevation and gradient of the stream." (emphasis added)).[5]

[4] The Department applied the setbacks designed to account for discharge from the saturated basin fill and tributary alluvium, which may impact flow direction. *See* Subflow Report at 5-1, 5-2. The Subflow Report does not otherwise consider flow direction.

[5] This Court authorized the Department to consider the criteria of *Gila IV* to be encompassed by the saturated extent of the floodplain Holocene alluvium. 2005 Order

The Supreme Court's direction that the Department consider all the *Gila IV* factors, not just identification of what the Department assumes to be the saturated floodplain Holocene alluvium, is made clear by the Court's statement that the added work will provide even more certainty and reliability. *See Gila IV*, 198 Ariz. at 337 ¶ 17, 9 P.3d at 1076. It is completely implausible that the Court would require that "the test used for determining the boundaries of a subflow zone be as accurate and reliable as possible," *id.* 198 Ariz. at 335 ¶ 6, 9 P.3d at 1074, yet allow the Department to ignore the factors that would promote the required degree of accuracy.

B. The Department's Assumption that the Entire Extent of the Floodplain Holocene Alluvium Is Saturated Is Inconsistent with *Gila IV* and the Hydrologic Reality of the San Pedro River Watershed

The Department, as permitted by this Court, assumed that the entire lateral extent of the floodplain Holocene alluvium is saturated for the purpose of delineating the subflow zone. Subflow Report at 2-4; 2005 Order at 41. This assumption is invalid and inconsistent with the hydrologic reality of the San Pedro River watershed.

The Department's own subflow witness, Mr. Burtell, conceded that portions of the floodplain Holocene alluvium along the San Pedro River may not be saturated:

> Q: And in fact, it's not all saturated; is it?
>
> A: As I just said, it's the assumption that we made in the report.
>
> Q: But I'm asking, in fact, if you go out in the field and you test all of the floodplain Holocene alluvium is not, in fact, saturated; correct?
>
> A: It's not a yes or no question. There are times when it will be saturated and there are times when it's possible that it will not be saturated.

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at 9-10. However, as discussed *infra* at II.B., this Court directed the Department to assume that the entire floodplain Holocene alluvium is saturated. This Court's instructions, taken as a whole, culminated in designation of a subflow zone inconsistent with the standard imposed by *Gila II*. *See Gila II*, 175 Ariz. at 392, 857 P.3d at 1246 ("As we stated above, it [the determination of whether a well is pumping subflow] turns on whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium.").

Transcript of Proceedings at 43, *In re Subflow Technical Report, San Pedro River Watershed* (Oct. 21-22, 2003) ("Trans."). Mr. Burtell further referenced "testing in the San Pedro River basin that shows the variability of the saturation of Holocene. . . ." *Id.* at 44. The Department acknowledged this fact in the Subflow Report. Subflow Report at 3-3 ("During entrenchment, the water table in saturated alluvium adjacent to a stream channel may be lowered and, for a brief period, increase the baseflow of the stream. Over time, the water table will reach a new equilibrium." (citation omitted)). Salt River Project's expert, Mr. Ford, also conceded that the saturated portion of the floodplain Holocene alluvium is not always conterminous with the lateral extent of the floodplain Holocene alluvium. Trans. at 256-58.

The flawed saturation assumption expands the narrow concept of subflow far beyond that approved by the Supreme Court. *See Gila IV*, 198 Ariz. at 342 ¶ 36, 9 P.3d at 1081. The Court expressly rejected the notion that the entire floodplain Holocene alluvium would necessarily constitute the subflow zone of a particular area:

> Contrary to the groundwater users' argument, the saturated floodplain Holocene alluvium does not automatically or necessarily encompass the entire younger alluvium. *Equating the two would fail to take into account the pertinent criteria that must be applied and satisfied for determining the "saturated" subflow zone in a particular area. See Southwest Cotton*, 39 Ariz. at 96, 4 P.2d at 380 (noting that "the water from the surface stream must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow"). It also would conflict with our rejection in *Gila River II* of any unqualified, blanket rule that invariably would include "all of an alluvial valley's wells" or "all waters pumped any place in the younger alluvium" in the definition of subflow. 175 Ariz. at 391, 393, 857 P.2d at 1245, 1247.

Gila IV, 198 Ariz. at 342 ¶ 36, 9 P.3d at 1081 (emphasis added).[6] The Court further noted

[6] The Department assured this Court and the Supreme Court, through the testimony of Steve Erb, that it "does not include as part of a floodplain aquifer any area where the floodplain alluvium is above the water table." *Gila IV*, 198 Ariz. at 342 n.7 ¶ 35, 9 P.3d at 1081 n.7. The Supreme Court cited and relied on this assurance in dismissing the groundwater users' concerns in the passage quoted above. The Department's full

that "the saturated floodplain Holocene alluvium occupies only very narrow portions of the alluvial basins." *Id.*

The full saturation assumption is tantamount to including all younger alluvium wells in the Adjudication, a prospect "at odds with" the Supreme Court's view of subflow. *Gila II*, 175 Ariz. at 391, 857 P.2d at 1245 ("To say that all of an alluvial valley's wells may be pumping subflow is at odds with *Southwest Cotton's* statement that subflow is found within or immediately adjacent to the stream bed.").[7] Proceeding on the basis of an assumption that is contrary to evidence cannot yield results that are as accurate and reliable as possible as required by the Supreme Court. *See Gila IV*, 198 Ariz. at 335 ¶ 6, 9 P.3d at 1074.

C. The Subflow Report's Use of Predevelopment Conditions To Determine the Subflow Zone Is Inconsistent with *Gila IV*

The errors attendant the full saturation assumption and the failure to consider all the *Gila IV* factors are compounded by the Court's directive that the Department use predevelopment conditions[8] to determine the subflow zone. *See* Subflow Report at 2-1, 2-2; 2005 Order at 20-21.

The Department's application of the predevelopment conditions directive merits some explanation. The Subflow Report lacks any information on historical data demonstrating the saturation of the floodplain Holocene alluvium under predevelopment conditions. Rather, the Department assumed that the entire lateral extent of the floodplain

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saturation assumption is a complete about-face from the assurance on which the Supreme Court relied. This Court erred in approving that assumption.

[7] The Subflow Report demonstrates the massive reach of this assumption: "[T]he width of floodplain Holocene alluvium along the San Pedro River is typically hundreds of feet wide and can reach almost one mile in some areas." Subflow Report at 4-3.

[8] The Department considered predevelopment conditions to be those conditions "existing during an identifiable chronological year or range of years immediately prior to regular, discernable diversion or depletion of streamflows resulting from human activity." Subflow Report at 2-2; *see also* 2005 Order at 21. Nowhere in the Subflow Report does the Department indicate the year(s) or range(s) of years it considered as the predevelopment baseline.

Holocene alluvium historically was (and still is) saturated. Subflow Report at 2-4; *see supra*, at II.B. The Subflow Report also provides no data on the other *Gila IV* factors under predevelopment conditions. *See supra*, at II.A. It is therefore inaccurate to say that the Department considered "predevelopment conditions" to determine the subflow zone.

The Department did gather historic data to make its determinations on perennial, intermittent and ephemeral reaches of the San Pedro River, Aravaipa Creek, and Babocomari River. Subflow Report at 3-1-3-22.[9] The existence of a perennial or intermittent stream, however, is only one of the many factors the Department must consider in determining the subflow zone. *See Gila IV*, 198 Ariz. at 338 ¶ 18, 9 P.3d at 1077.

Furthermore, the use of predevelopment conditions is inconsistent with the Supreme Court's standards for determining subflow. In *Gila II* the Court struck down the 50%/90 day test, in part, because the rule set arbitrary limits rather than focusing on the nature of the water being pumped. 175 Ariz. at 392, 857 P.2d at 1246; *see also Gila IV*, 198 Ariz. at 336 ¶ 12, 9 P.3d at 1075.

In *Gila IV*, the Court reaffirmed that

> the determination of whether a particular well is pumping subflow depends on "whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium," . . . and "'whether *'drawing off the subsurface water tend[s] to diminish appreciably and directly the flow of the surface stream.*'" . . . That determination, in

[9] That data included: historic accounts of streamflow conditions; location of historic irrigation ditch diversions and ore mills; early streamflow data; analysis of 1935 aerial photographs; and recent streamflow data. *Id.* at 3-19. The Department included charts that illustrated its findings in Figures 3-20-3-23. Despite the existence of conflicting evidence, *see, e.g.,* Figure 3-21b, the Department determined that the San Pedro River was perennial or intermittent from the International Border to its confluence with the Gila River. Subflow Report at 3-19-3-21; *id* at Figures 3-21a-3-21d. The Department determined that the Babocomari River was perennial or intermittent from stream mile 21 to its confluence with the San Pedro River. Subflow Report at 3-21-3-22; *id.* at Figure 3-22. The Department determined that Aravaipa Creek was perennial or intermittent from stream mile 36 to its confluence with the San Pedro River. Subflow Report at 3-22; *id* at Figure 3-23.

> turn, necessitates a comparative evaluation of such factors as "elevation, gradient, [flow direction,] and perhaps chemical makeup."

198 Ariz. at 341 ¶ 30, 9 P.3d at 1080 (citations omitted; underlined emphasis added). The Supreme Court required that there be "a hydraulic connection to the stream from the saturated 'subflow' zone." *Id.* 198 Ariz. at 338 ¶ 18, 9 P.3d at 1077. If the Department's subflow test is to be as "accurate and reliable as possible," *id.* 198 Ariz. at 335 ¶ 6, 9 P.3d at 1074, the factors determining the nature of the water being pumped can only be considered under current conditions. As the Ninth Circuit observed in affirming the Federal Energy Regulatory Commission's decision to employ an existing project baseline rather than a pre-project baseline in evaluating the environmental impacts of a proposed relicensing: "It defies common sense and notions of pragmatism to require the [Federal Energy Regulatory] Commission or license applicants to 'gather information to recreate a 50-year-old environmental base upon which to make present day development decisions.'" *American Rivers v. FERC*, 201 F.3d 1186, 1197 (9th Cir. 2000). By applying unsubstantiated and therefore arbitrary estimates of unknown predevelopment conditions, the Subflow Report likely will result in the characterization of wells as capturing subflow that do not in fact withdraw appropriable subflow.

This Court approved the Department's use of predevelopment conditions, in part because it believed predevelopment conditions would "ensure the adjudication adopts a jurisdictional standard that assures surface water users that their rights are not prejudiced by the mere passage of time . . . ." 2005 Order at 21. That rationale unfairly shifts the burden to groundwater users and fails to account for the impacts of riparian vegetation, surface water diversions, and other factors on streamflows in the San Pedro River watershed. *See* Subflow Report at 3-4 ("Development of dense strands of woody riparian vegetation during the 20th Century has increased natural watershed use in the San Pedro River Watershed and, during the growing season, likely decreased the baseflow of its

major streams . . . . Across the watershed, ADWR (1991) estimated that water use by riparian vegetation in 1990 was substantial and totaled 52,600 acre-feet or almost 44% of the overall natural and cultural water uses that year." (citation omitted)); Subflow Report at 3-4 ("A decrease in the frequency, magnitude, and duration of storms across the watershed may also explain the decline in annual river flows over the period."); Subflow Report at 3-7 ("'[I]n the lower portion of its course, the river is in places dry, owing to the diversions made by a large number of small canals.'" (citation omitted)).

Finally, the statement that the Department's subflow zone is a "jurisdictional standard," 2005 Order at 21, that "merely sets parameters with respect to the Court's water use inquiry," *id.* at 16, discounts the significance the Supreme Court accorded to the Department's determination. *See Gila IV*, 198 Ariz. 335 ¶ 6, 9 P.3d at 1074 (noting that when the Department applies the appropriate standards for delineating the subflow zone, its determination that a well is located in that zone "constitutes clear and convincing evidence" that the well is pumping appropriable subflow). This shifting of the burden to the groundwater user is only appropriate if the Department's determinations are as accurate and reliable as possible. *See id.* The Report's reliance on arbitrary and unknown predevelopment conditions does not meet that standard.

III. CONCLUSION

For the foregoing reasons, ASARCO urges the Court to reject the Department's Subflow Report and order that the Subflow Report be revised to incorporate all the relevant criteria for determining subflow as required by *Gila IV*.

DATED this 23rd day of December, 2009.

FENNEMORE CRAIG, P.C.

By _____
Lauren J. Caster
Gregory L. Adams
Attorneys for ASARCO LLC

COPIES OF THE FOREGOING
mailed this 23rd day of December,
2009, to all persons on the
Court-approved mailing list for
the Gila River Adjudication
dated July 27, 2009

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DEPT OF WATER RESOURCES

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

IN THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE	W-1 (Salt) W-2 (Verde) W-3 (San Pedro) W-4 (San Pedro) (Consolidated) **Contested Case No. W1-103** **OBJECTIONS/COMMENTS OF THE BELLA VISTA WATER CO., PUEBLO DEL SOL WATER COMPANY AND CITY OF SIERRA VISTA TO THE SUBFLOW ZONE DELINEATION REPORT FOR THE SAN PEDRO RIVER WATERSHED** (The Honorable Eddward P. Ballinger, Jr.)

DESCRIPTIVE SUMMARY: Bella Vista Water Co., Inc., Pueblo Del Sol Water Company and the City of Sierra Vista (the "Sierra Vista Parties") file their Objections/Comments to the Subflow Zone Delineation Report for the San Pedro River Watershed.

STATEMENT OF CLAIMANT NOs.:

Bella Vista Water Co., Inc.: 39-11-2739 through 39-11-2750; 39-11-2753; 39-11-2754
Pueblo Del Sol Water Co.: 39-11-4262 through 39-11-4264 and 39-11-12704
City of Sierra Vista: 39-1488-89; 39-2752; 39-5807; 39-7844-48; 39-2557-58 and 39-12469

NUMBER OF PAGES: 6 **DATE OF FILING**: December 28, 2009

Bella Vista Water Co. Inc., Pueblo Del Sol Water Company and the City of Sierra Vista (the "Sierra Vista Parties"), through undersigned counsel, file their Objections/Comments to Arizona Department of Water Resources' ("ADWR") Subflow Zone Delineation Report for the San Pedro River Watershed dated June 2009 (the "Report"), pursuant to the Court's order dated September 28, 2009 ("2005 Subflow Order"). The Sierra Vista Parties are entitled to file objections/comments in this matter because they hold the above referenced Statements of Claimant in the San Pedro River Watershed.

OBJECTIONS/COMMENTS TO THE SUBFLOW ZONE DELINEATION REPORT

A. PRESERVATION OF LEGAL DEFICIENCIES IN THE PROCESS FOLLOWED BY ADWR.

The Report provides: "Objections must be limited to ADWR's findings regarding the lateral extent of the subflow zone." As noted in the Report, significant legal proceedings preceded the issuance of the Report. These objections and comments are limited to referencing deficiencies in following the directives of the general adjudication court's order dated September 28, 2005 ("2005 Subflow Order")[1] that resulted in errors in ADWR's findings regarding the lateral extent of the subflow zone.

In so limiting the focus of these objections and comments to the Report, the Sierra Vista Parties do not waive any challenge to the underlying deficiencies in the Report arising from factual and legal deficiencies with the 2005 Subflow Order, the 2004 Subflow Order or ADWR's March 29, 2002 Subflow Technical Report. The Sierra Vista Parties hereby expressly incorporate the evidence and arguments presented before the Special Master, the adjudication court and in Petitions and Cross-Petitions for Interlocutory Review of the

[1] The 2005 Subflow Order adopted, clarified and amended the July 16, 2004 Report of the Special Master ("2004 Subflow Decision") on ADWR's Subflow Technical Report, San Pedro Watershed dated March 29, 2002.

2005 Subflow Order as to the infirmities of the evidence and legal basis of the subflow delineation process proposed by ADWR and approved, with modification, by the 2005 Subflow Order, including, without limitation, the evidence and argument presented by the Sierra Vista Parties, Arizona Public Service Company, Phelps Dodge Corporation, Roosevelt Water Conservation District, City of Safford, Paloma Irrigation and Drainage District, Rio Rico Properties, Inc., ASARCO Incorporated, Arizona Water Company, Tucson Electric Power Company, Gila Valley Irrigation District, Franklin Irrigation District, City of Sedona, Town of Jerome, Town of Clarkdale, Central Arizona Irrigation and Drainage District, City of Casa Grande and the cities of Chandler, Glendale, Mesa and Scottsdale.

The Sierra Vista Parties further note that the recap of proceedings leading to the Report contained in Chapter 1 is incomplete and does not supersede the actual decisions and orders referenced therein (or omitted therefrom).

B. FAILURE TO BASE PREDEVELOPMENT STATE ON A SINGLE YEAR OR A RANGE OF YEARS IMMEDIATELY PRIOR TO WIDESPREAD DIVERSION AND DEPLETION OVERSTATES THE SUBFLOW ZONE.

The 2005 Subflow Order adopts the recommendation that: "The Court should define predevelopment stream flow conditions, for the purpose of subflow analysis, to mean a chronological year or a range of years immediately prior to widespread diversion and depletion of the stream's flows as a result of human activity."[2] The Report does not identify a single year or a range of years where reliable data exists as the basis of its predevelopment state determination. Rather the Report examines the eighty-year period from approximately 1860 to 1940. The Report indicates that the evidence relied on (e.g., the location of irrigation ditches) "do[oes] not provide direct evidence of perennial and intermittent streamflows." The Report, however, states they "suggest a reliable water source." In reaching its conclusion, the

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[2] The Report's use of the "predevelopment state" as the standard for delineating the subflow zone is one of the issues preserved as inconsistent with Arizona law.

Report ignores the inverse conclusion that looking at water uses, over longer periods, tends to make a water source appear more reliable because it ignores the impacts of years where precipitation and snowmelt is unavailable. For example, a possible explanation for multiple diversions developing at or near the same location over a long period is that none of them were viable over the long term because the water source was ephemeral. The Report's erroneous use of data is highlighted by Figures 3-20 through 3-23. Where many of the sources identify no water or ephemeral flows, the Report concludes it was perennial or intermittent because at least one of the sources indicate the availability of water for at least one year. Had the Report used a single calendar year, or a specific series of years to determine the predevelopment state, rather than a period spanning almost 80 years, the number of stretches identified as ephemeral would likely have increased.

C. ADWR'S FAILURE TO INVESTIGATE THE ASSUMPTION OF SATURATION RESULTS IN OVERSTATING THE SUBFLOW ZONE.

The Report assumes the entire floodplain Holocene alluvium is saturated. This assumption was challenged as legally unsupportable before the Special Master and the adjudication court. While preserved above, those arguments will not be repeated in these objections/comments. However, the Sierra Vista Parties object to ADWR's failure to make any attempt to investigate the assumption as part of the preparation of the Report. The 2005 Subflow Order at p. 41¶ 3 included a general directive that ADWR should use other criteria that are geologically and hydrologically appropriate for the particular location where the criteria approved by the adjudication court does not allow it to delineate a reasonably accurate and reliable subflow zone. Because saturation is critical to a "subflow" determination, ADWR, during its field work was required to test segments of the outer reaches of the subflow zone to evaluate the reasonableness of its assumption. This ADWR did not do. As a result, the entire width of the floodplain Holocene alluvium, (which can stretch "almost a mile in some areas" Report at 4-3) is assumed to constitute the subflow zone. The Sierra Vista

Parties object to the resulting overstatement of the lateral extent of the subflow zone without the clear and convincing evidence required by Arizona law to overturn the presumption that underground waters are percolating and not subject to appropriation. *See*, *Maricopa County Mun. Water Conservation District v. Southwest Cotton Co.*, 39 Ariz. 65, 4 P.2d 369 (1931); *In re General Adjudication of All Rights to Use Water In Gila River System & Source,* 175 Ariz. 382, 857 P.2d 1236 (1993), *In re General Adjudication of All Rights to Use Water In Gila River System & Source,* 198 Ariz. 330, 9 P.3d 1069 (2000).

D. THE METHOD OF DETERMINING THE LOCATION OF FLOODPLAIN HOLOCENE ALLUVIUM OVERSTATES THE SUBFLOW ZONE.

The Report recognizes that the boundary of the floodplain Holocene Alluvium is being depicted with varying degree of accuracy. Figures 4-8 and 4-9 highlight that a significant portion of the delineation is between plus or minus 25 feet to 250 feet inaccurate. This is because "[t]he contact between floodplain Holocene alluvium and the other geologic units was not always well defined in the field." Report at 4-10. Even where the contact is clear and well defined, the delineation is still plus or minus 25 feet. Where the contact was subtle or gradational, the inaccuracy is estimated at plus or minus 50 feet. Where the contact has been disturbed, the delineation is estimated inaccurate of plus or minus 250 feet. It is necessary to review the individual Quad Maps set forth in Appendix D-1 of the Report to appreciate the extent to which the Report is providing ADWR's guess as to what constitutes the subflow zone for the San Pedro and Babocomari Rivers and the Aravaipa Creek.

E. CONCLUSION

ADWR has generally followed the 2005 Subflow Order in preparing its Report. As a result, the Report has the legal and evidentiary infirmities that have previously been presented to the Special Master and the general adjudication court. In the end, the lateral extent of the subflow zone depicted by the Report is overstated. The Report does not provide clear and convincing evidence of the lateral extent of the subflow zone along the San Pedro

clear and convincing evidence of the lateral extent of the subflow zone along the San Pedro and Babocomari Rivers and the Aravaipa Creek. Certainly, the Report does not legally justify shifting the legal presumption (and thus the burden of proof) that all underground water within the depicted zone is unappropriable percolating groundwater to a presumption that it is appropriable surface water.

DATED this 28th day of December, 2009.

Curtis, Goodwin, Sullivan,
Udall & Schwab, P.L.C.

By _____
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Original of the foregoing filed this
28th day of December, 2009 with:

Clerk of the Maricopa County Superior Court
601 West Jackson
Phoenix, Arizona 85003
Attention: Water Case

Copies of the foregoing mailed this 28th
day of December, 2009 to those parties who
appear on the Court-approved mailing list
for Case No. W1, W-2, W-3 and W-4 (consolidated)
dated July 27, 2009.

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872\-2-15-2 Subflow Zone Report\Pleadings\SV Parties Objection

Freeport-McMoRan Corporation (Freeport)

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IN THE SUPERIOR COURT OF THE STATE OF ARIZONA
IN AND FOR THE COUNTY OF MARICOPA

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE	W-1 (Salt) W-2 (Verde) W-3 (Upper Gila) W-4 (San Pedro) (Consolidated) **COMMENTS OF FREEPORT-MCMORAN CORPORATION ON ARIZONA DEPARTMENT OF WATER RESOURCES SUBFLOW ZONE DELINEATION REPORT FOR THE SAN PEDRO RIVER WATERSHED**

DESCRIPTIVE SUMMARY: Freeport-McMoRan Corporation submits its Comments on the Arizona Department of Water Resources' ("ADWR") Subflow Zone Delineation Report for the San Pedro River Watershed.

NUMBER OF PAGES: 14

STATEMENT OF CLAIMANT NOS: 39-02297 *et al.* (numerous claims)

DATE OF FILING: December 31, 2009

I. INTRODUCTION

Freeport-McMoRan Corporation ("Freeport") submits the following comments on the Arizona Department of Water Resources ("ADWR") Subflow Zone Delineation Report for the San Pedro River Watershed dated June 30, 2009 (the "Report").

Freeport commends ADWR on its comprehensive analysis and attention to detail in this Report. In particular, the Report generally adheres to the criteria set forth in the Court's "Order Re: Report of the Special Master on the ADWR's Subflow Technical Report, San Pedro River Watershed and Motion for Approval of Report" dated September 28, 2005 ("2005 Subflow Order") to map the subflow zone for the San Pedro River Watershed. However, some aspects of the Report diverge from the applicable law regarding groundwater in Arizona. Freeport submits the following limited comments to address these legal issues and to identify concerns regarding some technical procedures used in the preparation of the Report.

Freeport's comments derive largely from two guiding legal principles that control the definition of subflow in Arizona. First, "[u]nderground waters are presumed to be percolating and, therefore, not appropriable as subflow." *In re the General Adjudication of All Rights to use Water in the Gila River Sys. and Source*, 198 Ariz. 330, 335, 9 P.3d 1069, 1074 (2000) ("*Gila IV*"). Second, this presumption may only be overcome by presenting clear and convincing evidence that water withdrawn from a well is actually part of a stream's subflow and, therefore, appropriable. *Id.*[1]

These legal principles have been the law in Arizona since before statehood, when the Territorial Supreme Court decided *Howard v. Perrin*, 8 Ariz. 347, 354, 76 P. 460, 463 (1904), *aff'd* 200 U.S. 71 (1906), and they have been repeatedly and consistently reaffirmed. *See Maricopa County Mun. Water Conservation Dist. No. 1 v. Southwest Cotton Co.*, 39 Ariz. 65, 85, 4 P.2d 369, 376 (1931); *Neal v. Hunt*, 112 Ariz. 307, 311, 541 P.2d 559, 563 (1975); *In re the General Adjudication of All Rights to Use*

[1] The Arizona Supreme Court has held that the clear and convincing evidence standard requires proof that an assertion is "highly probable." *State v. King*, 158 Ariz. 419, 422-23, 763 P.2d 239, 242-43 (1988).

Water in the Gila River Sys. And Source, 175 Ariz. 382, 392, 857 P.2d 1236, 1246 (1993) ("*Gila II*"); *Gila IV*, 198 Ariz. at 335, 9 P.3d at 1074.

In *Gila IV*, the Arizona Supreme Court affirmed the Superior Court's determination that the saturated floodplain Holocene alluvium constituted the "subflow zone" for the San Pedro River Watershed and directed ADWR to "determine the specific parameters of that zone in a particular area by evaluating all of the applicable and measurable criteria set forth in the tribal court's order and any other relevant factors." *Gila IV*, 198 Ariz. at 344 , 9 P.3d at 1083.

In *Gila IV*, the Supreme Court set forth the test to be used by ADWR in order to determine if the presumption that underground waters are presumed to be percolating and, therefore, not appropriable, could be overcome. The Supreme Court held that "[w]hen DWR determines and establishes that a well is in the subflow zone by using the pertinent criteria or that it is pumping subflow by reason of its cone of depression, DWR provides clear and convincing evidence of that fact." *Id.* at 1082, 9 P.3d at 343. To meet this test, ADWR must prove that it is "highly probable" that (1) a well is located within the "subflow zone" for the San Pedro River Watershed (i.e., the saturated floodplain Holocene alluvium) and (2) all other pertinent criteria required to delineate the subflow zone are met (e.g., the subflow zone is adjacent only to perennial and intermittent streams, and not ephemeral streams).

Given the strong initial presumption that a well is pumping percolating groundwater and the potential impact to well owners in the San Pedro River Watershed included within the subflow zone, the importance that ADWR's analysis to delineate the subflow zone be as accurate and reliable as possible cannot be overstated. In *Gila II*, the Supreme Court recognized that:

> [U]se of a flawed test for identifying wells pumping subflow could cause significant injustice. Many [land] surface owners unable to mount a challenge could effectively lose their right to pump percolating groundwater, simply because their wells were improperly presumed to be pumping appropriable subflow. Considering the time, expense, and importance of accurate hydrographic survey reports, and the complex lawsuits over their correctness, it would be a senseless waste to use a flawed presumption for identifying wells pumping subflow.

Gila II, 175 Ariz. at 388-89, 857 P.2d at 1242-43.

In *Gila IV*, the Court further stated:

> Thus, it is critical that any test used for determining the boundaries of a subflow zone be as accurate and reliable as possible. Otherwise, use of an inaccurate test to determine whether a well is pumping subflow would not satisfy the clear and convincing evidentiary standard and would improperly shift the burden to the groundwater user to show that its well is not pumping subflow.

Gila IV, 198 Ariz. at 335, 9 P.3d at 1074.

The right to use groundwater is vitally important to the people of the State of Arizona. In the San Pedro River Watershed, groundwater is an essential component of the water supply for numerous municipal, commercial, industrial, agricultural and domestic water users. Application of a flawed delineation of the subflow zone will improperly and unjustly shift the burden of proof to certain groundwater users to prove that their wells are not pumping subflow or be subject to the deprivation of their right to pump and use percolating groundwater.

In the 2005 Subflow Order, this Court directed ADWR to follow certain criteria and procedures to delineate the subflow zone within the San Pedro River Watershed. For the reasons stated by the Supreme Court, it is of great importance that the parties

and the Court now carefully vet the Report to ensure that ADWR's application of those criteria and procedures meets the clear and convincing evidentiary standard for each segment of the streams considered (i.e., the San Pedro River, the Babocomari River, and Aravaipa Creek). As discussed below, Freeport believes that, in some instances, the Report reaches conclusions on the location of the jurisdictional subflow zone that are not supported by clear and convincing evidence. Where the requisite burden of proof has not been met, the presumption in favor of percolating groundwater must prevail to preclude any such areas from inclusion in the jurisdictional subflow zone.

II. SPECIFIC COMMENTS TO REPORT

Freeport's specific comments on the Report can be separated into to categories: (A) comments on ADWR determinations of predevelopment streamflows and (B) comments regarding ADWR mapping of the floodplain Holocene alluvium for the San Pedro River, Babocomari River and Aravaipa Creek. Each category is discussed in turn below.

A. Comments Regarding Predevelopment Stream Classifications

In *Gila IV,* the Arizona Supreme Court approved this Court's determination that the subflow zone "is adjacent to and beneath a perennial or intermittent stream ***and not an ephemeral stream***." *Gila IV*, 198 Ariz. at 338, 9 P.3d at 1077 (approving Order of Hon. Stanley Z. Goodfarb dated June 30, 1994 ("Goodfarb Order") (emphasis added). Consequently, it is essential to ADWR's delineation of the subflow zone for the San Pedro River Watershed that ADWR accurately and reliably determine the whether the streams in question are perennial, intermittent or ephemeral.

In his June 30, 1994 order, Judge Goodfarb adopted the following definitions of "perennial," "intermittent," and "ephemeral" streams:

> Perennial streams discharge water continuously through the year. Their source of supply is normally comprised of both direct runoff from precipitation events or snow melt, and baseflow derived from the discharge of groundwater into the stream.
>
> Intermittent streams discharge water for long periods of time, but seasonally. For example, an intermittent stream may flow all winter, every winter, but never flow continuously during the summer. During seasons when baseflow is maintained, groundwater is contributing to the stream. During seasons of discontinuous streamflow, natural and cultural losses may be greater than the contribution from groundwater, resulting in a losing stream. Or, the amount of groundwater discharge itself may have decreased due to natural or cultural uses.
>
> Ephemeral streams discharge water only in response to precipitation events or snowmelt, and do not have a baseflow component at any time of the year; they flow out sporadically. The groundwater system and surface water systems do not establish a hydraulic connection in these systems.

Goodfarb Order at 23-24. This Court approved the Special Master's recommendation to direct ADWR to use these definitions in delineating the subflow zone for the San Pedro River Watershed. *See* 2005 Subflow Order at 41; Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed dated July 16, 2004 ("Special Master's Report") at 28.

To determine whether a stream is perennial, intermittent or ephemeral, this Court, in its 2005 Subflow Order, further directed ADWR to consider predevelopment

streamflow conditions. In directing ADWR to consider predevelopment streamflow conditions, the Court stated:

> The predevelopment stream flow conditions ADWR considers in its stream flow analysis should be those existing during an identifiable chronological year or rage or years immediately prior to regular discernable diversion or depletion of stream flows resulting from human activity... ADWR should take a practical approach and adopt the earliest predevelopment period timeframe ***for which accurate and reliable data is available***.

2005 Subflow Order at 21 (emphasis added). As the Special Master's also recognized in his report, any period selected

> must consider the feasibility of obtaining the requisite technical data and evidence; potential delay and expense of those efforts and of subsequent investigations; level of accuracy and reliability of the subflow analysis; ***confidence of meeting the clear and convincing evidence standard; and fairness***.

Special Master's Report at 51 (emphasis added). Therefore, as with other aspects of ADWR's analysis, ADWR's determination of predevelopment streamflow conditions must be sufficiently accurate and reliable to meet the clear and convincing evidence standard.

In consideration of the applicable evidentiary standard, Freeport submits the following specific comments on ADWR's analysis of predevelopment streamflow conditions:

- Page 3-7, Section 3.2.1, 2nd paragraph: ADWR relies upon historical accounts of streamflow in its analysis. Such information should be used cautiously because by human nature, items that are more often noticed and recorded are the abnormal or extraordinary events, such as a flood event,

rather than the normal baseline flow conditions. ADWR considered several different sources of information for its predevelopment streamflow analysis. However, ADWR has apparently applied equal weight to all lines of evidence considered, despite the reliability or ambiguity of such evidence. The reliability of the historical accounts is questionable in some instances and should be weighted accordingly. Furthermore, several stream reaches have numerous conflicting accounts of streamflow. [*Id.* at Figure 3-6, Historical Accounts of Stream Flow Conditions.] ADWR does not, however, disclose the process used to reconcile these types of differences in the Report. For example, ADWR does not explain whether the conflicting evidence was weighted one way or another to make a determination regarding predevelopment streamflows. Where conflicting evidence cannot be reconciled clearly in favor of a perennial/intermittent determination, the presumption in favor of percolating groundwater should prevail and the stream segment should be classified as ephemeral for purposes of the delineation of the subflow zone in the San Pedro River Watershed.

- Page 3-11, Section 3.2.3, 3rd paragraph: ADWR's conclusion that the "seepage runs" were perennial or intermittent was apparently based upon a one-day measurement conducted in March 1899 and a one-day measurement conducted in March 1921. These are extremely small datasets used to evaluate flow conditions could easily be misinterpreted. As with the other historical accounts considered for the Report, these accounts should be weighted as any evidence, based on their perceived accuracy and reliability.
- Page 3-13, Section 3.2.4, 2nd full paragraph: In the Report, it is stated that

> "ADWR used the tone, texture, and shape of features in the Fairchild photographs to identify stream reaches where flow was likely. Where a stream channel is believed to be dry, it often appears on aerial photographs in light tones in contrast to the dark, nearly black tones where water in the channel is believed to be relatively deep. Gray or medium tones suggest reaches where water in the channel is shallower or channel sediments are moist from recent streamflow or shallow subsurface water. The active channel can be distinguished from nearby riparian vegetation by its smoother texture and sinuous shape. Figure 3-14 shows a Fairchild photograph of the San Pedro River near Redington where ADWR inferred a dry reach and reaches of relatively shallow and deep water."

While the actual photographs may be more illustrative and useful for the purposes identified by the ADWR, the reproductions of the Fairchild photographs provided in the Report do not appear to be definitive for the purposes identified by the ADWR. As a result, ADWR's interpretations based on "tone, texture and shape of features" in the photographs appear questionable and could be subject to differing interpretations. The Report could be improved by providing additional information to the parties and Court to allow proper legal consideration of the value of this type of evidence.

The following examples of problem areas in the photographs are illustrated on Figure 3-14:

- Sunlight appears to be coming at a low angle from the SSW and casts shadows to the NNE, but the NE bank of the river near the "Dry Alluvium" label is black and it should not be;
- The "Shallow Water" label might be nothing more than a shadow cast by a river channel bank;

- The "Dry Alluvium" section may very well have "Deep Water" along the NE side of the channel; and
- The "Deep Water" section could simply be a "Dry Alluvium" section that is accompanied by "shadow issues" similar to the "Dry Alluvium" section immediately downstream.

Given the apparent ambiguity with the Fairchild photographs, the photographs should not be relied upon as sole source of evidence of predevelopment streamflow conditions. The task of determining predevelopment conditions assigned to ADWR is daunting. We recognize that ADWR has limited tools available to use for this task, however that does not negate the fact that the conclusions regarding the photos are suspect in several instances and not sufficiently definitive to meet clear and convincing evidence standard.

- Page 3-19, Section 3.4.1, Sierra Vista Subwatershed, 1st bullet: Regarding lines of evidence, the 1935 Fairchild aerial photography represents just one point in time, whereas the other lines of evidence listed span longer periods of time. Freeport reasserts that the lines of evidence considered by ADWR should be weighted according to their degree of uncertainty prior to making any conclusions on streamflow. [*See also* Page 3-19, Section 3.4, 1st ¶, 4th bullet.]

- Page 3-20, Section 3.4.1, Benson Subwatershed: It appears that significant evidence of dry conditions was not given due consideration for this

subwatershed. ADWR's conclusions seem to be based largely on a one-point-in-time aerial photograph. This is not sufficient data to support the conclusion.

B. Comments Regarding ADWR Mapping Techniques

In the 2005 Subflow Order, this Court directed ADWR to follow certain procedures and criteria concerning geologic conditions to delineate the subflow zones within the San Pedro River Watershed, which included certain directions regarding maps to be used by ADWR in its analysis. These criteria are restated in the Report at Pages 2-3 through 2-4. Among those directions was for ADWR to "[t]ake special care in transferring or re-projecting any depiction on a surficial map to a base map." Report at 2-3 (citing 2005 Subflow Order at 41; Special Master's Report, Recommendation No. 10).

In the Report, it is stated that "ADWR prepared these maps by obtaining the Geographic Information System ("GIS") data that the Arizona Geological Survey ("AZGS") used to depict geologic units on its strip maps. After regrouping the units as described above, ADWR transferred the GIS data from AZGS directly to USGS quadrangles base maps." [*See* Page 4-12, Section 4.3, 2nd full paragraph.] Given the importance of the maps in defining the subflow zone, the process of constructing the ADWR maps from AZGS maps requires a more detailed explanation in the Report. Specifically, Freeport believes that the explanation should at least address the following questions:

- What AZGS data was used and how was it "transferred" to ADWR maps?
- Were any manual or electronic smoothing functions applied to AZGS?

- Is the AZGS data digitized from their field maps or from their compiled 1:24,000 scale geologic maps?
- Were all the individual AZGS digitized points used by ADWR?
- Did the ADWR perform any manual transfer or tracing of unit contacts, or do the contacts represent an electronic transfer of data points and contact lines?

In addition, ADWR chose to reduce the scale of the AZGS mapping from 1:24,000 to an odd scale of approximately 1:52,000. The numerical ratio scale should be added to ADWR maps and figures. Anytime scales are reduced, resolution of detail is lost. Because of this reduction in scale, the ADWR Subflow Zone Maps are less accurate than they should be for use as evidence in this case.

Furthermore, the AZGS mapping should include contact lines and geologic unit designations. The distinctions between "solid, dashed and dotted" lines are not clear on the maps provided so they are very difficult to discern. The alpha-numeric labeling of geologic units are not clear. This is particularly important in the floodplain Holocene alluvium and tributary Holocene alluvium units. Also, there appears to be some inconsistency in the color of mapped units and the corresponding color in the legend. For example, the Qy unit is blue on the maps and tan in the legend.

Finally, on Page 4-12, 4th full paragraph, of the Report, it is stated that "[t]he maps in Appendix D-1 also show where tributaries ***have recently*** deposited alluvium on top of the floodplain." [emphasis added.] ADWR should consider revising this statement to reflect the language on the maps in Section D-4, which state that tributaries ***have potentially*** deposited alluvium on top of the floodplain. Likewise, the language on Page D-4-1, 1st paragraph should be revised to read: "Review of the maps in

Appendix D-1 show that where tributary Holocene alluvium ***potentially*** overlies floodplain Holocene alluvium..."

III. CONCLUSION

In summary, Freeport commends ADWR for its thorough and comprehensive analysis in the Report. However, Freeport respectfully requests the Court to order ADWR to revisit its analysis of predevelopment streamflow conditions and to provide additional information, including but not limited to an explanation of its mapping techniques, consistent with all of the foregoing comments.

RESPECTFULLY SUBMITTED this 31st day of December, 2009.

RYLEY CARLOCK & APPLEWHITE

By _____
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Attorneys for Freeport-McMoRan Corporation

ORIGINAL of the foregoing filed this 31st day of December, 2009, with:

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Phoenix, Arizona 85003

///

///

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All parties on the Gila River Adjudication
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DEPT OF WATER RESOURCES

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

IN RE:

THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE.

No. W-1 (Salt)
No. W-2 (Verde)
No. W-3 (Upper Gila)
No. W-4 (San Pedro)
(Consolidated)

Contested Case No. W1-103

GILA RIVER INDIAN COMMUNITY COMMENTS TO THE ARIZONA DEPARTMENT OF WATER RESOURCES SUBFLOW ZONE DELINEATION REPORT FOR THE SAN PEDRO RIVER WATERSHED

(Assigned to the Hon. Eddward P. Ballinger, Jr.)

Descriptive Summary: The Gila River Indian Community submits its Comments to the Arizona Department of Water Resources Subflow Zone Delineation Report for the San Pedro River Watershed.

Statement of Claimant Nos.: 39-11-54-78, 39-05-41142, 39-07-12652, 39-U8-60083, 39-L8- 36340, and 39-L8-37360 (Gila River Indian Community)

Date of Filing: December 28, 2009

Number of Pages: 7

The Gila River Indian Community ("Community") submits its Comments to the Arizona Department of Water Resources Subflow Zone Delineation Report for the San Pedro River Watershed. The Community's overall impression is that the foundational geologic and hydrologic work performed by the Arizona Department of Water Resources ("ADWR") were well done and well documented. However, the Community notes that ADWR did not use the geologic information correctly in delineating the Floodplain Holocene Alluvium (FHA). Specifically, ADWR selected only the current, visible extents of the fluvial deposits of the San Pedro and Babocomari Rivers and Aravaipa Creek and ignored where the deposits were covered by alluvial fans encroaching from the sides. The result is too narrow in general and significantly so in numerous locations.

GENERAL COMMENTS AND RECOMMENDATIONS

ADWR contracted with the Arizona Geological Survey ("AZGS") to do the foundational work of delineating the FHA for this basin. AZGS described all surface geologic units within one mile on either side of the San Pedro and Babocomari Rivers and Aravaipa Creek for their entire extents within the United States. This is a significant and valuable contribution to understanding the hydrogeology of this basin. AZGS' merged the mix of available geologic mapping in GIS, viewing the latest 2007 aerial photography and visiting and documenting their observations at one-mile intervals along the entire stretch. However, AZGS used only the current, surface extents of FHA.

ADWR determined from an impressive collection of source material that the entire San Pedro and much of the Babocomari River and Aravaipa Creek were perennial or intermittent prior to development. Therefore these same extents are subject to Subflow evaluation and indicate saturation. However, in the process of delineating the FHA, ADWR

did not recognize the most stable, key features defining the edges of the FHA, which have now been made much clearer by AZGS' foundational geologic mapping effort.

ADWR's report used parts of AZGS' detailed geologic mapping and GIS to delineate the FHA. This was required because AZGS delineated many units that qualify as FHA. To this combined mapping, ADWR applied setbacks for tributary and basin fill aquifers to define the Subflow Zone. ADWR's selection process comprehensively excluded current, surface Holocene alluvial fan units. Both the AZGS and ADWR clearly recognize that Holocene fluvial (river) deposits may be present beneath the encroaching alluvial fans. The surface floodplain and alluvial fan deposits engage during each major flood event in a persistent tug of war along their boundaries. Comparison of recent aerial photography with aerial photographs from 1935 clearly shows that this persistent battle significantly shifts this surface boundary.

ADWR's sole reliance on current, surface FHA for their delineation does not result in the stable geologic structure recognized by Judge Goodfarb. Each judicial review since Judge Goodfarb's decision applauded his definition of, and echoed the critical need for, a stable geologic unit. ADWR should strive for a geologic expression of a boundary in the subsurface to the Floodplain Holocene Alluvium. That expression in the subsurface is the Holocene Trough. The Holocene Trough contains the FHA at the surface and at depth. The Holocene Trough is the last (so far) of a series of troughs cut into the Tertiary Basin Fill and filled with primarily coarse-grained floodplain alluvium and forms stable boundaries for sediment movement along major streams. In contrast, the boundary between the current surface floodplain and alluvial fan units shift with major floods.

The lack of stability of current, surface boundaries for floodplain alluvium causes the ADWR approach to become entangled in local juxtapositions of geologic units and resulted in ADWR drawing arbitrary lines through plowed and disturbed areas. ADWR proposed a method for dealing with the problems arising from drawing lines between current surface materials in Appendix D-4, but the Community is concerned because it is arbitrary and therefore problematic for long-term, sustained use in the Adjudication. A simpler and sounder approach is to draw a smooth curve connecting the exposures of units clearly older than Holocene where they come closest to the river of interest.

The Floodplain Holocene Alluvium delineated, based on the surface expressions of the Holocene Trough edges, is wider than the current surface extents of the Floodplain Holocene Alluvium selected by ADWR for their process of defining the Subflow Zone. However, it is still quite narrow compared to the extents of the groundwater basin. Sudden movements and shifting of the surface fluvial or alluvial fan deposits are contained within the Holocene Trough, a stable geologic unit that won't be shifted by a sudden flood or lost to development for irrigated fields or municipal uses.

SPECIFIC COMMENTS AND RECOMMENDATIONS

Pages 1-6, Par. 3 to Page 1-7, Par. 1 – ADWR did not include "mountain front streams", though one could view the Babocomari River and Aravaipa Creek as such. ADWR justifies ignoring the other streams based on their being short, often isolated, restricted or difficult as to access, and therefore require research to map. Because excluding mountain front streams is inconsistent with the criteria issued by the Adjudication Court, all mountain front streams should be included.

Page 2-3, Par 2 – ADWR says they were to exclude all ephemeral streams shown on NRCS soil survey maps. It is not clear that the NRCS has expertise in stream flow duration analysis superior to that of ADWR such that ADWR should defer to NRCS on this issue.

Page 2-5, Par. 3 – ADWR notes that they had to develop other criteria or require further direction from the Adjudication Court. The outcomes of addressing these anomalies are not provided in this report.

Pages 4-9 – 4-11, Section 4.2.5 – The Community concurs with the selection and definition of individual geologic units presented here by the AZGS. However, the Community notes that the subsurface distribution of an individual unit may vary from that mapped at the surface.

Pages 4-11 to 4-12, Section 4.3 –ADWR's grouping of AZGS' geologic units into Floodplain Holocene Alluvium, Tributary Holocene Alluvium, Basin Fill, and Bedrock is too simplistic in that part of the Tributary Holocene Alluvium is Floodplain Holocene Alluvium at depth. At some point the current surface Tributary Holocene Alluvium crosses the edge of the Holocene Trough and drapes over some area of the Trough.

Page 4-12, Section 4.3 – The Community disagrees that "disturbed area" is of the nature of a geologic unit. It is a modification by man of a geologic unit that has obfuscated its identification. The Community recommends instead that disturbed areas be noted, but not mapped as geologic units. Perhaps they can simply be defined areas of greater uncertainty in identification and delineation, but they are not geologic units.

Page 4-13, Par. 1 – ADWR clearly says that the tributary Holocene alluvium (fans spread on the surface towards the stream of interest) are not FHA. In Appendix D-4, ADWR proposes a method for including some tributary Holocene alluvium into the

subflow zone (see later comment). AZGS also recognizes (see Page 10 of their report) that Holocene alluvial fans may cover Floodplain Holocene Alluvium or be inter-bedded in the subsurface with Floodplain Holocene Alluvium. While ADWR has chosen to exclude all of the current, surface extents of tributary Holocene alluvium, this extreme position is problematic for them due to the unusual shapes. The edge of the Holocene Trough is a more appropriate dividing line as it contains all FHA at depth.

Appendix D-4 – The perimeter/length parallel to the stream (P/L) criteria for including tributary Holocene alluvium into the subflow zone is arbitrary. Yet this indicates that ADWR recognizes that some of the tributary Holocene alluvium mapped currently at the surface should be included in an overall delineation of Floodplain Holocene alluvium. A simpler and more robust approach considers the key issue of what volume of geologic material has a close relationship to the stream. The extents of Floodplain Holocene Alluviums beneath the current surface tributary Holocene alluvium constitute a better criterion.

CONCLUSION

On balance, ADWR has done an excellent job of confirming the extent of the Floodplain Holocene Alluvium in the San Pedro River Watershed and the perennial and intermittent streams that, prior to human development, created the Floodplain Holocene Alluvium. The Community believes that the admirable work performed by ADWR can be made even more accurate, reliable, and usable by considering the subsurface geologic composition of the San Pedro River Watershed, rather than focusing exclusively on current surface appearances. The Community recommends that ADWR incorporate the pertinent subsurface geologic conditions by applying the scientific knowledge of the Holocene Trough.

RESPECTFULLY SUBMITTED this 28th day of December, 2008

GILA RIVER INDIAN COMMUNITY

Jennifer K. Giff
Counsel for the Gila River Indian Community

ORIGINAL and ONE COPY of the foregoing hand-delivered this 28th day of December, 2009, to:

Clerk of the Superior Court of Maricopa County
Attention: Water Case
601 W. Jackson Street
Phoenix, AZ 85003

COPY of the foregoing mailed this 28th day of December, 2009, to:

The Honorable Eddward P. Ballinger, Jr.
Judge of the Superior Court
Northeast Regional Court Center
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AND A COPY of the foregoing mailed this 29th day of December, 2009, to all parties appearing on the Court-approved mailing list for W1-103.

By _____

City of Phoenix

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IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM SOURCE	W-1 (Salt) W-2 (Verde) W-3 (Upper Gila) W-4 (San Pedro) (Consolidated) Contested Case No. W1-103 **(Assigned to the Honorable Eddward P. Ballinger, Jr.)** **JOINDER BY CITY OF PHOENIX IN SALT RIVER PROJECT'S OBJECTIONS TO ARIZONA DEPARTMENT OF WATER RESOURCES' SAN PEDRO RIVER SUBFLOW ZONE DELINEATION REPORT**

OFFICE OF THE CITY ATTORNEY
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Descriptive Summary:

The City of Phoenix files its Joinder to the Salt River Project's Objections to the Arizona Department of Water Resources' San Pedro River Subflow Zone Delineation Report.

Statement of Claimant Nos.: Phoenix: 39-07-7927; 39-05-50153 through 39-05-50155, inclusive; and 39-L8-37666 through 39-L8-37691, inclusive.

Date of Filing: December 28, 2009

Number of Pages: 2

The City of Phoenix joins in Salt River Project's Objections to Arizona Department of Water Resources' San Pedro River Subflow Zone Delineation Report.

Respectfully submitted this 28th day of December, 2009.

GARY VERBURG, City Attorney

By _____ for
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Clerk of the Superior Court
in and for Maricopa County
Attn: Water Case
601 W. Jackson
Phoenix, AZ 85003

AND COPIES mailed this 28th day of December, 2009 to all parties appearing on the Court-approved mailing list for Case No. W-1– W-4 dated July 27, 2009.

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IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE

No. W-1 (Salt)
No. W-2 (Verde)
No. W-3 (Upper Gila)
No. W-4 (San Pedro)

Contested Case No. W1-103

SALT RIVER PROJECT'S OBJECTIONS TO ARIZONA DEPARTMENT OF WATER RESOURCES' SAN PEDRO RIVER SUBFLOW ZONE DELINEATION REPORT

(Assigned to the Hon. Eddward P. Ballinger)

(Oral Argument Requested)

Descriptive Summary: The Salt River Project files its objections to the Arizona Department of Water Resources' June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed.

Statement of Claimant Nos.: 39-07-1040, -1041, -1998, -1206, -1207; 39-0550053, -50054, -50055; 39-68-35212 and -35213.

Date of Filing: December 28, 2009.

Number of Pages: 33 + 140 (attachments) = 173 (total).

Pursuant to the Court's September 28, 2005 Order ("2005 Order") and the June 30, 2009 Notice of Publication and Filing of Report by the Arizona Department of Water Resources ("ADWR"), the Salt River Valley Water Users' Association and the Salt River Project Agricultural Improvement and Power District (collectively, "SRP") submit their objections to the June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed ("2009 ADWR Report"). These objections are supported by the attached maps and figures, including the affidavit of Jon R. Ford (*Attachment 1*). At the end of this document is a listing of all attachments, which are incorporated herein by this reference. In order to distinguish them from "exhibits" in the ADWR report, references herein to attachments to these objections are shown in italics.

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I. Introduction

For over twenty years, SRP has actively participated in the proceedings relating to the definition and delineation of appropriable subflow in this Adjudication, including efforts leading up to the 2009 ADWR Report. Those past activities have included field work and numerous rounds of expert testimony. As SRP has repeatedly stated, determination of the subflow zone is of critical importance to those Arizona water users who, like SRP, hold senior vested prior appropriative water rights. Moreover, since 2002, SRP has acquired land and water rights along the lower San Pedro River and Aravaipa Creek to be managed in perpetuity as riparian habitat for endangered species.[1] This riparian habitat is absolutely dependent on the maintenance of subflow.

The subflow zone delineation process made progress with ADWR's 2002 Technical Report, the Special Master's 2004 Report, and Court's 2005 Order. However, while SRP supports many aspects of ADWR's 2009 analysis, which are discussed below (*inter alia*, hydrologic criteria, predevelopment flows and water levels, sources of information, and mapping methods), ADWR has made a critical error that essentially turns back the subflow clock to 1993 or earlier by creating a new concept of "tributary Holocene alluvium." See 2009 ADWR Report, at 4-11 through 4-13; Section V, infra.

The most significant problem with ADWR's report is in its treatment of thin alluvial fans that come from side tributaries and lie across portions of the mainstem Holocene alluvium. ADWR's approach focused solely on surficial geology, so it excluded these areas, even though it is beyond dispute that they are underlain by saturated floodplain Holocene alluvium. See Section V.I, infra. Worse yet, ADWR applied 200-foot setbacks in those

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[1] The acquisition and maintenance of these riparian lands and water rights is required by the Roosevelt Habitat Conservation Plan, which supports an Incidental Take Permit issued by the U.S. Fish & Wildlife Service for continued operation of Roosevelt Dam and Lake. In addition to lands along the San Pedro, hundreds of acres of additional riparian habitat have been acquired and will be managed in perpetuity along the Gila and Verde rivers for the same purpose. See SRP, Roosevelt Habitat Conservation Plan, Gila and Maricopa Counties (2002), available at http://www.fws.gov/southwest/es/arizona/HCPs.htm.

locations, from the toe of the tributary alluvial fans, thereby making its subflow zone even more narrow. See Section V.E, infra. In some instances, the setbacks even overlap each other, so there is no subflow zone, even though no one could reasonably contend that the saturated floodplain Holocene alluvium is less than several hundred feet in width in those areas. See Section V.H, infra.

ADWR recognized the inherent problem with this approach in its Appendix D-4, where it tried to arbitrarily account for its wrongful exclusion of tributary alluvial fans based upon a ratio of the perimeter to the length of the deposit. See Section V.J, infra. That attempt to artificially cure the fundamental defects in ADWR's treatment of the tributary alluvial fans is of little avail. Because it incorrectly excluded these fans, the subflow zone delineated by ADWR is not a stable geologic unit; is subject to the temporal whims of floods and other high water flows; is substantially more narrow than the area of phreatophytes along the river in many places; and is demonstrably inconsistent with the prior decisions by the Arizona Supreme Court, this Court, and the Special Master. See Sections IV through VI, infra.

II. The Entire Saturated Floodplain Holocene Alluvium is the Subflow Zone.

Efforts by this Court to delineate the subflow zone are a continuation of the work undertaken by Judge Goodfarb that began in 1987 and resulted in his adoption of the "50%/90-day" test in 1988. That test was rejected in Gila II, the Arizona Supreme Court's first decision on Interlocutory Issue 2. In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 175 Ariz. 382, 857 P.2d 1236 (1993). In rejecting that test, the Gila II Court remanded the issue to Judge Goodfarb. Judge Goodfarb subsequently held extensive evidentiary hearings, conducted a field trip to the San Pedro River, and determined that the saturated floodplain Holocene alluvium constitutes the subflow zone. See Judge Goodfarb's Order (June 30, 1994) ("1994 Order"). The Supreme Court upheld that determination "in all respects" in Gila IV. In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 198 Ariz. 330, 344, 9 P.3d 1060, 1083 (2000).

A. General principles

Judge Goodfarb (in his 1994 Order) and the Supreme Court (in Gila II and Gila IV) each discussed various "principles," "factors," or "criteria" that are helpful in determining the location and extent of the subflow zone. See, e.g., 1994 Order, at 1-2 (reiterating the Gila II court's discussion of various "factors" such as "stable geologic formations, available hydrological information, and/or organic characteristics of the area"); see also Gila IV, 198 Ariz. at 341-42, 9 P.3d at 1080-81. ADWR's March 29, 2002 technical report regarding subflow in the San Pedro River Watershed ("2002 Technical Report"),[2] Special Master Schade's July 16, 2004 Report and Recommendations on the Technical Report ("2004 Master's Report"),[3] and this Court's 2005 Order each reaffirm that the saturated floodplain Holocene alluvium satisfies those principles and constitutes the subflow zone. See 2005 Order, at 10 (Court agreed with the Special Master's recommendation without qualification).

In Judge Goodfarb's 66-page 1994 Order, he presented a detailed analysis of the evidence and the Gila II "principles." Comparing the legal analysis in Gila II and Maricopa County Munic. Water Cons. Dist. No. 1 v. Southwest Cotton Co., 39 Ariz. 64, 4 P.2d 369 (1931), with the scientific evidence presented to him at the hearing, Judge Goodfarb stated:

> The only logical and rational way the 'Southwest Cotton' and [Gila II] theories as to "subflow" can be made consistent with the scientific principles testified to is to turn to the tests on page 392 of 175 Ariz. where the Supreme Court [in Gila II] itself urged [consideration] of flow direction, elevation, gradient, and chemical composition.

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[2] In its 2002 Technical Report, ADWR concluded that the Gila II "principles" were subsumed into the analysis that resulted in Judge Goodfarb's finding that the saturated floodplain Holocene alluvium constitutes the subflow zone. Relying upon Judge Goodfarb's 1994 Order and Gila IV, DWR stated: "The trial court applied the criteria described in *Gila II* and concluded that the saturated floodplain Holocene alluvium was the 'most credible' subflow zone." 2002 Technical Report, at 2.

[3] Responding to questions raised by some parties about whether ADWR needed to further evaluate the factors embodied in the concept of subflow as part of its work, the Special Master recommended: "The Court should adopt the finding that the criteria specified in *Gila IV* to delineate the subflow zone have been taken into account in the Supreme Court's holding that the saturated floodplain Holocene alluvium is the subflow zone." 2004 Master's Report, at 42.

1994 Order, at 34 (also quoting the Gila II passage quoted above) (emphasis in original). He continued:

> If we add to those tests the concept that if a "subflow" zone can be differentiated from adjacent geologic units such as tributary aquifers and the basin-fill aquifer which discharge into it or receive discharge from it, a set of principles can be developed to define "subflow" and still be consistent with "Southwest Cotton" and science.

Id.

Judge Goodfarb went on to further clarify seven specific principles for delineating the subflow zone. See 1994 Order, at 35-36. He then applied those principles to the various subflow determination methodologies presented by each of the parties' experts. Specifically, he found:

> After consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and "subflow" direction, the Court finds the most accurate of all the markers is the edge of the saturated floodplain Holocene alluvium.

Id. at 56.

B. Specific considerations in delineating the saturated floodplain Holocene alluvium

The process to define the subflow zone took nearly twenty years to complete. The task now at hand is merely to "delineate" the lateral extent of the subflow zone (i.e., the saturated floodplain Holocene alluvium), which should be a relatively straightforward and simple process. As a result of ADWR's misinterpretation of Judge Goodfarb's 1994 Order, however, it is first necessary to revisit some of the basic premises of and rulings set forth in the 1994 Order to demonstrate how ADWR has failed, in certain critical respects, to comply with that order in mapping the San Pedro subflow zone.

1. Concepts of subflow zone delineation rejected by Judge Goodfarb's 1994 Order

After a thorough review and discussion of geologic and hydrologic principles that apply in general to the Gila River System and in particular to the San Pedro River (including, among other things, a hydrologic overview of younger alluvium, tributary aquifers, and alluvial valley streams, various reports prepared by ADWR, expert witness reports, and a report prepared by Richard Hereford entitled "Entrenchment and Widening of the Upper San Pedro River, Arizona"), Judge Goodfarb applied those general geologic and hydrologic principles to the definition of subflow set forth in Gila II. See generally 1994 Order, at 9-34. Judge Goodfarb noted that there were four basic positions taken by the parties as to how a "subflow" zone should be delineated: (1) a narrow band defined by the edge of the river principal channel; (2) a slightly larger post-1880 entrenchment depositional layer; (3) the edge of the central valley's younger alluvium; or (4) an area determined by the growth of phreatophytic plants located in the riparian zone. See 1994 Order, at 35.

Judge Goodfarb first discussed the two proposed subflow zones delineated by the edge of the principal channel and the post-1880 entrenchment, which were the narrowest of the four proposed subflow zones. He found that the sole merit of these two narrow subflow zone proposals was that the banks or edges of the channel could be easily found on aerial photography. See 1994 Order, at 36-37. Judge Goodfarb determined, however, that the contour lines found in the principal channel proposed subflow zone bore no relationship to any geologic difference in the alluvial formation and that this proposed subflow zone was based on the theory of using the most easily found ground feature and then dealing with the real problems of surface water depletion on a case-by-case method by determining the extent of each well's "cone of depression," which he noted was a complicated, difficult, and expensive process. See id. Judge Goodfarb found that the real problem with the principal channel subflow zone proposal was that today's principal channel boundaries have no stability and that the principal channel is subject to being moved by high floods and high water flows.

Id. at 39. He requested that ADWR compare 1935 aerial photography of the San Pedro River with 1990 aerial photography along the entire river and report any channel changes found. The ADWR report indicated that the San Pedro River channel is not stable over time and that it narrows, widens, and shifts significantly. In fact, the study showed a single channel widening of up to 168 feet and a narrowing in twenty-seven locations of from sixty-seven feet to 976 feet, and it also showed twenty-eight shifts in overall channel location of from sixty-six feet to 1,200 feet. Id. at 40.[4]

After a thorough discussion of the lack of stability of the proposed principal channel subflow zone delineation, see 1994 Order, at 40-45, Judge Goodfarb turned to the proposed post-1880 entrenchment subflow zone delineation theory, which was the principal theory proposed by the "groundwater users." Id. at 45. Judge Goodfarb found this narrow subflow zone delineation proposal to be subject to the same lack of stability problems as the principal channel boundary proposal. Id. at 45-48. He found another problem with the post-1880 entrenchment theory to be the lack of consistency between the lateral and vertical limits of the proposed "subflow" zone. Id. at 48. Therefore, Judge Goodfarb rejected both the principal channel boundary theory and the post-1880 entrenchment theory of subflow zone delineation, finding both of them to be without merit. Id. at 52.

As demonstrated in detail in Section V below, ADWR's 2009 subflow zone delineation proposal for the San Pedro River is too narrow and suffers from the same lack of stability over time found by Judge Goodfarb in the principal channel boundary and post-1880 entrenchment theories of subflow zone delineation. The narrow subflow zone proposed by the 2009 ADWR Report would be constantly redefined after shifts in the channel of the San Pedro River caused

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[4] The issue of channel stability arising from ADWR's comparison of the 1935 and 1990 aerial photography was so significant that Judge Goodfarb allowed the parties to submit expert witness affidavits and then conducted a two-day evidentiary hearing (on June 14 and 15, 1994) on this issue alone, which was in addition to the ten-day evidentiary hearing in February 1994 and the two-day field trip to the San Pedro River watershed in March 1994. See Gila IV, 198 Ariz. at 336, 9 P.3d at 1066.

by flooding and other high water flows. This ever-changing snap-shot approach is unacceptable for any subflow zone delineation that must meet the test of time.

2. Concepts of subflow zone delineation embraced by Judge Goodfarb's 1994 Order

After rejecting the principal channel boundary and post-1880 entrenchment theories, Judge Goodfarb next considered the phreatophytic plant growth/riparian zone subflow zone delineation theory proposed by The Nature Conservancy ("TNC"). See 1994 Order, at 52-56. The TNC approach was an alternative proposal, i.e., defining the subflow zone by the delineation of Holocene alluvium or, alternatively, defining the subflow zone by readily observable surface indicators of where underground water is located, those being the phreatophytic plants located in the riparian area or zone immediately adjacent to the river. Id. at 53.

Judge Goodfarb found some merit in the proposed riparian zone subflow delineation criteria, but he found several problems to exist. See 1994 Order, at 55-56. First, he found that the delineation of all riparian areas in their pre-development stage, as advocated by TNC, would be a difficult task. Second, he noted that the study of channel changes and shifts he had requested from ADWR included an analysis of any change in riparian habitat along the San Pedro River from 1935 to 1990. That study indicated significant riparian changes from reductions of up to 3,100 feet along one transect to an additional 1,900 feet along another transect. Id. at 55. He found that, "[t]o the extent that phreatophication exists or can be documented in the areas adjacent to the principal channel, it does mark that portion of the area of the 'subflow' zone. If it extends to the lateral edge of the saturated floodplain Holocene alluvium, then it is a vital marker . . . . ." Id. at 55-56. He also concluded that "[t]he boundaries of the riparian zones are helpful and certainly within the subflow zones if they do not extend over the top of tributary aquifer or basin fill." Id. at 56. He then concluded, however, that, "[a]fter consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and the lack of

hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and 'subflow' direction, the Court finds the most accurate of all markers is the edge of the saturated floodplain Holocene alluvium." Id. at 56.

3. ADWR's deviation from Judge Goodfarb's 1994 Order

ADWR's delineation of the San Pedro River subflow zone deviates from Judge Goodfarb's 1994 Order in several major and critical respects. The 1994 Order provides, among other things: "The "subflow" zone must be distinguished from adjacent tributary aquifers or connecting basin fill." 1994 Order, at 36.

After adopting the saturated floodplain Holocene alluvium as the "subflow" zone, and in reliance on the testimony of Steve Erb, ADWR's witness at the 1994 subflow evidentiary hearing, Judge Goodfarb stated in his "CONCLUSION":

> 3. Even though there may be a hydraulic connection between the stream and its floodplain alluvium to an adjacent tributary aquifer or basin-fill aquifer, neither of the latter two or any part of them may be part of the "subflow" zone.
>
> 4. That part of the floodplain alluvium which qualifies as a "subflow," beneath and adjacent to the stream, must be that part of the geologic unit where the flow direction, the water level elevations, the gradations of the water level elevations and the chemical composition of the water in that particular reach of the stream are substantially the same as the water level, elevation and gradient of the stream.
>
> 5. That part of the floodplain alluvium which qualifies as a "subflow" zone must also be where the pressure of side recharge from adjacent tributary aquifers or basin fill is so reduced that it has no significant effect on the flow direction of the floodplain alluvium. (i.e., a 200-foot setback from connecting tributary aquifers and a 100-foot setback from the basin-fill deposits).
>
> 6. Riparian vegetation may be useful in marking the lateral limits of the "subflow" zone particularly where there is observable seasonal and/or diurnal variations in stream flow caused by transpiration. However, riparian vegetation on alluvium of a tributary aquifer or basin fill cannot extend the limits of the "subflow" zone outside of the lateral limits of the saturated floodplain Holocene alluvium.

1994 Order, at 65.

In its 2009 report, ADWR has made critical errors in, among other things: (1) its analysis of the principles and criteria set forth by Judge Goodfarb relating to excluding adjacent tributary aquifers, the alluvial plains of ephemeral streams, and connecting basin fill and inliers; (2) its application of the 100-foot and 200-foot setbacks set forth in Paragraph 5 of Judge Goodfarb's "CONCLUSION"; (3) its failure to recognize riparian vegetation as a useful subflow zone marker; and (4) its creation and application of a new concept of "tributary Holocene alluvium." See Sections IV through VI, infra.[5]

III. SRP Generally Agrees with ADWR's Hydrologic Criteria and Analysis.

As set forth below, SRP generally agrees with the hydrologic criteria and analysis contained in ADWR's report.

A. SRP agrees with ADWR's hydrologic criteria.

SRP agrees with ADWR's hydrologic criteria and procedures described in Section 2.1 of its report, including the definitions of perennial, intermittent, and ephemeral streams; and the use of predevelopment flow conditions. See 2009 ADWR Report, at 2-1 to 2-3. ADWR's hydrologic criteria accurately summarize these criteria and procedures from the 2005 Order.

B. SRP agrees with ADWR's estimate of phreatophyte evapotranspiration.

SRP agrees with the general magnitude of ADWR's estimate of phreatophyte evapotranspiration in 1991. See 2009 ADWR Report, at 3-4. However, increasing cultural depletions are another major explanation of the decrease in annual stream flow in the 20th Century, in addition to increases in riparian vegetation, climate change, and changes in upland vegetation. See id. at 3-4 to 3-5.

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[5] Unfortunately, ADWR's 2002 Technical Report did not set forth the procedures ADWR intended to follow in excluding tributary aquifers, the alluvial plains of ephemeral streams, connecting basin fill and inliers, and how the 100-foot and 200-foot setbacks would be applied. The 2009 ADWR Report is, therefore, the first time that any of the parties has had an opportunity to see a physical demonstration of how ADWR intended to apply the 1994 Goodfarb criteria.

C. SRP agrees with ADWR's estimate of cultural depletions.

SRP agrees with ADWR's summary of cultural depletions in Section 3.1.4. See 2009 ADWR Report, at 3-4 to 3-5. As noted above, the increase in water withdrawals from near zero in 1900 to over 40,000 acre-feet per year recently, is a major reason for decline in stream flows over that same period of time.

D. SRP agrees with ADWR's evaluation of predevelopment flows and water levels.

SRP agrees with ADWR's analysis of predevelopment flows and water levels described in Sections 3.2 through 3.4 of its report. See 2009 ADWR Report, at 3-5 to 3-22. However, it is worth noting that future efforts by ADWR on many streams will not need to be as intensive as required for the San Pedro River watershed because it will be clear that the stream has always been perennial, intermittent, or ephemeral.

IV. ADWR's Exclusion of Stream Reaches is Inappropriate.

SRP objects to ADWR's criteria for excluding "mountain front streams" from subflow delineation due to short length, isolation from major streams, and difficulties with access. See 2009 ADWR Report, at 1-6 to 1-7. Streams may be excluded only if the stream was ephemeral under predevelopment conditions and there is not a connection of saturated floodplain Holocene alluvium between the ephemeral stream and a perennial or intermittent stream. See 2005 Order, at 22-23.

The Court has not authorized ADWR's exclusion criteria in its 2009 report (short length, isolation from major streams, and difficulties with access). Figure 1-2 of the 2009 ADWR Report shows a number of "Potential Perennial or Intermittent Mountain Front Stream[s]" that ADWR did not specifically evaluate. It appears that many of these streams are short reaches that lie upstream of relatively long ephemeral reaches, which is perhaps what ADWR means by "short length" and "isolation from major streams." In such cases, ADWR must evaluate each of these streams and make findings that such streams are excluded due to their ephemeral nature, the lack of a connection of saturated floodplain Holocene alluvium

between the ephemeral stream and a perennial or intermittent stream, and that there are no appropriative water rights to the isolated intermittent or perennial reach of stream. Access should not be an issue; the Adjudication Court could require landowners to provide access to ADWR. See Pre-Trial Order No. 3 re: Discovery Procedures, at 21 (March 25, 1988); Rules for Proceedings Before the Special Master § 9.11; A.R.S. § 45-256.

SRP also objects to ADWR's exclusion of at least two stream reaches (Redfield Canyon and Buehman Canyon) without explanation, even though they are shown as "potential perennial or intermittent mountain front streams." See 2009 ADWR Report, at Figure 1-2. Both of those reaches are connected to intermittent or perennial streams. Id.

SRP objects to ADWR's exclusion of all reaches of Aravaipa Creek upstream of the Stream Mile 36 from its delineation of subflow. See 2009 ADWR Report, at 3-22 and Figure 3-23. The mapping of actual irrigation diversions by the Arizona Water Commissioner in 1921 between Stream Miles 42 and 46 is strong evidence that the stream was historically intermittent or perennial. Id.[6]

V. SRP Agrees with Some, but Not All, of ADWR's Geologic and Hydrogeologic Criteria and Applications.

SRP agrees in part and objects in part to ADWR's geologic and hydrologic criteria and applications, as set forth below.

A. SRP agrees in part with ADWR's use of maps, consideration of mapping methods, and hydrogeologic criteria.

In general, SRP agrees with ADWR's procedures concerning the use of existing maps, consideration of mapping methods for previous work, using the largest scale maps possible, and taking special care in transfers and projections of maps summarized in Section 2.2 of the report. See 2009 ADWR Report, at 2-3 to 2-4. SRP agrees with ADWR's hydrogeologic criteria that the entire lateral extent of floodplain Holocene alluvium is saturated. See id. at 2-

[6] SRP's expert, Jon Ford, mapped the Aravaipa subflow zone upstream of Stream Mile 36, as discussed in Section VI and shown on *Attachment 10*, Sheet 6 of 6, Figure 15; and Map 21 of *Attachment 11*.

4. SRP also agrees with ADWR's criteria of excluding "tributary aquifers, areas of basin fill recharge, and the alluvial plains of ephemeral streams." Id. As discussed in the rest of this section, however, SRP objects to ADWR's application of the geologic and hydrogeologic criteria to exclude areas where dry alluvial materials form a thin veneer overlying saturated floodplain Holocene alluvium.

B. The Arizona Geological Survey maps have certain limitations for use in this context.

The Arizona Geological Survey ("AGS"), 2008, has appropriately mapped the surficial geology along the San Pedro River. See 2009 ADWR Report, at Appendix C-1. SRP agrees with the AGS methods and procedures.

The limitation of the AGS mapping of surface geologic units is that it does not provide important subsurface information for the floodplain Holocene alluvium—i.e., the thickness of each of the units and the subsurface lateral extent of the older floodplain Holocene alluvium underlying younger floodplain Holocene alluvium. The primary reference to subsurface relationships is shown on Figure 3. See 2009 ADWR Report, at 10; see also id. at Figure 4-1. SRP objects to Figure 3 because it does not properly show the subsurface relationships among the geologic units. It erroneously shows that the following mapping units lie directly on basin fill (Tsy):

Qy4r – Flood channel and low terrace deposits

Qy3r – Historical river terrace deposits

Qy2r – Latest Holocene to historical river terrace deposits

Qy1r – Late to early Holocene river terrace deposits

AGS Figure 3 also erroneously shows that basin fill (Tsy) is exposed at the ground surface between units Qy2r and Qy3r and likewise between Qy3r and Qy4r. Id. This conflicts with the AGS mapping, which does not show that basin fill is exposed in terraces anywhere on the floodplain of the San Pedro River. See 2009 ADWR Report, at Appendix C-5.

Attachment 2, Figure A shows AGS Figure 3 which has been modified to include SRP's interpretation of how the subsurface geologic relationships should be presented, which shows that the oldest floodplain alluvium (Units Qy1r and Qy2r) extend beneath units Qy3r and Qy4r. Figure A also shows how the lateral limits of saturated floodplain Holocene alluvium should be defined compared to how ADWR defines it. See Section VI, infra.

Attachment 2, Figures B and C are geologic cross-sections across the floodplain in the vicinity of TNC's San Pedro Preserve and at the Hereford[7] meander. The San Pedro Preserve cross-section (Figure B) is based upon the AGS mapping and well driller's logs. The Hereford meander cross section (Figure C) is based upon the AGS mapping, three test borings done by the United States prior to the 1994 hearing, and well driller's logs.[8] Both cross-sections show that the Holocene floodplain alluvium extends beneath the more recent Holocene floodplain alluvium. The cross-sections also show that Holocene floodplain alluvium extends to depths of 80 to 140 feet. This depth range is consistent with a similar cross-section in the Palominas area that was included as Figure 9.1 in Mr. Ford's 1993 report filed prior to the 1994 hearing by Judge Goodfarb.[9] It is also consistent with the 1973 Roeske and Werrell report prepared by ADWR's predecessor, the Arizona Water Commission.[10]

C. ADWR's interpretation of the subflow zone from geologic mapping of surficial deposits is in error.

SRP objects to ADWR's exclusion of dry "tributary Holocene alluvium" overlying the saturated floodplain Holocene alluvium. See 2009 ADWR Report, at 4-12 to 4-13. As discussed above, the prior court decisions focused on distinguishing tributary aquifers from

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[7] The "Hereford meander" is shown on Figure 5; Hereford, Richard, 1993, Entrenchment and Widening of the Upper San Pedro River, Arizona: Geological Society of American Special Paper 282. Hereford's report was Exhibit 190 in the 1994 proceedings.

[8] Stetson Engineers' Rebuttal Affidavit, The Delineation of Subflow in the San Pedro River Basin, Arizona; February 24, 1994; Well Log 55-566902 from ADWR records.

[9] This was Exhibit 1 in the record before Judge Goodfarb.

[10] Roeske, R.H. and W.L. Werrell, Hydrologic Conditions in the San Pedro River Valley, Arizona, 1971: Arizona Water Commission, Bulletin 4 (1973).

the subflow zone, not dry alluvial material deposited on top of the saturated floodplain Holocene alluvium such as fans and other deposits, which are only thin veneers. See Section II, supra. ADWR has misinterpreted language in the 1994 Order referring to the exclusion of "floodplain alluvium of ephemeral streams." See 1994 Order, at 57. The 1994 Order referred to ephemeral stream alluvium in the context of tributary aquifers:

> Where the alluvial plain of tributary aquifers or ephemeral streams connects to the floodplain Holocene alluvium of the stream itself and provides tributary or basin fill recharge, that tributary aquifer must also be excluded because its flow direction is different and often perpendicular to the stream-flow direction.

1994 Order, at 57 (emphasis added).

Chapter 4 of the 2009 ADWR Report concludes with several summary paragraphs, which explain the basis of key flaws in ADWR's approach. ADWR elected to exclude all areas "where tributaries have recently deposited alluvium on top of the floodplain," even though "this tributary Holocene alluvium may eventually get washed away during a large flood." 2009 ADWR Report, at 4-12. Although fundamental and essential to the entire effort of delineating the lateral extent of the saturated floodplain Holocene alluvium, ADWR states that it would be "impractical and was considered beyond the scope of this project" to identify where saturated floodplain Holocene alluvium underlies surface deposits of "tributary Holocene alluvium." Id. Taking a couple of sentences out of context from the 1994 and 2005 Orders, ADWR declares that its approach is consistent with prior direction from the Court.[11] See 2009 ADWR Report, at 4-13. ADWR's statement that it "does not consider tributary Holocene alluvium to be part of the floodplain Holocene alluvium," id., misses the point in situations where a thin, dry, surface mantle of alluvium overlies the saturated floodplain

[11] The 1994 Order's reference to "tributary alluvial deposits" was in the context of "inliers" in the broad alluvial plains south of Benson and St. David. The 2005 Order approved Recommendation 5 of the Special Master, which stated: "If other deposits or materials (such as Pleistocene) are found within the floodplain alluvium of a stream, the presence and existence of those deposits shall be reported, but the criterion is the floodplain Holocene alluvium." 2004 Master's Report, at 38. The Special Master's recommendation was in the context of distinguishing "Pleistocene or relic fan deposits" and using "its best technical analysis and evaluation to delineate the lateral extent of the floodplain Holocene alluvium." Id. at 34.

Holocene alluvium. The issue at hand is the lateral extent of the saturated floodplain Holocene alluvium and its interaction with tributary aquifers, not the presence of a surface veneer of some other material or whether it is actually "part of" the saturated floodplain Holocene alluvium.

ADWR's approach to delineating the saturated floodplain Holocene alluvium excluded all geologic units except the following:

Qycr – Active river channel deposits

Qy4r – Flood channel and low terrace deposits

Qy3r – Historical river terrace deposits

Qy2r – Latest Holocene to historical river terrace deposits

Qy1r – Late to early Holocene river terrace deposits

Id. at 4-12.

ADWR excluded the following geologic units from the saturated floodplain Holocene alluvium because they were piedmont[12] alluvial deposits or surficial deposits:

Qyc – Modern stream channel deposits

Qy3 – Latest Holocene alluvium

Qyaf – Latest Holocene, active fan deposits

Qy2 – Late Holocene alluvium

Qy1 – Older Holocene alluvium

Qys – Holocene fine-grained deposits

Qy – Holocene alluvial deposits, undifferentiated

Id. at 4-11 to 4-12; Appendix C, at 45-48; Appendix D-1.

These deposits were excluded because ADWR considered them to be alluvium of tributary drainages, even though ADWR recognizes (as does the AGS) that these geologic

[12] "Piedmont" refers to "Tributary Alluvium and Younger Basin Fill." 2009 ADWR Report, at Figures 4-1 and 4-7.

units are deposited on top of the saturated floodplain Holocene alluvium and that they are temporary deposits that will eventually be washed away. Id. at 4-12.

In summary, ADWR's approach is incorrect for at least two reasons. First, as discussed above in this section, it is geologically incorrect in that it excludes saturated floodplain Holocene alluvium (the subflow zone as defined by Judge Goodfarb), which lies beneath significant portions of ADWR's "tributary" alluvium. Second, it results in a subflow zone that will be redefined after major flood events, which is not a stable delineation. See Section V.D, infra.

D. ADWR's subflow zone is not a stable geologic feature, which is required by the 1994 Order.

As summarized above, SRP objects to ADWR's delineation of only a part of the saturated floodplain Holocene alluvium because it is not a stable geologic feature, which is required by the 1994 Order. See Section II.B.1, supra. The San Pedro River, like its tributaries and all streams that are not confined by bedrock, meanders and changes course over time, periodically working its way back and forth across the entire floodplain.

Attachment 2, Figure E shows the location of the active channel of the San Pedro River in the Dudleyville area at various times between 1877 and the present. This figure demonstrates that the San Pedro River has migrated back and forth across the floodplain over the last 120 years and, in places, the river channel has historically been outside of the ADWR Subflow Zone.

Attachment 2, Figure F is a reproduction of Appendix O-3, Exhibit 319 of Judge Goldfarb's 1994 Order. This figure was originally prepared by Leonard Rice Engineers, Inc. for the field trip portion of the hearing. It shows how the San Pedro River has migrated in the past in the Pomerene area. Figure F also shows how the Pomerene Canal Company diversion structure on the San Pedro River had to be relocated as a result of the river migration. Similarly, although they are not included here, Appendix O-1, Exhibit 317; Appendix O-2,

Exhibit 338; Appendix O-4, Exhibit 320; and Appendix O-5, Exhibit 325 of the 1994 Order all show how the San Pedro River has migrated over time.

Attachment 3 contains a series of maps of the northern half of the San Pedro River and lower Aravaipa Creek, showing the 1935 and 2008 river channels relative to the ADWR subflow delineation. These maps show the shifts in the location of the river channel over time as well as the numerous locations where the 1935 and 2008 channels are outside of ADWR's delineation. See Section V.H, infra.[13]

Attachment 2, Figure B shows a geologic cross-section across the floodplain of the San Pedro River at TNC's San Pedro Preserve near Dudleyville. This figure shows that late Holocene, active fan deposits and somewhat older alluvial fan deposits, which ADWR defines as tributary alluvium and not part of the saturated floodplain Holocene alluvium, overlie San Pedro River Holocene floodplain deposits including the 1947, 1955, 1972, 1980, and 1990 active channel deposits of the San Pedro River.

The current active channel of the San Pedro River meanders back and forth across the entire floodplain at many places. There are at least 184 locations along the San Pedro River where the active channel is on one side of the floodplain or the other. *Attachment 2*, Figure G shows several examples of where this occurs; the maps in *Attachment 3* show many more of these instances along the northern half of the San Pedro River. This meandering process has occurred throughout the Holocene. It began soon after the San Pedro first incised a channel into the basin fill sediments. This meandering process removed and redistributed alluvial fans and other deposits brought onto the floodplain by tributary streams. Eventually, this process resulted in the formation of the current floodplain.

As recognized by ADWR, this process is still going on today. See 2009 ADWR Report, at 4-12. *Attachment 2*, Figure H shows how the active channel of the San Pedro River has removed the toe of a recent alluvial fan deposited at the mouth of a tributary stream.

[13] 1992 USGS Digital Orthophotos were used to register aerial photography as part of the mapping process for channel changes. Slight shifts due to registration are possible but are expected to be less than 100 feet.

Eventually, the entire fan will be completely removed and reworked by the San Pedro River to become part of the floodplain.

The San Pedro River is actively eroding other "tributary" deposits as shown on *Attachment 2*, Figure I. There are at least 295 locations with a total length of approximately twenty-four miles, where erosion of ADWR "tributary" alluvial deposits is active and ongoing.

Attachment 2, Figures B, and D through I show that the ADWR approach is incorrect in that it does not result in a stable subflow zone and it excludes much of the saturated floodplain Holocene alluvium.

E. ADWR inappropriately applied 200-foot setbacks in numerous locations where a tributary aquifer or inflow from ephemeral stream alluvium does not exist.

There are a few minor exceptions to delineating the entirety of the saturated floodplain Holocene alluvium as the subflow zone. Those exceptions, namely the presence of geological "inliers" in the saturated floodplain Holocene alluvium and "setbacks" from the exterior edge of the saturated floodplain Holocene alluvium, are intended to exclude the presence and effects of tributary aquifers.

Mr. Erb's 1994 testimony regarding inliers resulted in the concept of "setbacks" inside the edge of the saturated floodplain Holocene alluvium to account for the perceived effect of inflow from tributary aquifers. Judge Goodfarb was concerned that some uncertainty existed about the direction of flow to the stream versus flow with the stream along the boundary between a tributary aquifer and the saturated floodplain Holocene alluvium. See Reporter's Transcript of Proceedings, vol. X, a 81-82 (February 16, 1994) (excerpts attached hereto as *Attachment 4*). Judge Goodfarb asked Mr. Erb: "How far should I pull in those parameters to be certain in my own mind that I've now got subflow going in the same direction as the stream?" Id. at 83-84. Mr. Erb responded: ". . . I would say [on] the order of 100 to 200 feet . . . ." Id. Ultimately, the 1994 Order established setbacks of 200 feet inside the connecting

zone between saturated floodplain Holocene alluvium and a tributary aquifer or floodplain alluvium of ephemeral streams, and 100 feet where the connection is between the saturated floodplain Holocene alluvium and basin fill. See 1994 Order, at 57-58.

SRP objects to ADWR's use of 200-foot setbacks in locations where thin veneers of dry "tributary alluvium" overlie the saturated floodplain Holocene alluvium. Except for the mouths of larger ephemeral streams or washes (which may have periodic flow in the alluvium underlying those tributaries), the setbacks should be 100 feet from the edge of the saturated floodplain Holocene alluvium because the basin fill aquifer adjoins the saturated floodplain Holocene alluvium.[14] For these purposes, SRP defines a "large" ephemeral stream or wash as being a named watercourse on a USGS quadrangle map. In contrast to unnamed washes and watercourses, named ephemeral streams and washes typically have sufficient watershed size to generate periods of sustained flow in the alluvium underneath the channel.[15]

F. ADWR ignored the extensive presence of dense phreatophytes outside of its subflow delineation.

SRP objects that ADWR ignored the presence of dense communities of phreatophytes outside of its subflow zone delineation as one indicator of the presence of saturated floodplain Holocene alluvium underlying the shallow veneers of "tributary alluvium." The 1994 Order noted:

> To the extent that phreatophication exists or can be documented in the areas adjacent to the principal channel, it does mark that portion of the area of the 'subflow' zone. If it extends to the lateral edge of the saturated floodplain

[14] Small washes rarely add substantial amounts of groundwater to the Holocene floodplain alluvium. 100-foot setbacks are appropriate along the San Pedro River, Aravaipa Creek, and the Babocomari River, even where regional pumping has lowered the water table below the level in the saturated floodplain Holocene alluvium because the basin fill was tributary to the saturated floodplain Holocene alluvium under predevelopment contributions. The San Pedro and Babocomari Rivers, and Aravaipa Creek, and their saturated floodplain Holocene alluvium are located on broad, deep sedimentary basins or "basin fill." See 2009 ADWR Report, at 4-5.

[15] See A. Coes and D.R. Pool, Ephemeral-Stream Channel and Basin-Floor Infiltration and Recharge in the Sierra Vista Subwatershed of the Upper San Pedro Basin, Southeastern Arizona, U.S. Geological Survey Open File Report 2005-1023.

> Holocene alluvium, then it is a vital marker. The boundaries of riparian [phreatophyte] zones are helpful and certainly within the 'subflow' zones if they do not extend over the top of tributary aquifer or basin fill.

1994 Order, at 55-56. ADWR makes no mention of the use of the "vital marker" of phreatophytes to assist in the delineation of the subflow zone.

Attachment 5 is a series of maps showing the extent of dense mesquite and cottonwood-willow communities along the main channel of the northern half of the San Pedro River relative to the ADWR and SRP[16] subflow delineation.[17] A substantial amount of the dense phreatophyte cover, which indicates the roots are withdrawing water from the water table, occurs outside of ADWR's subflow delineation. *Attachment 5* also contains detailed maps showing the same phreatophyte communities on an aerial photograph base along with the ADWR and SRP subflow delineations. The high density of the phreatophytes straddling and outside of ADWR's delineation is evident on these maps. Also, the dense phreatophytes are within SRP's subflow delineation, except for small areas within the setbacks and near the mouths of major ephemeral washes.

G. ADWR ignored the direction of water flow parallel to the stream underlying thin veneers of alluvial material overlying the saturated floodplain Holocene alluvium.

The Nature Conservancy ("TNC") provided SRP with a water table map in the vicinity of TNC's San Pedro Preserve (known as the Paul Sale property during the 1994 proceedings).[18] See *Attachment 6*. This map, which was prepared by a TNC contractor,

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[16] SRP's subflow delineation is shown on the attached maps as the "LRE Subflow Zone," which was mapped by Jon Ford or Leonard Rice Engineers, Inc. ("LRE").

[17] 1992 USGS Digital Orthophotos were used to register aerial photography as part of the mapping process for riparian vegetation. Slight shifts due to registration are possible but are expected to be less than 100 feet. The riparian vegetation, including phreatophytic communities, were mapped using photo interpretation of 2008 aerial photography of the San Pedro mainstem, supplemented by field verification. Only the dense phreatophytic communities are shown on *Attachment 5*.

[18] The San Pedro Preserve is part of the Roosevelt Habitat Conservation Plan discussed in Note 1, supra.

shows that groundwater flowing in the floodplain beneath ADWR's designation "tributary" alluvium flows in the same general direction as the San Pedro River so the area beneath the tributary alluvium should be included in the saturated floodplain Holocene alluvium.

Attachment 2, Figure M shows a more regional interpretation of the water table. This figure is from Pool and Coes (1999), with SRP's interpretation of the saturated floodplain Holocene alluvium added.[19] It shows how groundwater flows toward and into the subflow zone then down-gradient in the same general direction as the San Pedro River.

H. ADWR's delineation is in error where it mapped no subflow zone due to mistakes in geologic interpretation and misapplied setbacks.

ADWR's blind focus on surficial geology and mechanical application of setbacks results in absurd subflow delineations in a number of locations. For example, ADWR identifies and then excludes "islands of floodplain Holocene alluvium," which have been circumscribed by "tributary Holocene alluvium" deposited on top of the floodplain. See 2009 ADWR Report, at 4-13. These "islands" are comprised of the same saturated floodplain Holocene alluvium that underlies the surficial deposits, all of which is the same as, and is connected to, the saturated floodplain Holocene alluvium bordering the stream. Id. at Figure 4-9. These islands, as well as the surrounding thin veneer of alluvium overlying the saturated floodplain Holocene should be incorporated into the subflow zone.

In many other locations, ADWR has excluded the active river channel itself from the saturated floodplain Holocene alluvium by routine application of setbacks from the "tributary Holocene alluvium." There are almost 500 places where the active river channel is excluded from the ADWR saturated floodplain Holocene alluvium. *Attachment 2*, Figure D shows an example of this situation. Additional examples are shown in the maps in *Attachment 3*. By definition, the active river channel contains saturated floodplain Holocene alluvium, which must be part of the subflow zone.

[19] See Pool, D.R. and A.L. Coes, 1999, Hydrogeologic Investigations of the Sierra Vista Subwatershed of the Upper San Pedro Basin, Cochise County, Southeast Arizona: USGS WRI 99-4197.

In another instance along Aravaipa Creek, AGS mapped a finger of late Holocene alluvium (Qy2) extending onto the floodplain. See 2009 ADWR Report, at Figure 5-5; see also Appendix C-5, Sheet 5 of 6, Figure 11. Because of its mechanical application of setbacks to this so-called "tributary" alluvium, ADWR concludes there is no subflow zone along a ½-mile stretch of lower Aravaipa Creek. Moreover, this "geologic unit" is actually a man-made berm bulldozed into place in order to protect a well and agricultural fields from the frequent floods on Aravaipa Creek. *Attachment 7* contains two panoramic photos of the berm and surrounding floodplain, both of which are underlain by the saturated floodplain Holocene alluvium (i.e., the subflow zone).

I. Combined, ADWR's methodology results in an overly narrow, discontinuous, and geologically incorrect delineation of the subflow zone, in contradiction to the 1994 Order.

SRP objects to the narrow width of the ADWR subflow zone, which is as narrow or narrower in many places as the post-1880 entrenchment and principal channel approaches rejected by Judge Goodfarb in his 1994 Order. See Section II.B.1, supra. It is also discontinuous in some locations, which will ultimately raise questions regarding whether water rights that rely in part on subflow can be administered between arbitrarily unconnected reaches of stream. *Attachment 8* contains a series of maps of the San Pedro and Babocomari Rivers and Aravaipa Creek showing the location of the post-1880 entrenchment mapped by Montgomery and Associates, Inc. for the 1994 proceedings before Judge Goodfarb. These maps also show the 2009 ADWR subflow delineation and SRP's mapping of the saturated floodplain Holocene alluvium/subflow zone. These maps (especially Maps 1, 5, and 12) show that there is relatively little difference between the ADWR subflow delineation and the post-1880 entrenchment that Judge Goodfarb specifically rejected in his 1994 Order.

ADWR's rote approach to applying setbacks and excluding various geologic map units lying on the floodplain has resulted in a number of disconnected reaches along the San Pedro and Babocomari River and Aravaipa Creek. Examples are provided in Figures 5-1 and 5-2 of

the 2009 ADWR Report. Other examples can be found by examination of the maps in *Attachment 8*; see also *Attachment 11*.

Attachment 9 is a series of maps showing the extent of large wells within and adjacent to the ADWR and SRP subflow zones along the San Pedro and Babocomari Rivers and Aravaipa Creek.[20] Approximately 355 wells that are not likely to be classified as *de minimis* are located outside of ADWR's proposed subflow zone but within SRP's proposed subflow zone. These wells would be subject to the "cone test" to determine how much of the water pumped is subflow, which is likely to approach or equal 100% of their pumping given their proximity to the subflow zone.[21] Thus, ADWR's narrow subflow delineation will require enormous amounts of additional time and money to be spent by ADWR, the parties, and the Court.

J. ADWR's approach in Appendix D-4 to include some of the areas it erroneously excluded is a step in the right direction but does not go far enough toward accurately identifying the full extent of the saturated floodplain Holocene alluvium.

ADWR recognized that its definition of the subflow zone is flawed because it excludes saturated floodplain Holocene alluvium beneath "tributary" sediments that have been temporarily deposited over saturated floodplain Holocene alluvium. In Appendix D-4,

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[20] The locations of "large wells" shown on the maps in *Attachment 9* include one or more pumping wells registered in the ADWR "55" database. The claimed water use from these wells is for commercial, industrial, irrigation, mining, municipal, production, recreation, subdivision, or utility company purposes. Not included in the analysis are domestic, monitor, piezometer, geotechnical, or cathodic wells. ADWR's 55 database locates a well by its cadastral or ¼ ¼ ¼ (10 acre) legal description. The Geographic Information System ("GIS") tools used to create these well maps locates the well to the center point of the 10-acre parcel. The depicted well locations are accurate to within a 330-foot radius of the mid-point of the 10-acre designation. Thus, the actual location of the well (within the 10-acre parcel) could theoretically fall inside or outside of a subflow zone delineation and would need to be verified in the field using Global Positioning System ("GPS") or survey instruments. For recent wells, ADWR initiated a new well registration process, which requires the well driller to include the latitude and longitude coordinates of the well. This information is ascertained using a hand-held GPS or survey equipment and recorded on the well driller's report or well log (ADWR Form 55-55).

[21] For context, there are 325 wells within both the ADWR and LRE zones and an additional 19 wells only within the ADWR zone.

ADWR outlines an approach to solving this problem that is based upon the ratio of the perimeter to the length of the deposit. ADWR prepared three figures (D-4a-c) that illustrate the process. For reasons not explained, however, the approach was not adopted.

Although SRP agrees with ADWR that the exclusion of saturated floodplain Holocene alluvium is a problem, SRP objects to the potential mechanical method of using a simple mathematic formula (which appears to have no scientific basis) to include some areas where tributary alluvium overlaps saturated floodplain Holocene alluvium. *Attachment 2*, Figure J is ADWR Figure D-4a with SRP's interpretation of the subflow zone added to it. Figure J shows that the ADWR ratio approach is not adequate but that it more closely matches the saturated floodplain Holocene alluvium than does the ADWR subflow zone delineation.

VI. The Proper Subflow Zone

Mapping of the saturated floodplain Holocene alluvium can be done accurately and inexpensively using basic scientific principles and professional judgment without resorting to detailed subsurface analysis using driller's logs. SRP's expert, Jon Ford, accomplished this when he prepared a map of the subflow zone for the hearing before Judge Goodfarb in 1994 using topographic slope breaks, aerial photograph interpretation, and analysis of the vegetation, coupled with two days of field verification.

Attachment 2, Figure H shows how geologic mapping and topographic slope change can be used to map the edge of the saturated floodplain Holocene alluvium. It also shows how changes in vegetation can be used to map the edge of the saturated floodplain Holocene alluvium where it is beneath alluvium deposited by ephemeral side tributaries.

Attachment 2, Figure K shows a portion of Mr. Ford's mapping for the 1994 hearing compared to his current interpretation of the lateral extent of the saturated floodplain Holocene alluvium. The current interpretation is based upon the 2008 AGS survey mapping done for ADWR and the direction provided by the 1994 Order, the 2004 Master's Report, and the 2005 Order. Figure K shows that the flat broad floodplain, along with its Holocene alluvium, is an obvious feature compared to the steep side slopes of basin fill dissected by

arroyos. The figure also shows that the two interpretations (1994 and current) agree very well. Based upon making this comparison throughout the entire basin, Mr. Ford concluded that the saturated floodplain Holocene alluvium can be mapped with little difficulty where it underlies deposits ADWR has deemed to be "tributary."

To illustrate his interpretation of the saturated floodplain Holocene alluvium and the saturated floodplain Holocene alluvium with the required 100- and 200-foot setbacks, Mr. Ford has added them to AGS Sheets 1-6. See *Attachment 10*. On these maps, the saturated floodplain Holocene alluvium with and without the setbacks can be seen relative to the geology. These maps show how Mr. Ford interpreted the edge of the saturated floodplain Holocene alluvium beneath the veneer of deposits brought onto the floodplain by tributary streams and washes. Where it is beneath other deposits, the location of the edge of the saturated floodplain Holocene alluvium is based upon professional geologic judgment using exposures of basin fill and Pleistocene deposits mapped by the AGS, topographic slope analysis (geomorphology), and vegetation analysis. *Attachment 11* is a series of maps showing Mr. Ford's updated subflow delineation versus ADWR's delineation throughout the watershed.[22]

As mentioned above, in some locations, inliers of basin fill (Tsd), which are remnants of basin fill protruding through the veneer of thin alluvium deposited over the basin fill by ephemeral side drainages, can be used to map the edge of the saturated floodplain Holocene alluvium on the San Pedro River floodplain. *Attachment 2*, Figure L shows how this is done.

After the lateral limits of the saturated floodplain Holocene floodplain were defined, Mr. Ford developed a process to incorporate the 100- and 200-foot setbacks defined in the 1994 Order. Because the AGS mapping shows Holocene sediments have been deposited on

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[22] Mr. Ford did not map the subflow zone along streams that ADWR shows as "potential perennial or intermittent mountain front streams," see Section IV, supra, because there is not sufficient information in the record to determine if they are actually perennial or intermittent, and whether any appropriative water rights exist on those stream reaches. If the Court determines that some or all of those streams should be included, ADWR should delineate the saturated floodplain Holocene alluvium using the process described herein.

top of floodplain Holocene floodplain alluvium nearly everywhere along the edge of the floodplain, a process for determining which washes were subject to the setback needs to be developed. Additionally, the process would include adjusting the setbacks to avoid having the San Pedro River active channel outside of the subflow zone.

The setback process used by Mr. Ford consisted of the following steps:

1. To account for the possibility of groundwater inflow from basin fill into the Holocene floodplain alluvium, Mr. Ford applied a 100-foot setback line along the entire length of the saturated floodplain Holocene floodplain delineation on both sides of the floodplain. Each 100-foot setback line is parallel to and located on the floodplain side of the saturated floodplain Holocene floodplain line.

2. Mr. Ford identified named washes from topographic maps and determined how far their alluvial fans extended upstream and downstream on the floodplain along the saturated floodplain Holocene floodplain line. The AGS mapping and topography were used to make this determination. In many places, alluvial fans overlap and, in those cases, professional judgment was used to make the determination.

3. Once the extent of the alluvial fans of named washes were identified, a 200-foot setback line was applied to the extent of each fan parallel to the saturated floodplain Holocene floodplain line.

4. The 200-foot alluvial fan setback line was connected to the 100-foot setback line by drawing a line from the point where the 200-foot setback line reached the edge of each named wash alluvial fan to the 100-foot setback line. This connecting line was drawn at a 45-degree angle between the 100- and 200-foot setback lines. The curving nature of the setback lines causes the connecting line to be only approximately 45 degrees in many places.

5. The 100-foot setback line within the named wash alluvial fans was then removed.

6. The composite 100- and 200-foot setback lines were then reviewed to identify areas where the setbacks caused the river channel, as identified by AGS, to be outside of the

subflow zone. In those places, the setbacks were adjusted so that the river channel was included in the subflow zone.

SRP asserts that ADWR should have used this process, or one like it, in dealing with the setback issues in its report.

VII. Summary and Requested Action

ADWR was correct on several issues when delineating the San Pedro River subflow zone, but certain significant problems exist with ADWR's methodology. SRP requests that the Court reject ADWR's report and require ADWR to revise the subflow zone delineation mapping and modify both ADWR Figure 4-1 and AGS Figure 3 in accordance with the correct criteria as set forth herein.

DATED this 28th day of December, 2009.

SALMON, LEWIS & WELDON, P.L.C.

By Mark A. McGinnis

M. Byron Lewis
John B. Weldon, Jr.
Mark A. McGinnis
2850 East Camelback Road, Suite 200
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Attorneys for SRP

ORIGINAL of the foregoing, with hard copy attachments, hand-delivered this 28th day of December, 2009 to:

Clerk of the Superior Court of Maricopa County
101/201 West Jefferson
Phoenix, AZ 85003-2205

. . .

. . .

. . .

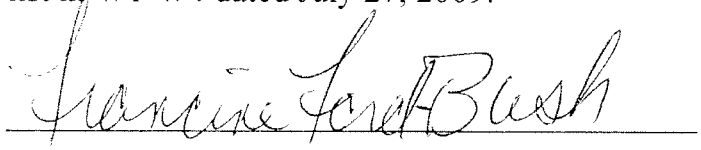
AND COPY, with hard copy attachments and DVD containing attachments, hand-delivered this 28th day of December, 2009 to:

Honorable Eddward P. Ballinger
Judge of the Superior Court
Northeast Regional Court Center
18380 North 40th Street, Ste. L
Phoenix, Arizona 85032

Special Master George A. Schade
Arizona General Stream Adjudication
Maricopa County Superior Court
201 West Jefferson, Suite 5B
Phoenix, AZ 85003-2205

Arizona Department of Water Resources
Legal Division
Janet L. Ronald
3550 North Central Avenue
Phoenix, AZ 85012

AND COPY, with DVD containing attachments, mailed this 28th day of December, 2009 to all persons appearing on the Court-approved mailing list in W1-W4 dated July 27, 2009.



Attachments

Attachment 1 Affidavit of Jon R. Ford

Attachment 2 Figures A through M

Attachment 3 1935 and 2008 Channel Comparison Maps

Attachment 4 Steve Erb Testimony; Reporter's Transcript of Proceedings, vol. X, pp. 75-85 (February 16, 1994)

Attachment 5 Riparian Vegetation Maps

Attachment 6 The Nature Conservancy Water Table Map

Attachment 7 Aravaipa Creek Berm Photos

Attachment 8 Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison Maps

Attachment 9 Large Wells In and Near the Subflow Zone

Attachment 10 LRE Subflow Zone on AGS Maps

Attachment 11 ADWR and LRE Subflow Zone Comparison Maps

Attachment 1

Affidavit of Jon R. Ford

AFFIDAVIT OF JON R. FORD

STATE OF COLORADO)
) ss
County of Denver)

JON R. FORD, being first duly sworn, upon his oath deposes and says:

1. I am a principal in the Denver, Colorado firm of Leonard Rice Engineers, Inc. ("LRE"). I have been with that company since 1986. Prior to that time, I worked in various roles as a geologist and geophysicist in Colorado from 1972 to 1986. Among other things, I served as President and Senior Coal and Petroleum Geologist for Resource Technology Corporation in Denver from 1981 to 1985. I was Vice President and Senior Ground Water Geologist for Willard Owens Associates, Inc., in Wheat Ridge, Colorado from 1972 to 1977. A copy of my resume is attached to this affidavit.

2. I received bachelor's degrees in Geological Engineering and Geophysical Engineering from the Colorado School of Mines in 1972. In addition, I have over thirty-five years of experience working in the geology and groundwater hydrology field in Colorado, Arizona, and other parts of the West.

3. I am a Registered Professional Engineer in Colorado, a Registered Professional Geological Engineer in Arizona, and a Registered Professional Geologist in Wyoming.

4. I am a member of various professional groups, including the Arizona Hydrological Society, Colorado Ground Water Association, the Rocky Mountain Association of Geologists, the Society of Exploration Geologists, the American

Association of Petroleum Geologists, and the American Council of Engineering Companies of Colorado.

5. The statements contained in this Affidavit are made based upon my own personal knowledge and upon work performed by me or by the staff at LRE under my direct supervision.

6. I am familiar with issues relating to underground water in Arizona, in part as a result of my work for the Salt River Valley Water Users' Association and the Salt River Project Agricultural Improvement and Power District (collectively, "SRP").

7. I served as a consulting groundwater hydrology expert for SRP in the 1994 evidentiary proceedings before Judge Goodfarb regarding "subflow," which resulted in the Arizona Supreme Court's opinion in In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 198 Ariz. 330, 9 P.3d 1060 (2000) ("Gila IV").

8. Between 2001 and 2004, I served as a consulting groundwater hydrology expert for SRP in proceedings before Judge Eddward Ballinger of the Maricopa County Superior Court relating to implementation of the Arizona Supreme Court's decision in Gila IV.

9. SRP asked me to assist it in preparing its objections to the Arizona Department of Water Resources' June 2009 subflow zone delineation report for the San Pedro River Watershed. As part of that work, I reviewed ADWR's report and prepared various maps and figures that are included as attachments to SRP's objections to be filed on or about December 28, 2009.

10. In particular, I assisted in the preparation of Sections V through VI of those objections. The technical statements made in those sections are true and correct to the best of my knowledge and professional opinion.

JON R. FORD

SUBSCRIBED AND SWORN TO before me by Jon R. Ford this 18th day of December, 2009.

Martha K. Jones
Notary Public

My Commission Expires:

12/10/2011

MARTHA K. JONES NOTARY PUBLIC STATE OF COLORADO

Jon R. Ford

EDUCATION

B.S., 1972, Geological Engineering, Colorado School of Mines
B.S., 1972, Geophysical Engineering, Colorado School of Mines

REGISTRATION/CERTIFICATION

Registered Professional Engineer: Colorado
Registered Professional Geological Engineer: Arizona
Registered Professional Geologist: Wyoming
A.I.P.G. Certified Professional Geologist

EXPERIENCE

Leonard Rice Engineers, Inc., Denver, Colorado

1986-Present – Principal, Vice President, Senior Ground Water Geologist

Responsible for ground water geology studies, including interpretation and evaluation of hydrogeologic systems, computer modeling, aquifer testing, water supply development, water well drilling, ground water contamination and monitoring, evaluation of mining impacts on ground water systems, ground water/surface water relationships and stream depletions caused by well pumping. Duties require collection and analysis of data, report preparation and expert testimony. Significant projects include:

- Develop and calibrate a MODFLOW ground water model of the Big Chino Basin, Arizona. The purpose of the model is to predict the impact of future pumping on the base flow of the Verde River.
- Develop and calibrate two MODFLOW ground water models in the Verde Valley, Arizona. The purposes of the models were to estimate the Subflow Zone depletion caused by wells located within the lateral limits of the Subflow Zone but completed in a deeper aquifer.
- Evaluation of the hydrogeology of the Box Elder and Beebe Draw alluvial aquifers, preparation of an aquifer mass balance for eleven time periods from 1930 to the present, and estimation of the timing and amount of depletion to the South Platte River caused by irrigation well pumping. This project relied heavily upon GIS tools that we specifically developed for this project. It was done for the Central Colorado Water Conservancy District in support of adjudication of the District's augmentation plans and application to Ground Water Commission for Designated Basin (included expert testimony).
- Served as a member of the U.S. Bureau of Reclamation "C" Aquifer Technical Advisory Group representing the Salt River Project. The Bureau of Reclamation has been tasked with evaluating the feasibility of the "C" Aquifer in northeast Arizona to replace the "N" Aquifer as source of supply for a coal slurry pipeline. My role included review and interpretation of technical data and computer modeling of the aquifer, as well as providing suggestions regarding revisions to the work plan based upon my interpretations. A significant focus of this effort was quantification of future stream depletions due to well pumping and at its impact on endangered aquatic species.
- Evaluation and computer modeling of the South Platte alluvial aquifer in the vicinity of Brighton, Colorado. This work was done for the City of Brighton for various purposes including siting a new well field to meet future water supply needs of the City and to quantify stream depletions due to well pumping.
- Participation in a peer review team of the hydrogeology of the Hueco Bolson and ground water modeling of the Bolson completed by the U.S. Geological Survey. The purpose of this review was to provide the El Paso Water Utilities with an independent assessment of the Bolson aquifer and the computer modeling.
- Computer simulation of Beebe Draw Alluvial Aquifer near Barr Lake to assess return flow pattern of historically irrigated farms and depletion pattern of well pumping to Beebe Seep Canal.

- Design and construction observation of numerous Denver Basin Aquifer wells for Donala Water and Sanitation District, Towne Center Metropolitan District, Heather Gardens, and South Suburban Parks and Recreation.
- Design and construction observation, Little Nell Well and Tourtellotte Spring Collection System, Aspen, Colorado; Sopris Village Well, El Jebel Colorado, Well R2 and West Vail 7, Vail, Colorado; Wells 26 and 31, Beebe Draw Wells A & B, City of Brighton.
- Analysis of Ground Water available for Appropriation, Lakewood, Colorado (includes expert witness testimony and litigation negotiation with objectors).
- Well yield forecast and well field development plan including present value economic analyses for Rangeview Water and Sanitation District, City of Lakewood, City of Arvada, and Donala Water and Sanitation District.
- Hydrogeologic analysis and delineation of fracture system to select well sites, and design and construction observation of two wells at Buttermilk Ski Area, Aspen, CO.
- Evaluation of the Hydrogeologic setting and ground water mass balances of the Big Chino Valley, San Pedro River, and Verde River Basins, Arizona.
- Evaluation and appraisal of value of ground water available for export to Phoenix metropolitan area from two ranches in northwestern Arizona.
- Evaluation of hydrogeologic setting of the Pagosa Springs geothermal reservoir, Pagosa Springs, Colorado.
- Expert testimony in the Gila River Adjudication in Arizona regarding the delineation of appropriable ground water.

Responsible for well pump and pump station design. Significant projects include:

- South Suburban and Lone Tree Golf Course well pump installation (Denver Basin).
- Donala Water and Sanitation District, Towne Center Metropolitan District and Heather Gardens (Denver Basin).
- City of Black Hawk North Clear Creek Pump Station and Infiltration Gallery.
- City of Black Hawk Four Mile Gulch Pump Station.
- Upgrade of Vail Well R2 and Well R6 Pump Station.
- Transient pressure analysis of Eagle Pines Pump Station, Aspen, Colorado.
- Transient Pressure analysis, Little Nell Well, Aspen, Colorado.
- Design and transient pressure analysis, Hidden Valley Booster Pump Stations (3), Black Hawk, Colorado.

1985-1986 – Consulting Geological Engineer

- Conducted detailed geological evaluation of a 198 well, oil field in preparation of field extension drilling program. Drilled two successful wells that proved 8-10 additional drill sites.
- Conducted geologic and engineering evaluation of 120 gas well purchase. Work included reserve forecasts, economic analyses and analysis of undrilled acreage.

Resource Technology Corporation, Denver, Colorado

1981-1985 – President and Senior Coal and Petroleum Geologist/Engineer

- Developed a petroleum exploration model that delineated areas of greatest potential in the Niobrara Formation of the Denver Basin. Model integrated geologic elements of well log analysis, core examination and satellite image analysis with engineering data that included production forecasts and well completion practices.
- Completed a subsurface mapping effort in the Piceance Basin to identify mature source (coal beds) rocks and reservoir rocks. The effort focused on identifying areas where there was secondary permeability of sandstones of the Mesa Verde Formation along with mature gas generating coal beds.
- Designed gas and oil well completions (casing, perforations, cementing, hydro-tracing) for wells in Colorado and Wyoming (D-J and Powder River Basins).

1978-1981 – Vice President and Senior Geologist

Managed a team of up to 30 geologists and technicians that conducted a three-year-long evaluation of coal resources in Colorado, Wyoming, Utah, New Mexico, South Dakota and Montana for the U.S. Geological Survey. Project included detailed subsurface mapping and estimation of reserves of 120 Federal coal leases including leases in the San Juan, Raton, and Piceance Basins. Mapping included coal bed isopach, overburden isopach, structure maps, and coal bed correlation cross-sections.

Digilog Inc., Broomfield, Colorado

1977-1978 – Vice President and Geophysicist

Founded and managed a uranium and coal borehole geophysical logging company. Designed and built state of the art geophysical logging units.

Willard Owens Associates, Inc., Wheat Ridge, Colorado

1972-1977 – Vice President and Senior Ground Water Geologist

Responsible for design and installation of municipal wells in the Denver Basin. Designed and installed high capacity irrigation wells in Kit Carson and Alamosa Counties. Conducted water supply evaluations in Routt, Jefferson, Boulder, Douglas, and Eagle Counties. Served as expert witness before State of Colorado Water Court, and various County Commissions regarding water supply availability. Designed uranium in-situ leaching monitoring programs.

PROFESSIONAL ACTIVITIES

Colorado Ground Water Association
Rocky Mountain Association of Geologists
American Council of Engineering Companies of Colorado
Arizona Hydrological Society
Society of Exploration Geophysicists
American Association of Petroleum Geologists

PUBLICATIONS

Two Examples of Quantification of Subflow Zone Depletion in Arizona, American Institute of Professional Geologists and Arizona Hydrological Society Joint Symposium, Flagstaff, AZ, 2008 (with Thad Kuntz and Stephanie Schmidt).

Using MODFLOW and PEST to Estimate Yields of Horizontal and Radial Collector Wells, Proceedings of MODFLOW and More 2006: Managing Ground Water Systems, Colorado School of Mines, May 21-24, 2006 (with Mike LeFrancois).

Designing Brighton's New Well to Maximize Yield During a Drought, American Society of Civil Engineers Biennial Denver Geotechnical Symposium, Denver, CO, 2004.

Stream Depletion Determination Methods: A Survey; Modeling and non-Modeling Issues, Colorado Bar Association Ground Water Conference, Denver, CO, 2004.

Big Chino Valley Ground Water as the Source of the Verde River, American Water Resources Association Conference, July 2002.

Gila River Adjudication "Issue 2" from the Hydrologist's Perspective – A Panel Presentation, Arizona Water Law Conference, Phoenix, AZ, 2001.

Ground Water Resources of the Denver Basin, a map of ground water available by County, April 2000 (with Heather Justus).

Evaluation of the Pagosa Springs Geothermal Reservoir, American Society of Civil Engineers Conference, Denver, CO, May 1994 (with Dennis McGrane).

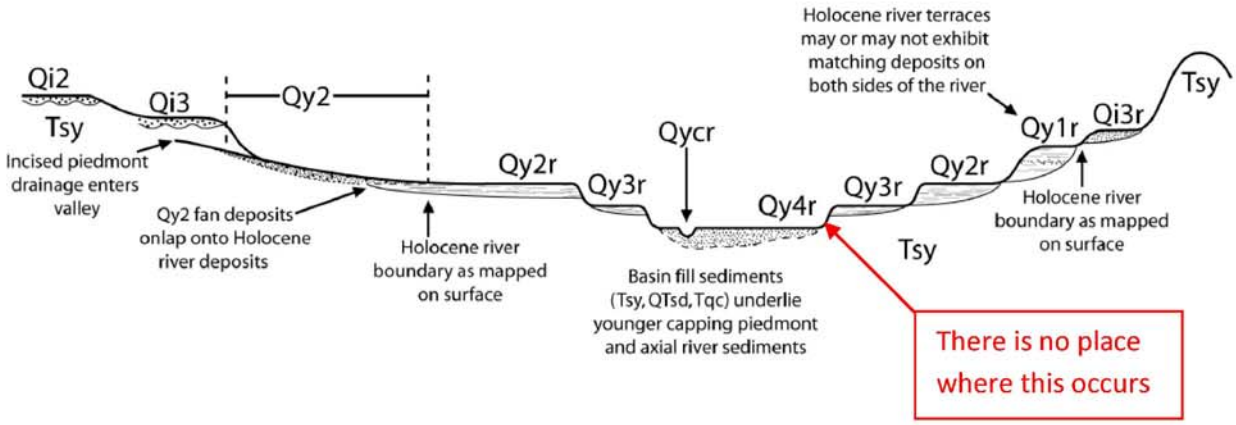
Gila River Recharge Project As An Alternative to Buttes Dam, Conserv90, Phoenix, AZ, August 1990 (with Dennis McGrane).

Resolving a Groundwater Conflict in Colorado, ASCE Water Resources Planning and Management Division Specialty Conference, Norfolk, VA, June 1988 (with Leonard Rice).

Attachment 2

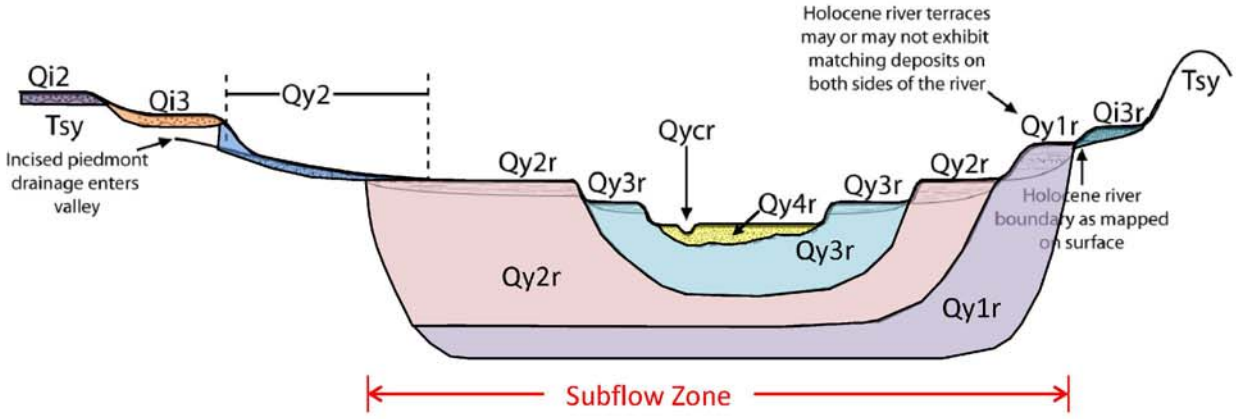
Figures A through M

ADWR/AGS View of Quaternary Stratigraphy



Generalized cross section of geomorphic relationships between Tertiary basin fill (Tsy), Pleistocene piedmont and river (Qi_n and Qi_nr units), and Holocene piedmont and river (Qy_n and Qy_nr units) deposits (from ADWR Figure 4.1, 2009, and AGS Figure 3, 2008).

Corrected Quaternary Stratigraphy



Corrected generalized cross section based upon subsurface interpretation of driller's logs.

ATTACHMENT 2
FIGURE A

GENERALIZED QUATERNARY STRATIGRAPHY
SAN PEDRO RIVER FLOODPLAIN

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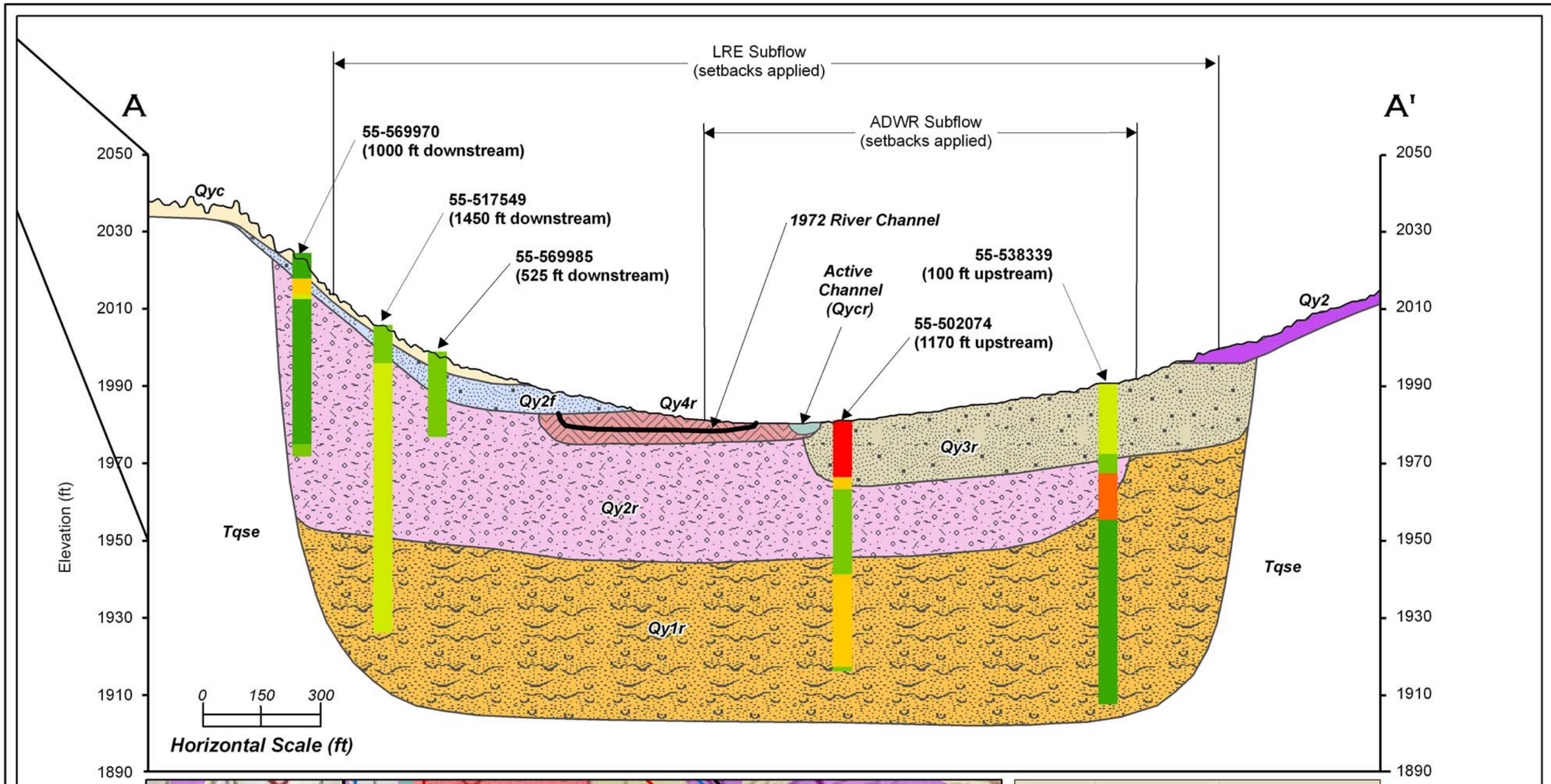
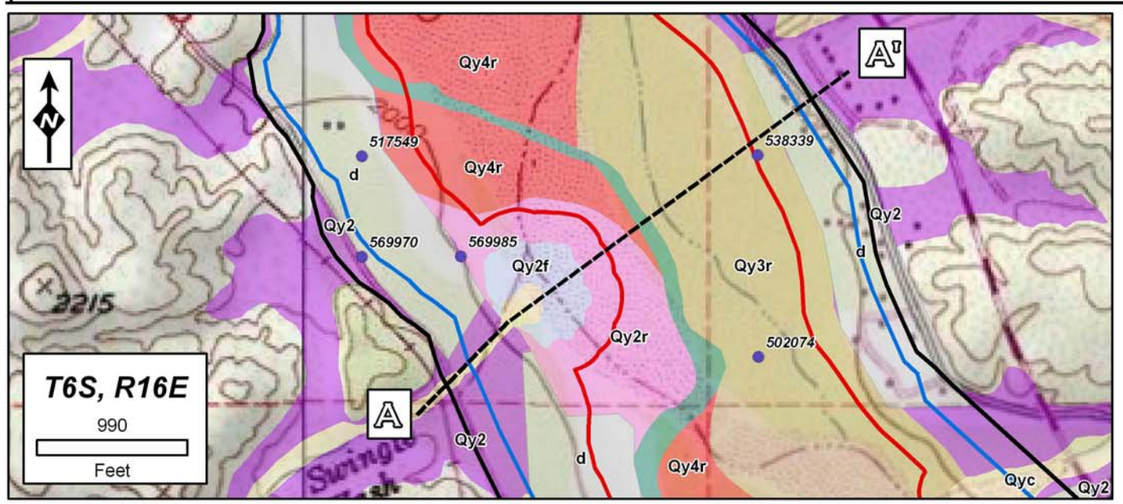
ATTACHMENT 2
FIGURE B

SAN PEDRO PRESERVE GEOLOGIC CROSS-SECTION





RIVER
- Active River Channel (Qycr)
- Flood channel and low terrace deposits (Qy4r)
- Historical river terrace deposits (Qy3r)
- Latest Holocene to historical river terrace deposits (Qy2r)
- Late to early Holocene river terrace deposits (Qy1r)

TRIBUTARY
- Modern stream channel deposits (Qyc)
- Older Holocene alluviul fan (Qy2f)
- Late Holocene alluvium (Qy2)

- Pliocene Quibris basin fill deposits, (Tqse)

Qy4r includes 1947, 1955, 1972, 1990, 1994, and current San Pedro River Channels
Qy3r includes 1877, 1910, and 1934 San Pedro River channels

Wellbore Lithology
- Topsoil
- Gravel with sand, silt, and clay
- Clay, silt, and sand
- Gravel and cobbles
- Sand and gravel
- Silt and sand

- Saturated Floodplain Holocene Alluvium
- LRE Subflow Zone
- ADWR Subflow Zone

Surface Geologic mapping from AGS, 2008

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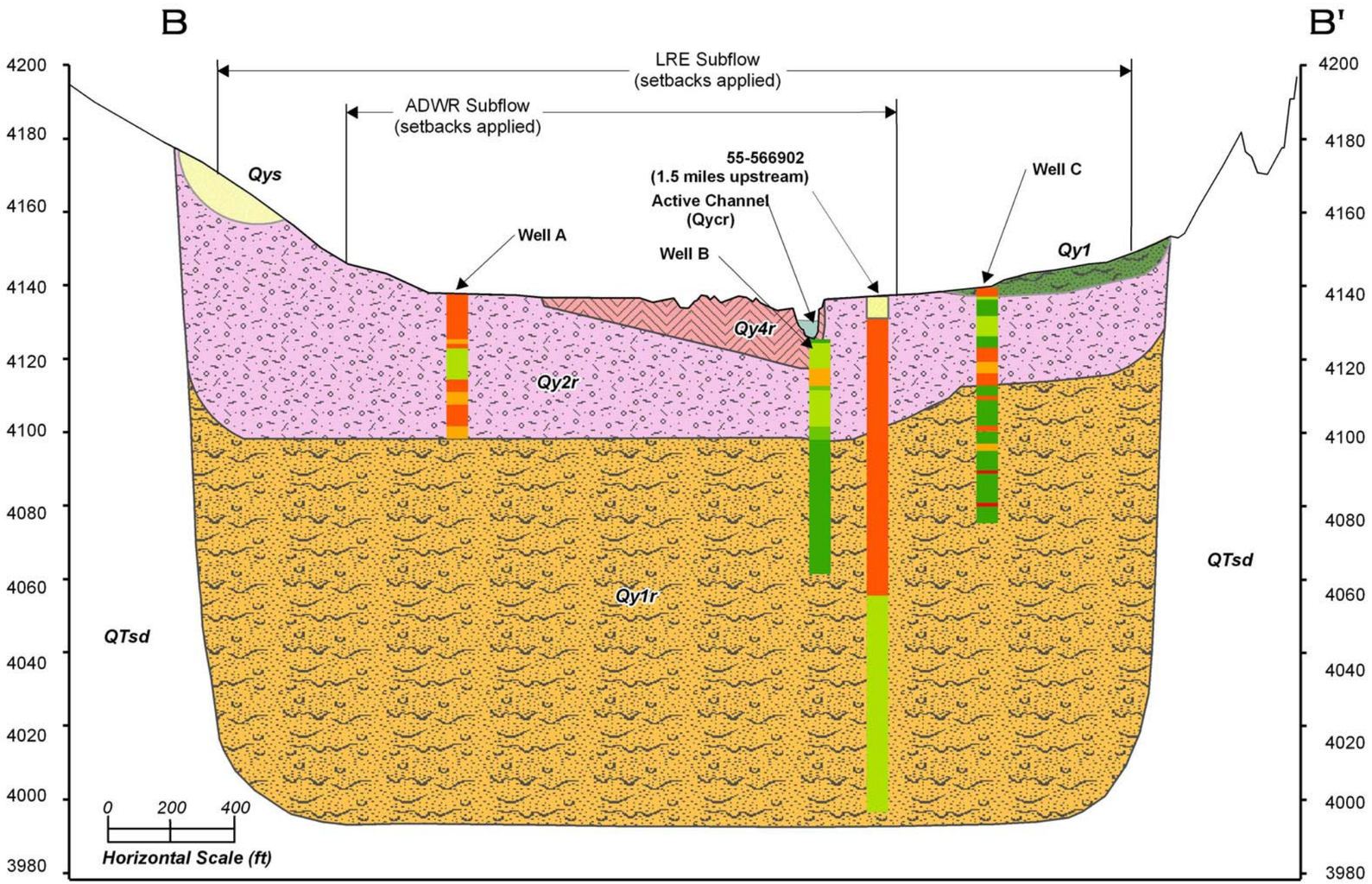
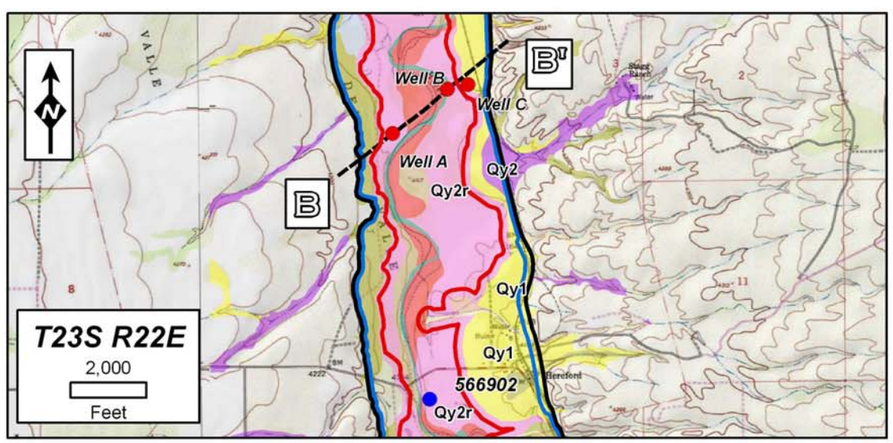
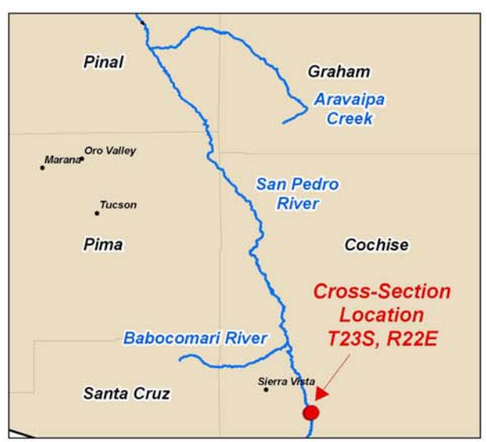
ATTACHMENT 2
FIGURE C

HEREFORD MEANDER CROSS-SECTION







RIVER
- Active River Channel (Qycr)
- Flood channel and low terrace deposits (Qy4r)
- Latest Holocene to historical river terrace deposits (Qy2r)
- Late to early Holocene river terrace deposits (Qy1r)

TRIBUTARY
- Older Holocene alluvium (Qy1)
- Holocene fine-grained deposits (Qys)
- Pliocene to Pleistocene Saint David Formation (QTsd)

Wellbore Lithology
- Silty Clay
- Gravel
- Sand and Gravel
- Overburden
- Sand
- Clay, Silt, and Sand
- Shale

- Saturated Floodplain Holocene Alluvium
- LRE Subflow Zone
- ADWR Subflow Zone

Surface Geologic mapping from AGS, 2008

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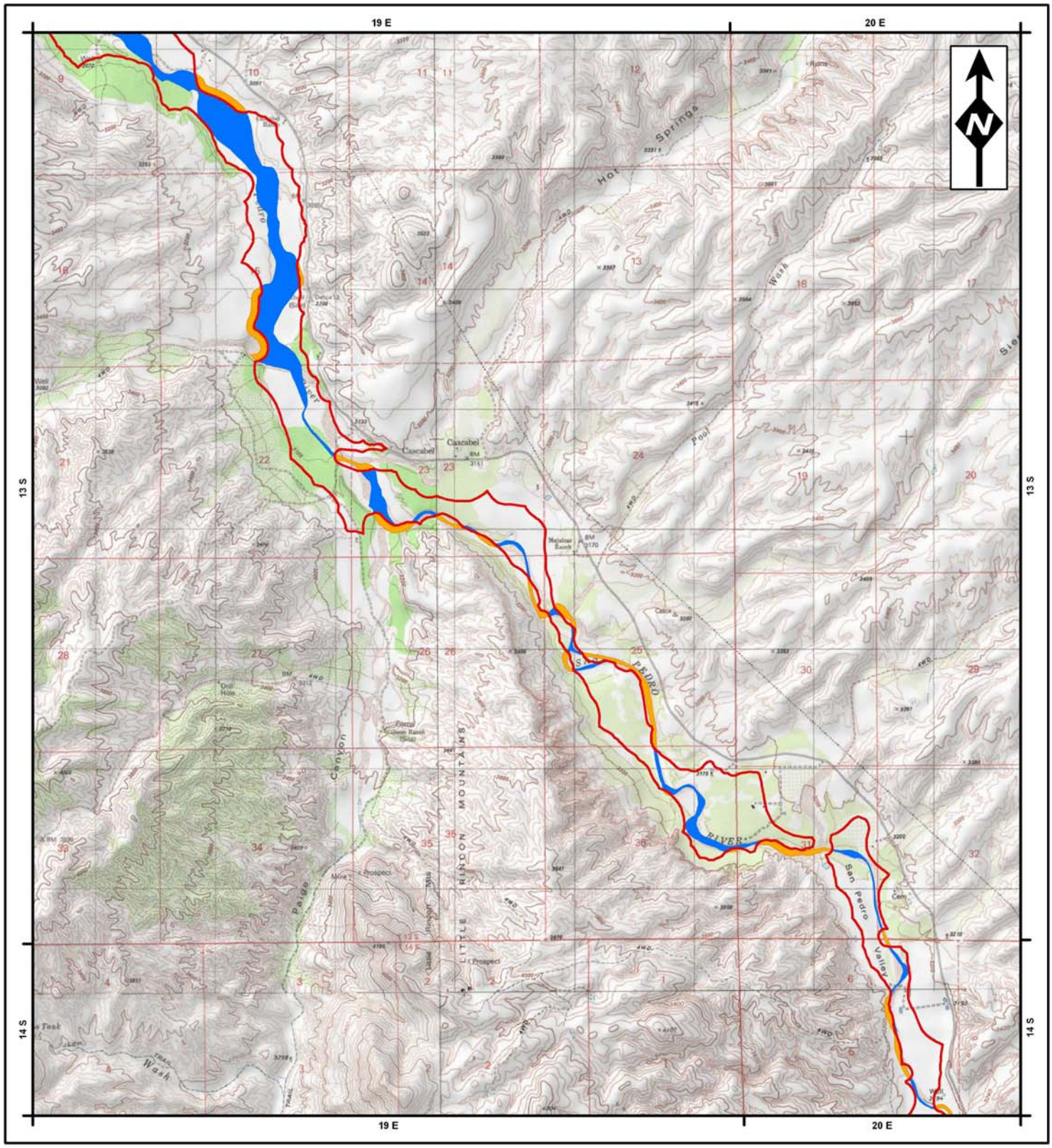

2009 ADWR Subflow Zone

Instances where active river channel is outside of ADWR subflow zone

2008 AGS active river channel

0 1 2

Miles

ATTACHMENT 2
FIGURE D

EXAMPLE LOCATIONS WHERE THE ACTIVE RIVER CHANNEL (ADWR 2009) IS OUTSIDE OF THE ADWR SUBFLOW ZONE

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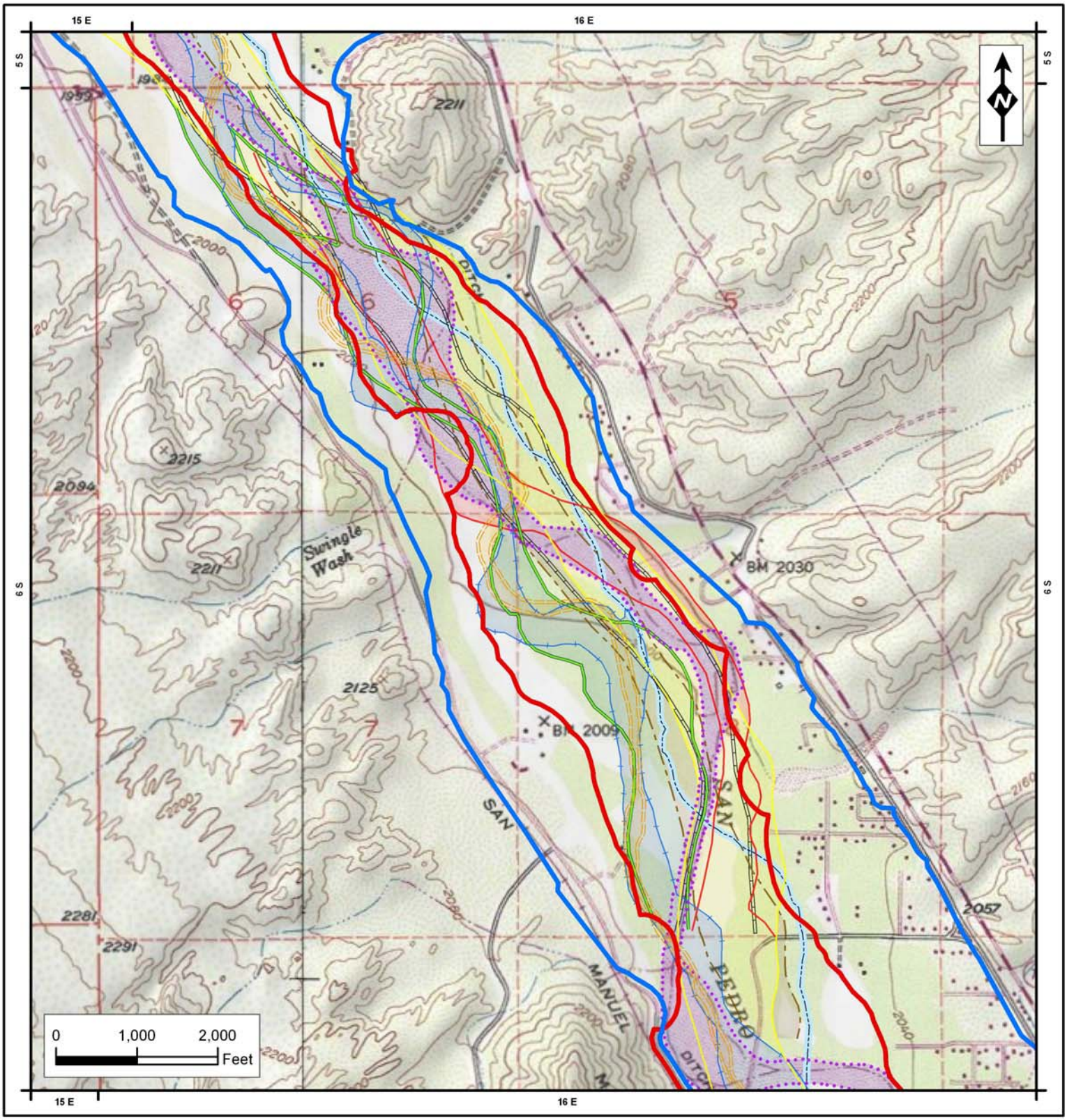

- *1877: Survey of Gila and Salt River Meridian, General Land Office
- *1910: Winkelman Quadrangle, 30 Minute Series, 1913 Edition, USGS.
- *1934: Aerial Photographs, Soil Conservation Service
- 1947: LRE Aerial Photograph Interpretation
- 1955: LRE Aerial Photograph Interpretation
- *1972: Winkelman, Dudleyville, and Lookout Mountain quadrangles, 7.5 Minute Series, USGS.
- 1990: LRE Aerial Photograph Interpretation
- *1994: Aerial Photographs, Pinal County
- 2008: Arizona Geological Survey
- ADWR Subflow Zone
- LRE Subflow Zone

* Indicates that the Data was Derived from Arizona Geological Survey Open-File Report OFR 97-21. Plate 3. Historical Changes in the Active Boundaries of the San Pedro River, Dudleyville Area.

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ATTACHMENT 2
FIGURE E

SAN PEDRO RIVER MEANDERS SINCE 1877

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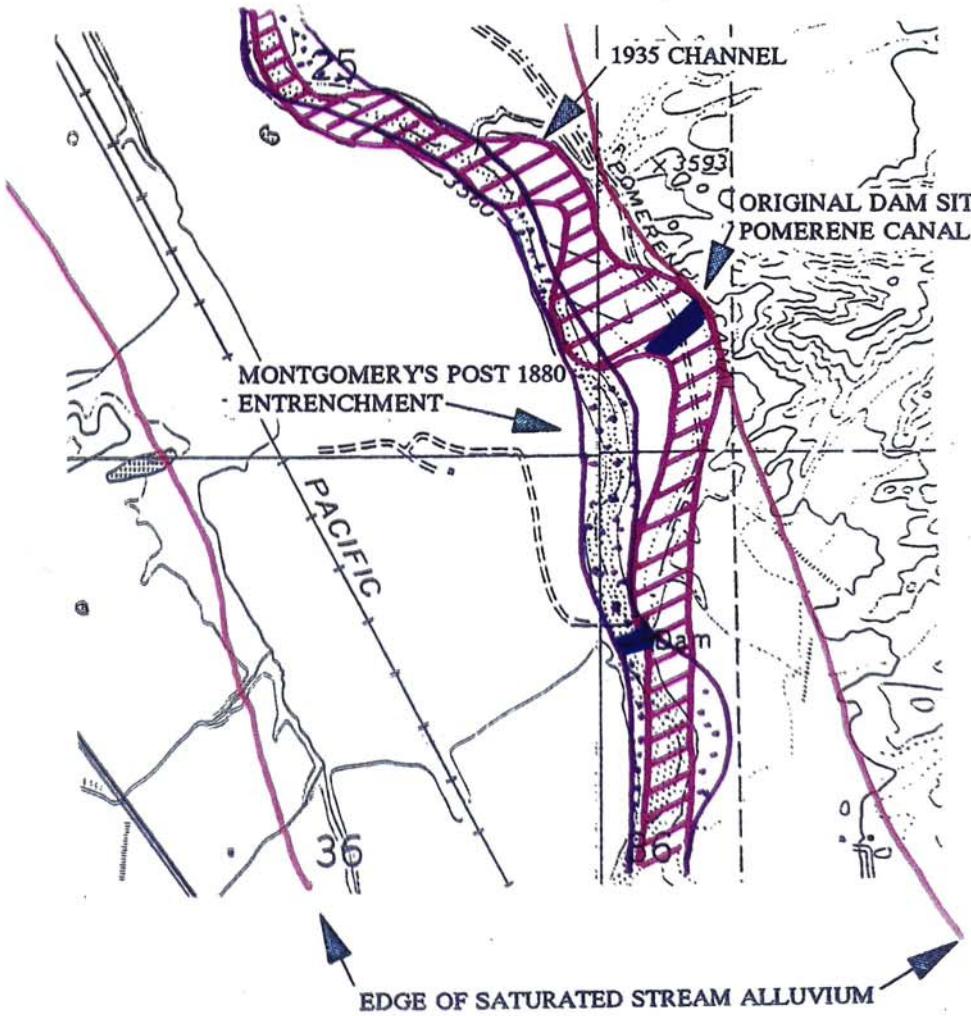
EXTENT OF ENTRENCHMENT OF SAN PEDRO RIVER

VICINITY OF POMERENE CANAL COMPANY DAM

T.17S., R.20-21E.



Appendix 0-3
Exhibit 319

0 0.25 0.5
Miles

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ATTACHMENT 2
FIGURE F

APPENDIX 0-3, EXHIBIT 319, 1994 ORDER

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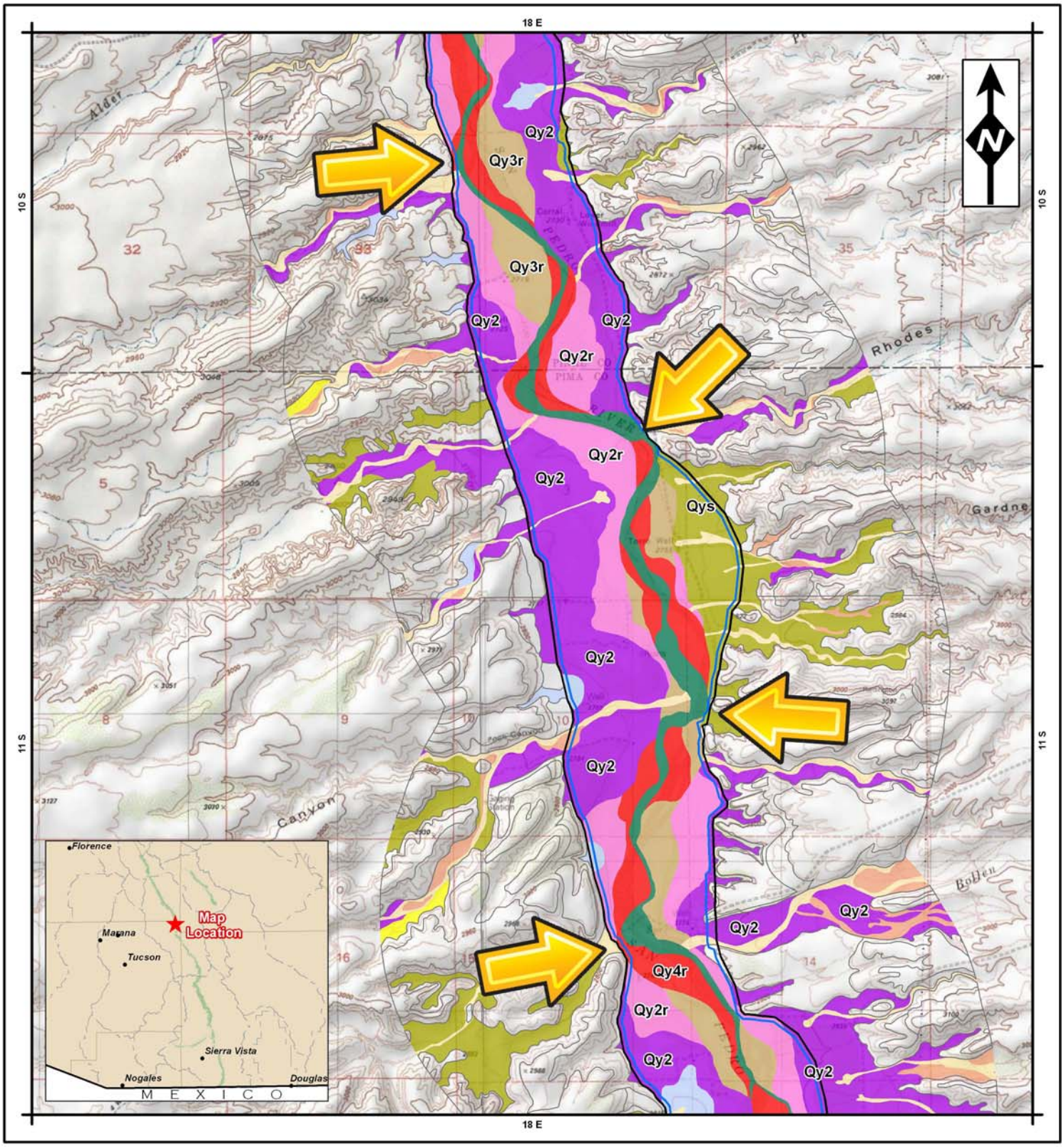

Geologic Unit

River
- Active river channel deposits (Qycr)
- Flood channel and low terrace deposits (Qy4r)
- Historical river terrace deposits (Qy3r)
- Latest Holocene to historical river terrace deposits (Qy2r)
- Late to early Holocene river terrace deposits (Qy1r)

Tributary
- Modern stream channel deposits (Qyc)
- Latest Holocene alluvium (Qy3)
- Older Holocene alluviul fan (Qy2f)
- Late Holocene alluvium (Qy2)
- Older Holocene alluvium (Qy1)
- Holocene fine-grained deposits (Qys)
- Disturbed ground (d)

Geology from AGS 2008

Indicates locations where active river channel meanders from one side of the floodplain to the other

LRE edge of Subflow Zone

LRE edge of Saturated Floodplain Holocene Alluvium

0 50 100
Miles

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Attachment 2
Figure G

Example Locations where the San Pedro River Meanders Back and Forth Across the Entire Floodplain

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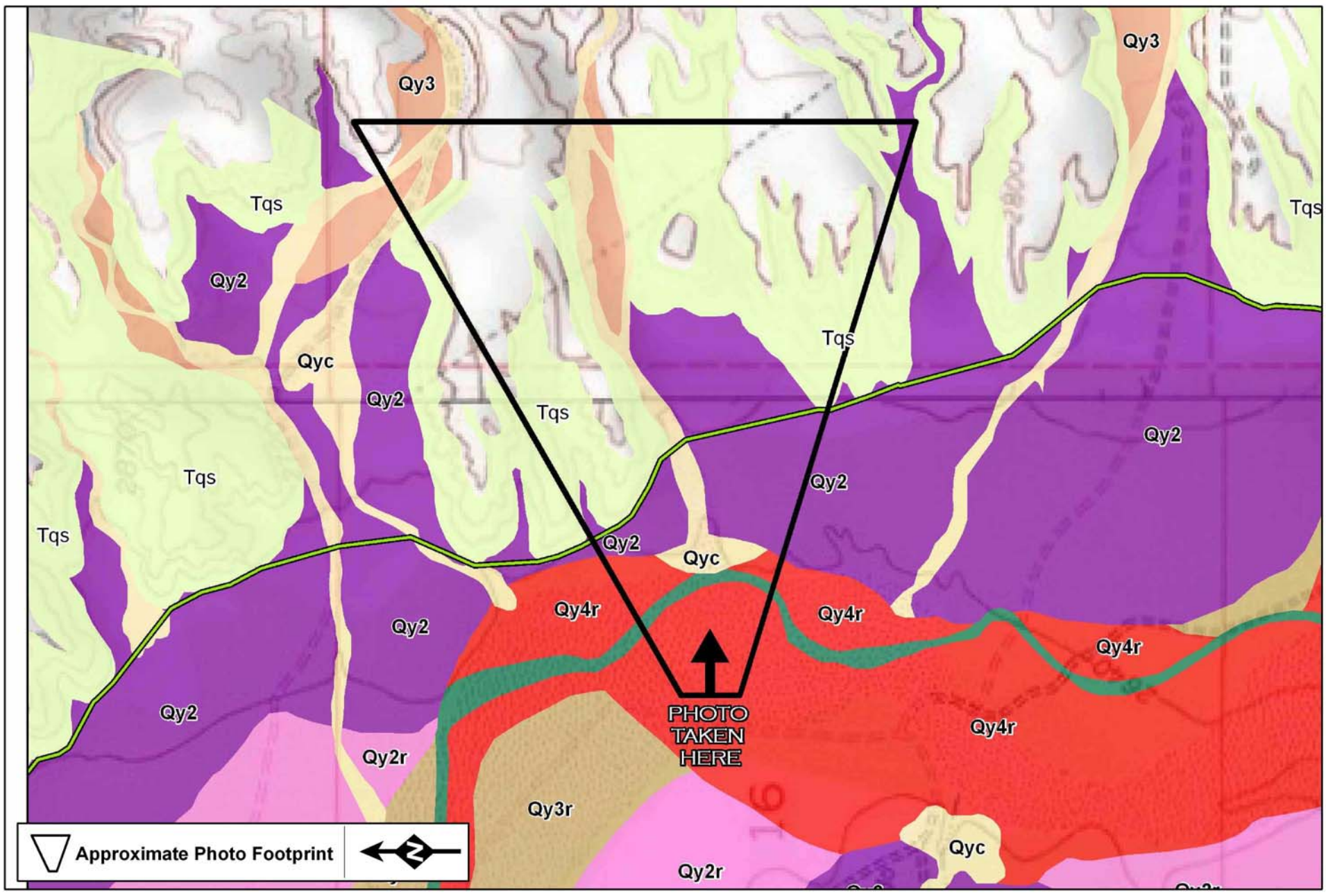

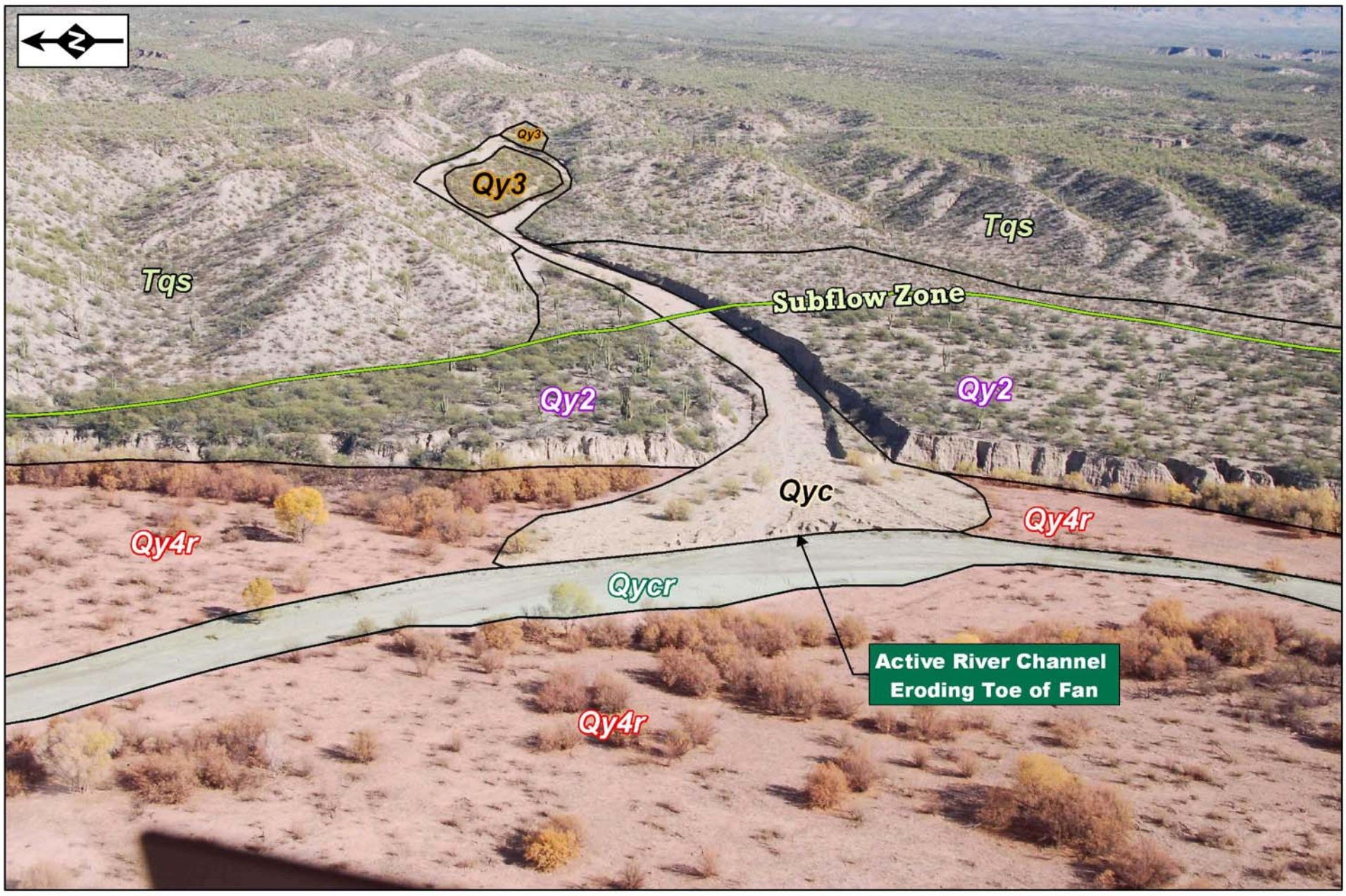

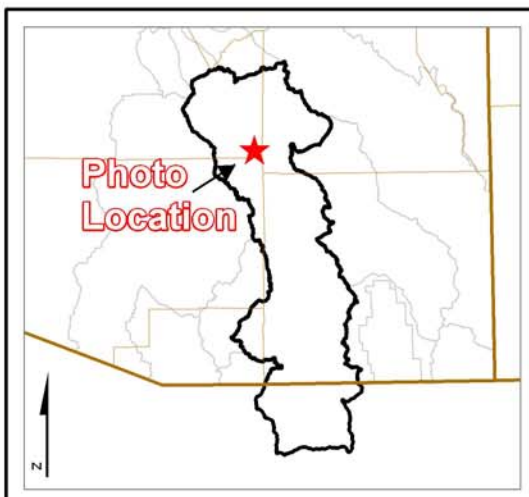

LRE edge of Saturated Floodplain Holocene Alluvium

MAP LEGEND:

RIVER
- Active river channel deposits (Qycr)
- Flood channel and low terrace deposits (Qy4r)
- Historical river terrace deposits (Qy3r)
- Latest Holocene to historical river terrace deposits (Qy2r)

TRIBUTARY
- Modern stream channel deposits (Qyc)
- Latest Holocene alluvium (Qy3)
- Late Holocene alluvium (Qy2)
- Tertiary and Pleistocene basin fill deposits (Tqs)

PHOTOGRAPH LEGEND:

RIVER
- Active river channel deposits (Qycr)
- Flood channel and low terrace deposits (Qy4r)

TRIBUTARY
- Modern stream channel deposits (Qyc)
- Late to early Holocene river terrace deposits (Qy1r)
- Late Holocene alluvium (Qy2)
- Tertiary and Pleistocene basin fill deposits (Tqs)

GEOLOGY FROM AGS 2008

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ATTACHMENT 2
FIGURE H

SAN PEDRO RIVER ACTIVELY ERODING TOE OF ALLUVIAL FAN

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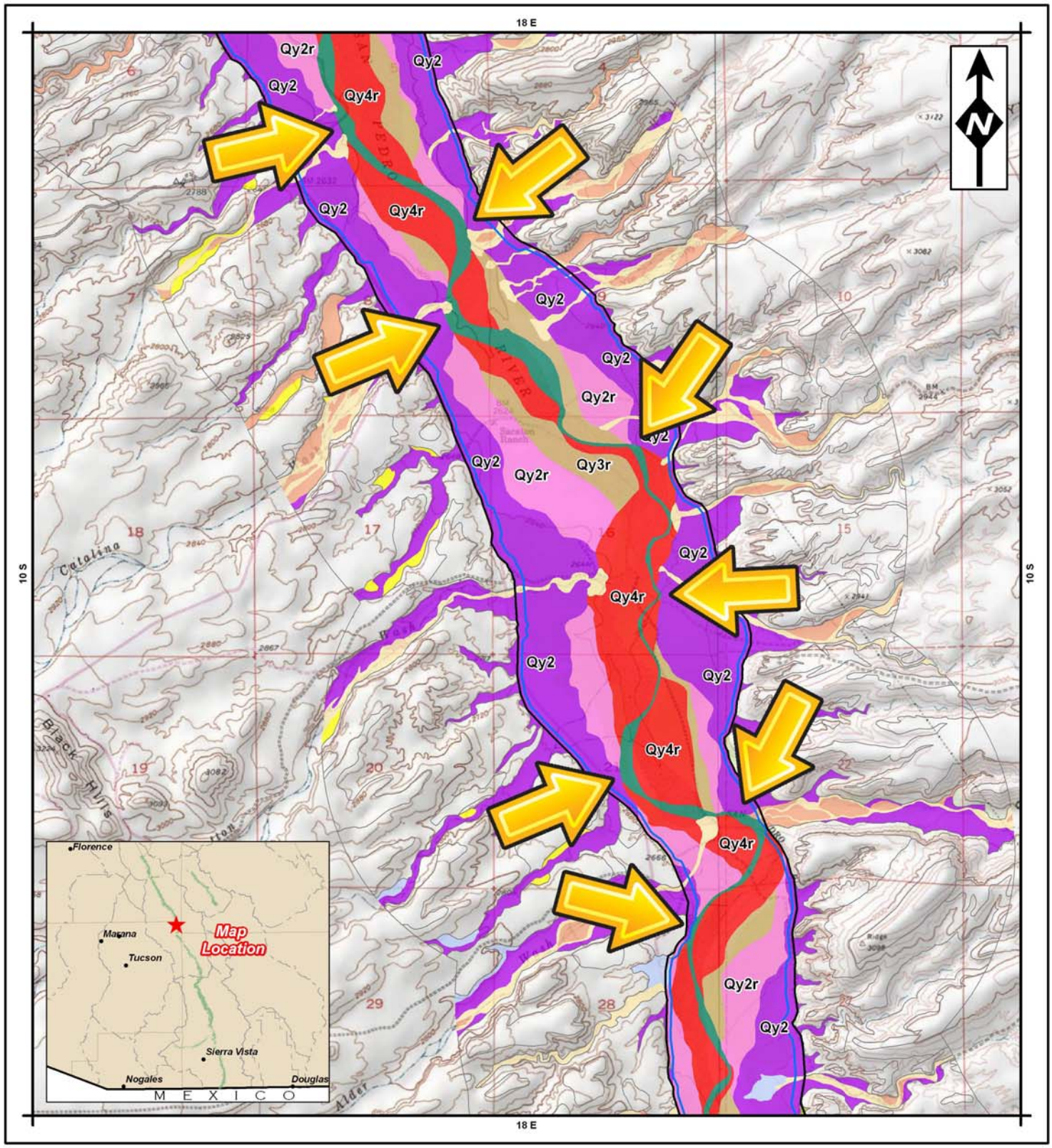

Geologic Unit

River
- Active river channel deposits (Qycr)
- Flood channel and low terrace deposits (Qy4r)
- Historical river terrace deposits (Qy3r)
- Latest Holocene to historical river terrace deposits (Qy2r)
- Late to early Holocene river terrace deposits (Qy1r)

Tributary
- Modern stream channel deposits (Qyc)
- Latest Holocene alluvium (Qy3)
- Older Holocene alluvium (Qy2f)
- Late Holocene alluvium (Qy2)
- Older Holocene alluvium (Qy1)
- Holocene fine-grained deposits (Qys)
- Disturbed ground (d)

Geology from AGS 2008

Indicates locations where the current river channel is eroding the late Holocene alluvial fans overlapping the floodplain alluvium

LRE edge of Subflow Zone

LRE edge of Saturated Floodplain Holocene Alluvium

0 50 100
Miles

Substantial efforts have been made to accurately compile GIS data and documentation. Accuracy is not guaranteed. This product is for reference purposes only and is not to be construed as a legal document or survey instrument.

Attachment 2
Figure I

Example Locations where the Active River Channel is Eroding Holocene Alluvial Fans Overlapping the Floodplain Alluvium

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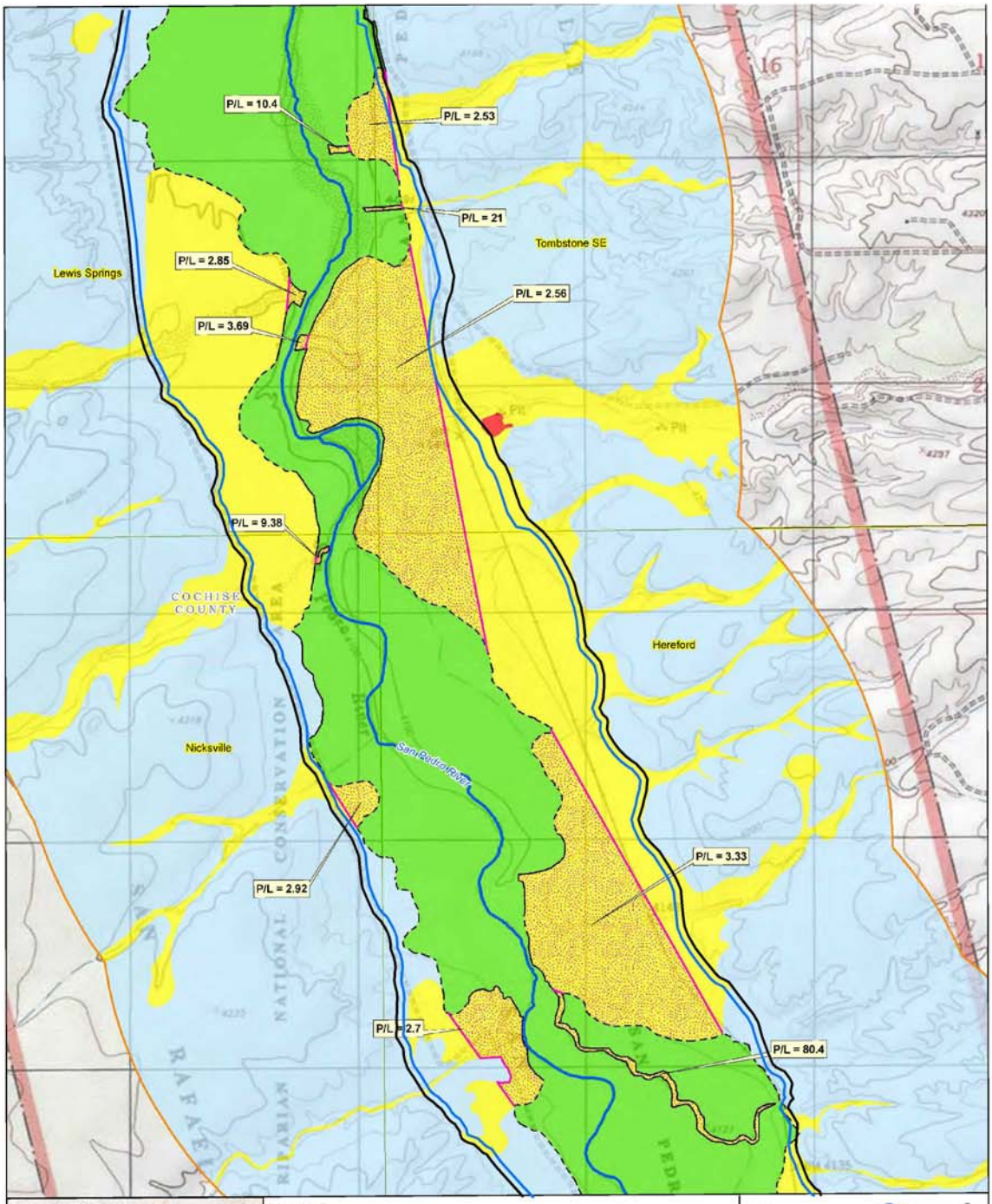

Legend

- Tributary Holocene Alluvium (THA) potentially overlaying Floodplain Holocene Alluvium (FHA)
- Inferred contact line (L)
- P/L — Ratio of perimeter (P) of feature within floodplain to its length (L) at floodplain edge (*only features with P/L ≥ 2.5 are shown*)
- Area Mapped by AZGS (2009)

Generalized Geologic Units*

- FHA [ADWR Subflow Zone]
- THA
- Disturbed (unit not determined)
- Basin Fill
- Bedrock

*See Table 4-2 for AZGS map units used by ADWR to define generalized geologic units in the San Pedro River Watershed.

Contact Between FHA and Other Mapped Units

- Well Defined (± 25 feet accuracy)
- Subtle or Gradational (± 50 feet accuracy)
- Approximate (± 250 feet accuracy)
- Major Stream
- San Pedro River Watershed
- County
- International Boundary
- USGS Topo Quad Boundary

- LRE edge of Subflow Zone
- LRE edge of Saturated Floodplain Holocene Alluvium

Base Map: USGS 1:24,000 Topo

N

ARIZONA DEPARTMENT OF WATER RESOURCES ©

0 0.25 0.5 Miles

Figure D-4a
Application of ADWR Criteria to Address Tributary Holocene Alluvium Mapped Within the San Pedro River Floodplain

Subflow Zone Delineation Report for the San Pedro River Watershed

Note: LRE Subflow Zone and Saturated Floodplain Holocene Alluvium added to ADWR Figure

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ATTACHMENT 2
FIGURE J

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695SLW01

0 1 2 Miles

LRE 1994 Subflow Zone
LRE 2009 Subflow Zone
ADWR Subflow Zone

ATTACHMENT 2
FIGURE K
SUBFLOW ZONE COMPARISON

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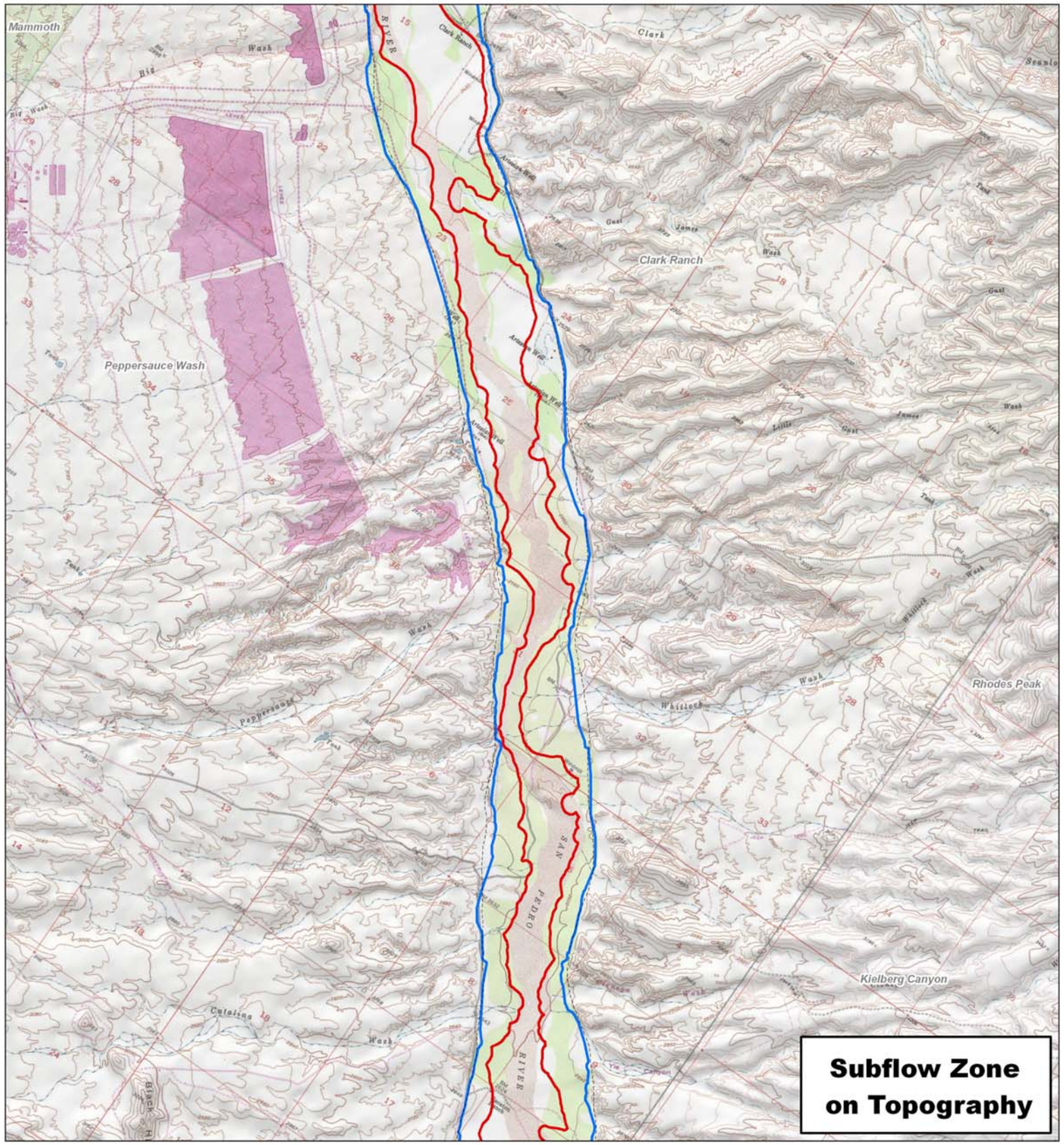

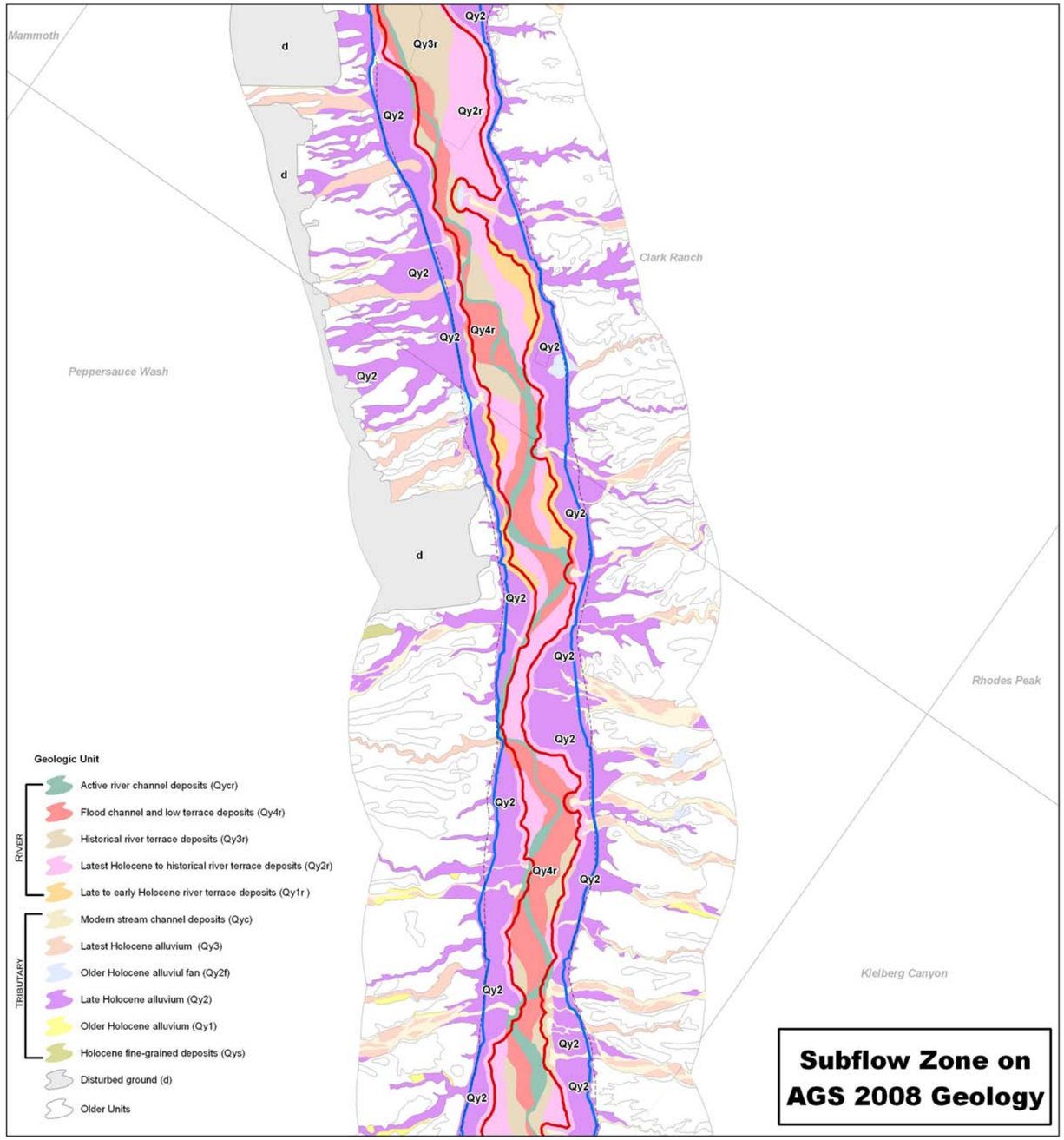

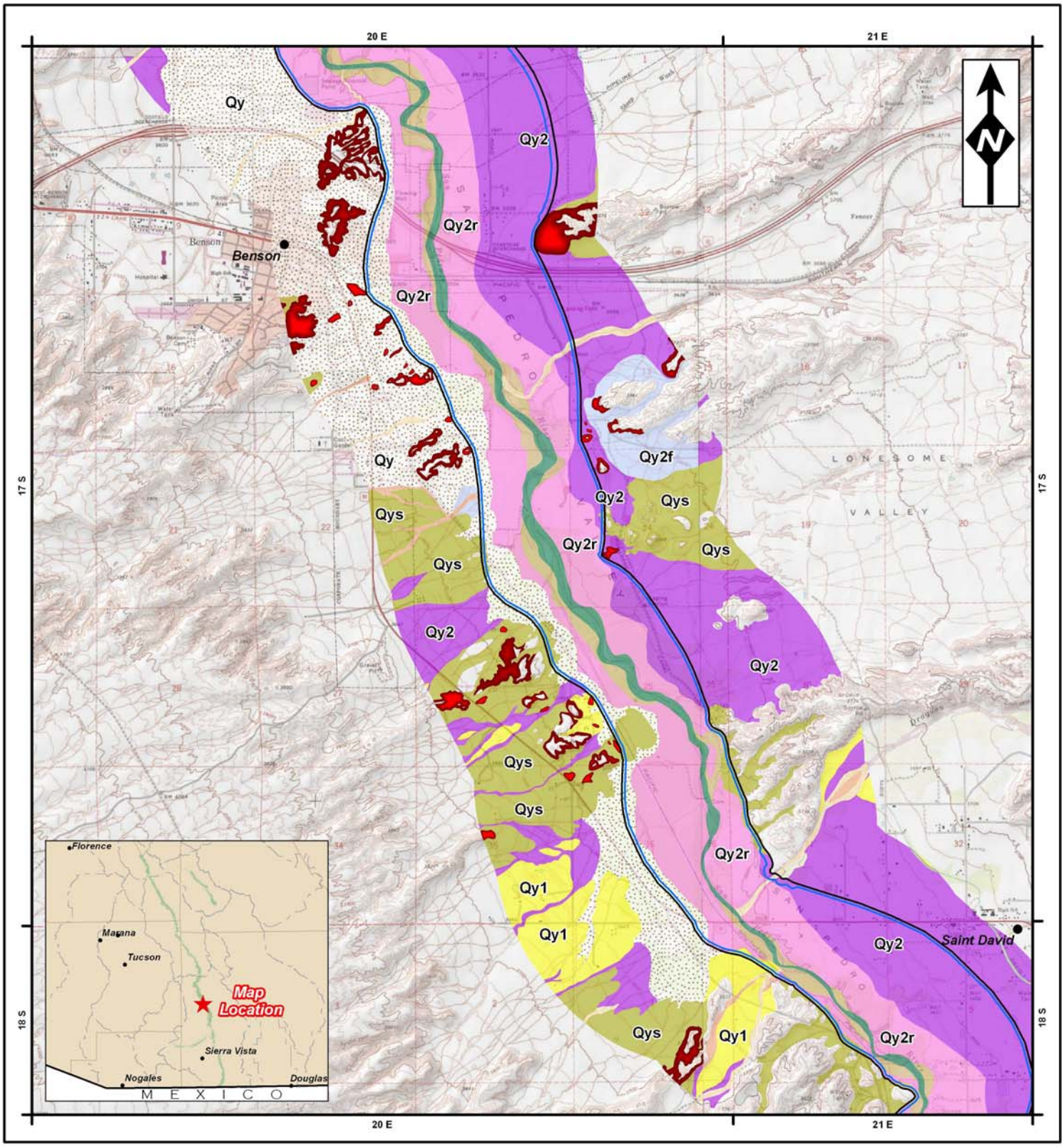

Geologic Unit

River

- Active river channel deposits (Qycr)
- Flood channel and low terrace deposits (Qy4r)
- Historical river terrace deposits (Qy3r)
- Latest Holocene to historical river terrace deposits (Qy2r)
- Late to early Holocene river terrace deposits (Qy1r)

Tributary

- Modern stream channel deposits (Qyc)
- Latest Holocene alluvium (Qy3)
- Older Holocene alluvium fan (Qy2f)
- Late Holocene alluvium (Qy2)
- Older Holocene alluvium (Qy1)
- Holocene fine-grained deposits (Qys)
- Holocene deposits undifferentiated (Qy)
- Disturbed ground (d)

Geology from AGS 2008

- *Basin fill inliers*
- *LRE edge of Subflow Zone*
- *LRE edge of Saturated Floodplain Holocene Alluvium*

0 50 100

Miles

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Attachment 2
Figure L

Example Locations where Basin Fill Deposits (Inliers) Extrude through Alluvium

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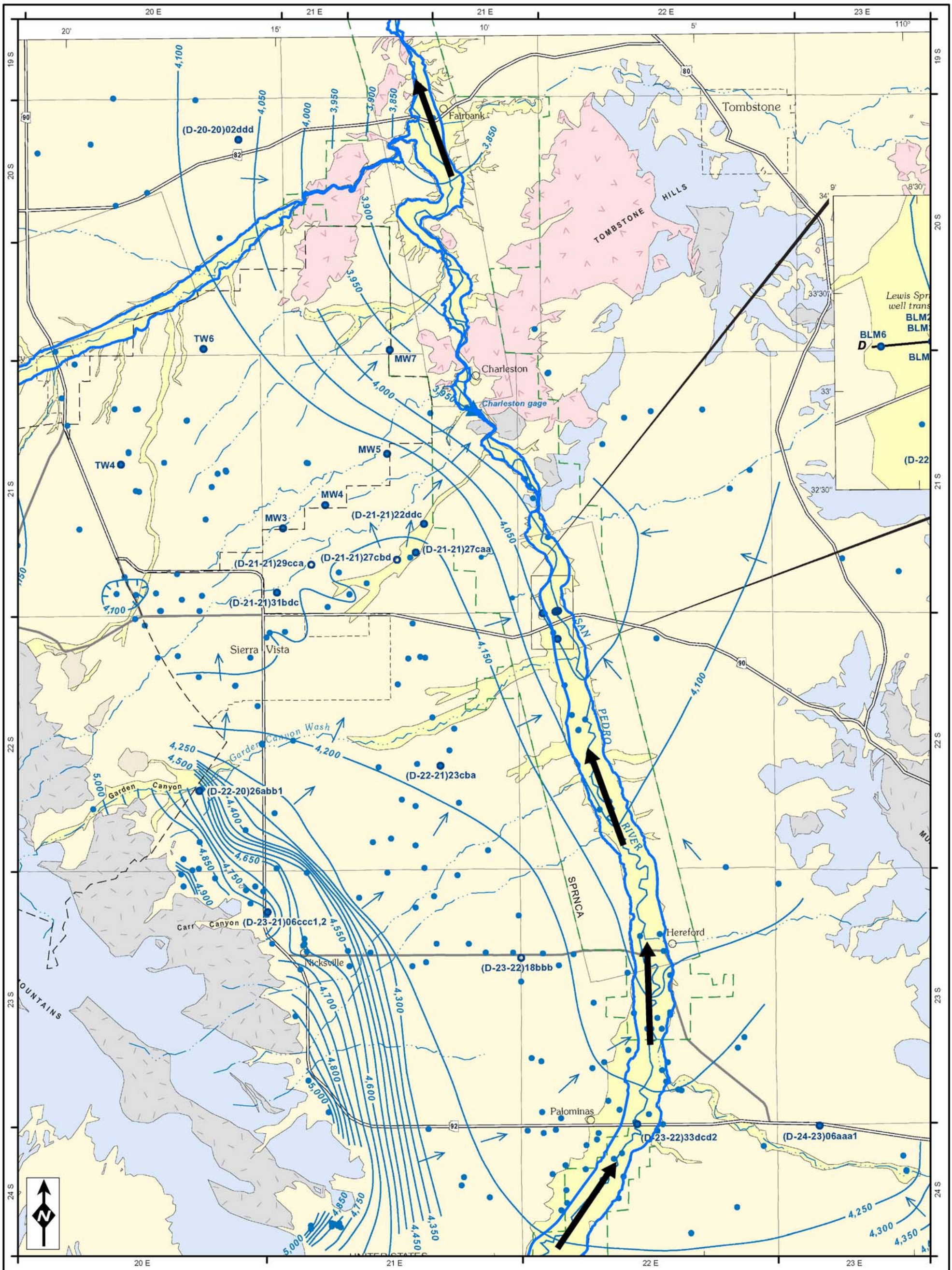
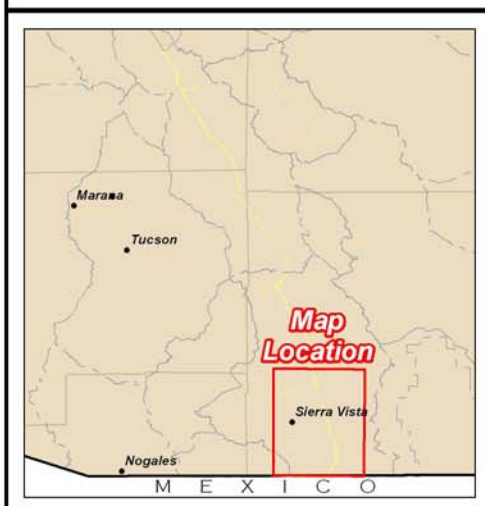




LRE edge of Subflow Zone

Driection of ground water flow in Subflow Zone parallel to San Pedro River

Substantial efforts have been made to accurately compile GIS data and documentation. Accuracy is not guaranteed. This product is for reference purposes only and is not to be construed as a legal document or survey instrument.

ATTACHMENT 2
FIGURE M

WATER TABLE IN THE UPPER SAN PEDRO BASIN FROM USGS WRI 99-4197 (PLATE 2)

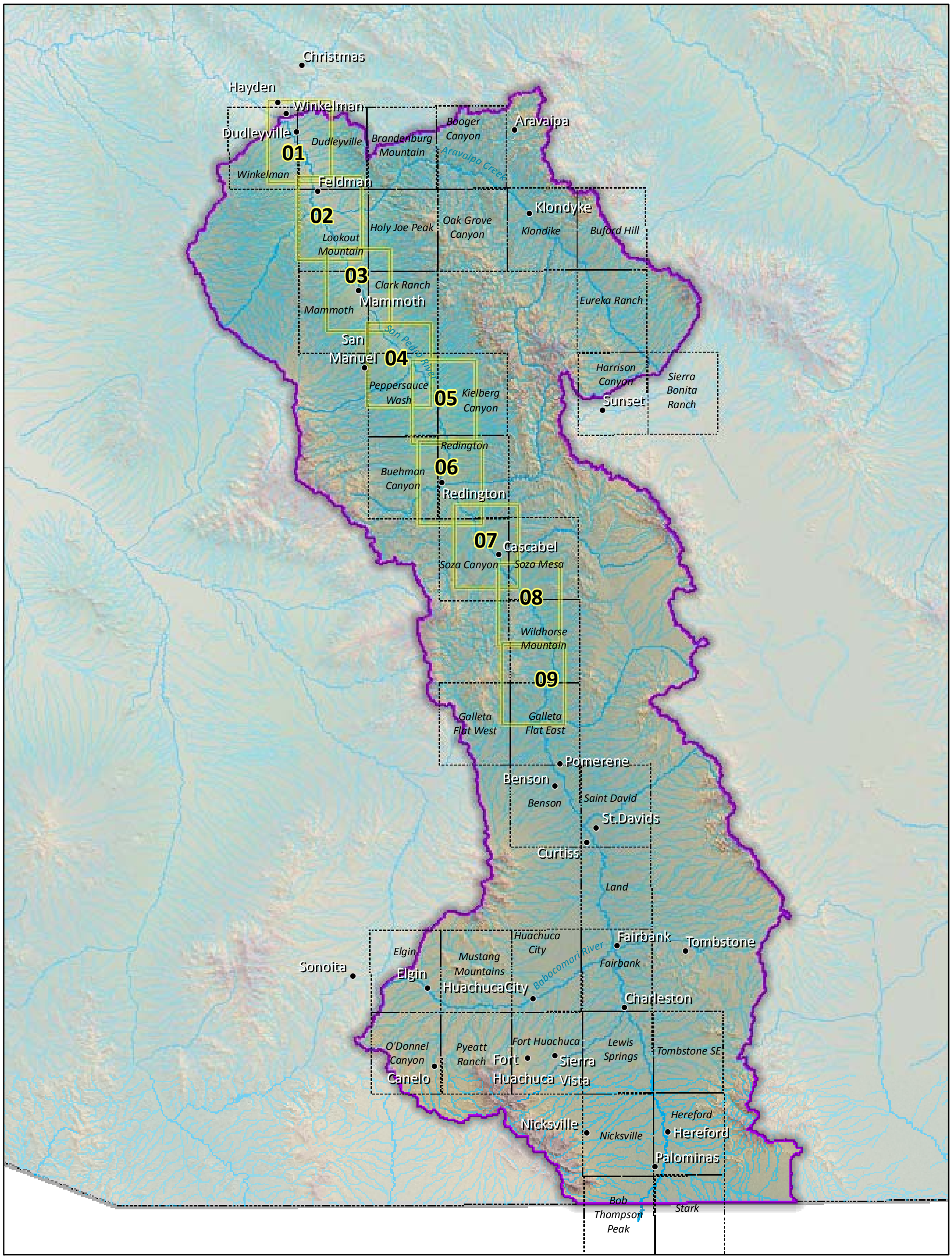
PROJECT: 695SLW01
DECEMBER 2009

LEONARD RICE ENGINEERS, INC.
2000 Clay Street, Suite 300 Denver, Colorado 80211-5119
(303) 455-9589 ♦ (800) 453-9589 ♦ Fax (303) 455-0115

Attachment 3

1935 and 2008 Channel Comparison Maps

Map Index for SRP San Pedro Attachments 3 & 5



Sheet Index

Miles
0 5 10 20

0 5 10 20
Kilometers

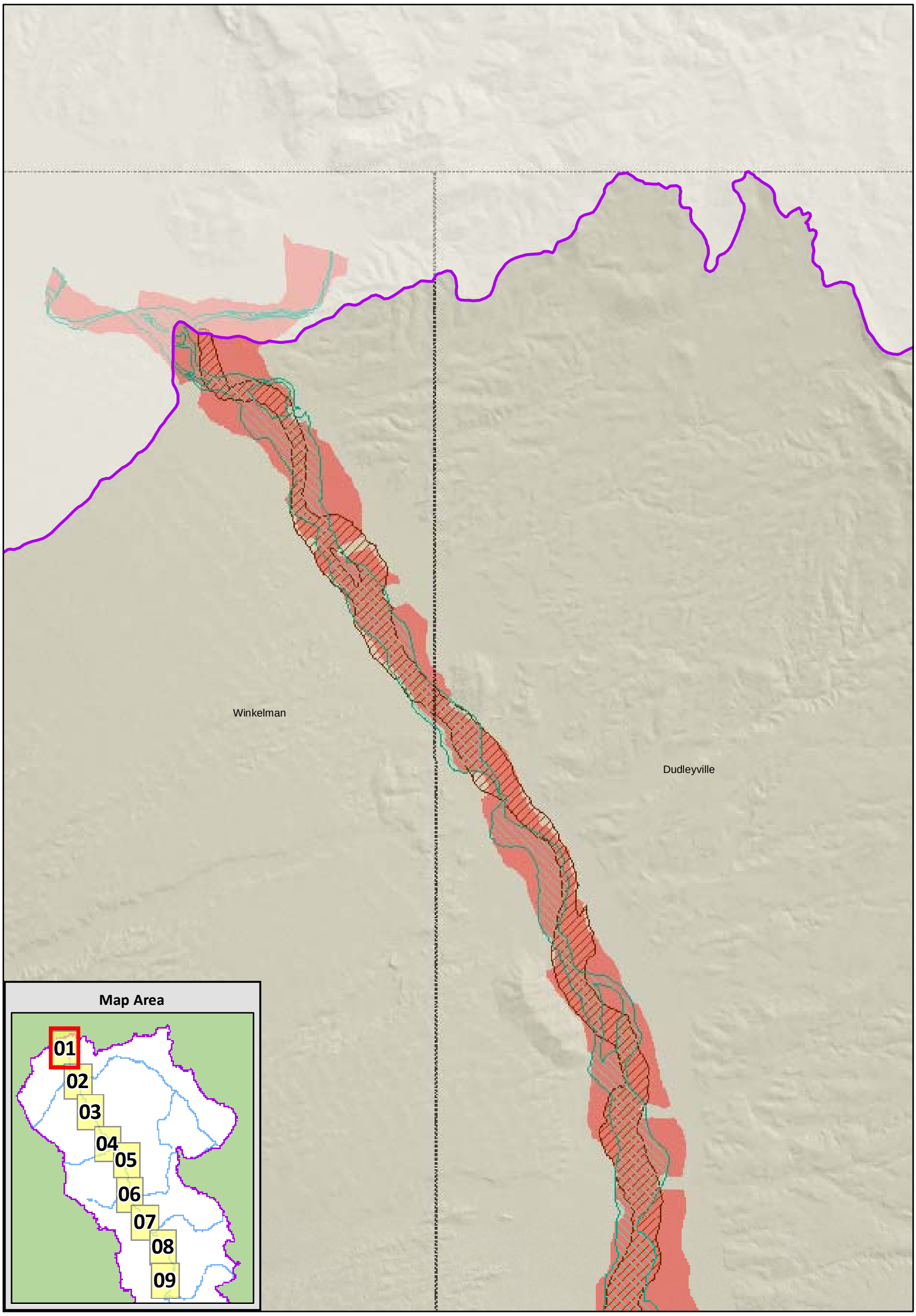
Legend

- Map Book Pages
- USGS Topo (24k) Quad Boundary
- San Pedro River Watershed Boundary

SanPedro_MapIndex3.mxd

Attachment 3

1935 and 2008 River Channels and ADWR Subflow Zone, San Pedro River



Sheet 1

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Kilometers

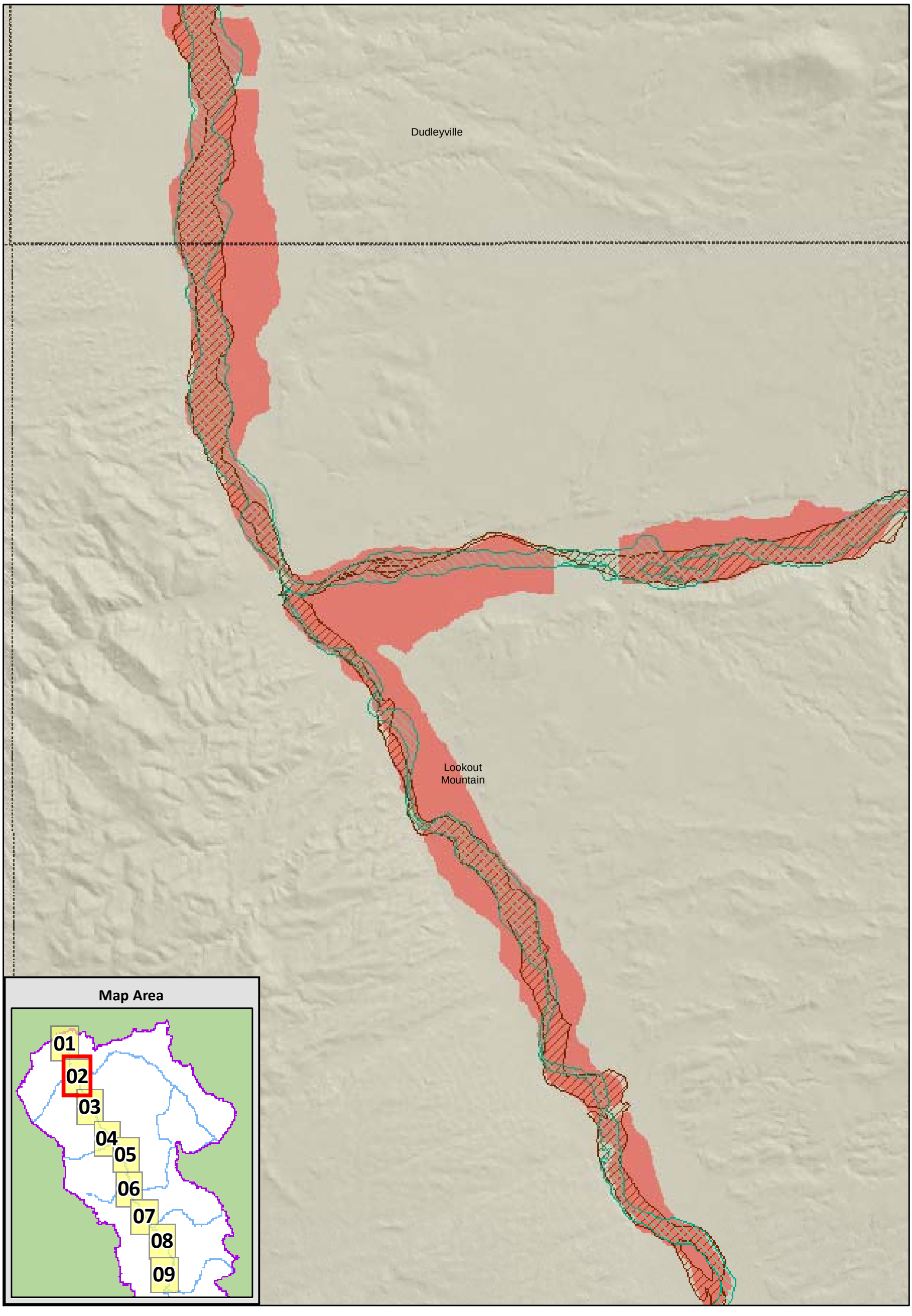
Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- 2008 Stream Channel
- 1935 Stream Channel

Data Sources:
ADWR: Subflow Zone
AGS: 2008 Stream Channel
SRP: 1935 Stream Channel
interpreted from and limited to extent of 1935 aerial photography along the main stem San Pedro river and lower Aravaipa Creek

SanPedro_Channels.mxd

1935 and 2008 River Channels and ADWR Subflow Zone, San Pedro River



Sheet 2

Legend

- USGS Topo (24k) Quad Boundary
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- 1935 Stream Channel

Miles
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0 0.5 1
Kilometers

Data Sources:
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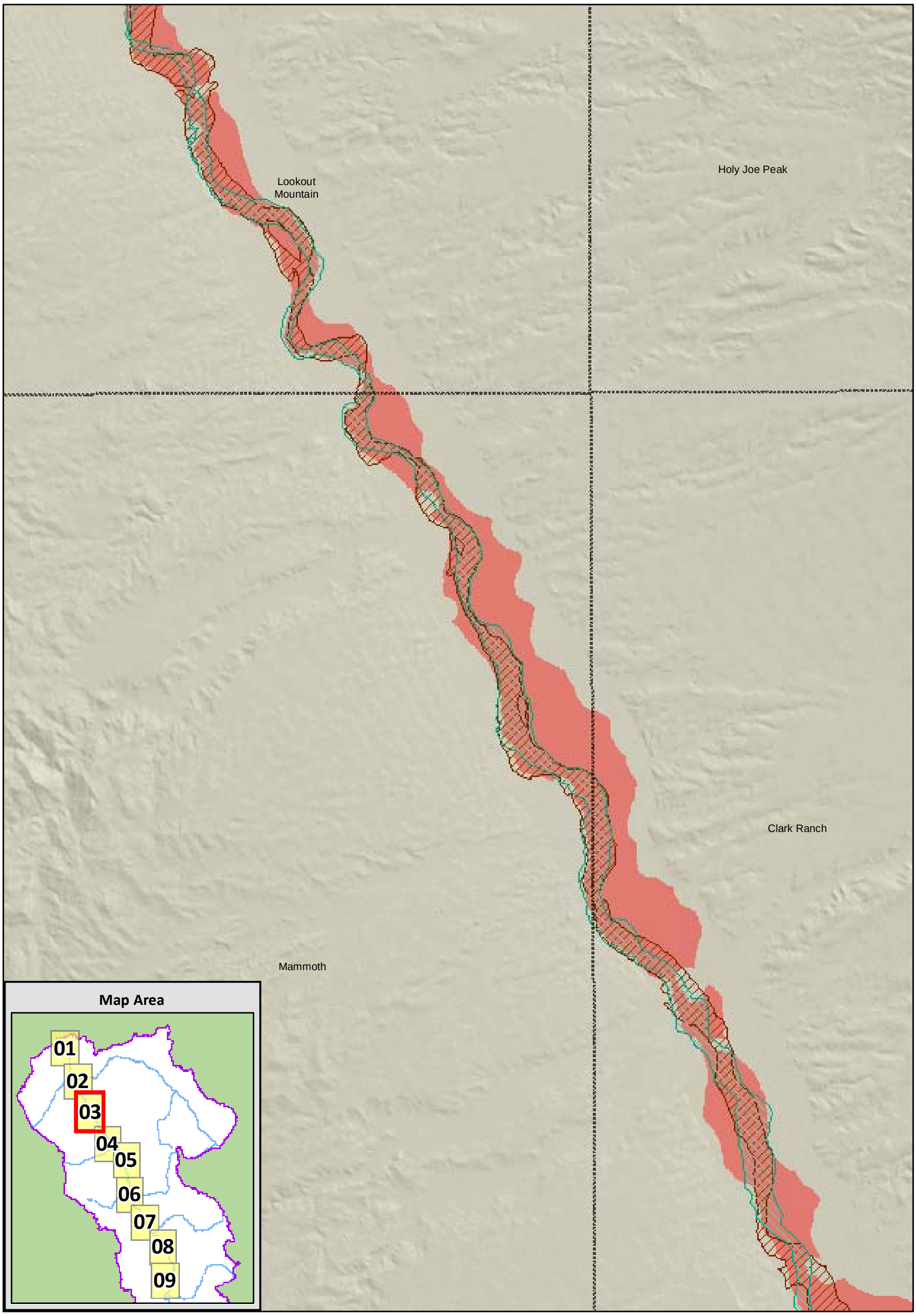
interpreted from and limited to extent of 1935 aerial photography along the main stem San Pedro river and lower Aravaipa Creek

SanPedro_Channels.mxd

Attachment 3

1935 and 2008 River Channels and ADWR Subflow Zone, San Pedro River



Sheet 3

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- 2008 Stream Channel
- 1935 Stream Channel

Miles
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0 0.5 1
Kilometers

Data Sources:
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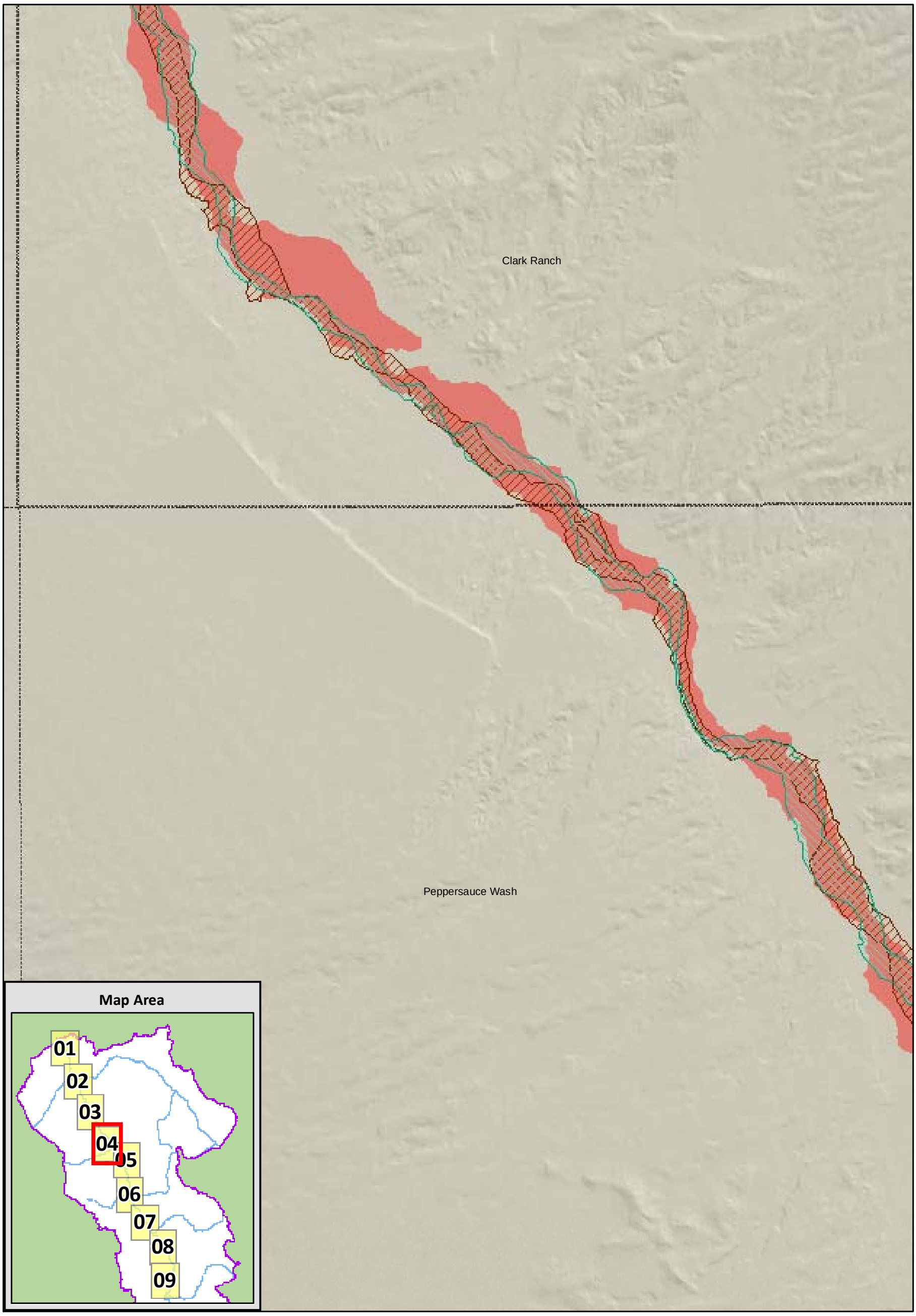
interpreted from and limited to extent of 1935 aerial photography along the main stem San Pedro river and lower Aravaipa Creek

SanPedro_Channels.mxd

Attachment 3

1935 and 2008 River Channels and ADWR Subflow Zone, San Pedro River



Sheet 4

Miles
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Kilometers

Legend

- USGS Topo (24k) Quad Boundary
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SanPedro_Channels.mxd

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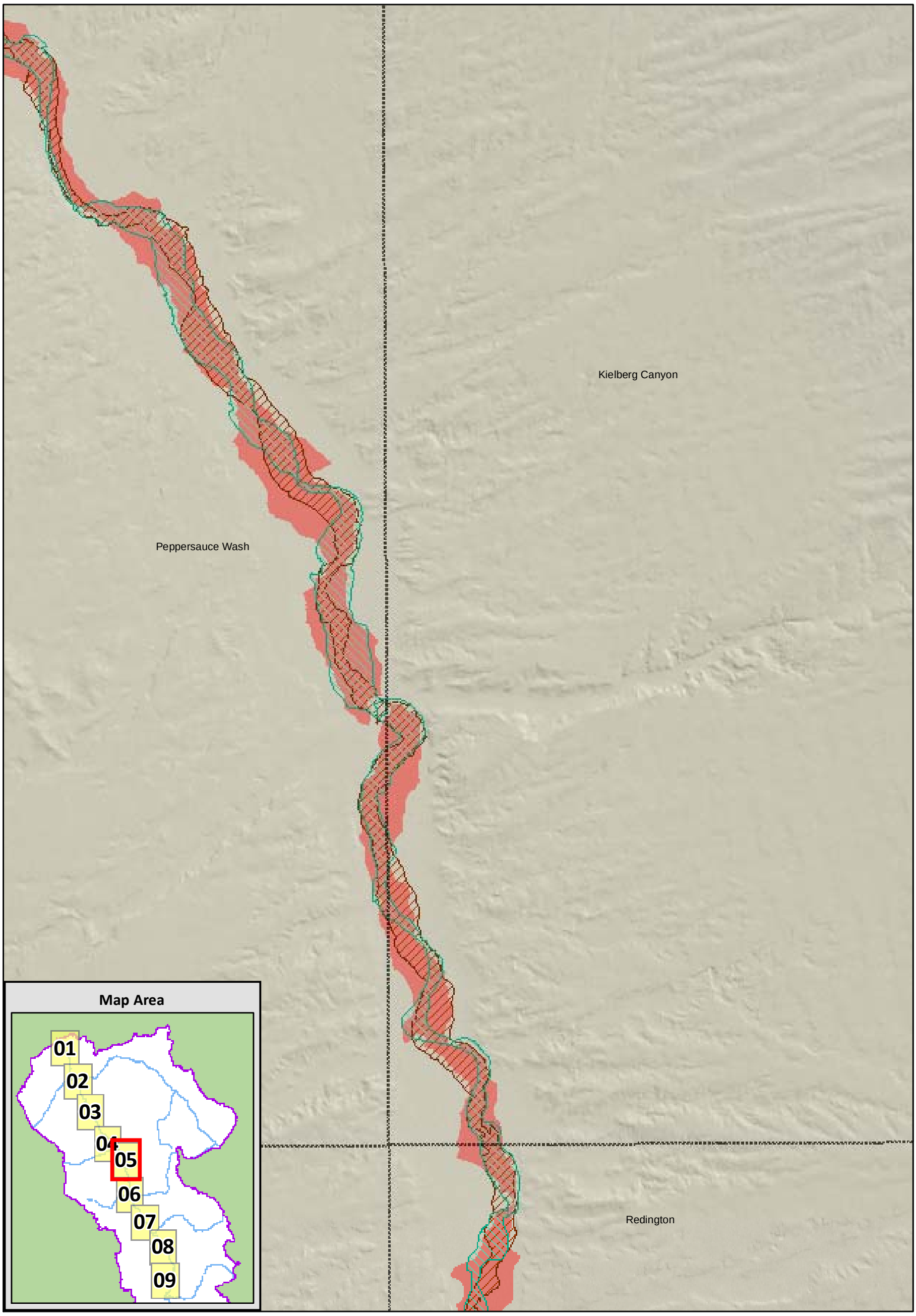

Sheet 5

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
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- 1935 Stream Channel

Miles
0 0.5 1

0 0.5 1
Kilometers

Data Sources:
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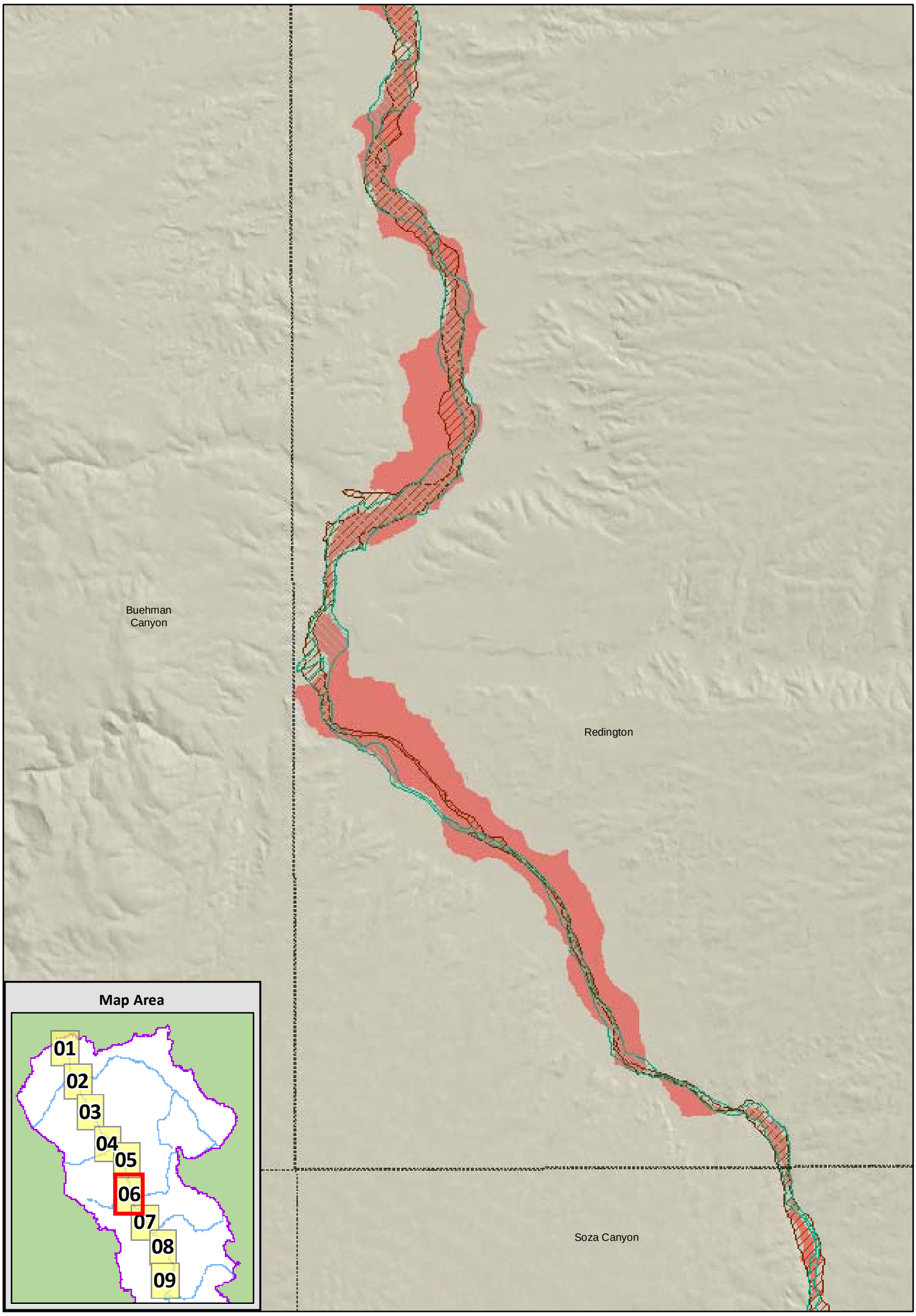
interpreted from and limited to extent of 1935 aerial photography along the main stem San Pedro river and lower Aravaipa Creek

SanPedro_Channels.mxd

1935 and 2008 River Channels and ADWR Subflow Zone, San Pedro River



Sheet 6

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
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- 1935 Stream Channel

Miles
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0 0.5 1
Kilometers

Data Sources:
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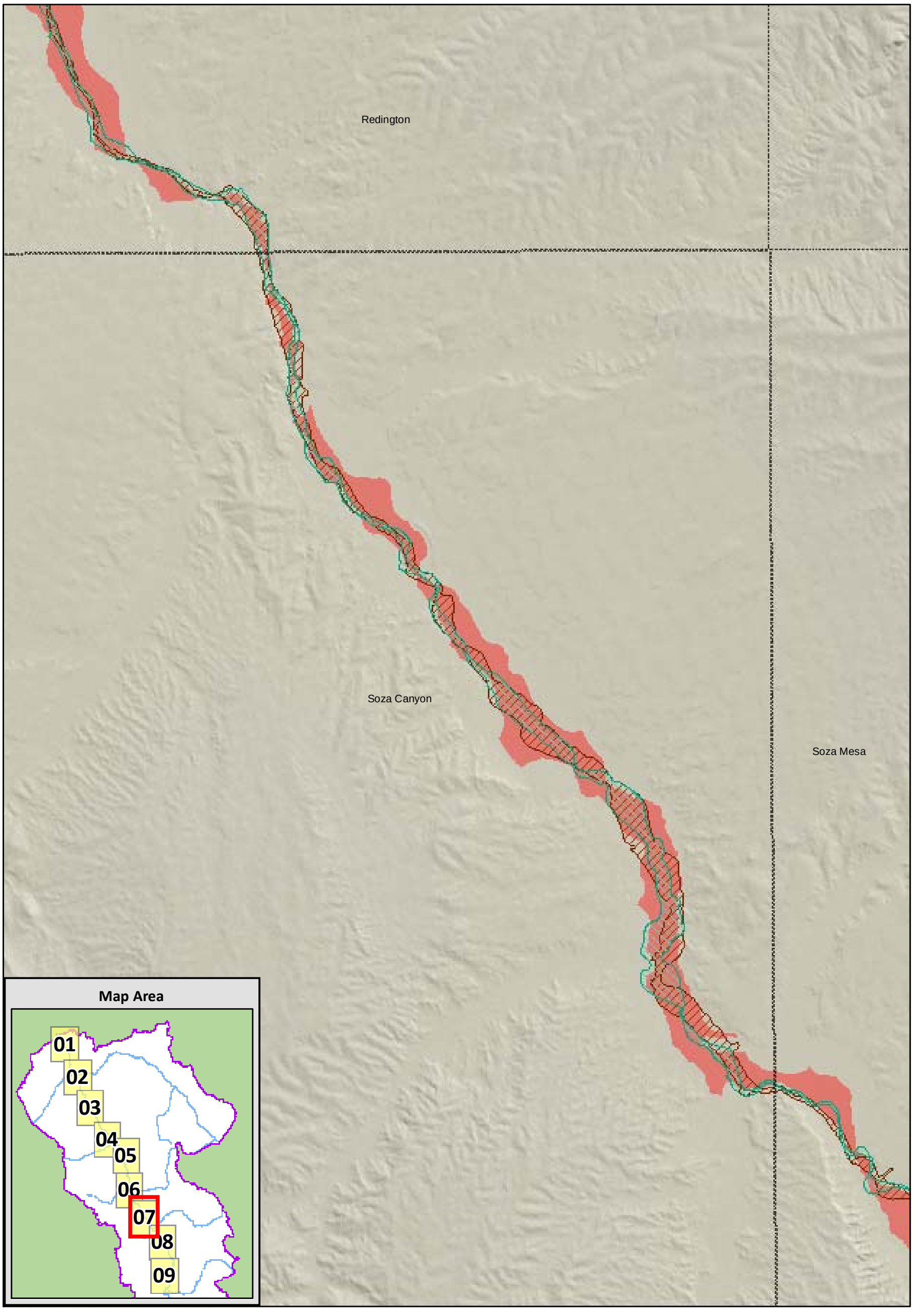
interpreted from and limited to extent of 1935 aerial photography along the main stem San Pedro river and lower Aravaipa Creek

SanPedro_Channels.mxd

Attachment 3

1935 and 2008 River Channels and ADWR Subflow Zone, San Pedro River



Sheet 7

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0 0.5 1
Kilometers

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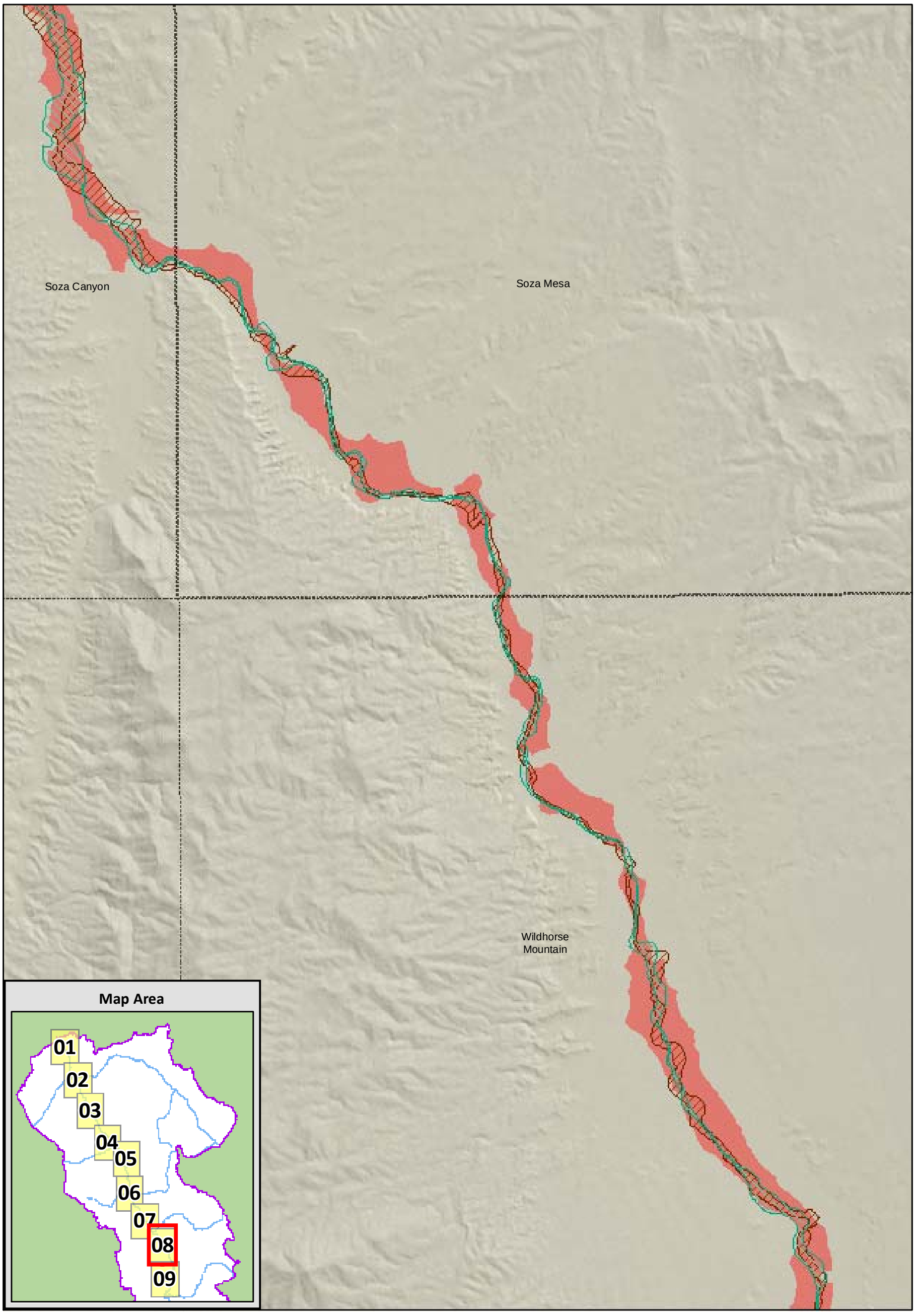
SanPedro_Channels.mxd

Attachment 3

1935 and 2008 River Channels and ADWR Subflow Zone, San Pedro River



Sheet 8

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Kilometers

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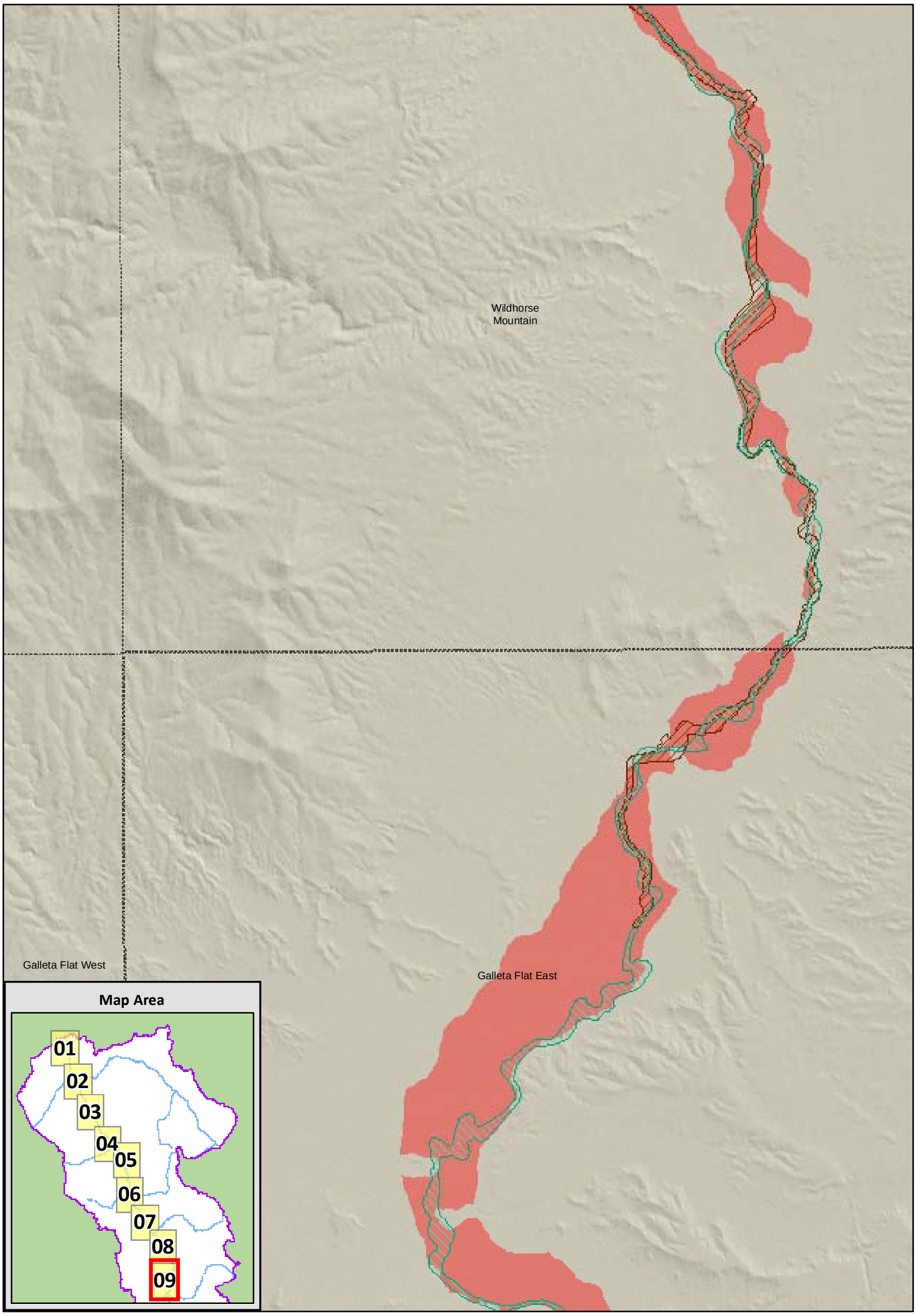

Sheet 9

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0 0.5 1
Kilometers

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SanPedro_Channels.mxd

Attachment 4

Steve Erb Testimony

Reporter's Transcript of Proceedings, vol. X, pp. 75-85 (February 16, 1994)

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

In re the general adjudication of all rights to use water in the Gila River System and Source) W-1, W-2, W-3, W-4

REPORTER'S TRANSCRIPT OF PROCEEDINGS

Evidentiary Hearing

Volume X

Phoenix, Arizona
February 15, 1994
10:40 a.m.

BEFORE: THE HONORABLE STANLEY Z. GOODFARB,
Judge of the Superior Court

Prepared by Teresa Louis,
Official Court Reporter

Again, to emphasize, all of the technical factors involved in the subflow criteria need to be specified by this Court's criteria if we are going to bring closure on this issue.

THE COURT: That's a hell of a task for a kid who had a tough time with plane geometry.

Let me ask you a couple of questions, Steve. What I want to start with is, if you'll get your sheet, your overhead of Exhibit 266. It's a green, red and yellow one. Let me see if I can utilize this to answer some simple questions that the Supreme Court raised.

First of all, Steve, would I be correct that the two black lines on the outer edge of the drawing are the ridge lines, correct?

THE WITNESS: These lines?

THE COURT: No.

THE WITNESS: This line?

THE COURT: Yes. That's the ridge.

THE WITNESS: Yes.

THE COURT: The other one is the ridge line to the east, ridge line to the west, right?

THE WITNESS: Yes.

THE COURT: On one side they got the Dragoons, on the other side I've got the Winchesters, and the line to the west is the Dragoons and ridge line

Again, to emphasize, all of the technical factors involved in the subflow criteria need to be specified by this Court's criteria if we are going to bring closure on this issue.

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THE WITNESS: Yes.

THE COURT: On one side they got the Dragoons, on the other side I've got the Winchesters, and the line to the west is the Dragoons and ridge line

of the Dragoons, the line to the east in this thing is the ridge line of the Whetstones, right?

THE WITNESS: To the west are the Whetstones.

THE COURT: Now, the gray area is hard rock. The yellow is basin fill aquifer, which really represents the debris from the geological erosion of the mountains as they grow up, isn't that correct?

THE WITNESS: That's correct.

THE COURT: It's transported by various streams, and part of it might have been transported by the Ice Age if the glaciers ever got down here, right?

THE WITNESS: Certainly. Over a very long period of time.

THE COURT: Now, in the middle of this there is a green area, and there are also some green areas along where there are probably the remains of ephemeral streams that were arroyos, and that constitutes the younger alluvium, right?

THE WITNESS: The younger alluvium formations. It is younger alluvium.

THE COURT: The younger alluvium formation is that erosive material which was deposited in various layers in the last 8500 or 85,000 years.

THE WITNESS: That's correct.

THE COURT: Now, the younger alluvium does not reach from ridge line to ridge line except where there are thin bands of younger alluvium along where the tributary waterways or arroyos go up almost to the ridge line.

THE WITNESS: That's correct. It occurs in very, very few places.

THE COURT: There's debris in arroyo and a channel that kind of fills it except for the places where you get to the hard rock, but there's always sand and some rock in any of these mountain canyons that are coming down.

THE WITNESS: Sure.

THE COURT: But the younger alluvium we've been talking about is that which fills the center of this valley, and that alluvium does not go from ridge line to ridge line, correct?

THE WITNESS: No, it does not.

THE COURT: According to your diagram here, the younger alluvium here, the solid, the large green area basically consists of the alluvium which is supportive of the stream and also constitutes a portion of the tributary aquifers that feed into the San Pedro, correct?

THE WITNESS: It could be viewed that way.

THE COURT: In fact of the matter, isn't the basin fill also a tributary, a part of the tributary aquifer because there's water there that slowly comes to the center, eventually gets to the center, and then starts drifting down the San Pedro to the Gila, and if it ever gets past Ashurst Dam it keeps on going clear down to the Sea of Cortez, to the Colorado and the Sea of Cortez. Takes a few eons in geologic time, but it does do that, doesn't it?

THE WITNESS: Yes. Conceptually that could occur.

THE COURT: Now, you've been talking about something that you call inliers. The Supreme Court basically talks about something called tributary aquifers. With regard to this exhibit, can we agree that that portion of the tributary aquifers which consists of the younger alluvium is that green which is outside of the red?

THE WITNESS: Within the context of the Supreme Court's order, the guidelines that they put down and the way that I understand that they were trying to separate tributary aquifer ground water from ground water associated with the stream, yes, I think you could say that ground water in these green areas would be associated with their definition of tributary

ground water.

THE COURT: Unfortunately, the molecules of water are too stupid to understand the legal distinction between tributary aquifer and the subflow aquifer of the stream, right?

THE WITNESS: Not only are they too stupid, they don't care.

THE COURT: Probably the latter.

MR. SPARKS: They are probably teenagers, Your Honor.

THE COURT: If we were to draw a distinction between the ground water flow in what I call the tributary aquifer and the ground water flow of the aquifer below the San Pedro and shown in red, would it not largely be the direction of flow in that the tributary aquifer is headed toward the stream and the stream aquifer is headed in the direction of the stream?

THE WITNESS: I believe that could occur in many areas. This area of younger alluvium in the Pomerene-St. David area, as you well know, is occupied with extensive cultural development. Cultural development alters the natural course of ground water flow from a lot of different activities, pumpage and recharge incidental to use.

So flow directions can sometimes reverse. They can go one way one season and back again. But I think as a general way of viewing it, if water occurs in this area, if there's, for example, recharge and water levels in the aquifer in this area are higher than water levels at the stream, then naturally it's not going to travel down the basin through these inliers, but rather it's going to go flow more towards the stream. Because inliers, probably what there is there is older alluvium, and it probably has a lower hydraulic conductivity.

THE COURT: Let's take what you've told us and let's see if we can agree. If the areas shown in green in the natural condition, because water comes from high to low and those areas are obviously higher than the stream, in its natural condition before people started farming in there it flowed toward the stream, correct?

THE WITNESS: Yes, I believe it did.

THE COURT: In its subsequent condition, post-development, it may flow toward the stream, it may flow away from the stream, it may flow in circular conditions, it may flow in any one of many different directions.

But the stream only has an effect of having

it flow toward the stream, but it flows in many directions and does not have a stream flow direction generally.

THE WITNESS: Well, yes, it's probably highly variable from location to location.

THE COURT: It's highly variable because of development.

THE WITNESS: Yes, because of development and because of the shape of these inliers and so forth.

THE COURT: Now, you've drawn these, and I understand why you've drawn them, and obviously I think we've drawn them because the Supreme Court shot down--well, the Supreme Court having been told about tributary aquifers, which I never mentioned in my order and someone else raised for them, has shot down tributary aquifers, and therefore what they have said clearly, with no contest, is that you can't include tributary aquifers in the subflow, correct?

THE WITNESS: You can't?

THE COURT: Yes, you can't.

THE WITNESS: According to their--

THE COURT: Yes, according to their hydrologist.

THE WITNESS: That's correct.

THE COURT: Assuming I cannot shut down

tributary aquifers and assuming that the Page definition of subflow is to draw a band based on the closure where the inliers come, how can I be certain that where the inlier meets the stream aquifer, that the direction is sufficiently stream flow that I can draw the lines in that area?

Isn't this right where they meet some confusion of direction until it gets further into the younger alluvium and before I can be certain that its flow has straightened out sufficiently that I can in my mind be certain that flow with its elevation and its gradient is equivalent to the flow elevation and gradient of the stream?

THE WITNESS: You probably have seen with the surface water example, two streams come together. One is muddy and the other one isn't. You can see how the water is comingled. You can see how like the muddy one is the smaller stream, how it turns and goes down with the stream. It's pretty rapid. Things in an aquifer, movement is of course a different situation.

I suppose if you went out a little distance from the inliers, it would probably be a safe assumption that--

THE COURT: How far in from the inliers do you think I would normally have to come to be certain

in my own mind that the stream flow has now turned sufficiently in its substance that it's going with the stream?

How far should I pull in those parameters to be certain in my own mind that I've now got subflow going in the same direction as the stream?

THE WITNESS: I don't think it needs to be too far, Your Honor, because as a normal consequence, normal situation with these inliers and younger alluvium associated with the tributary aquifers, the amount of water flowing in the aquifer towards the stream is probably going to be relatively small compared to the amount of water flowing down the stream.

THE COURT: Are you talking about 100 feet or 50 feet or 200 feet?

THE WITNESS: I would think it would be rare if it's more than 100 or 200 feet unless the inlier goes down a shallow slope.

THE COURT: In most instances the slope from the ridge line to the river is pretty good in this area, isn't it?

THE WITNESS: What I mean is, for example, let's say this inlier, if it goes underneath the younger alluvium material here at some shallow angle,

it could be still an obstruction there, but I think that would be probably a rare situation.

So I would say than the order of 100 or 200 feet would probably be pretty certain that the general direction of the ground water was with the stream.

THE COURT: If I combined that with elevation, gradient and flow direction, in your opinion, hydrologically speaking, would that be a pretty safe assumption as to what would constitute subflow if we're talking about that saturated geological body which is supportive of and connected to the stream?

THE WITNESS: Yes, I think that would be appropriate.

THE COURT: Let's talk a little bit about post-entrenchment alluvium. You're familiar with the Hereford report, are you not?

THE WITNESS: Somewhat.

THE COURT: I'm going to read you something from an exhibit that was provided for us today, and see if you agree with this. This is page 46 of Exhibit-- do you know the number of this Oxford edition on Southwest Arroyos--

MR. PEARCE: 278.

THE COURT: Let me read you something that is

kind of long but I think pretty well spells it out, and tell me whether or not you agree with it.

Page 46. "After about 1880 the possible causes of entrenchment multiplied. Drainage concentration could have been a factor. Climatic change might have played a role. There were several severe floods during the last two decades of the century, and these may have initiated entrenchment.

"Finally, there is a strong possibility that vegetation changes resulting from overgrazing within the watershed, especially south of Benson, cattle damage along the trails and the river, and deforestation of some catchment basins from mining timber may have promoted entrenchment."

Would you agree with that?

THE WITNESS: Yes, I would. I believe that there has been extensive testimony that all three of those factors--

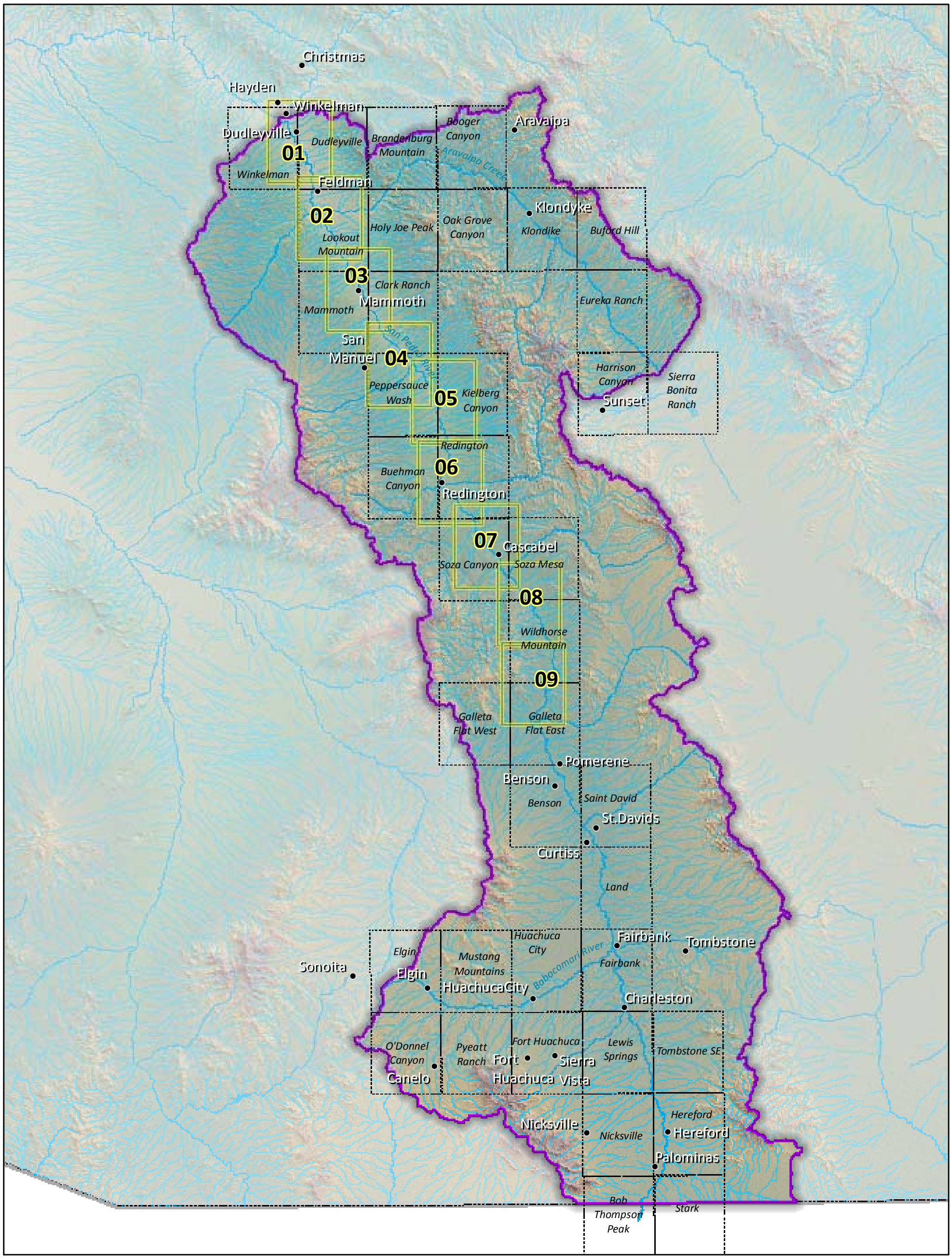
THE COURT: Let me read you the next paragraph, because I think it really spells it out.

"Evidence of vegetation changes is extensive and conclusive. It is recorded on numerous photographs reproduced in Hastings and Turner's (1965.) Rodgers (1965) reviewed the evidence in this southern San Pedro Valley. He argued that there appears in his view to be

Attachment 5

Riparian Vegetation Maps

Map Index for SRP San Pedro Attachments 3 & 5



Sheet Index

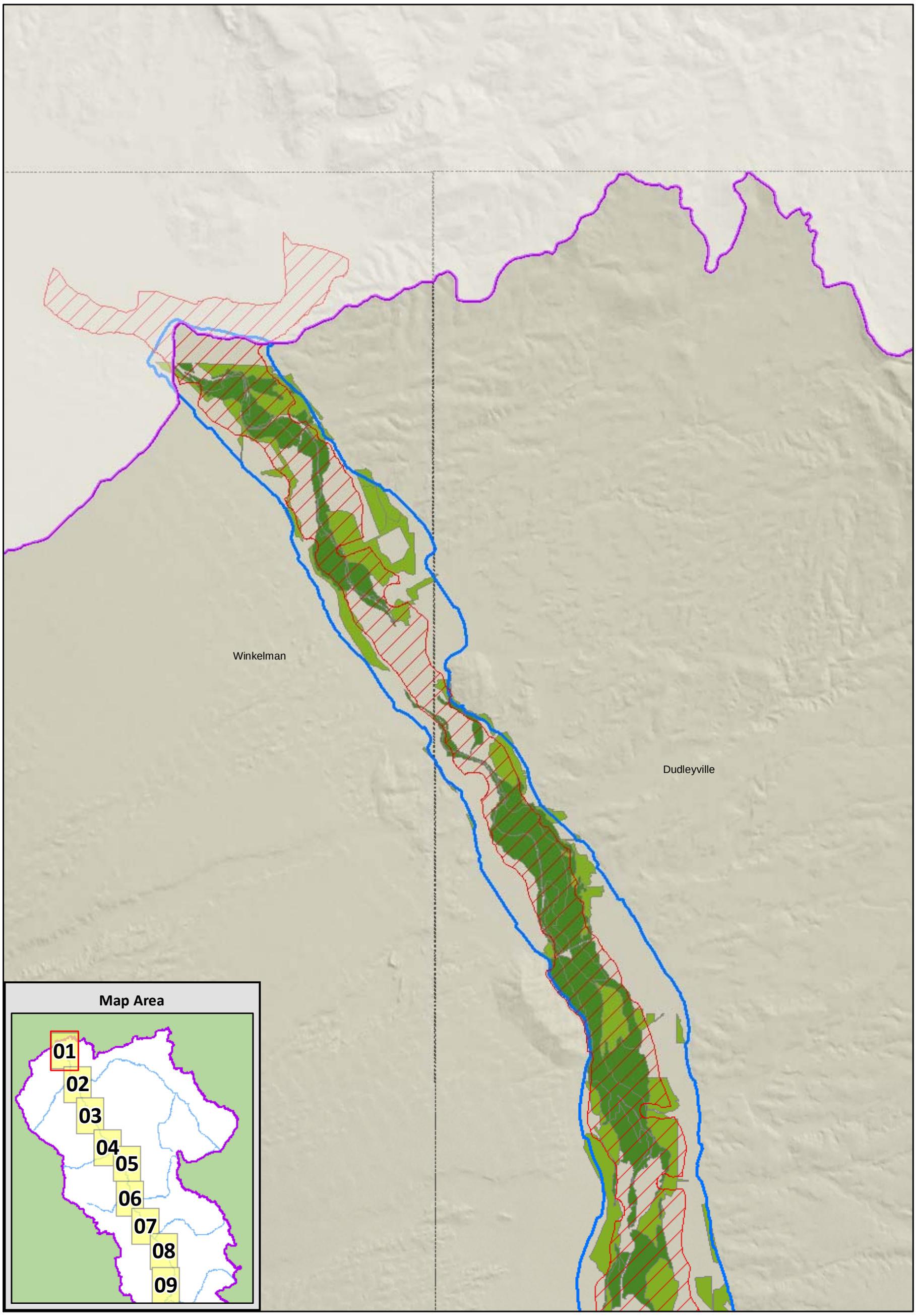
Legend

- Map Book Pages
- USGS Topo (24k) Quad Boundary
- San Pedro River Watershed Boundary

SanPedro_MapIndex5.mxd

Attachment 5

2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 1

Miles
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0 0.5 1
Kilometers

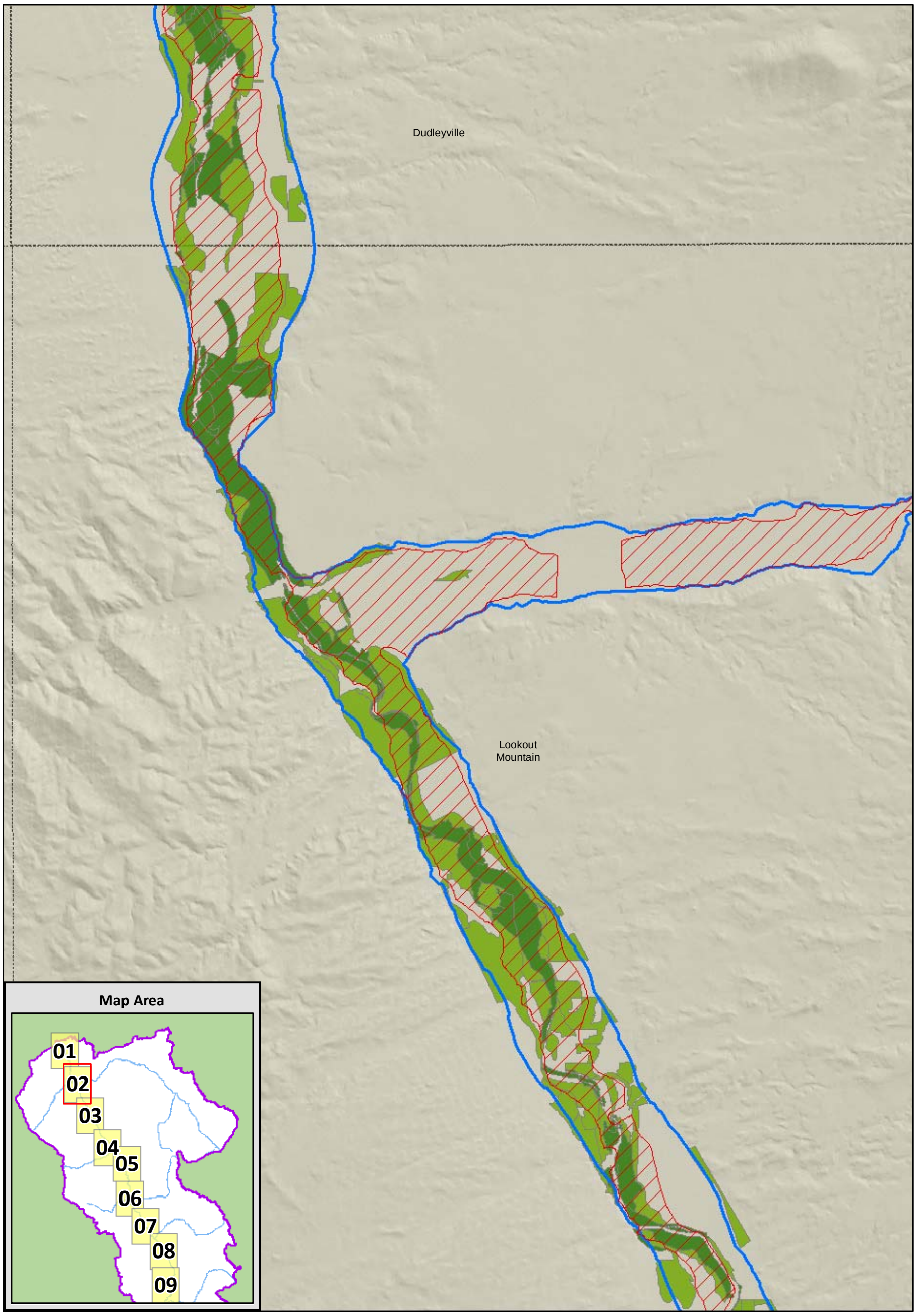
Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Cottonwood-Willow
- Mesquite Woodland

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

SanPedro_Vegetation.mxd

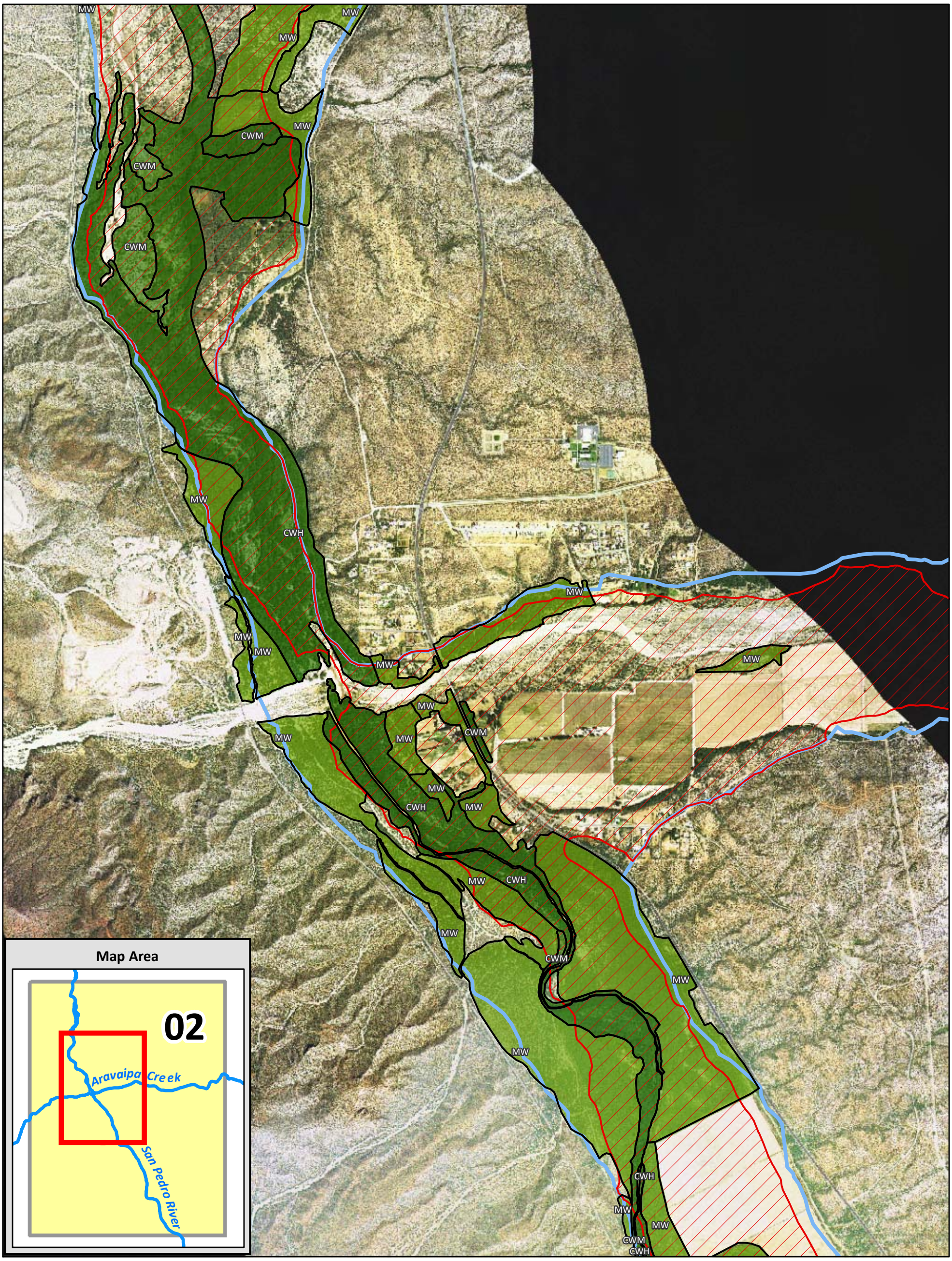
2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 2

Attachment 5

2008 Riparian Vegetation Detail, San Pedro River



Sheet 2 Detail

Miles
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0 0.25 0.5
Kilometers

Legend

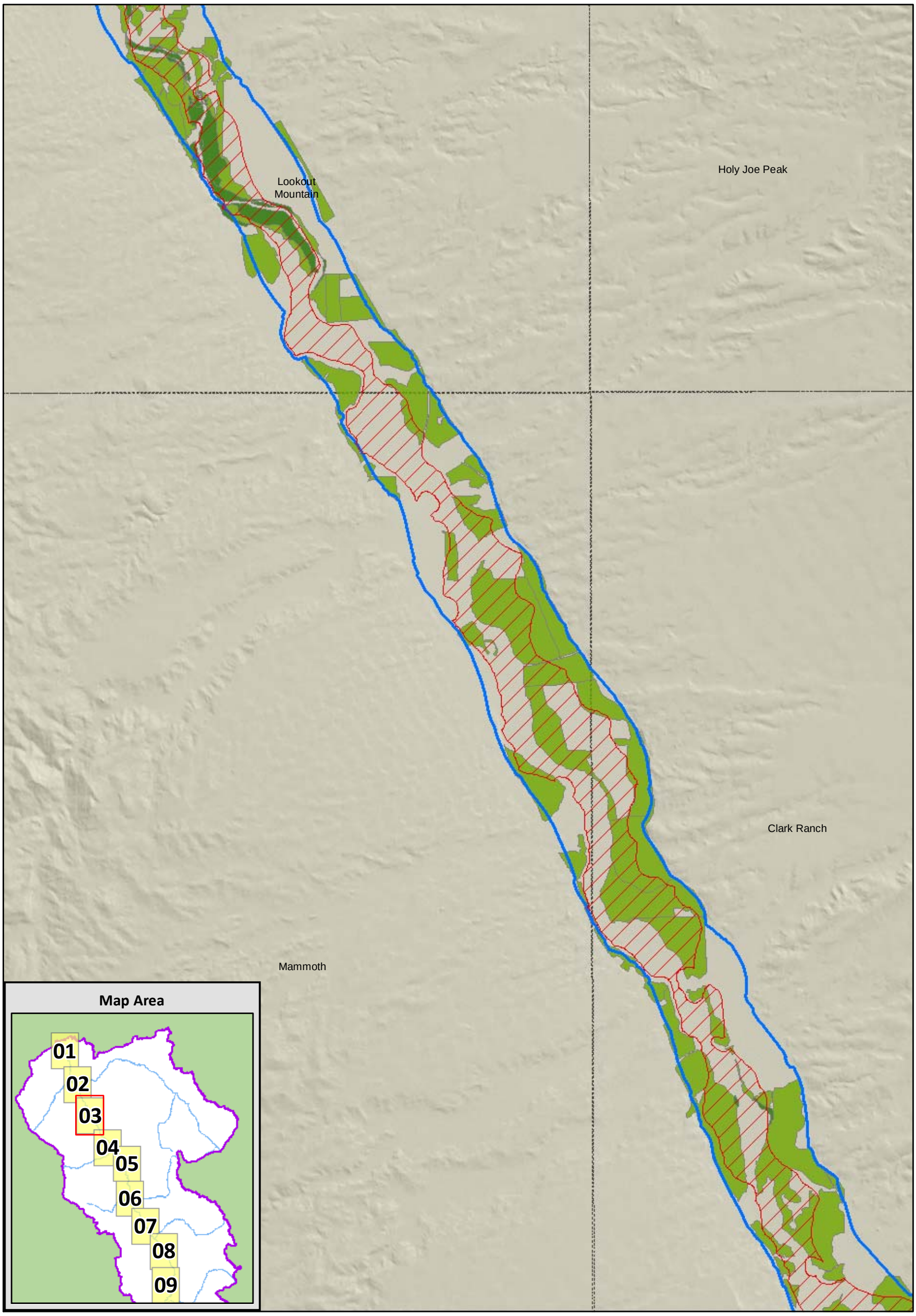
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Cottonwood-Willow (CWH, CWM)
- Mesquite Woodland (MW)

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

SanPedro_Vegetation_Details.mxd

Attachment 5

2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 3

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
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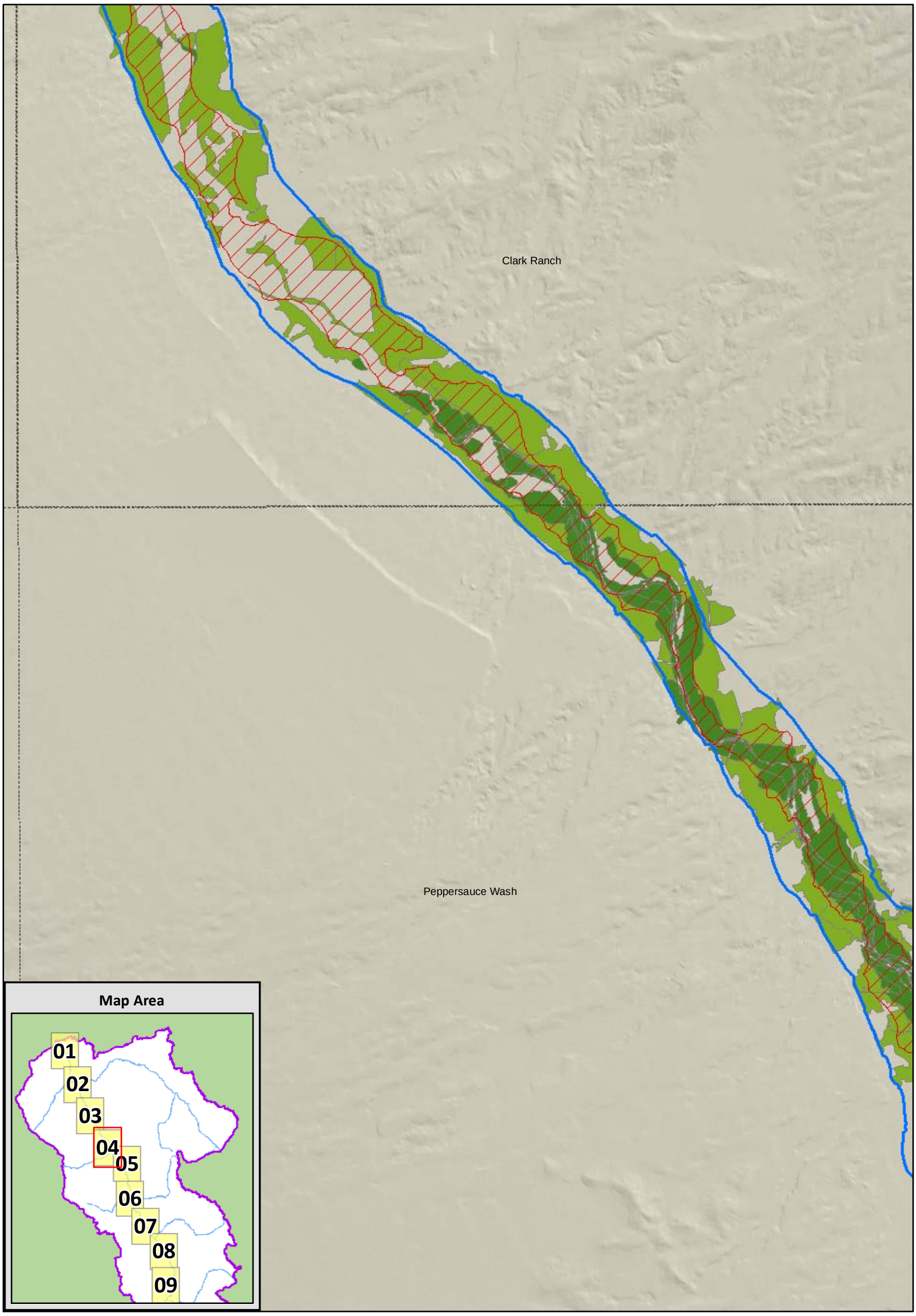
- Mesquite Woodland

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

SanPedro_Vegetation.mxd

Attachment 5

2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 4

Miles
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0 0.5 1
Kilometers

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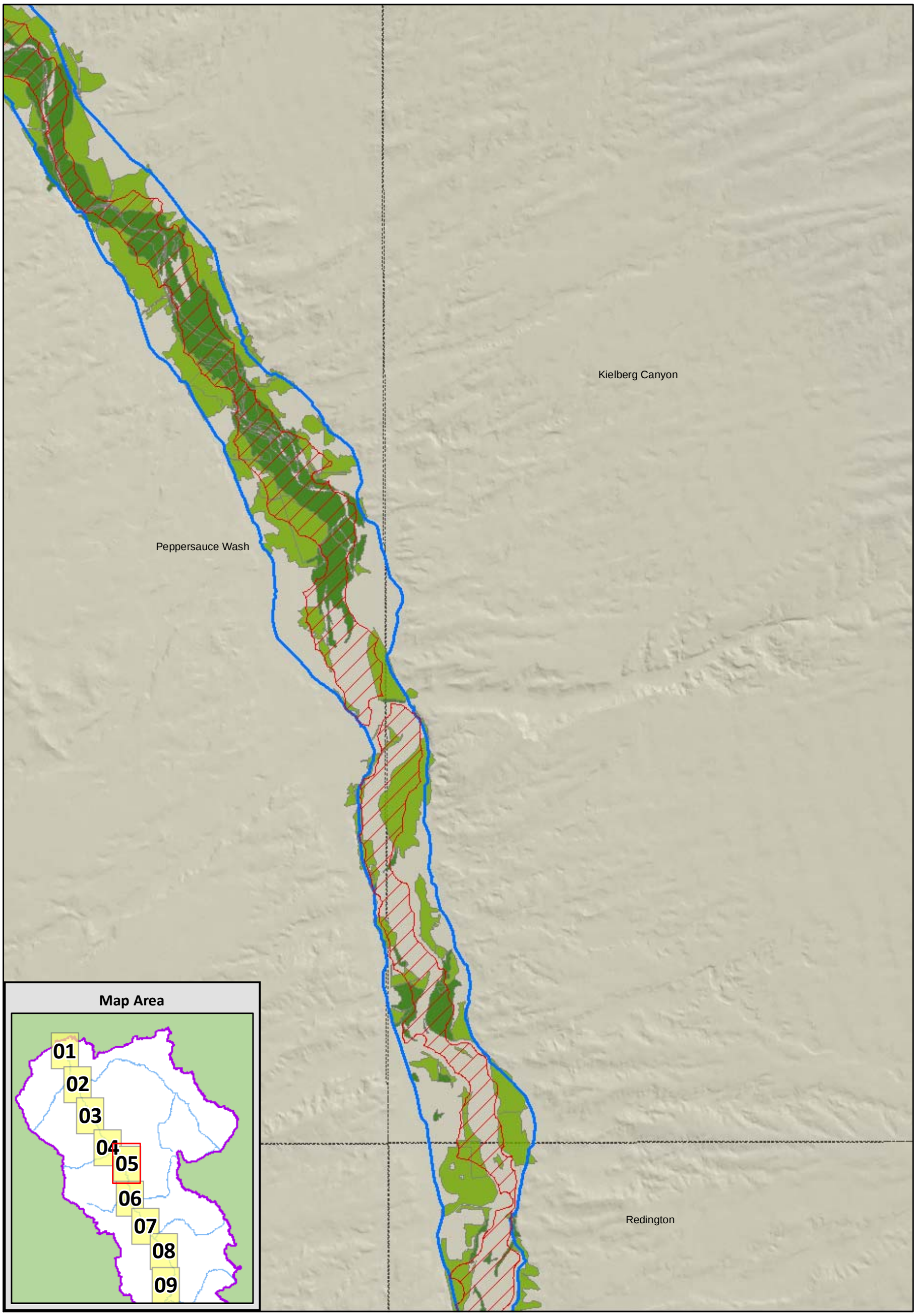
Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

SanPedro_Vegetation.mxd

Attachment 5

2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 5

Miles
0 0.5 1

0 0.5 1
Kilometers

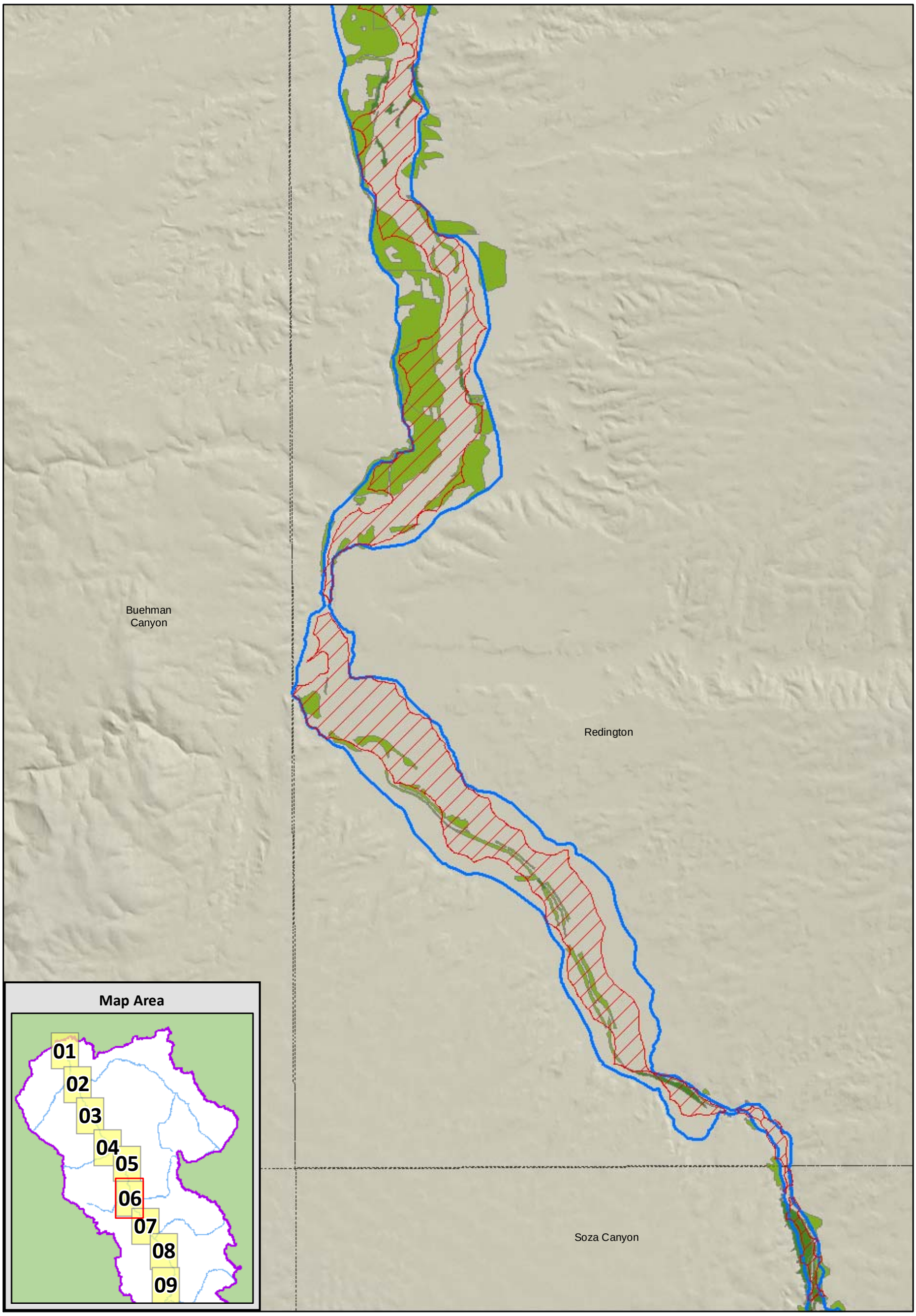
Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Cottonwood-Willow
- Mesquite Woodland

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

SanPedro_Vegetation.mxd

2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 6

Miles
0 0.5 1
0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Cottonwood-Willow
- Mesquite Woodland

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

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Attachment 5

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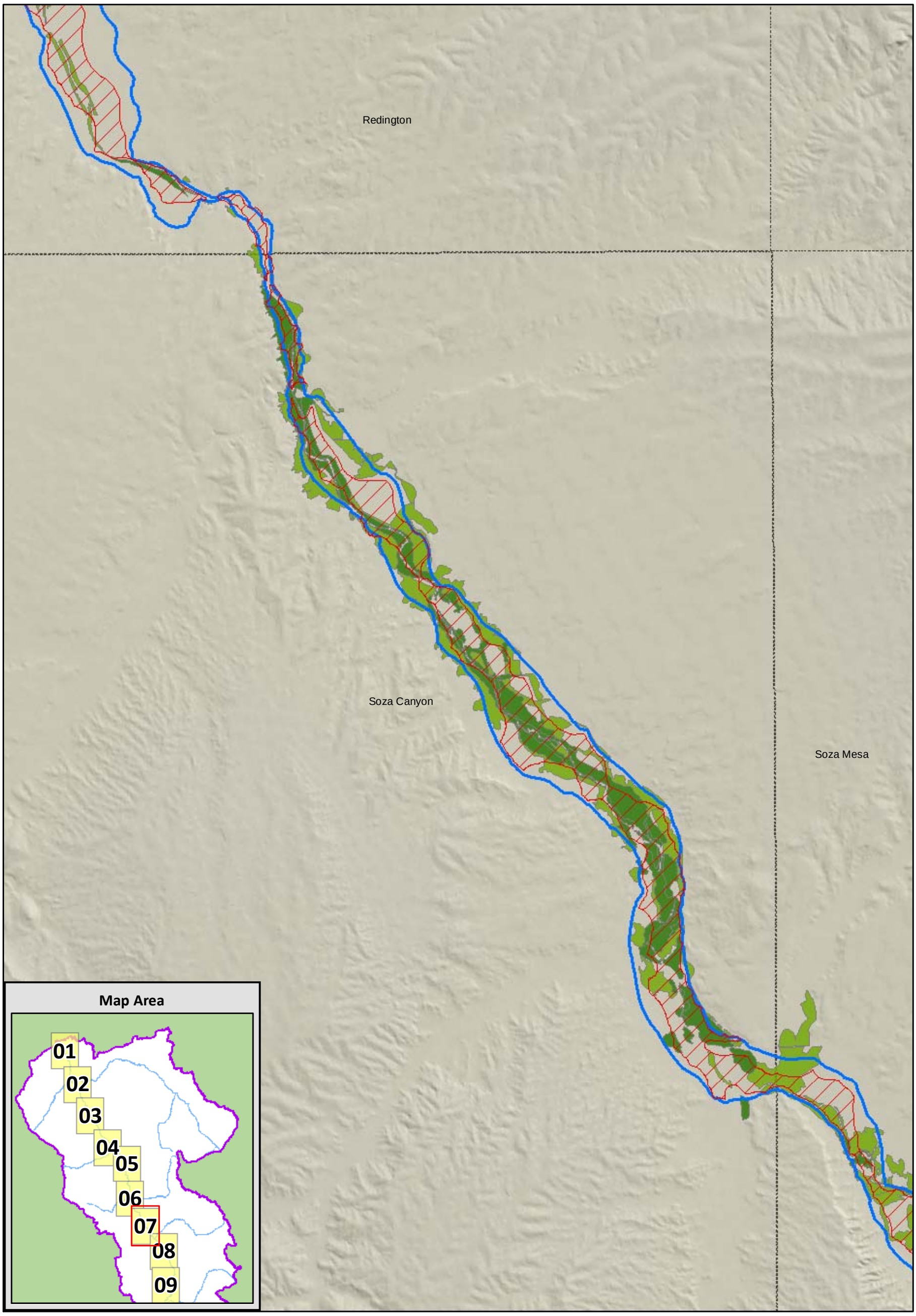

Sheet 7

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Cottonwood-Willow
- Mesquite Woodland

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

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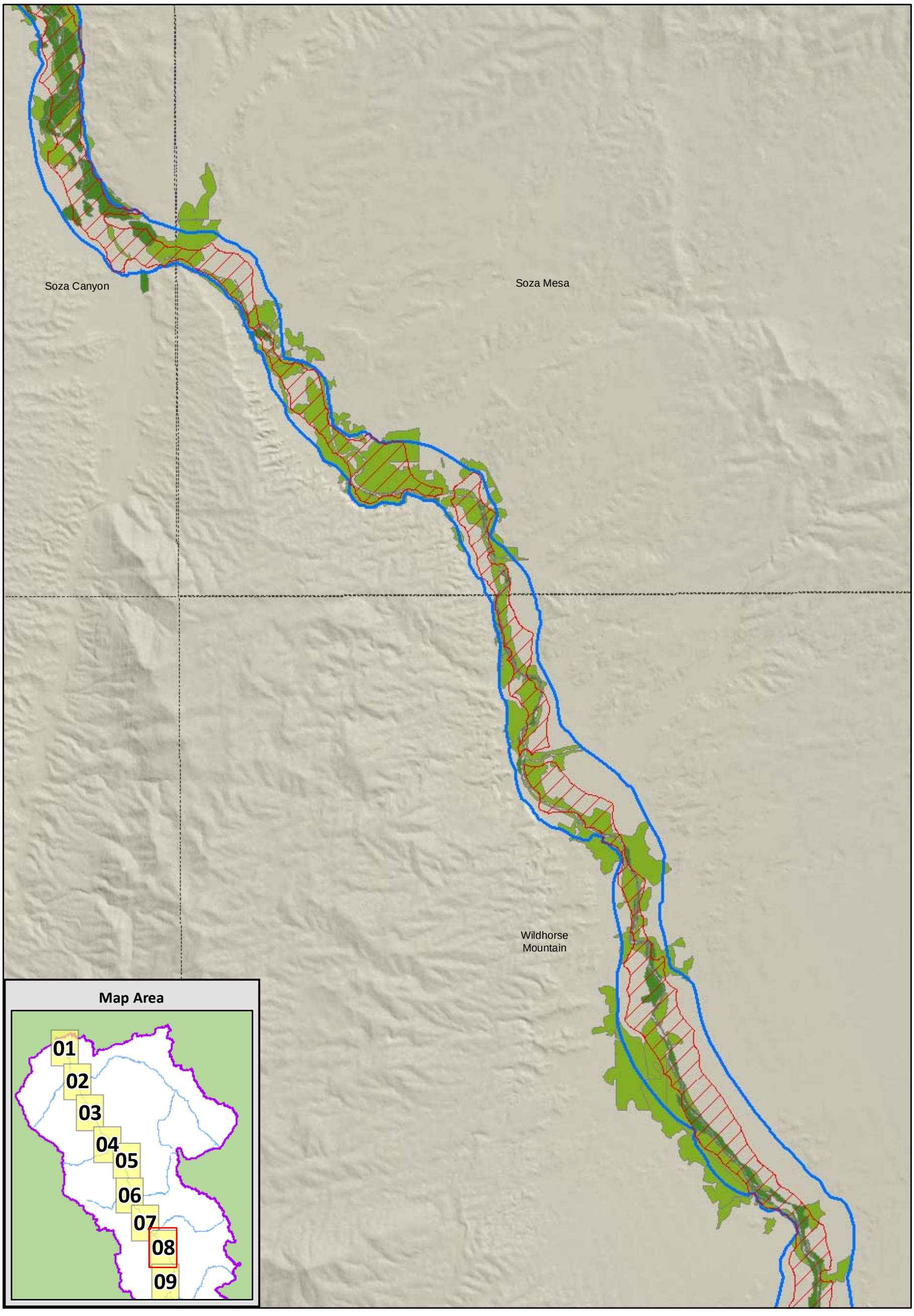
Attachment 5

2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 8

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

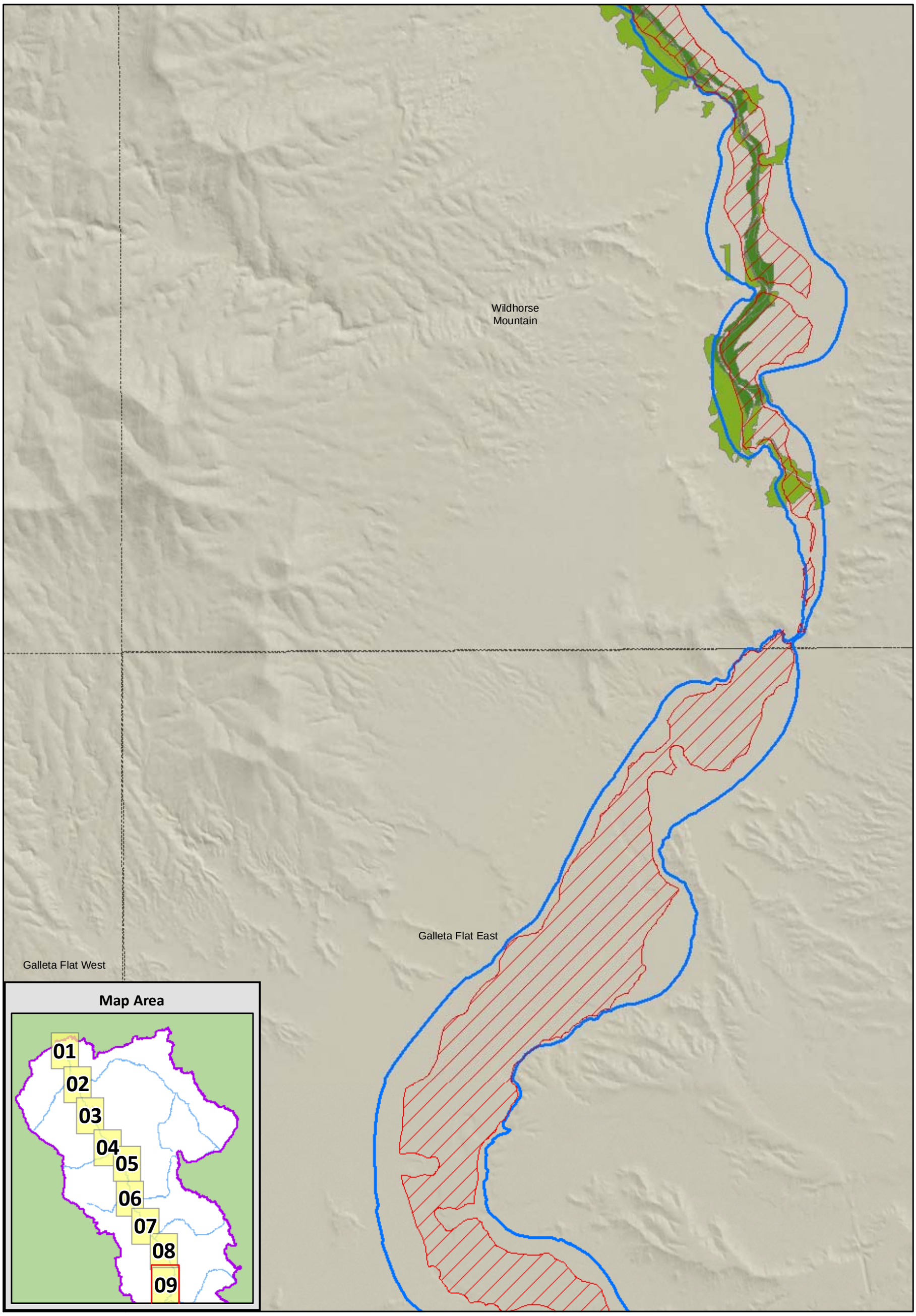
- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Cottonwood-Willow
- Mesquite Woodland

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

SanPedro_Vegetation.mxd

Attachment 5

2008 Riparian Vegetation and Subflow Zones, San Pedro River



Sheet 9

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Cottonwood-Willow
- Mesquite Woodland

Data Sources:
ADWR: Subflow Zone
SRP: LRE Subflow Zone;
Vegetation interpreted from, and limited to extent of 2008 aerial photography

SanPedro_Vegetation.mxd

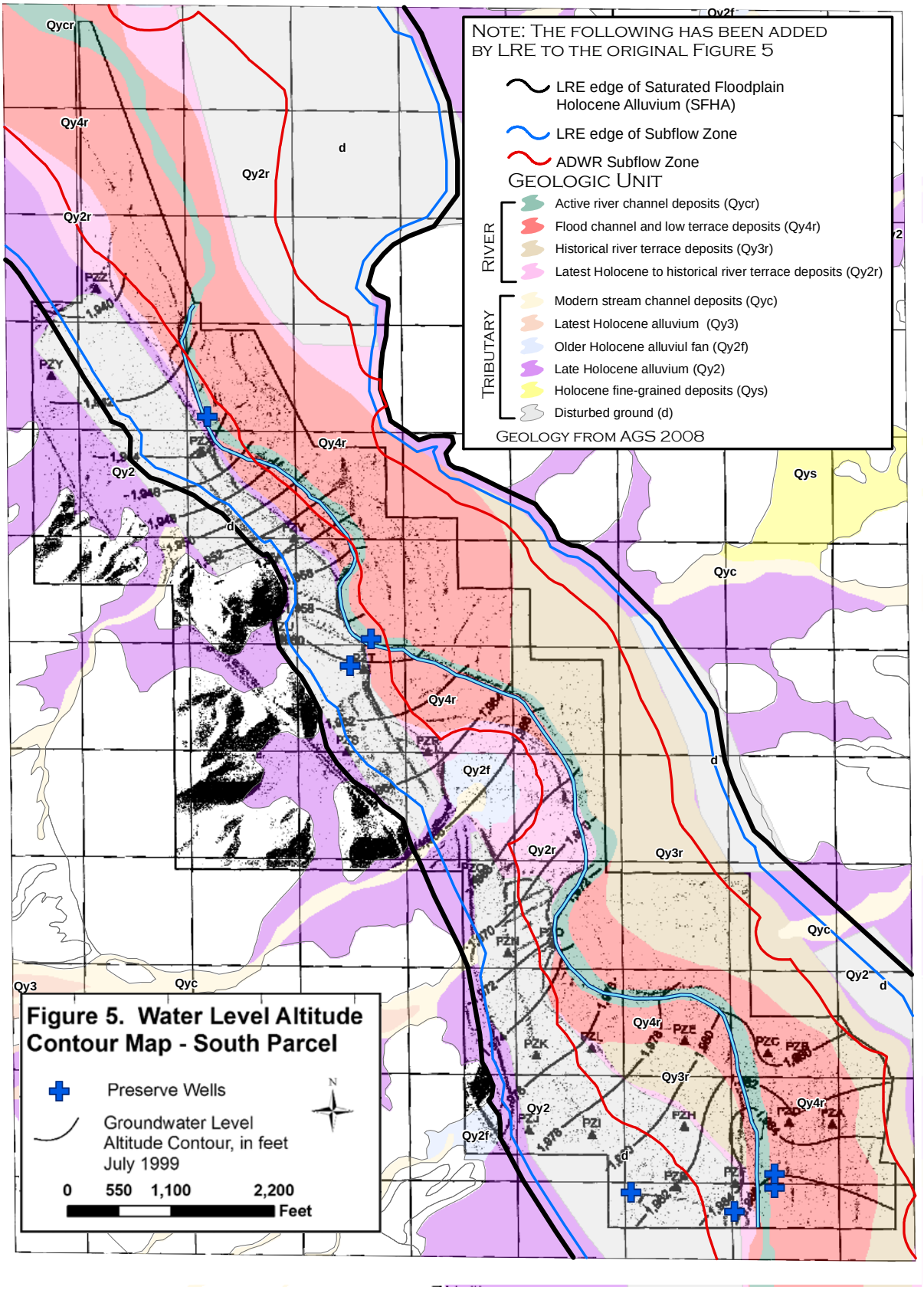
Attachment 6

The Nature Conservancy Water Table Map

Attachment 6

The Nature Conservancy Water Table Map for the San Pedro Preserve

[From the San Pedro River Preserve Hydrogeologic Summary Report; prepared by GeoSystems Analysis, Inc. for The Nature Conservancy; February 9, 2000]



Attachment 7

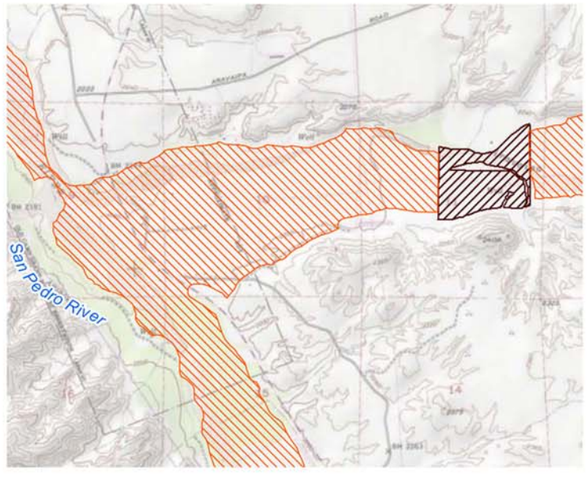
Aravaipa Creek Berm Photos

Attachment 7

Aravaipa Creek Berm Panorama A

Approximately 2.5 miles east of confluence with San Pedro River;
looking west-southwest

Photographs taken November 2009

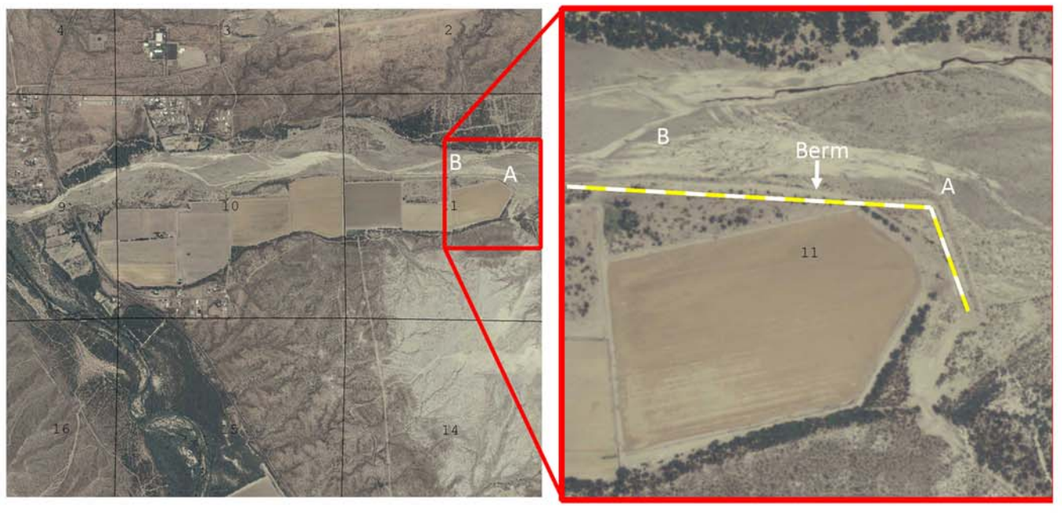


Excerpt from
ADWR Subflow Zone
Delineation Report
Appendix E, Map 20

Extent of Subflow Zone

Setbacks overlap with other geologic units in floodplain

Aerial photographs showing the location of the berm and panoramas.

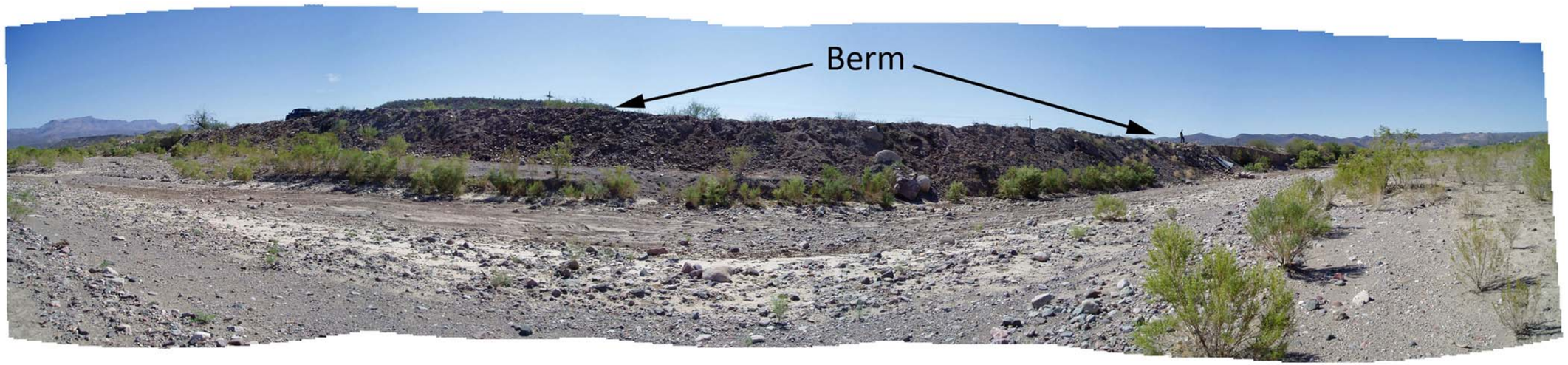


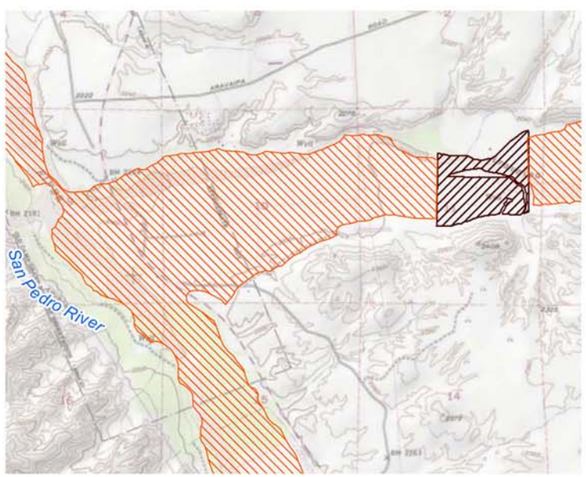
Attachment 7

Aravaipa Creek Berm Panorama B

Approximately 2 miles east of confluence with San Pedro River;
looking south

Photographs taken November 2009





Excerpt from
ADWR Subflow Zone
Delineation Report
Appendix E, Map 20

Extent of Subflow Zone

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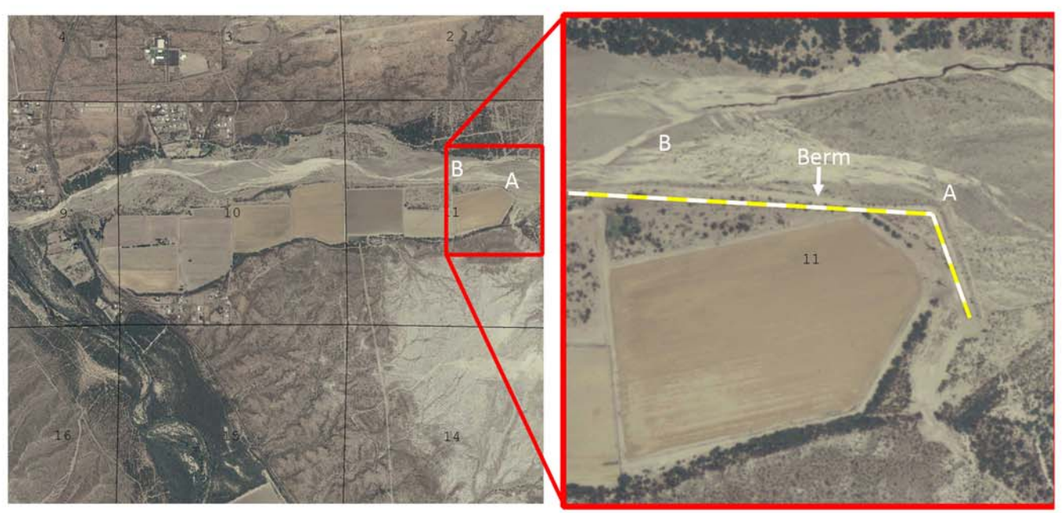
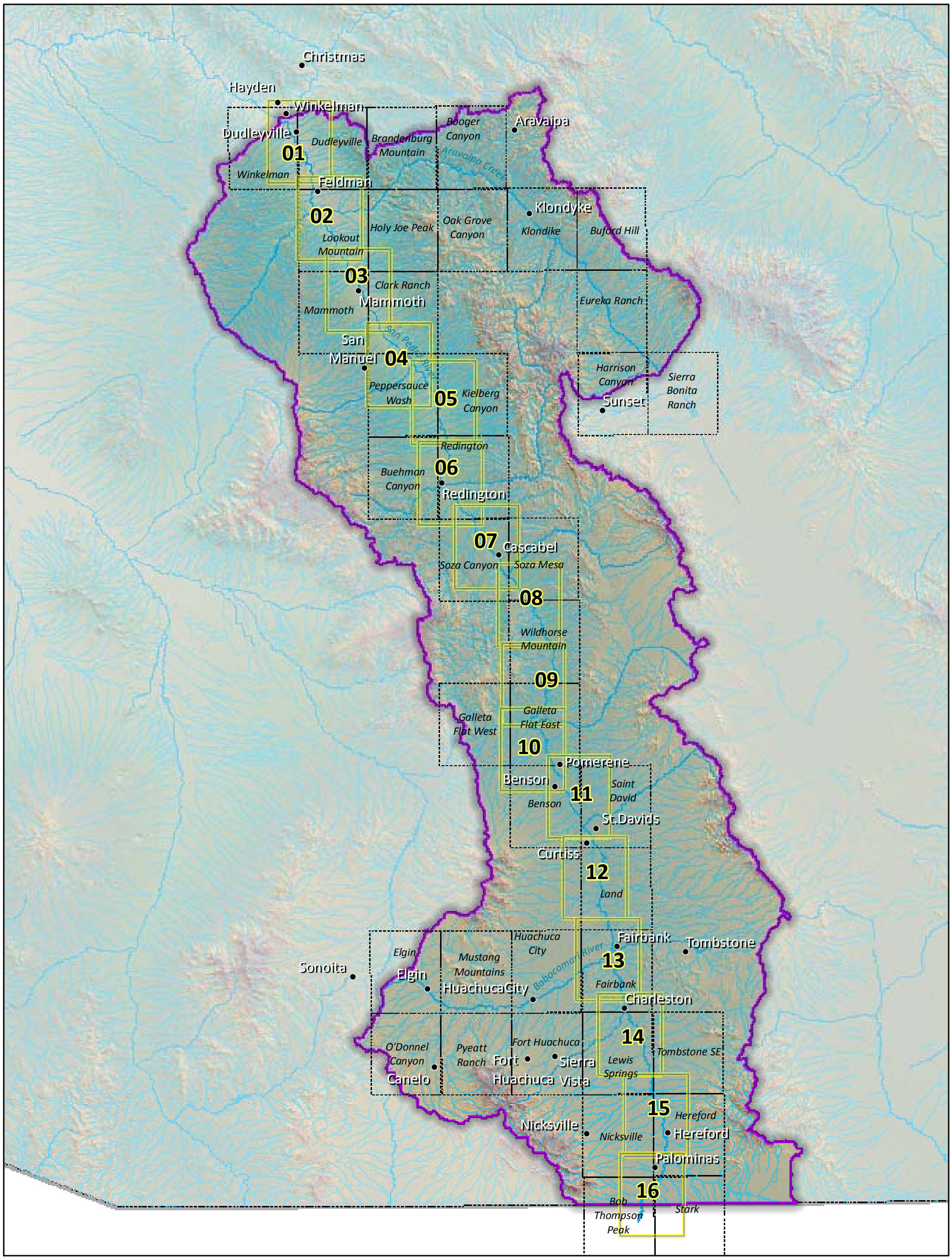
Aerial photographs showing the location of the berm and panoramas.



Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison Maps

Map Index for SRP San Pedro Attachment 8



Sheet Index

Miles
0 5 10 20

0 5 10 20
Kilometers

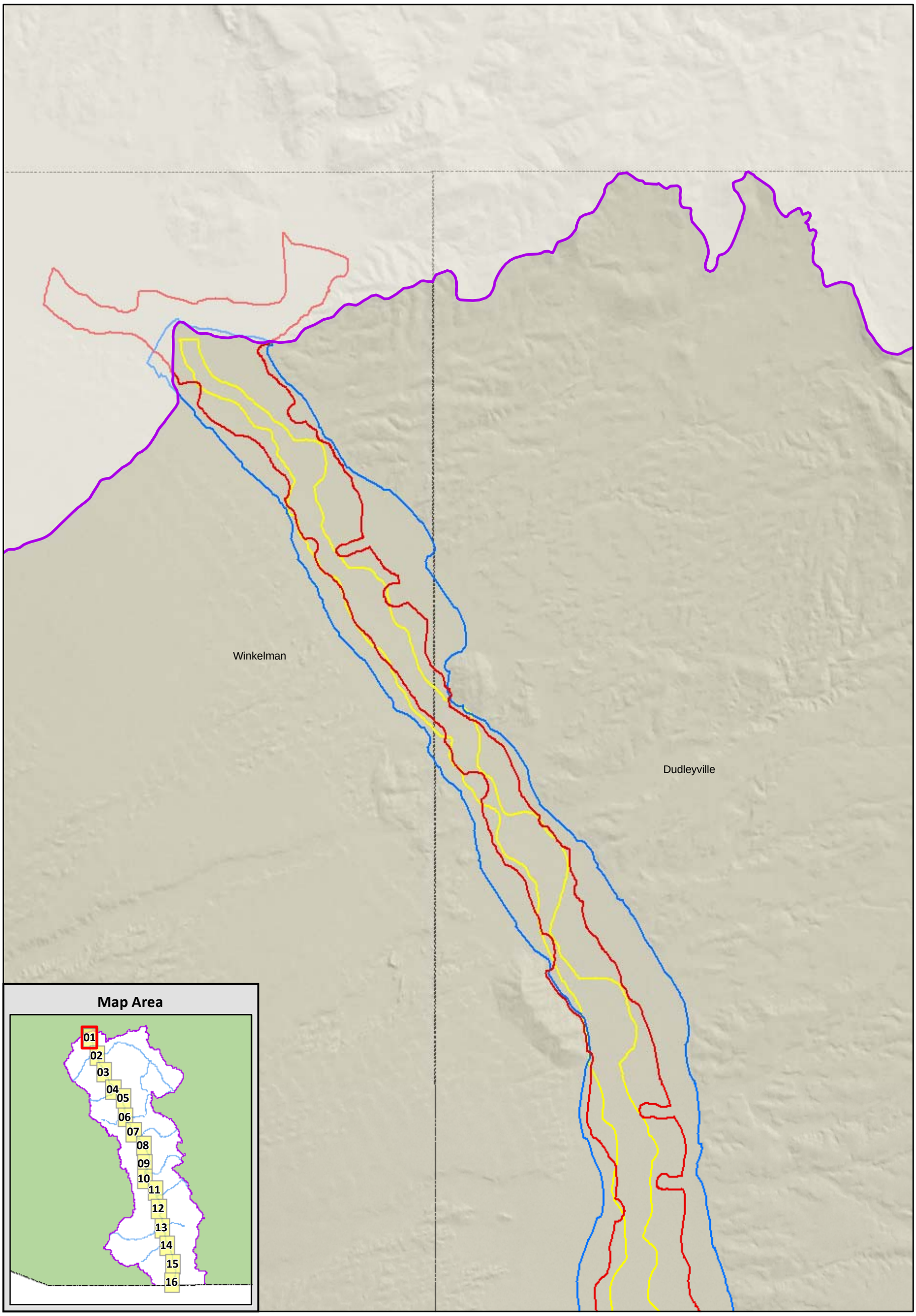
Legend

- Map Book Pages
- USGS Topo (24k) Quad Boundary
- San Pedro River Watershed Boundary

SanPedro_MapIndex8.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 1

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

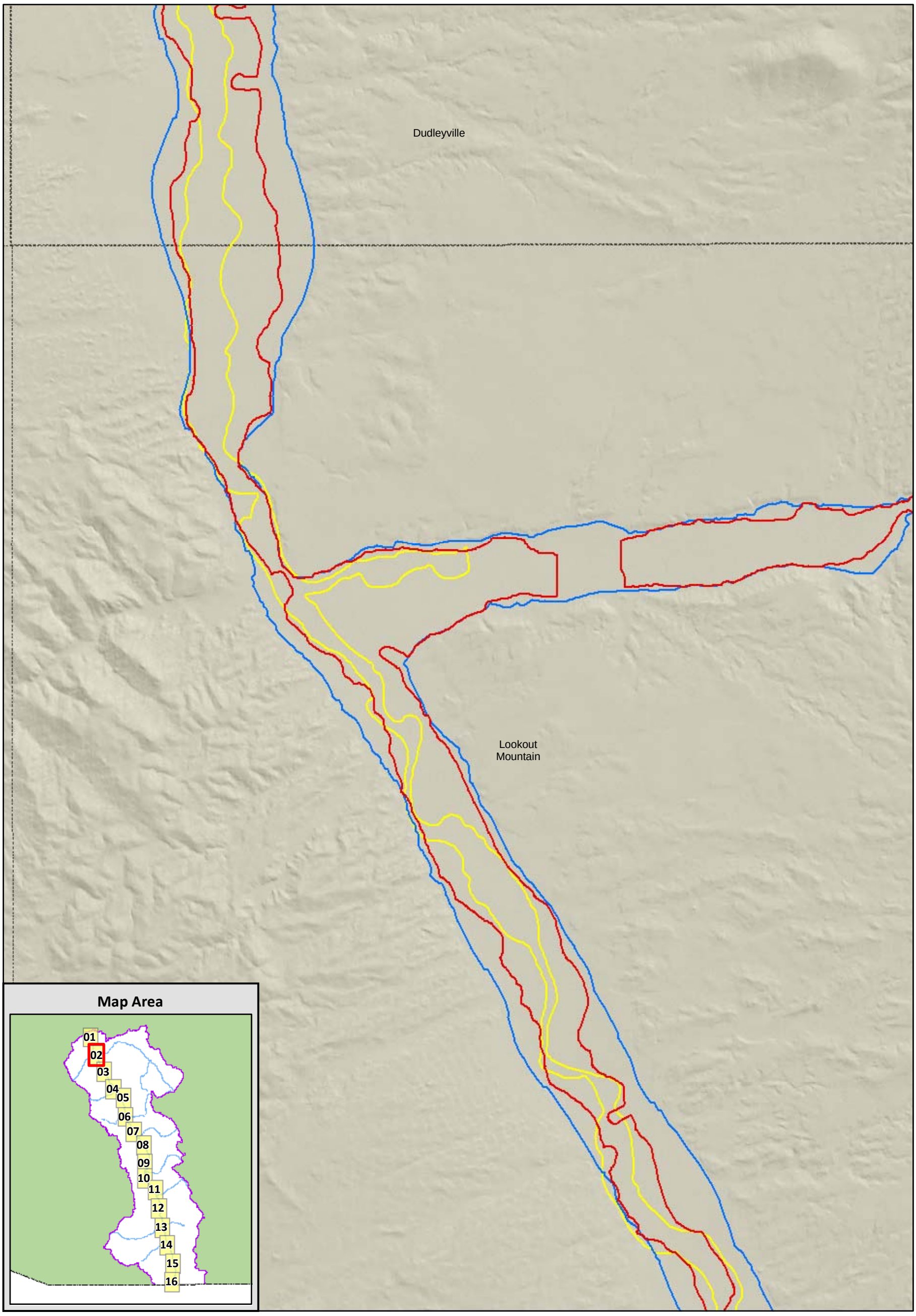
0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 2

Miles
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0 0.5 1
Kilometers

Legend

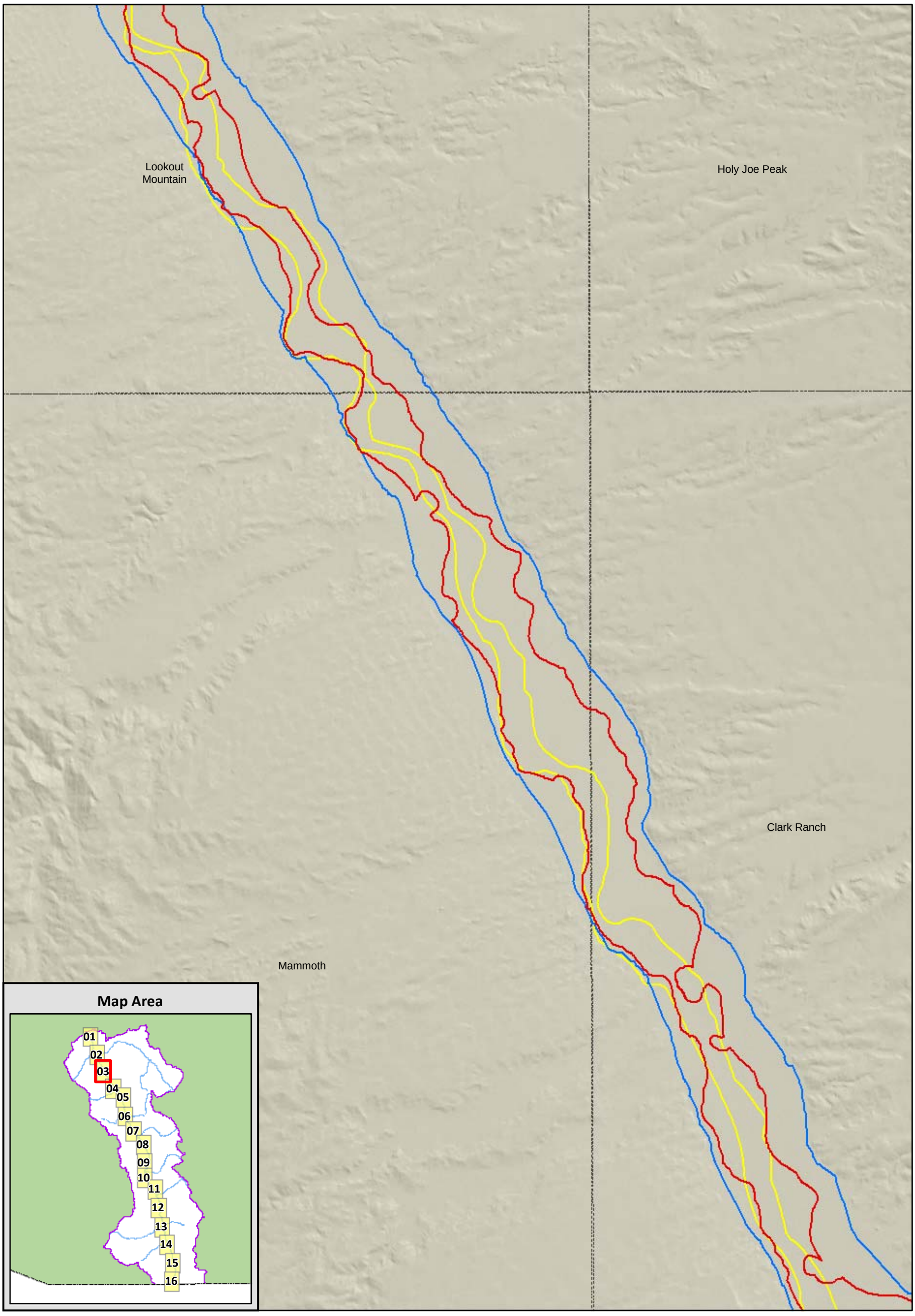
- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 3

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

0 0.5 1
Kilometers

Data Sources:
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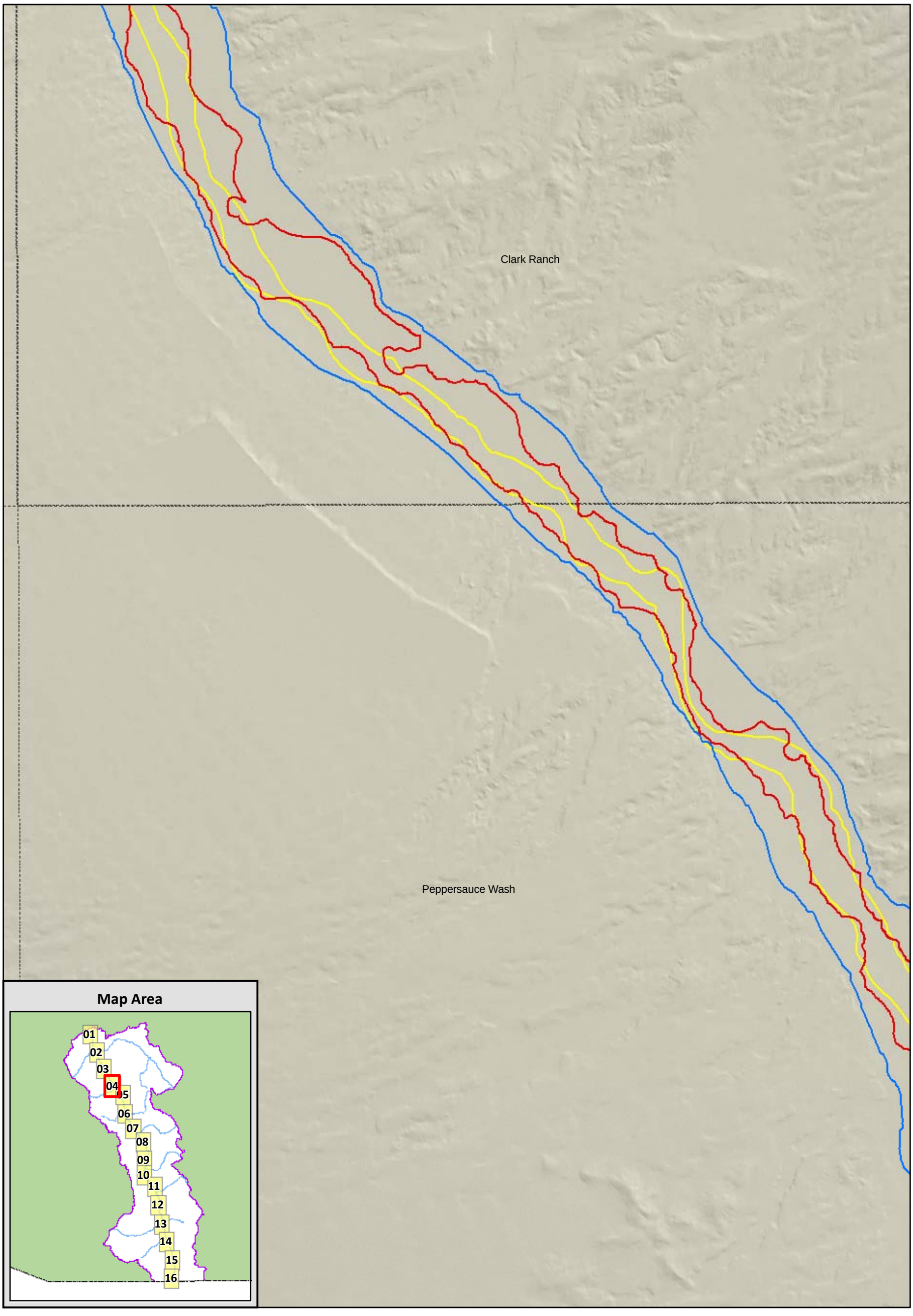
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 4

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

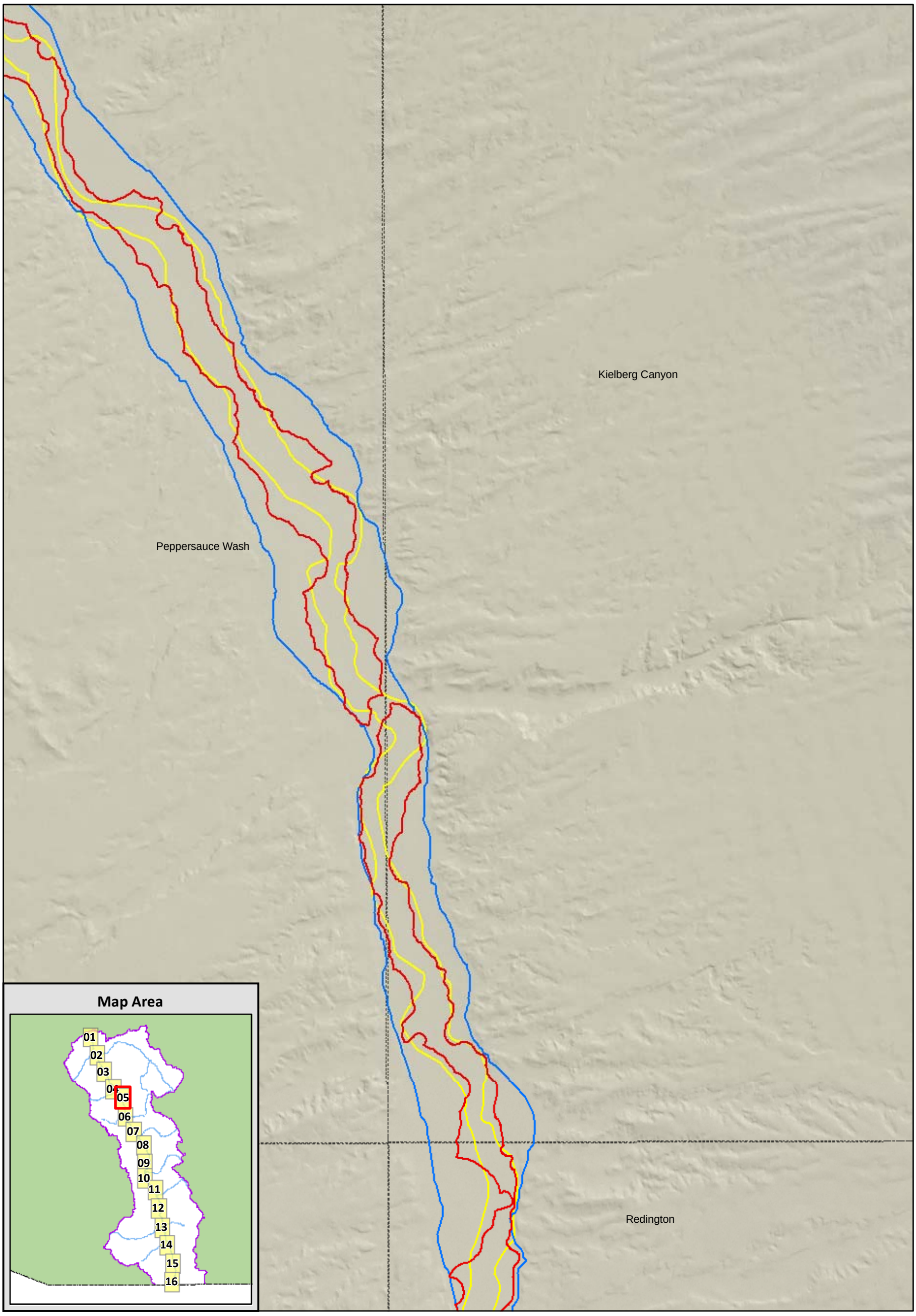
0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 5

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

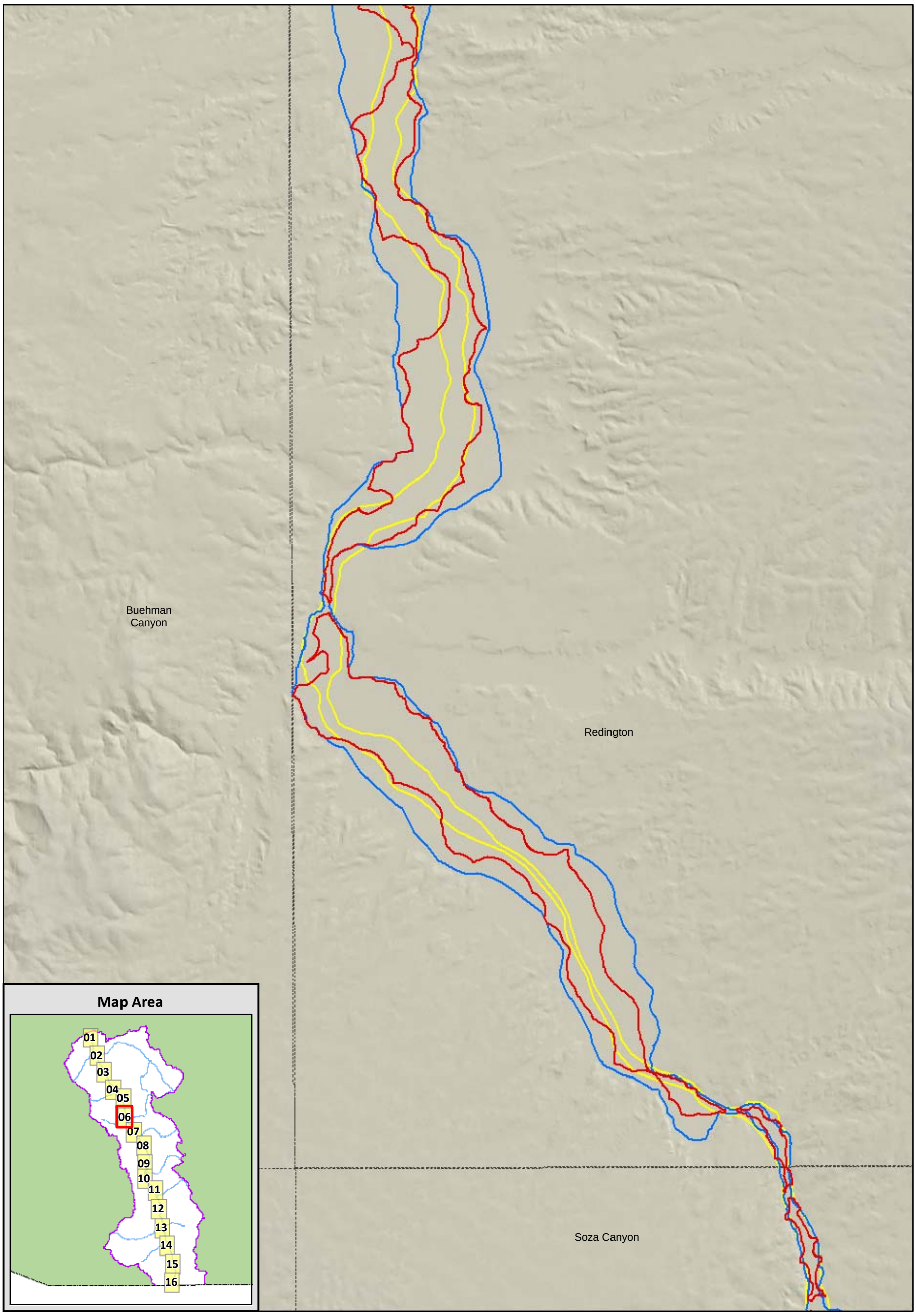
0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 6

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

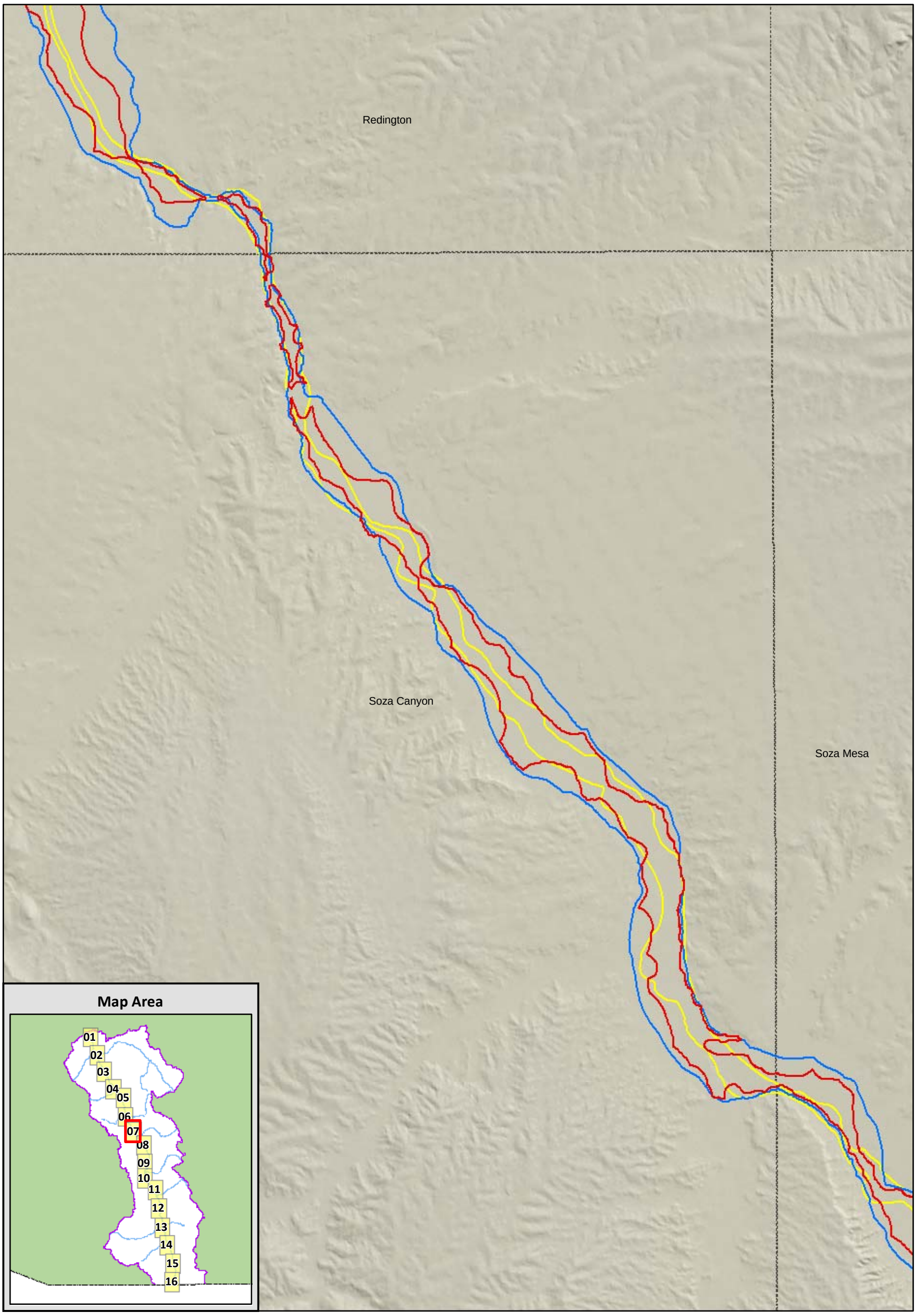
0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 7

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Data Sources:
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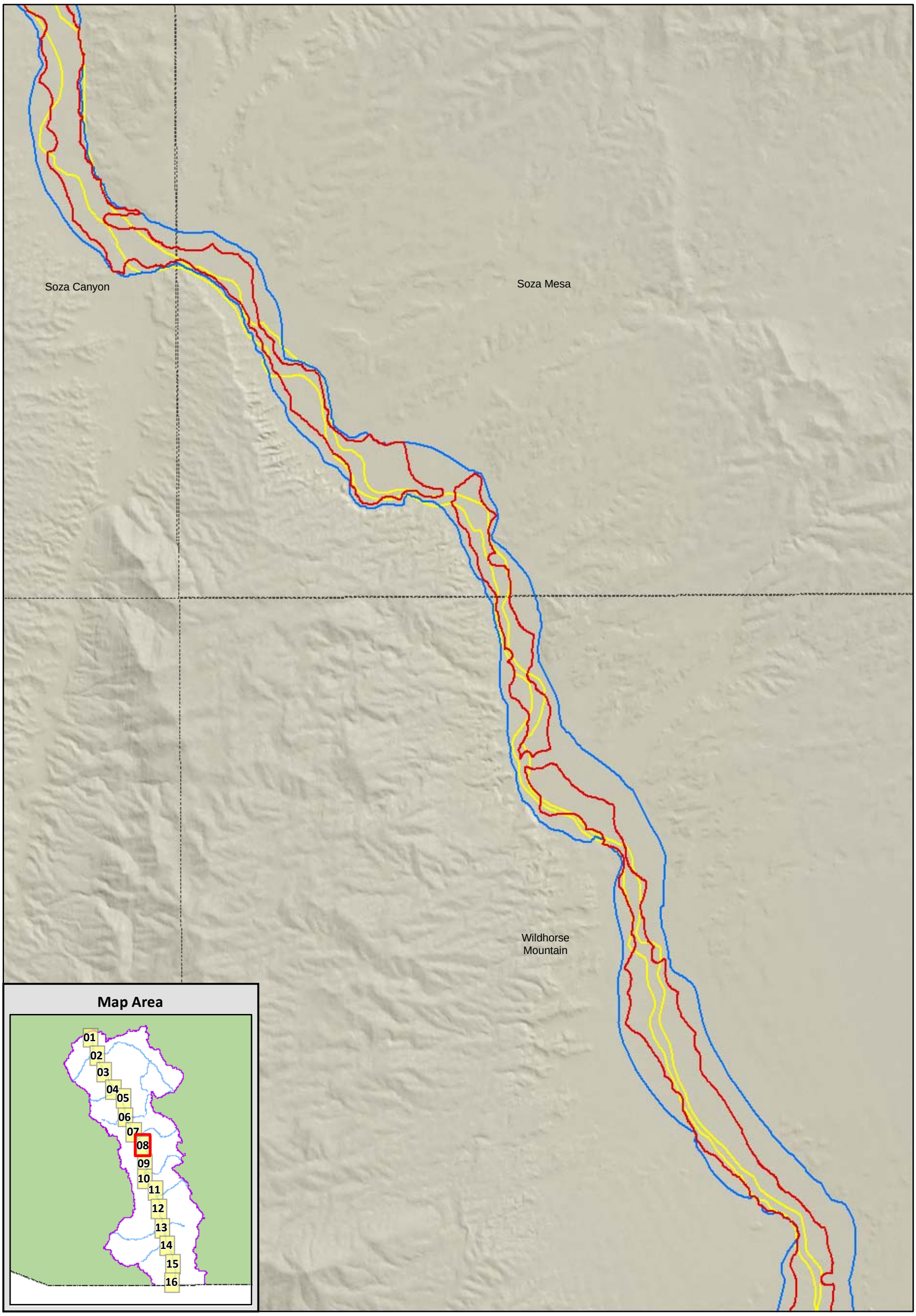
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 8

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Data Sources:
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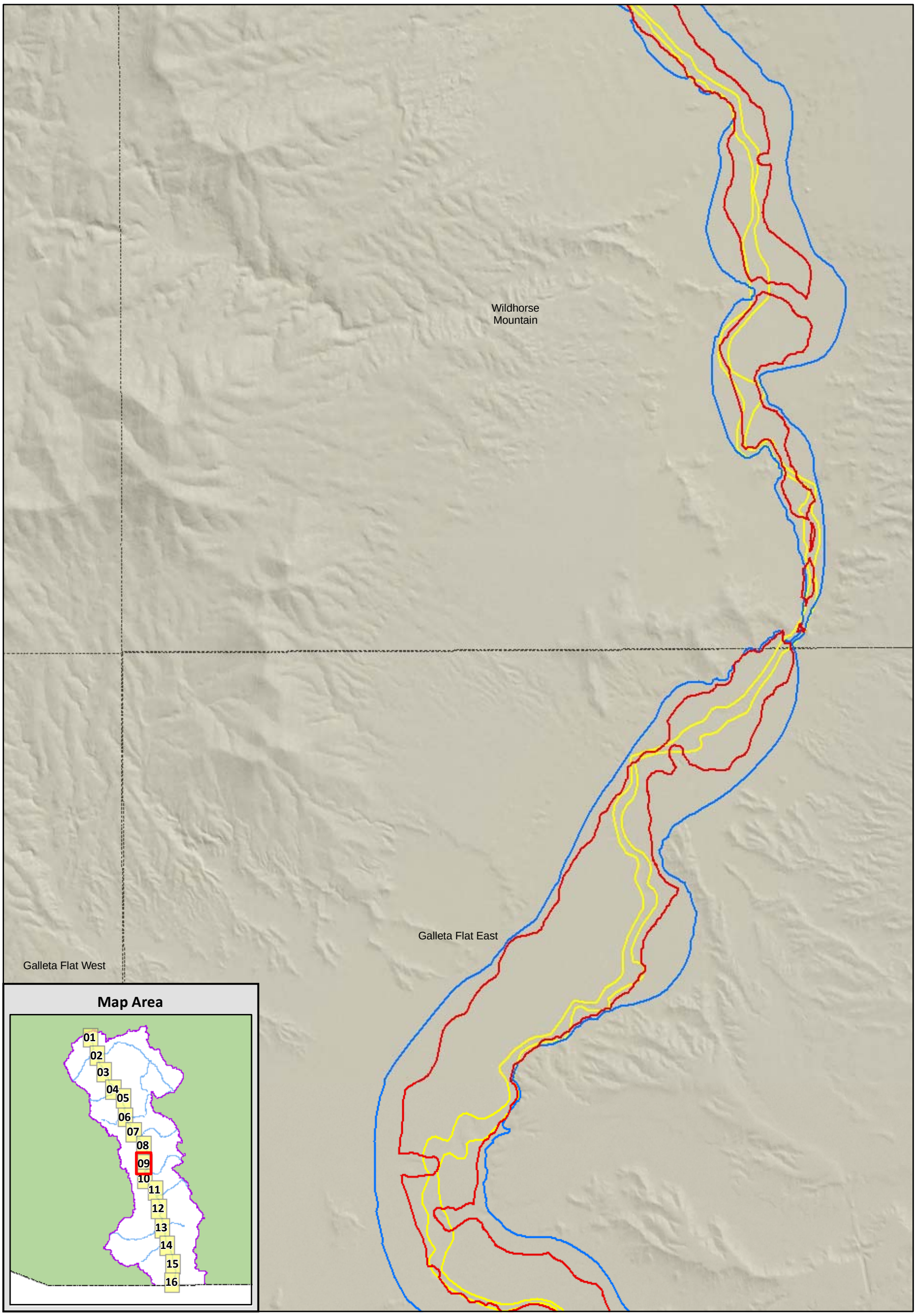
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 9

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
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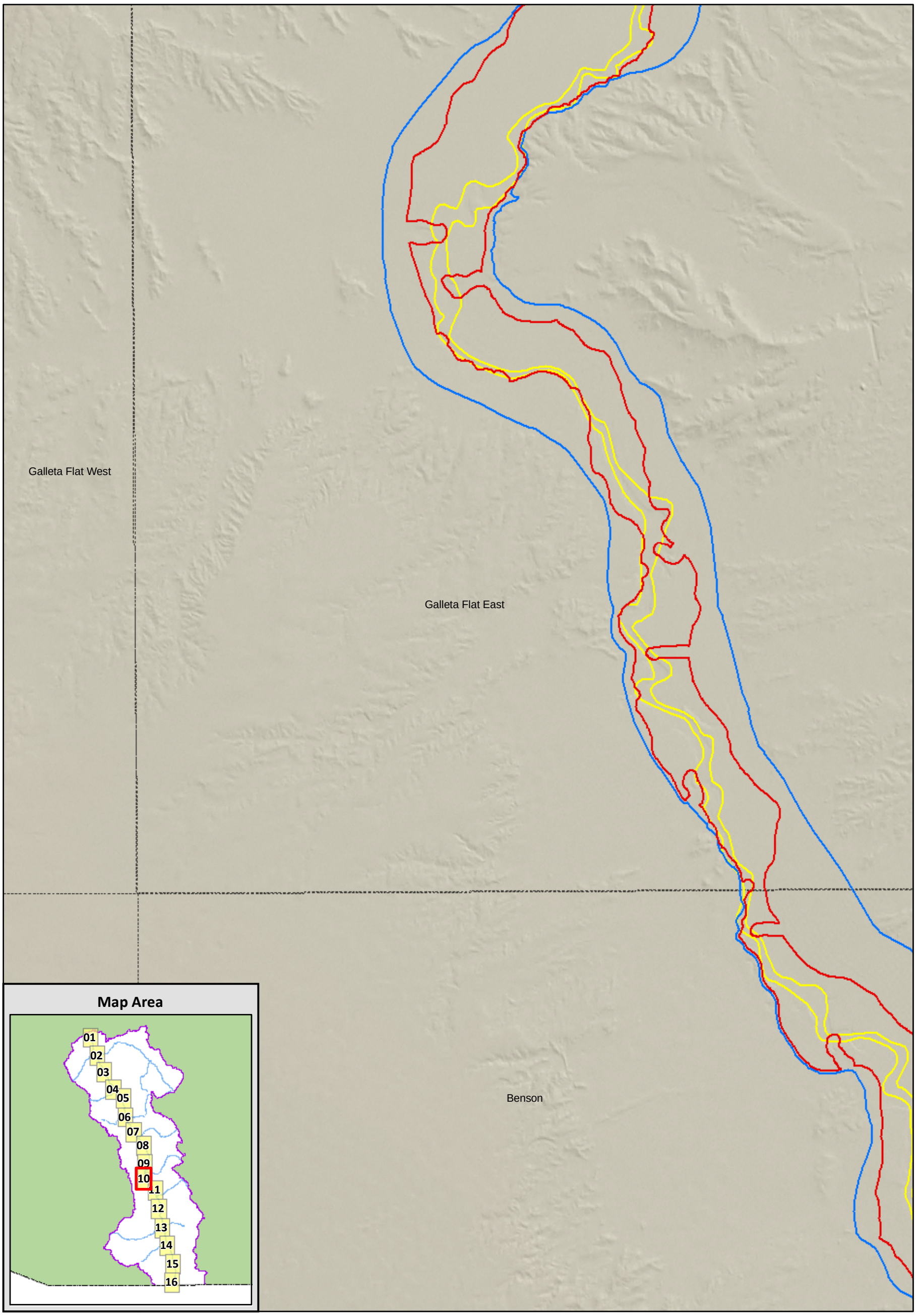
SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 10

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

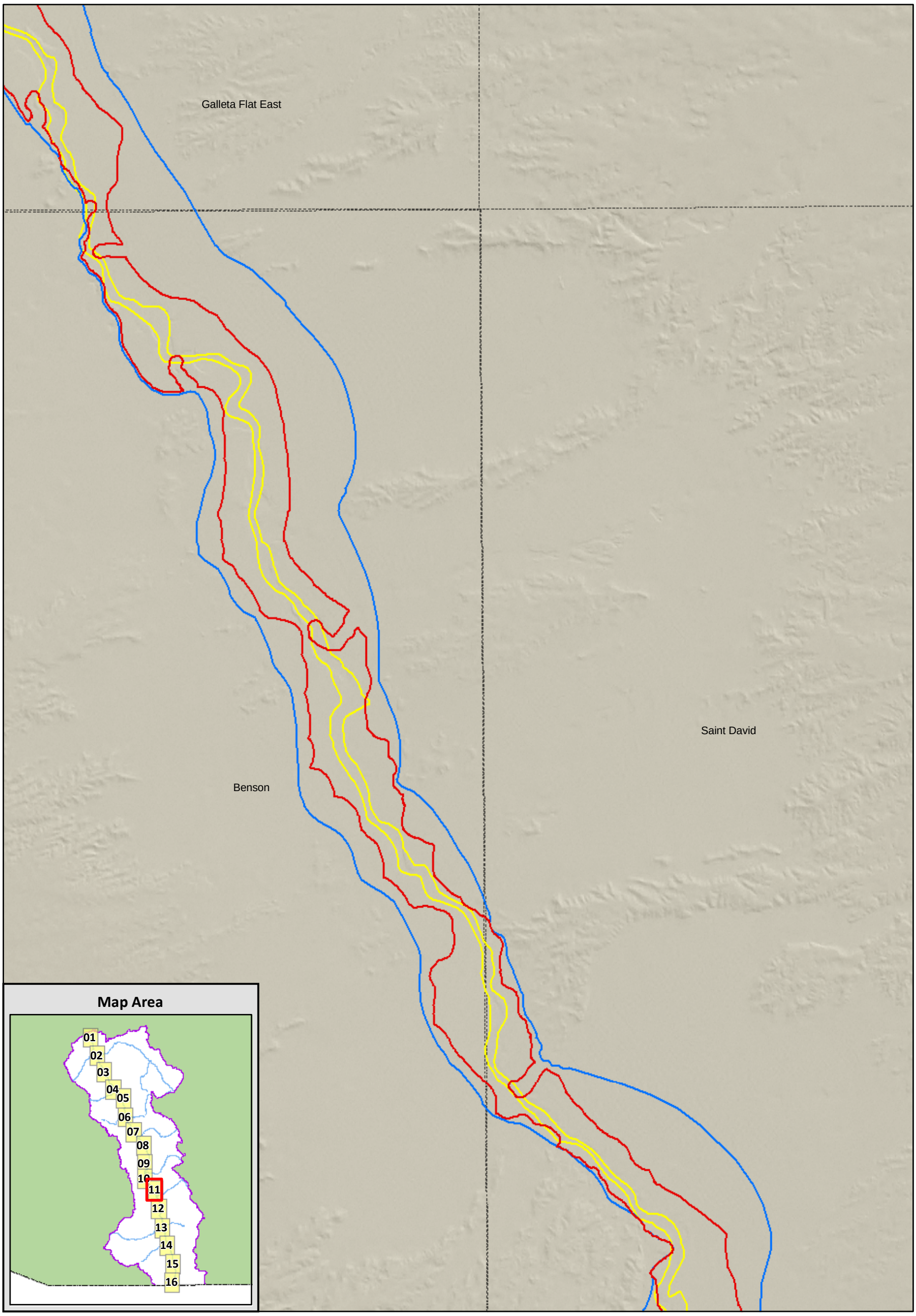
0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 11

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

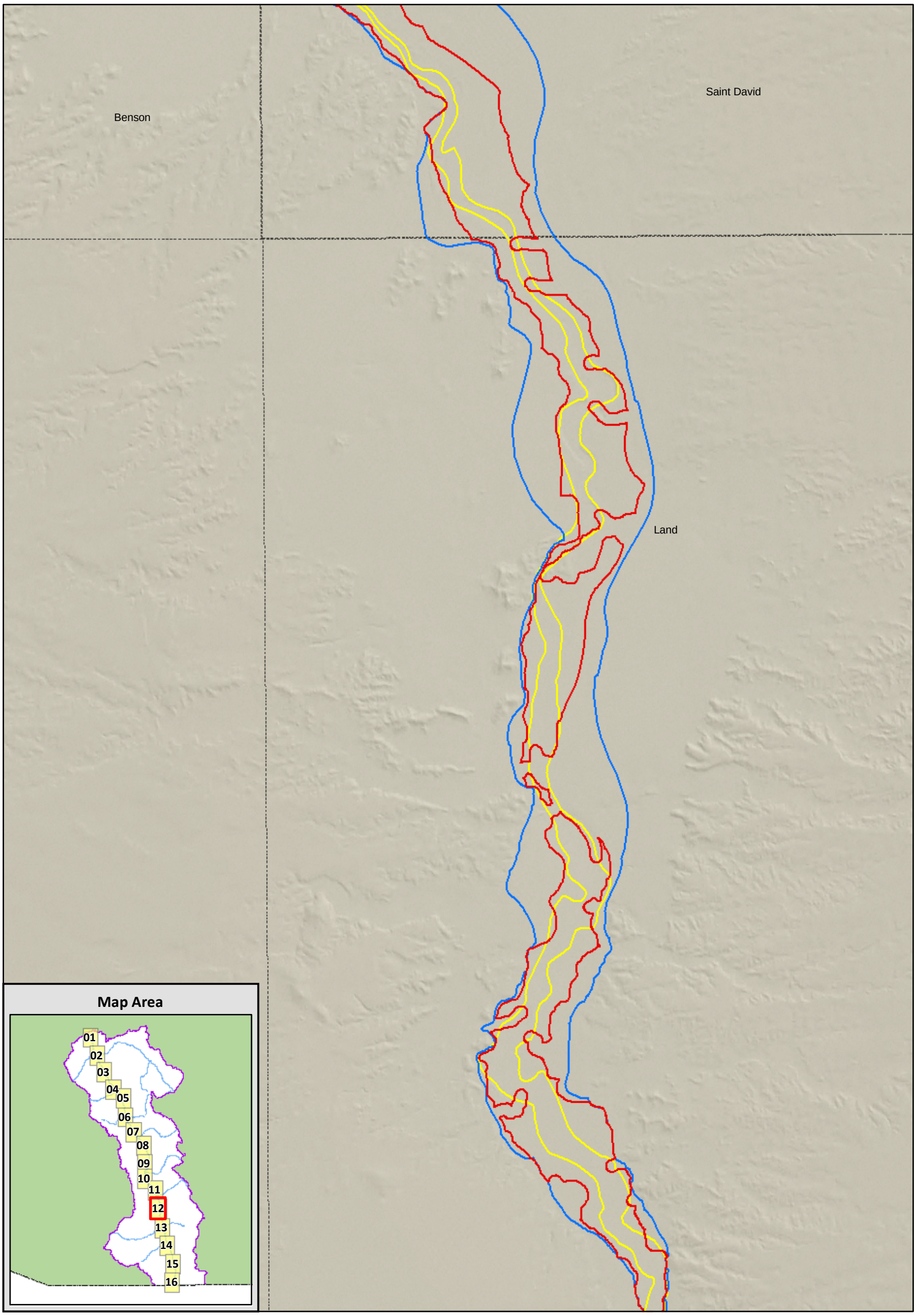
0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 12

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

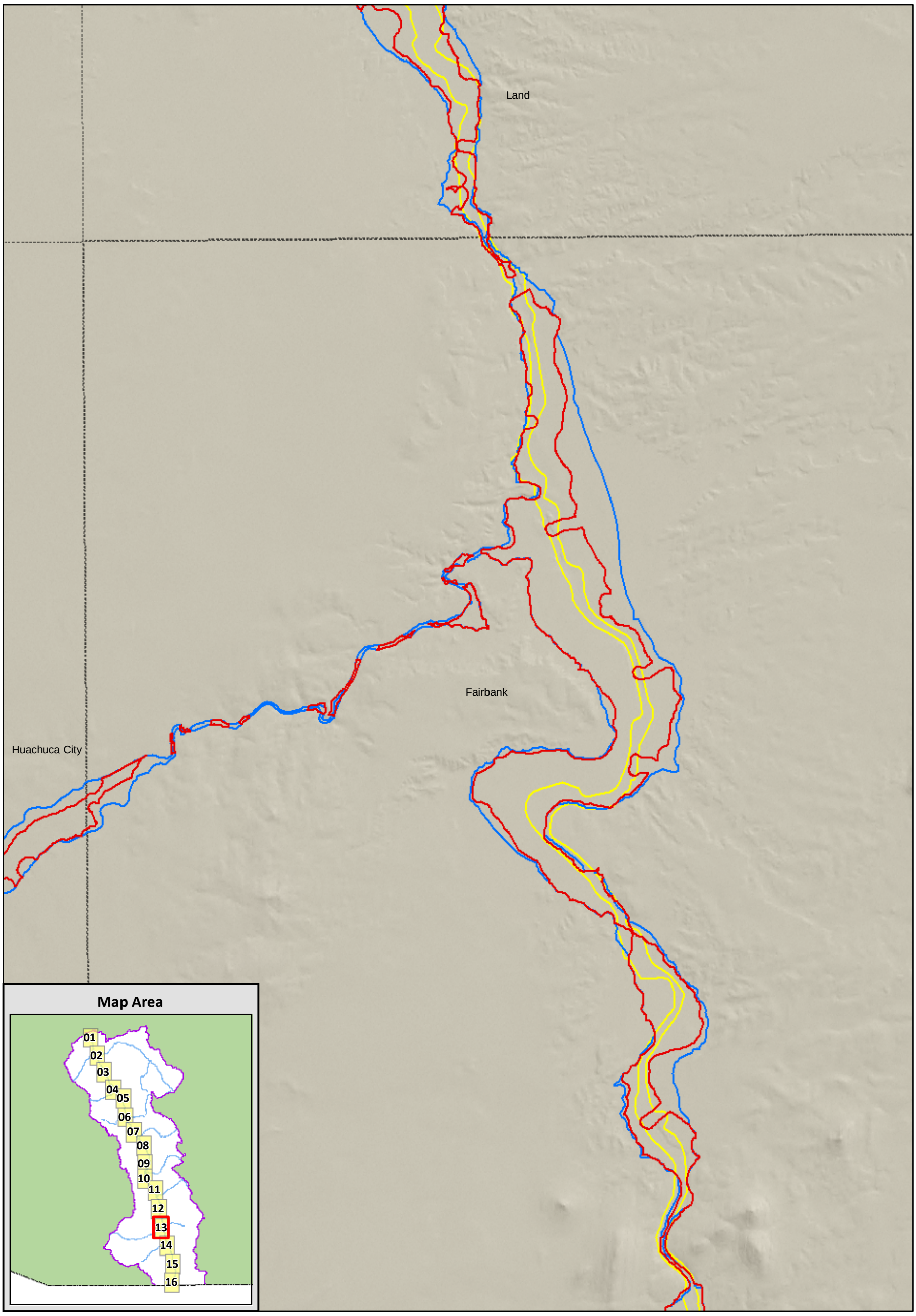
- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 13

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Data Sources:
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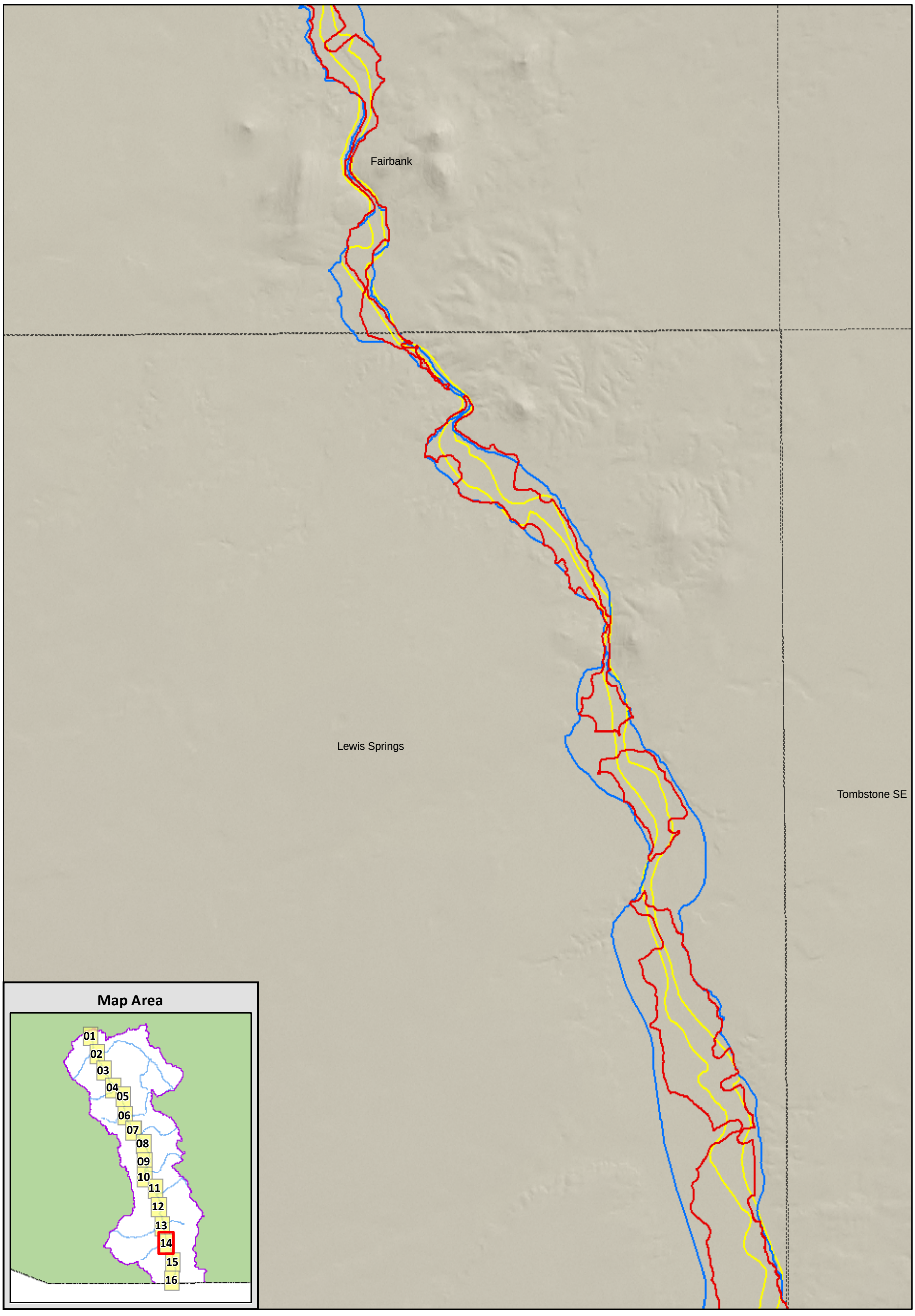
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

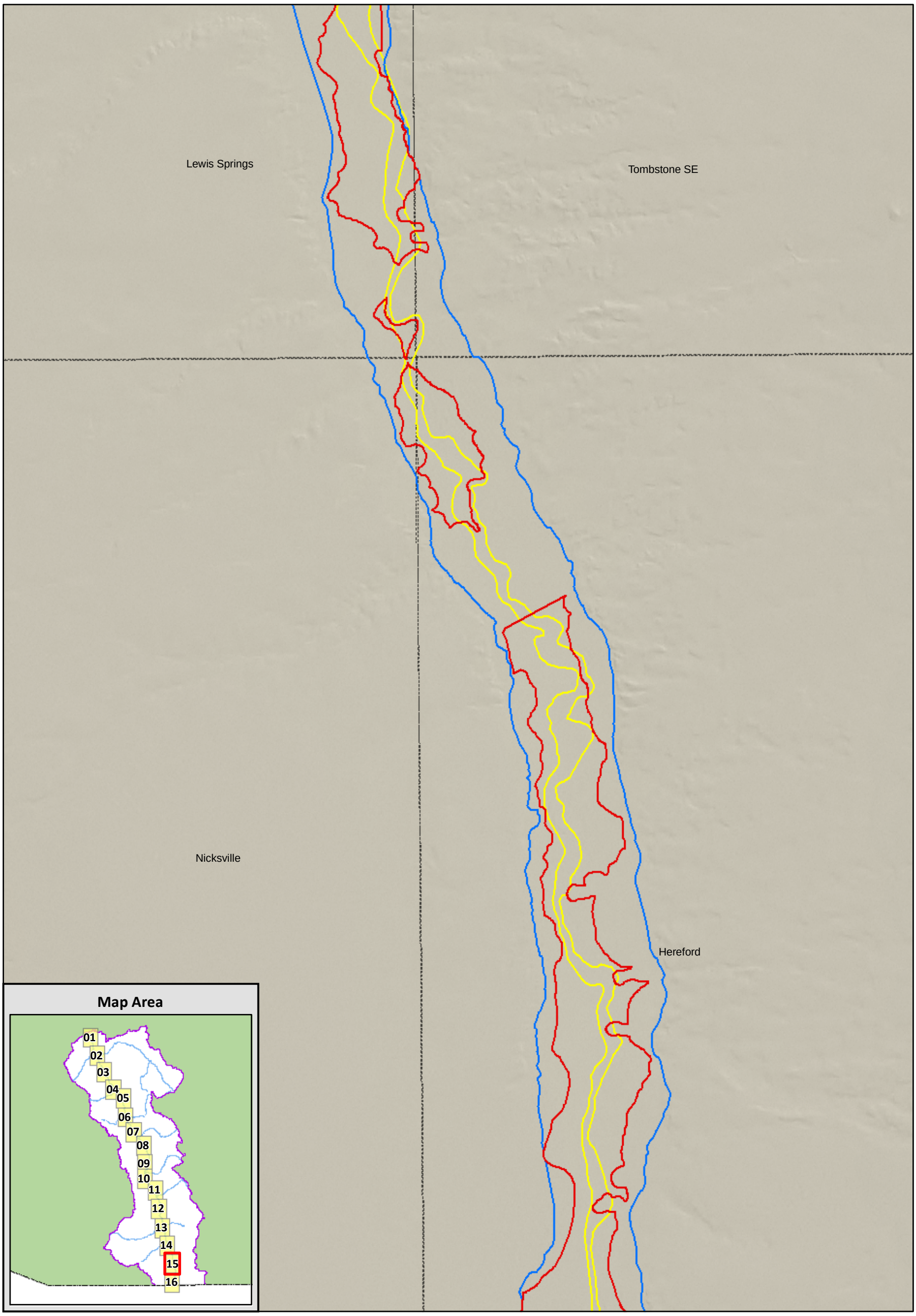
Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 14

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 15

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

Miles
0 0.5 1

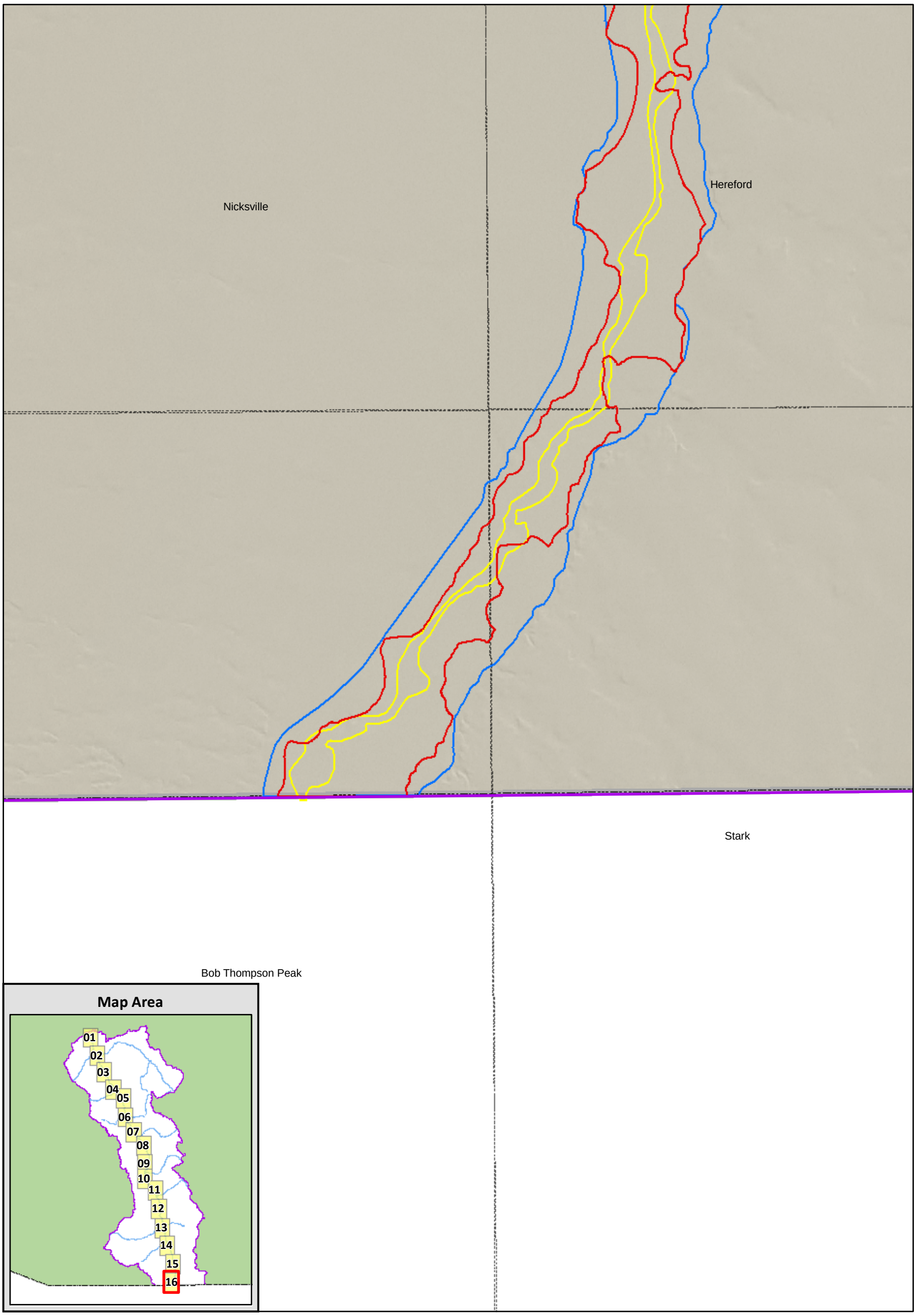
0 0.5 1
Kilometers

Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 8

Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison, San Pedro River



Sheet 16

Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Montgomery Post-1880 Subflow Zone

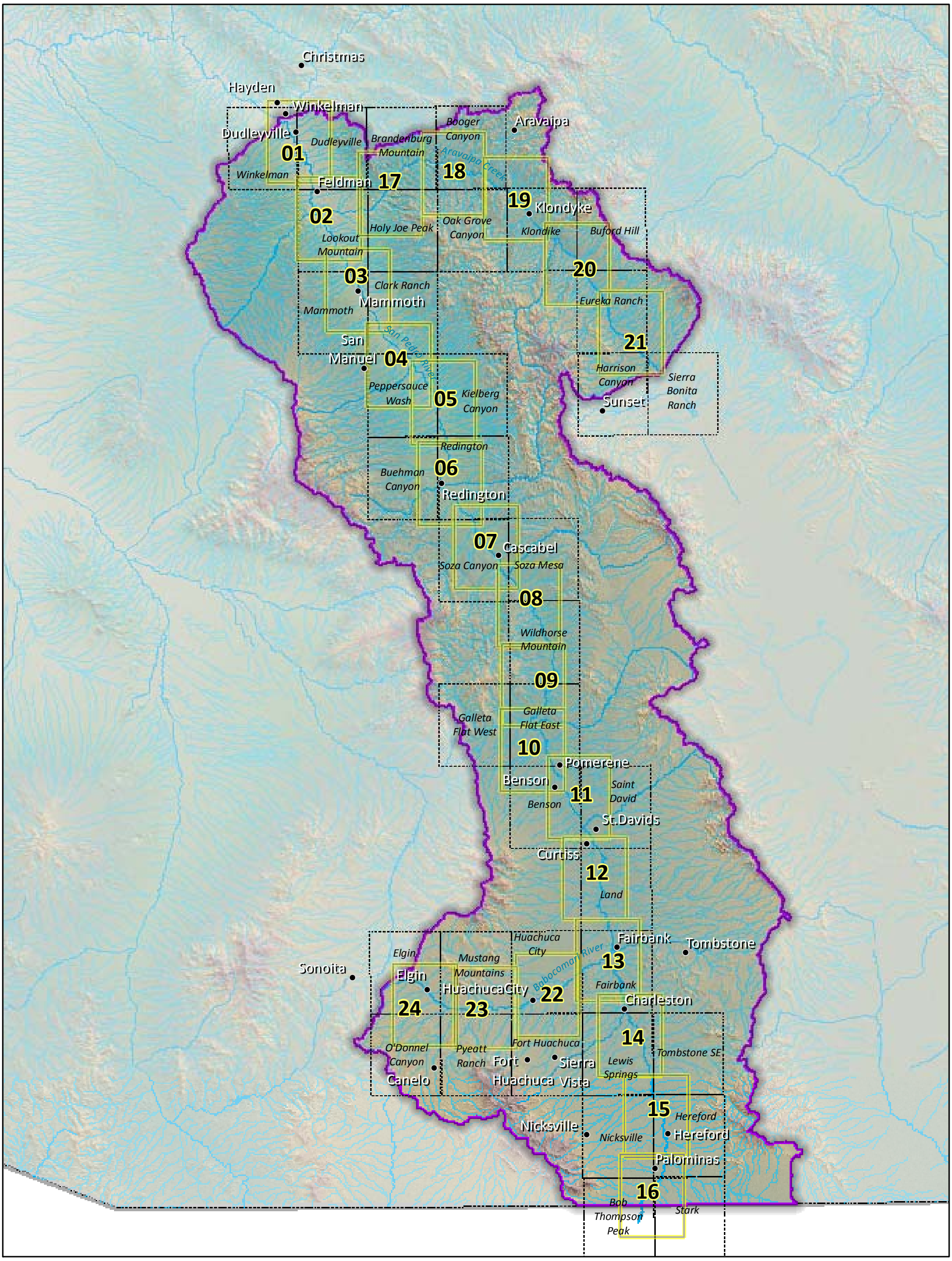
Data Sources:
1994 Exhibits 209-216: Montgomery post-1880 Subflow Zone
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_Montgomery.mxd

Attachment 9

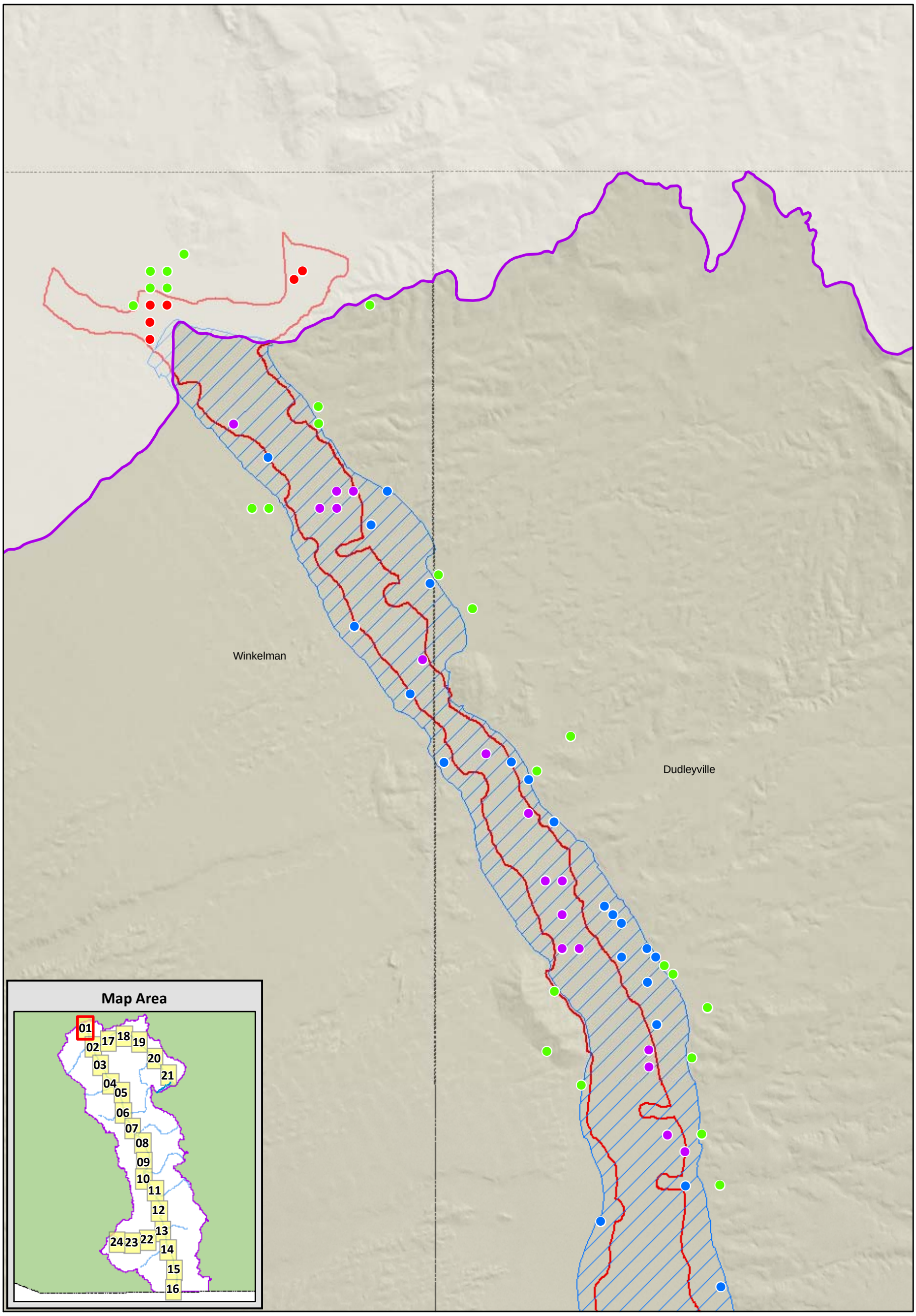
Large Wells In and Near the Subflow Zone

Map Index for SRP San Pedro Attachments 9 & 11



SanPedro_MapIndex9.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

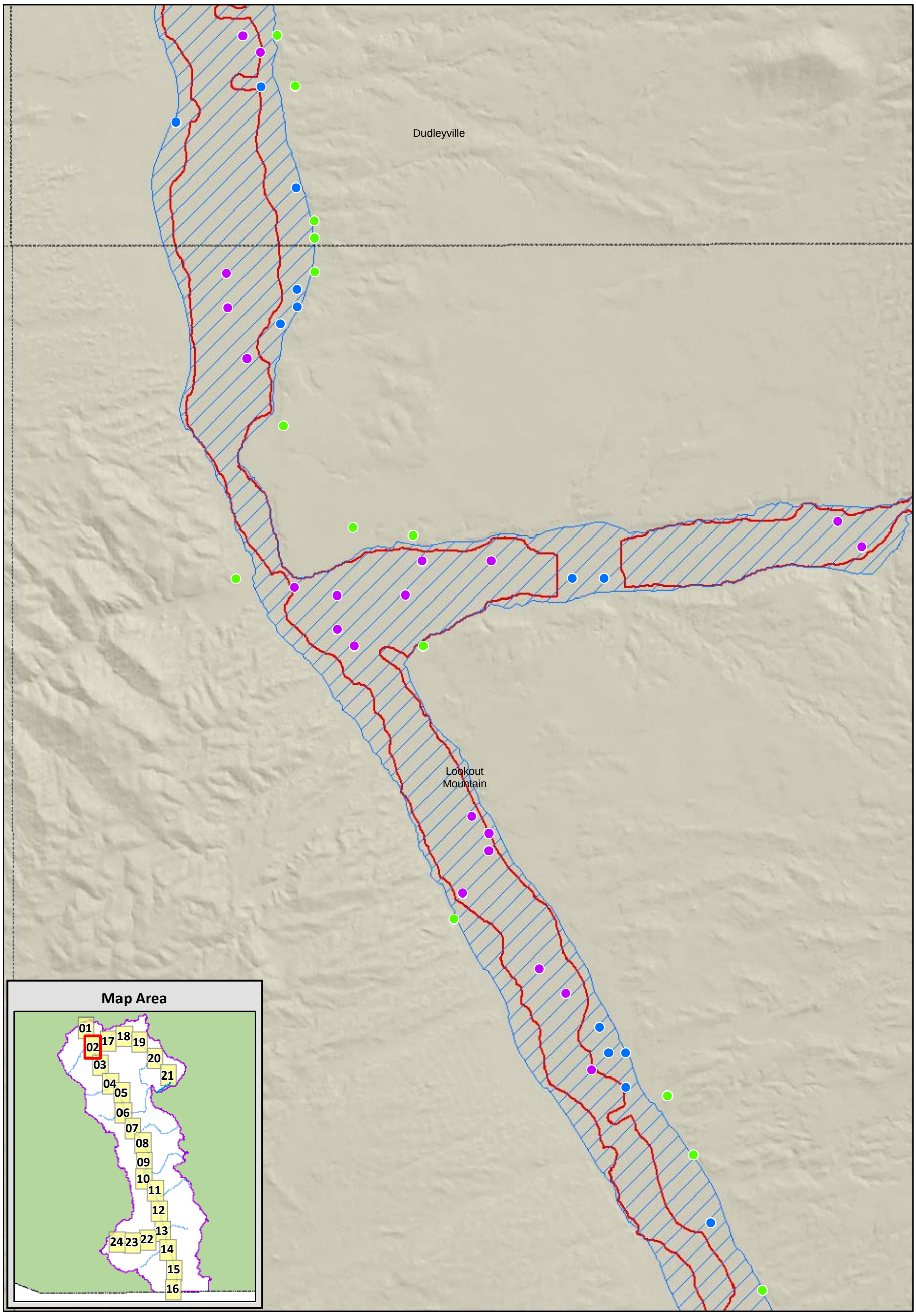
0 0.5 1
Kilometers

Sheet 1

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

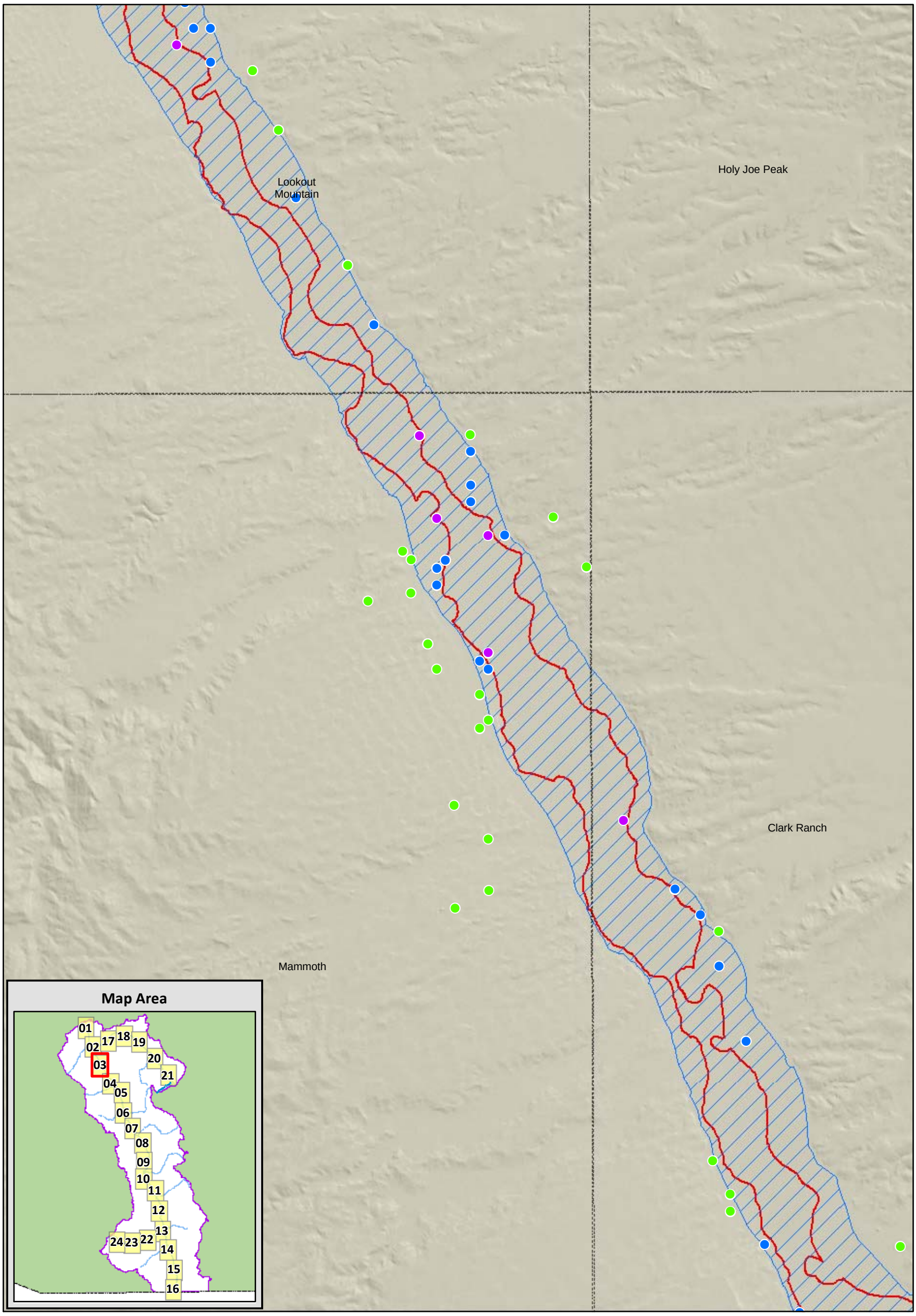
0 0.5 1
Kilometers

Sheet 2

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

0 0.5 1
Kilometers

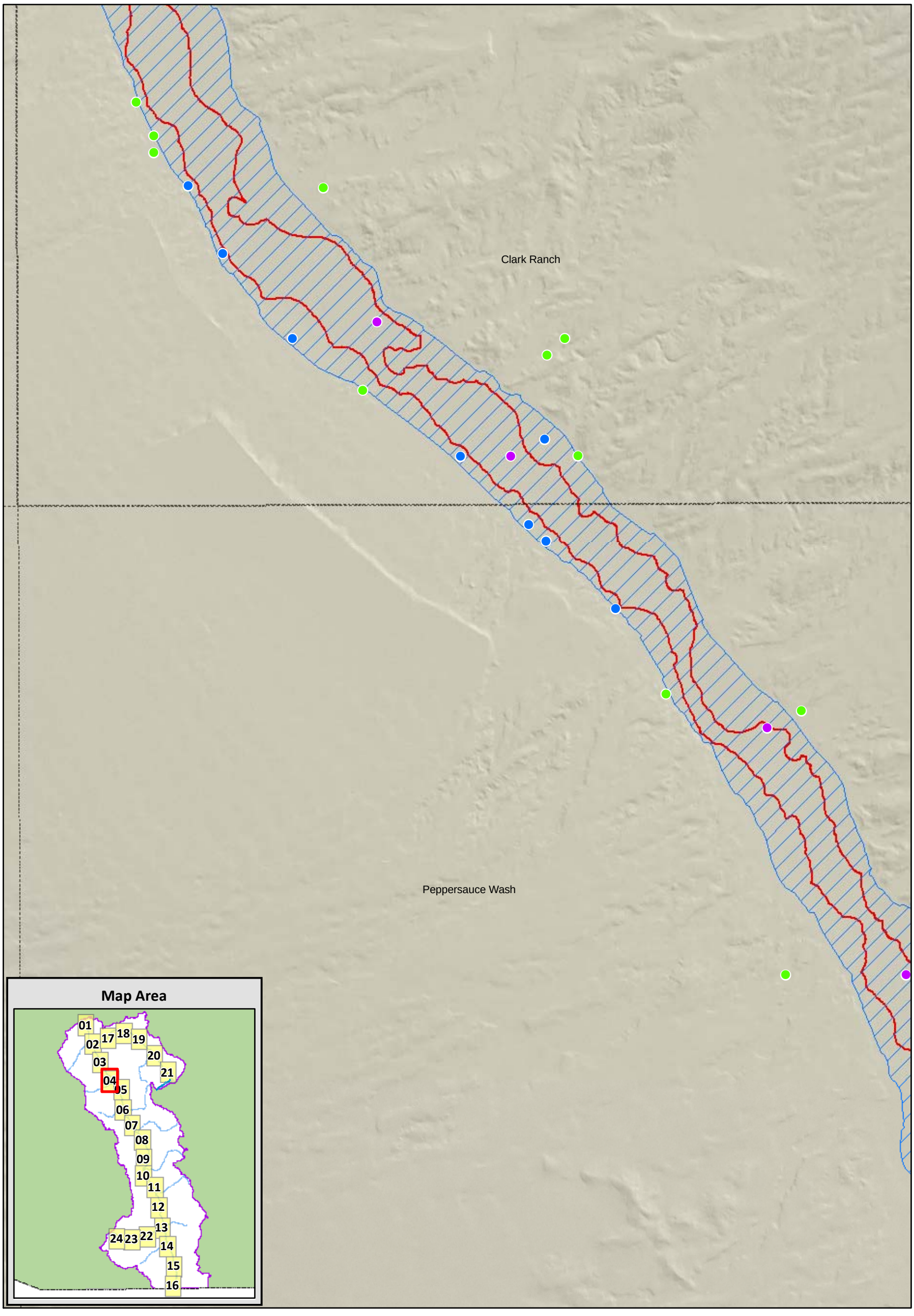
Sheet 3

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

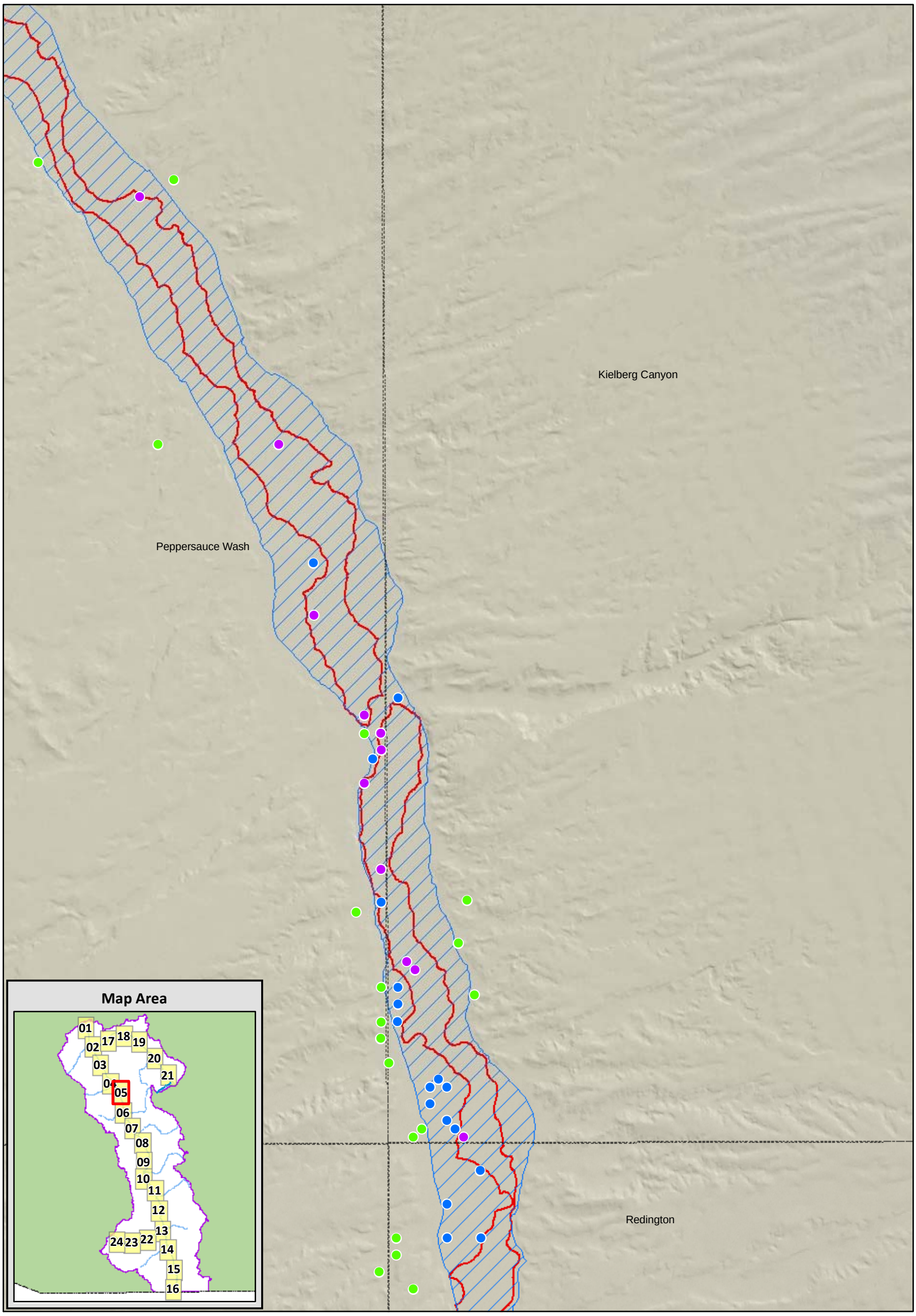
Sheet 4

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

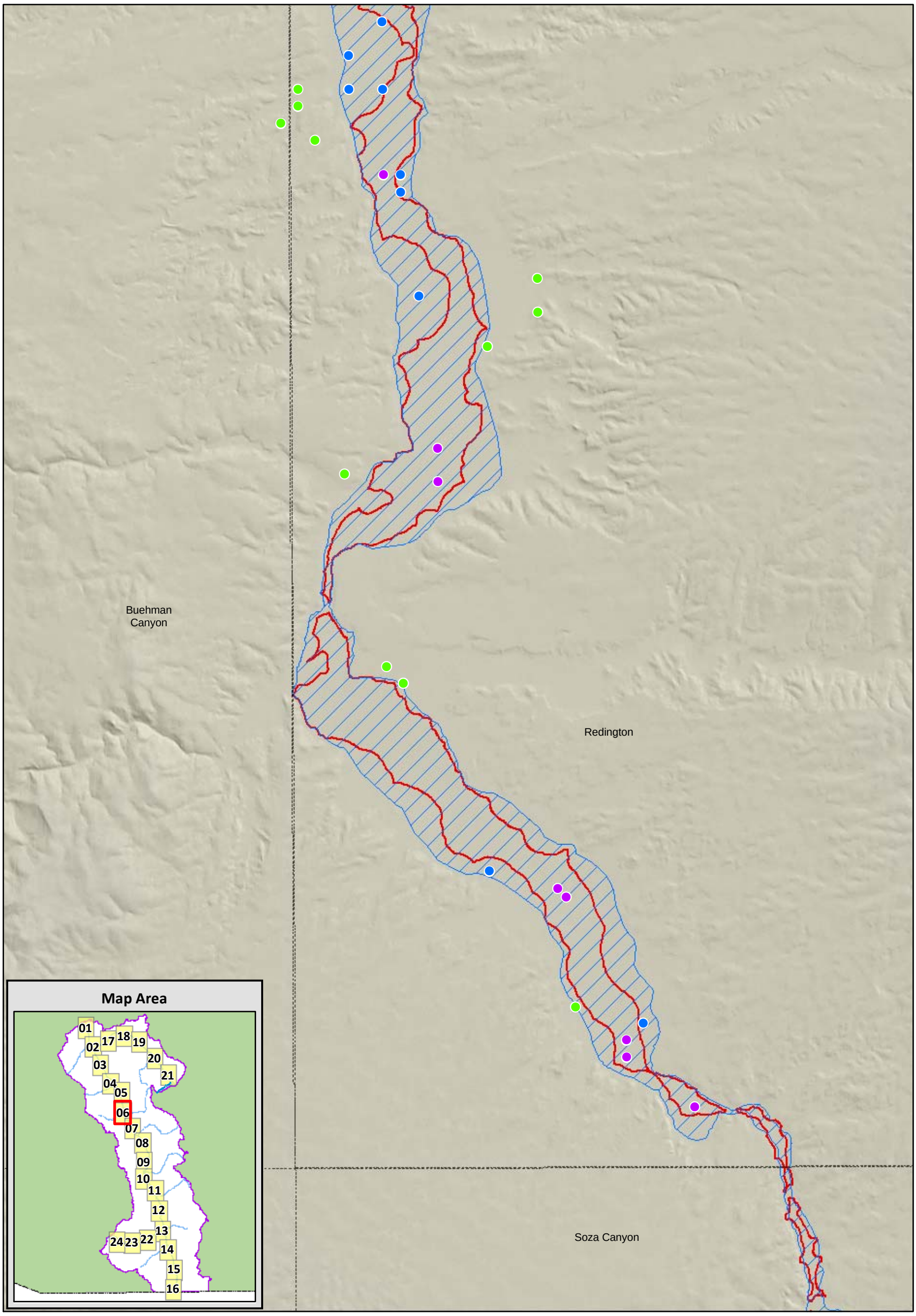
0 0.5 1
Kilometers

Sheet 5

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

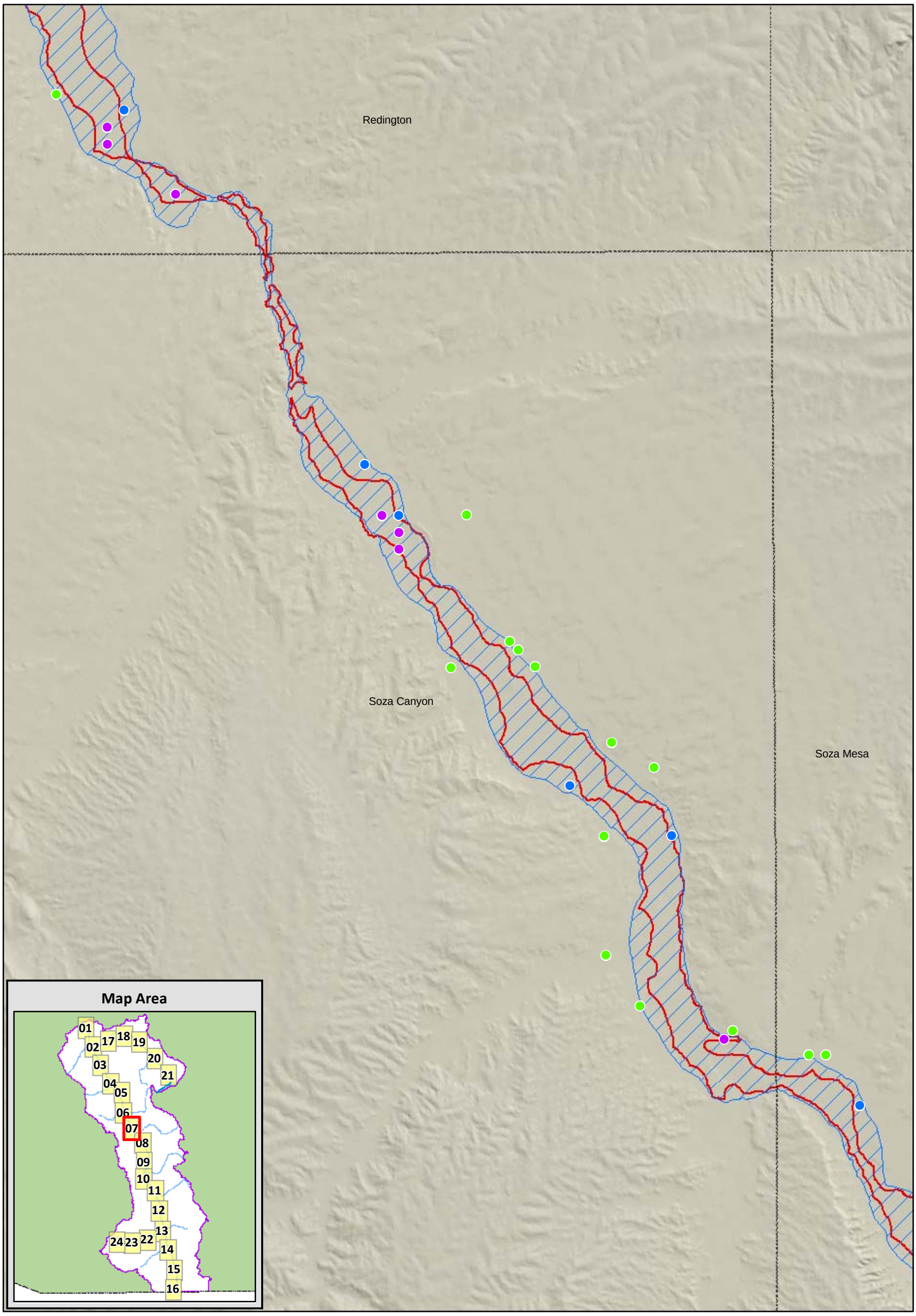
- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Sheet 6

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

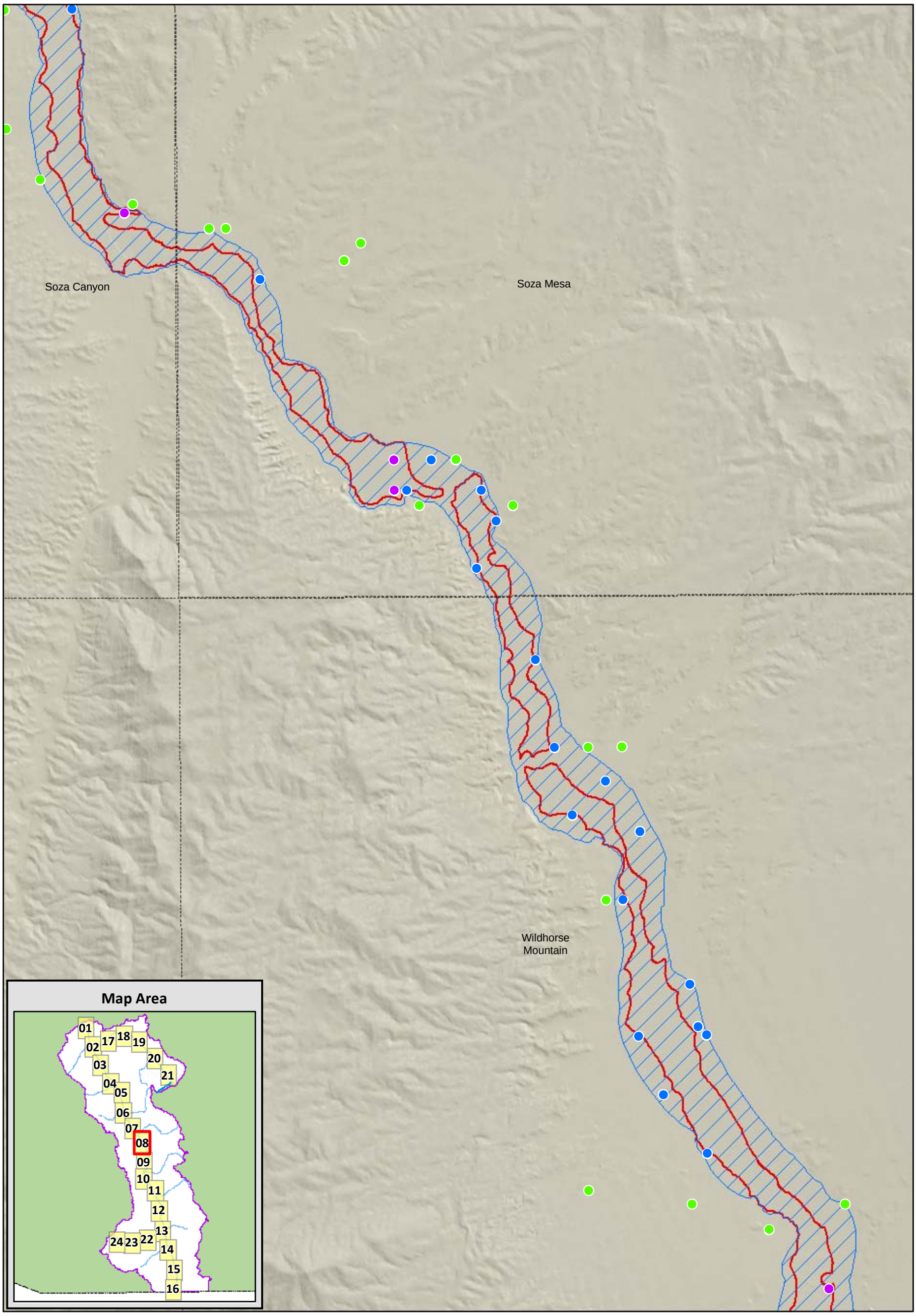
Sheet 7

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

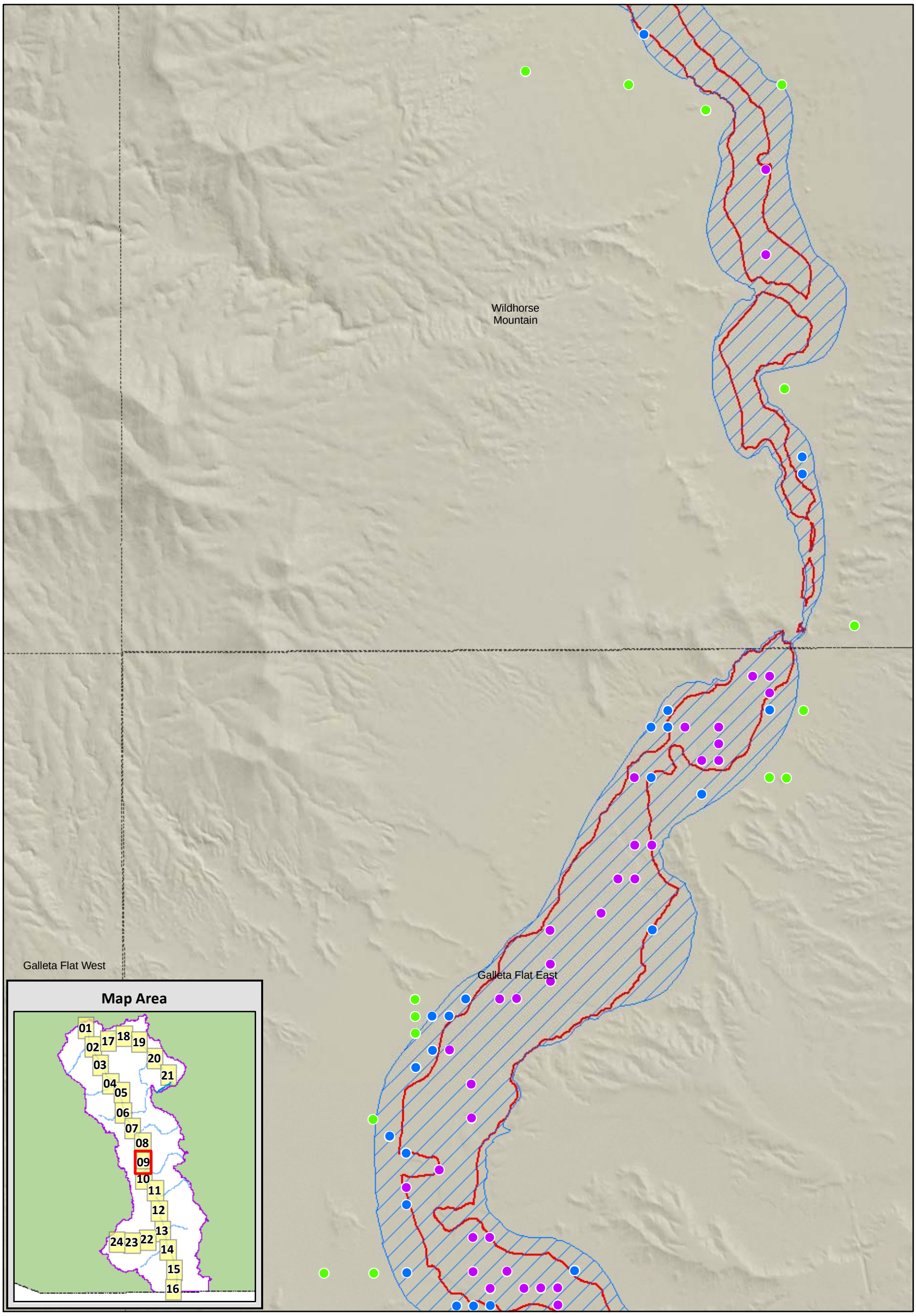
- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Sheet 8

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Sheet 9

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

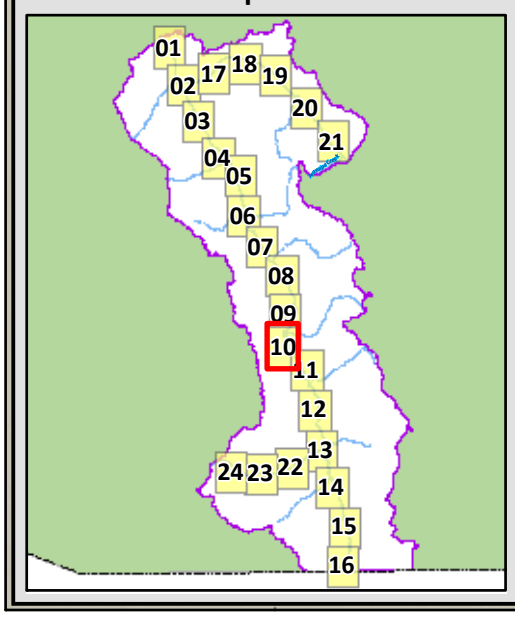
Large Wells In and Near the Subflow Zone, San Pedro River

Galleta Flat West

Galleta Flat East

Benson

Map Area



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
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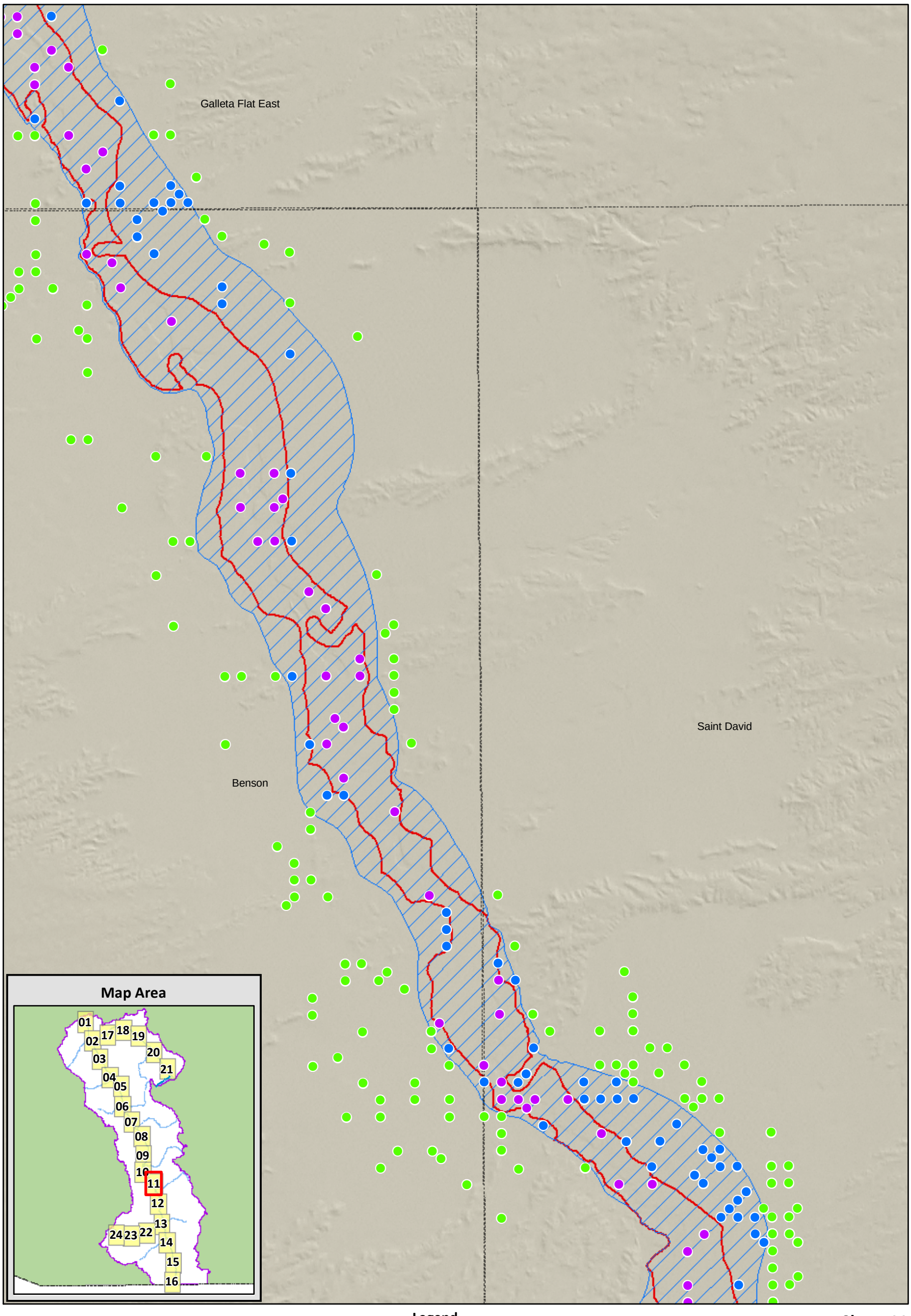
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Sheet 10

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

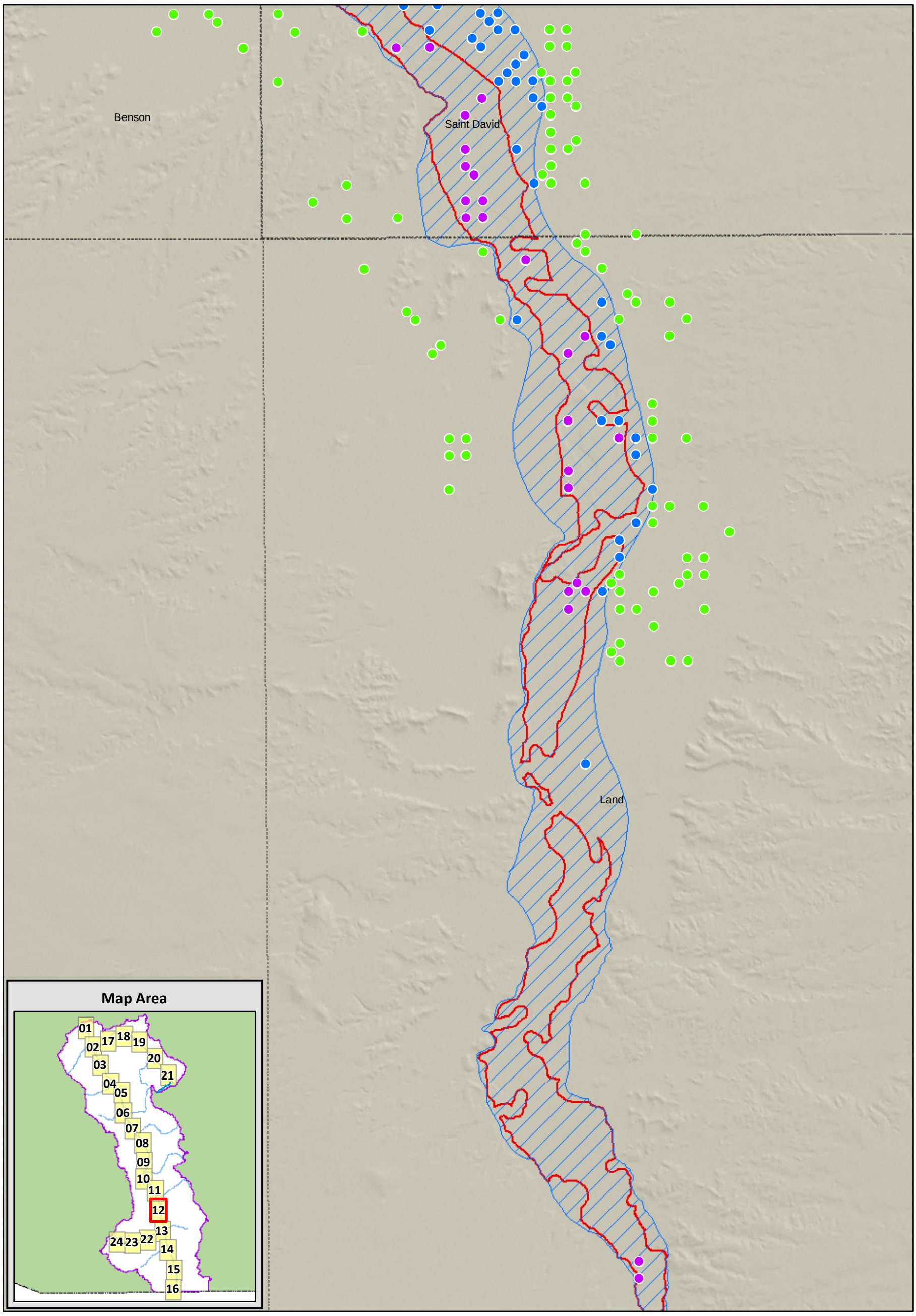
0 0.5 1
Kilometers

Sheet 11

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

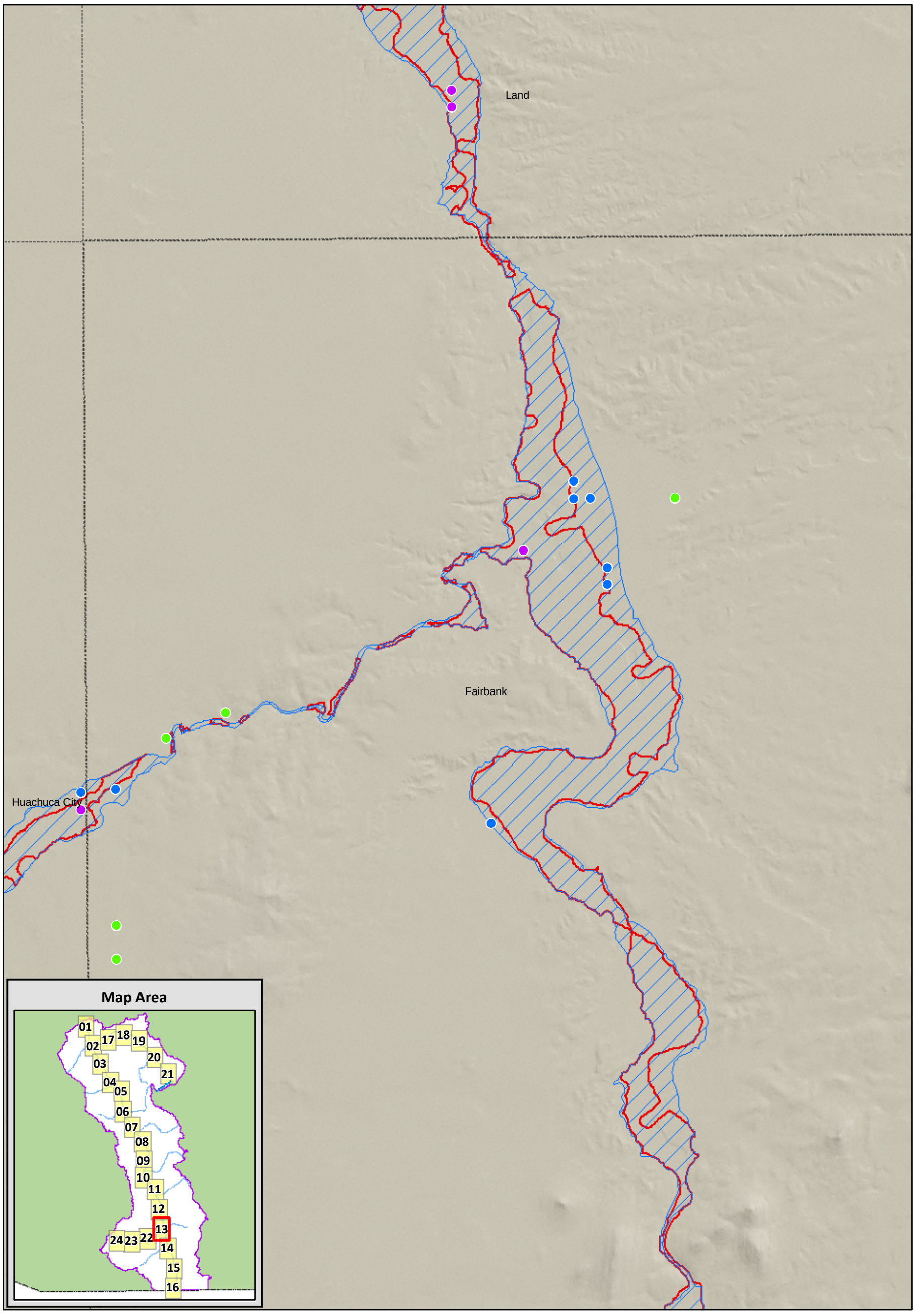
0 0.5 1
Kilometers

Sheet 12

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

0 0.5 1
Kilometers

Sheet 13

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

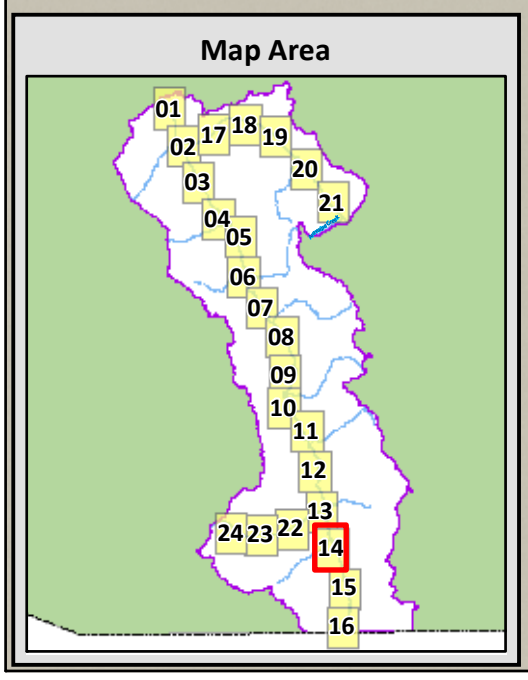
Large Wells In and Near the Subflow Zone, San Pedro River

Fairbank

Lewis Springs

Tombstone SE

Map Area



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

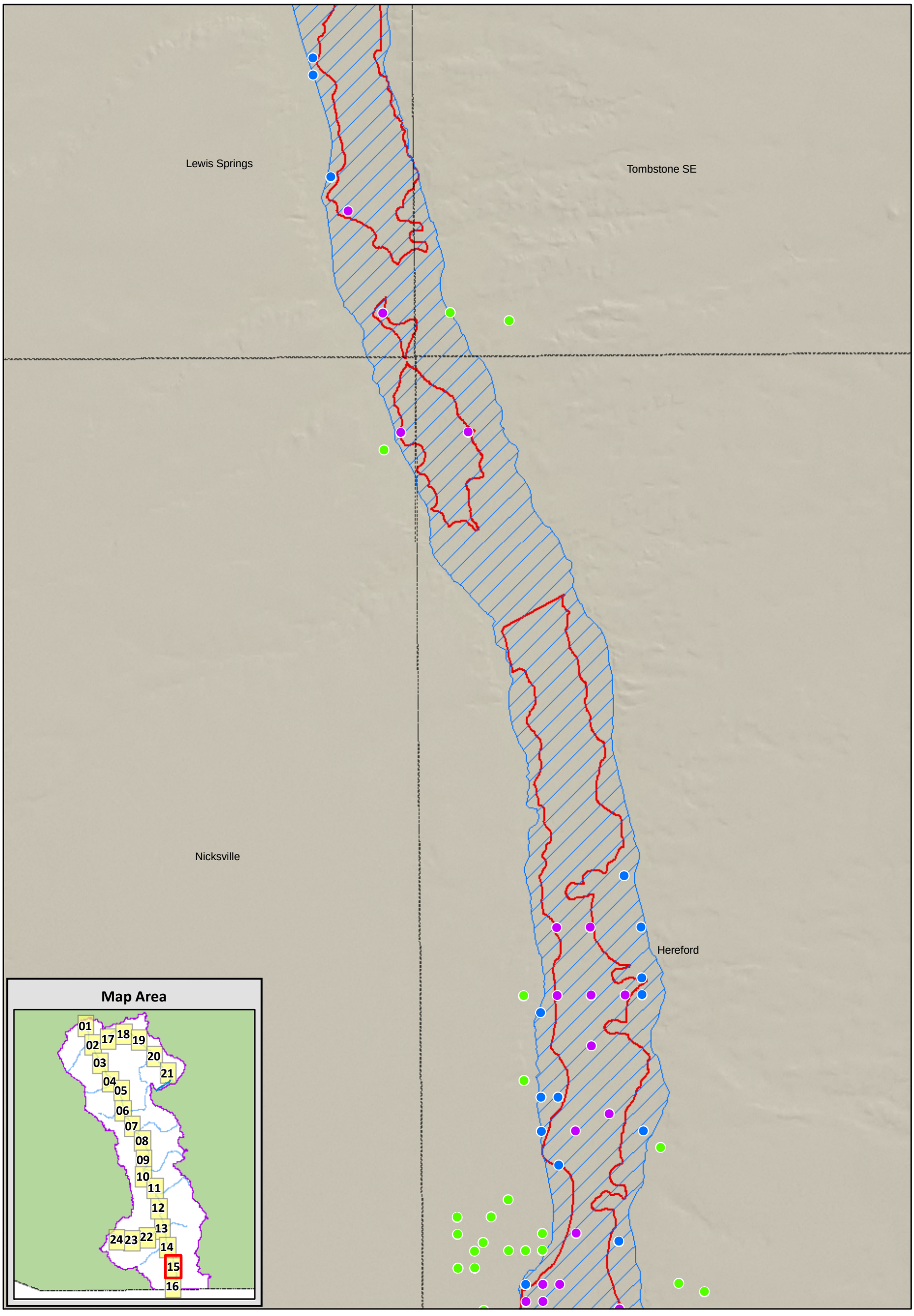
Sheet 14

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Miles
0 0.5 1

0 0.5 1
Kilometers

Sheet 15

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River

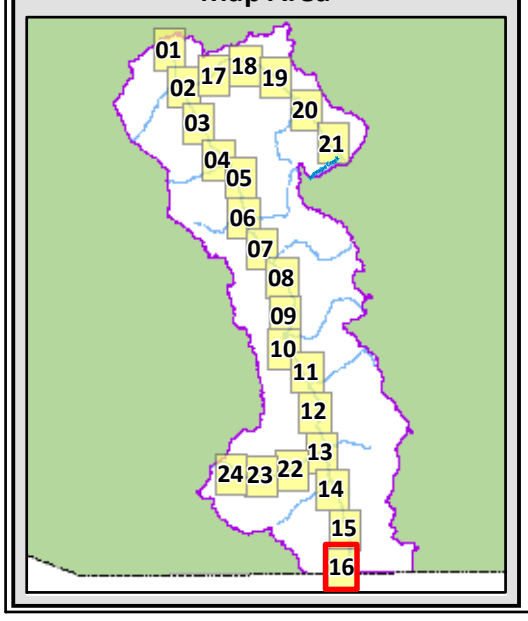
Nicksville

Hereford

Stark

Bob Thompson Peak

Map Area



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

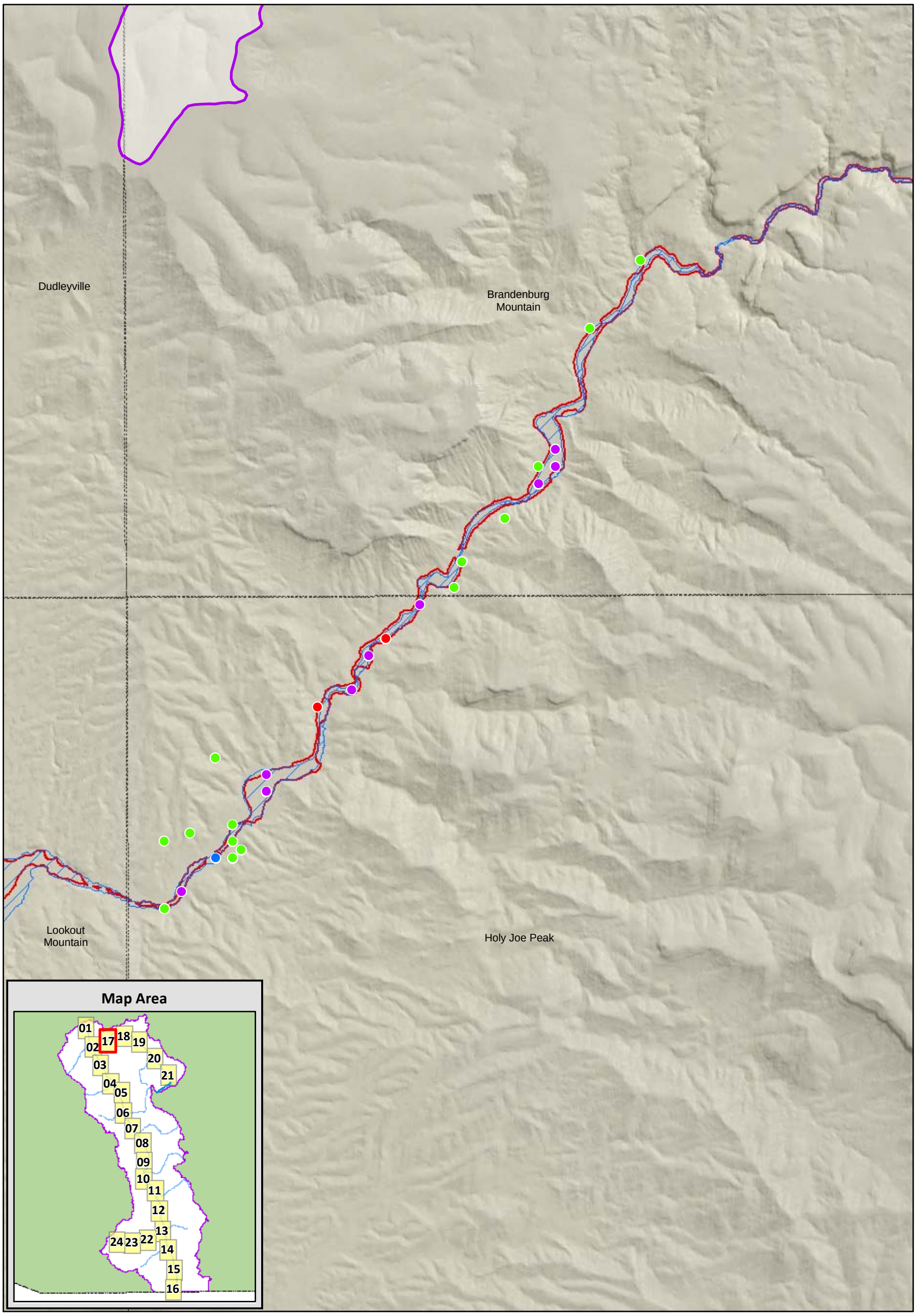
Sheet 16

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

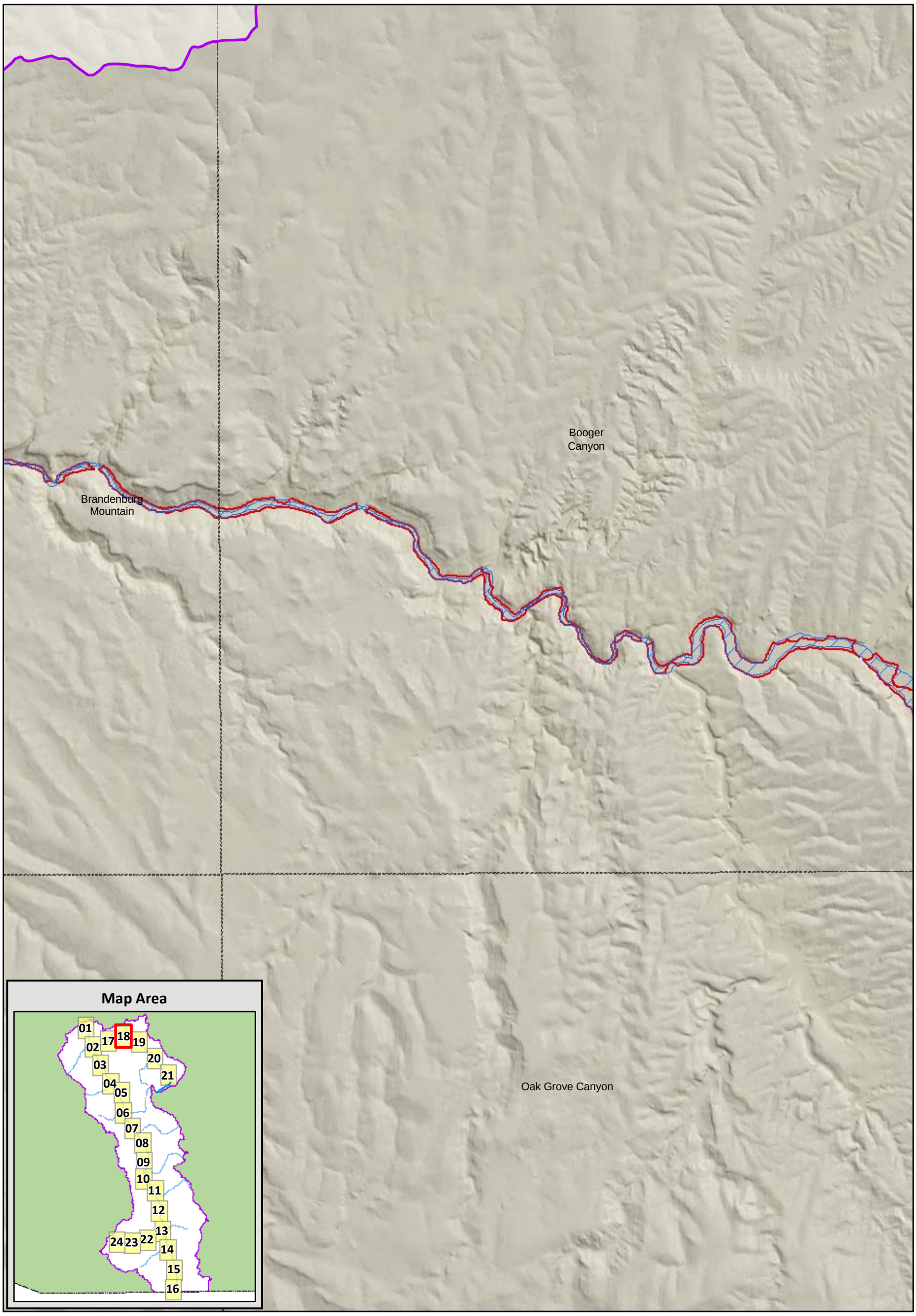
Sheet 17

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

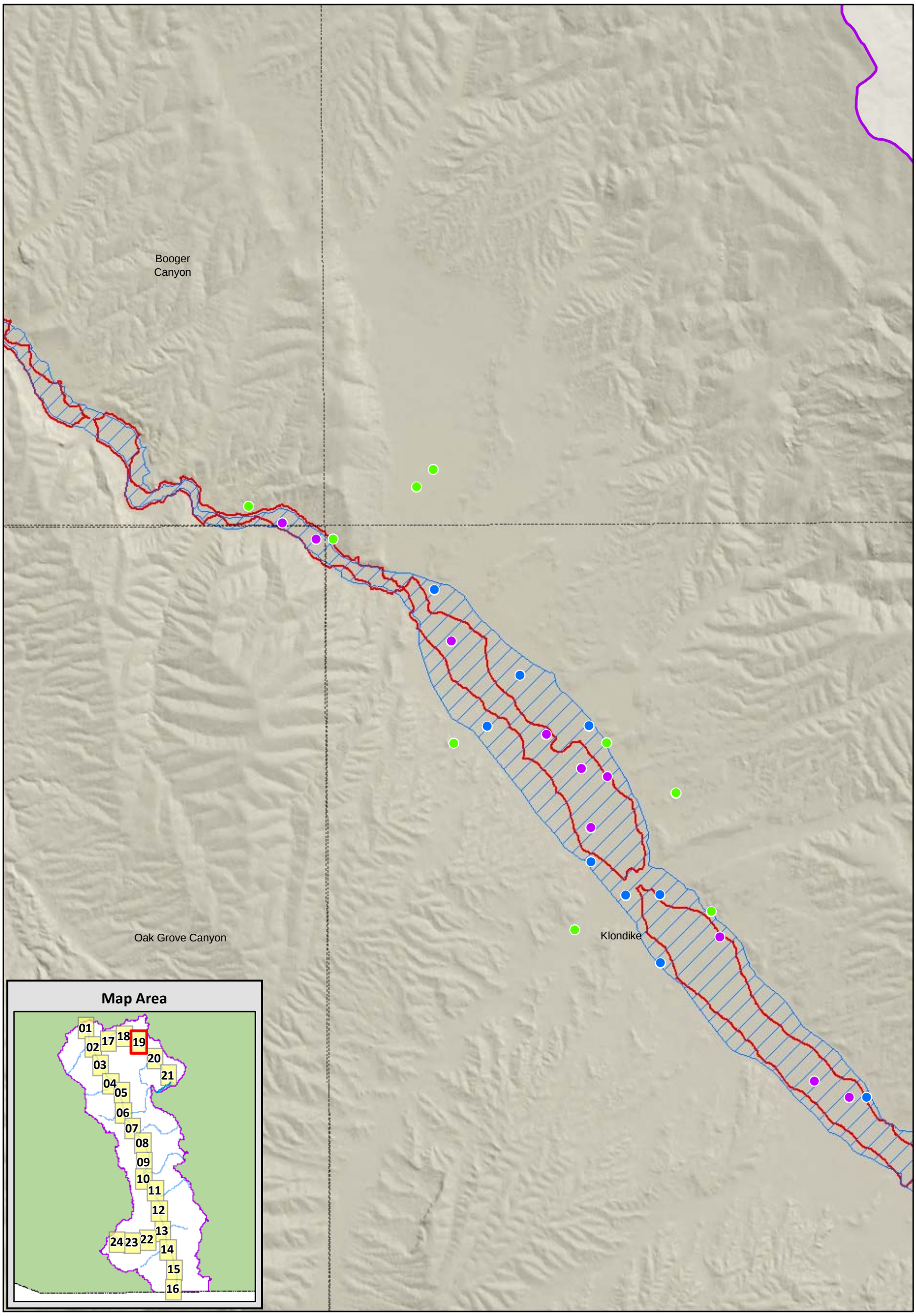
Sheet 18

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

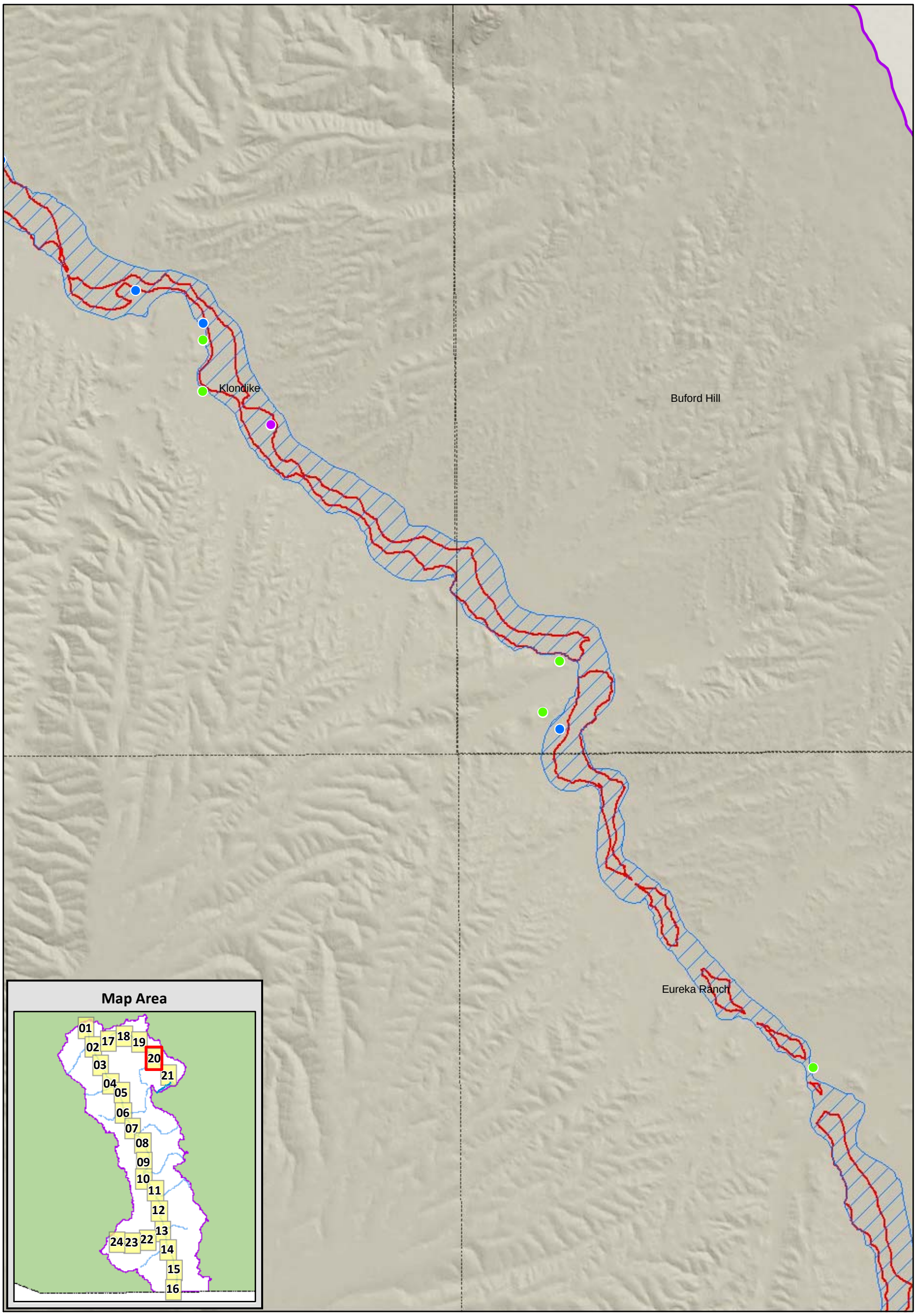
- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Sheet 19

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

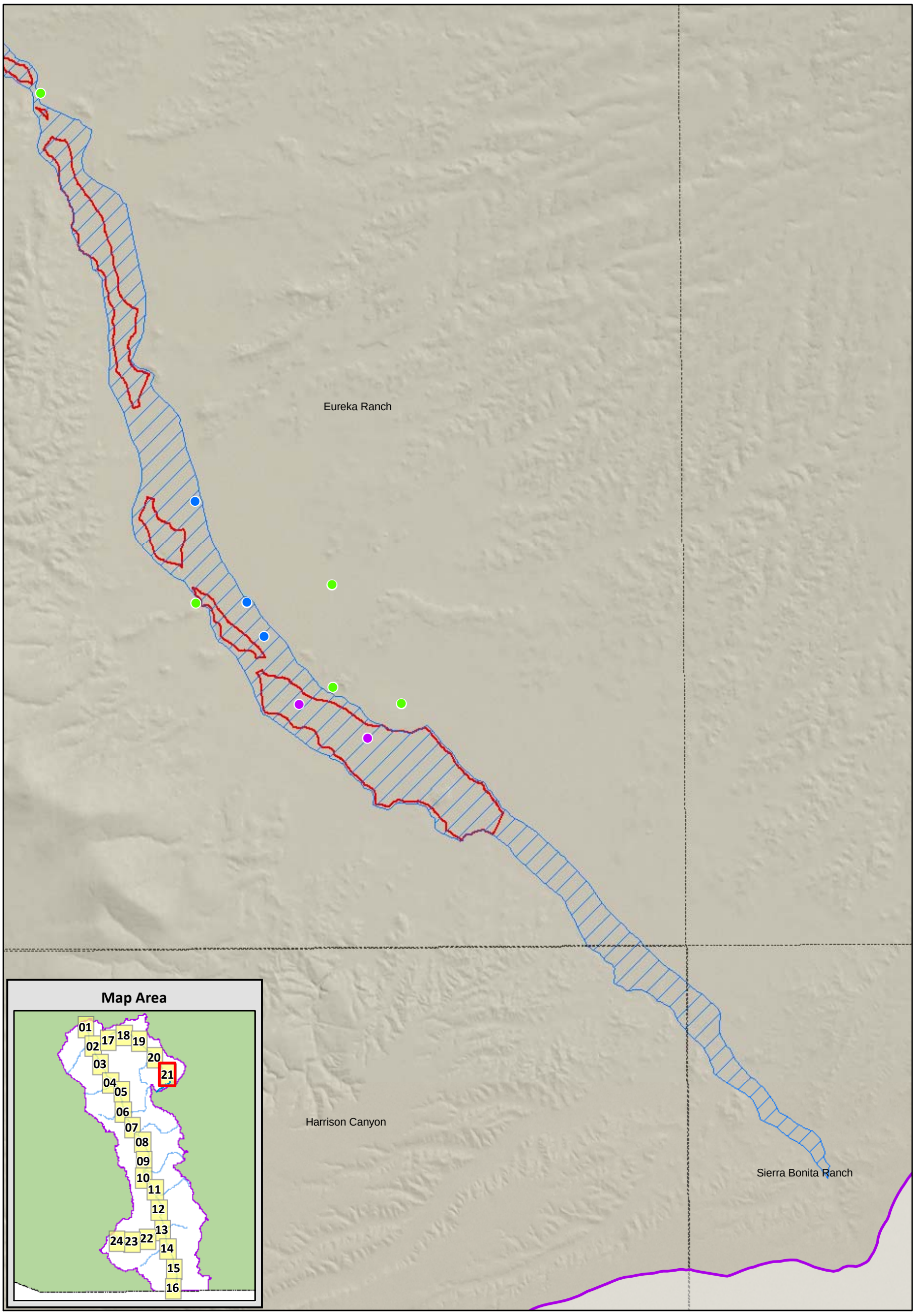
Sheet 20

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Sheet 21

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

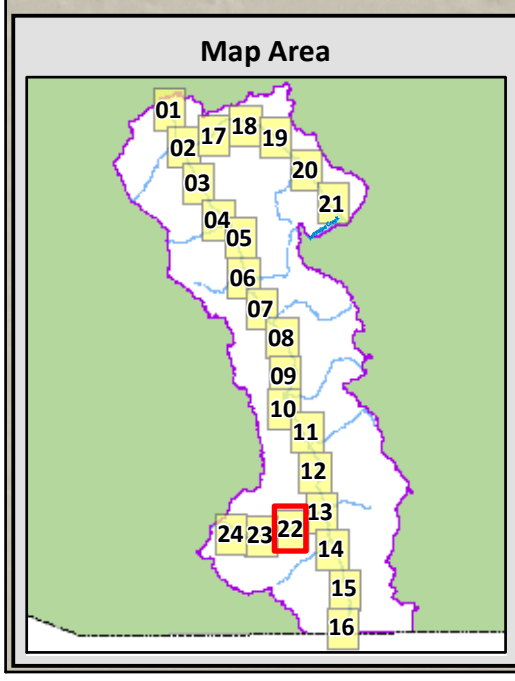
SanPedro_WellsComp.mxd

Large Wells In and Near the Subflow Zone, San Pedro River

Huachuca City

Fort Huachuca

Map Area



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

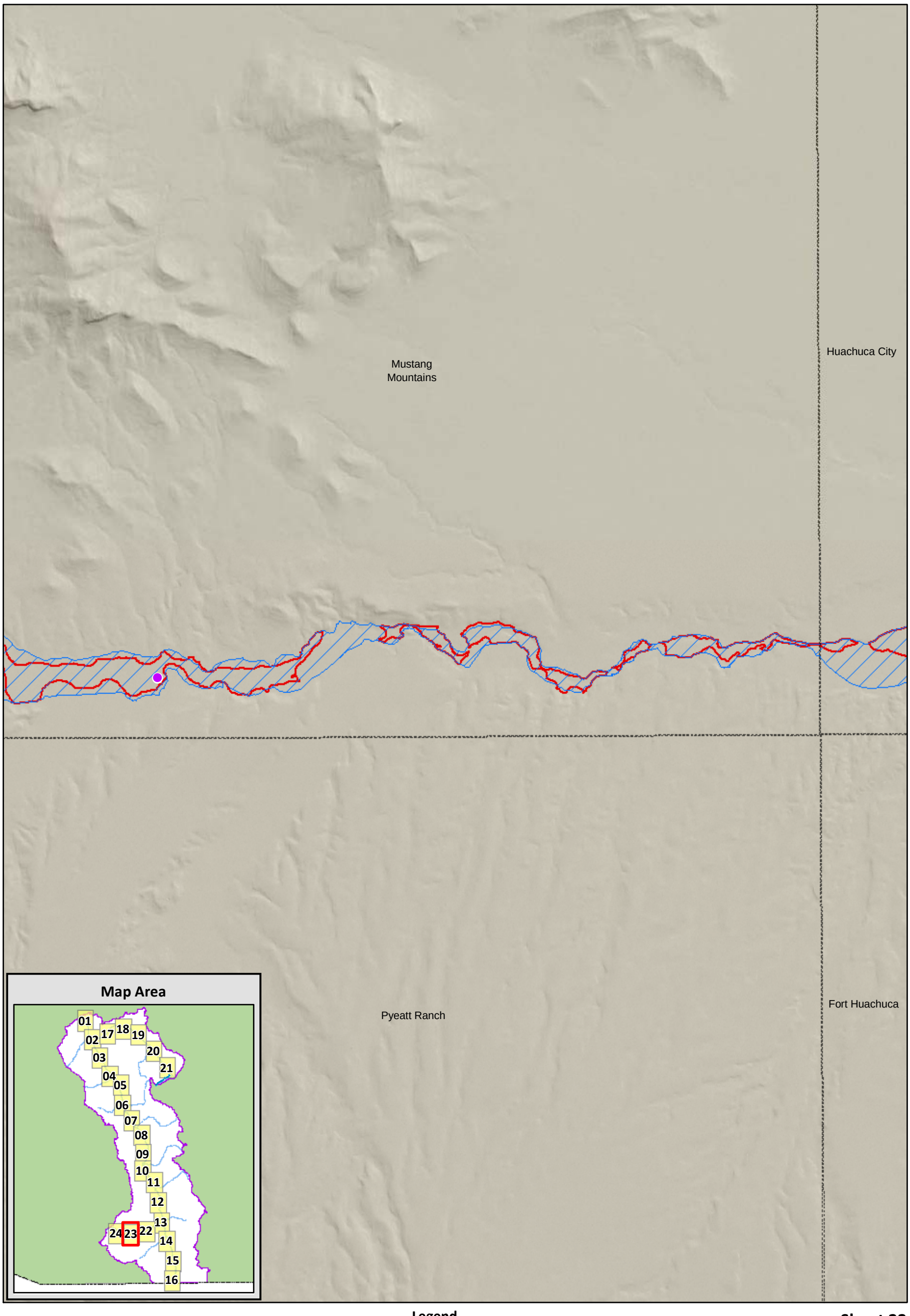
Sheet 22

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
- Large Well(s) Within Both ADWR and LRE Subflow Zones
- Large Well(s) Outside Both ADWR and LRE Subflow Zones

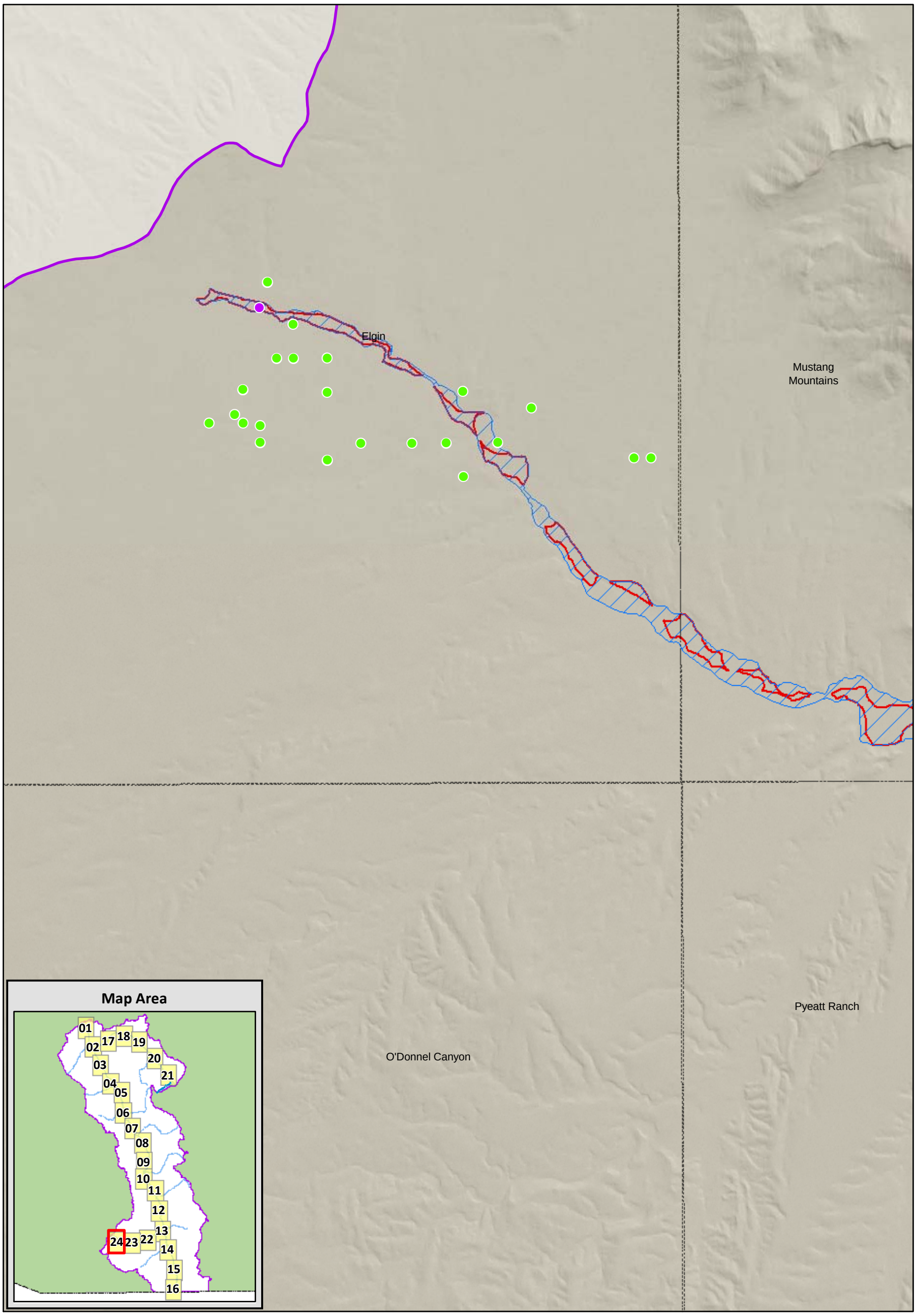
Sheet 23

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 9

Large Wells In and Near the Subflow Zone, San Pedro River



Miles
0 0.5 1

0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- Watershed Boundary
- ADWR Subflow Zone
- LRE Subflow Zone
- Large Well(s) Within ADWR Subflow Zone Only
- Large Well(s) Within LRE Subflow Zone Only
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- Large Well(s) Outside Both ADWR and LRE Subflow Zones

Sheet 24

Data Sources:
ADWR: ADWR Subflow Zone,
ADWR 55 Well Registry 12/1/2008
SRP: LRE Subflow Zone

SanPedro_WellsComp.mxd

Attachment 10

LRE Subflow Zone on AGS Maps

Figure 1

ATTACHMENT 10

SHEET 1 OF 6

DECEMBER 2009 SUBFLOW DELINEATION
BY LEONARD RICE ENGINEERS, INC.
FOR THE SALT RIVER PROJECT ON
SHEETS 1-6, COOK ET AL, 2008

Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium interpreted from sheets 1-6, Cook et al, 2008, aerial photography, topographic map analysis, drillers logs and field observation.

Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan onlap onto Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas which are significantly disturbed by anthropogenic activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

11105 Waypoint Location, showing station identification

Other Geologic Lines

Thin, Solid Line Accurate contact

Thin, Dashed Line Approximate contact

Thin, Dotted Line Concealed contact

Hashed Line Gradational Contact

Solid, Bold Line Accurate Fault

Dashed, Bold Line Approximate Fault

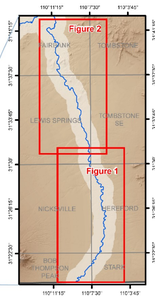
Dotted, Bold Line Concealed Fault

Statewide Location Map

Location of each sheet shown in black

Figures on this Sheet

Figure locations shown in red



Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Joseph P. Cook, David E. Haddad
and Philip A. Pearthree

December 2008

Sheet 1 of 6

Funding for this project was provided by the Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps.
North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

1 0.5 0 1 Miles
8,000 7,000 6,000 5,000 4,000 3,000 2,000 1,000 0 Feet
1 0.5 0 1 Kilometers
1:24,000 Scale

Arizona Geological Survey
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Figure 2

Map Unit Descriptions

Other units

- d — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground
- Qtc — **Quaternary hillslope talus and colluvium** - weakly bedded hillslope deposits mantling the middle and lower slopes of bedrock hills

River alluvium

- Qyaf — **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- Qyar — **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- Qyhr — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- Qyhf — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- Qyl — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- Qlr — **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- Qlcr — **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- Qlhr — **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- Qlr — **Pleistocene river terrace deposits, undifferentiated**

Piedmont alluvium and surficial deposits

- Qyc — **Modern stream channel deposits** - active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles
- Qy2 — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- Qyaf — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- Qy2 — **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief distal fan deposits onlapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
- Qy1 — **Older Holocene alluvium** - broad, low-relief, undulating fan deposits ehxibiting widespread, shallow braided drainage patterns
- Qys — **Holocene fine-grained deposits** - unconsolidated fine grained alluvium derived from basin fill deposits
- Qy — **Holocene alluvial deposits, undifferentiated**
- Qyl — **Holocene and Pleistocene alluvium** - mixed fine-grained Holocene (Qy) and Pleistocene (Ql2 or Ql3) alluvium
- Ql1 — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- Ql2 — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- Ql3 — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- Ql — **Pleistocene alluvial deposits, undifferentiated**
- Qo — **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil development
- Qcg — **Early Pleistocene cobble conglomerate** - cobble conglomerate cemented by calcium carbonate

Tertiary basin fill alluvium

- QTsd — **Pliocene to early Pleistocene Saint David Formation** - fine-grained, highly eroded basin-fill deposits

Bedrock

- Tg — **Conglomerate (Cenozoic)** - Tan, thin- to medium-bedded, pebble-cobble, sandy matrix conglomerate and pebbly sandstone
- Kai — **Fine-grained andesite dikes (Cretaceous)** - Andesite dikes containing <5%, <1mm plagioclase phenocrysts in very fine-grained matrix
- Kq — **Quartz monzonite of Bronco Hill (Upper Cretaceous)** - Medium-grained, slightly plagioclase-porphyritic, 10% biotite-hornblende, quartz monzonite to quartz monzodiorite
- Krd — **Porphyry of Fairbank (Upper Cretaceous)** - Phenocryst-rich porphyry
- Kgs — **Quartz monzonite of Government Draw (Upper Cretaceous)** - Medium-grained, slightly plagioclase-porphyritic, 10% biotite-hornblende, quartz monzonite
- Ku — **Uncle Sam Tuff (Upper Cretaceous)** - Phenocryst-rich ash-flow tuff
- Kdx — **Coarse-grained andesite (Cretaceous)** - volcanic complex dominated by coarse-grained, phenocryst-rich andesitic lava and probable hypabyssal bodies containing 15-30% 1-4 mm plagioclase phenocrysts
- Kr — **Rhyolite (Cretaceous)** - Rhyolite containing 5-10% 1-2.5mm quartz and feldspar phenocrysts
- Krt — **Nonwelded ash-flow tuff (Cretaceous)** - Felsic, nonwelded, thin- to thick-bedded lithic lapilli-rich ash-flow tuff and ash-fall tuff
- Kam — **Medium-grained andesite dikes (Cretaceous)** - North to northwest-striking, generally steeply dipping andesite dikes
- Kt — **Tuff of Charleston (Cretaceous)** - Rhyolite ash-flow tuff
- Ktx — **Tuff of Charleston megabreccia (Cretaceous)** - Zones of the tuff of Charleston containing greater than 25% lithic blocks ranging in size from lapilli to greater than 50m
- Kra — **Aphyric rhyolite (Cretaceous)** - Aphyric to very phenocryst-poor rhyolite lava with probable zones of hypabyssal rock, and tuff breccia
- Kap — **Andesite porphyry (Cretaceous)** - distinctive, hypabyssal andesite porphyry containing 10-25%, 1-3mm, euhedral plagioclase phenocrysts in a fine-grained crystalline matrix
- Ka — **Andesite (Cretaceous)** - Amalgamated, andesite lava flows intruded by a myriad of dikes
- Ks — **Bisbee Group (Lower Cretaceous)** - Complexly interfingering sequences of thin- to thick-bedded, cross-stratified and plane-bedded, quartz sandstone, feldspathic quartz sandstone, and lithic-feldspathic quartz sandstone, gray-green to red siltstone, mudstone, silty mudstone and shale

Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Ann Youberg, Philip A. Pearthree, Joe P. Cook, Erica R. Bigio

December 2008

Sheet 2 of 6

Funding for this project was provided by the Arizona Department of Water Resources

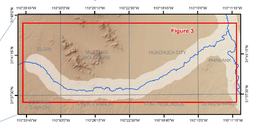
USGS 24k quadrangle series topographic base maps
North American Datum of 1983, Projection and 1000-meter
grid ticks (blue); Universal Transverse Mercator, zone 12.

Statewide Location Map

Location of each sheet shown in black

Figures on this Sheet

Figure locations shown in red



Map Unit Descriptions

Other units

- **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground
- **Quaternary hillslope talus and colluvium** - weakly bedded hillslope deposits mantling the middle and lower slopes of bedrock hills

River alluvium

- **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- **Early Pleistocene river terrace deposits** - very high remnant river terrace deposits located 30 to 40 m above the active channel emanating from Babocomari Wash

Piedmont alluvium and surficial deposits

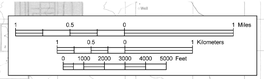
- **Modern stream channel deposits** - active channel deposits composed of very poorly sorted sand, gravel, pebbles, and cobbles with some boulders to moderately sorted sand and pebbles
- **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief debris fan deposits cmingling onto Holocene river alluvium, and infrequently active tributary drainage deposits
- **Older Holocene alluvium** - broad, low-relief, undulating fan deposits exhibiting widespread, shallow braided drainage patterns
- **Holocene alluvial deposits, undifferentiated**
- **Holocene fine-grained deposits** - unconsolidated alluvium derived predominantly from basin fill deposits
- **Holocene and Pleistocene alluvium** - mixed fine-grained Holocene (Qy) and Pleistocene (Qc or Qf) alluvium
- **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil development
- **Early Pleistocene cobble conglomerate** - cobble conglomerate cemented by calcium carbonate
- **Late Pliocene to early Pleistocene fan gravel** - coarse, moderately to well-consolidated gravelly deposits capping high rounded ridges

Tertiary basin fill alluvium

- **Early Pleistocene fine-grained basin-floor alluvium** - very old relict basin floor deposits forming a minimally dissected surface
- **Pliocene to early Pleistocene Saint David Formation** - fine-grained, highly eroded basin-fill deposits
- **Pliocene to middle Miocene deposits** - moderately to strongly indurated conglomerate and sandstone basin fill deposits

Bedrock

- **Conglomerate** - tan, thin- to medium-bedded, pebble-cobble, sandy matrix conglomerate and pebbly sandstone
- **Sandstones and conglomerates** - reddish mudstones and sandstones to tan sandstones and conglomerates
- **Mafic dikes** - mafic dikes within or adjacent to older deformed gravels, Tg
- **Porphyry of Fairbank** - phenocryst-rich porphyry
- **Uncle Sam Tuff** - phenocryst-rich ash-flow tuff
- **Uncle Sam Tuff megabreccia** - zones of megabreccia within the Uncle Sam Tuff
- **Uncle Sam Tuff andesite megabreccia** - zones of monolithic, andesite lava megabreccia within the Uncle Sam Tuff
- **Coarse-grained andesite** - volcanic complex dominated by coarse-grained, phenocryst-rich andesitic lava and probable hypabyssal bodies
- **Tuff of Charleston** - rhyolite ash-flow tuff
- **Aphyric rhyolite** - aphyric to very phenocryst-poor rhyolite lava with probable zones of hypabyssal rock, and tuff breccia
- **Andesite** - amalgamated, andesite lava flows intruded by a myriad of dikes
- **Sibley Group** - complexly interfinguring sequences of sandstone, mudstone, shale, and conglomerate
- **Volcanic and sedimentary rocks of Hualapai Mountain** - siliceous flows and minor welded tuff
- **Volcanic and sedimentary rocks of Hualapai Mountain** - conglomerate, sandstone, siltstone, mudstone, and volcanic rocks
- **Concha limestone** - light-gray relatively thick-bedded limestone with abundant diatreitive chert nodules
- **Scherrer Formation** - quartzose sandstone and dolomite
- **Epitaph dolomite** - dolomite and limestone, marl, siltstone, and gypsum
- **Colina limestone** - medium to dark-gray limestone



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Attachment 10

Sheet 2 of 6

December 2009 Subflow Delineation by Leonard Rice Engineers, Inc. for the Salt River Project on Sheets 1-6, Cook et al. 2008

- Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium interpreted from sheets 1-6, Cook et al, 2008, aerial photography, topographic map analysis, drillers logs and field observation.
- Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan onlap onto Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas where are significantly disturbed by anthropomorphic activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

Waypoint Location, showing station identification

Other Geologic Lines

- **Thin, Solid Line** — Accurate contact
- **Thin, Dashed Line** — Approximate contact
- **Thin, Dotted Line** — Concealed contact
- **Hashed Line** — Gradational Contact
- **Solid, Bold Line** — Accurate Fault
- **Dashed, Bold Line** — Approximate Fault
- **Dotted, Bold Line** — Concealed Fault

Figure 3

Figure 4

ATTACHMENT 10

SHEET 3 OF 6

DECEMBER 2009 SUBFLOW DELINEATION BY LEONARD RICE ENGINEERS, INC. FOR THE SALT RIVER PROJECT ON SHEETS 1-6, COOK ET AL. 2008

Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium interpreted from sheets 1-6, Cook et al, 2008, aerial photography, topographic map analysis, drillers logs and field observation.

Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium

Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by

Joseph P. Cook, David E. Haddad, and Philip A. Pearthree

December 2008

Sheet 3 of 6

Funding for this project was provided by the Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps.
North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

Figure 5

Map Unit Descriptions

Other Units

- **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground
- Qtc **Quaternary hillslope talus and colluvium** - unconsolidated to moderately consolidated colluvium and talus hillslope deposits

River alluvium

- Qyr **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- Qyf **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- Qyf **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- Qyf **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposit underlying the early historical floodplain
- Qyf **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- Qyf **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- Qmf **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- Qvf **Early to middle Pleistocene river terrace deposits** - older, highest preserved gravelly, sandy river terrace deposits
- Qcf **Early Pleistocene river channel alluvium** - volcanic and limestone marl cobble conglomerate from the Saint David Formation cemented by calcium carbonate
- QTsr **Pliocene-Pleistocene San Pedro River channel conglomerates** - ancestral San Pedro River channel deposits consisting of consolidated moderately to well-bedded, rounded pebbles and cobbles
- QTsr **Pliocene to early Pleistocene river deposits** - moderately thick sequence of old San Pedro River deposits

Piedmont alluvium and surficial deposits

- Qy **Modern stream channel deposits** - active channel deposits composed of very poorly sorted sand, pebbles, and cobbles with some boulders in moderately-swifter-land and pebble
- Qm **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overbow channel deposits
- Qyaf **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- Qyf **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad, shallow-braided drainage patterns, and overlapping inset Holocene river alluvium, and infrequently active tributary drainage deposits
- Qm **Older Holocene alluvium** - broad, low-relief, undulating fan deposits inheriting widespread, shallow-braided drainage patterns
- Qm **Holocene fine-grained deposits** - unconsolidated fine grained alluvium derived from basin fill deposits
- Qsp **Late Holocene spring deposits (present)** - deposits related to spring fed swamps
- Qy **Holocene alluvial deposits, undifferentiated**
- QH **Holocene and Pleistocene alluvium** - mixed fine-grained Holocene (Qy) and Pleistocene (Qf or Qf2) alluvium
- Qfa **Late Pleistocene alluvial fan and terrace deposits A** - mudstone with some floating cocoids filling the valleys incised into the Saint David Formation
- Qyf **Late Pleistocene alluvial fan and terrace deposits C** - weakly to moderately dissected alluvial fan deposits composed of clay loam mudstone
- Qyf **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- Qfc **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- Qc **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- Qpc **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil
- Qcg **Early Pleistocene cobble conglomerate** - cobble conglomerate cemented by calcium carbonate

Tertiary basin fill alluvium

- QTsd **Pliocene to early Pleistocene Saint David Formation** - fine-grained, highly eroded basin-fill deposits
- QTf **Late Pliocene-Early Pleistocene alluvial fan deposits** - reist, deeply dissected rounded ridges with strong laminate clevelandmetrical deposits found on upper piedmonts
- QTcs **Conglomerate and sandstone** - coarse, poorly sorted, tan sandstone, conglomeratic sandstone, and conglomerate
- QTsg **Early Pleistocene to Miocene alluvium** - tan to reddish, bioturbi to cross-bedded, carbonated cemented, matrix supported conglomerate with limestone, metasediments, and granite cobbles
- QTsl **Lacustrine facies of the Saint David Formation** - tabular limestone beds are found with interbedded brown to red-and green mudstone
- QTsc **Pliocene-Pleistocene channel conglomerates** - piedmont channel conglomerates composed of unconsolidated, matrix supported, moderately to well-sorted, subangular to rounded pebble, cobbles and sand
- QTM **Early Pleistocene fine-grained basin-floor alluvium** - very old relict basin floor deposits forming a minorally dissected surface
- Tsp **Playa facies of the Saint David Formation** - thick tabular gypsiferous layers interbedded with limestones and mudstone
- Ts **Red sandstone, silty sandstone, and siltstone** - massive to bedded, reddish brown (5YR to 10YR) sandstone, siltstone, and mudstone
- Tsd **St. David Formation, undifferentiated** - St. David Formation which includes the lower and middle members
- Tsd **Lower member of the St. David Formation** - lower St. David Formation consisting of red mudstones and fine grained sandstones

Bedrock

- Tg **Conglomerate (Cenozoic)** - Tan, thin- to medium-bedded, pebble-cobble, sandy matrix conglomerate and pebbly sandstone
- Tdm **Mafic dikes (Cenozoic-Cretaceous)** - Fine-grained, crystalline mafic porphyry dikes
- Kdi **Basaltic dikes (Cenozoic-Cretaceous)** - Fine-grained basaltic dikes
- Kmf **Porphyry of Fairbank (Upper Cretaceous)** - Phenocryst-rich porphyry
- Ku **Uncle Sam Tuff (Upper Cretaceous)** - Phenocryst-rich ash-flow tuff
- Kus **Uncle Sam Tuff megabreccia (Upper Cretaceous)** - Zones of megabreccia within the Uncle Sam Tuff. Clasts of andesite and rhyolitic volcanics, sandstone, argillite, and carbonate range in size from fort to several meters.
- Kusa **Uncle Sam Tuff andesite megabreccia (Upper Cretaceous)** - Zones of monolithic, andesite lava megabreccia within the Uncle Sam Tuff. Clasts range in size from 1cm to several meters.
- Kds **Coarse-grained andesite (Cretaceous)** - A volcanic complex dominated by coarse-grained phenocrystsrich andesitic lava
- Ka **Andesite (Cretaceous)** - Amalgamated andesitic lava flows intruded by a myriad of dikes
- Ks **Bisbee Group (Lower Cretaceous)** - Complexly interbringing sequences of thin to thick-bedded, crossstratified and plane-bedded, quartz sandstone, feldspathic quartz sandstone, and lithic lithicwacki to quartz sandstone, gray green to red siltstone, mudstone, silty mudstone and shale
- Kl **Mural Limestone (Lower Cretaceous)** - thin to medium-bedded, micrite, mollusc bearing limestone, and argillaceousbed limestone interbedded with subordinate dark shale

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan onlap onto Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas which are significantly disturbed by anthropogenic activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

Waypoint Location, showing station identification

Other Geologic Lines

- **Thin, Solid Line** Accurate contact
- **Thin, Dashed Line** Approximate contact
- **Thin, Dotted Line** Concealed contact
- **Hashed Line** Gradational Contact
- **Solid, Bold Line** Accurate Fault
- **Dashed, Bold Line** Approximate Fault
- **Dotted, Bold Line** Concealed Fault

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1:24,000 Scale

Figure 6

Statewide Location Map

Location of each sheet shown in black

Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sheet 5
Sheet 6

Figures on this Sheet

Figure locations shown in red

Figure 4
Figure 5
Figure 6

Figure 7

ATTACHMENT 10

SHEET 4 OF 6

DECEMBER 2009 SUBFLOW DELINEATION
BY LEONARD RICE ENGINEERS, INC.
FOR THE SALT RIVER PROJECT ON
SHEETS 1-6, COOK ET AL. 2008

Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium interpreted from sheets 1-6, Cook et al, 2008, aerial photography, topographic map analysis, drillers logs and field observation.

Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium

Figure 8

Map Unit Descriptions

Other units

- a — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground
- Qmt — **Quaternary hillslope talus and colluvium** - unconsolidated to weakly consolidated, very poorly sorted angular rock debris deposited at the base of bedrock slopes

River alluvium

- Qyr — **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- Qyf — **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- Qyf — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- Qyf — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- Qyf — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- Qyf — **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- Qmf — **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- Qof — **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- Qr?f — **Possible early to middle Pleistocene river terrace deposits** - deposits strongly resembling the oldest, highest preserved gravelly, sandy river terrace deposits
- QTdf — **Pliocene to early Pleistocene river deposits** - moderately thick sequence of old San Pedro River deposits

Piedmont alluvium and surficial deposits

- Qyc — **Modern stream channel deposits** - active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles
- Qy — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- Qyd — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- Qyr — **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief distal fan deposits onlapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
- Qy — **Older Holocene alluvium** - broad, low-relief, undulating fan deposits ehxibiting widespread, shallow braided drainage patterns
- Qyn — **Holocene fine-grained deposits** - unconsolidated alluvium derived predominantly from basin fill deposits
- Qy — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- Qya — **Middle to late Pleistocene alluvial fan and terrace deposits (younger member)** - broad planar fan terraces found capping Quiburis basin fill deposits, typically inset into slightly older Qi2 and Qi2a deposits
- Qya — **Middle to late Pleistocene alluvial fan and terrace deposits (younger member)** - broad planar fan terraces found capping Quiburis basin fill deposits, typically inset into slightly older Qi2 deposits
- Qi — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- Qi — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- Qo — **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial eratheme in the landscape composed of moderately consolidated gravelly deposits with moderate soil development
- QTg — **Late Pliocene to early Pleistocene fan gravel** - coarse, moderately to well-consolidated gravelly deposits capping high rounded ridges
- QTa — **Late Pliocene-Early Pleistocene alluvial fan deposits** - relict, deeply dissected rounded ridges with strong carbonate developmentalluvial deposits found on upper piedmonts
- QTcg — **Conglomerate (Pliocene to Pleistocene)** - massive to crudely stratified conglomerate
- QTcg — **Conglomerate and sandstone (Pliocene to Pleistocene)** - coarse, poorly sorted, tan sandstone, conglomeratic sandstone, and conglomerate

Tertiary basin fill alluvium

- Tqc — **Late Miocene to Pliocene Quiburis deposits, alluvial fan facies** - sandy to gravelly, moderately to strongly indurated alluvial fan deposits
- Tqe — **Pliocene Quiburis deposits, low energy fluvial deposits** - alternating thin weakly-consolidated beds of gypsum, silt, and very fine sand with sparse pebble stringers
- Tqe — **Pliocene Quiburis deposits, distal fan to axial valley deposits** - alternating thin unconsolidated beds of silt to very fine sand with sparse pebble stringers

Bedrock

- Tcms — **Conglomerate, San Manuel Formation, volcaniclastic Soza Canyon facies** - clasts are derived primarily from volcanic rocks like those that make up most of the Galiuro mountains as well as locally exposed volcanic rocks beneath the conglomerate in lower Soza Canyon
- Tcmm — **Conglomerate, San Manuel Formation, metamorphiclastic Paige Canyon facies** - clasts are derived primarily from metamorphic lactorites like those that form nearby bedrock in the Little Rincon Mountains
- Tvm — **Mafic volcanics of lower Soza Canyon (Oligo-Miocene)** - dark gray to black, somewhat crystal poor lava-flow breccia and local flow cores
- Tcg — **Conglomerate (Miocene)** - generally poorly to moderately bedded and poorly sorted conglomerate with bed dips of 10° to 50°
- Ts — **Red sandstone, silty sandstone, and siltstone** - massive to bedded, reddish brown (5YR to 10YR) sandstone
- K-bs — **Bisbee Group, undivided (Cretaceous to Jurassic)** - Carbonate, siltstone, sandstone, and conglomeratic of the Bisbee Group
- Kb — **Bisbee Group, undivided (Cretaceous to Jurassic)** - siltstone, sandstone, and conglomerate of the Bisbee Group, undivided
- TrMm — **Marble tectonite derived from Horquilla Limestone and Escabrosa Limestone, undivided (Mississippian to Pennsylvanian protolith)** - typically calcite marble and slightly siliceous calcite marble (mapped by Lingrey, 1982)
- P-tuf — **Tectonite derived from Earp Formation (Pennsylvanian to Permian protolith)** - generally consists of medium to light gray limestone, silty limestone, sandy limestone, and beds of quartzite
- P-tuf — **Tectonite derived from Horquilla Limestone and Earp Formation, undivided (Pennsylvanian to Permian protolith)** - interbedded marble and calc-silicate gneiss (Lingrey, 1982)
- Mc — **Escabrosa Limestone (Mississippian)** - typically massive medium to pale gray limestone
- Xgj — **Johnny Lyon granodiorite (Paleoproterozoic)** - medium-grained biotite granodiorite with blocky, 1-4 cm long, K-feldspar megacrysts that make up 15-25% of the rock unit, and ~5-10% mafic minerals, most of which is probably biotite
- Xdj — **Dioritic rocks associated with Johnny Lyon granodiorite (Paleoproterozoic)** - dark colored, mafic rich dioritic rock that forms local, small irregular bodies in Johnny Lyon Granodiorite. Texturally similar to non-porphyritic parts of Johnny Lyon Granodiorite

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan onlap onto Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas which are significantly disturbed by anthropogenic activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

WP39 Waypoint Location, showing station identification

Other Geologic Lines

- **Thin, Solid Line** — Accurate contact
- **Thin, Dashed Line** — Approximate contact
- **Thin, Dotted Line** — Concealed contact
- **Hashed Line** — Gradational Contact
- **Solid, Bold Line** — Accurate Fault
- **Dashed, Bold Line** — Approximate Fault
- **Dotted, Bold Line** — Concealed Fault

0.5 0 1 Miles
8,000 7,000 6,000 5,000 4,000 3,000 2,000 1,000 0 Feet
0.5 0 1 Kilometers

1:24,000 Scale

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Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Joseph P. Cook, David E. Haddad, Andrew L. Kowler and Philip A. Pearthree

December 2008

Sheet 4 of 6

Funding for this project was provided by the Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps.
North American Datums of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12

Figure 9

Statewide Location Map

Location of each sheet shown in black

Sheet 6
Sheet 5
Sheet 4
Sheet 3
Sheet 2
Sheet 1

Figures on this Sheet

Figure locations shown in red

Figure 9
Figure 8
Figure 7

Figure 11

Attachment 10

Sheet 5 of 6

December 2009 Subflow Delineation by Leonard Rice Engineers, Inc. for the Salt River Project on sheets 1-6, Cook et al, 2008

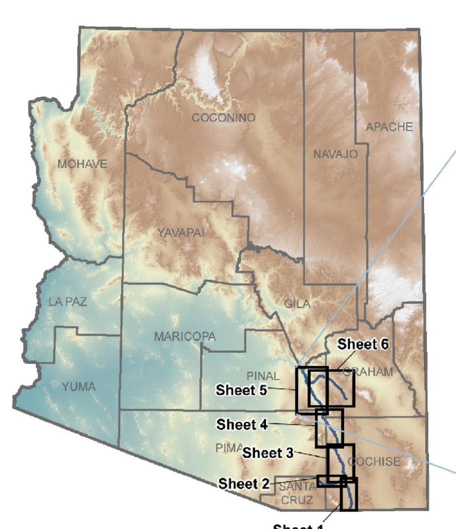
Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium interpreted from sheets 1-6, Cook et al, 2008, aerial photography, topographic map analysis, drillers logs and field observation.

Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium

Figure 10

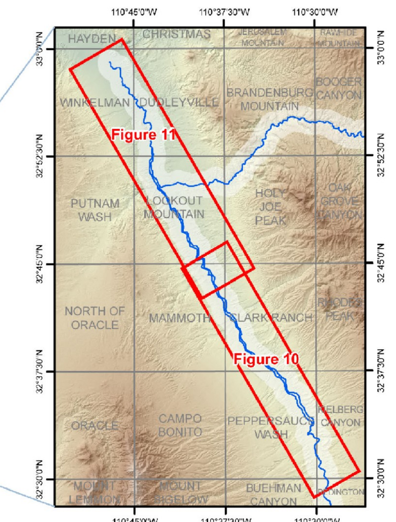
Statewide Location Map

Location of each sheet shown in black



Figures on this Sheet

Figure locations shown in red



Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Joseph P. Cook, Bryan J. MacFarlane,
Andrew L. Kowler and Philip A Pearthree

September 2008

Sheet 5 of 6

Funding for this project was provided by the Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps. North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

1:24,000 SCALE

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

0 1000 2000 3000 4000 5000 Feet

N

Arizona Geological Survey
416 W. Congress Street, Suite 100
Tucson, AZ 85701
(520) 770-3500
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Map Unit Descriptions

Other units

- d — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams.
- (hatched) — **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground.
- Qtc — **Quaternary hillslope talus and colluvium** - unconsolidated to weakly consolidated, very poorly sorted angular rock debris deposited at the base of bedrock slopes

River alluvium

- Qycr — **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- Qy4r — **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- Qy3r — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- Qy2r — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- Qy1r — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- Qi3r — **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- Qi2r — **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- Qi1r — **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- Qir — **Pleistocene river terrace deposits, undifferentiated**

Piedmont alluvium and surficial deposits

- Qyc — **Modern stream channel deposits** - active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles
- Qy3 — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- Qyaf — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- Qy2 — **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief distal fan deposits onlapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
- Qy1 — **Older Holocene alluvium** - broad, low-relief, undulating fan deposits ehxibiting widespread, shallow braided drainage patterns
- Qy1f — **Early to late Holocene (?) alluvial fan** - inactive fan deposits at the mouth of Tucson Wash
- Qys — **Holocene fine-grained deposits** - unconsolidated fine grained alluvium derived from basin fill deposits
- Qs — **Surficial deposits, undivided** - includes fine-grained colluvium and alluvium, talus, and some pediment and terrace gravels
- Qi3 — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- Qi2 — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- Qi1 — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- Qiu — **Pleistocene alluvial terrace - undivided** - coarse clastic alluvial fan and terrace deposits with slightly to moderately reddened soils
- Qo — **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil development
- QTa — **Late Pliocene to early Pleistocene fan gravel** - coarse, moderately to well-consolidated gravelly deposits capping high rounded ridges
- Tqp — **Late Miocene to Pliocene Quiburis deposits, playa facies** - silty, moderately to strongly indurated alluvial playa deposits
- Tqr — **Late Pliocene (?) Quiburis deposits, fluvial facies** - sandstone and conglomerate, fluvial deposits
- Tqs — **Pliocene Quiburis deposits, sandy fan toe facies** - sandy fan-toe, lake-margin, and delta-front sandflat facies
- Tqse — **Pliocene Quiburis deposits, delta front subfacies** - sandstone, locally pebbly, with multiple thin mudstone interbeds

Bedrock

- Tgv — **Galiuro Volcanics** - lateral equivalent of Cloudburst Formation
- Trx — **Rhyolite intrusion and intrusive breccia** - at the south edge of the map area, this unit consists of crystal-poor, massive to flow-banded rhyolite and clast-supported brecciated rhyolite
- Ta — **Basaltic andesite lava (Oligocene to lower Miocene)** - Lava flows and autobreccia with 1-10%, generally <5 mm pyroxene and up to 10%, <6 mm, plagioclase phenocrysts. Matrix commonly contains abundant <0.1 mm plagioclase needles and equant magnetite.
- Mzs — **Clastic sedimentary rocks** - sandstone and siltstone with basal conglomerate and chert-fragment breccia
- Me — **Escabrosa Limestone** - massive, cliff-forming, thick-bedded, mostly coarsegrained limestone
- Dm — **Martin Formation** - slope-forming shale unit with interbedded limestone beds
- _a — **Abrigo Formation** - Thin- to thick-bedded, cross bedded, dolomitic sandstone with local dolomite, siltstone, sandstone, and intraformational conglomerate. Dark chocolate-brown calcareous sandstone is characteristic of this unit in easternmost exposures.
- _b — **Bolsa Quartzite** - Fine- to locally medium-grained sandstone, plane bedded to cross bedded. Sandstone varies from chocolate brown to orangish tan to white. Sandstone is coarse to granule within basal several meters. Includes locally abundant, cylindrical trace fossils (burrows?), <1 cm diameter.
- Yd — **Diabase** - Dark greenish gray to olive gray, medium grained diabase forming sills and dikes in all Proterozoic rock units.
- Yt — **Troy Quartzite** - Thin-bedded sandstone and granule to small pebble conglomerate.

Tertiary basin fill alluvium

- Tqc — **Late Miocene to Pliocene Quiburis deposits, alluvial fan facies** - sandy to gravelly, moderately to strongly indurated alluvial fan deposits
- Tql — **Pliocene Quiburis deposits, playa-lacustrine facies** - fine-grained, laminated playa and lacustrine deposits
- Tqe — **Pliocene Quiburis deposits, low energy fluvial deposits** - alternating thin weakly-consolidated beds of gypsum, silt, and very fine sand with sparse pebble stringers
- Tqm — **Pliocene Quiburis deposits, prodelta mudstone facies** - massive prodelta mudstone deposited as foredelta facies of "Eskiminzin Delta"
- Ym — **Mescal Limestone** - Thick to thin bedded, brown to gray dolomite and silty to cherty dolomite, less abundant laminated limestone, and brown dolomitic sandstone locally at base (Krieger, 1968). Asbestos veins are locally present near intrusive contact with diabase.
- Yds — **Dripping Spring Quartzite** - Feldspathic, arkosic, and quartzose sandstone and less abundant siltstone. Sands are typically fine to medium grained and appear feldspathic with red K-feldspar grains. Sandstone is locally cross bedded.
- Ydsb — **Barnes Conglomerate Member, Dripping Spring Quartzite** - Up to 4 m of pebble and cobble conglomerate, with well rounded clasts up to 12 cm diameter of quartzite, vein quartz, and red jasper, in a matrix of red to gray arkosic sandstone (Krieger, 1968).
- Yp — **Pioneer Formation** - Very fine grained to coarse-grained, locally cross-bedded sandstone. Grain size generally decreases up section (Krieger, 1968).
- Yo — **Oracle Granite** - Porphyritic, medium- to coarse-grained biotite granite ("quartz monzonite" of Krieger [1968]). Microcline phenocrysts are as large as 2 x 4 cm and somewhat poikilitic, with included mafic minerals imparting a speckled appearance. K-feldspar is commonly pink to reddish, and mafic minerals are generally abundant (7-12%).
- Yoa — **Oracle Granite, alaskitic** - Equigranular, medium to coarse grained, dark orange to pale red alaskite that is gradational with the Oracle Granite (Krieger, 1968). Local porphyry, aplite, and potassic granite were included with this map unit by Krieger (1968).
- Xp — **Pinal Schist** - Faintly laminated, very fine-grained, medium to dark gray, foliated to weakly schistose sandstone to siltstone.

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan onlap onto Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas which are significantly disturbed by anthropogenic activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

H1105 Waypoint Location, showing station identification

Other Geologic Lines

Thin, Solid Line Accurate contact

Thin, Dashed Line Approximate contact

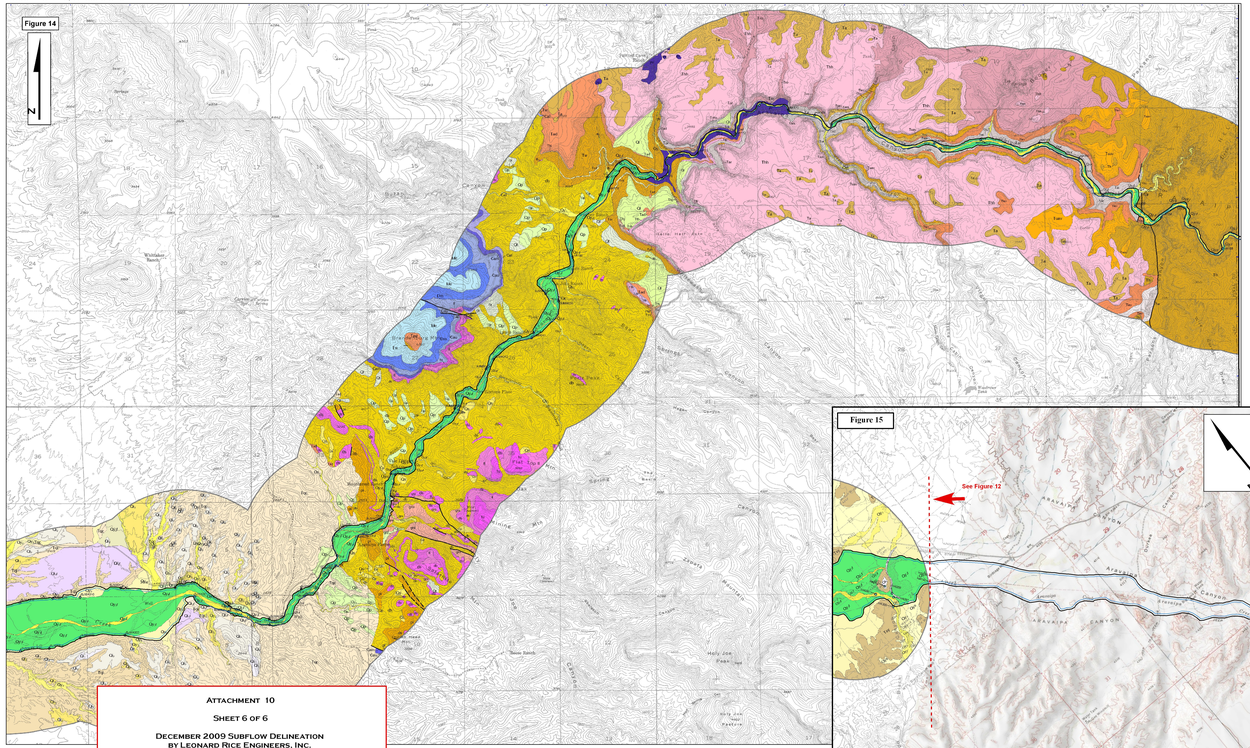
Thin, Dotted Line Concealed contact

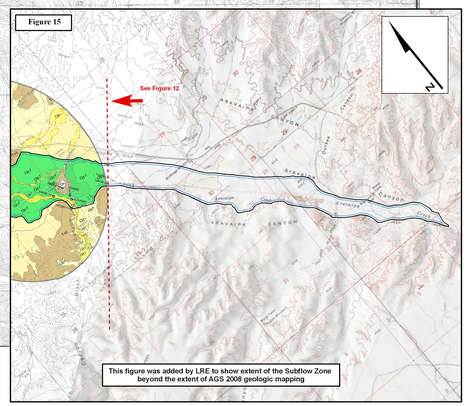
Hashed Line Gradational Contact

Solid, Bold Line Accurate Fault

Dashed, Bold Line Approximate Fault

Dotted, Bold Line Concealed Fault





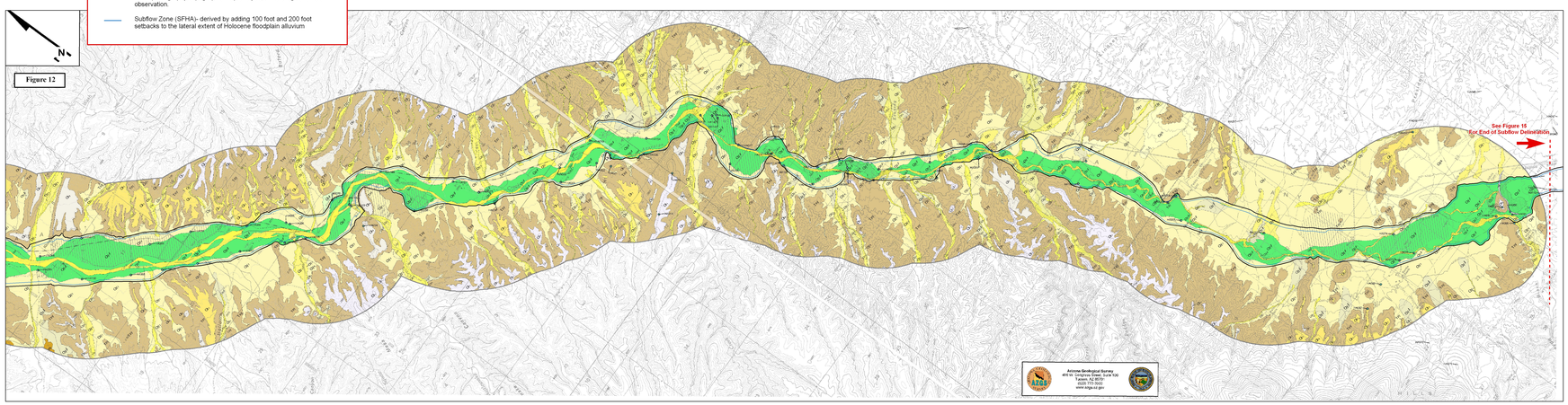
ATTACHMENT 10

SHEET 6 OF 6

DECEMBER 2009 SUBFLOW DELINEATION
BY LEONARD RICE ENGINEERS, INC.
FOR THE SALT RIVER PROJECT ON
SHEETS 1-6, COOK ET AL., 2008

Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium intergreted from sheets 1-6, Cook et al. 2008, aerial photography, topographic map analysis, drillers logs and field observation.

Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium



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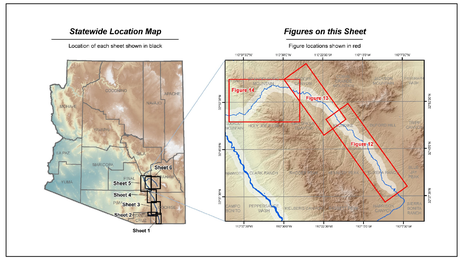


Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

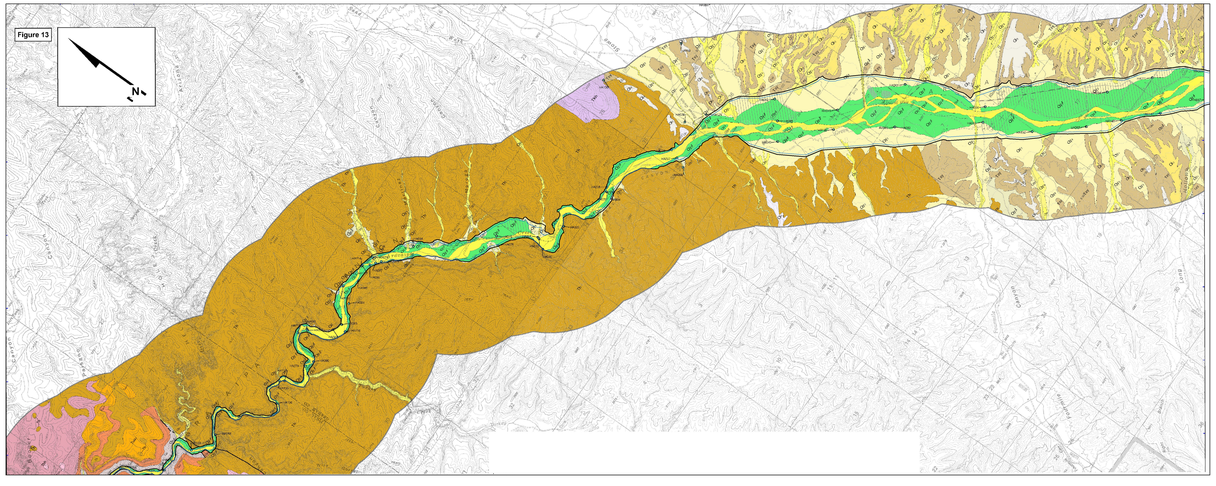
by
Joseph P. Cook, Erica R. Bigio,
Brian J. MacFarlane, Andrew L. Kowler
and Philip A Pearthree

December 2008

Sheet 6 of 6

Funding for this project was provided by the
Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps.
North American Datum of 1983. Projection and 1000-meter
grid ticks (blue): Universal Transverse Mercator, zone 12.



Map Unit Descriptions

Other units

- **af** — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams.
- **Qcp** — **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground.
- **Qw** — **Quaternary tributary lake and colluvium** - unconsolidated to weakly consolidated, very poorly sorted, angular to well-rounded deposits at the base of tributary mosses.

River alluvium

- **Qyaa** — **Active river channel deposits** - unconsolidated, very poorly sorted sand to cobbly bank or active river channels.
- **Qya** — **Young channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels.
- **Qyo** — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces lined below the alluvial-colluvial historical floodplain.
- **Qya2** — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain.
- **Qya1** — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits of gully mouths and early historical floodplain.
- **Qya** — **Late Pleistocene river terrace deposits** - gravelly sandy river terrace deposits up to 25 m above the active river channel.
- **Qya** — **Middle to late Pleistocene river terrace deposits** - cobbly, higher gravelly, sandy river terrace deposits.
- **Qya** — **Early to middle Pleistocene river terrace deposits** - cobbly, highest preserved gravelly, sandy river terrace deposits.

Piedmont alluvium and colluvial deposits

- **Qa** — **Modern stream channel deposits** - active channel deposits composed of very poorly sorted sand, gravelly, and cobbles with some boulders to moderately sorted sand and silt veneers.
- **Qa** — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly fan terrace and overflow channel deposits.
- **Qcol** — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting well-known drainage patterns.
- **Qa** — **Late Holocene alluvium** - similar terrace deposits bracketing incised drainages. Similar to modern fan deposits in topping with Holocene river alluvium, and comparable active fan deposits.
- **Qa** — **Older Holocene alluvium** - inset, low relief, unroofed fan deposits exhibiting scrapped, moderate to well-developed soil profiles.
- **Qa** — **Holocene fine-grained deposits** - unconsolidated silt and fine-grained predominantly mass basin fill deposits.
- **Ts** — **Talus** - rock debris consisting of large angular blocks to silt-sized particles, loosely cemented and coarse.
- **Qc** — **Basin-fill deposits, undivided** - includes fine-grained colluvium and alluvium, talus, and some piedmont and basinal gravels.
- **Qc** — **Landslide deposits** - consist largely of Cenozoic sedimentary, locally cemented with calcite.
- **Qa** — **Piedmont gravel veneer** - subangular pebbles and cobbles, includes some cobbles and boulders in layers of gravels.
- **Qa** — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development.
- **Qa** — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development.
- **Qa** — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strongest soil development.

Tertiary basin-fill alluvium

- **Tsp** — **Late Miocene to Pliocene Gallardo deposits, alluvial fan facies** - mainly to gravelly, moderately to strongly indurated alluvial fan deposits.
- **Tsp** — **Late Miocene to Pliocene deposits** - moderately to strongly indurated conglomerate and sandstone-bearing fill deposits.

Bedrock

- **Tg** — **Apache Conglomerate Member** - cliff-forming conglomerate and conglomeratic tuff
- **Tg** — **Hell Hole Conglomerate** - well-indurated tuff and conglomerate composed mainly of volcanic debris, incorporates some of tuff unit set.
- **Tmh** — **Hells Hell Acre Tuff member** - air fall, ashy, nonwelded to slightly welded ash flow, and reworked deposits (Lift)
- **Tmh** — **Hells Hell Acre Rhyolite-obsidian** - flow-banded obsidian to rhyolite flow breccias
- **Tmgr** — **Yingus Canyon upper Andesite** - fine-grained, aphyllitional andesite with small phenocrysts of plagioclase
- **Tmg** — **Yingus Canyon Conglomerate** - pebble-cobble-boulder derived from lower andesite of Yingus Canyon
- **Tmgr** — **Yingus Canyon lower Andesite** - coarsely porphyritic (Turkey Track) andesite
- **Tpkq** — **Knoxdale Member, nonwelded zone** - slope-forming ash tuff
- **Tpkq** — **Knoxdale Member, welded zones** - cliffy welded, welded, and zones nonwelded tuff
- **Tsp** — **Rear Springs Canyon Conglomerate** - sourced from older members of the Galiuro Volcanics, arkosic, and gneissic
- **Tsp** — **Rear Springs Canyon Tuff** - rhyolitic ash-flow tuff
- **Tsp** — **Conglomerate of Depression Canyon** - component of older rocks, including older members of the Galiuro Volcanics
- **Tsp** — **Depression Canyon Andesite** - massive, fine-banded, to aggloweratic, grey, brown, and rose andesite
- **Tsp** — **Holy Joe Member** - quartz-rich ash flow tuff
- **Tsp** — **Hilderado's Conglomerate** - conglomerate of pebbles and cobbles of Precambrian and Paleozoic rocks.
- **Tsp** — **Rhyolite of East cabin Hilderado Conglomerate** - white rhyolite tuff bed (23.8 ft thick) in Aravaipa Canyon.
- **Tsp** — **Horse Mountain Volcanics** - arkosic tuff, sandstone, siltstone, and mudstone
- **Tsp** — **Residence Limestone** - massive, cliff-forming, thick-bedded, mostly cryptocrystalline limestone
- **Tsp** — **Martin Formation** - slope-forming shale unit with interbedded limestone beds.
- **Tsp** — **Abrigo Formation, upper member** - cliff-forming, mostly poorly sorted, cross-bedded, arkosic with pebbly sandstone.
- **Tsp** — **Abrigo Formation, middle member** - cliff-forming mostly poorly sorted sandstone and argillaceous sandstone
- **Tsp** — **Abrigo Formation, lower member** - thin bedded, slope-forming mudstone, siltstone, and sandy limestone
- **Tsp** — **Dubois** - dolostone
- **Tsp** — **Troy Quartzite, upper unit** - sandstone, quartzite, and granule to small pebble conglomerate
- **Tsp** — **Troy Quartzite, lower unit** - conglomerate and sandstone
- **Tsp** — **Dripping Springs Quartzite** - feldspathic to arkosic quartzite and siltstone
- **Tsp** — **Pioneer** - massive to slightly foliated, finegrained porphyritic rock
- **Tsp** — **Granitic rocks, undivided** - granodiorite or leucocratic quartz monzonite
- **Tsp** — **Pinal schist** - flows, tuffs, and fine-banded rock of andesitic composition

1:24,000 SCALE

0.5 0 1 Miles

0 0.5 0 1 Kilometers

0 1000 2000 3000 4000 5000 Feet

USGS 24k quadrangle series topographic base maps.
North American Datum of 1983. Projection and 1000-meter
grid ticks (blue): Universal Transverse Mercator, zone 12.

Waypoint Location, showing station identification

Other Geologic Lines

- Thin, Solid Line — Accurate contact
- Thin, Dashed Line — Approximate contact
- Thin, Dotted Line — Concealed contact
- Hashed Line — Gradational Contact
- Solid, Bold Line — Accurate Fault
- Dashed, Bold Line — Approximate Fault
- Dotted, Bold Line — Concealed Fault

Boundaries of Holocene River Alluvium

Thin, Solid Line
Closely defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

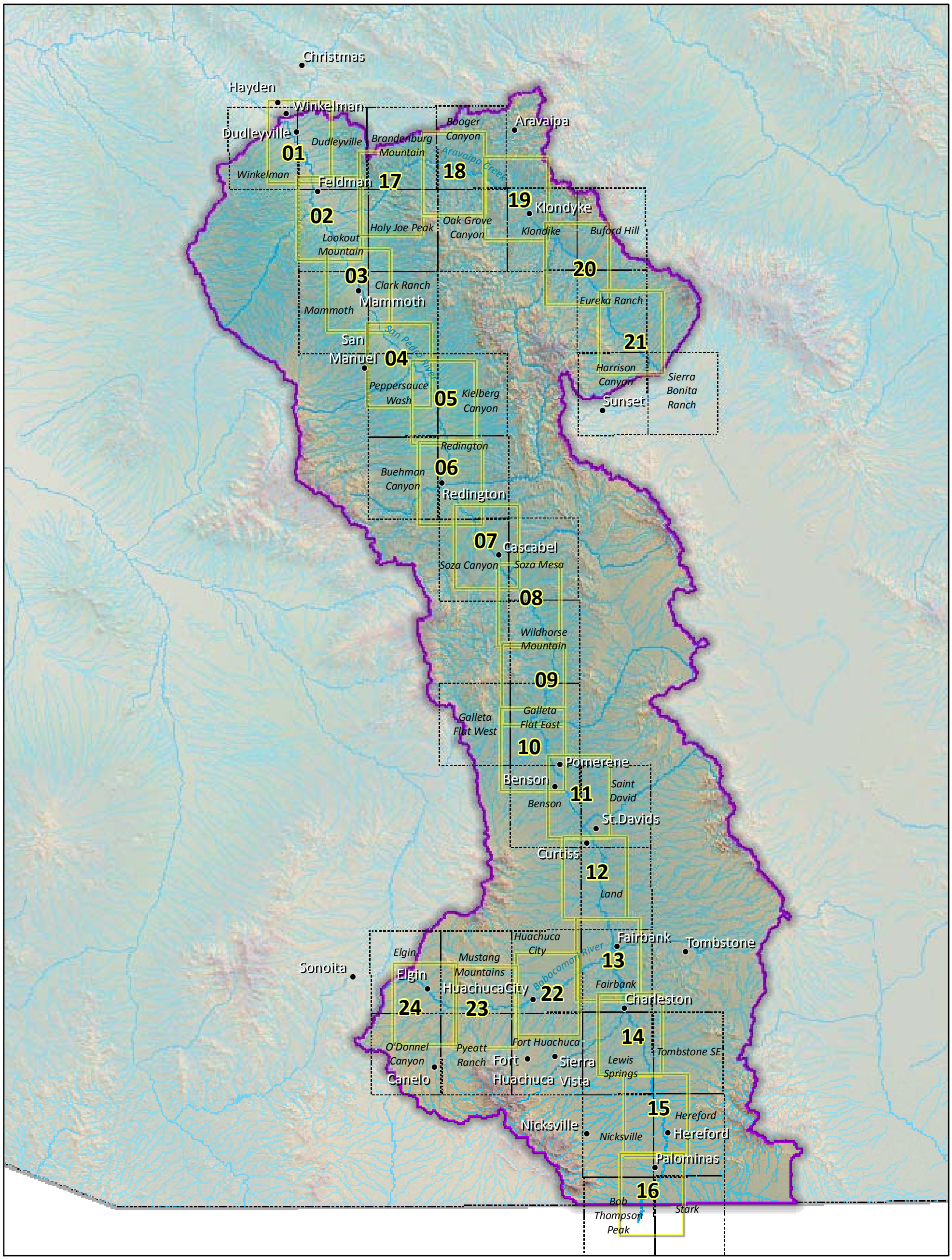
Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with broad, low-gradient alluvial fans and terraces that grade into alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas where the contact is obscured by human disturbance activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.).

Attachment 11

ADWR and LRE Subflow Zone Comparison Maps

Map Index for SRP San Pedro Attachments 9 & 11



Sheet Index

Miles
0 5 10 20

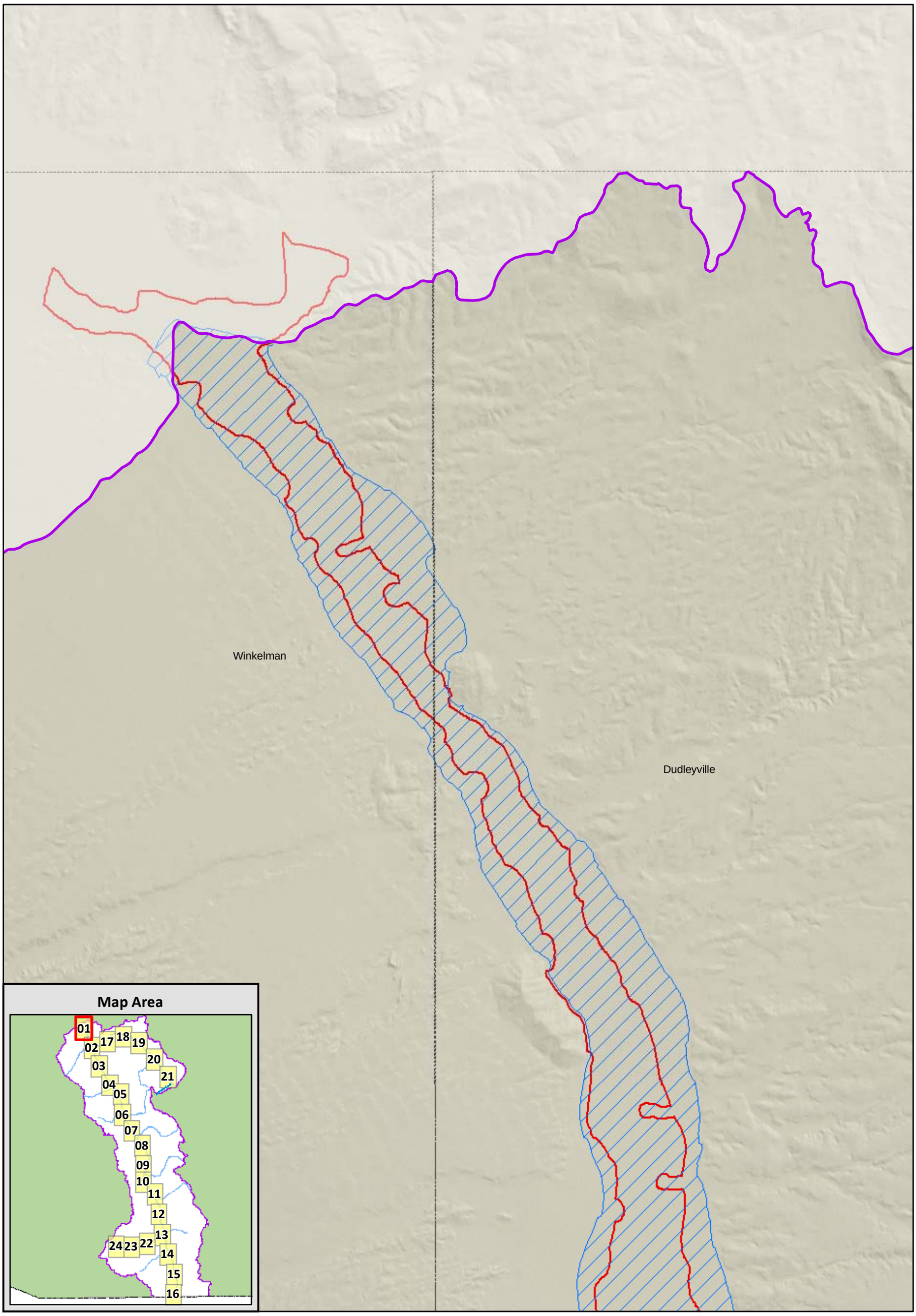
0 5 10 20
Kilometers

Legend

- Map Book Pages
- USGS Topo (24k) Quad Boundary
- San Pedro River Watershed Boundary

SanPedro_MapIndex11.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 1

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
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0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

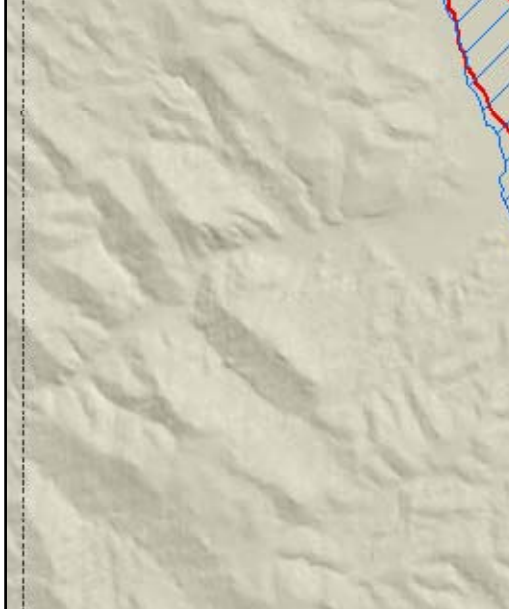
SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River

Dudleyville

Lookout Mountain

Map Area



Sheet 2

Miles
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0 0.5 1
Kilometers

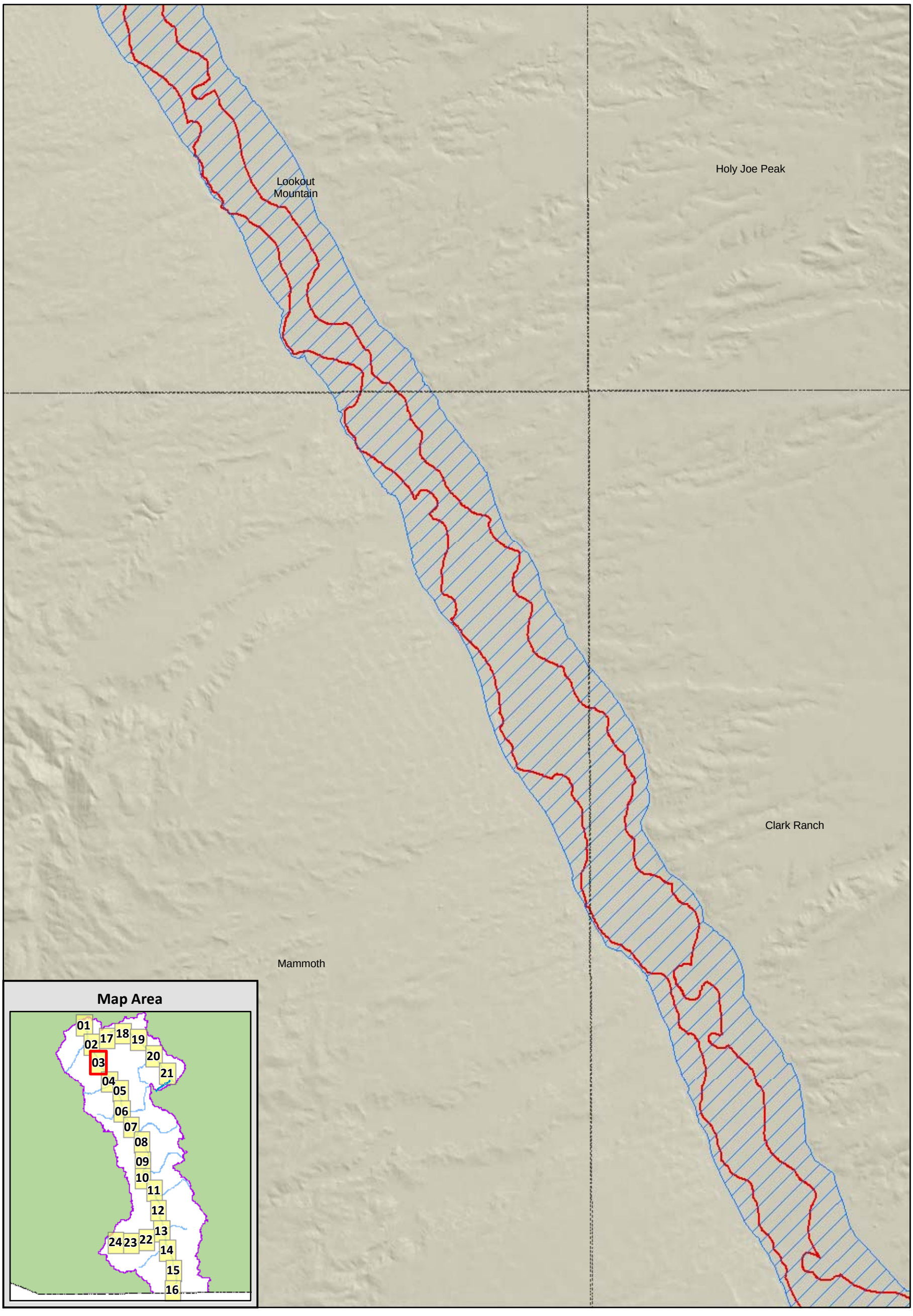
Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 3

Miles
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0 0.5 1
Kilometers

Legend

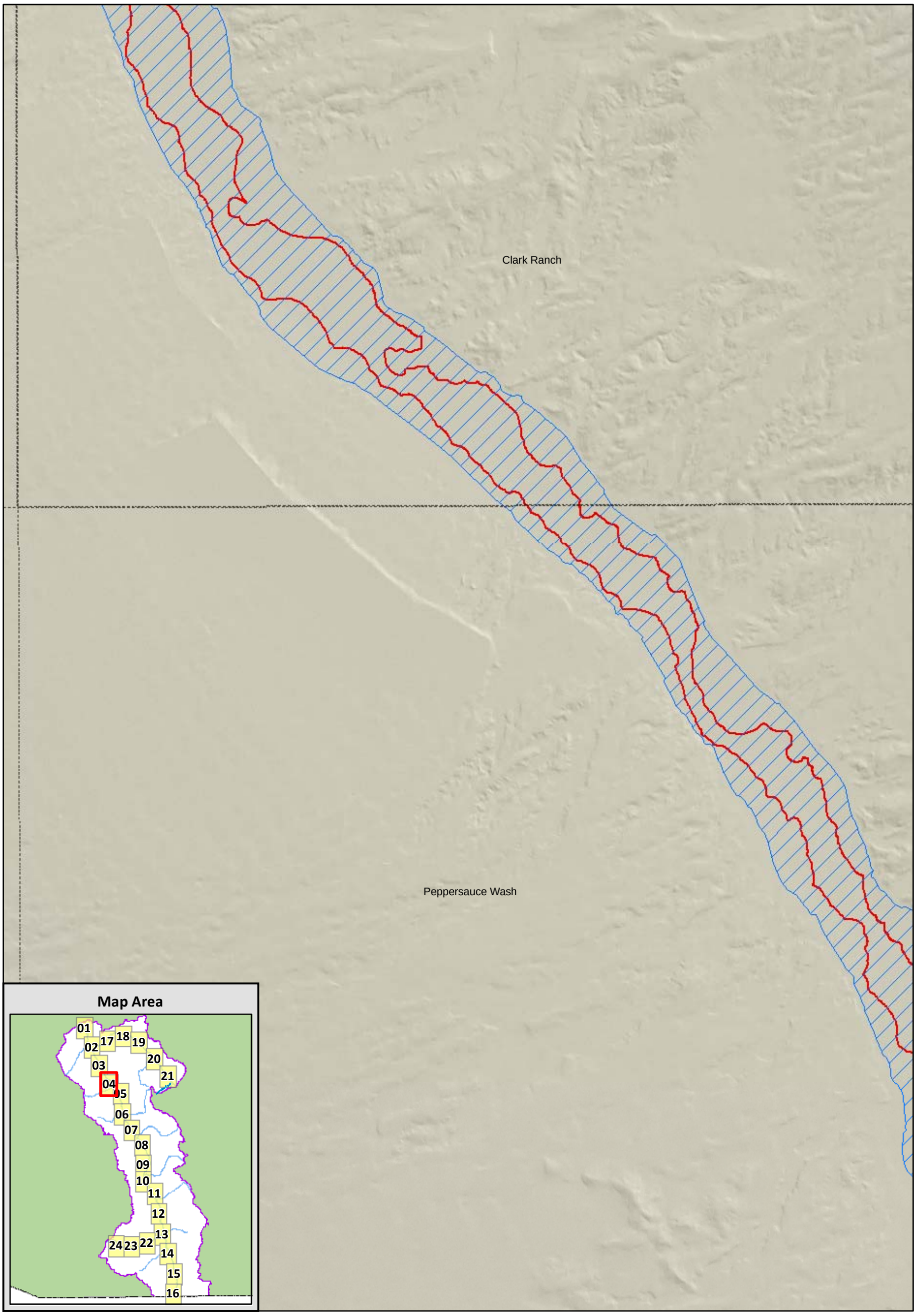
- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 4

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
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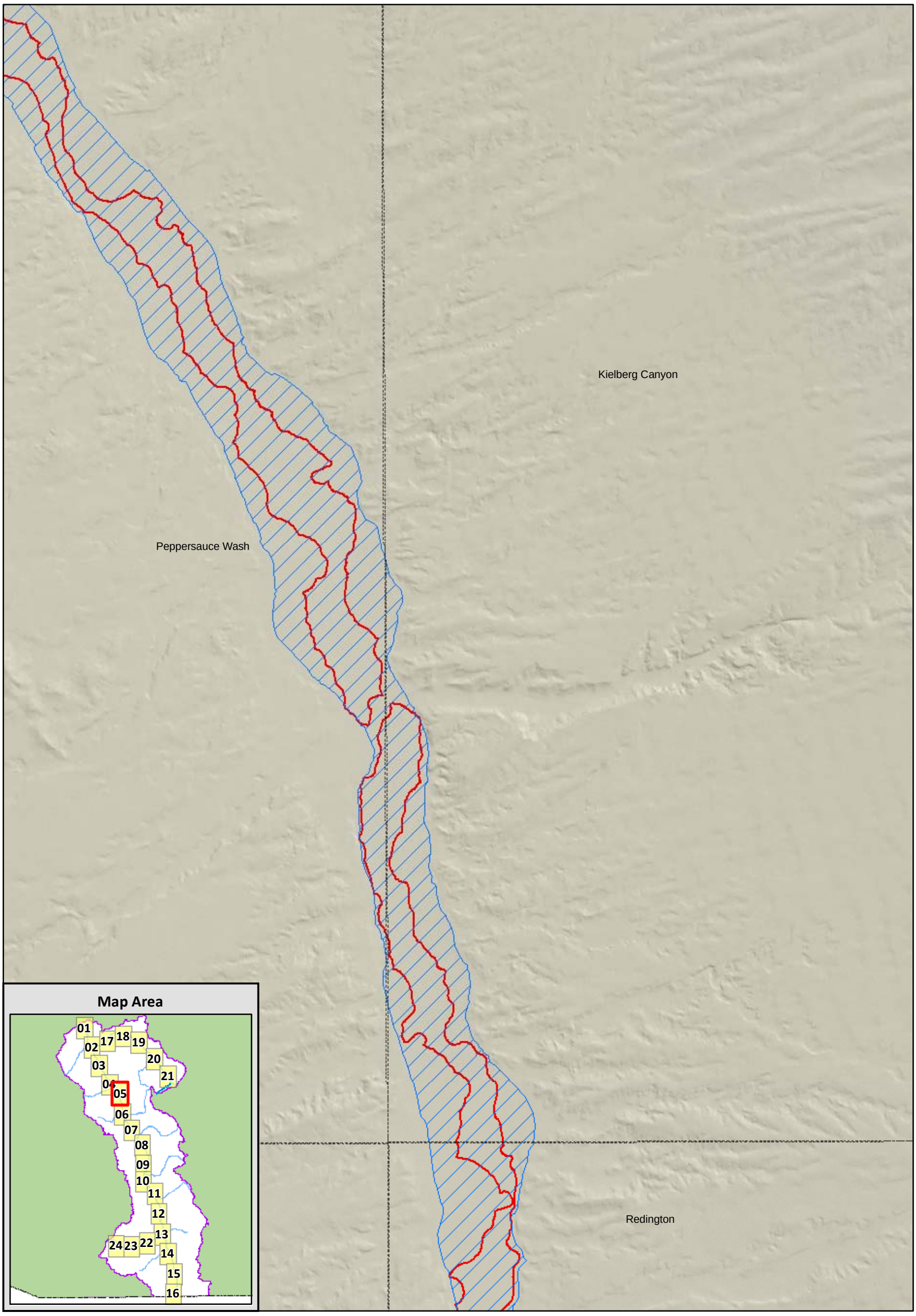
0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 5

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
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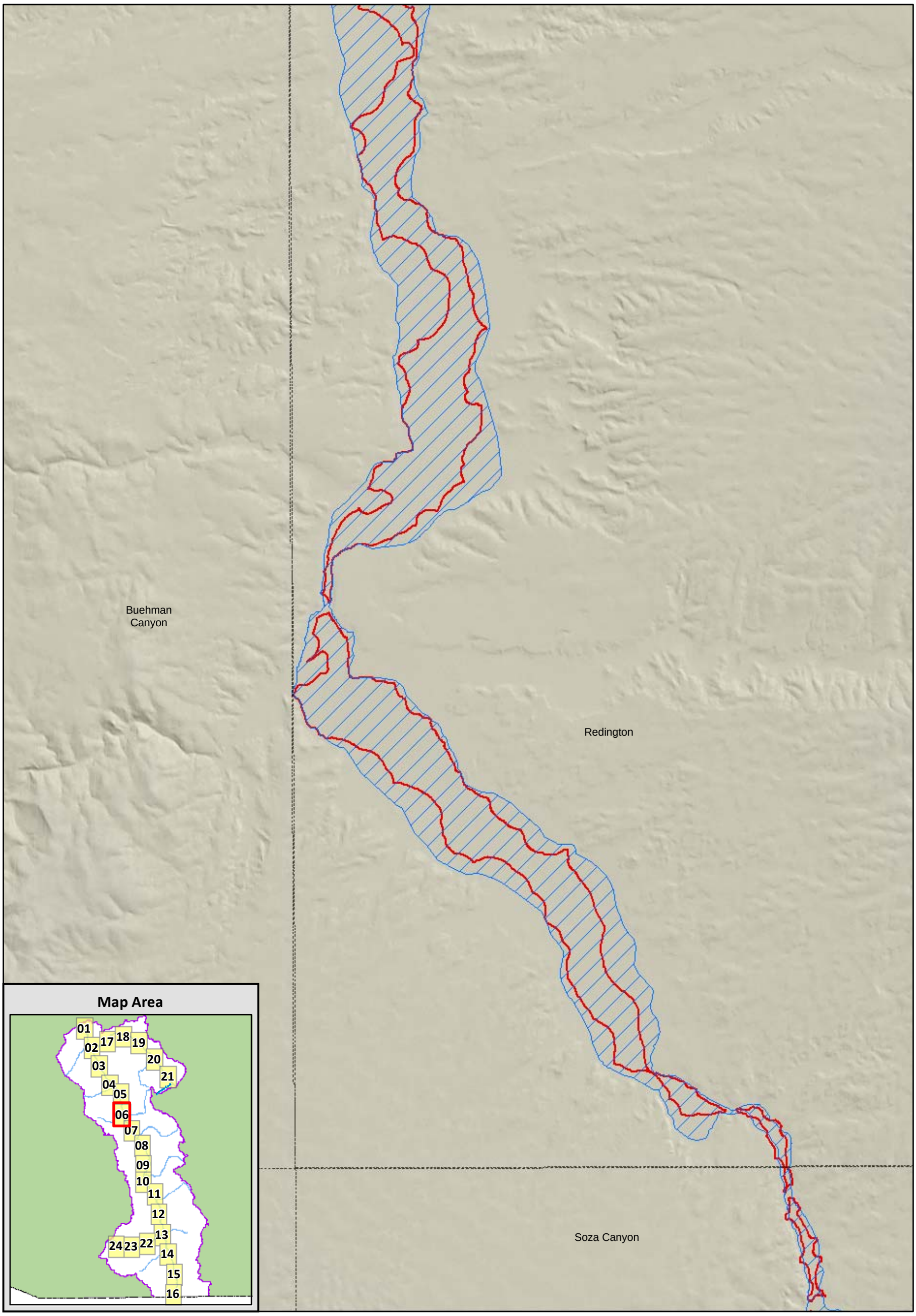
0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 6

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
0 0.5 1

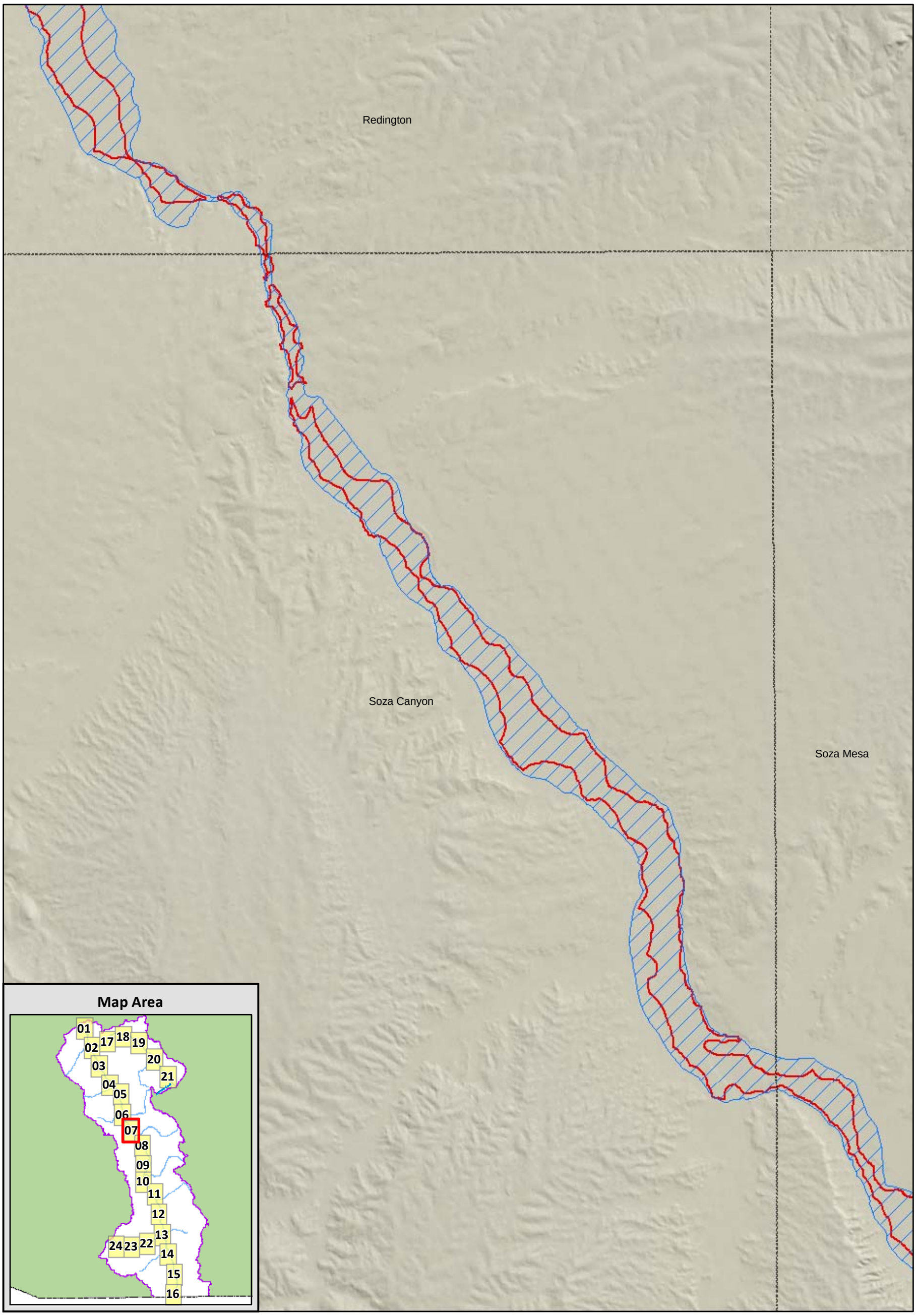
0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 7

Miles
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0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
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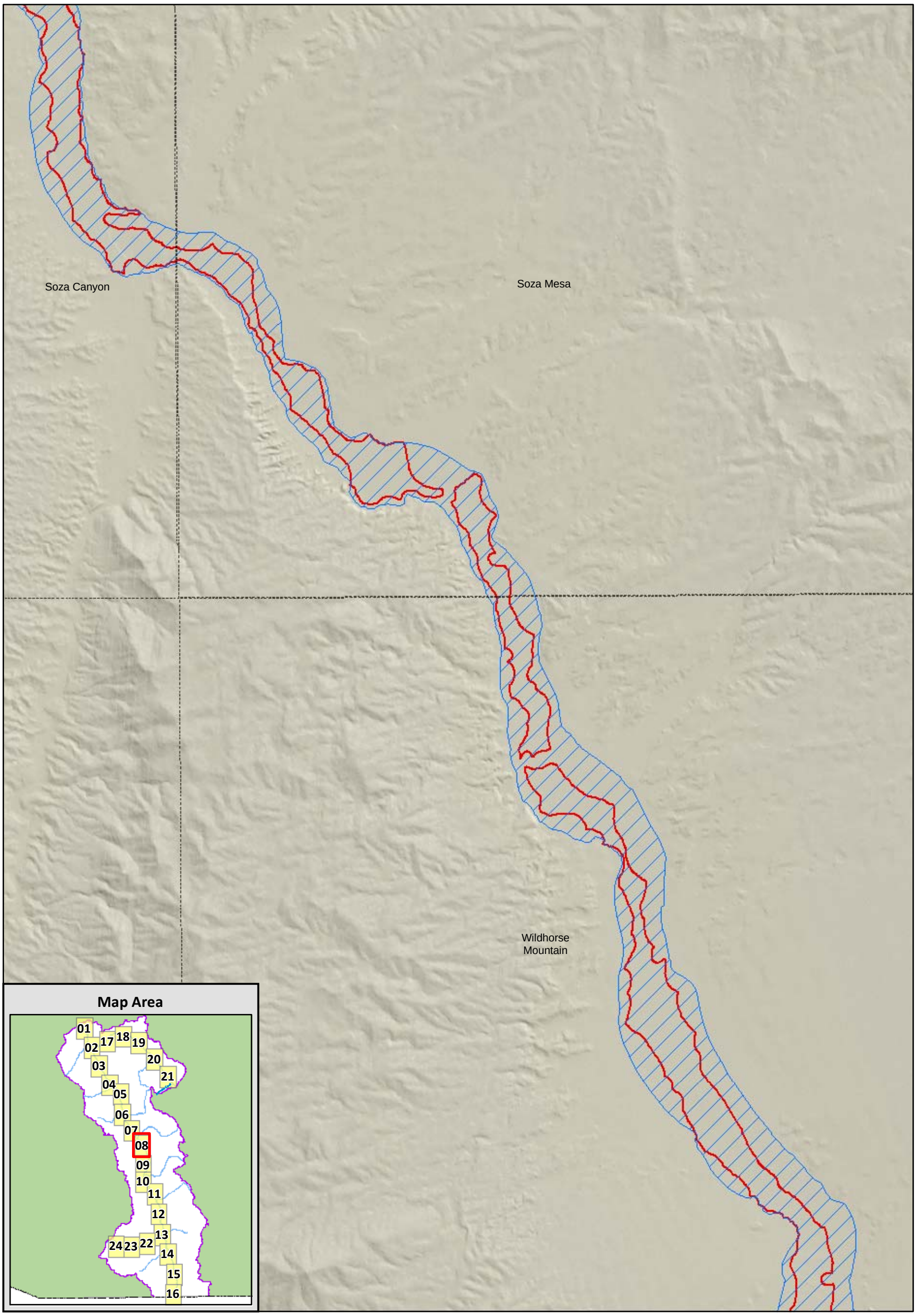
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 8

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

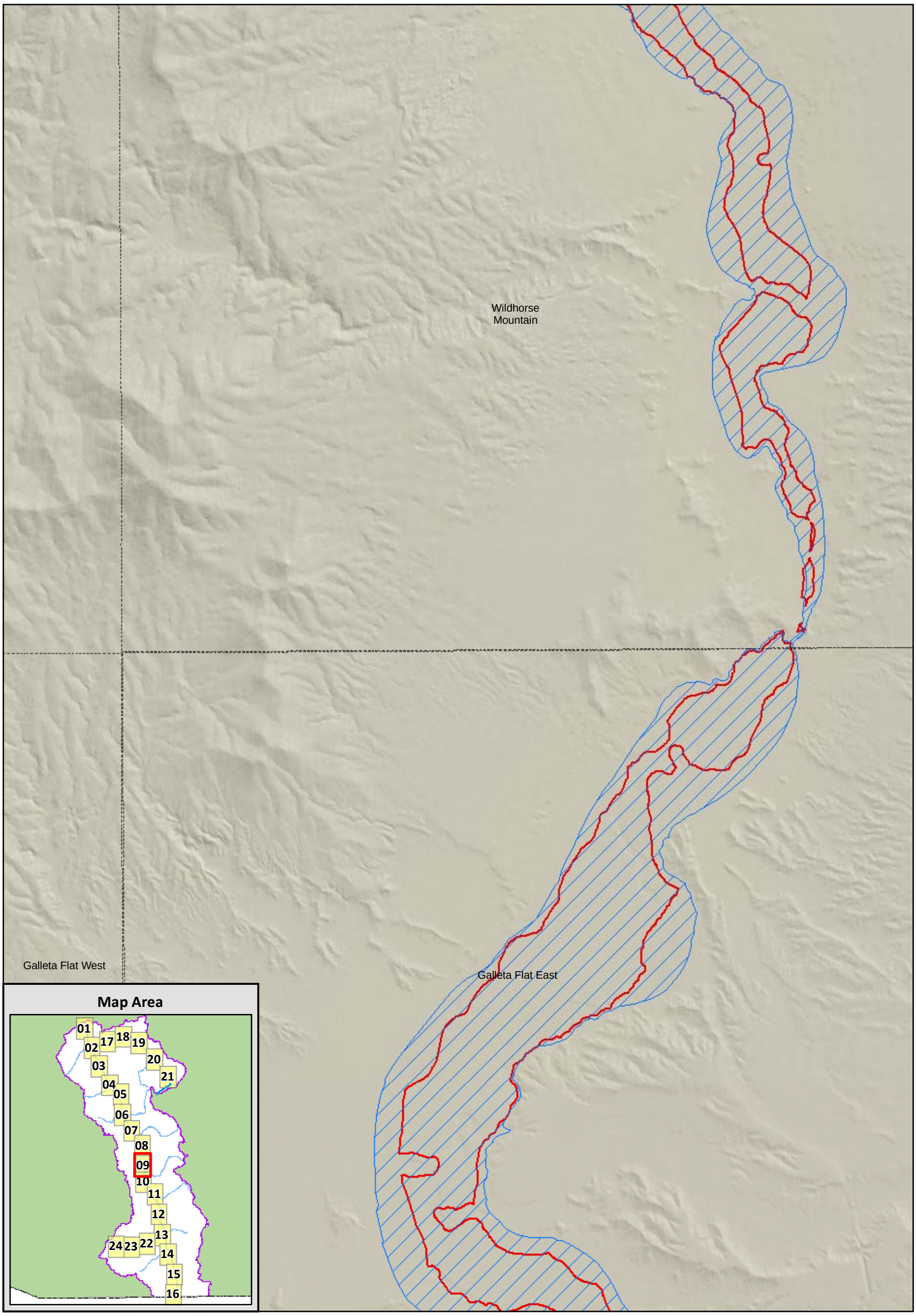
Miles
0 0.5 1

0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 9

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
0 0.5 1

0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

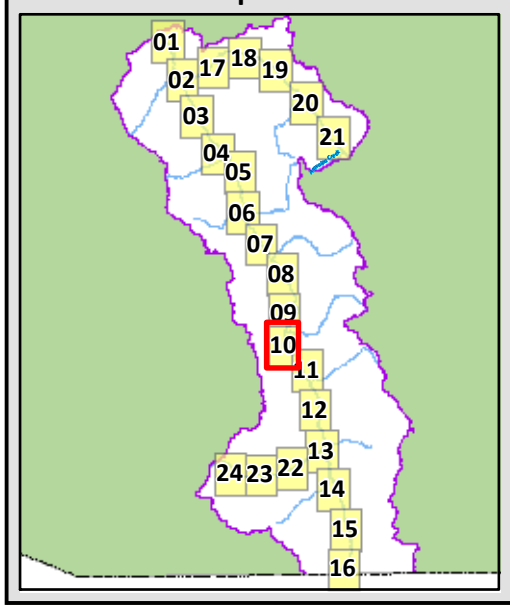
ADWR and LRE Subflow Zone Comparison, San Pedro River

Galleta Flat East

Galleta Flat West

Benson

Map Area



Sheet 10

Miles
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0 0.5 1
Kilometers

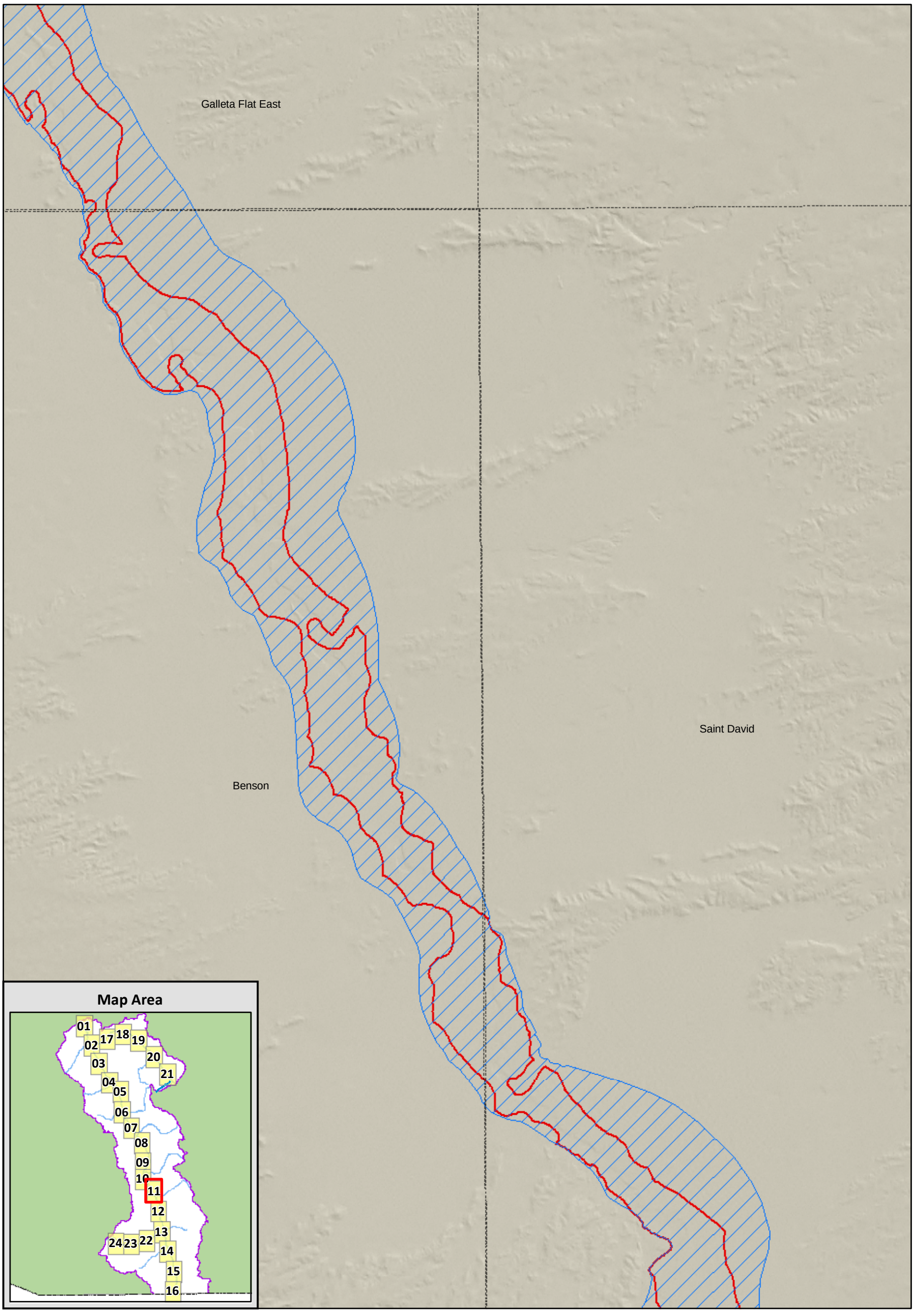
Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 11

Miles
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0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
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- LRE Subflow Zone

Data Sources:
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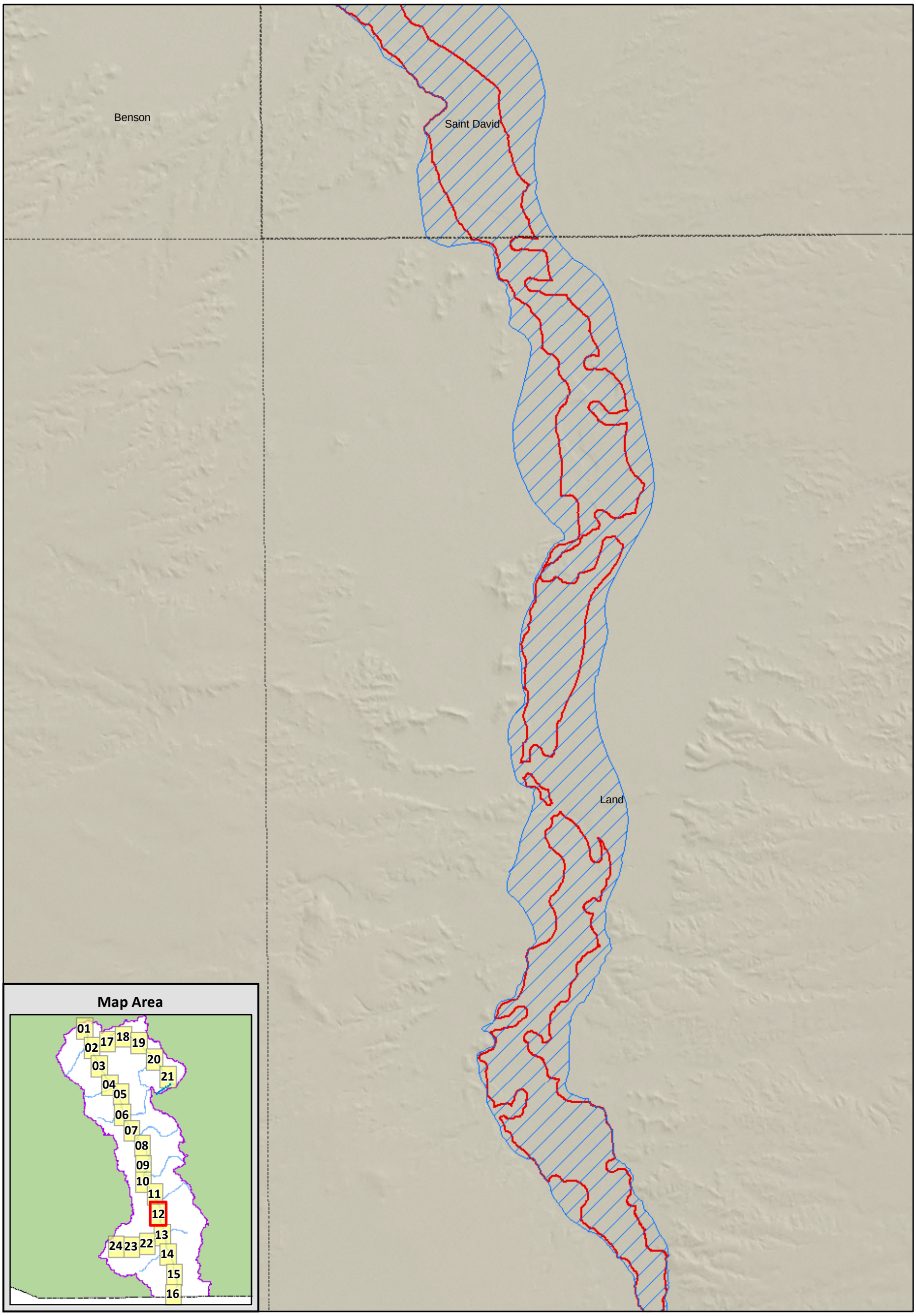
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 12

Miles
0 0.5 1

0 0.5 1
Kilometers

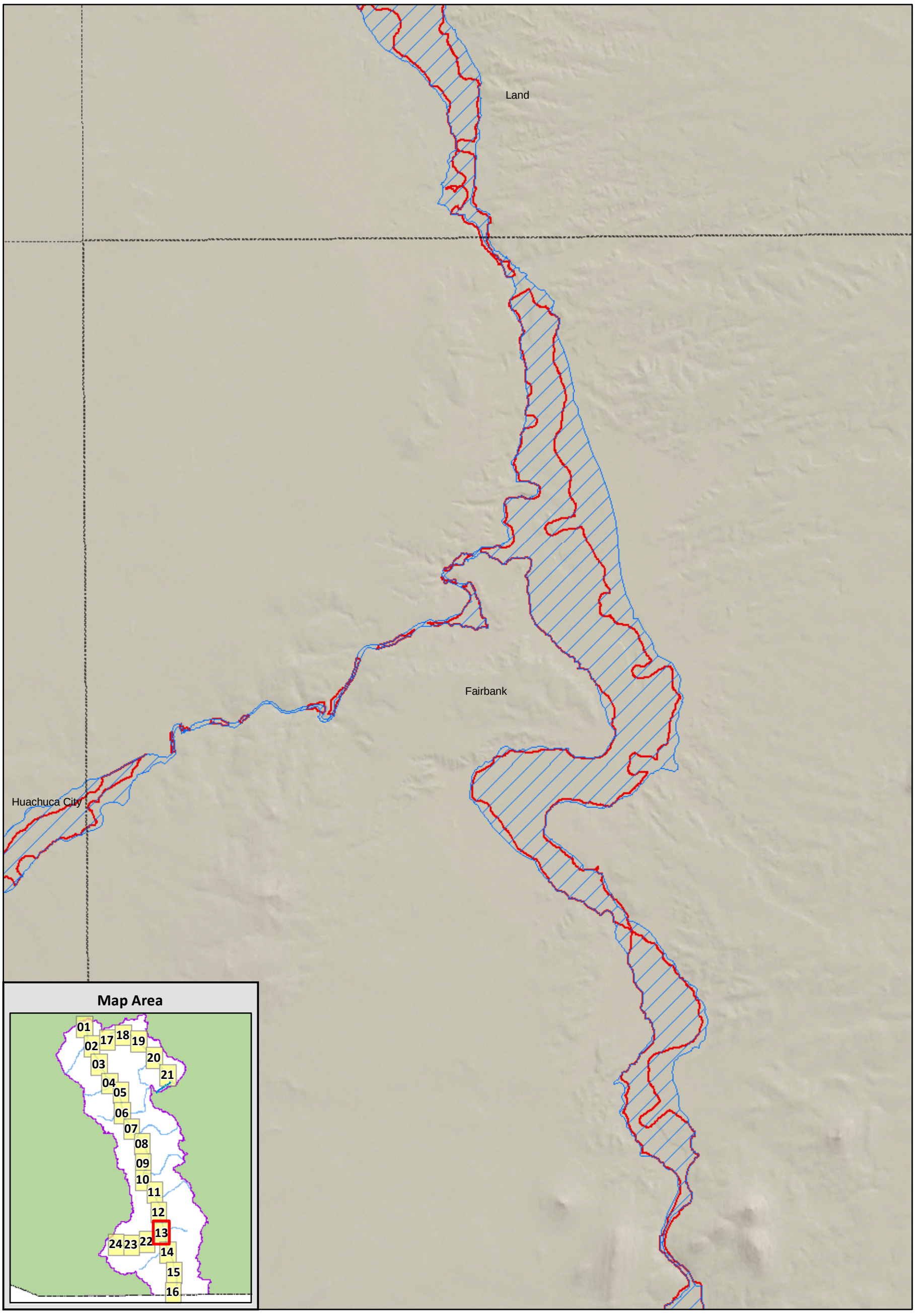
Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 13

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
0 0.5 1

0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

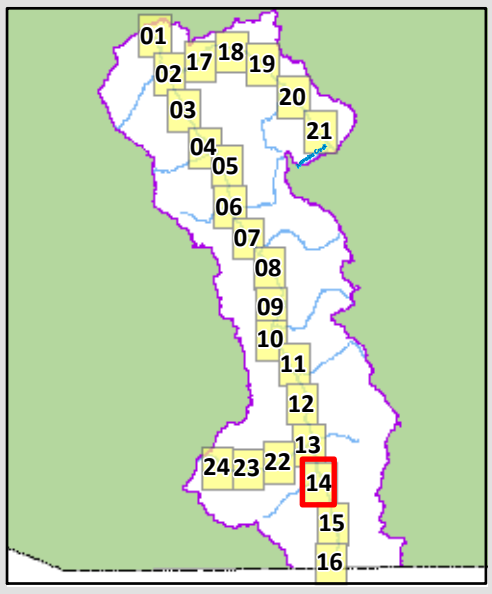
ADWR and LRE Subflow Zone Comparison, San Pedro River

Fairbank

Lewis Springs

Tombstone SE

Map Area



Sheet 14

Miles
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0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
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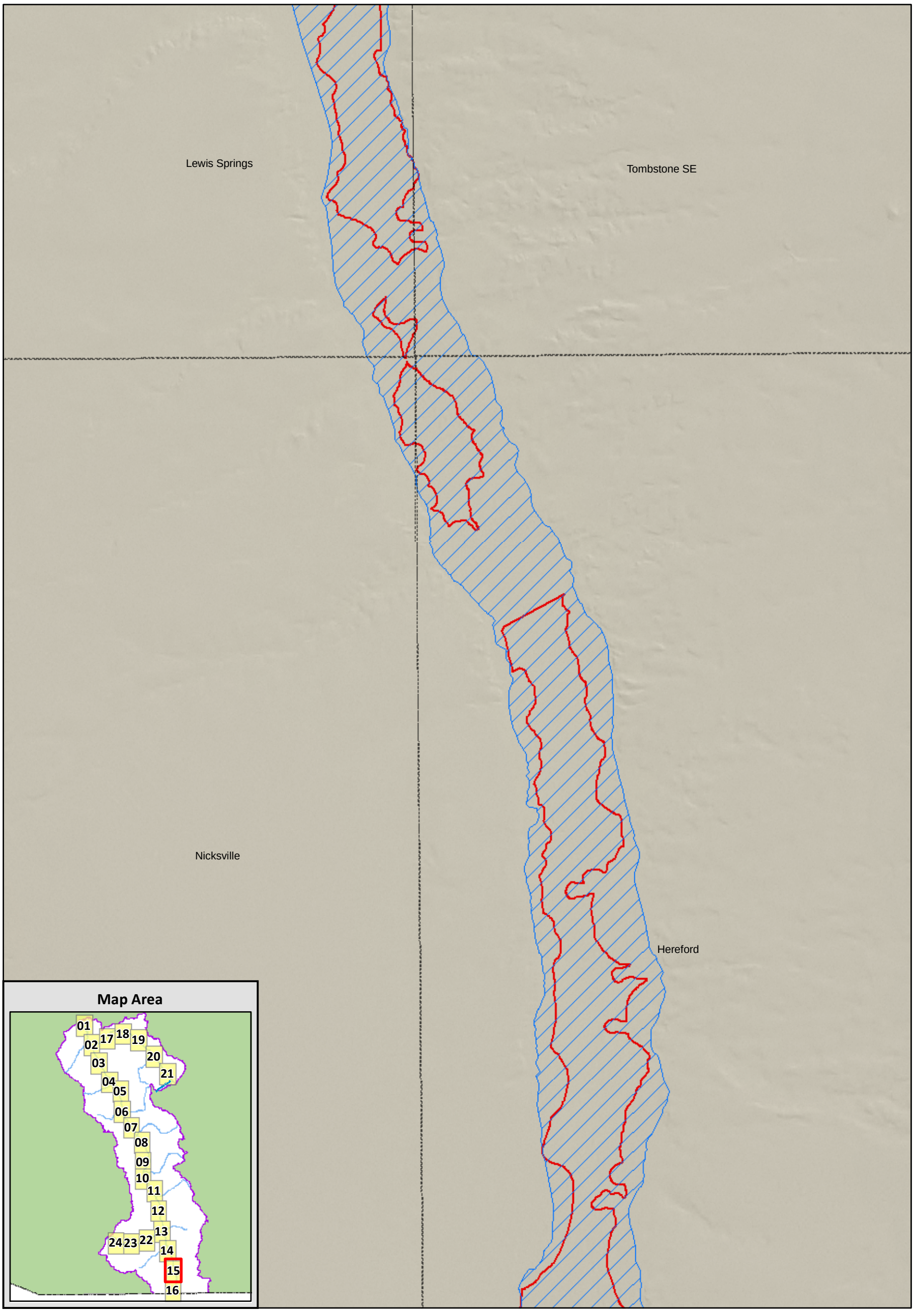
SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 15

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
0 0.5 1

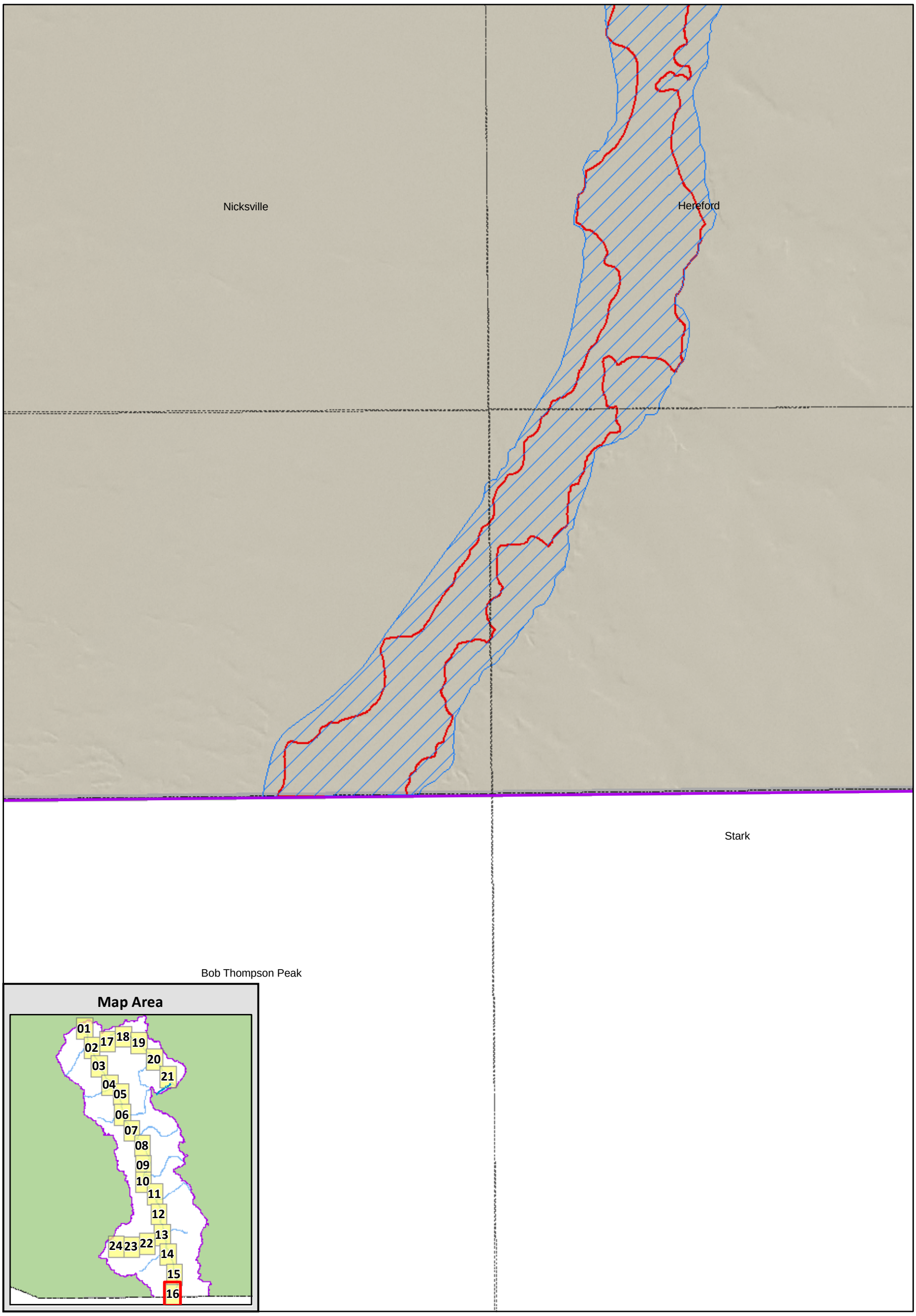
0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 16

Miles
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0 0.5 1
Kilometers

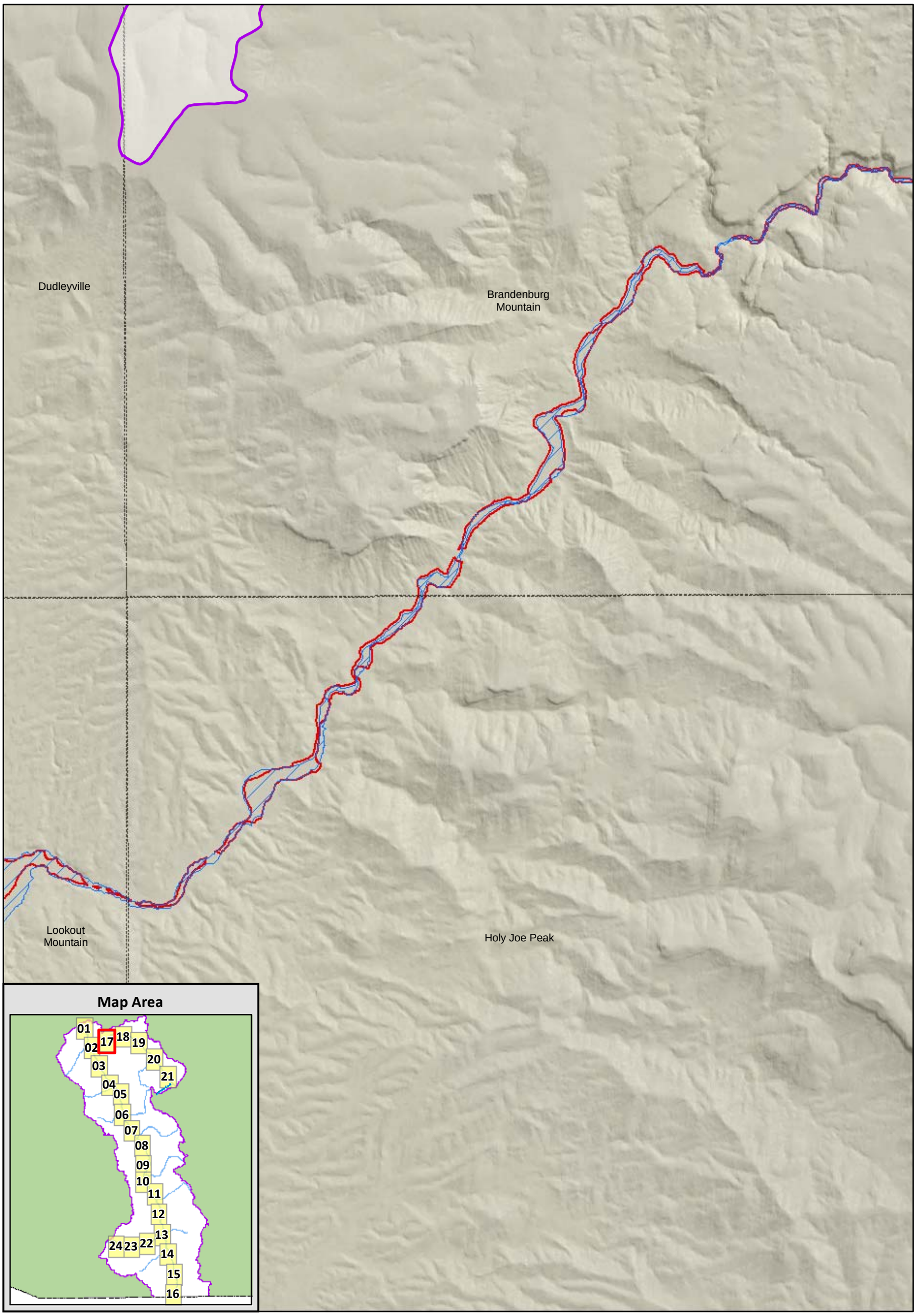
Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 17

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
0 0.5 1

0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

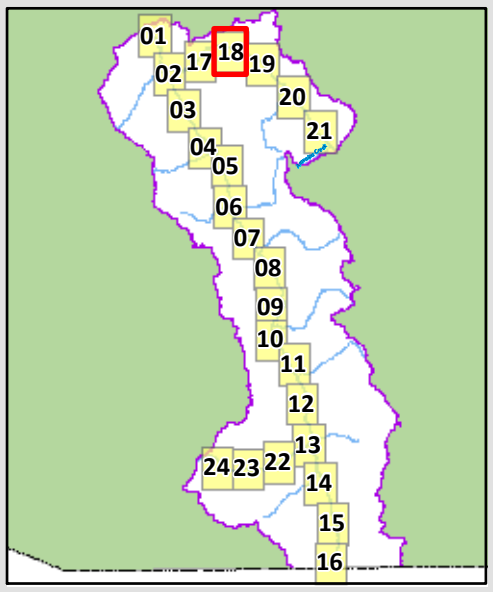
ADWR and LRE Subflow Zone Comparison, San Pedro River

Booger Canyon

Brandenburg Mountain

Oak Grove Canyon

Map Area



Sheet 18

Miles
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0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

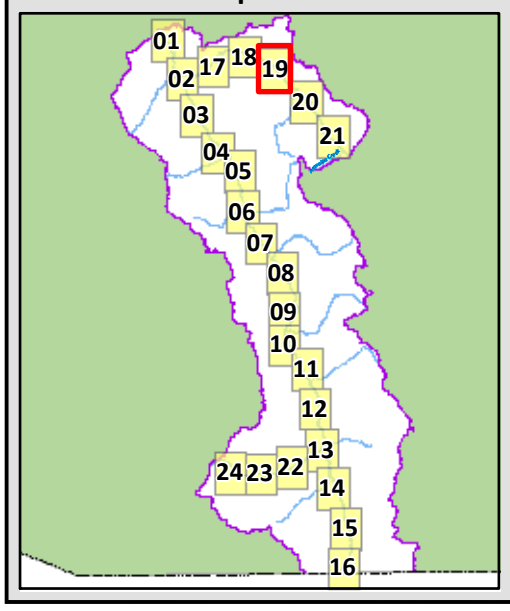
ADWR and LRE Subflow Zone Comparison, San Pedro River

Booger Canyon

Oak Grove Canyon

Klondike

Map Area



Sheet 19

Miles
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0 0.5 1
Kilometers

Legend

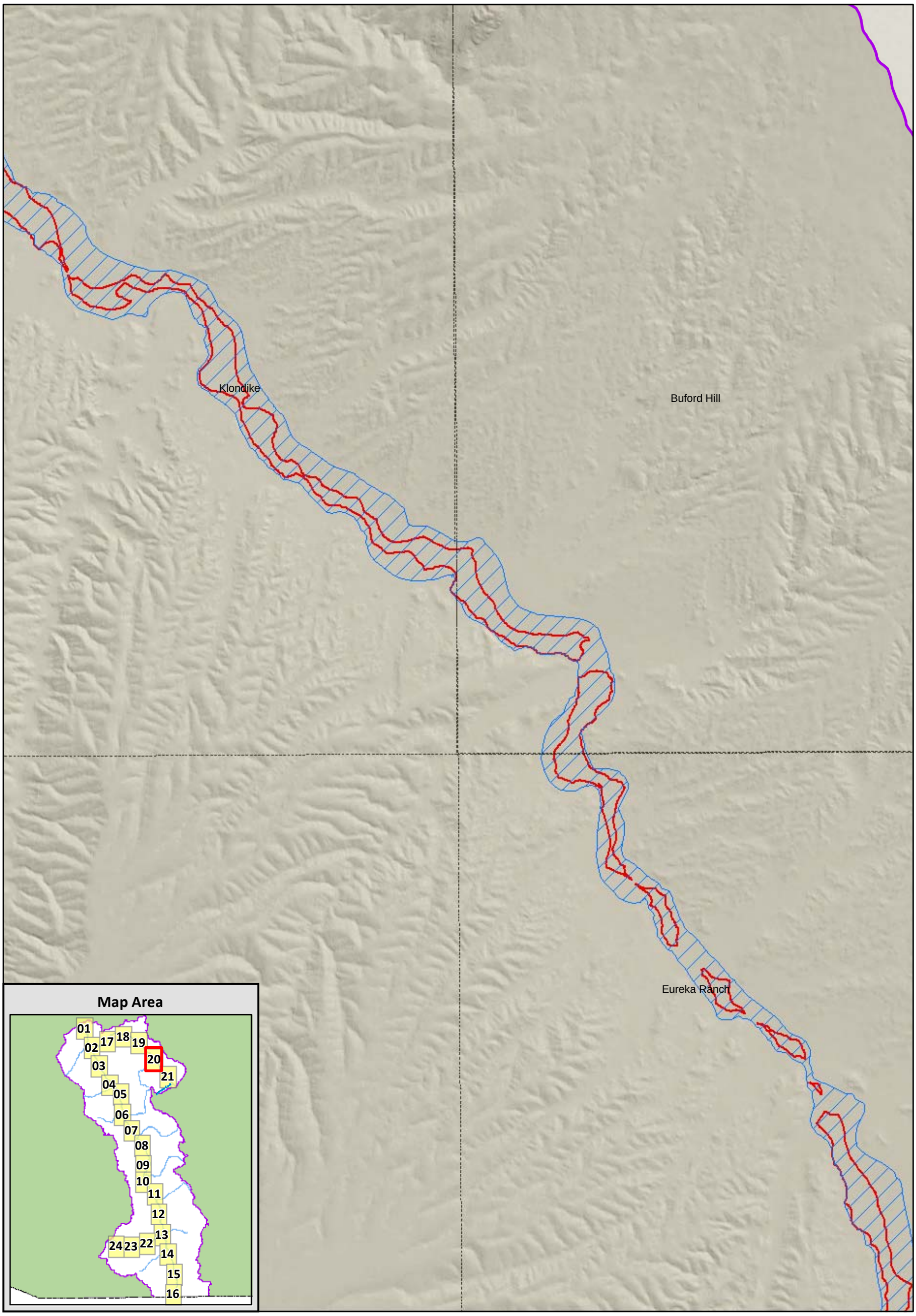
- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 20

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
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0 0.5 1
Kilometers

Data Sources:
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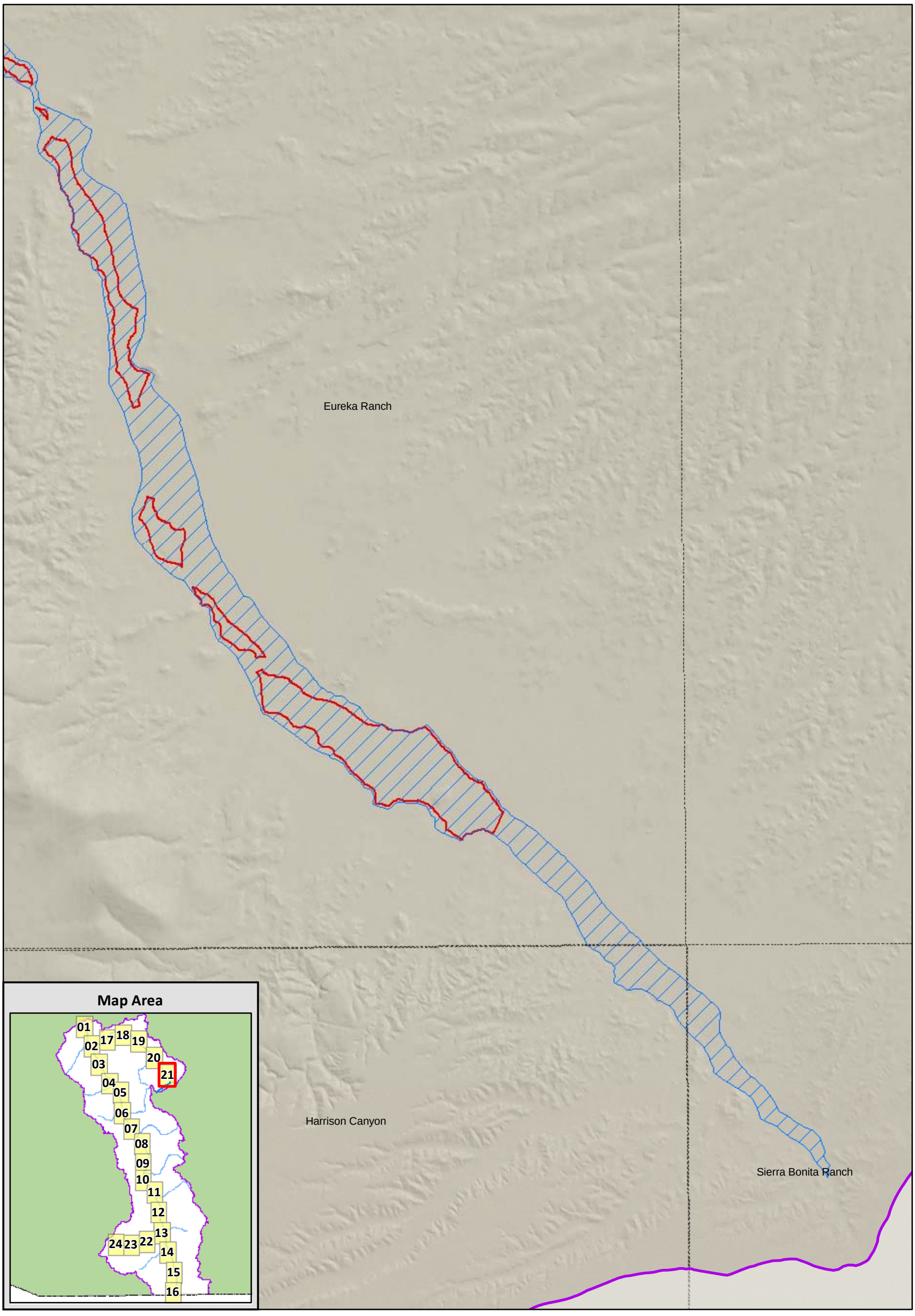
SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 21

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Miles
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0 0.5 1
Kilometers

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

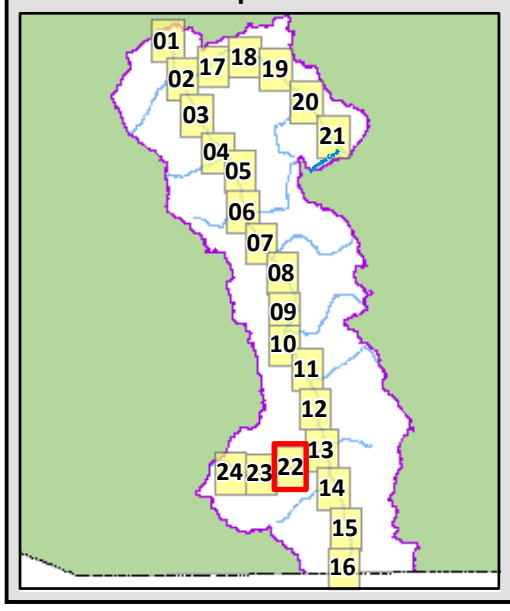
SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River

Huachuca City

Fort Huachuca

Map Area



Sheet 22

Miles
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0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
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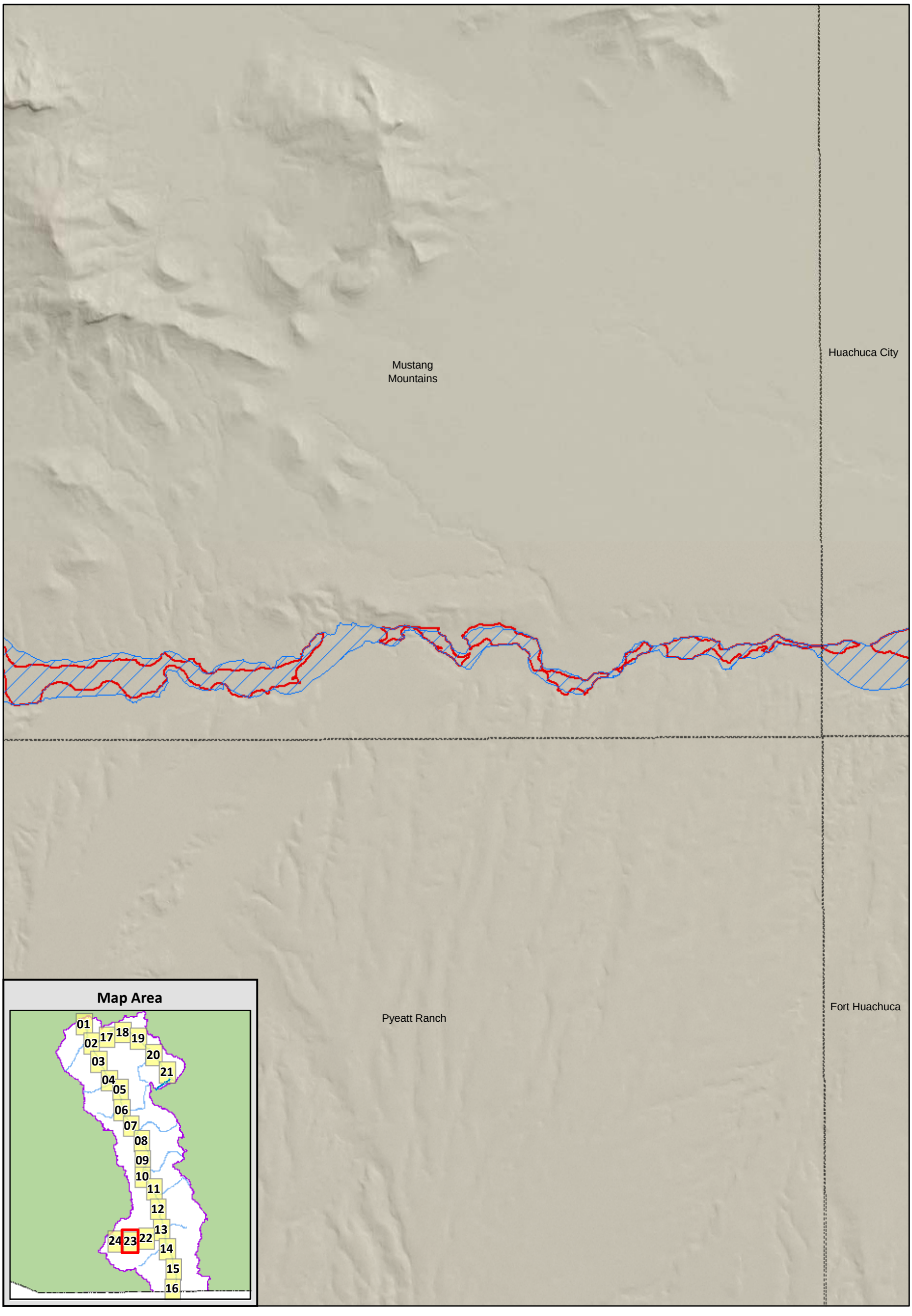
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

Attachment 11

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 23

Miles
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0 0.5 1
Kilometers

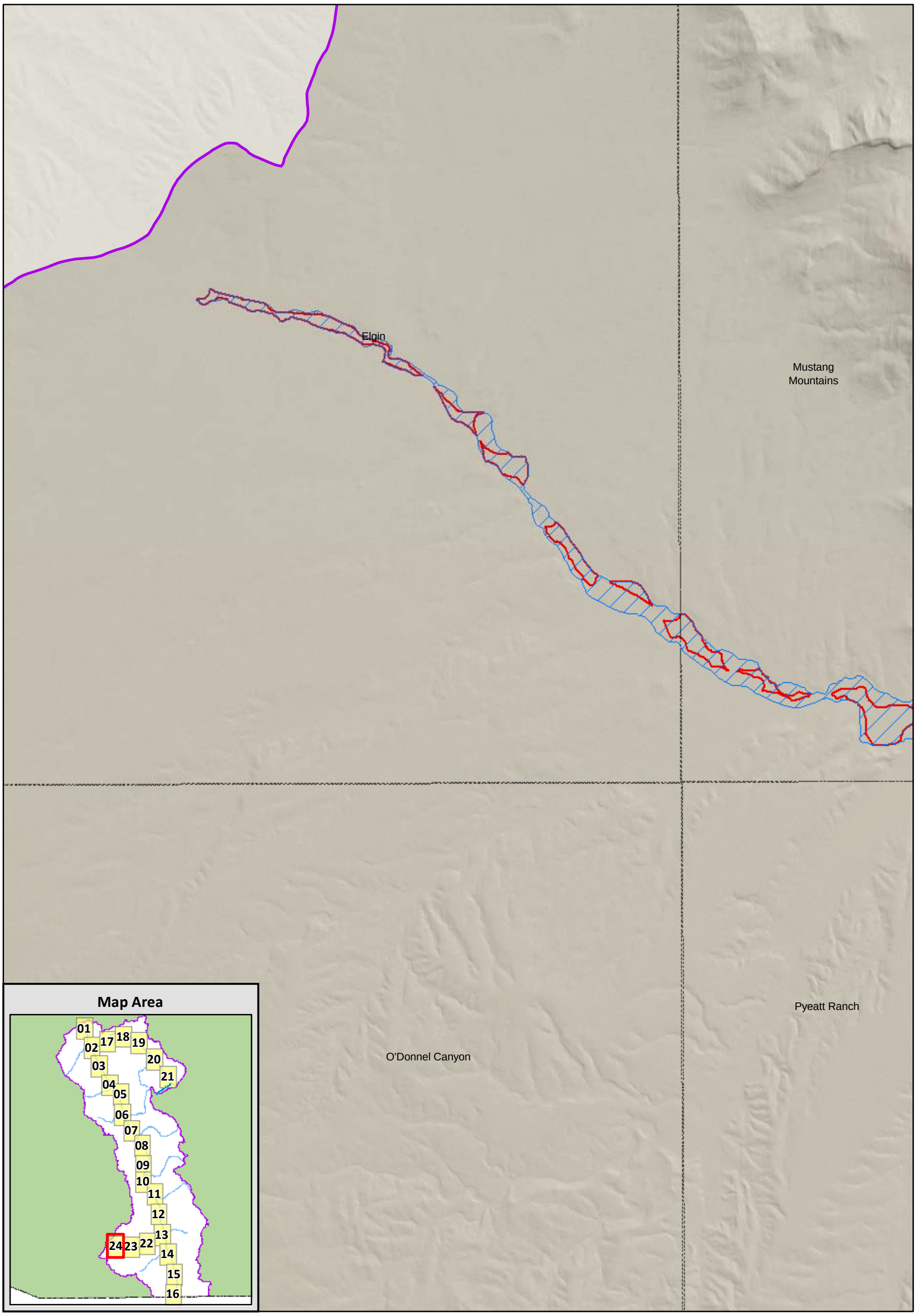
Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

ADWR and LRE Subflow Zone Comparison, San Pedro River



Sheet 24

Miles
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0 0.5 1
Kilometers

Legend

- USGS Topo (24k) Quad Boundary
- ADWR Subflow Zone
- Watershed Boundary
- LRE Subflow Zone

Data Sources:
ADWR: ADWR Subflow Zone
SRP: LRE Subflow Zone

SanPedro_SubflowComp.mxd

City of Tempe

Charlotte Benson, 015383
CITY OF TEMPE
P.O. Box 5002
Tempe, Arizona 85280
(480) 350-2813
Charlotte_Benson@Tempe.gov

Attorney for City of Tempe

RECEIVED
DEC 28 2009
LEGAL
DEPT OF WATER RESOURCES

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE

No. W-1 (Salt)
No. W-2 (Verde)
No. W-3 (Upper Gila)
No. W-4 (San Pedro)

Contested Case No. W1-103

TEMPE'S JOINDER IN SALT RIVER PROJECT'S OBJECTIONS TO ARIZONA DEPARTMENT OF WATER RESOURCES' SAN PEDRO RIVER SUBFLOW ZONE DELINEATION REPORT

(Assigned to the Hon. Eddward P. Ballinger)

Descriptive Summary: The City of Tempe files a joinder in the Salt River Project's objections to the Arizona Department of Water Resources' June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed.

Statement of Claimant Nos.: 39-7929; 39-37600-37608 inclusive.

Date of Filing: Mailed December 23, 2009.

Number of Pages: 2.

Pursuant to the Court's September 28, 2005 Order and the June 30, 2009 Notice of Publication and Filing of Report by the Arizona Department of Water Resources ("ADWR"), the City of Tempe joins in the Salt River Valley Water Users' Association and the Salt River Project Agricultural Improvement and Power District (collectively, "SRP") objections to the June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed.

DATED the 23rd day of December, 2009.

CITY OF TEMPE

By _____
Charlotte Benson
P.O. Box 5002
Tempe, AZ 85280

ORIGINAL of the foregoing sent by first-class mail the 23rd day of December, 2009, to:

Clerk of the Superior Court of Maricopa County
Attn: Water Case
601 West Jackson Street
Phoenix, AZ 85003

AND COPY sent by first-class mail the 23rd day of December, 2009 to:

Honorable Eddward P. Ballinger
Judge of the Superior Court
Northeast Regional Court Center
18380 North 40th Street, Ste. L
Phoenix, Arizona 85032

Special Master George A. Schade
Arizona General Stream Adjudication
Maricopa County Superior Court
201 West Jefferson, CCB 5B
Phoenix, AZ 85003-2205

Arizona Department of Water Resources
Janet L. Ronald, Legal Division
3550 North Central Avenue
Phoenix, AZ 85012

All persons appearing on the Court-approved mailing list in W1-W4 dated July 27, 2009.

The Nature Conservancy (TNC)

LEWIS AND ROCA LLP LAWYERS

One South Church Avenue Suite 700
Tucson, Arizona 85701-1611
Telephone: (520) 622-2090

Linda C. McNulty, State Bar No. 012282
Direct Dial: (520) 838-7720
Direct Fax: (520) 879-4734
EMail: LMcNulty@LRLaw.com

Attorneys for The Nature Conservancy

RECEIVED
DEC 24 2009
LEGAL
DEPT OF WATER RESOURCES

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA
IN AND FOR THE COUNTY OF MARICOPA

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE,	NO. W-1 (SALT) NO. W-2 (VERDE) NO. W-3 (UPPER GILA) NO. W-4 (SAN PEDRO) No. Contested Case No. W1-103 **OBJECTION TO SUBFLOW ZONE DELINEATION REPORT FOR THE SAN PEDRO RIVER WATERSHED DATED JUNE 30, 2009** (Assigned to The Honorable Eddward P. Ballinger, Jr.)

1. This objection is filed on behalf of The Nature Conservancy which is a claimant in the Gila River adjudication and is entitled to file an objection in this matter because it holds Statements of Claimant for water rights in the San Pedro River Watershed listed on **Exhibit 1** attached hereto.

2. The Nature Conservancy requests that the Court direct the Arizona Department of Water Resources ("ADWR") to revise its 2009 subflow zone delineation based on additional physical features that, taken as a whole, will more accurately correspond to the stable geologic unit of the saturated floodplain Holocene alluvium. ADWR relied on surficial exposure of floodplain Holocene alluvium, with setbacks applied, as being exclusively indicative of the subflow zone. ADWR's reliance on surface exposures of floodplain Holocene alluvium, together with application of setbacks, results in numerous locations where there are gaps in the subflow zone along the river, or where

the present river channel lies outside the ADWR delineated subflow zone. The expert report of The Nature Conservancy's staff hydrologist, Jeanmarie A. Haney, attached hereto as **Exhibit 2**, details the basis for The Nature Conservancy's objection herein.

3. The original copy of this objection is being sent by first class mail for receipt no later than December 28, 2009 to:

Clerk of the Superior Court
Maricopa County, Attn: Water Case
601 W. Jackson Street
Phoenix, Arizona 85003

4. Also, copies of this objection are being sent by first class mail to each person on the attached mailing list, which includes the judge and Special Master assigned to this matter.

DATED this 21st day of December, 2009.

LEWIS AND ROCA LLP

By Linda C. McNulty
Linda C. McNulty
Attorneys for The Nature Conservancy

GILA RIVER ADJUDICATION
COURT APPROVED MAILING LIST

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LEWIS AND ROCA LLP LAWYERS

EXHIBIT 1
to The Nature Conservancy's
Objection to Subflow Zone Delineation Report
for the San Pedro River Watershed dated June 30, 2009

Statements of Claimant for water rights in the San Pedro River Watershed held by The Nature Conservancy:

39	333	39	5500	39	5598
39	334	39	5503	39	5599
39	335	39	5505	39	5600
39	336	39	5506	39	5601
39	989	39	5507	39	5990
39	990	39	5508	39	5991
39	991	39	5509	39	5992
39	992	39	5510	39	5993
39	2116	39	5511	39	5994
39	2217	39	5512	39	5995
39	2219	39	5513	39	6084
39	2220	39	5514	39	6085
39	2221	39	5515	39	6086
39	2222	39	5516	39	6087
39	2225	39	5517	39	6088
39	2640	39	5518	39	6089
39	2642	39	5519	39	6090
39	2645	39	5520	39	6091
39	2647	39	5521	39	6092
39	2648	39	5522	39	6093
39	2649	39	5524	39	6094
39	2650	39	5527	39	6095
39	2651	39	5528	39	6096
39	3653	39	5529	39	6097
39	3655	39	5534	39	6098
39	3657	39	5535	39	6115
39	3658	39	5536	39	6116
39	3669	39	5548	39	6525
39	3693	39	5549	39	11371
39	3958	39	5550	39	11584
39	4150	39	5574	39	11585
39	5486	39	5576	39	11588
39	5487	39	5577	39	12016
39	5488	39	5578	39	12017
39	5489	39	5579	39	12018
39	5492	39	5586	39	14131
39	5493	39	5587	39	14132
39	5494	39	5592	39	14133
39	5497	39	5593	39	14134
39	5498	39	5594	39	14486
39	5499	39	5595		

LEWIS AND ROCA LLP LAWYERS

EXHIBIT 2
to The Nature Conservancy's
Objection to Subflow Zone Delineation Report
for the San Pedro River Watershed dated June 30, 2009

[See attached]

Exhibit 2

Report of Jeanmarie A. Haney

Qualifications

I am an employee of The Nature Conservancy ("Conservancy"), based in Tucson, Arizona. The statements contained in this report are made based upon my own personal knowledge and work performed by me or by contractors to The Nature Conservancy and from knowledge gained from review of published and unpublished reports and data. I am a Registered Professional Geologist in the state of Arizona (#30437) and I have 13 years of work experience as a groundwater hydrologist in the state of Arizona. In that capacity, I have conducted aquifer pumping tests and analyzed results; conducted water quality testing and analyzed results; supervised exploratory borehole drilling and monitor and production well installation and testing; and conducted geologic mapping and hydrogeologic characterization throughout the southwestern U.S. and in Baja Sur, Mexico, and in northern Chile. I have an additional 8 years of work experience as a conservation hydrologist with The Nature Conservancy in Arizona. In that capacity, I oversee hydrologic monitoring on Conservancy preserves in Arizona and analyze results; conduct analyses of hydrologic data and conduct stream channel and watershed analyses; provide hydrologic technical assistance to site program managers; and analyze potential ecological impacts from human-imposed flow alterations. I have completed review and analysis the Arizona Department of Water Resource's San Pedro River subflow zone delineation report (ADWR 2009). I provide my professional conclusions and comments in this report.

ADWR Hydrologic and Geologic Analysis

The Arizona Department of Water Resources (ADWR) provides a concise summary of court decisions and criteria for delineating the subflow (ADWR 2009; Chapters 1 and 2) and a thorough and accurate description of hydrologic conditions in the San Pedro River watershed (ADWR 2009; Chapter 3). ADWR identified stream reaches with predevelopment perennial or intermittent streamflow and concluded that the San Pedro River was perennial or intermittent from the International Border to its confluence with the Gila River (ADWR 2009; Chapter 3). I agree with this conclusion and with the extent of predevelopment perennial or intermittent conditions determined by ADWR on Aravaipa Creek and Babocomari River. I commend ADWR staff for their thorough and comprehensive work on this subject.

Geologic Mapping by the Arizona Geological Survey

The Arizona Geological Survey (AZGS) did an exemplary job in mapping surficial geology adjacent to the San Pedro River and Babocomari and Aravaipa Creeks (AZGS 2009). Their methods and results are well documented.

ADWR Extent of Floodplain Holocene Alluvium and Setbacks for "Side Recharge"

As directed by the adjudication court and consistent with Judge Ballinger's September 28, 2005 Subflow Order ("2005 Subflow Order"), ADWR defines the subflow zone as the lateral extent of the saturated floodplain Holocene alluvium. ADWR applied procedures outlined in the 2005 Subflow Order to delineate the subflow zone, categorizing the procedures as hydrologic, geologic, and hydrogeologic criteria. Also, ADWR followed the procedures described in Chapter 2 of ADWR's 2002 Subflow Report (ADWR 2002) to determine the lateral extent of the floodplain Holocene alluvium; and the saturated portion of the floodplain Holocene alluvium, to the extent that they were consistent with the 2005 Subflow Order.

While acknowledging that tributaries have recently deposited alluvium on top of the floodplain (**Figure 1**), ADWR excludes all surficial exposures of tributary Holocene alluvium from the floodplain Holocene alluvium boundary, based upon their interpretation of Judge Goodfarb's June 30, 1994 Subflow Order ("1994 Subflow Order"). ADWR asserts that subsurface mapping to delineate the extent to which tributary Holocene alluvium overlies floodplain Holocene alluvium would be impractical and beyond the scope of their report (ADWR 2009). While I agree that subsurface mapping is not practicable within the time frames of the adjudication proceedings, I believe some of the techniques discussed below can provide a reasonably simple means to delineate the subflow zone to more accurately correspond to the saturated floodplain Holocene alluvium. It is clear that ADWR's delineation excluding all surficial exposures of tributary Holocene alluvium from the subflow zone does not meet the criteria for correlation to the stable geologic unit as set forth in the 1994 and 2005 Subflow Orders. The word "stable" occurs numerous times in these orders, originating with Judge Goodfarb's 1994 Order, ...the floodplain Holocene alluvium "is the only stable geologic unit which is beneath and adjacent to most rivers and streams..." (Goodfarb 1994, p.56). The subflow zone as delineated by ADWR does not correspond to the stable geologic unit for two primary reasons: active channel migration will cause the river to leave the subflow zone and tributary deposits are transitional and easily eroded by active channel migration and high flows.

Based on ADWR's interpretation of geologic mapping conducted by the Arizona Geological Survey, ADWR drew the boundary for the floodplain Holocene alluvium along the San Pedro River (ADWR 2009). To map the subflow zone, ADWR adjusted the lateral extent of floodplain Holocene alluvium using 100- and 200-foot setbacks to account for "side recharge from saturated basin fill and tributary alluvium", in strict compliance with the 1994 Subflow Order.

ADWR drew the boundary of the floodplain Holocene alluvium and the subflow zone based on data available to them and based on strict compliance with their interpretation of directions from the adjudication court. However, examination of site specific data from properties owned/managed by The Nature Conservancy -- including geologic and soil

maps, groundwater levels, borehole geologic-driller's logs, soil map units, and extent of riparian vegetation -- supports delineation of a wider subflow zone that will more accurately correspond to the central, overarching mandates of the adjudication court. Based on these data and directions from the adjudication court (1994 Subflow Order; 2005 Subflow Order), I delineate the Haney2009 subflow zone on three properties owned by The Nature Conservancy. I assert that the Haney2009 subflow zone meets the intent of the court to designate the subflow zone as the aerial extent of the stable saturated floodplain Holocene alluvium and the location where groundwater flow direction and gradient is essentially in the same direction as the surface flow of the river. I present hydrologic, geologic, and hydrogeologic data from three properties owned/managed by the Conservancy and provide an interpretation of the subflow zone at these properties. I then apply that interpretation to basin-wide analysis of the subflow zone.

J. Haney Analysis of Subflow Zone

AZGS delineated five units comprising river alluvium of Holocene age and four units comprising piedmont (tributary) alluvium of Holocene age. In addition, AZGS identified three units of river alluvium of Pleistocene age and four units of river piedmont alluvium of Pleistocene age, as well as Tertiary-age basin-fill deposits.

The U.S. Natural Resource Conservation Service (NRCS) mapped soil units along the San Pedro River (SSURGO 2009). These deposits comprise various portions of the Holocene-age floodplain and also include alluvial fan and terrace deposits. NRCS specifies the depositional environment of each unit as inner channel, recent floodplain, floodplain, or alluvial fan. Units comprised of transient alluvial fan deposits and unstable terrace material may overlie floodplain deposits and may also extend uphill where they overlie non-floodplain materials. AZGS used published NRCS soil maps to assist in their interpretations of floodplain Holocene alluvium, especially in disturbed areas.

Geologic and soil mapping delineate the surficial extent of the floodplain Holocene alluvium. However, surficial extent does not account for the true lateral extent of the floodplain Holocene alluvium, because tributary alluvium may overlie deposits of floodplain Holocene alluvium, especially near the edge of the floodplain or where alluvium fans extend into the floodplain from tributaries. Thus, surficial extent does not account for the true lateral extent of the stable floodplain Holocene alluvium. Geologic logs and pumping tests provide information on the subsurface geology and hydrology, allowing delineation of the true lateral extent of the floodplain Holocene alluvium on a site-specific basis. The site-specific data available to the Conservancy on our properties on the lower San Pedro River can be used as a basis for refining a method to delineate a more accurate subflow zone basin-wide. Particular outcrop patterns (as mapped by AZGS), together with topographic and phreatophyte vegetation patterns, are good indicators of the edge of the Holocene-age alluvium and hence the subflow zone. Specific examples will be given below.

I analyzed data and information for three properties along the river in the lower San Pedro River subbasin: San Pedro River Preserve (SPRP), H&E Farm, and Three Links Farm **(Figure 2)**. These properties are owned and/or managed by The Nature Conservancy. In addition, I obtained data sets from ADWR, the Arizona Geological Survey (AZGS), and the Natural Resource Conservation Service (NRCS), and reviewed published literature. I spoke with professionals from the AZGS, NRCS, and ADWR and accessed records and publications and U.S. Geological Survey, AZGS, NRCS, and exhibits from Gila River adjudication.

Data and Findings at Conservancy Properties

San Pedro River Preserve: There are 31 water level monitor wells and 4 water production wells at the SPRP (**Figure 3**). Well depths range from 10 to 81 feet below land surface. Geologic logging was conducted at the time of drilling (Geosystems Analysis Inc 2000). Water levels have been measured regularly since 1998. Depth to water in monitor wells at the San Pedro River Preserve ranges from about 10 to 45 feet below land surface. The large number of water level monitor wells provides high resolution in developing groundwater level altitude contour maps. Observed groundwater level gradients indicate that groundwater underlying the entire extent of the floodplain Holocene alluvium is moving as subflow in approximately the same direction as the San Pedro River, and at about the same gradient as the riverbed throughout the year (**Figures 4 and 5**). Results from pumping tests conducted on wells W3 (55-517549), W4 (55-612036), and W5 (55-515185) indicate average aquifer transmissivity of 44,000 ft^2/day at these wells, indicating they are completed in coarse-grained saturated floodplain Holocene alluvium, which the adjudication court has defined as the stable geologic unit. Observation of outcrops at SPRP indicates that basin-fill deposits underlying the floodplain Holocene alluvium are clay-rich and thus are poorly transmissive, indicating the lower boundary of the floodplain Holocene alluvium.

Based on a search of ADWR 55 Well Registry imaged records, 27 wells in the vicinity of the SPRP have geologic (driller's) logs on file (**Table 1**). Fourteen of these wells clearly indicate a transition from coarse-grained sediments (sand and gravel, with or without clay stringers) to fine-grained sediments (clay). This lithologic transition is commonly accepted as the base of the floodplain Holocene alluvium. Ten of the 14 wells are located in surficial exposures of tributary Holocene alluvium. Examination of surficial relation of geologic units and of units encountered during drilling indicates coarse-grained floodplain Holocene alluvium underlies tributary Holocene alluvium at these locations. Thus, although surficial geology indicates these wells are located in tributary Holocene alluvium, drill logs indicate the wells are pumping from stable floodplain Holocene alluvium.

Based on examination of NRCS soil maps and discussions with NRCS soil scientist Bill Svetlik regarding the depositional environment for each soil unit of Holocene age, I conclude that there are five soil units of Holocene age in the vicinity of the SPRP. Together with surficial geologic mapping from the AZGS, these units delineate the extent of floodplain Holocene alluvium.

Based on hydrogeologic information, I conclude: 1) the thickness of the floodplain alluvium ranges from approximately 80 to 90 feet in the vicinity of the SPRP; 2) the floodplain Holocene alluvium extends beneath, and maintains a nearly constant thickness beneath, tributary Holocene alluvium, extending to the break in topographic slope, after which tributary Holocene alluvium overlies older, non-alluvial deposits; 3) groundwater leakage from the alluvial basin-fill deposits aquifer into the flood-plain alluvium aquifer is not significant; there is no indication of "side recharge" from tributary Holocene alluvium or from basin-fill deposits; and 4) the large value for transmissivity indicates that the wells are pumping from coarse-grained floodplain Holocene alluvium.

Using the cited data and references, I prepared **Figure 6**, which shows my interpretation of the subflow zone on the San Pedro River Preserve (Haney Subflow Zone). Geologic logs, AZGS geologic mapping units, NRCS soil units, topography, and hydrogeologic data obtained during investigations and regular monitoring at the San Pedro River Preserve are the chief criteria on which I delineated the Haney Subflow Zone. Figure 6 also shows the ADWR Subflow Zone, which includes setbacks for "side recharge" and which does not include areas overlain by deposits of tributary Holocene alluvium.

H&E Farm: There are 13 water level monitor wells at H&E Farm (**Figure 7**). Well depths range from 75 to 150 feet below land surface. Water levels have been measured monthly since 2001. Depth to water in monitor wells at H&E Farm ranges from 7 to 45 feet below land surface. Observation of outcrops at H&E Farm indicates that basin-fill deposits underlying the floodplain Holocene alluvium are clay-rich and thus are poorly transmissive, indicating the lower boundary of the floodplain Holocene alluvium.

Based on a search of ADWR 55 Well Registry imaged records, 11 wells in the vicinity of the H&E Farm have geologic (driller's) logs on file (**Table 2**). Four of these wells clearly indicate a transition from coarse-grained sediments (sand and gravel, with or without clay stringers) to fine-grained sediments (clay). This lithologic transition is commonly accepted as the base of the floodplain alluvium. Two of the four wells are located in surficial exposures of tributary Holocene alluvium. Examination of surficial relation of geologic units and of units encountered during drilling indicates coarse-grained floodplain Holocene alluvium underlies tributary Holocene alluvium at these locations. Thus, although surficial geology indicates these wells are located in tributary Holocene alluvium, drill logs indicate the wells are pumping from stable floodplain Holocene alluvium.

Based on hydrogeologic information, I conclude: 1) the thickness of the floodplain Holocene alluvium ranges from approximately 80 to 90 feet in the vicinity of the H&E Farm and 2) the floodplain Holocene alluvium extends beneath, and maintains a nearly consistent thickness beneath, tributary Holocene alluvium, extending to the break in topographic slope, after which tributary Holocene alluvium overlies older, non-alluvial deposits.

Using the cited data and references, I prepared **Figure 8**, which shows my interpretation of the subflow zone at H&E Farm (Haney Subflow Zone). Geologic logs, AZGS geologic mapping units, NRCS soil units, topography, and hydrogeologic data obtained during investigations and regular monitoring at the H&E Farm are the chief criteria on which I delineated the Haney Subflow Zone. Figure 8 also shows the ADWR Subflow Zone, which includes setbacks for "side recharge" and which does not include areas overlain by deposits of tributary Holocene alluvium.

Three Links Farm: There are 19 water level monitor wells at Three Links Farm (**Figure 9**); depths range from 62 to 135 feet. Water levels have been measured regularly since 2003. Depth to water in monitor wells at Three Links Farm ranges from 11 to 52 feet below land surface. Results from pumping tests conducted on Well 6 indicate that the average aquifer transmissivity is 40,000 ft^2/day. Observation of outcrops at SPRP indicates that basin-fill deposits underlying the Holocene alluvium are clay-rich and thus are poorly transmissive.

Based on a search of ADWR 55 Well Registry imaged records, 13 wells in the vicinity of this site have geologic (driller's) logs on file (**Table 3**). Six of these wells clearly indicate a transition from coarse-grained sediments (sand and gravel, with or without clay stringers) to fine-grained sediments (clay). This lithologic transition is commonly accepted as the base of the floodplain alluvium. Three of the six wells are located in surficial exposures of tributary Holocene alluvium. Examination of surficial relation of geologic units and of units encountered during drilling indicates coarse-grained floodplain Holocene alluvium underlies tributary Holocene alluvium at these locations. Thus, although surficial geology indicates these wells are located in tributary Holocene alluvium, drill logs indicate the wells are pumping from stable floodplain Holocene alluvium.

I have examined the soil units on the NRCS draft map and spoken with the NRCS soil scientist regarding soil units of Holocene age. Based on this information, I conclude that there are 13 soil units of Holocene age in the area of the Three Links Farm. Together with surficial geologic mapping from the AZGS, these units provide an indication of the extent of floodplain Holocene alluvium.

Based on hydrogeologic information, I conclude: 1) the thickness of the floodplain Holocene alluvium ranges from approximately 50 to 100 feet in the vicinity of the Three Links Farm; 2) the floodplain Holocene alluvium extends beneath, and maintains a nearly consistent thickness beneath, tributary Holocene alluvium, extending to the break in topographic slope, after which tributary Holocene alluvium overlies older, non-alluvial deposits; and 3) the large value for transmissivity indicates that the wells are pumping from coarse-grained, poorly indurated floodplain alluvium.

Using the cited data and references, I prepared **Figure 10**, which shows my interpretation of the subflow zone on Three Links Farm (Haney Subflow Zone). Geologic logs, AZGS geologic mapping units, NRCS soil units, topography, and

hydrogeologic data obtained during investigations and regular monitoring at the San Pedro River Preserve are the chief criteria on which I delineated the Haney Subflow Zone. Figure 10 also shows the ADWR Subflow Zone, which includes setbacks for "side recharge" and which does not include areas overlain by deposits of tributary Holocene alluvium.

Summary of Findings from Site Specific Analysis

The three Conservancy properties examined herein, distributed along 80 miles of the river, reflect consistent physical relationships in the floodplain Holocene alluvium. Data from geologic and drillers logs from wells on and near the three Conservancy properties described in this report indicates that the floodplain Holocene alluvium is on the order of 100 feet thick and extends beneath the thin veneer of surficial tributary alluvium to near the break in slope at the edge of the historic floodplain. Groundwater level altitude contour maps for the San Pedro River Preserve (based on a high density grid of water level monitor wells) show that direction of groundwater movement is parallel to and at nearly the same gradient as the river. Results from pumping tests indicate that highly transmissive materials underlie the properties.

These data indicate that "side recharge", if occurring at all, is so reduced as to have no significant effect on the flow direction of groundwater in the floodplain alluvium. At the three locations examined, flow direction, water level elevations, and hydraulic gradients in the Subflow Zone I have delineated are substantially the same as flow directions, water level elevations, and gradient in the river. It is expected that these conditions would be representative for many locations along the river in the San Pedro basin.

Regional Observations

ADWR used surficial exposures of floodplain Holocene alluvium, with setbacks applied, to draw the subflow zone. However, by not including subsurface extent of the floodplain Holocene alluvium, ADWR has delineated a subflow zone that does not meet the criteria and central intent set forth by the adjudication court for delineating a subflow zone that corresponds to the floodplain Holocene alluvium as the stable geologic unit. The combination of considering only surface exposures of floodplain Holocene alluvium, together with application of setbacks, results in numerous locations where there are gaps in the subflow zone along the river, or where the present river channel lies outside the ADWR delineated subflow zone. **Figures 11 and 12** show such examples in the vicinity of the San Pedro River Preserve and the Three Links Farm. These anomalies demonstrate that additional analysis of geologic and hydrologic features of the San Pedro River Basin is needed to delineate the full extent of the subflow zone.

In Appendix D-4 of the subflow report (ADWR 2009), ADWR recognized the challenges that are inherent with their current subflow zone, and suggests a method for "smoothing" the outer edge of the subflow zone while still aligning with the court's

direction that the floodplain Holocene alluvium comprises the subflow zone. Thus, ADWR is aware that adjustments are needed. ADWR suggests using a perimeter to length ratio for units of tributary alluvium, and including those units in the subflow zone if the P:L ratio is larger than 2.5. Although this approach more closely mirrors the physical system, it does not account for the geologic pattern seen in the physical system. The outcrop pattern of pre-Holocene (Pleistocene and older basin-fill) units provides clear guidance for the edge of the subsurface floodplain Holocene alluvium. The outcrop pattern of these units, together with the topographic break, are strong indicators of the edge of the floodplain Holocene alluvium, the stable geologic unit. This approach is illustrated in **Figure 13**, where the Haney subflow zone is drawn inward from the outcrops of basin-fill materials. Revision of ADWR's Subflow Zone would be more accurate based on the geology and hydrology of the system, rather than on an arbitrary ratio.

The Nature Conservancy suggests that the adjudication court direct ADWR to revise its subflow zone delineation. I recommend that ADWR use much of the data and conclusions from the 2009 subflow report, but utilize additional physical features for revising the irregular boundaries produced by the strict adherence to surficial outcrops as subflow zone boundary indicators. The basis for revision of ADWR's delineation could consist of interpretation of outcrop patterns as shown on AZGS geologic maps and would not require analysis of drill logs or new drilling to examine subsurface materials. In addition to subsurface interpretation of geologic outcrop pattern as mapped by AZGS, evidence that could be integratively examined to delineate a smoother subflow zone boundary that corresponds to the stable geologic unit include soil units as mapped by Natural Resource Conservation Service; pattern of phreatophytes–type and density; surface topography; readily available site-specific data; and nature and spatial pattern of connecting tributary aquifers versus basin-fill deposits.

Examination and subsurface interpretation of geologic maps provided by the AZGS along with patterns of phreatophyte vegetation and topography provide a sound physical basis for delineating the lateral extent of floodplain Holocene alluvium beneath deposits of tributary alluvium. The appropriateness of such delineation can be supported by examining site-specific data such as those available on The Nature Conservancy's properties in the lower San Pedro River basin.

References

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Arizona Department of Water Resources, 2005. Subflow Technical Report, San Pedro River Watershed, Arizona Department of Water Resources.

Arizona Geological Survey, 2009. Mapping of Holocene River Alluvium along the San Pedro River, Aravaipa Creek, and Babocomari River, Southeastern Arizona, J.P. Cook, A. Youberg, P.A. Pearthree, J.A. Onken, B.J. MacFarlane, D.E. Haddad, E.R. Bigio and A.L. Kowler. Digital Map DM-RM-1E

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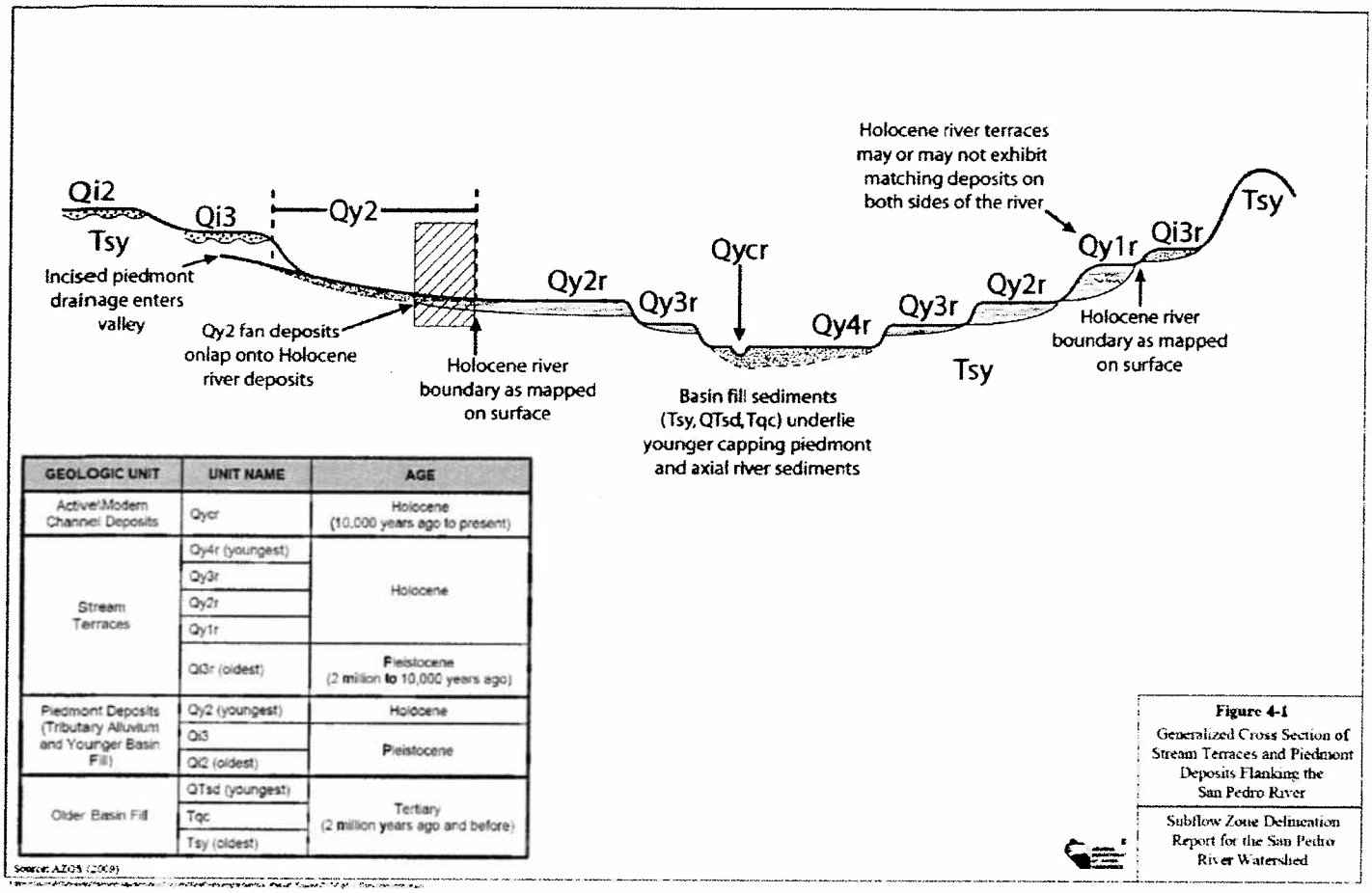
Judge Ballinger Order dated September 28, 2005, Case Nos W-1, W-2, W-3, W-4 (Consolidated) Contested Case No. W1-103, In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, Superior Court of Arizona, Maricopa County. Order Re: Report of the Special Master on the ADWR's Subflow Technical Report, San Pedro River Watershed and Motion for Approval of Report.



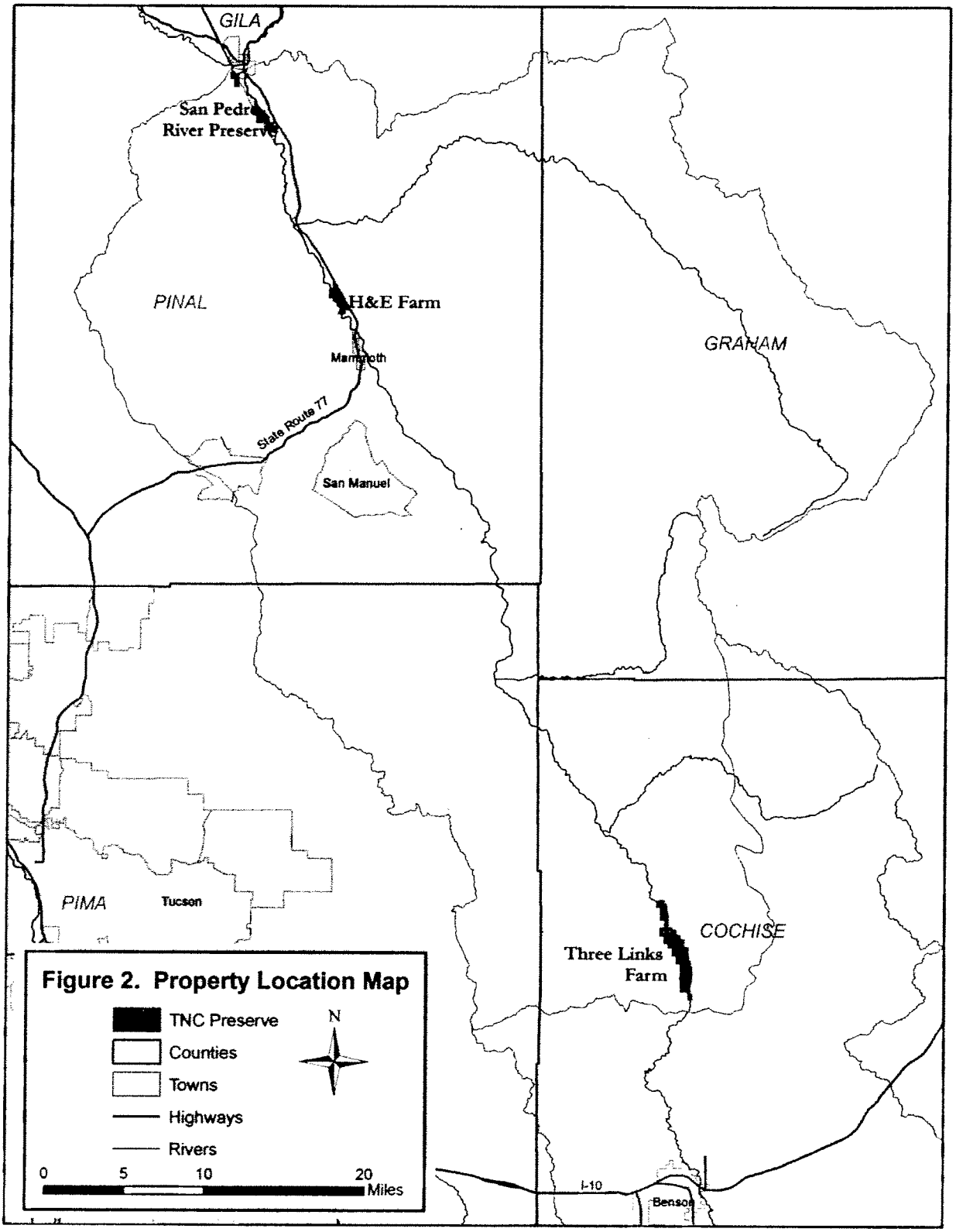
GEOLOGIC UNIT	UNIT NAME	AGE
Active\Modern Channel Deposits	Qycr	Holocene (10,000 years ago to present)
Stream Terraces	Qy4r (youngest)	Holocene
	Qy3r	
	Qy2r	
	Qy1r	
	Qi3r (oldest)	Pleistocene (2 million to 10,000 years ago)
Piedmont Deposits (Tributary Alluvium and Younger Basin Fill)	Qy2 (youngest)	Holocene
	Qi3	Pleistocene
	Qi2 (oldest)	
Older Basin Fill	QTsd (youngest)	Tertiary (2 million years ago and before)
	Tqc	
	Tsy (oldest)	

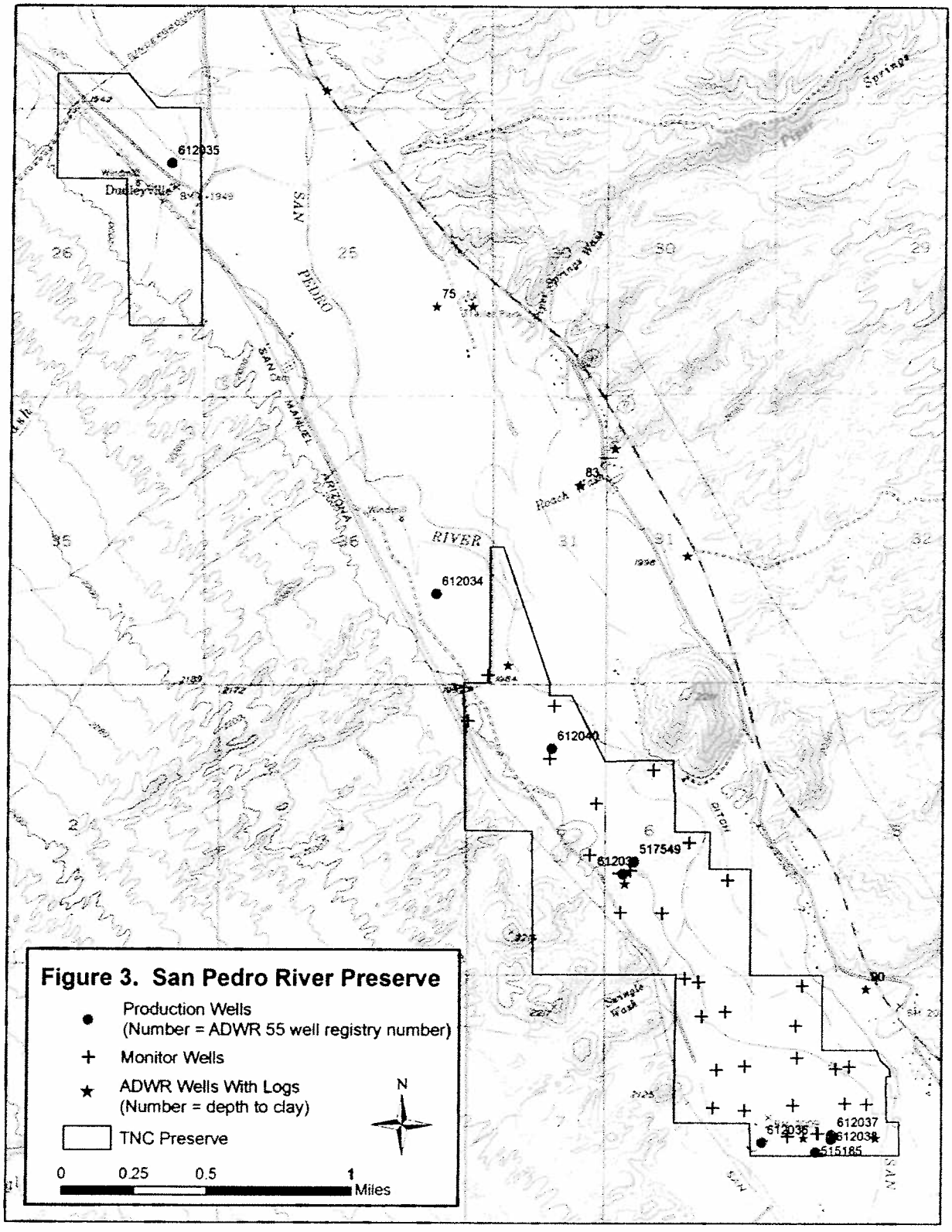
Source: AZGS (2009)

Figure 4-1
Generalized Cross Section of Stream Terraces and Piedmont Deposits Flanking the San Pedro River

Subflow Zone Delineation Report for the San Pedro River Watershed

Figure 1. From ADWR 2009 subflow report. Red crosshatched box is added and shows zone where tributary alluvium occurs as a thin layer over floodplain Holocene alluvium.


GILA
San Pedro
River Preserve
PINAL
H&E Farm
Mammoth
State Route 77
San Manuel
GRAHAM
PIMA
Tucson
COCHISE
Three Links
Farm
I-10
Benson
Figure 2. Property Location Map
TNC Preserve
Counties
Towns
Highways
Rivers
N
0
5
10
20
Miles


612035
612034
612040
517549
612037
612038
515185
75
83
90
SAN PEDRO
RIVER
Figure 3. San Pedro River Preserve
Production Wells
(Number = ADWR 55 well registry number)
Monitor Wells
ADWR Wells With Logs
(Number = depth to clay)
TNC Preserve
N
0
0.25
0.5
1
Miles

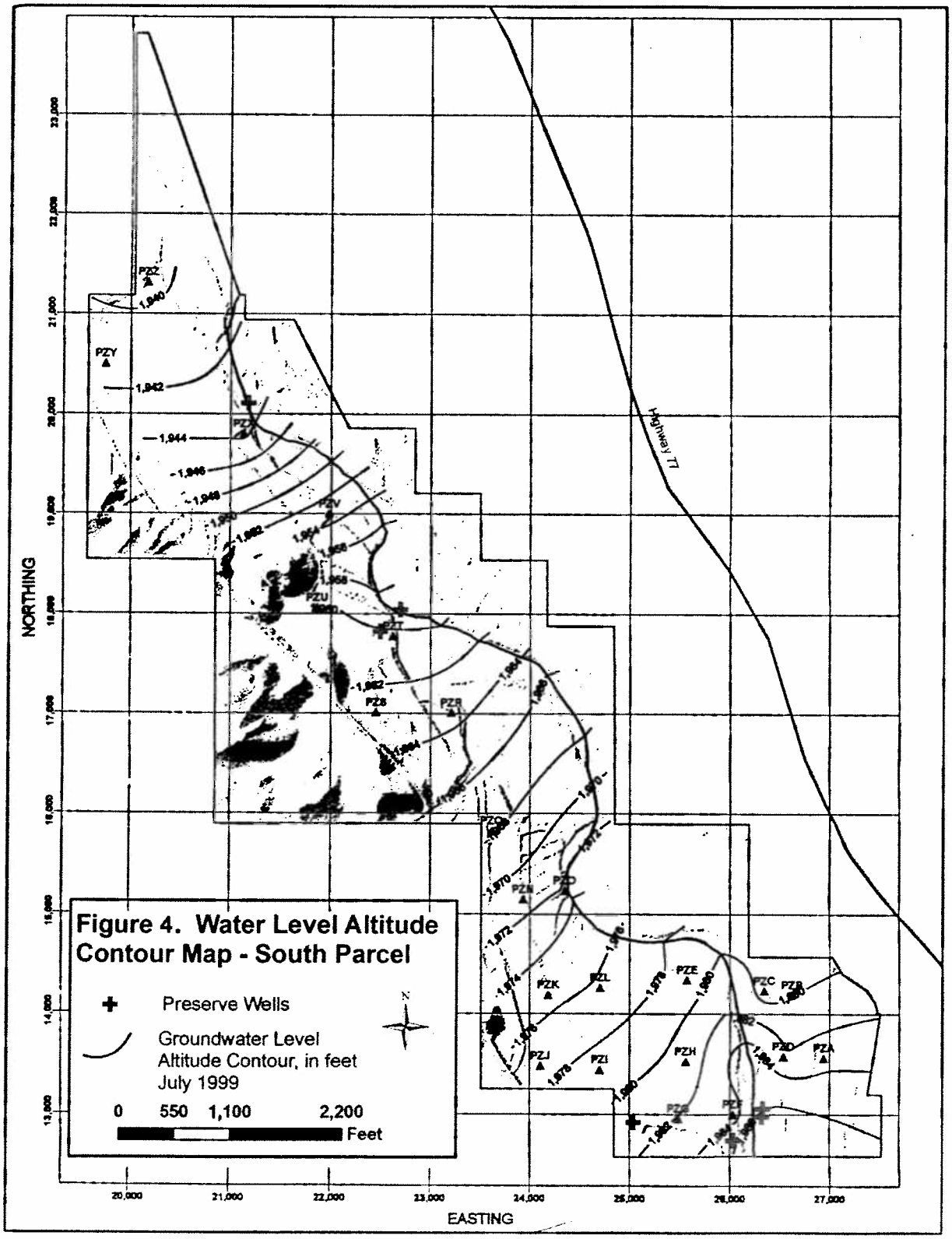


Figure 4. Water Level Altitude Contour Map - South Parcel
Preserve Wells
Groundwater Level Altitude Contour, in feet July 1999
0 550 1,100 2,200
Feet
N
NORTHING
EASTING
Highway 77
PZZ
PZY
PZX
PZV
PZU
PZS
PZR
PZN
PZD
PZK
PZL
PZE
PZC
PZB
PZJ
PZI
PZH
PZG
PZA
1,940
1,942
1,944
1,946
1,948
1,950
1,952
1,954
1,956
1,958
1,960
1,962
1,964
1,966
1,968
1,970
1,972
1,974
1,976
1,978
1,980
20,000
21,000
22,000
23,000
24,000
25,000
26,000
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22,000
23,000

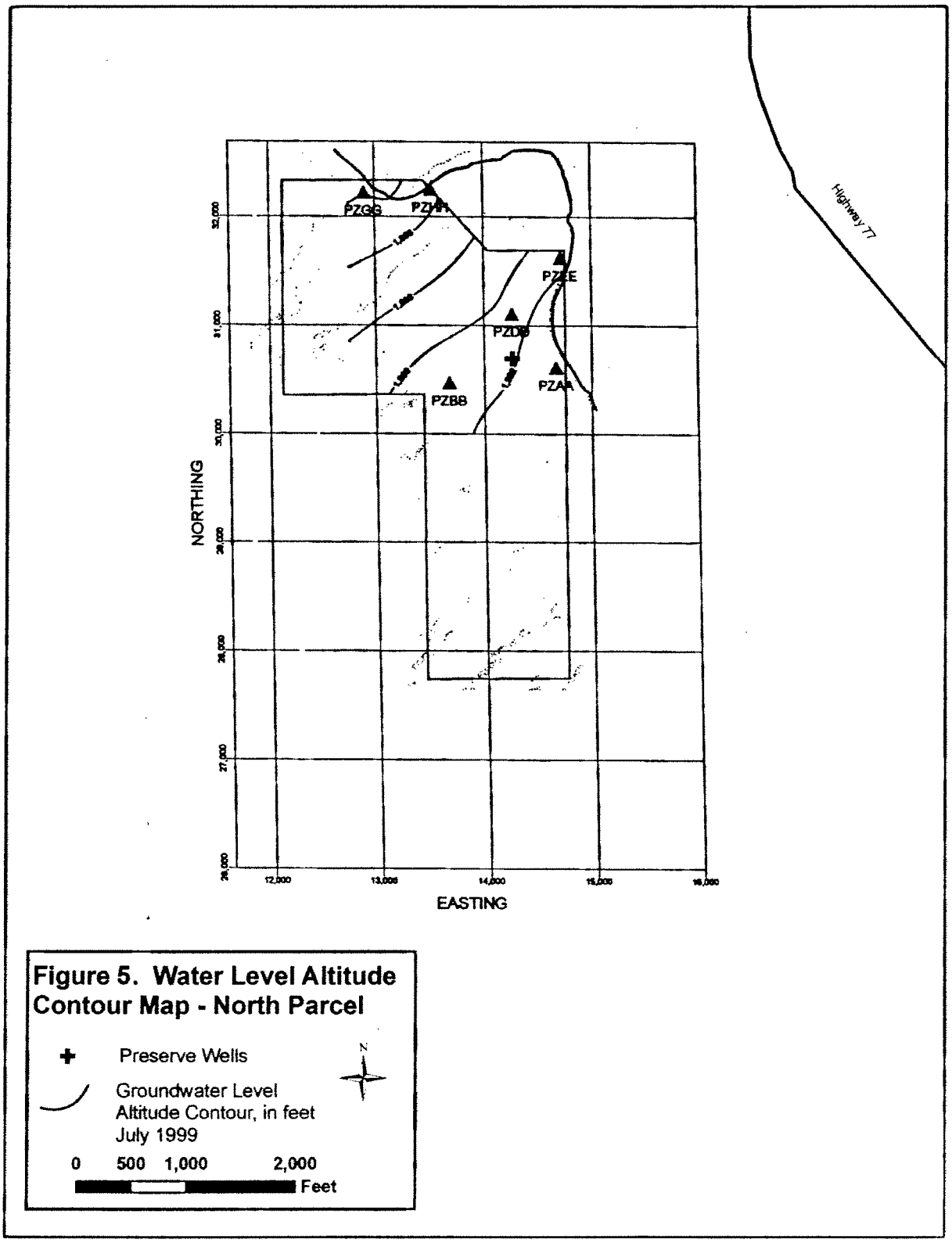


Figure 5. Water Level Altitude Contour Map - North Parcel

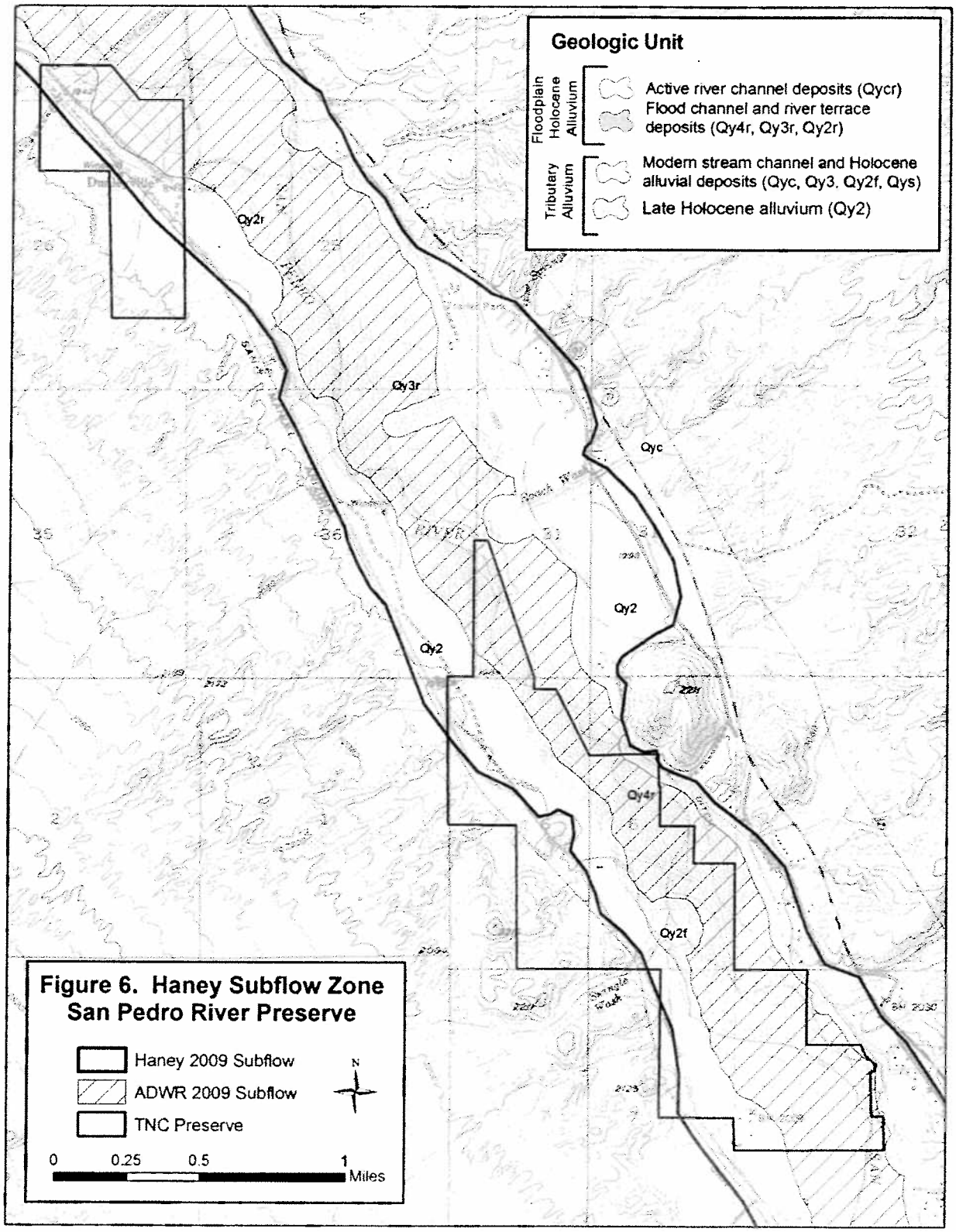


Figure 6. Haney Subflow Zone San Pedro River Preserve

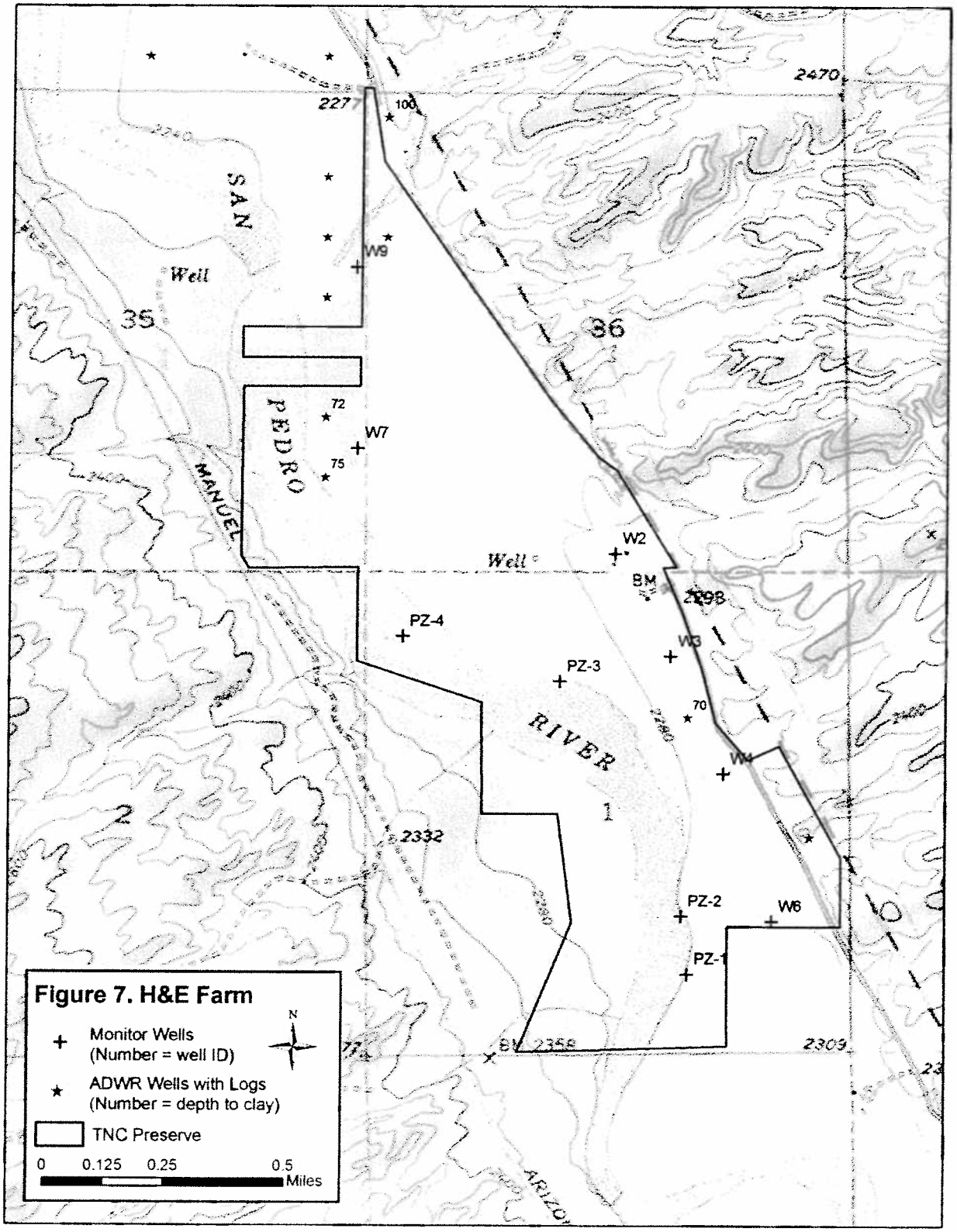
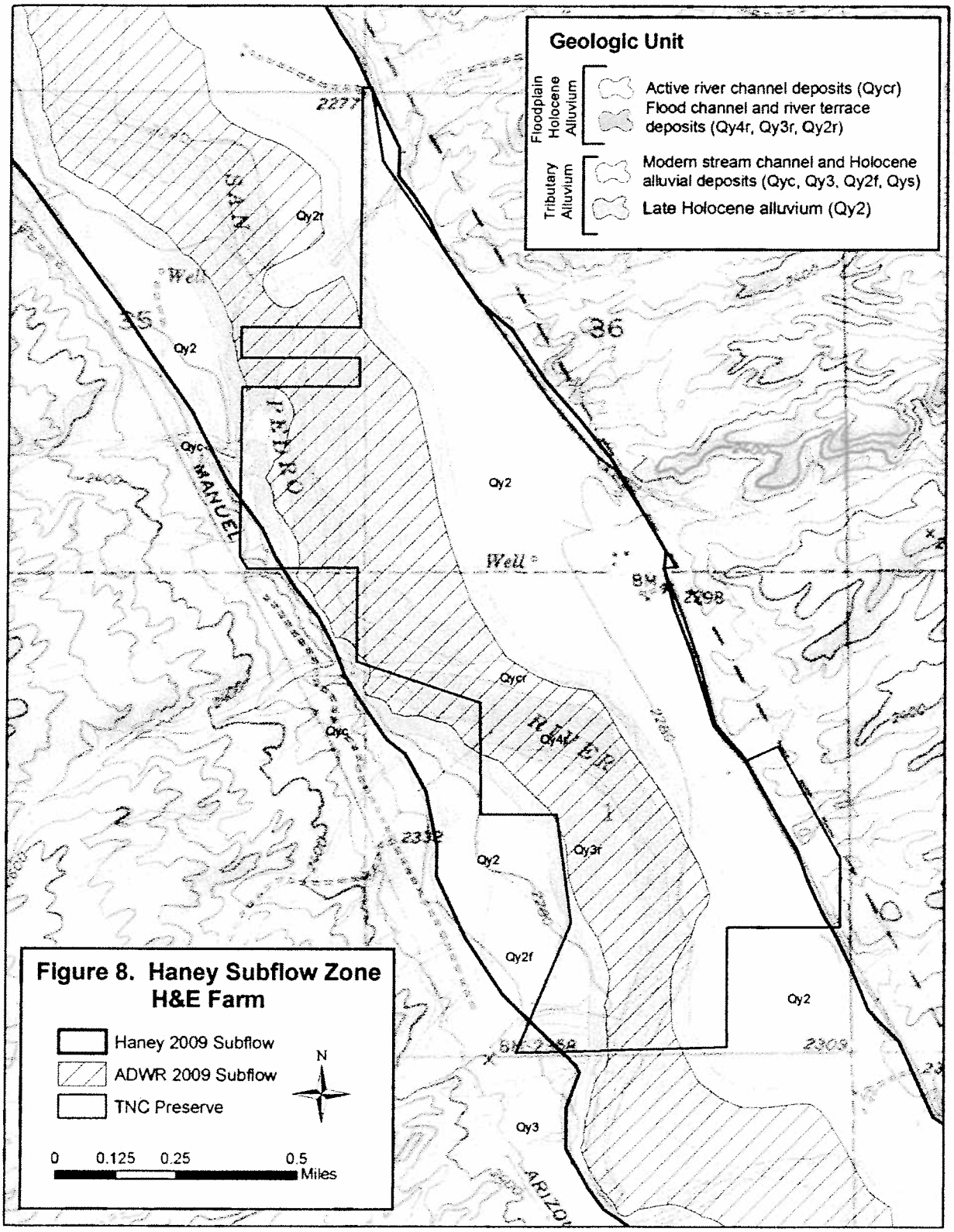
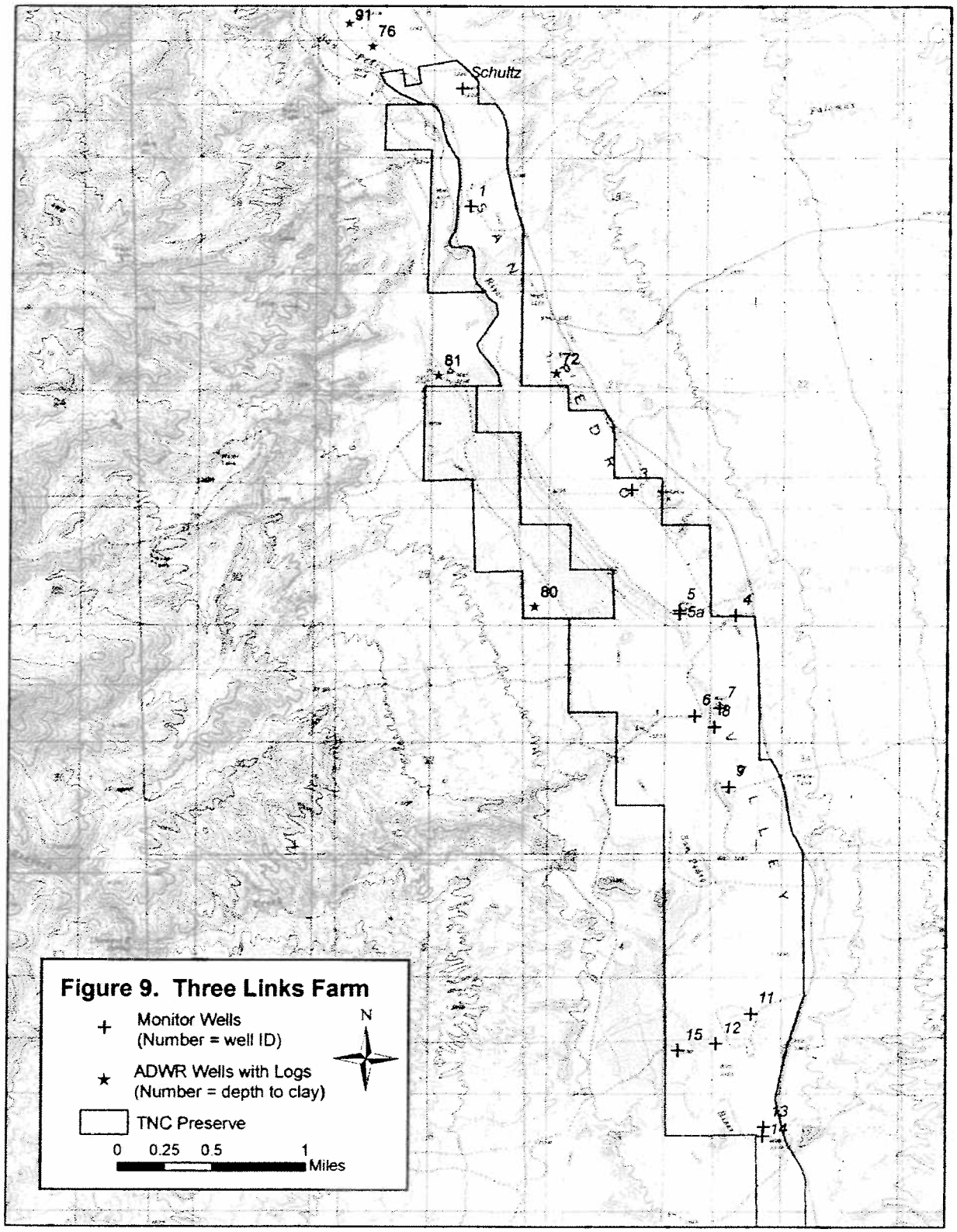
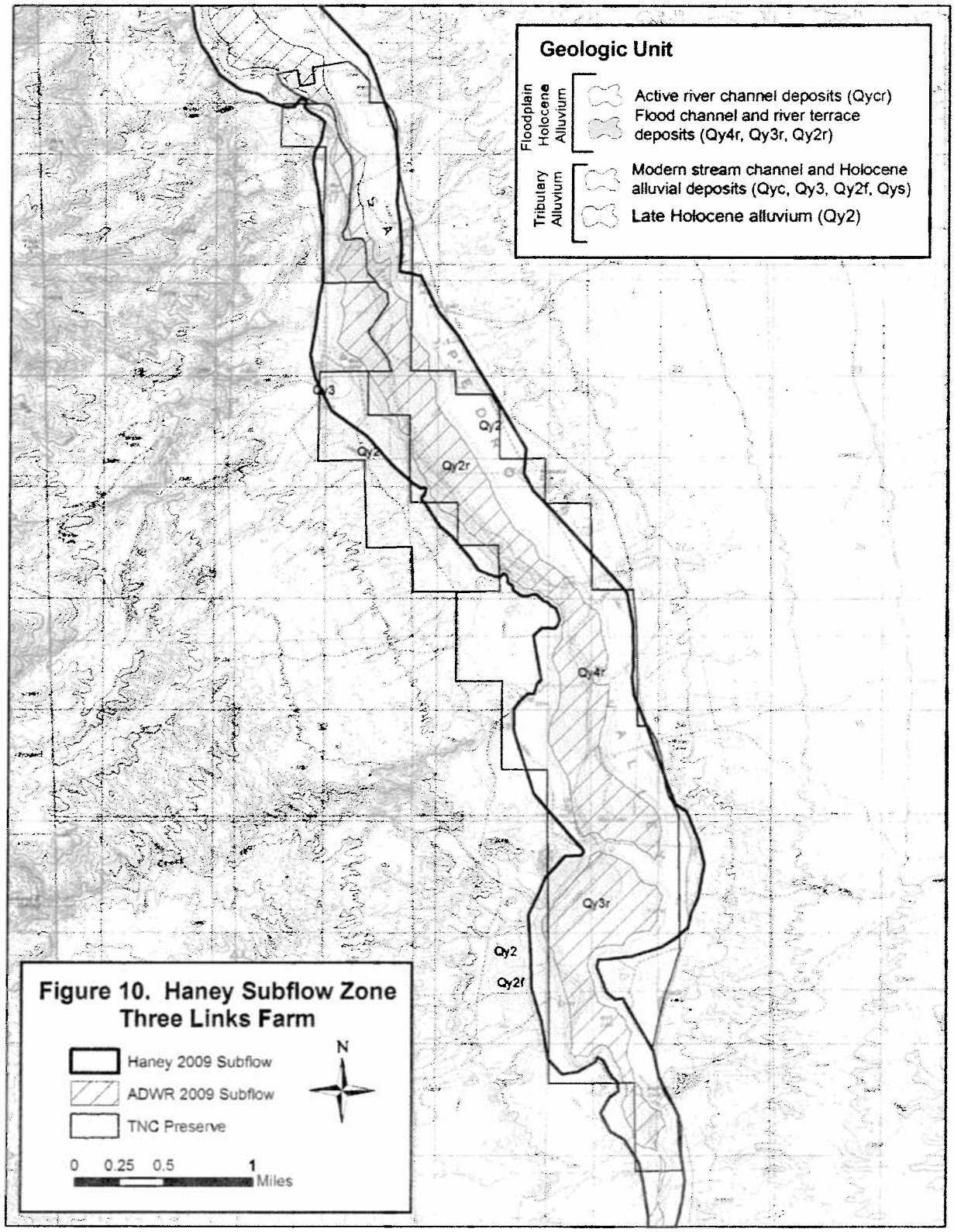
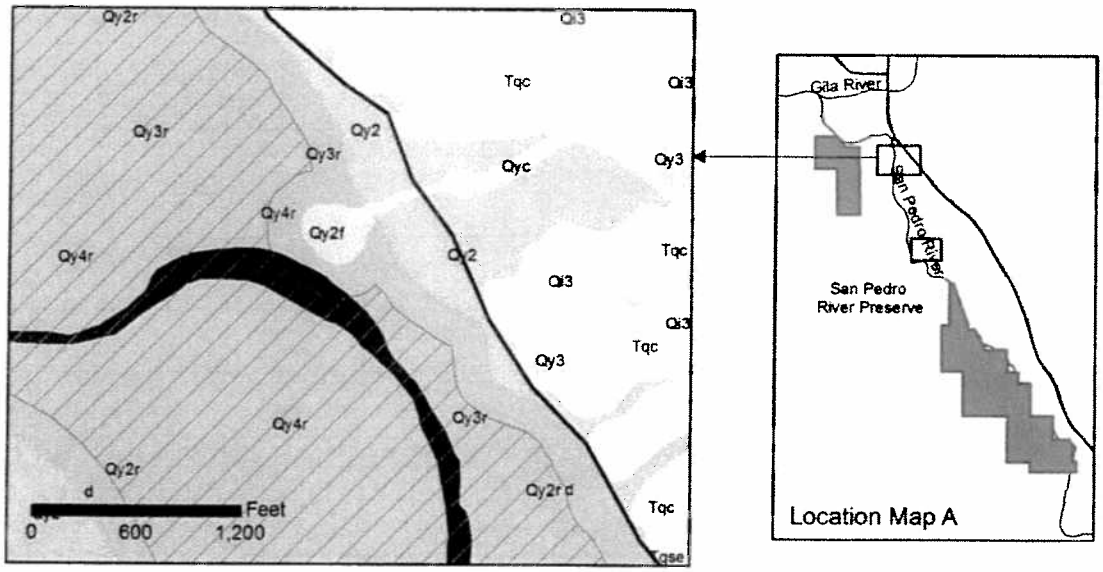


Figure 7. H&E Farm
Monitor Wells
(Number = well ID)
ADWR Wells with Logs
(Number = depth to clay)
TNC Preserve
0 0.125 0.25 0.5
Miles
N
SAN PEDRO RIVER
MANUEL
Well
W9
W7
W2
W3
W4
W6
PZ-4
PZ-3
PZ-2
PZ-1
227
100
72
75
70
2470
2332
2358
2303
35
36
1

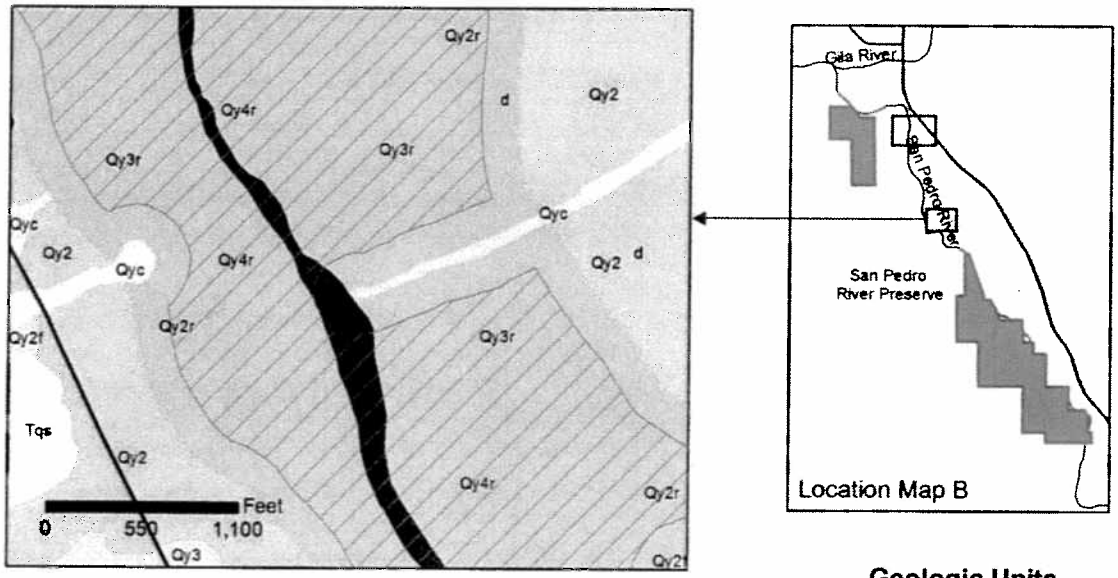

Geologic Unit
Floodplain Holocene Alluvium
Active river channel deposits (Qycr)
Flood channel and river terrace deposits (Qy4r, Qy3r, Qy2r)
Tributary Alluvium
Modern stream channel and Holocene alluvial deposits (Qyc, Qy3, Qy2f, Qys)
Late Holocene alluvium (Qy2)
Qy2
Qy2r
Qyc
Qycr
Qy4r
Qy3r
Qy2f
Qy3
Well
Figure 8. Haney Subflow Zone
H&E Farm
Haney 2009 Subflow
ADWR 2009 Subflow
TNC Preserve
N
0 0.125 0.25 0.5 Miles


91
76
Schultz
1
2
81
72
3
80
5
5a
4
6
7
8
9
11
15
12
13
14
Figure 9. Three Links Farm
Monitor Wells
(Number = well ID)
ADWR Wells with Logs
(Number = depth to clay)
TNC Preserve
N
0 0.25 0.5 1
Miles


Geologic Unit
Floodplain Holocene Alluvium
Active river channel deposits (Qycr)
Flood channel and river terrace deposits (Qy4r, Qy3r, Qy2r)
Tributary Alluvium
Modern stream channel and Holocene alluvial deposits (Qyc, Qy3, Qy2f, Qys)
Late Holocene alluvium (Qy2)
Qy3
Qy2
Qy2r
Qy4r
Qy3r
Qy2
Qy2f
Figure 10. Haney Subflow Zone
Three Links Farm
Haney 2009 Subflow
ADWR 2009 Subflow
TNC Preserve
N
0 0.25 0.5 1
Miles



A. ADWR subflow zone excludes tributary alluvial fan (Qy2f). Portion of active channel outside subflow zone. Migration of active channel to northeast, as fan debirs is removed, will place more of the river outside ADWR subflow zone.



B. ADWR subflow zone excludes the full width of the active channel, because a small finger of tributary alluvium (Qyc) overlies the floodplain Holocene alluvium.

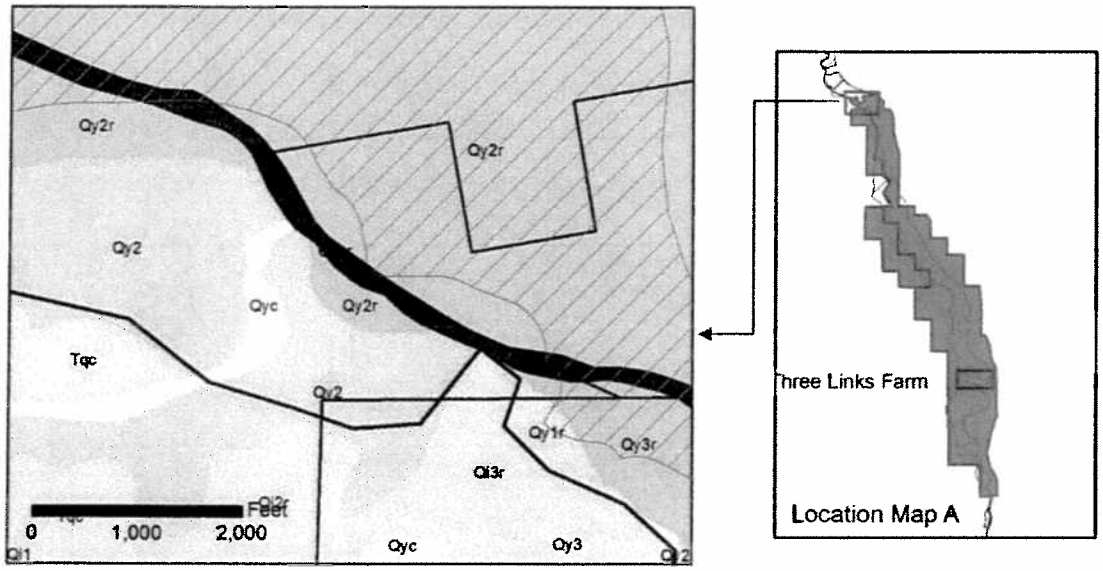
Figure 11. Examples: ADWR Subflow Zone Excludes Active Channel

ADWR 2009 Subflow Haney 2009 Subflow

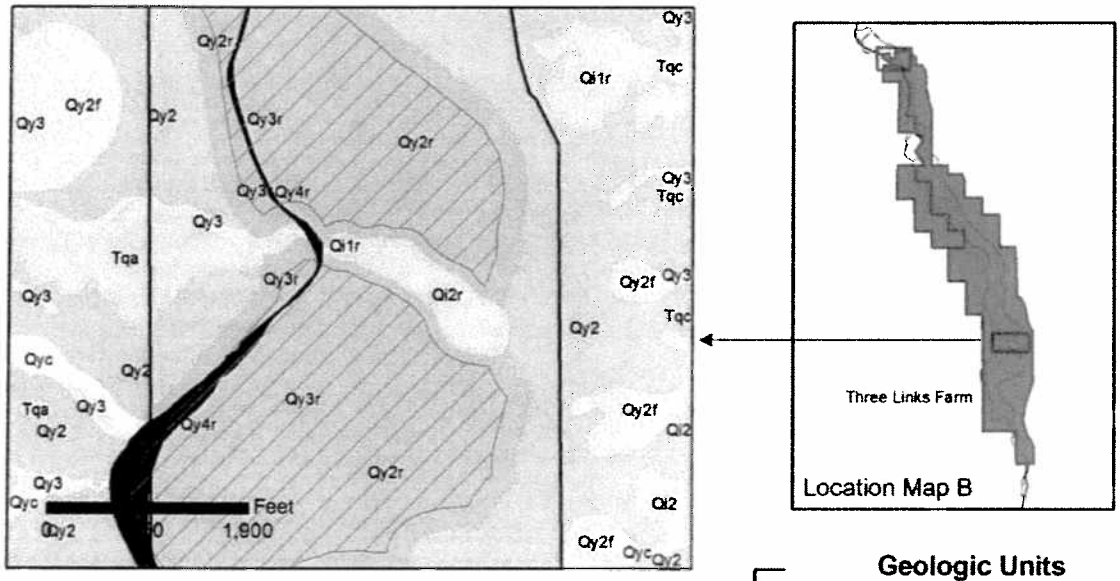
Geologic Units

Floodplain Holocene Alluvium
- Active river channel deposits (Qycr)
- Flood channel and river terrace deposits (Qy4r, Qy3r, Qy2r)

Tributary Alluvium
- Modern stream channel deposits (Qyc)
- Holocene alluvial deposits (Qy3, Qy2f, Qys)
- Late Holocene alluvium (Qy2)



A. ADWR subflow zone excludes portions of the river and active channel, due to setback from edge of surficial exposure of floodplain Holocene alluvium.



B. ADWR subflow zone excludes the river and active channel.

Figure 12. Examples: ADWR Subflow Zone Excludes Active Channel

ADWR 2009 Subflow

Haney 2009 Subflow

Geologic Units

Floodplain Holocene Alluvium

- Active river channel deposits (Qycr)
- Flood channel and river terrace deposits (Qy4r, Qy3r, Qy2r)

Tributary Alluvium

- Modern stream channel deposits (Qyc)
- Holocene alluvial deposits (Qy3, Qy2f, Qys)
- Late Holocene alluvium (Qy2)
- Basin-fill deposits, undifferentiated

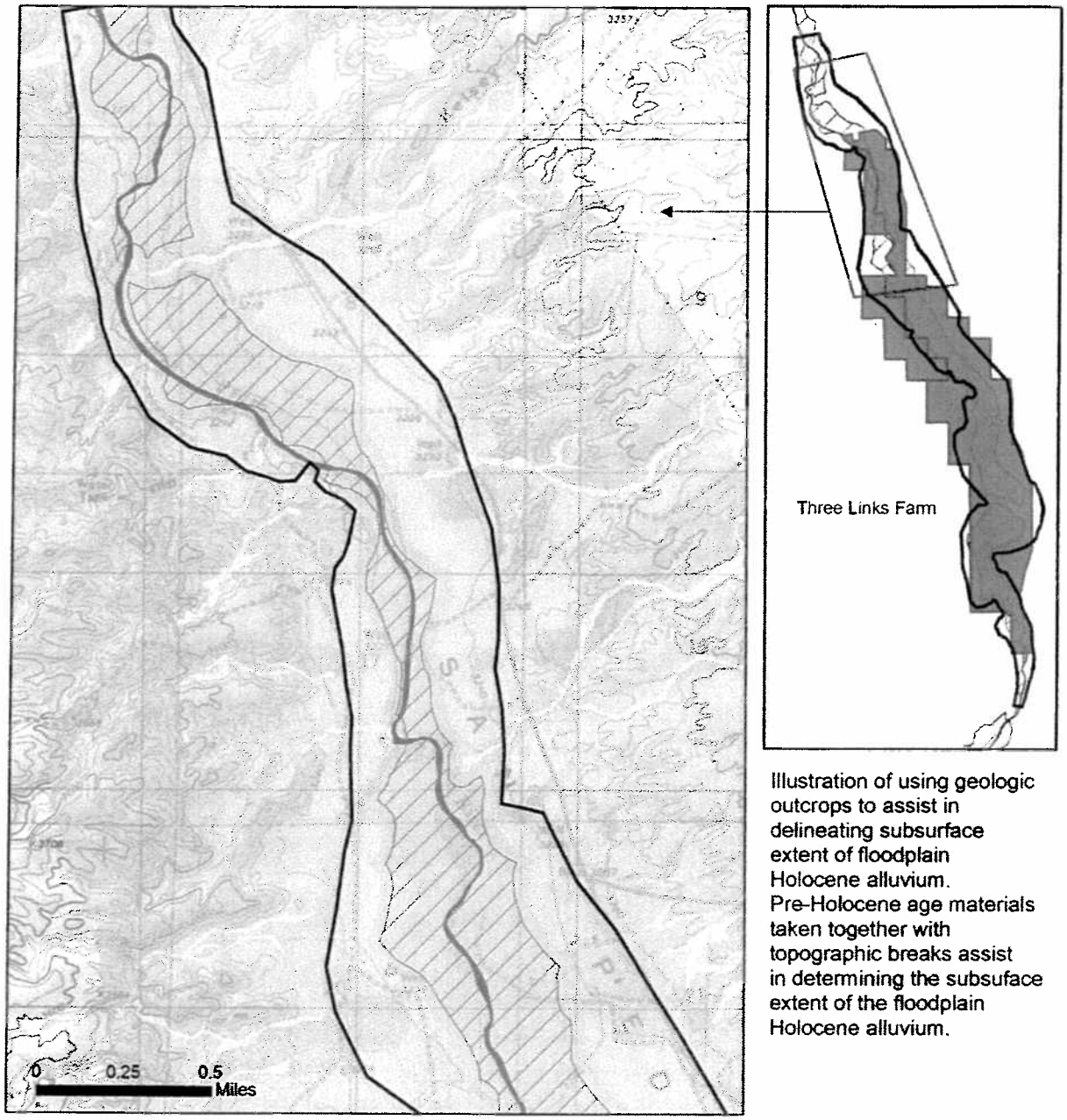


Illustration of using geologic outcrops to assist in delineating subsurface extent of floodplain Holocene alluvium. Pre-Holocene age materials taken together with topographic breaks assist in determining the subsuface extent of the floodplain Holocene alluvium.

Figure 13. Using Geologic Outcrop Pattern to Map Subsurface Extent of Floodplain Holocene Alluvium

Table 1: Well Logs in the Vicinity of San Pedro River Preserve

Reg No	From	To	Description	Collared in
504927	0	18	Sand & gravel	Qy2r
	18	22	Hard rock layer	
	22	25	Sand & gravel-water	
	28	28	Clay	
	28	48	Sand & gravel	
	48	54	Quick sand & water	
	54	65	Hard white rock	
540663	0	18	Gravel	Qy2r
	18	137	Conglomerate consolidated	
	137	147	Unconsolidated gravel-water	
506187	0	240	Sand-clay-gravel	Tqc-Qy2
506463	0	15	Overburden	Qy2r
	15	75	Sand & gravel	
	75	80	**Clay**	
586161	0	45	Loose sand	
	45	60	Gray & white rock 1/4-1"	Qy2
535727	0	54	sand and gravel water	Tqse/Qy2
	54	64	sand and gravel	
	64	178	sand and gravel	
644307	0	2	Topsoil	Qy2
	2	23	Caliche, cemented	
	23	80	Clay	
	80	83	Sand gravel water	
	83	100	**Clay**	
518322	67	68	first water - sand and gravel	Qy2
	123		water - sand and gravel	
569983	0	3	Brn silt & clay	Qy4r
	3	6	Brn silty clayey sand & gravel	
	6	9	Brn sand	
	9	12	Brn sand & gravel w/cobbles	
	12	15	Brn gravelly sand	
	15	20	Brn silty clayey sand & gravel	
			TD-20 ft.	
			Water-10 ft	
517549	0	10	Hard clay	Qy4r/Qy2
	10	80	Gravel and small boulders	

First water-10 feet

588864	0	6	Topsoil (Potato dirt)	Qy2
	6	47	Sand comglomerate some clay	
	47	90	Gravel,rounded, lot of sand	
	90	100	**Clay**	
542796	0	5	Sand and boulders	Qy2/Tqm
	5	20	Boulders and clay	
	20	400	Clay and gravels	
570118	0	81	Sand gravel cobbles	Qy2r
515185	0	10	Clay or caliche	
	10	60	Sand and gravel	
	60	67	Conglomerate, 2/3 rock, 1/3 clay	
502627	0	15	Top soil	Qy2
	15	20	Sand & gravel	
	20	75	Clay	
	75	90	Gravel & sand, small water	
	90	135	Clay	
	135	165	Sand, gravel, large rock, water	
	165	180	Clay	
			Water strata 135 to 165 ft	
528815	60	70	Sand and gravel	Qy2
	70	100	**Clay**	
534764	0	8	Brown gravel	Qy2
	8	38	Brown gravel & clay	
	38	57	Firm hard packed gravel, water	
	57	80	Brown sand clay and gravel	
	80	89	Boulders and gravel	
	89	91	**Red Clay**	
502289	0	15	Silt	Qy4r
	15	35	Sand gravel & clay	
	35	55	Silt	
	55	65	Gravel	
	65	86	Sandy clay	
	86	---	**Red clay**	
508378	0	35	Soil and gravel	Qy2
	35	100	**Clay streaked sand**	
530492	0	4	Top soil	Qy2
	4	10	clay	
	10	15	clay, sand and rock mix	
	15	20	clay	

	20	23	sandy loam, ponding water	
	23	30	clay	
	30	36	clay sandy	
	36	38	sand stringer, first water	
	38	45	clay	
	45	47	very hard red caliche, 2nd water	
	47	52	caliche? mixed w/clay	
	52	62	river sand coarse	
	62	72	large gravel	
	72	77	large boulders	
	77	80	**dark red clay**	
508496	0	20	Soil	Tqm
	20	50	Clay and boulders	
	50	73	Gravel	
	73	102	**Clay**	
534899	0	43	Brown sandy clay	Qy2/Qy2f
	43	55	Brown clay and gravel	
	55	74	Brown sandy gravel	
	74	80	**Brown clay**	
521131	65	100	Sand & gravel,streaks of clay	Qy2/Qy2f
541858	0	20	Sandy clay	
	20	50	Clay gravel; water at 45 feet	
	50	60	Gravel	
	60	140	**Clay**	
552142	0	27	Silt, clay, and gravel	Qy2
	27	45	Gravel and clay	
	45	70	Gravel and sand	
	70	80	**(Red) Sandy clay**	
542060	0	50	Clay	Qy2
	50	63	Gravel, sand, and water	
	63	100	**Clay**	
565875	0	20	Brown clay	Qy2
	20	40	Sand	
	40	62	Sand, gravel, & cobbles	
	62	85	**Brown clay**	

Table 2: Well Logs in the Vicinity of the H&E Farm

Reg No	From	To	Description		Collared in
527192	0	20	8" PVC cemented in place		Qy2
	20	140	sandy clay		
	140	160	sandy clay with streaks of sand		
523699	0	25	dirt & clay		Qy3r
	25	75	sand & gravel	1st water 35'	
	75	77	**clay**	**static 18'**	
523698	0	25	dirt & clay		Qy3r
	25	72	sand & gravel	1st water 35'	
	72	75	**clay**	**static 14'**	
523696	0	10	surface soil		Qy2r
	10	70	sand		
	70	100	gravel & water		
523695	0	10	surface soil		Qy2r
	10	65	sand		
	65	100	gravel and water		
522331	0	6	loam		Qy3r
	6	20	gravel		
	20	70	clay		
	70	78	sand & gravel		
522142	0	50	clay		Qy2
	50	30	sand & gravel		
	60	95	clay with large rocks		
	95	180	some sand & gravel		
503079	0	12	top soil		Qy2
	12	30	sand & gravel		
	30	35	gravel with some clay		
	35	36	water first encountered		
	36	70	grave, river boulders, & water		
	70	75	**clay**		
501673	0	8	top soil		Qy2
	8	20	sand & gravel		

	20	30	clay	
	30	40	sand	
	40	65	gravel to large rock water 44'	
	65	70	clay	
	70	100	gravel & water	
	100	110	**clay**	
534685	0	6	silt	Qy2r
	6	10	silty fine sand	
	10	12	coarse sand	
	12	35	gravelly coarse sand; water at 14'	
573355	0	20	loose gravel	Qy2
	20	195	gravel & shale	

Table 3: Well Logs in the Vicinity of the Three Links Farm

Reg No	From	To	Description	Collared in
910588	0	50	Sandy brown clay	Qy2r
	50	95	Decomposed granite	
906973	0	170	Weathered granite	Qi1r
906970	0	168	Weathered granite	Qy2
598659	0	30	brown dirt	Qyc
	30	60	brown clay	
	60	110	sand and course gravel	
	110	142	**brown sandy clay**	
582635	0	26	dirt and clay	Qy2r
	26	310	conglomeration	
	310	405	clay and gravel	
	405	430	sand and gravel	
546954	0	35	silty clay	Qy2r
	35	114	sandy gravel	
520298	0	3	soil	Qy2r
	3	26	sandy clay	
	26	76	gravel 1st water 51'	
	76	79	**clay**	
	79	112	sandy clay-streaks of sand	
	112	115	**clay**	
520105	0	3	soil	Qy2
	3	28	sand clay	
	28	81	gravel & sand 1st water 46'	
	81	93	**clay**	
	93	98	sand clay	
	98	103	clay	
518817	0	28	sand & sandy clay	Qy2
	28	113	clay	
	113	117	sand 1st water	
	117	200	clay	

502244	0	20	red clay		Qy2
	20	60	clay conglomerate		
	60	80	clay with sand streaks		
	80	152	**clay congl, layers sand & gravel**		
502111	0	5	soil		Qy2
	5	12	sand & boulders		
	12	30	clay		
	30	50	gravel & rock		
	50	72	sand-gravel-water		
	72	204	**red clay**		
502022	0	2	sand		Qy2
	2	15	hard sand & boulders		
	15	28	hard sand & boulders		
	28	40	clay & gravel		
	40	50	hard sand & boulders		
			clay	1st water	
	50	111	50'		
	111	117	conglomerate (hard)		
	117	165	clay		
502003	0	6	soil		Qy2r
	6	28	red clay		
	28	40	sandy clay		
	40	46	sand	1st water	
	46	85	sandy clay		
	85	91	gravel - water		
	91	120	**red clay**		

United States (US)

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DEPT OF WATER RESOURCES

IGNACIA S. MORENO
Assistant Attorney General

R. LEE LEININGER
Attorney, U.S. Department of Justice
Environment and Natural Resources
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IN THE SUPERIOR COURT OF THE STATE OF ARIZONA
IN AND FOR THE COUNTY OF MARICOPA

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE	No. W1-W4 Contested Case W1-103 UNITED STATES' OBJECTIONS TO ARIZONA DEPARTMENT OF WATER RESOURCES' SUBFLOW ZONE DELINEATION REPORT

CONTESTED CASE NAME:	*In re Subflow Technical Report, San Pedro River Watershed,* W1 - 103.
HSR INVOLVED:	None
DESCRIPTIVE SUMMARY:	The United States' Objections to the Arizona Department of Water Resources' 2009 Subflow Zone Delineation Report, San Pedro River Watershed.
NUMBER OF PAGES:	11
DATE OF FILING:	Original filed with the Clerk of the Court on December 28, 2009.

Pursuant to the Court's September 28, 2005 Order ("2005 Order") and the June 30, 2009 Notice of Publication and Filing of Report by the Arizona Department of Water Resources ("ADWR"), the United States submits its objections to the June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed ("ADWR Report"). These objections are supported by the attached affidavit of Peter M. Pyle (attached hereto as Exhibit 1)("Pyle Affidavit") and accompanying exhibits.

Introduction

ADWR has produced a flawed delineation of the subflow zone in the San Pedro River watershed. While the agency has done a commendable job of accumulating data and presenting geologic maps of river floodplain deposits, it has lost sight of the fact that subflow is fundamentally a hydrological concept. The numerous court decisions ruling on this issue hold that groundwater occurring in the floodplain and hydrologically connected to intermittent and perennial streams and rivers is subflow. ADWR, however, excludes large areas of saturated floodplain deposits - indeed, eliminated large segments of perennial rivers - based on geologic units, not hydrogeology. ADWR must re-analyze its data, and if necessary procure more definitive data, and produce a delineation of the subflow zone that includes the entire pre-development saturated Holocene floodplain alluvium.

Objections

Objection Number 1: ADWR has failed to delineate subflow based on pre-development conditions.

ADWR recognizes that it must use predevelopment streamflow conditions in its analysis of subflow. ADWR Report at 2-1. Accordingly, ADWR accumulated published and unpublished historic accounts, a record of historic irrigation ditch and ore mill diversions, historic streamflow and diversion measurements, aerial photographs, published predevelopment streamflow maps, recent instream flow claims, wet/dry surveys, recent streamflow and diversions measurements, and recently published streamflow maps. *Id.* at 3-5 to 3-22. ADWR has taken the "practical approach" approved by the Court, *see* 2005 Order at 21, yet has still managed to accumulate and analyze multiple sources of information and large amounts of data. By any

measure, the agency's delineation of predevelopment conditions is thorough, accurate and reliable.

From the accumulated evidence, ADWR makes the following conclusions:

- Prior to development, the San Pedro River was perennial or intermittent from the International Border (Stream Mile 157) to its confluence with the Gila River (Stream Mile 0). ADWR Report at 3-19.
- Prior to development, the Babocomari River was perennial or intermittent downstream of Elgin at Babocomari Ranch (Stream Mile 21) to its confluence with the San Pedro River (Stream Mile 0). ADWR Report at 3-21.
- Aravaipa Creek was perennial or intermittent at predevelopment from about six miles upstream of Klondyke at Stream Mile 36 to its confluence with the San Pedro River at Stream Mile 0. ADWR Report 3-22.

In sum, then, the entire San Pedro River; 21 miles of the Babocomari River; and, 6 miles of the Aravaipa Creek were perennial or intermittent streams and rivers prior to development. In addition, ADWR has performed a geologic analysis and concludes that the San Pedro and Babocomari rivers and the Aravaipa Creek all exist within an alluvial channel in the floodplain Holocene alluvium.[1/] Furthermore, as the Court has previously ruled, saturation in the entire extent of the floodplain Holocene alluvium is assumed. 2005 Order at 18.

Putting both the physical evidence (predevelopment perennial and intermittent rivers and

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[1/] *See e.g.*, ADWR Report at 4-3 ("the width of floodplain Holocene alluvium along the San Pedro River is typically hundreds of feet wide and can reach almost one mile wide in some areas. Where bound, its width can be less than 100 feet."); ADWR Report at 4-4 ("The current channel and floodplain of the Babocomari River is typically covered with coarse alluvium and entrenched from 3 to 20 feet below terraces formed by abandoned floodplains."); ADWR Report at 4-5 ("The active floodplain of Aravaipa Creek is typically sandy, from 300 feet or more wide, and entrenched from 6 to 15 feet below older Holocene terraces and Tertiary basinfill deposits.")

The only exception to ADWR's conclusion that the river beds are composed of floodplain alluvium appears to be a small section of the Babocomari River where "[c]hannel alluvium is thin to absent only along bedrock reaches in its headwaters near the Mustang Mountains and along a 1-mile bedrock canyon near its confluence with the San Pedro River." ADWR Report at 4-5 However, even here ADWR states that Holocene floodplain alluvium is present but "narrows to less than a 100 feet." *Id.*

steams and Holocene alluvium in the bed of the rivers and streams) and the physical assumptions (saturation in the Holocene alluvium) together, subflow must exist - at a minimum - in the alluvium beneath the bed of the predevelopment perennial and intermittent rivers and steams. In other words, the evidence and assumptions compel a finding that a subflow zone exists along at least the width of the bed of the entire length of the San Pedro River and most of the Babocomari River and the Aravaipa Creek.

ADWR, however, does not delineate subflow along the entire length of these rivers and streams. Instead, the agency's subflow delineation has large gaps along the course of the predevelopment perennial and intermittent rivers and steams. *See* ADWR Report, Figure 6-1 (Subflow Zone Along Major Streams in the San Pedro River Watershed). ADWR excludes these segments because of the existence of tributary alluvium in the floodplain and/or the extension of 200 and 100 foot "setbacks" which overlap and consequently remove portions of the rivers and streams from subflow designation.[2]/ As shown below, ADWR misinterprets these criteria, but more importantly, the agency has applied these exclusions to an illogical and irrational extreme. The agency has allowed its "exceptions" to consume the rule. The rule is the saturated floodplain Holocene alluvium of the predevelopment perennial and intermittent rivers and streams is subflow. Because this condition exists along, at least, the beds of the entire length of the San Pedro River, and most of the Babocomari River and the Aravaipa Creek, no segments of these rivers and streams should be excepted from subflow delineation.

Objection Number 2: **Areas where saturated floodplain Holocene alluvium are overlain by tributary deposits are still areas of subflow and should not be excluded.**

Despite the existence of subflow, i.e., areas of predevelopment perennial and intermittent rivers in Holocene floodplain alluvium presumed to be saturated, along the continuous length of

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[2]/ Somewhat confusingly, ADWR states that it did delineate a subflow zone along the entire length of the San Pedro River and all except the upper reaches of the Babocomari River and Aravaipa Creek, *see* ADWR Report at 6-1, but then states that it did not delineate a subflow zone along numerous reaches of each stream, *see id.* at 6-2. Both statements cannot be correct. As discussed, *infra*, ADWR's first conclusion is correct.

the rivers and streams in the San Pedro watershed, ADWR has excluded large river segments from its subflow delineation. ADWR explains that it is excluding these areas based upon the 2005 Subflow Order p. 42, ¶ 6, approving the Special Master's July 16, 2004 Subflow Decision, Recommendation No. 18. The Special Master's recommendation states "[t]he Court should direct ADWR to exclude tributary aquifers, areas of basin fill recharge, and the alluvial plains of ephemeral streams from the subflow zone." Interpreting these directions, ADWR mapped the width of the floodplain Holocene alluvium and areas where tributaries have recently deposited alluvium on top of the floodplain. ADWR Report at 4-12. ADWR then applied a 100 foot setback at the boundary of the floodplain Holocene alluvium with the basin fill, and a 200 foot setback at the boundary of the floodplain Holocene alluvium with alluvial deposits from ephemeral streams tributary to the San Pedro River, the Babocomari River and Aravaipa Creek. Consequently, where recent tributary deposits overlie the river floodplain alluvium, combined with 200 foot setbacks, large segments of the Holocene floodplain alluvium are excluded from subflow delineation.

By focusing on the presence of alluvial plains of ephemeral streams, ADWR has misinterpreted the Court's instructions. Fundamentally, the subflow delineation is a determination of groundwater "that is more closely associated with the stream than with the surrounding [basin] alluvium." *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 175 Ariz. 382, 392, 857 P.2d 1236, 1246 (1993) ("*Gila II*"). After rejecting the trial court's first definition of subflow that included a temporal test on the effects of well pumping on a river or stream, the Arizona Supreme Court approved a second definition that applied each of the criteria announced in *Gila II*:

> For example, the [trial court] order states: After consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and "subflow" direction, the Court finds the most accurate of all the markers is the edge of the saturated floodplain Holocene alluvium.

In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 198 Ariz. 330, 337, 9 P.3d 1060, 1076 (2000)("*Gila IV*"); *see also id.*, 9 P.3d at 1083 (approving

the trial judge's determination "in all respects"). The hydrologic conditions, therefore, within the floodplain Holocene alluvium define the concept of subflow.

In excluding large areas of Holocene floodplain alluvium covered by ephemeral tributary deposits, however, ADWR has made no attempt to discern whether groundwater beneath the tributary deposits is water that flows in the direction of the river or stream and is "more closely associated with the stream." Indeed, instead of considering whether "hydraulic pressure from tributary aquifers" is consistent with the stream flow direction, ADWR has eliminated large segments of floodplain based solely on surficial geology. *See* ADWR Report at 4-13 ("ADWR does not consider tributary Holocene alluvium to be part of the floodplain Holocene alluvium").

Peter Pyle, a licensed professional geologist and certified hydrogeologist involved in the adjudication's subflow cases since 1993, explains the error in ADWR's methodology as follows:

> Most small tributaries sustain little or no surface or subflow, and may only be partially saturated during high runoff events. Therefore, it is unreasonable to allow temporary deposits of tributary stream alluvium or encroachment of piedmont tributary alluvium to narrow the subflow zone, particularly in cases where setbacks are applied such that the subflow zone disappears entirely. It is unlikely that the Court envisioned this application of the setback rules, or that tributary alluvium would be interpreted in such a way as to extend continuously on either side of the floodplain Holocene alluvium rather than terminating where tributary washes join the San Pedro River floodplain.

Pyle Affidavit, at 2. A more reasonable application of the Supreme Court's criteria is one that recognizes fundamental hydrogeologic principles of groundwater flow combined with the geology and geomorphology. Pyle recommends an approach that applies the Court's criteria without requiring ADWR to invest large additional expenditures of time and money:

> We believe the most appropriate criteria to use from this point forward is to define the San Pedro River floodplain based on geology, topography and geomorphology and the direction of flow within the Holocene alluvium. Initially this approach will allow drawing a boundary that includes mapped Holocene alluvial deposits within the San Pedro River floodplain which contains subflow by the Court's definition. If there is any doubt as to the boundary in some areas of Holocene alluvium, then the general direction of groundwater flow within it should be determined by measurements or inferred from existing data and experience in similar areas. If groundwater flow in the floodplain Holocene alluvium is in the direction of the San Pedro River, then the area should be within the subflow boundary.

Pyle Affidavit at 3. First, therefore, ADWR should use its existing geologic and topographic maps to identify, as *Gila IV* directs, "the edge of the saturated floodplain Holocene alluvium." 9

P.3d at 1076. Once the edge of the saturated floodplain Holocene alluvium is located, appropriate setbacks to account for hydraulic pressure from tributary aquifers and basin fill recharge may be applied. This setback is 200 feet near tributary alluvial washes where they meet the floodplain deposits and 100 feet at the basin fill boundary with the floodplain deposits.

As shown on Attachment B of the Pyle affidavit this approach uses the easily identifiable floodplain deposits and topography to establish the Holocene floodplain alluvium boundary. Applying a 100 foot and 200 foot setback from the boundary (the black line on Pyle's Attachment B) then delineates the subflow boundary. This method creates a more uniform boundary that does not contain a multitude of "edges" that have little bearing on the presence of saturated floodplain Holocene alluvium. It is a relatively quick, effective and inexpensive means of mapping the Holocene floodplain alluvium boundary and adheres to the Supreme Court's observation that "the saturated floodplain Holocene alluvium is readily identifiable; that DWR can quickly, accurately, and relatively inexpensively determine the edge of that zone . . . ." *Gila IV*, 9 P.3d at 1081.

As Pyle further recommends, if there is any doubt as to the subflow boundary in some areas of Holocene alluvium, then the general direction of groundwater flow within the floodplain may be determined by measurements or inferred from existing data and experience in similar areas. Pyle Affidavit at 4. This approach applies the general principle that groundwater in the floodplain alluvium adjacent to perennial and intermittent rivers and streams flows in the direction of the river and streams and is "more closely associated with the stream." Pyle proposes a simple test to confirm this:

> A simple field test to determine the direction of flow can be performed in areas where the subflow boundary is uncertain. This test can involve driving three well points or piezometers into the Holocene alluvium and carefully measuring the water levels and measurement point elevation.

Pyle Affidavit at 3. An example of the possible locations of piezometers to be used to determine groundwater flow direction in the floodplain of the San Pedro River is shown on Attachment B with black X's. Such a test may determine if there is "a lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and 'subflow'

direction." *Gila IV*, 9 P.3d at 1076. If there is no such perpendicular hydraulic pressure, then ADWR's exclusion of large swaths of river floodplain merely because tributary deposits lie on top of the floodplain Holocene alluvium is clearly erroneous.

Objection Number 3: **ADWR has erroneously eliminated from subflow delineation areas where the San Pedro River is flowing adjacent to bedrock.**

ADWR has reduced the width of the floodplain Holocene alluvium or eliminated it entirely where the San Pedro River flows through two areas of bedrock in the northern part of the Lewis Springs quad. *See* ADWR Report Appendix D1 - Map 19 and Appendix D3 - Map 19. However, even where bedrock outcrops are adjacent to the river, there are deposits of floodplain Holocene alluvium in the beds and banks. Attachment C to the Pyle Affidavit is a revised geologic map of the Arizona Geological Society's Lewis Springs quad showing where the San Pedro River flows through an area of bedrock with deposits of Holocene floodplain alluvium. As Pyle states,

> San Pedro River subflow must occur in at least the Holocene alluvium in this reach, highlighting the problem with applying setbacks in all areas.[3]/ The flow direction test described above and shown in Attachment B would confirm that groundwater in this segment flows in the direction of the river in the Holocene alluvium, but it is unnecessary because it can be inferred based on existing data and experience. The subflow boundary should be extended through this bedrock area and no setbacks should be applied.

Pyle Affidavit at 4. The elimination of the subflow zone even where it is shown that a perennial river is flowing in Holocene alluvium is clearly erroneous.

Objection Number 4: **ADWR's method to compensate for large gaps in the delineation of subflow of the rivers and streams is arbitrary and speculative.**

To its credit, ADWR recognizes that there is a serious deficiency in its delineation of subflow and the resulting exclusion of large areas of river floodplain due to the presence of surficial tributary deposits and application of "setbacks." ADWR Report at 4-13. The agency proposes to correct for these omissions by use of a formula comparing the tributary deposits'

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[3]/ Pyle also notes that "[t]here are also insignificant deposits of undifferentiated Pleistocene alluvium (Qi) to which ADWR has applied a setback of 200 feet which narrows the subflow in that area to zero."

length and perimeter.

> Where tributary Holocene alluvium likely overlies floodplain Holocene alluvium, it borders the floodplain or forms fingers of material that extend out into the floodplain. To determine whether these features should be treated as floodplain Holocene alluvium, a ratio could be used of the perimeter of the feature (P) to its length at the edge of the floodplain (L).

ADWR Report at D-4-1. ADWR does not cite to any scientific authority, published or unpublished, showing that its proposed methodology is generally accepted in the scientific community. It is unlikely that such scientific support exists, for the reason noted by Pyle:

> One problem with this is that the length at the edge of the floodplain is a straight line joining two random points unrelated to geology or the floodplain boundary and is entirely arbitrary. This approach fails to recognize that earth processes such as sediment deposition and stream geomorphology are not readily approximated by simple equations and linear features.

Pyle affidavit at 3. ADWR's ratio methodology, therefore, appears to be entirely arbitrary and speculative. ADWR includes an interesting justification for its proposed ratio methodology. The agency claims it "result[s] in a more regular floodplain boundary." The United States agrees that, consistent with the Arizona Supreme Court's instruction in *Gila IV* to locate "the edge of the saturated floodplain Holocene alluvium," the floodplain boundary (or edge) should be more regular. However, the means to produce a more regular boundary is to map the edge of the Holocene floodplain with geologic and topographic data, not by using speculative methods not generally accepted by the scientific community.

Objection Number 5: Tributary surficial deposits are subject to flood and regular river processes and are not reliable indicators of the subflow boundary.

The courts have held, and consistently reiterated, that the adjudication's jurisdiction is limited to the Holocene alluvium because it constitutes "the only stable geologic unit which is beneath and adjacent to most rivers and streams. . . . " *Gila IV*, 9 P.3d at 1076; *see also* 2005 Order at 16, Order dated June 30, 1994, at 56, Special Master's Report dated July 16, 2004, at 33. Stability of the geologic units, therefore, is a key factor when mapping the extent of subflow. ADWR, however, limits the extent of subflow, and in places eliminates it entirely, based on what it admits is unstable deposits of tributary alluvium in the floodplain.

The Department recognizes "[e]ventually, a large flood may remove this [tributary

alluvium] material and allow the river to return to its prior course. As a result, tributary alluvium may temporarily cover floodplain Holocene alluvium at the surface and, overtime, interfinger with it in the subsurface (Figure 4.1)." ADWR Report at 4-4.[4]/ Despite this acknowledgment that tributary surficial deposits are temporary, these geologic units form the basis for ADWR's delineation of a subflow boundary. ADWR Report at 4-12 ("Although this tributary Holocene alluvium may eventually get washed away during a large flood, at the time of mapping, AZGS distinguished it from the floodplain deposits.")

Because subflow should be based on, in part, a "stable geologic unit," ADWR has erred in using the tributary alluvium deposits to map the boundary and extent of the floodplain Holocene alluvium.

Conclusion

ADWR should be directed to amend its subflow delineation report and include all areas where under predevelopment conditions there is saturated floodplain Holocene alluvium. The agency should not exclude areas of saturated floodplain Holocene alluvium based on the presence of overlying temporary tributary alluvium deposits and "setbacks" from these tributary deposits or from adjacent bedrock outcrops. If the agency is in doubt whether groundwater in the floodplain is more associated with the river than a nearby basin fill or tributary aquifer it should perform a simple test to confirm groundwater flow direction.

RESPECTFULLY SUBMITTED this 28th day of December, 2009.

UNITED STATES OF AMERICA

BY: _____
R. Lee Leininger
Attorney
U.S. Department of Justice

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[4]/ Our expert agrees with ADWR and states that "[t]he location of the edges of the tributary alluvium and piedmont deposits in the floodplain of the San Pedro River are subject to change due to ongoing erosion and deposition." Pyle Affidavit at 4. Furthermore, mapping the edges of the tributary alluvium does not define a stable boundary. *Id.*

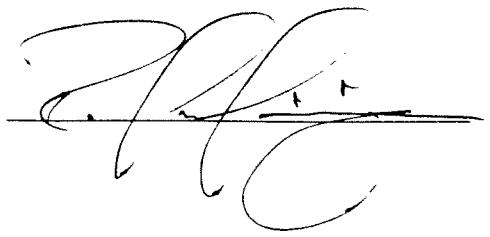
CERTIFICATE OF SERVICE

The original and one copy of the foregoing sent via Federal Express this 28th day of December, 2009 to:

Clerk of the Arizona Superior Court
Attn: Water Case
601 W. Jackson St.
Phoenix, AZ 85003

Special Master
Arizona General Stream Adjudication
George A. Schade, Jr.
1501 W. Washington, Suite 228
Phoenix, AZ 85007

A copy of the foregoing mailed this 28th day of December, 2009, to all parties on the Court-approved W-1-W-4 mailing list dated July 27, 2009.



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IN THE SUPERIOR COURT OF THE STATE OF ARIZONA
IN AND FOR THE COUNTY OF MARICOPA

IN RE THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE	)	W-1 (Salt)
	)	W-2 (Verde)
	)	W-3 (Upper Gila)
	)	W-4 (San Pedro)
	)	
	)	Contested Case No. W1-103
	)	
	)	AFFIDAVIT OF PETER M. PYLE

CONTESTED CASE NAME: *In re Subflow Technical Report, San Pedro River Watershed.*

HSR INVOLVED: None

DESCRIPTIVE SUMMARY: Affidavit of Peter M. Pyle

NUMBER OF PAGES: 5

DATE OF FILING: Original mailed to the Clerk of Court on December 28, 2009

STATE OF CALIFORNIA
COUNTY OF MARIN

Affidavit of Peter M. Pyle, PG, CHG

Review of -
Arizona Department of Water Resources, Subflow Delineation Report for the San Pedro River Watershed, June 2009

Qualifications:

I am a licensed Professional Geologist and Certified Hydrogeologist with 27 years experience in geology, hydrogeology, water rights, ground and surface water modeling, groundwater development and related fields. I have worked for Stetson Engineers since January 1991 on various hydrogeologic studies in the western U.S., including Arizona. I have been involved in the subflow and groundwater and surface water interaction aspects of the Gila River Adjudication for Stetson Engineers including the San Pedro River subflow determination since 1993.

EXHIBIT 1

Experience in San Pedro Watershed and Gila River Watershed 1993 - Present

- Drilling, lithologic logging, and geophysics
- Litigation support and expert witness testimony preparation
- Review of ADWR reports, Court rulings, and consultants reports
- Research and preparation of reports and documents, coauthored reports and assisted with briefs, declarations and rebuttal affidavits
- Attendance at hearings and reviewed testimony
- Review of previous work by USGS, ADWR and other consultants
- Met with USGS and reviewed model.
- Met with USDA and discussed use of soils data for mapping Subflow zone.
- Field trips:
  - With Judge Goodfarb
  - Detailed survey of the geology along the San Pedro River from Hereford to with GPS waypoints, photos, field log and filed declaration

1. San Pedro River Subflow is occurring in areas where AGS has mapped tributary Holocene alluvium within the San Pedro River floodplain and ADWR has eliminated those areas from the subflow zone.

ADWR (2009) has stated that it based its delineation of the subflow zone on recent mapping by the Arizona Geological Survey (AGS) and that if that mapping showed tributary alluvium in the floodplain of the San Pedro River, it was allowed to remain as mapped even though high flow events would remove the tributary alluvium temporarily deposited in the San Pedro River floodplain (pg 4-4).

> Where the introduction of tributary alluvium is particularly large, the floodplain may narrow and the river changes course, at least temporarily, to accommodate the additional sediment. Eventually, a large flood may remove this material and allow the river to return to its prior course. As a result, tributary alluvium may temporarily cover floodplain Holocene alluvium at the surface and, overtime, interfinger with it in the subsurface (Figure 4.1).

There is little doubt that subflow associated with the floodplain of the San Pedro River flows in the direction of the River in these areas. Most small tributaries sustain little or no surface or subflow, and may only be partially saturated during high runoff events. Therefore, it is unreasonable to allow temporary deposits of tributary stream alluvium or encroachment of piedmont tributary alluvium to narrow the subflow zone, particularly in cases where setbacks are applied such that the subflow zone disappears entirely. It is unlikely that the Court envisioned this application of the setback rules, or that tributary alluvium would be interpreted in such a way as to extend continuously on either side of the floodplain Holocene alluvium rather than terminating where tributary washes join the San Pedro River floodplain. This interpretation allows the setbacks to occur all along the River and interfere with the interpretation of subflow to the extent that is assumed by ADWR not to exist in some areas, including the middle of the flowing San Pedro River channel itself.

Examples provided in ADWR, 2009 Volume 1, Figure 5-1 show areas where the setbacks

applied by ADWR in areas where the San Pedro River floodplain Holocene alluvium is mapped as relatively narrow due to lateral encroachment from areas mapped as piedmont or tributary stream alluvium. Several extreme examples of this occur on the Land, Hereford and Lewis Springs quads, as shown in a comparison of those quads in Appendix D1 and Appendix D3.

ADWR has recognized that strict adherence to the exclusion of tributary Holocene alluvial deposits from the subflow zone has led to the implausible narrowing or even elimination of the subflow zone along much of the San Pedro River (ADWR, 2009, p. 4-13). In recognition of these anomalous areas, ADWR provided a "possible approach" to rectifying these problems which could "result in a more regular floodplain boundary". ADWR also recognized that more direction is needed by the court to resolve the problems of strict adherence to the source of material now occurring in the floodplain as a basis for defining the floodplain Holocene alluvium. We would argue that the remedy that is needed is not one that results in a more "regular" boundary, but one that recognizes fundamental hydrogeologic principles, geomorphology and criteria set by the Court. These principles and criterion include:

1) Subflow moves in the same direction as the flow of the San Pedro River
2) Holocene alluvium within the floodplain of the San Pedro River
3) Topography

Some of the tributary alluvium mapped by the AZGS and categorized as piedmont deposits occur within the floodplain of the San Pedro River. In the floodplain, these deposits lie on top of areas containing the subflow of the San Pedro River.

ADWR's (2009) suggested method for developing a more regular subflow boundary is presented in their Appendix D-4. An example of this approach is shown in Figure D-4a (enclosed herein as Attachment A). It involves an equation or ratio of the perimeter of the excluded feature to its length at the edge of the floodplain. One problem with this is that the length at the edge of the floodplain is a straight line joining two random points unrelated to geology or the floodplain boundary and is entirely arbitrary. This approach fails to recognize that earth processes such as sediment deposition and stream geomorphology are not readily approximated by simple equations and linear features. Stetson Engineers strongly disagrees with this approach.

We believe the most appropriate criteria to use from this point forward is to define the San Pedro River floodplain based on geology, topography and geomorphology and the direction of flow within the Holocene alluvium. Initially this approach will allow drawing a boundary that includes mapped Holocene alluvial deposits within the San Pedro River floodplain which contains subflow by the Court's definition. If there is any doubt as to the boundary in some areas of Holocene alluvium, then the general direction of groundwater flow within it should be determined by measurements or inferred from existing data and experience in similar areas. If groundwater flow in the floodplain Holocene alluvium is in the direction of the San Pedro River, then the area should be within the subflow boundary.

A simple field test to determine the direction of flow can be performed in areas where the subflow boundary is uncertain. This test can involve driving three well points or piezometers into the Holocene alluvium and carefully measuring the water levels and measurement point elevation. Once a more scientifically based boundary is drawn, the floodplain Holocene alluvium boundary

can then be determined that includes the appropriate offsets near tributary alluvial washes where they meet the San Pedro River floodplain (200 feet) and at the basin fill boundary (100 feet) that have been specified by the Court. The 200 ft offset for tributaries where they meet the San Pedro River floodplain should only apply for large tributaries that have groundwater flow in the tributary Holocene alluvium at the edge of the San Pedro River floodplain year round. It is only in these areas that the groundwater flow in the tributary alluvium is expected to be perpendicular to that of the San Pedro River subflow as defined by the Court.

An example of Stetson Engineers proposed method this is shown on Attachment B of this affidavit. Attachment B shows the northern portion of the revised Hereford quad geologic map (AZGS- DGM 57 V2, 2009) with the approximate FHA boundary added (in green) based on ADWR (2009, Appendix D-3, Map 13 of 33) following specified alluvial geologic unit contacts. Also included on Attachment B is an alternative, approximate floodplain Holocene alluvium subflow boundary proposed by Stetson Engineers (in red) based primarily on geology and topography. The setbacks of 100 feet for basin fill and 200 feet for large tributaries as defined above, would have to be added to the floodplain Holocene alluvium boundary to create a new subflow boundary. An example of the possible locations of piezometers to be used to determine groundwater flow direction is shown on Attachment B with black X's.

The boundary of Holocene alluvium in the San Pedro River floodplain may be more difficult to define in some places rather than others due to limited basin fill or bedrock outcrops, and low topography. However, this example shows that the proposed approach to defining the Holocene floodplain alluvium, regardless of its source, would serve the intent of the court better than, 1) the floodplain Holocene floodplain alluvium (subflow) boundary drawn by ADWR (2009, Appendix D-3), or 2) ADWR's suggested approach to redefining the boundary in some areas described in Appendix D-4, Figure D-4a (Attachment A of this affidavit).

2. The ADWR has based it subflow boundary on temporary surficial tributary alluvium and piedmont deposits.

The location of the edges of the tributary alluvium and piedmont deposits in the floodplain of the San Pedro River are subject to change due to ongoing erosion and deposition. The ADWR has acknowledged that these changes occur in their report (ADWR, 2009) as quoted above under item (1). The Court instructed ADWR to define a stable boundary. A stable boundary is the edge of the San Pedro River floodplain which is based on hydrogeology and topography. The boundary plotted by Stetson Engineers on Attachment B of this affidavit is an example of such a boundary.

3. San Pedro River subflow is occurring where ADWR has erroneously applied setbacks where the River flows through bedrock.

ADWR (2009, p. 5-2) states:

> "ADWR applied a 100-foot setback where the floodplain Holocene alluvium was bordered by basin fill and a 200-foot setback where it was bordered by tributary Holocene alluvium. The 1994 Subflow order did not discuss hydrostatic pressure effects from bedrock bordering the floodplain. "

However, ADWR appears to have reduced the width of the subflow boundary or eliminated it entirely where the San Pedro River flows through two areas of bedrock in the northern part of the Lewis Springs quad as shown in a comparison of Appendix D1 - Map 19 and Appendix D3 - Map 19.

A review of the AZGS (2009, DGM-57, V2) revised Lewis Springs geologic quad shows an example of where the River flows through an area of bedrock with deposits of Holocene floodplain alluvium (Attachment C, this affidavit). There are also insignificant deposits of undifferentiated Pleistocene alluvium (Qi) to which ADWR has applied a setback of 200 feet which narrows the subflow boundary in that area to zero. San Pedro River subflow must occur in at least the Holocene alluvium in this reach, highlighting the problem with applying setbacks in all areas. The flow direction test described above and shown in Attachment B would confirm that groundwater in this segment flows in the direction of the river in the Holocene alluvium, but it is unnecessary because it can be inferred based on existing data and experience. The subflow boundary should be extended through this bedrock area and no setbacks should be applied.

In conclusion, I find that the method used by ADWR (2009) to define the San Pedro River floodplain Holocene alluvium is flawed due to strict adherence to the source areas of Holocene alluvium found in the floodplain of the San Pedro River. Their suggested approach to rectifying this error, as demonstrated in Appendix D-4 of that report, is also seriously flawed and arbitrary. An alternative approach is provided in this affidavit that incorporates the criteria set fourth by the Court and uses, geology, topography and groundwater flow direction to define the boundaries of the San Pedro River Holocene alluvium.

I declare upon penalty of perjury that the foregoing is true and correct.
EXECUTED this 28th day of December, 2009, at San Rafael, California.

Peter M. Pyle, PG, CHG

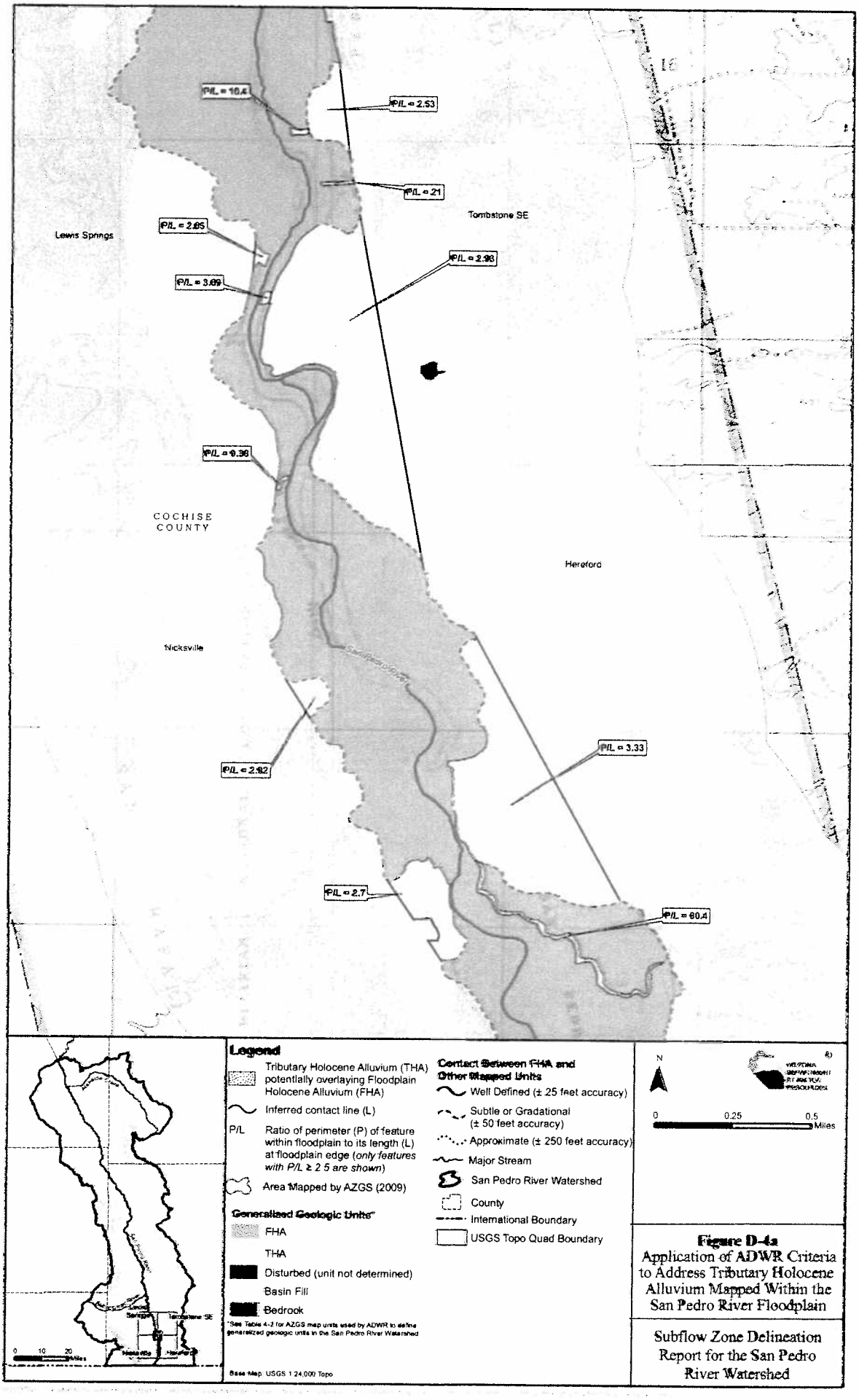
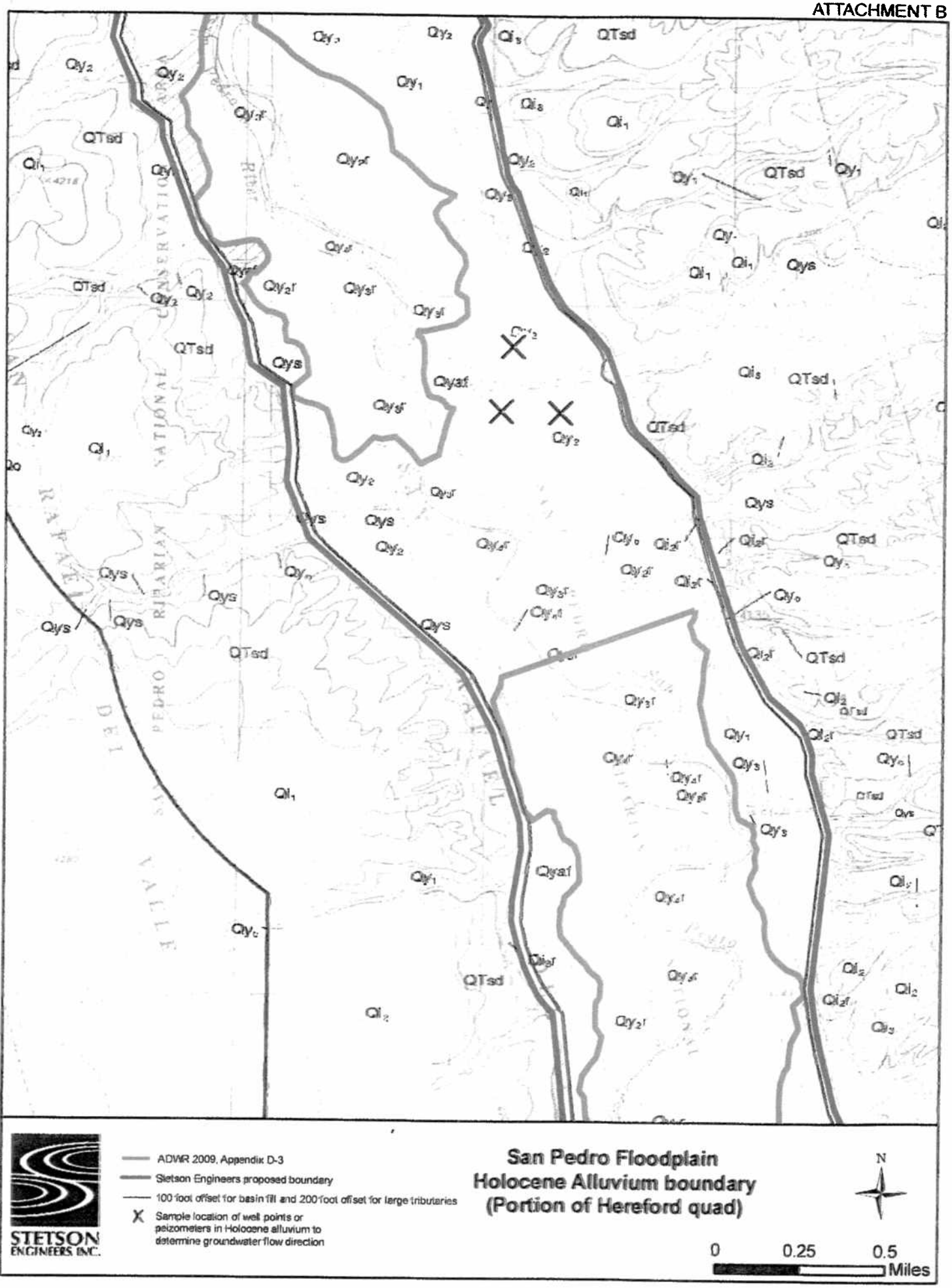
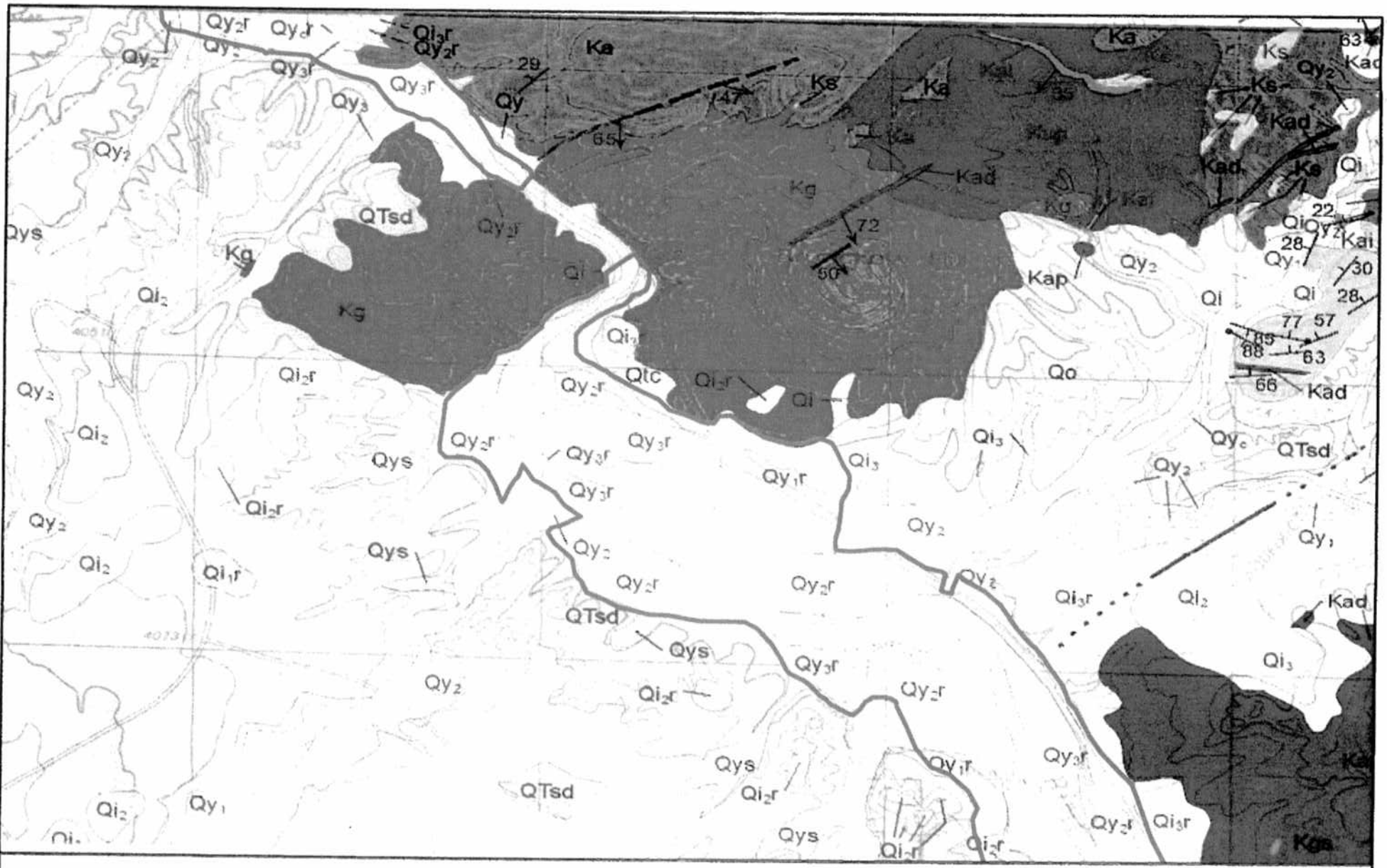


Figure D-4a
Application of ADWR Criteria to Address Tributary Holocene Alluvium Mapped Within the San Pedro River Floodplain

Subflow Zone Delineation Report for the San Pedro River Watershed

ATTACHMENT B





Floodplain Holocene Alluvium Boundary within Bedrock defined by ADWR, 2009
(portion of Lewis Springs quad)

STETSON ENGINEERS INC.

N

0 1,500 3,000 Feet

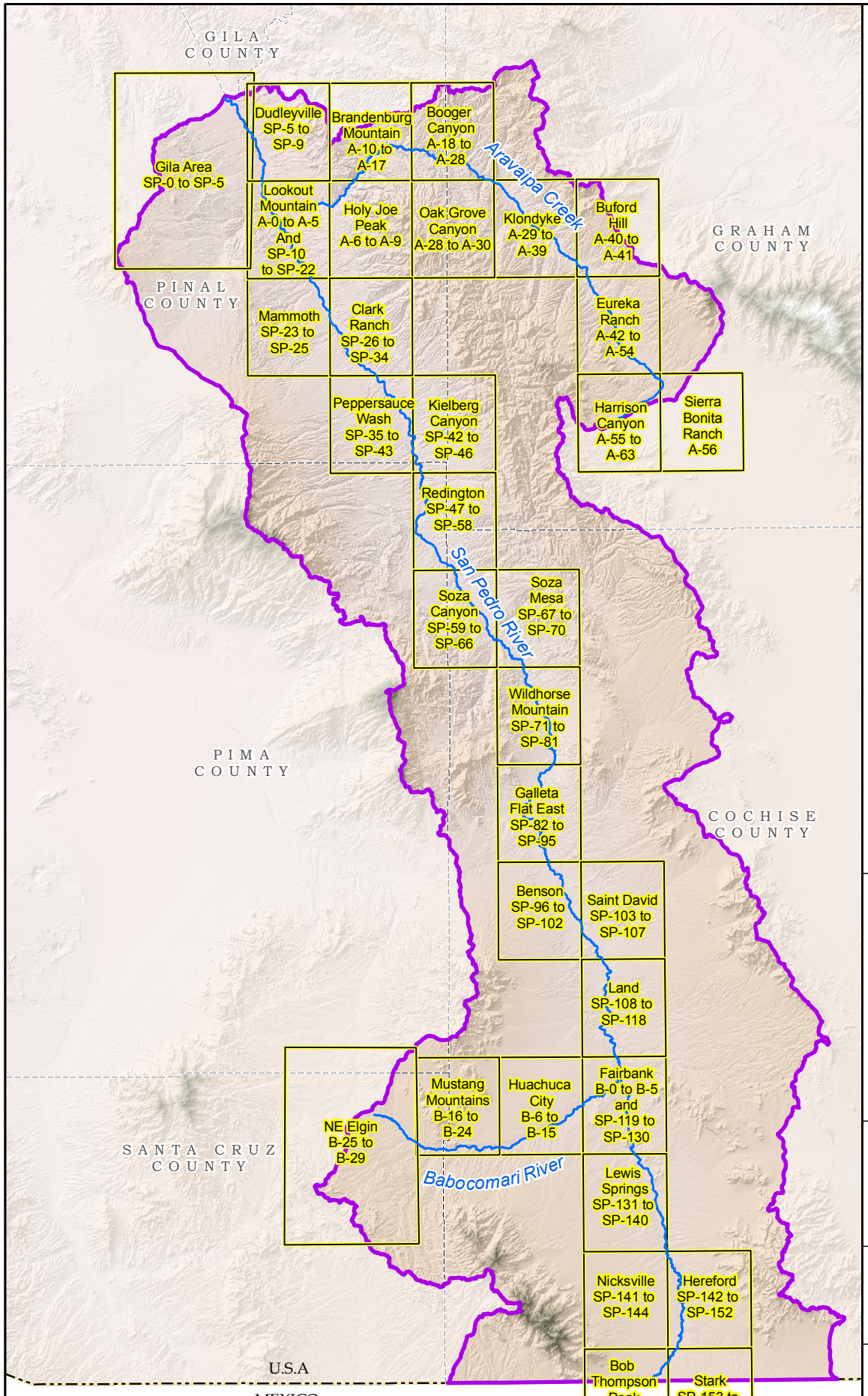
ATTACHMENT C

J:\jn2324\Attachment C.mxd N.Wasserman 12/16/2009

APPENDIX C

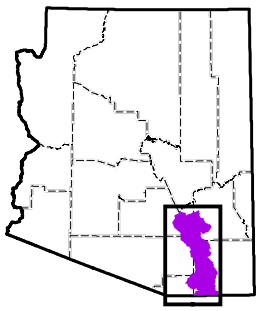
Historic Aerial Photography

Note: ***Digital images of the 1935 aerial photographs are saved as jpg files and stored in a separate folder on this DVD.***



Legend

- Photo Name and River Miles
  - SP = San Pedro River
  - A = Araviapa Creek
  - B = Babocomari River
- San Pedro River Watershed
- Stream
- County
- State Boundary
- International Boundary



N

ARIZONA DEPARTMENT OF WATER RESOURCES ©

0 5 10 15 Miles

Appendix C
Index of Historic Aerial Photography

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

APPENDIX D

Analysis of Active Floodplain Migration

APPENDIX D: HISTORIC ACTIVE FLOODPLAIN ANALYSIS

BACKGROUND

Some objectors commented that ADWR did not properly map the full extent of floodplain Holocene alluvium (FHA) since it relied on surficial geology, which is not stable, and did not address potentially overlapping tributary Holocene alluvium (fan deposits). In response to these comments, ADWR analyzed how the location of the active floodplain has changed over time for the San Pedro and Babocomari Rivers and Aravaipa Creek. The purpose of this analysis was to look for evidence where the active floodplain of these major streams is now covered by fan deposits.

For this analysis, the active floodplain was considered the relatively flat surface adjacent to the active channel that is periodically inundated by overbank flows and largely consists of unconsolidated stream sediments. Secondary, high flow and flood flow channels may occur within the active floodplain but only convey flow during large flow events. The boundary of the active floodplain thereby delineates the extent to which FHA is periodically transported downstream and is distinguishable from adjacent fan deposits.

DATA

Table D-1 lists the aerial imagery that ADWR used to delineate historic active floodplains in the watershed including their flight years, scale and data sources. The following years of imagery were selected for analysis based on availability, scale, watershed coverage and relation to regional flood events:

- 1935
- 1954-56
- 1984-85
- 1992/1996
- 2007.

Figure D-1 compares these years to annual peak flows measured at U.S. Geological Survey (USGS) stream gages in the watershed. The figure shows that the aerial imagery selected by ADWR should document the effects from major recent flood events. The largest measured flood on the San Pedro River occurred in 1926 and its geomorphic effect on the active floodplain is captured by the 1935 imagery. Effects from relatively large flows during 1940, 1951 and 1954 are reflected in the 1954-56 imagery, and the 1984-86 imagery documents prior flooding on the San Pedro River during 1978-79 and 1984 as well as the 1984 flood of record for Aravaipa Creek. The 1992/1996 imagery also shows the effect of flood events captured in the 1984-86 imagery and was available as digital orthophoto quadrangles (DOQs). Finally, the 2007 imagery represents the most recent, high resolution aerial photography currently available for the entire watershed.

METHODS

Active floodplains were delineated using the aerial imagery described above and the Geographic Information System (GIS) software ARCMap 9.3. Hard copy photographs from 1935 and 1954-56 were digitally imaged and then georeferenced to ensure their locational accuracy. Hard copy photographs from 1984-85 were compared to the 1992/1996 DOQs, which had already been georeferenced to an accuracy of less than 1 meter, and any active floodplain features observed on the former were aggregated with the latter. The 2007 imagery was available as seamless digital orthophotographs that could be directly input to ARCMap.

The extent of the active floodplains was identified based on differences in the tone, texture, shape and pattern of the imagery. Active floodplain surfaces were distinguished as either unvegetated or sparsely vegetated areas along the streams that appear in the imagery with light to medium tones. Small channels and swales as well as flood debris produce rippled textures with linear or lenticular patterns in the direction of flow. Sparse vegetation on the active floodplain produces patches with mottled or granular texture which are dissected by unvegetated features also oriented parallel to flow. (van Zuidam, 1986 and Way, 1973)

Geomorphic surfaces outside of the active floodplain include inactive floodplains and terraces, upland areas and exposed bedrock. Bedrock surfaces generally appear in medium or gray tones with variable texture and lack the linear or lenticular patterns seen in the active floodplain. Inactive floodplain, terrace and upland surfaces also lack these patterns but often exhibit uniformly speckled or granular texture indicative of vegetation. (Pandy, 1987 and Ray, 1984)

RESULTS

Attachment 1 shows how the active floodplain of the San Pedro and Babocomari Rivers and Aravaipa Creek has varied in location since the 1930s. Along some reaches, the active floodplain has been relatively stable and its location varied little over the period. Along other reaches, the active floodplain has been more dynamic and its location migrated across the floodplain and/or changed appreciably in width. For comparison, the boundaries of the active floodplain in 1935, 1950s, 1980s/1990s and 2007 are plotted using different colors along with a composite boundary that delineates the full extent of the floodplain during this time.

Attachment 2 presents a series of quadrangle maps that cover the stream reaches that ADWR determined had perennial or intermittent flows during predevelopment. Each map plots the composite active floodplain boundary delineated by ADWR on top of the generalized surficial geology that ADWR presented in its Subflow Zone Delineation Report. Review of these maps shows certain areas where the historic (1930s to 2007) active floodplain, depicted using a hatched pattern, is currently covered by fan deposits which are depicted in yellow. In these areas of overlap, it is likely that FHA occurs beneath the fan deposits.

USE IN DELINEATION OF EXTENT OF FLOODPLAIN HOLOCENE ALLUVIUM

The historic active floodplain mapping described above could be used to better delineate the full extent of FHA along major streams in the watershed. In areas where the composite active floodplain is now covered by fan deposits, the extent of FHA could be extended to include the areas of overlap.

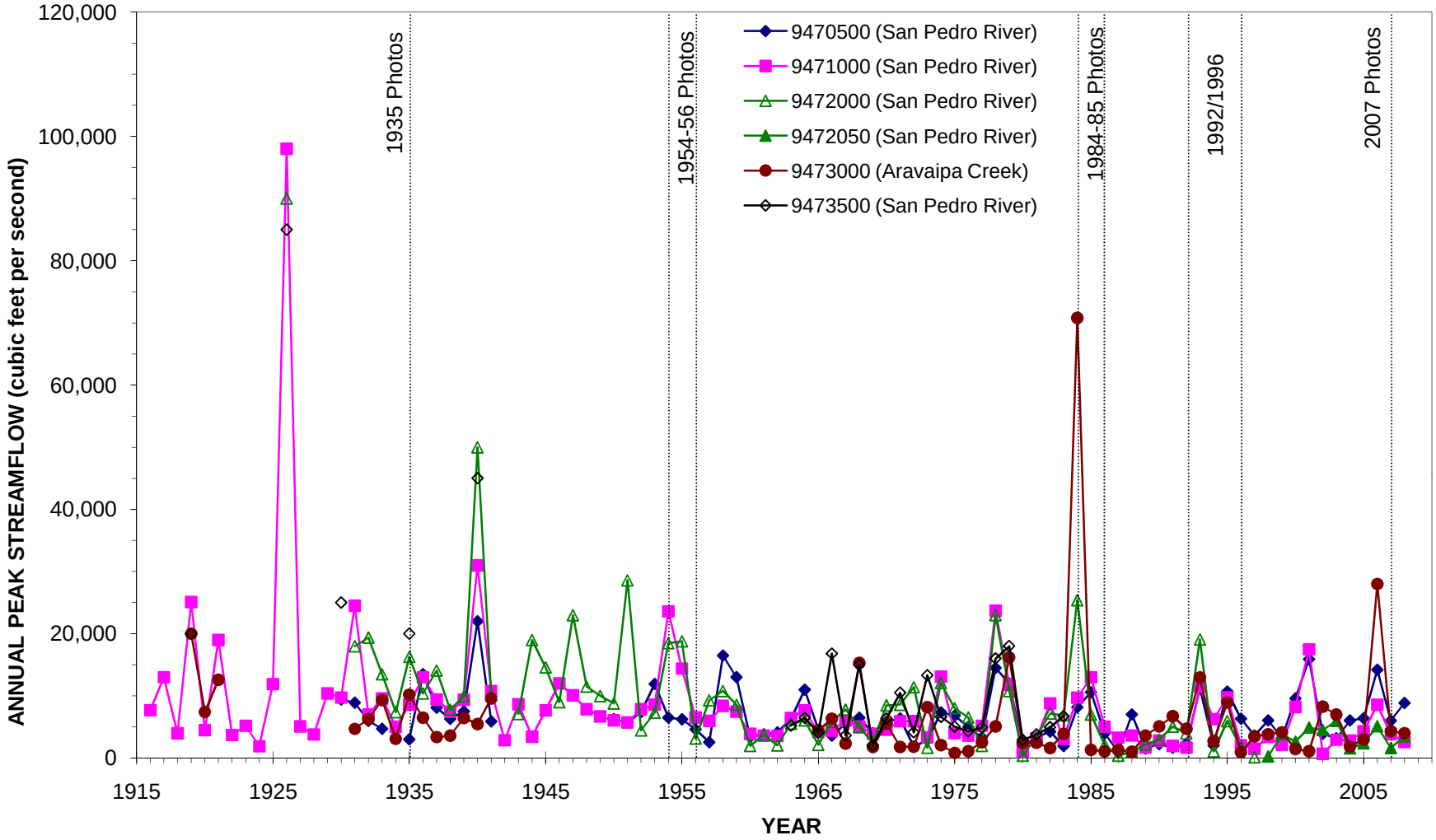
TABLE

TABLE D-1. AERIAL PHOTOGRAPHY USED FOR HISTORIC ACTIVE FLOODPLAIN ANALYSIS IN THE SAN PEDRO RIVER WATERSHED

FLIGHT YEAR(S)	SCALE	SOURCE
1935	1:24,000	Soil Conservation Service (SCS)
1954-56	1:20,000-23,600	SCS / U.S. Geological Survey (USGS)
1984-86	1:24,000	Arizona Department of Water Resources
1992,1996	1:24,000	USGS
2007	1-m resolution	USGS

FIGURE

Figure D-1. Comparison of Annual Peak Streamflows at USGS Gaging Stations to Aerial Photography Flight Years within the San Pedro River Watershed (1916-2008)



ATTACHMENTS

Attachment 1

Appendix D - Attachment 1
Selection of Dynamic and Stable Reaches
Composite Active Floodplain Boundary
Benson Quad
Relatively Dynamic Reach of the San Pedro River (Part 1)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

Galleta Flat East

Saint David

Land

0 0.25 0.5 0.75 1 Kilometers

0 0.25 0.5 Miles

Legend

- Composite Active Floodplain Boundary
- Floodplain in 2007
- Floodplain in 1980s/1990s
- Floodplain in 1950s
- Floodplain in 1935

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

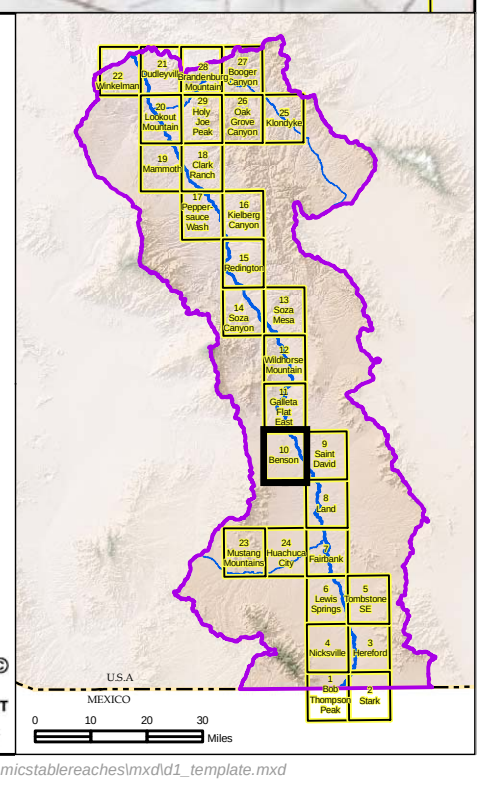
- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



Base Map: USGS 1:24,000 Topo

ARIZONA DEPARTMENT OF WATER RESOURCES ©

Wildhorse Mountain

Galleta Flat East

Benson

Saint David

San Pedro River

82
83
84
85
86
87
88
89
90
91
92
93
94
95

0 0.25 0.5 Kilometers

0 0.25 0.5 Miles

Legend

- Composite Active Floodplain Boundary
- Floodplain in 2007
- Floodplain in 1980s/1990s
- Floodplain in 1950s
- Floodplain in 1935

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

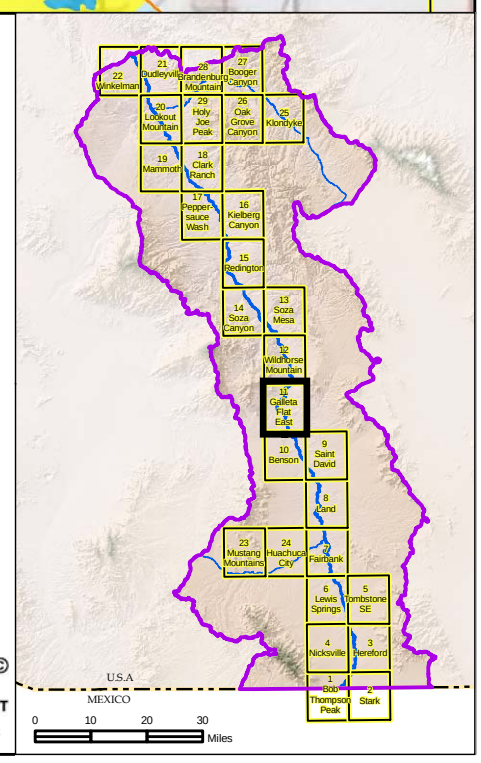
Base Map: USGS 1:24,000 Topo

Appendix D - Attachment 1
Selection of Dynamic and Stable Reaches
Composite Active Floodplain Boundary
Galleta Flat East Quad
Relatively Dynamic Reach of the San Pedro River (Part 2)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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Lookout Mountain

Holy Joe Peak

Oak Grove Canyon

0 0.25 0.5 0.75 1 Kilometers

0 0.25 0.5 Miles

Legend

- Composite Active Floodplain Boundary
- Floodplain in 2007
- Floodplain in 1980s/1990s
- Floodplain in 1950s
- Floodplain in 1935

26

27

Mammoth

28

29

30

San Pedro River

31

32

33

34

Tailings Pond

Peppersauce Wash

Kielberg Canyon

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

Historical (1930s to 2007) Composite Active Floodplain Boundary

Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

Base Map: USGS 1:24,000 Topo

Appendix D - Attachment 1
Selection of Dynamic and Stable Reaches
Composite Active Floodplain Boundary
Clark Ranch Quad
Relatively Stable Reach of the San Pedro River

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

157 Major Stream and River Mile Locations

San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

N

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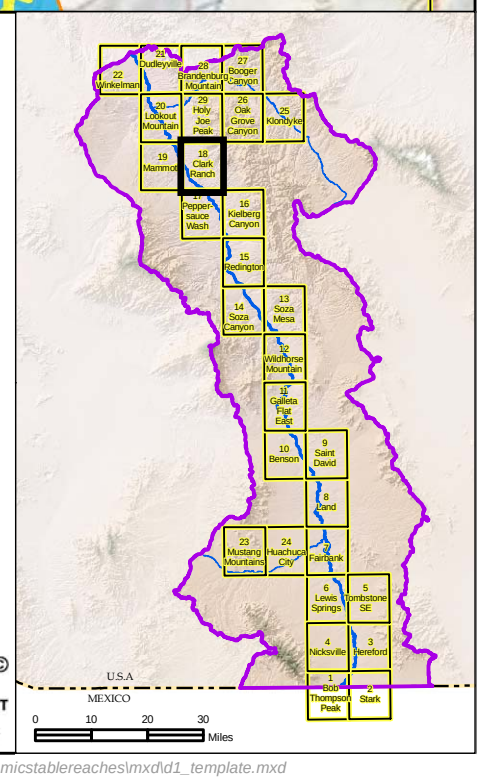

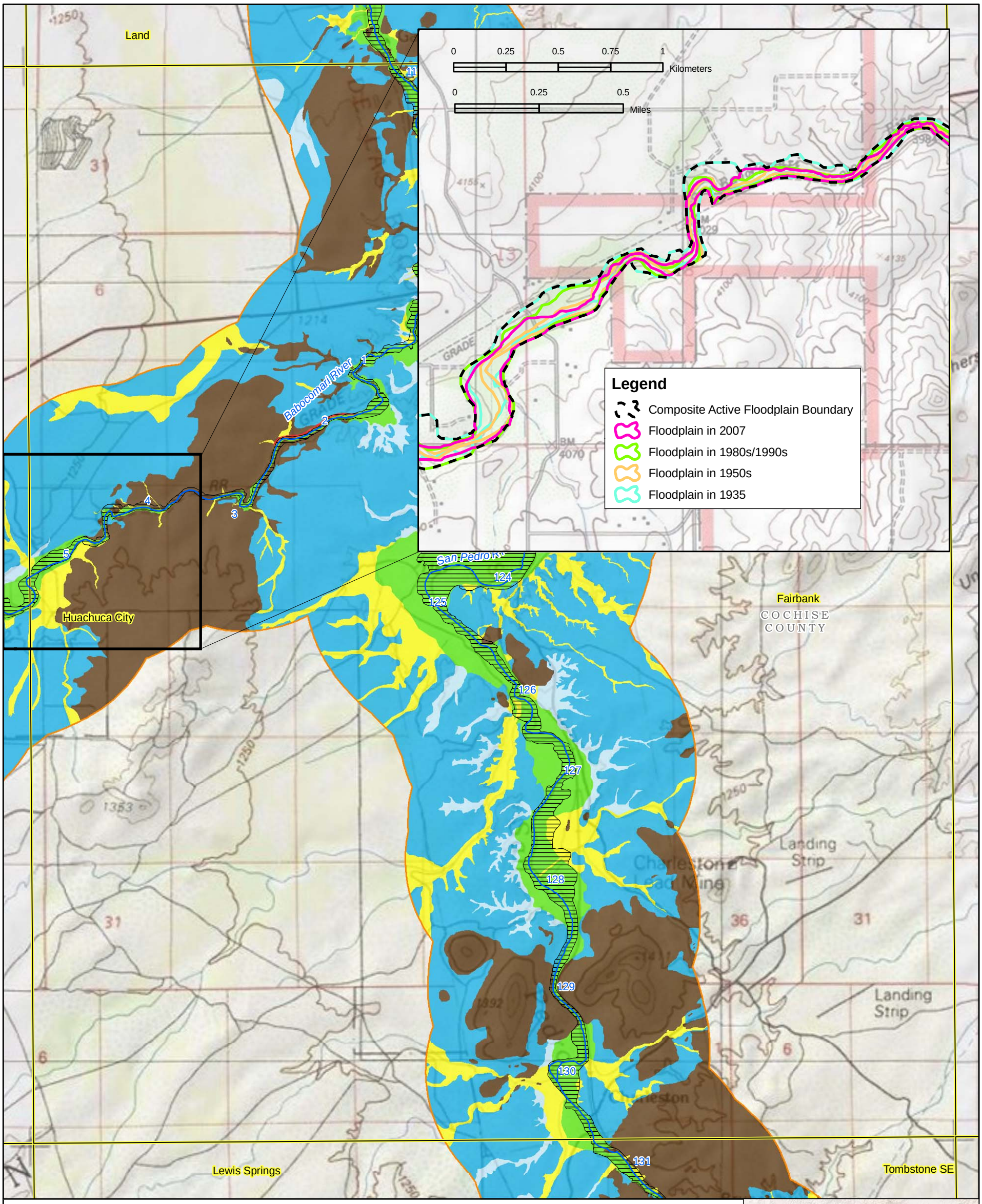

0 0.5 1 1.5 2
Kilometers
0 0.5 1 1.5 2
Miles

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

Base Map: USGS 1:24,000 Topo

Appendix D - Attachment 1
Selection of Dynamic and Stable Reaches
Composite Active Floodplain Boundary
Fairbank Quad
Relatively Dynamic Reach of the Babocomari River (Part 1)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N

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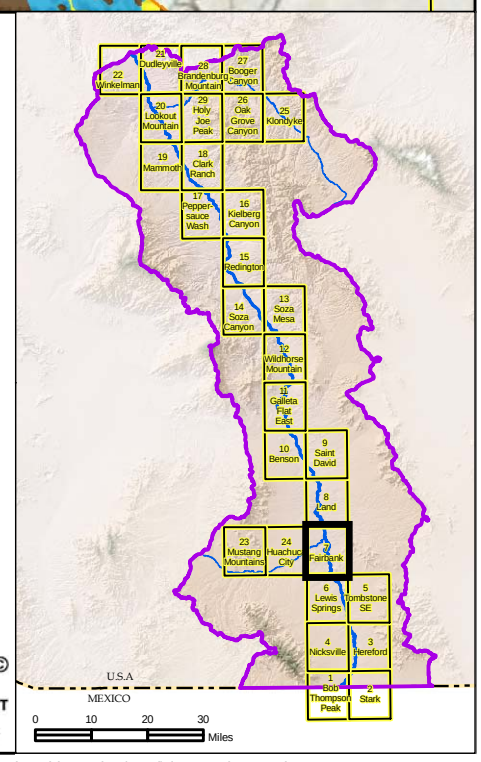

0 0.25 0.5 0.75 1 Kilometers

0 0.25 0.5 Miles

Legend

- Composite Active Floodplain Boundary
- Floodplain in 2007
- Floodplain in 1980s/1990s
- Floodplain in 1950s
- Floodplain in 1935

Land

Fairbank

Huachuca City

Mustang Mountains

Babocomari River

Lewis Springs

North Gate

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

Base Map: USGS 1:24,000 Topo

Appendix D - Attachment 1
Selection of Dynamic and Stable Reaches
Composite Active Floodplain Boundary
Huachuca City Quad
Relatively Dynamic Reach of the Babocomari River (Part 2)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

157 Major Stream and River Mile Locations

San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

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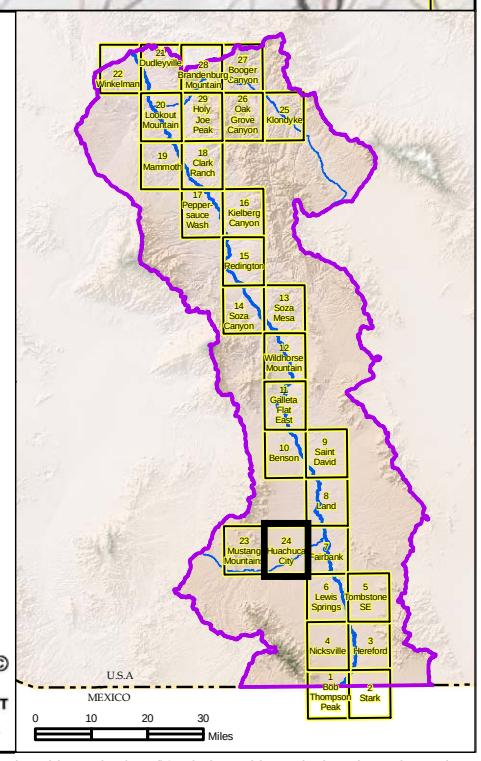
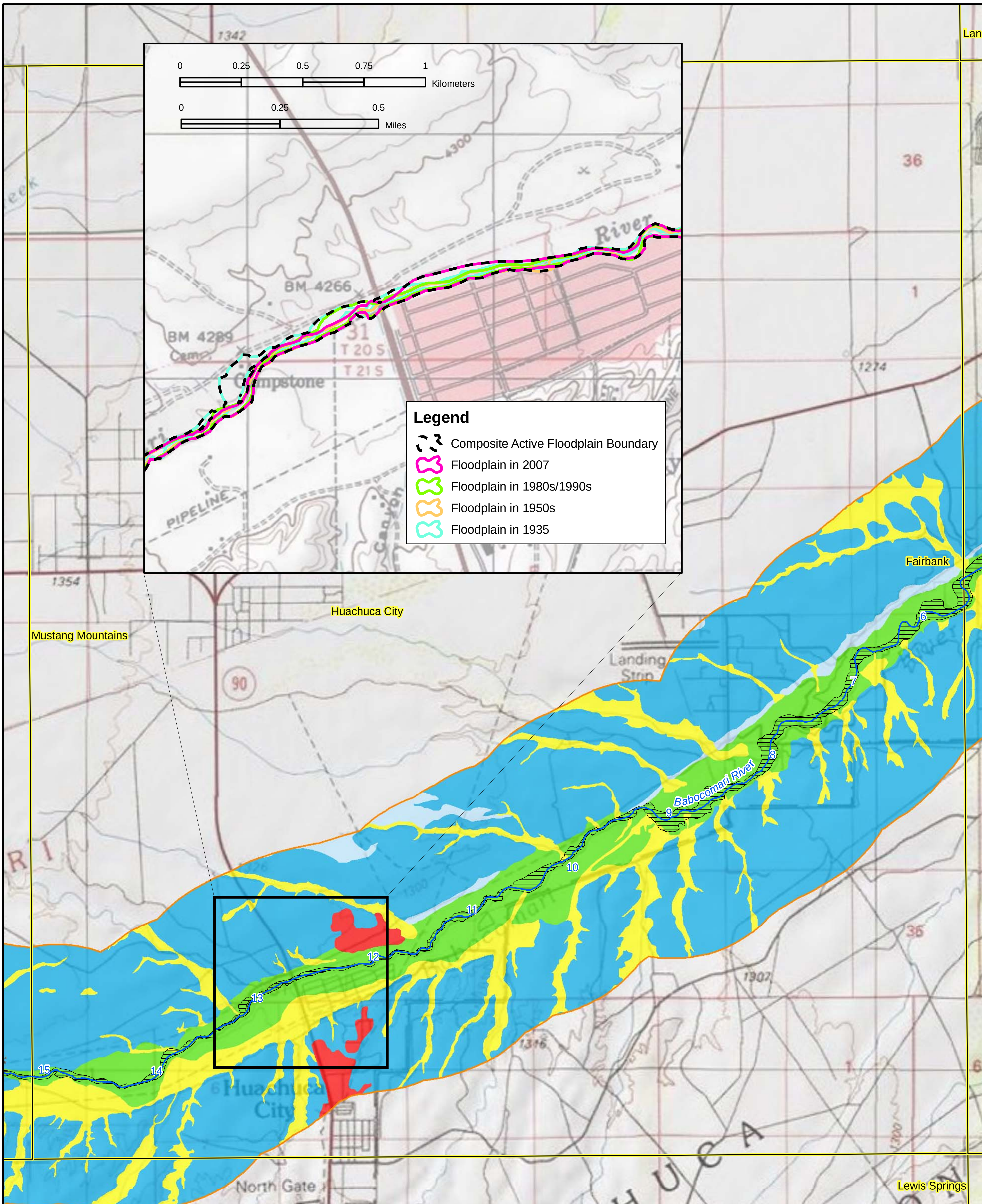




0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

Historical (1930s to 2007) Composite Active Floodplain Boundary

Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

Base Map: USGS 1:24,000 Topo

Appendix D - Attachment 1
Selection of Dynamic and Stable Reaches
Composite Active Floodplain Boundary
Huachuca City Quad
Relatively Stable Reach of the Babocomari River

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

157 Major Stream and River Mile Locations

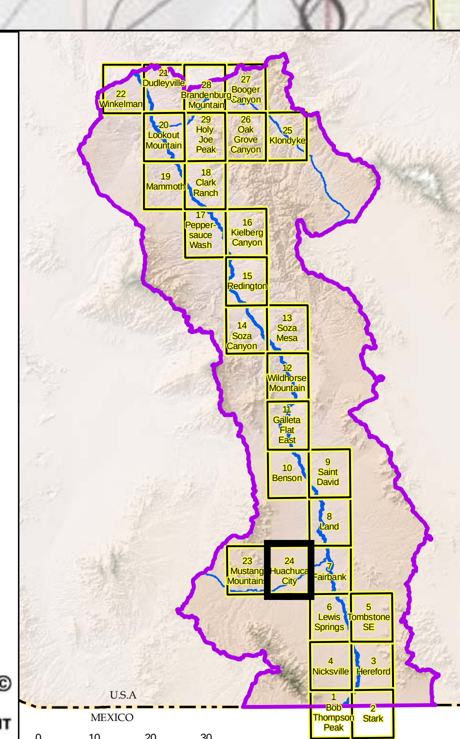
San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

N



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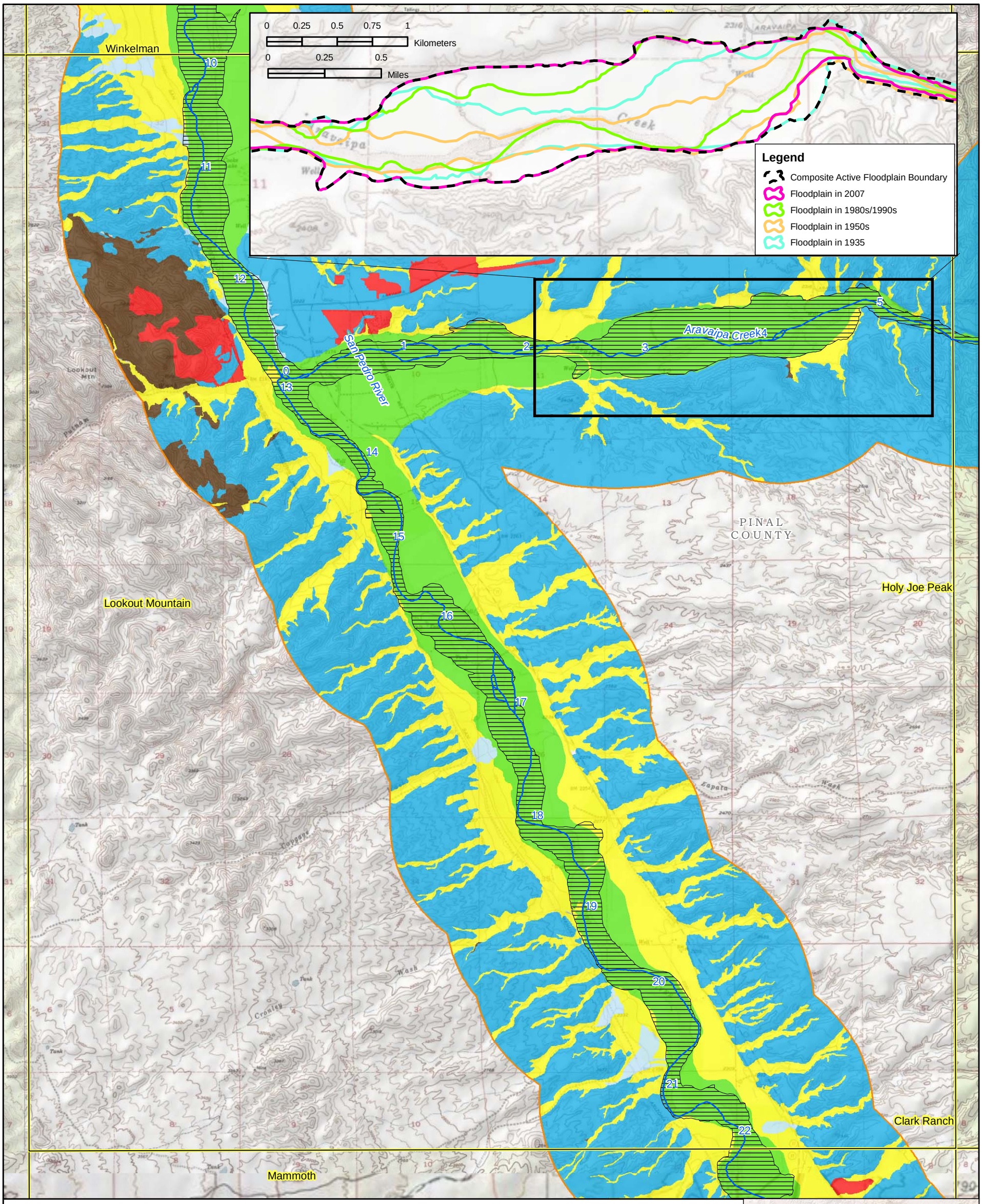

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Brandenburg Mountain
Dudleyville
Booger Canyon
Lookout Mountain
Mammoth
Clark Ranch
Aravaipa Creek
Flat Top Mountain
Oak Spring
Canyon
Mining Mtn
Holy Joe
Zapata Mtn
Satathite Mountain
Indian Head
Aravaipa Farms
Vale Distric
Interest Ranch
Satathite

Legend

- Composite Active Floodplain Boundary
- Floodplain in 2007
- Floodplain in 1980s/1990s
- Floodplain in 1950s
- Floodplain in 1935

0 0.25 0.5 0.75 1 Kilometers

0 0.25 0.5 Miles

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 1
Selection of Dynamic and Stable Reaches
Composite Active Floodplain Boundary
Holy Joe Peak Quad
Relatively Stable Reach of the Aravaipa Creek

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

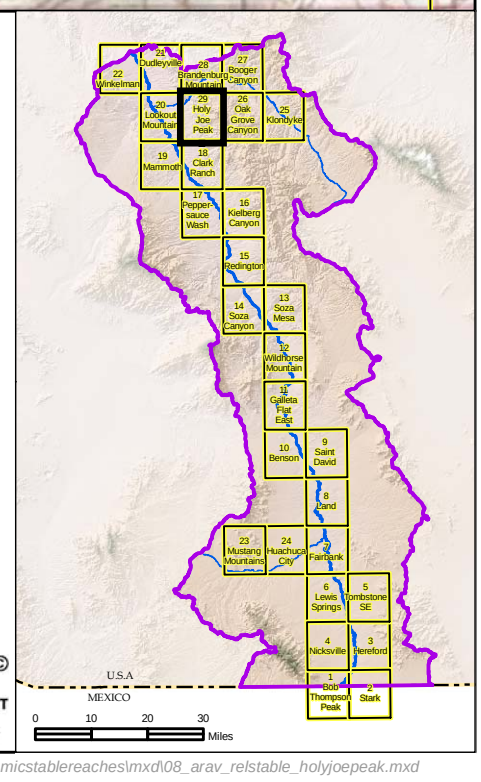
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

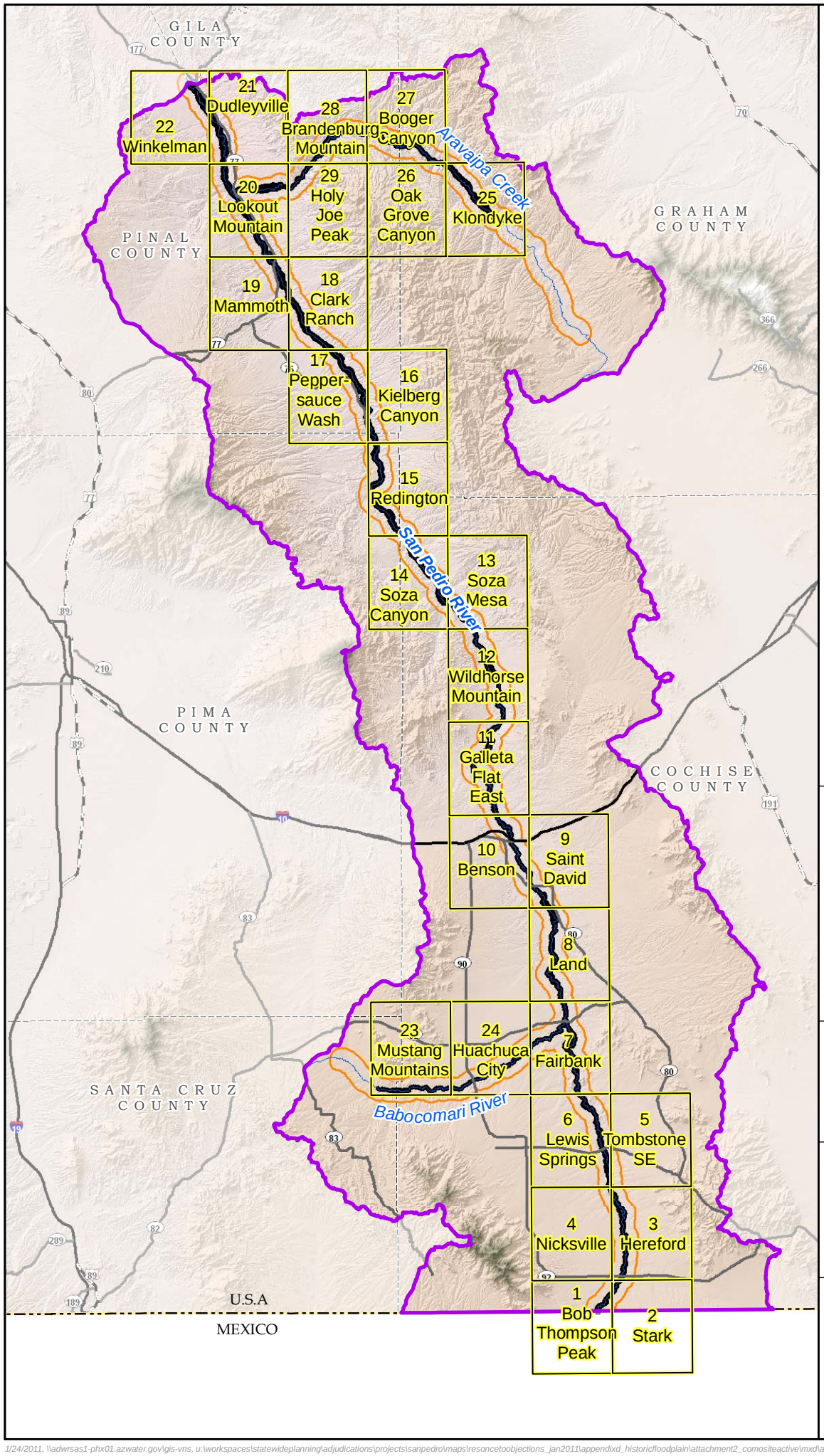
- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

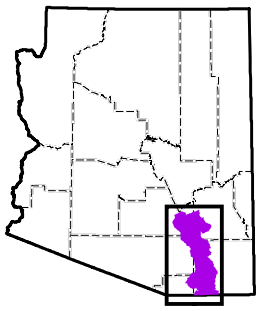
ARIZONA DEPARTMENT OF WATER RESOURCES ©

Attachment 2



Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)
- USGS Topo Quad Boundary
- San Pedro River Watershed
- Major Stream
- Interstate Highway
- U.S. Route
- State Highway
- County
- State Boundary
- International Boundary



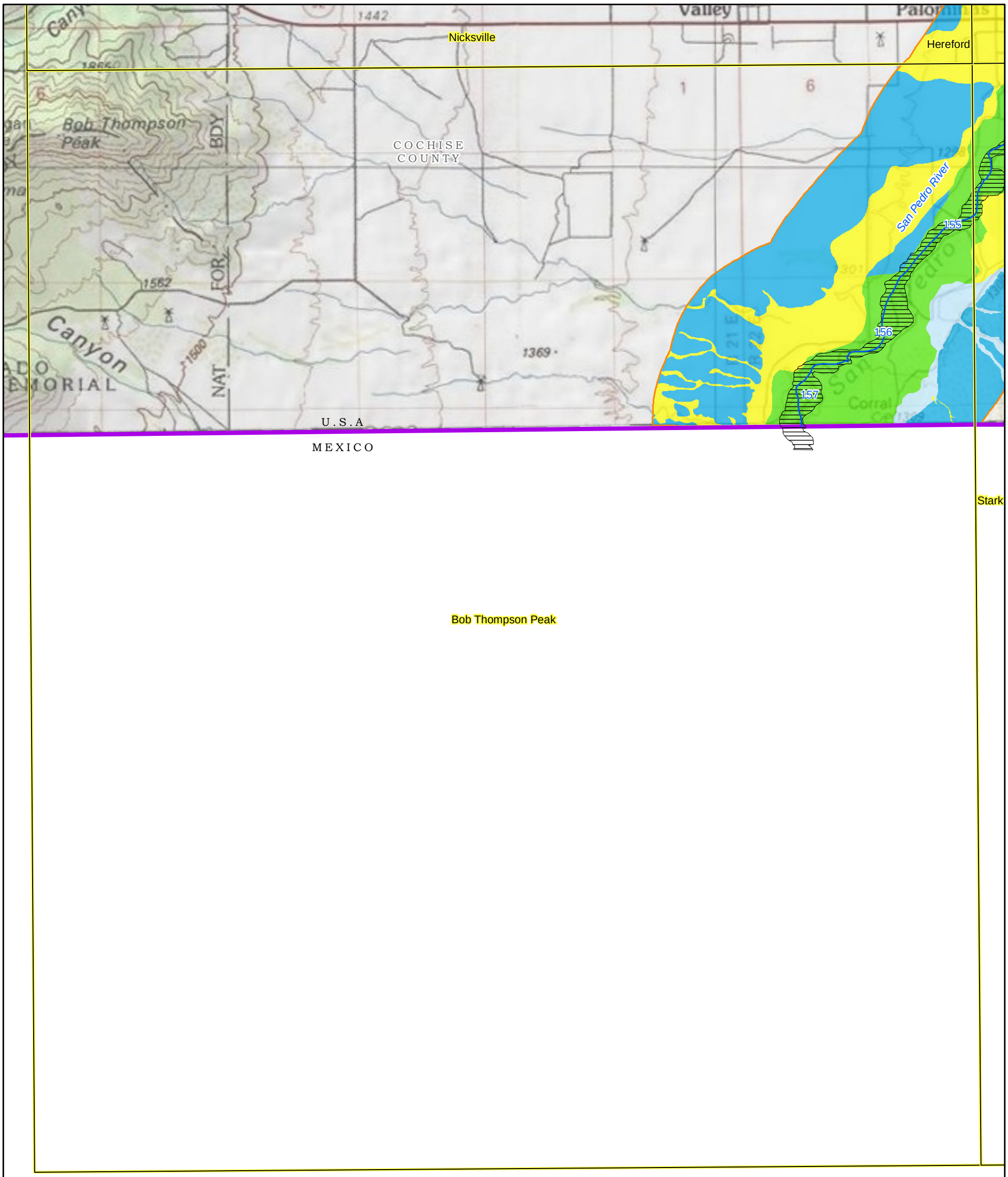
N

ARIZONA DEPARTMENT OF WATER RESOURCES

0 5 10 15 Miles

Appendix D
Attachment 2
Index Map
Composite Active Floodplain Boundary

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed



0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Bob Thompson Peak Quad (Page 1 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

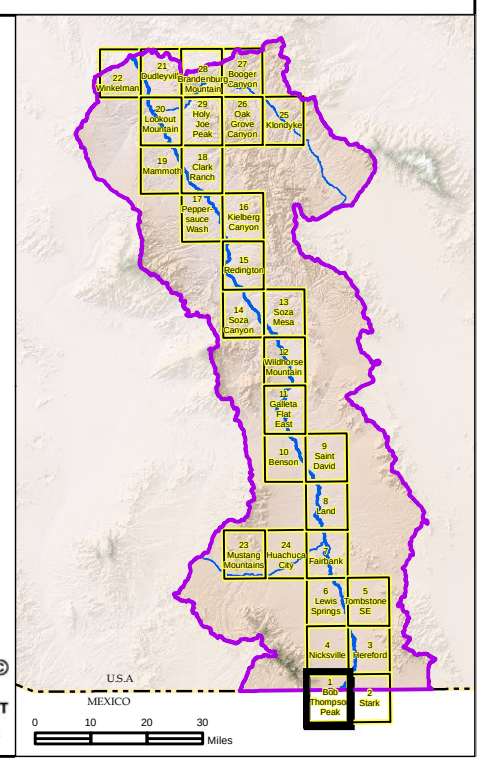
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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Nicksville
Hereford
Stark
153
San Pedro River
154
55
1331
Draw
6
92
1351
1350
1352
COCHISE
COUNTY
R 22 E
R 23 E
1395
U.S.A
COCHISE CO
MEXICO
Stark
Bob Thompson Peak

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Stark Quad (Page 2 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

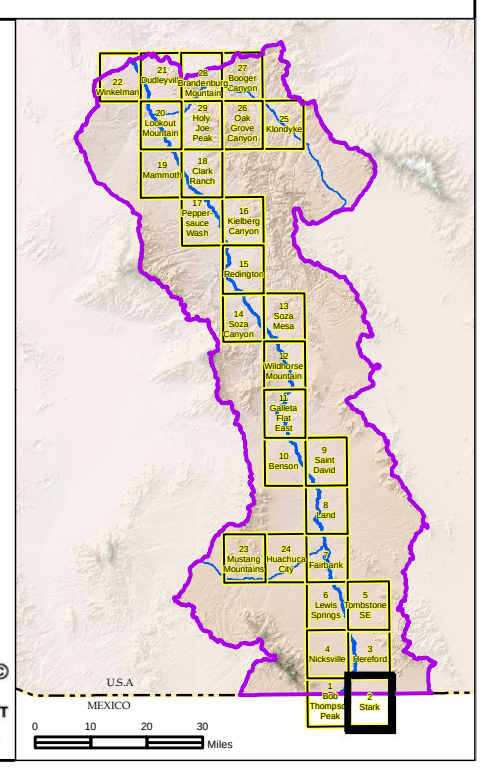
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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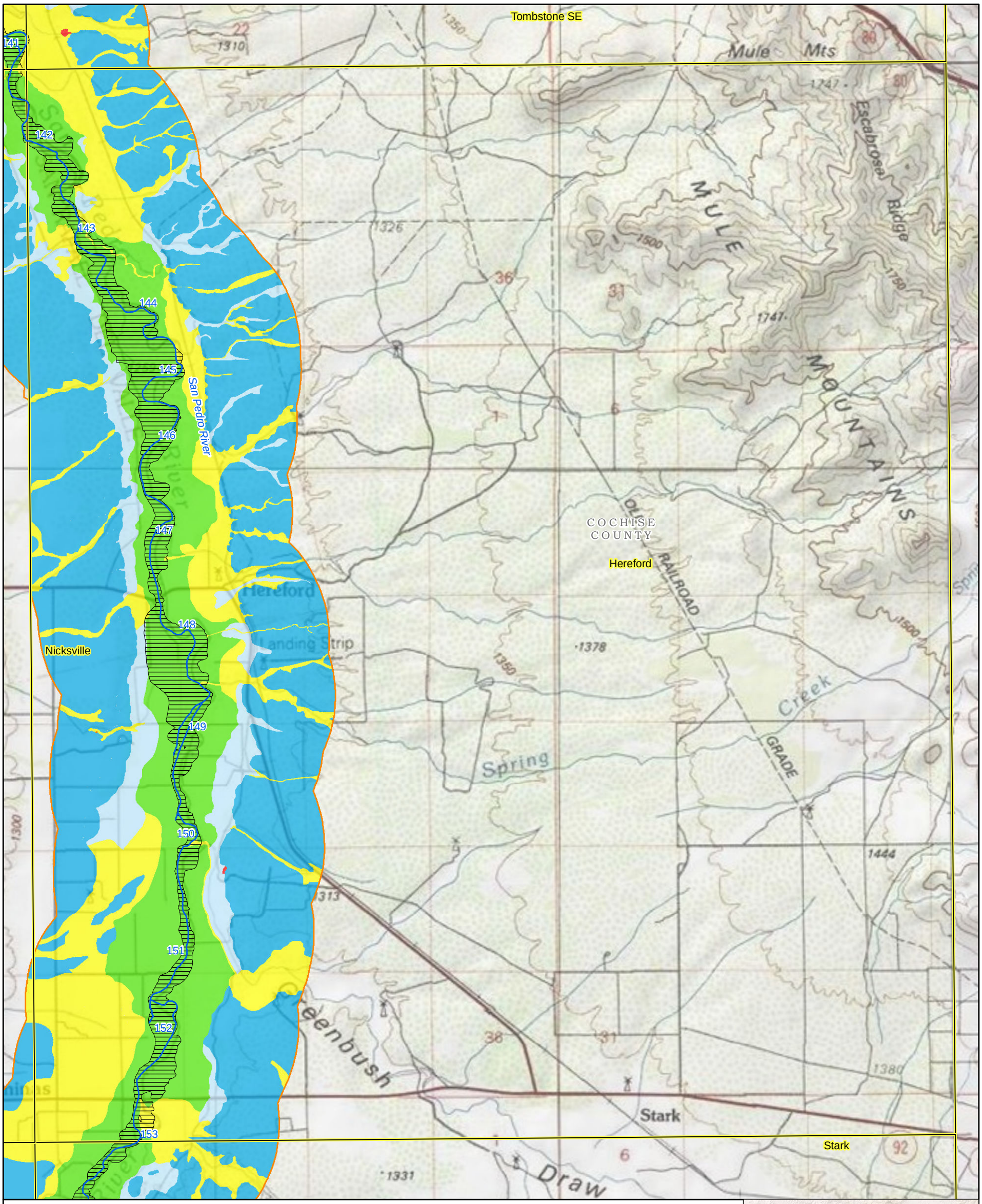


Appendix D - Attachment 2
Composite Active Floodplain Boundary
Hereford Quad (Page 3 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

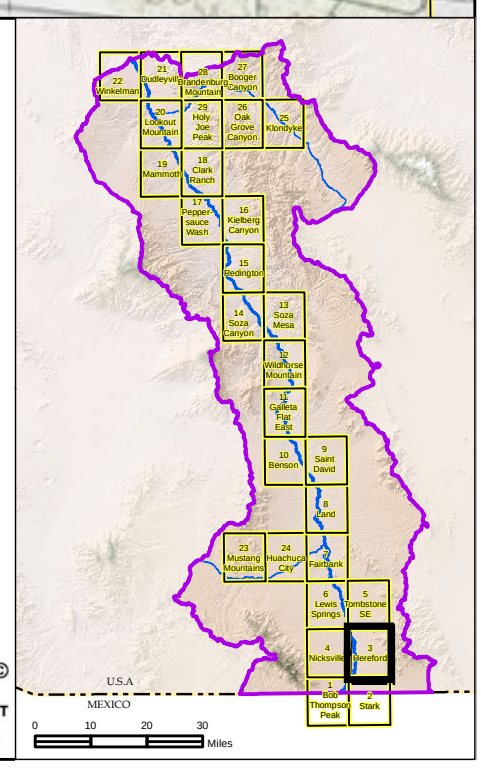
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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Lewis Springs
Tombstone SE
San Pedro River
Hereford
Nicksville
COCHISE COUNTY
Landing Strip
Miracle Valley
Bob Thompson Peak
Stark
T 22 S
T 23 S

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Nicksville Quad (Page 4 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

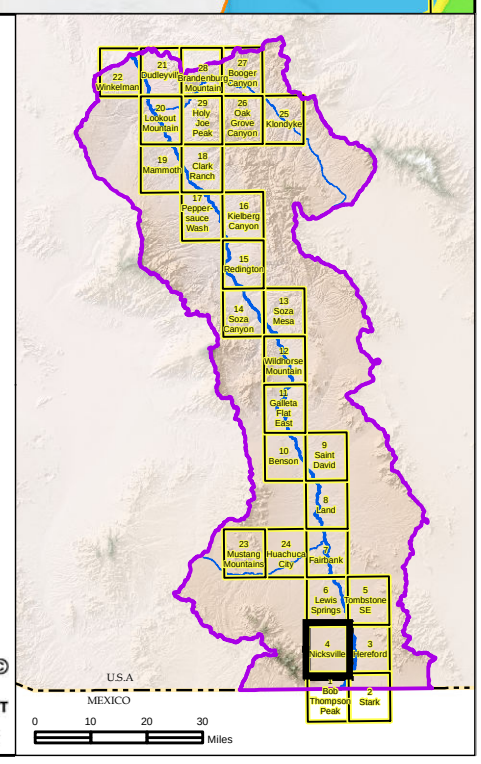
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



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Base Map: USGS 1:24,000 Topo

Fairbank

Draw

Government

COCHISE
COUNTY

Tombstone SE

Lewis Springs

Nicksville

Hereford

Mule Mts

San Pedro River

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Tombstone SE Quad (Page 5 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

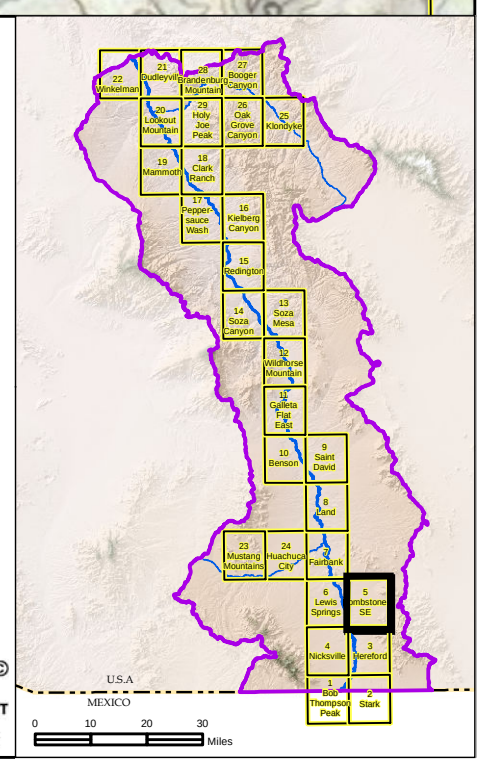
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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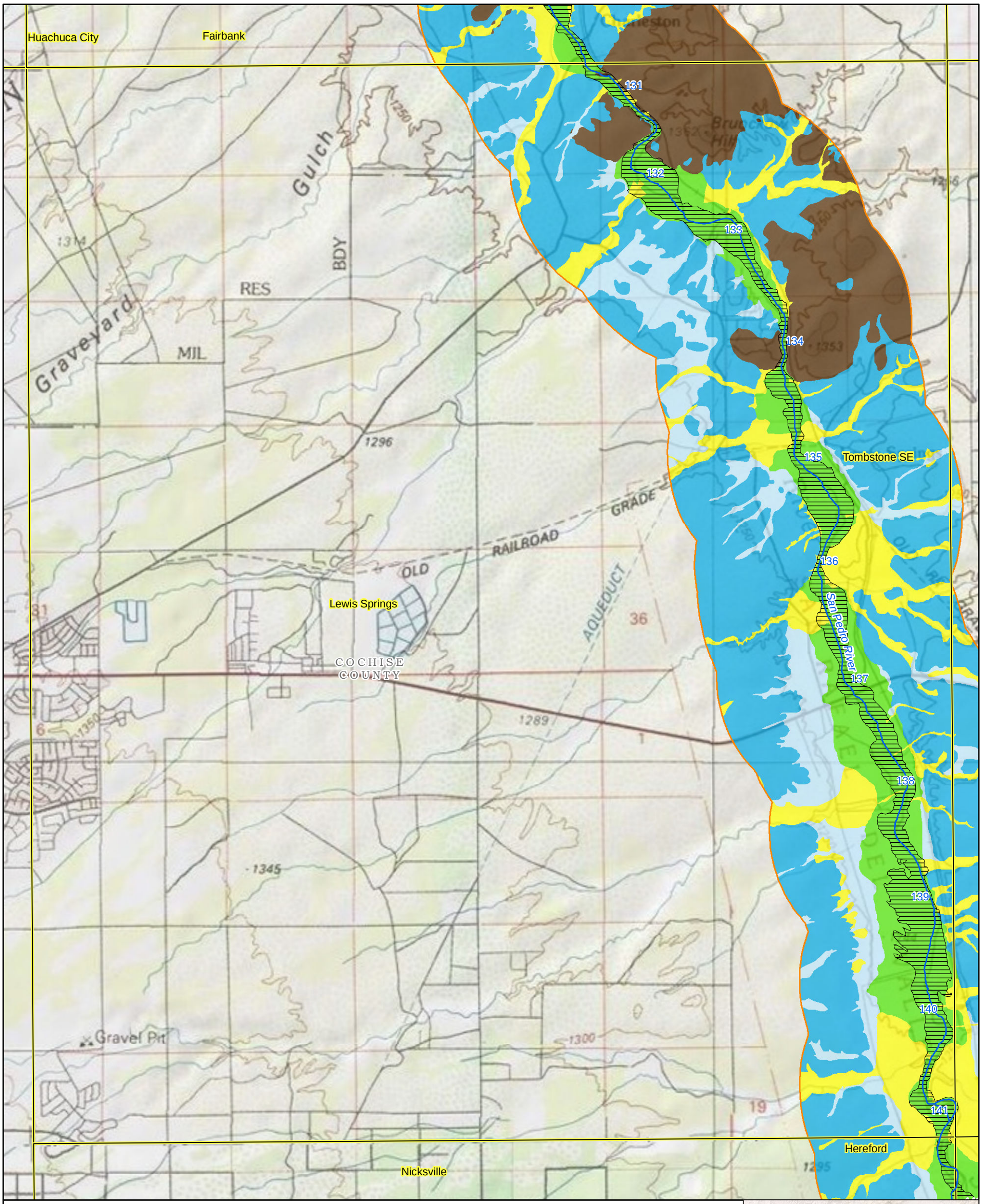

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Lewis Springs Quad (Page 6 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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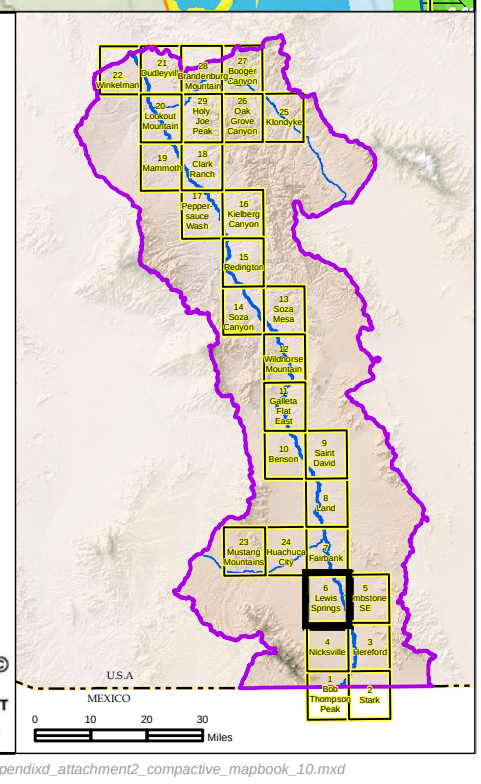
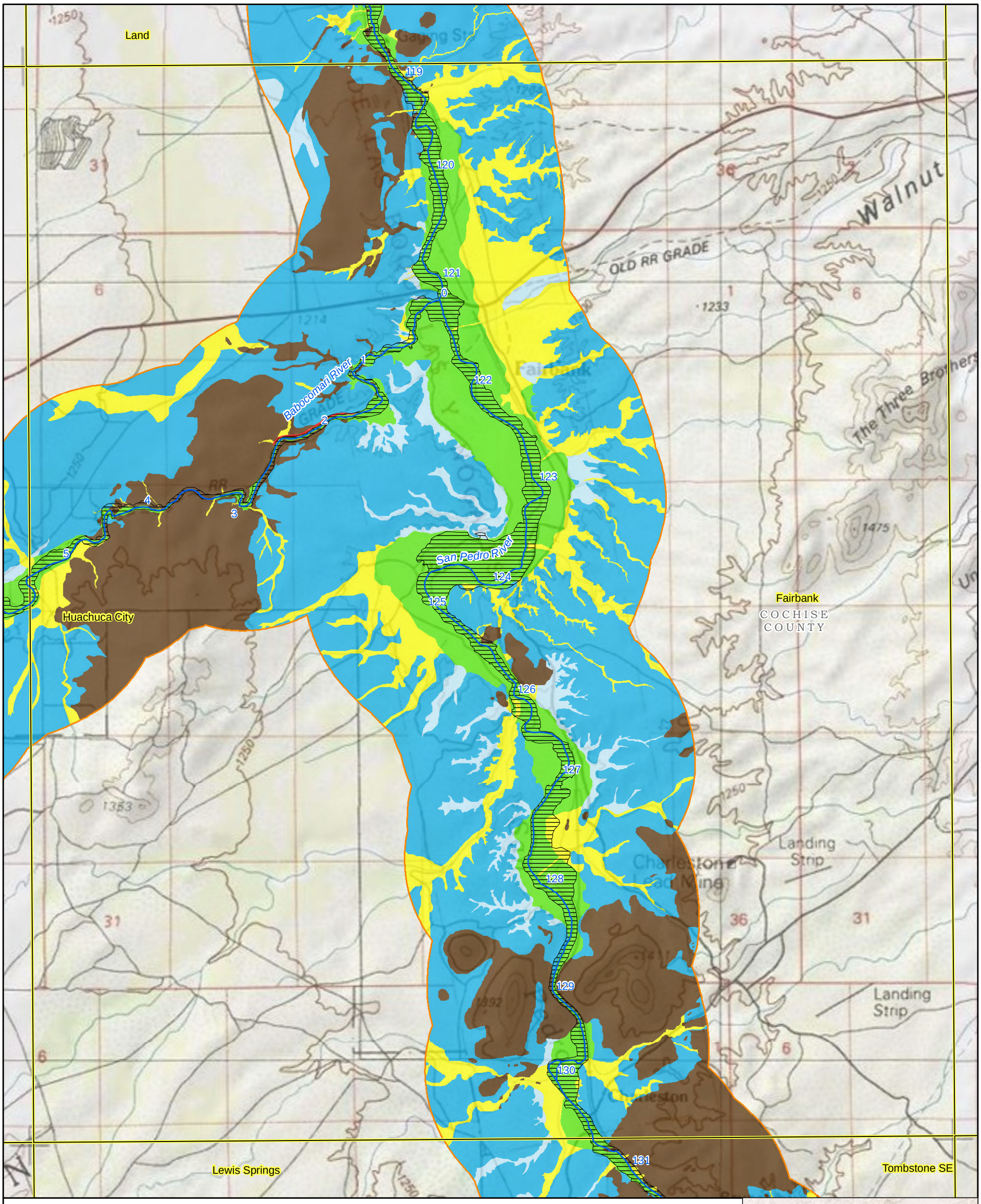


Base Map: USGS 1:24,000 Topo



Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

Base Map: USGS 1:24,000 Topo

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Fairbank Quad (Page 7 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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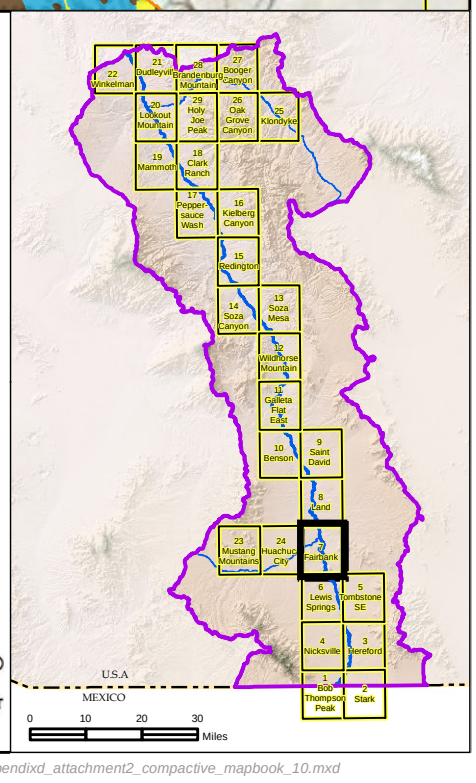

Saint David
Benson
Slavin
Escalante
Curtis
Corral
Wash
Section 30
Windmill
Flowing Well
COCHISE COUNTY
San Pedro River
Land
Curtis Windmill
Huachuca City
Fairbank
107
108
109
110
111
112
113
114
115
116
117
118
119

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Land Quad (Page 8 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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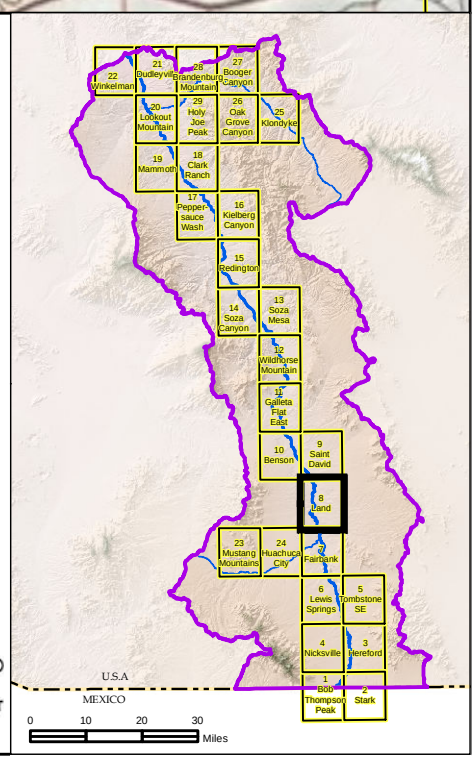

Base Map: USGS 1:24,000 Topo

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Appendix D - Attachment 2
Composite Active Floodplain Boundary
Saint David Quad (Page 9 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

Galleta Flat East
Benson
Saint David
Land
Fenner
Sibyl
Substa
Tul
Slavin
Lonesome Valley
COCHISE COUNTY
Dragoon
Sheep Wash
San Pedro River
103
104
105
106
107
1131
1150
1246
1256
1288
1250

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

N

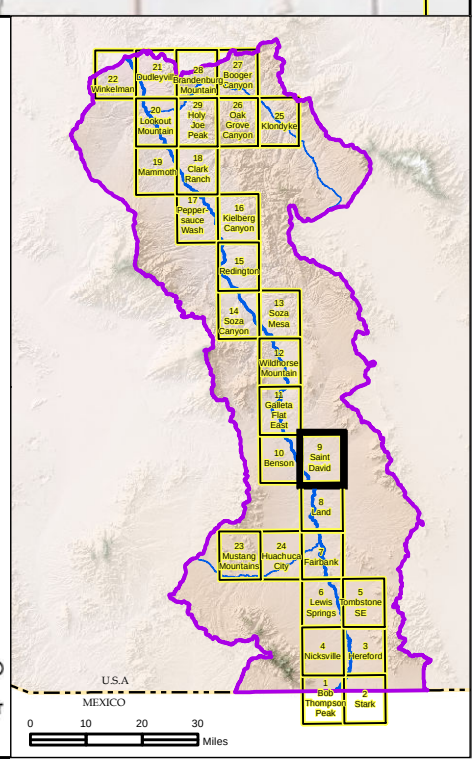
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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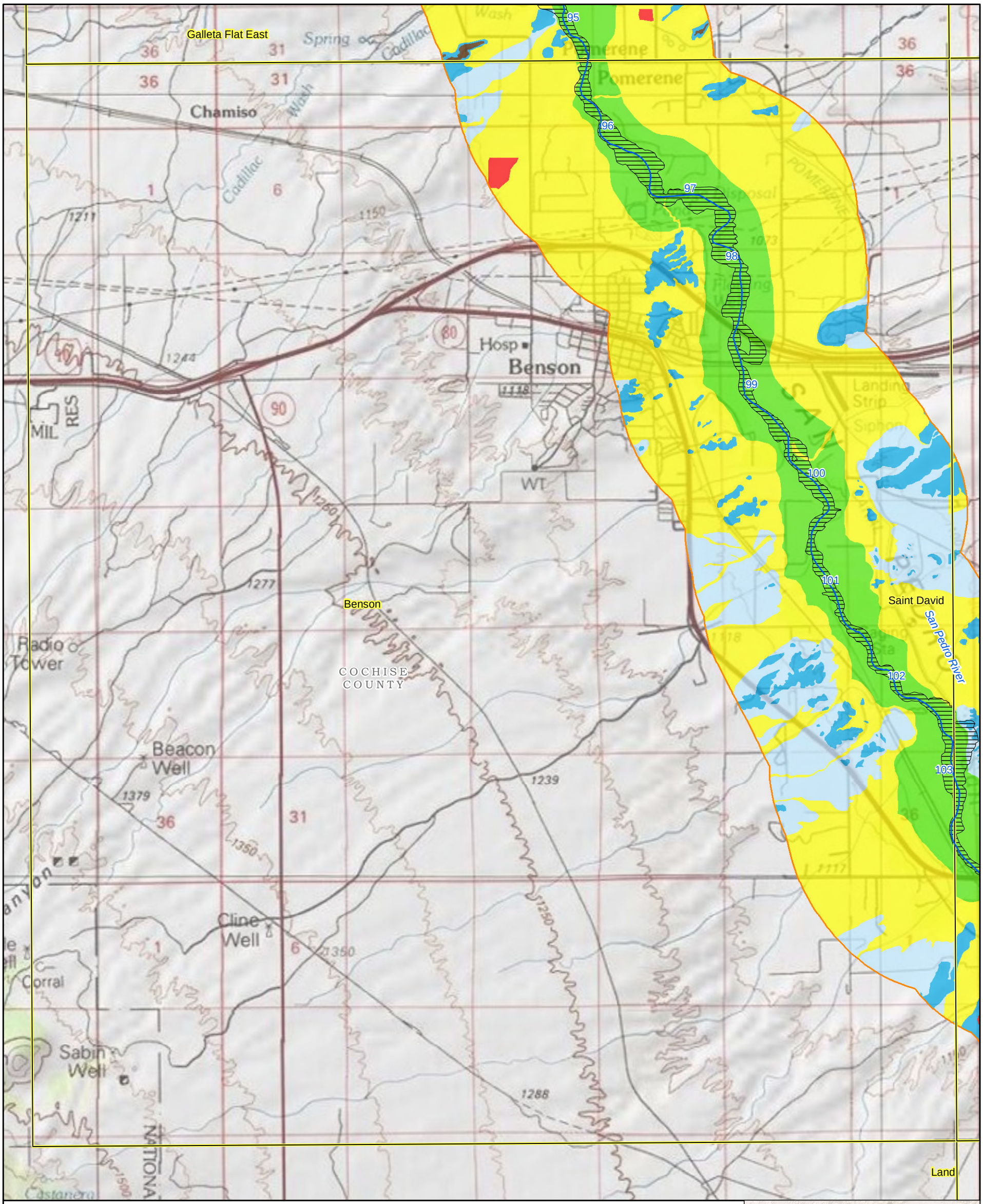


Appendix D - Attachment 2
Composite Active Floodplain Boundary
Benson Quad (Page 10 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

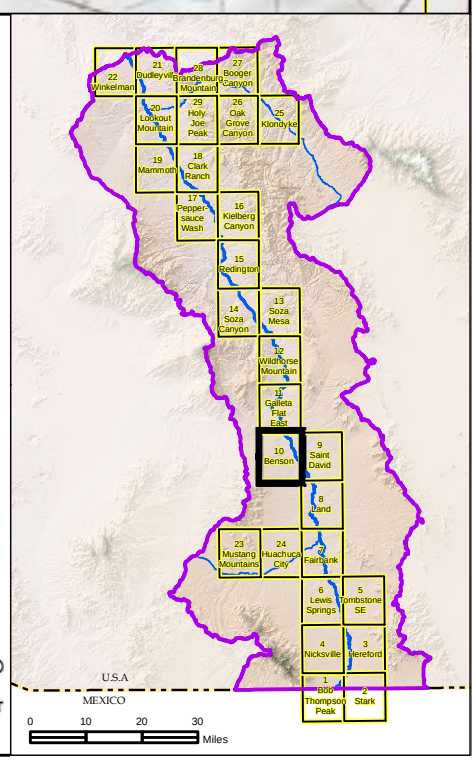
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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Appendix D - Attachment 2
Composite Active Floodplain Boundary
Galleta Flat East Quad (Page 11 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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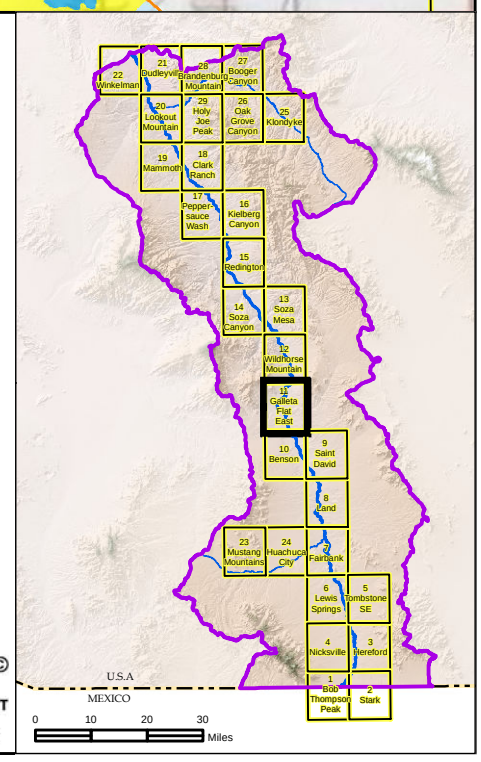


Base Map: USGS 1:24,000 Topo

Soza Mesa
Soza Canyon
Wildhorse Mountain
Galleta Flat East
San Pedro River
Palomas
Water tank
COCHISE COUNTY
Creek
Spring
Well
Bedrock
Wildhorse Mtn
4WD
MEXICO
U.S.A

71 72 73 74 75 76 77 78 79 80 81 82

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Wildhorse Mountain Quad (Page 12 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

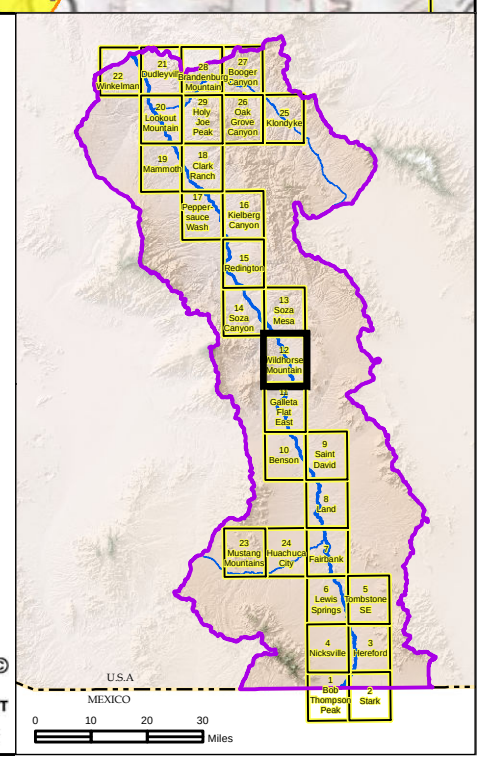
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



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Base Map: USGS 1:24,000 Topo

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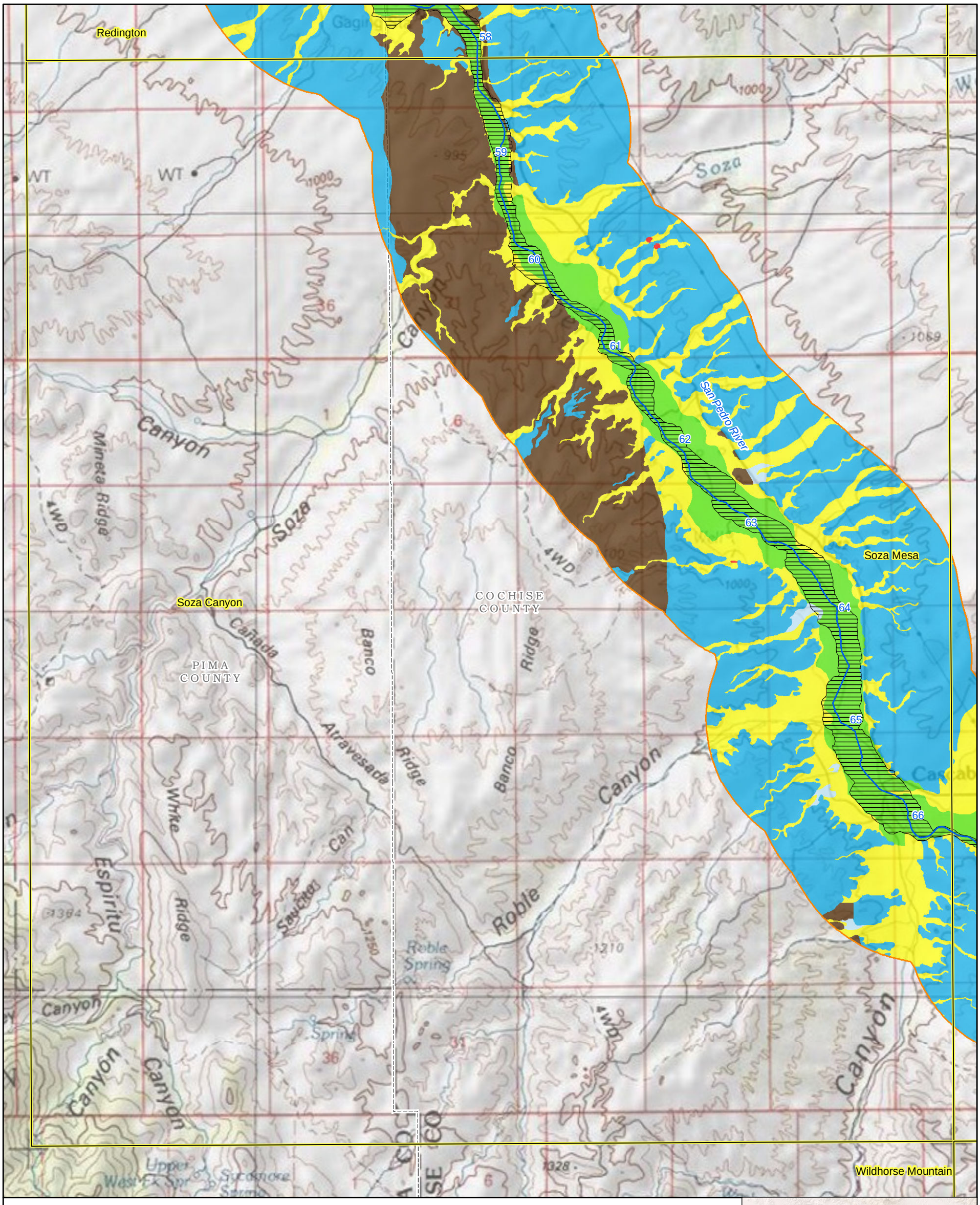


0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Soza Canyon Quad (Page 14 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

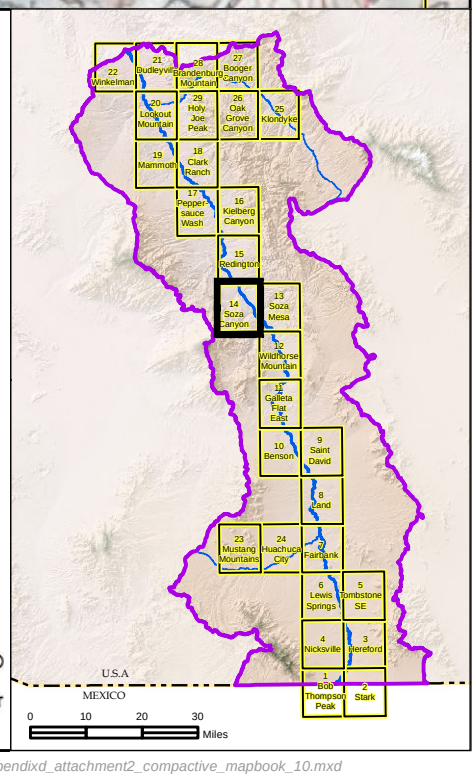
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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Appendix D - Attachment 2
Composite Active Floodplain Boundary

Redington Quad (Page 15 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

N

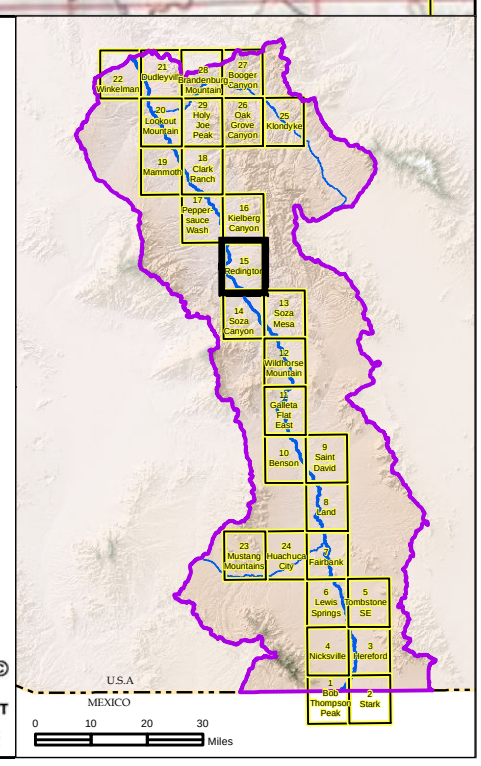
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



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Base Map: USGS 1:24,000 Topo

Clark Ranch

Peppersauce Wash

Kielberg Canyon

Redington

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Kielberg Canyon Quad (Page 16 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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Base Map: USGS 1:24,000 Topo

U.S.A
MEXICO
0 10 20 30 Miles

12/20/2010, \\adwrsas1-phx01.azwater.gov\gis-vns, u:\workspaces\statewideplanning\adjudications\projects\sanpedro\maps\resoncetoobjections_jan2011\appendixd_historicfloodplain\attachment2_comositeactive\mxd\appendixd_attachment2_compactive_mapbook_10.mxd

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Peppersauce Wash Quad (Page 17 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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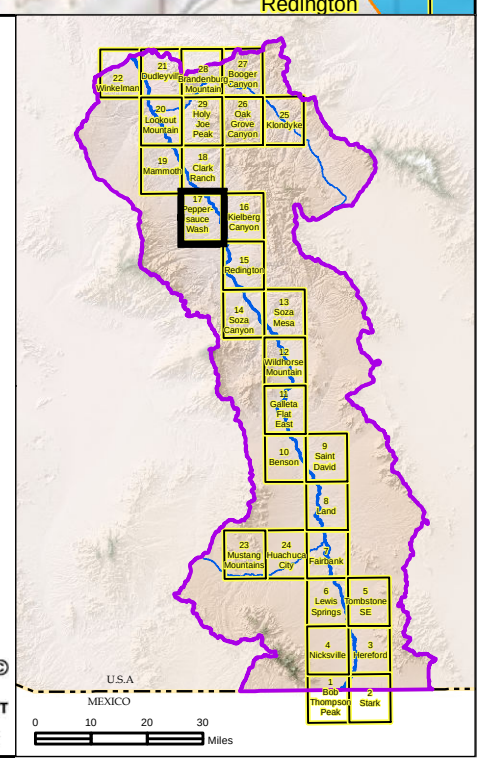


Base Map: USGS 1:24,000 Topo

Lookout Mountain
Holy Joe Peak
Oak Grove Canyon
Mammoth
Clark Ranch
Peppersauce Wash
Kielberg Canyon
Tailings Pond
San Pedro River
Copper Wash
Mulberry Spring
Mulberry Wash
Scraton Wash
Clark Wash
James Gust
Little James Wash
PINAL COUNTY
Canyon Well
1174
913
880
1000
26
27
28
29
30
31
32
33
34
36
1
6

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Clark Ranch Quad (Page 18 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

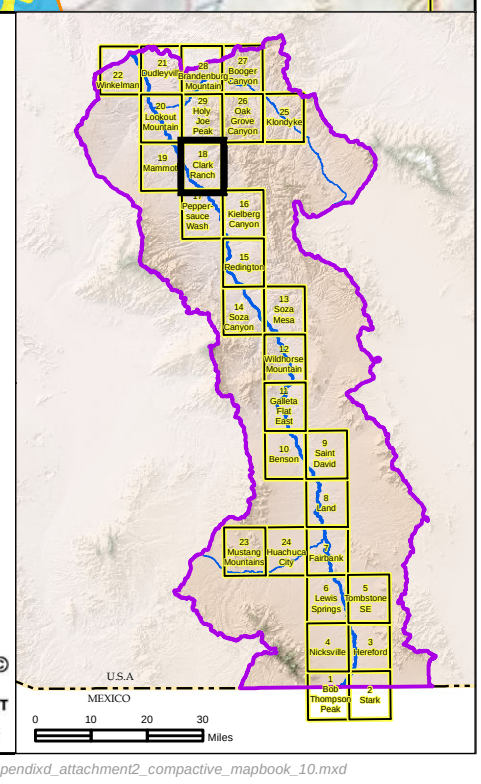
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



ARIZONA DEPARTMENT OF WATER RESOURCES ©

Base Map: USGS 1:24,000 Topo

Lookout Mountain
Holy Joe Peak
Pearl Mine
Hills
4WD
Wash
Tar
Tar Mine
Signal Peak
1330
San Pedro River
22
23
24
25
26
27
Mammoth
PINAL COUNTY
Clark Ranch
Peppersauce Wash

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Mammoth Quad (Page 19 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

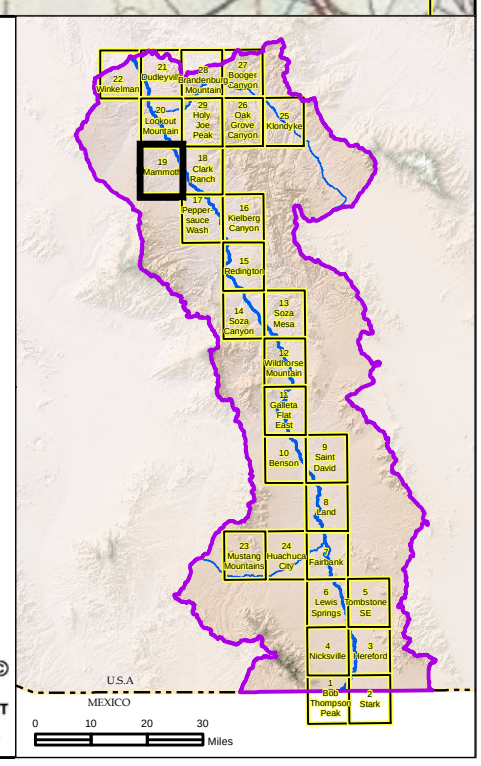
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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Winkelman
Dudleyville
Brandenburg Mountain
Lookout Mountain
PINAL COUNTY
Holy Joe Peak
Clark Ranch
Mammoth
Aravaipa Creek
San Pedro River

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Lookout Mountain Quad (Page 20 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

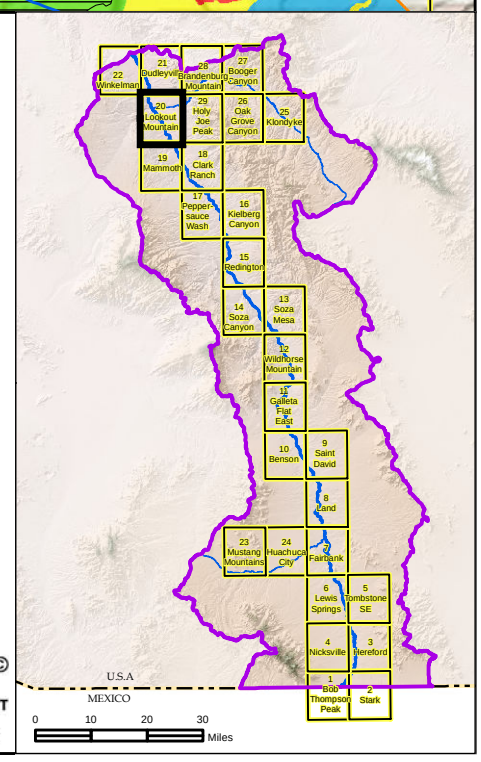
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



ARIZONA DEPARTMENT OF WATER RESOURCES

©

Base Map: USGS 1:24,000 Topo

Saddle Mtn
Piper Sprigg
Wash
Piper Sprigg
Reach
Wash
Kelleys Camp
Eskimazene Ranch
Winkelman
PINAL COUNTY
Dudleyville
Brandenburg Mountain
San Pedro River
Holy Joe Peak
Lookout Mountain

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Dudleyville Quad (Page 21 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

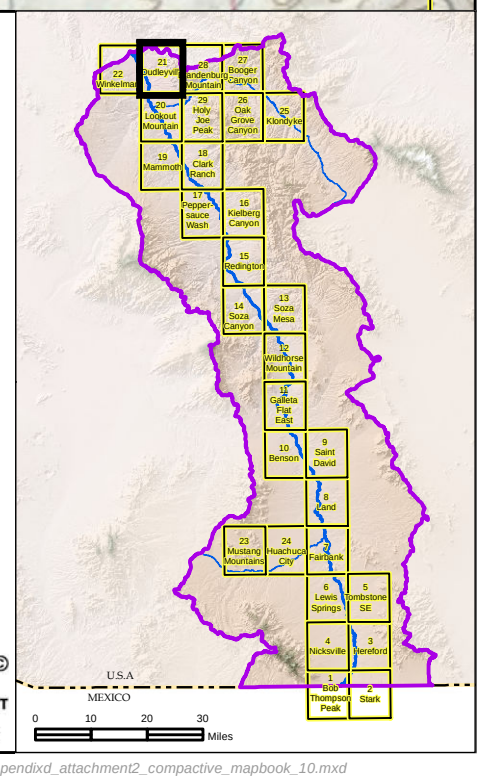
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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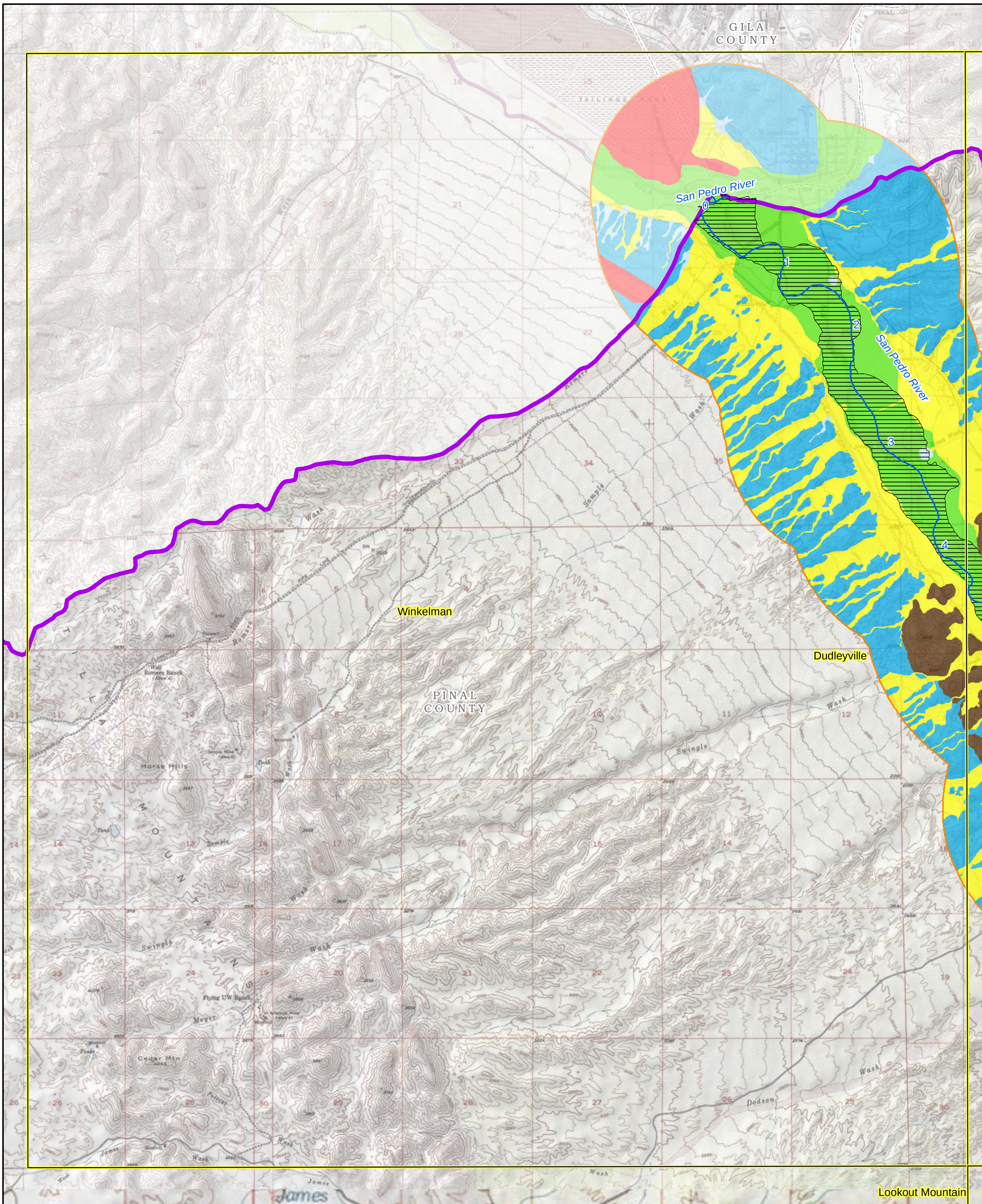


0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Winkelman Quad (Page 22 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

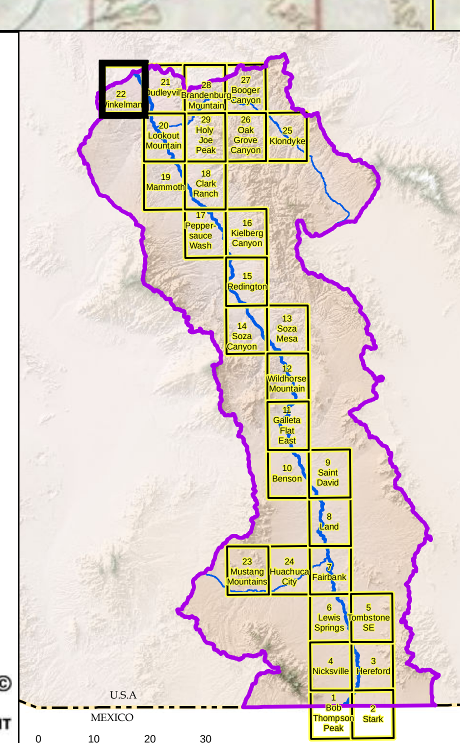
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



ARIZONA DEPARTMENT OF WATER RESOURCES ©

Base Map: USGS 1:24,000 Topo

PIMA COUNTY

Goat Well

1696

Cottonwood Spring

36

PIMA CO

SANTA CRUZ CO

1500

1

Rain Valley

1855 Mt Bruce

Mustang Mountains

Mustang Pk

1975

1750

Mustang Mountains

SANTA CRUZ COUNTY

1972

1750

Juniper Spring

NATIONAL FOREST BOUNDARY

Mescal Spring

4WD

31

COCHISE CO

Mescal Creek

1388

1500

1672

Huachuca City

COCHISE COUNTY

1580

1500

36

31

BABOCOMARI

1674

1380

Babocomari River

24

23

22

21

20

19

18

17

16

15

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Mustang Mountains Quad (Page 23 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

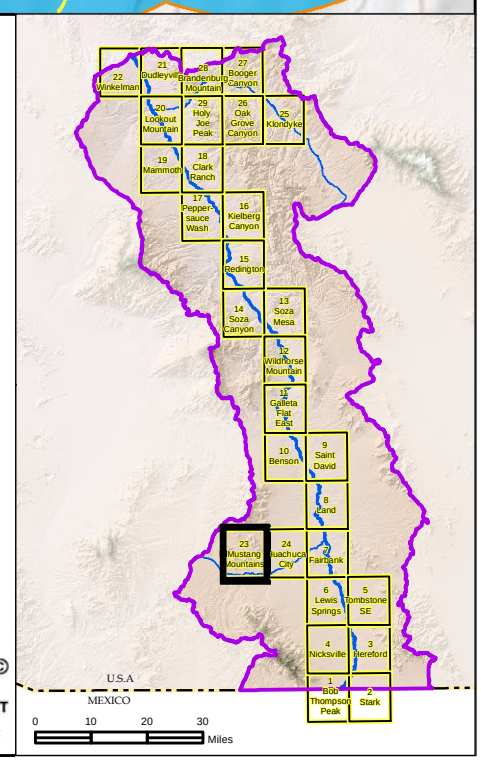
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

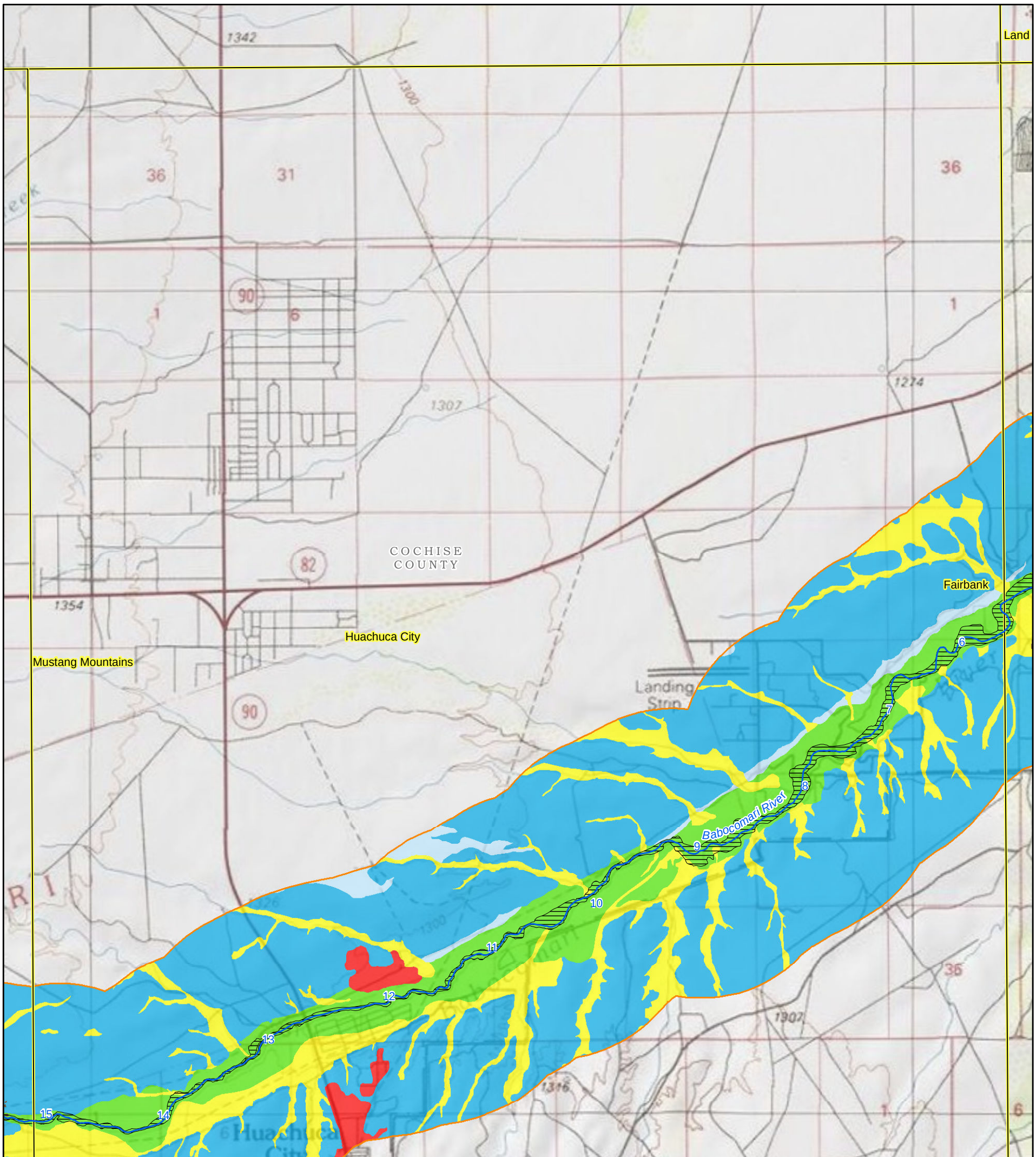
- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

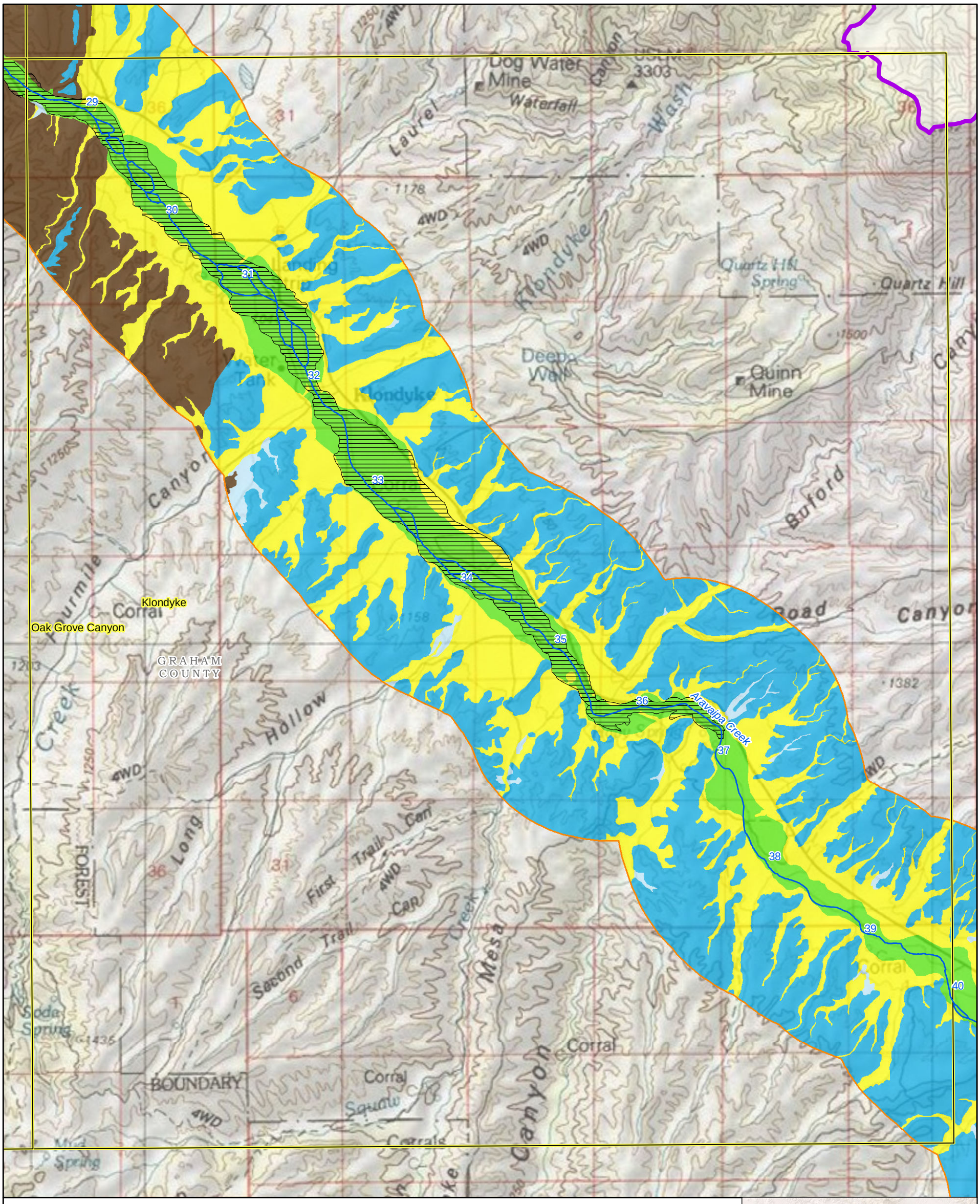


ARIZONA DEPARTMENT OF WATER RESOURCES

Base Map: USGS 1:24,000 Topo

©


Land
1342
1300
36
31
36
90
6
1
1
1274
1307
COCHISE
COUNTY
82
1354
Huachuca City
Mustang Mountains
Fairbank
Landing
Strip
90
6
7
8
Babocomari River
9
10
11
12
13
15
14
1316
1307
36
1
6
North Gate
Lewis Springs
HUCA
0 0.5 1 1.5 2
Kilometers
0 0.5 1 1.5 2
Miles
Legend
Historical (1930s to 2007) Composite Active Floodplain Boundary
Surficial Geology Mapped by AZGS (2009)
Generalized Geologic Units
Floodplain Holocene Alluvium (FHA)
Tributary Holocene Alluvium (THA)
Holocene Basin Fill
Older Basin Filll
Bedrock
Disturbed (unit not determined)
Base Map: USGS 1:24,000 Topo
Appendix D - Attachment 2
Composite Active Floodplain Boundary
Huachuca City Quad (Page 24 of 29)
Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed
N
157
Major Stream and River Mile Locations
San Pedro River Watershed
USGS Topo Quad Boundary
County
International Boundary
ARIZONA
DEPARTMENT
OF WATER
RESOURCES
©
22 Winkelman
21 Dudleyville
28 Brandenburg Mountain
27 Booger Canyon
20 Lookout Mountain
29 Holy Joe Peak
26 Oak Grove Canyon
25 Klondyke
19 Mammoth
18 Clark Ranch
17 Pepper sauce Wash
16 Kielberg Canyon
15 Redington
14 Soza Canyon
13 Soza Mesa
12 Wildhorse Mountain
11 Galleta Flat East
10 Benson
9 Saint David
8 Land
23 Mustang Mountains
24 Huachuca City
7 Fairbank
6 Lewis Springs
5 Tombstone SE
4 Nicksville
3 Hereford
1 Bob Thompson Peak
2 Stark
U.S.A.
MEXICO
0 10 20 30
Miles



0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

Base Map: USGS 1:24,000 Topo

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Klondyke Quad (Page 25 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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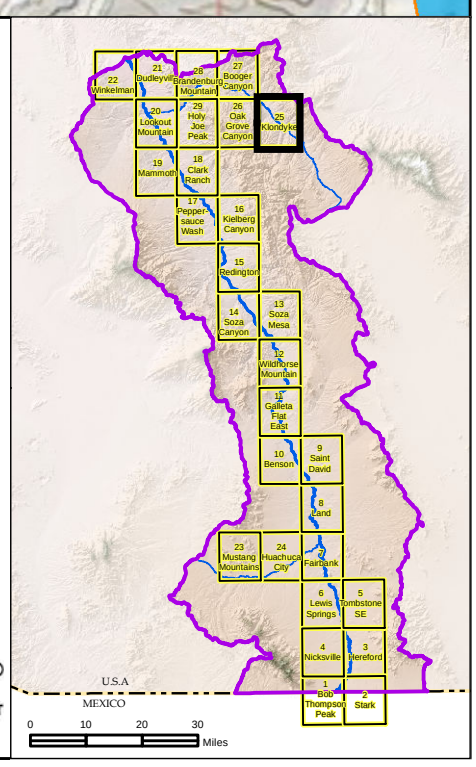


Appendix D - Attachment 2
Composite Active Floodplain Boundary
Oak Grove Canyon Quad (Page 26 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

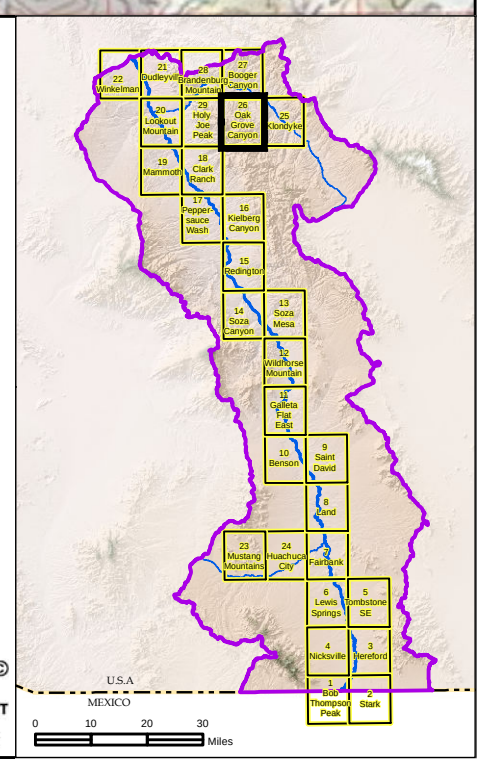
Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



Base Map: USGS 1:24,000 Topo

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Appendix D - Attachment 2
Composite Active Floodplain Boundary
Booger Canyon Quad (Page 27 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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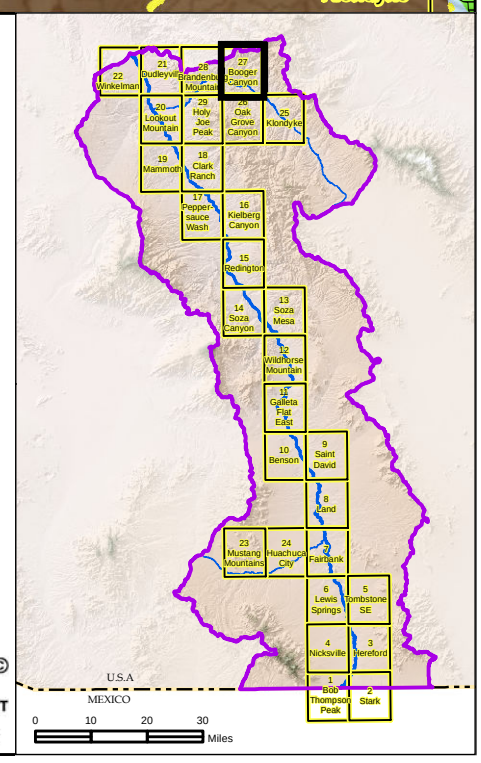
Base Map: USGS 1:24,000 Topo



Appendix D - Attachment 2
Composite Active Floodplain Boundary
Brandenburg Mountain Quad (Page 28 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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Base Map: USGS 1:24,000 Topo

Brandenburg Mountain
Dudleyville
Booger Canyon
Oak Grove Canyon
Holy Joe Peak
Lookout Mountain
Mammoth
Clark Ranch
PINAL COUNTY

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

Appendix D - Attachment 2
Composite Active Floodplain Boundary
Holy Joe Peak Quad (Page 29 of 29)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

Legend

- Historical (1930s to 2007) Composite Active Floodplain Boundary
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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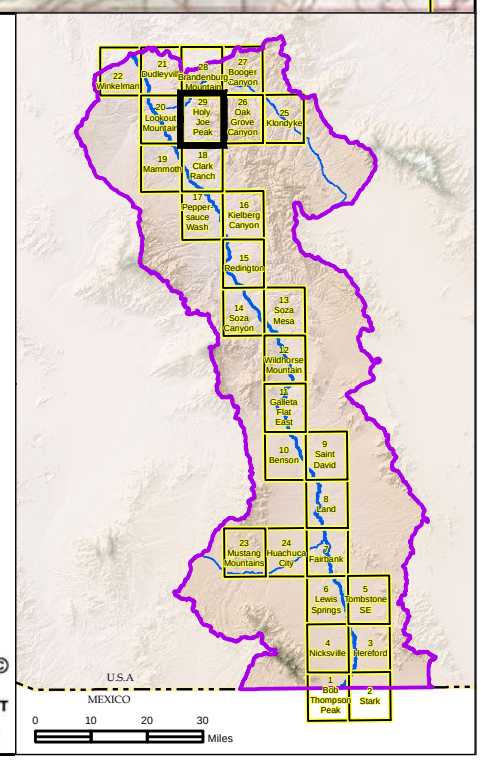
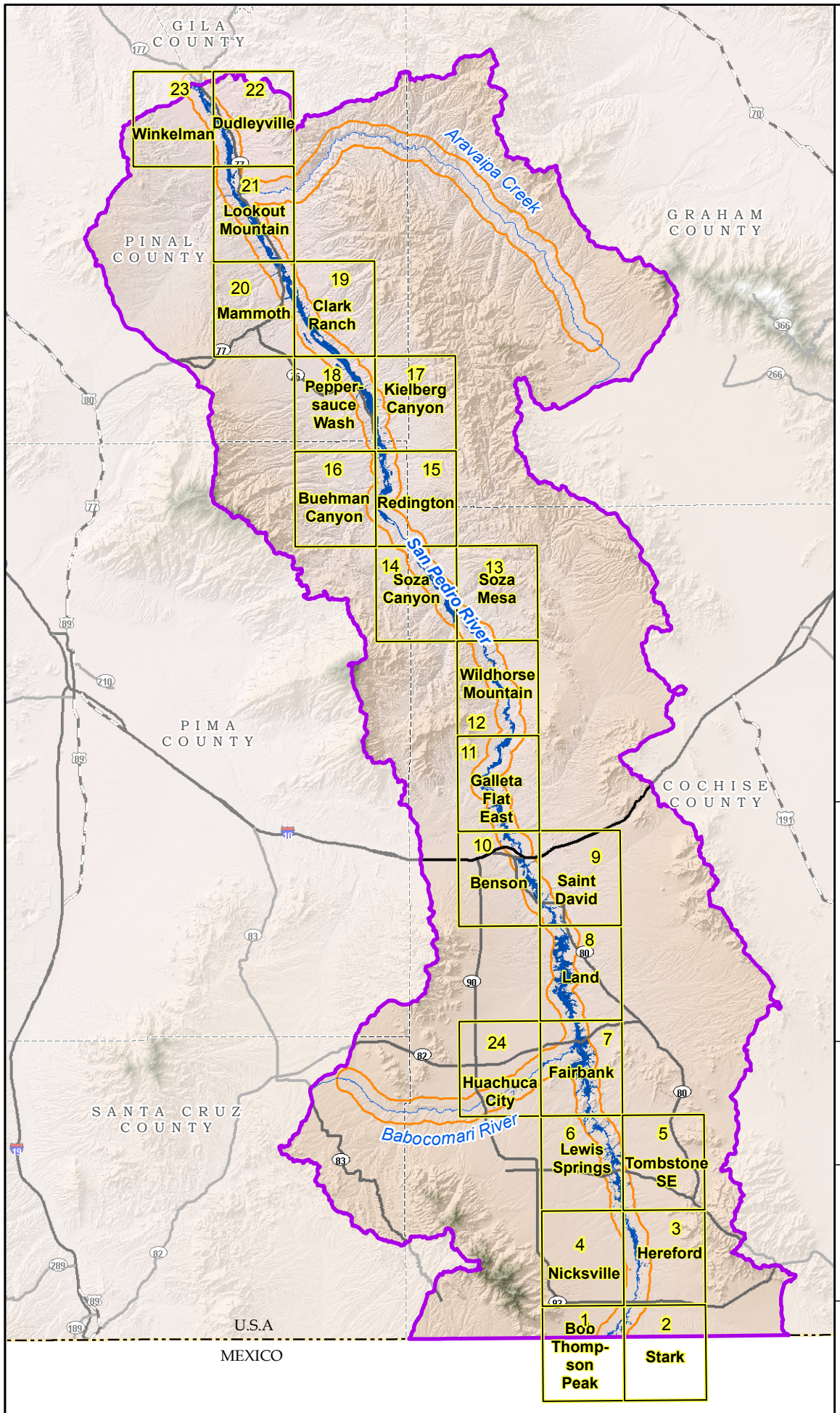


Base Map: USGS 1:24,000 Topo

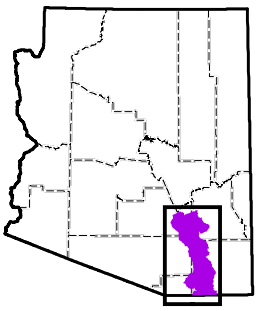
APPENDIX E

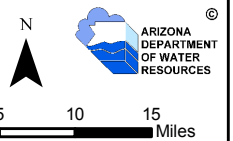
Distribution of
Current Riparian Vegetation



Legend

- USGS Topo Quad Boundary With USFW Wetland/Riparian Areas
- USFWS Riparian/ Wetland Areas
- San Pedro River Watershed
- Area Mapped by AZGS (2009)
- Major Stream
- Interstate Highway
- U.S. Route
- State Highway
- County
- State Boundary
- International Boundary





Appendix E
Surficial Geology of Riparian/Wetland Areas Mapped by the U.S. Fish and Wildlife Service

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

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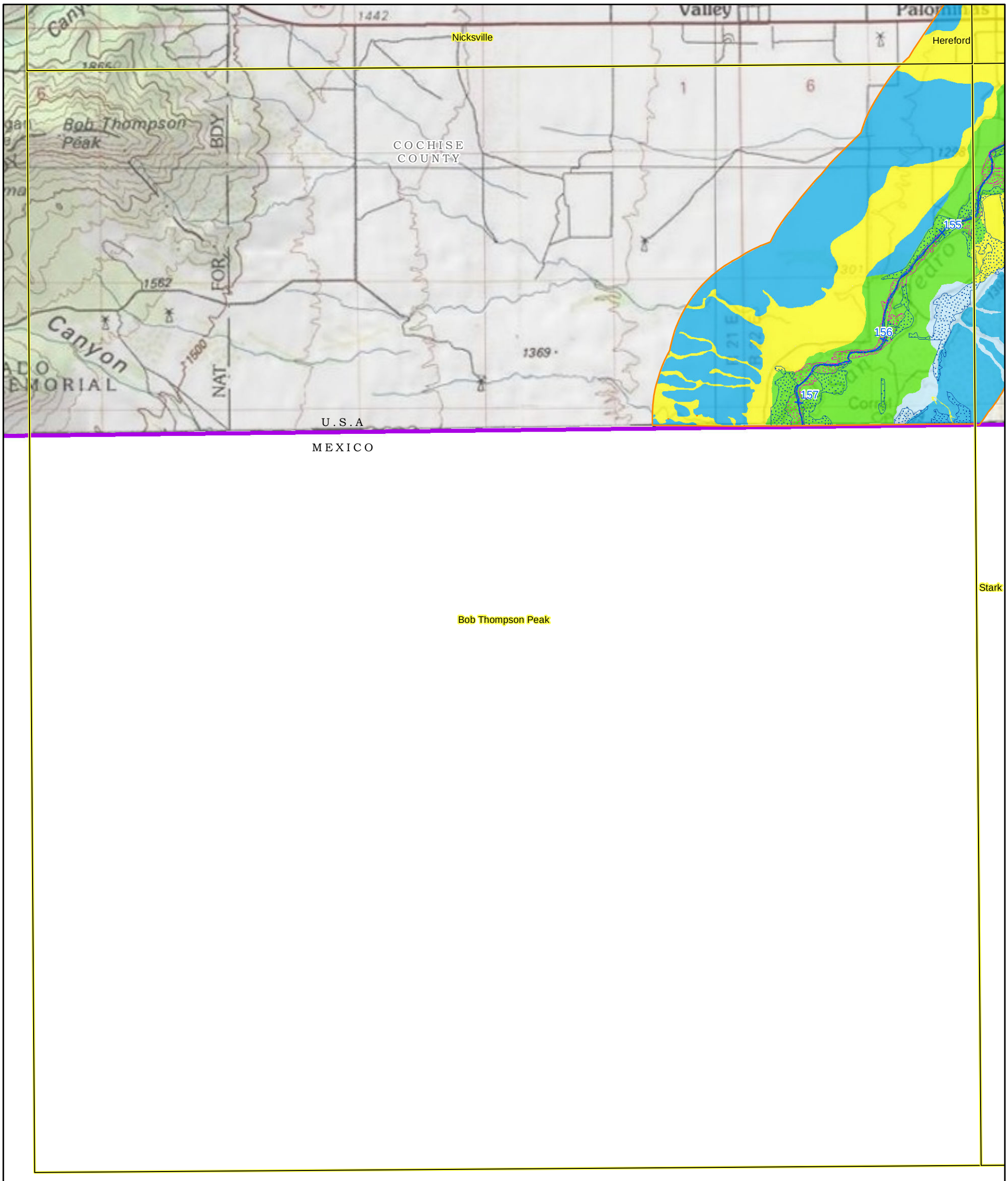

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Bob Thompson Peak Quad (Page 1 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

157 Major Stream and River Mile Locations

San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

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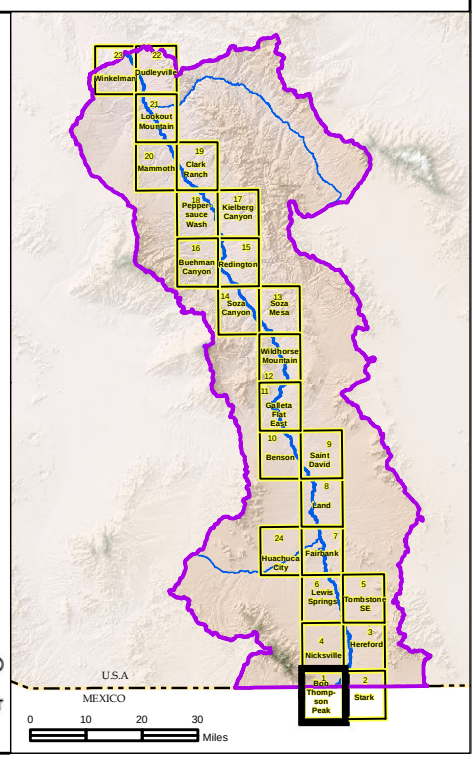

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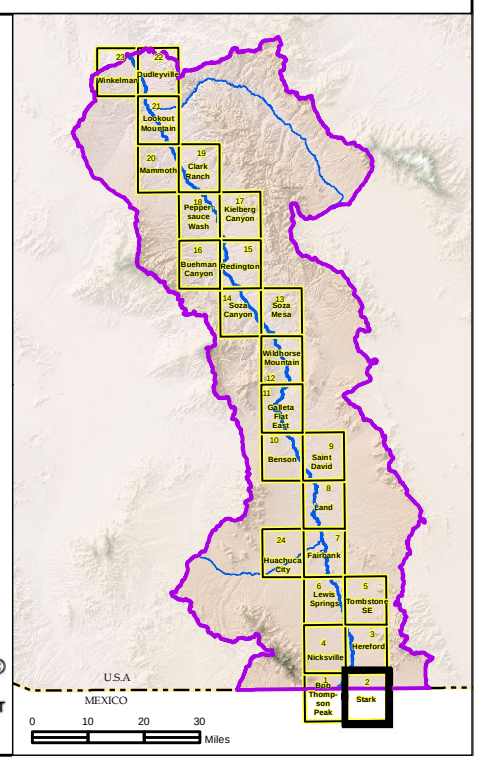
Nicksville
153
154
55
Hereford
Stark
92
6
1331
Draw
1351
1350
1352
COCHISE
COUNTY
R 22 E
R 23 E
1395
U.S.A
COCHISE CO
MEXICO
Stark
Bob Thompson Peak
0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles
Legend
2001 Cottonwood-Willow and Mesquite Forest
2001 Wetlands and Other Riparian Areas*
Surficial Geology Mapped by AZGS (2009)
Generalized Geologic Units
Floodplain Holocene Alluvium (FHA)
Tributary Holocene Alluvium (THA)
Holocene Basin Fill
Older Basin Filll
Bedrock
Disturbed (unit not determined)
*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.
Base Map: USGS 1:24,000 Topo
Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Stark Quad (Page 2 of 24)
Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed
N
157 Major Stream and River Mile Locations
San Pedro River Watershed
USGS Topo Quad Boundary
County
International Boundary


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Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Hereford Quad (Page 3 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N

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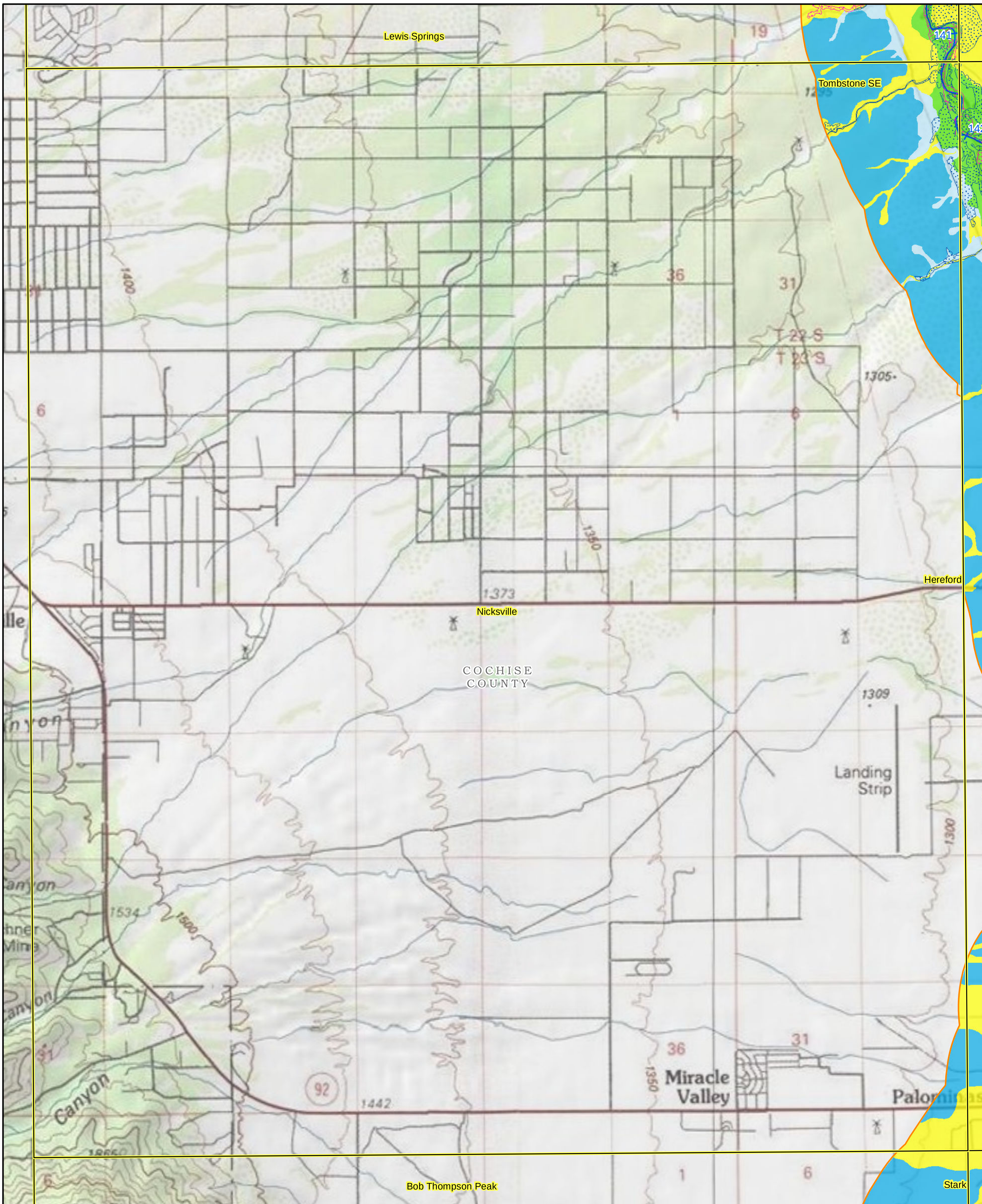

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

2001 Cottonwood-Willow and Mesquite Forest

2001 Wetlands and Other Riparian Areas*

Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

Floodplain Holocene Alluvium (FHA)

Tributary Holocene Alluvium (THA)

Holocene Basin Fill

Older Basin Filll

Bedrock

Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Nicksville Quad (Page 4 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

157 Major Stream and River Mile Locations

San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

N

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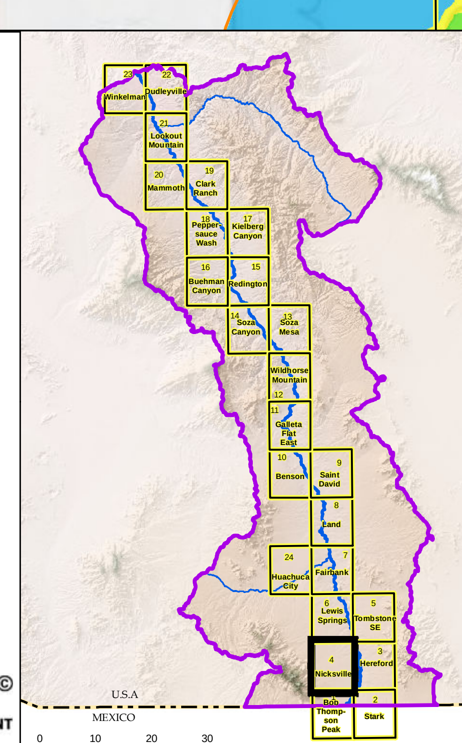

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Fairbank

Draw

Government

COCHISE
COUNTY

Tombstone SE

Lewis Springs

Nicksville

Hereford

Mule Mts

1295
1300
1340
1745
1500
1368
1350
1306
1369
1655
1310

0 0.5 1 1.5 2
Kilometers
0 0.5 1 1.5 2
Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Tombstone SE Quad (Page 5 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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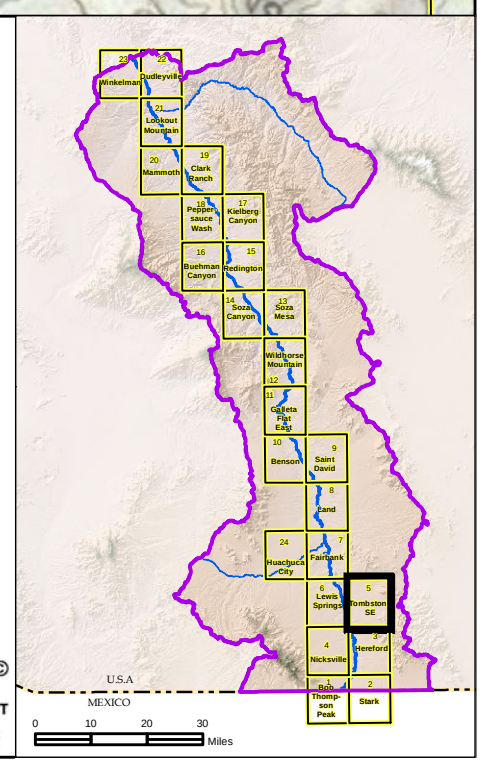

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Huachuca City
Fairbank
Lewis Springs
Tombstone SE
Nicksville
Hereford
Gulch
Graveyard
BDY
RES
MIL
RAILROAD
GRADE
OLD
AQUEDUCT
COCHISE
COUNTY
San Pedro River
Gravel Pit
131
132
133
134
135
136
137
138
139
140
141
1296
1289
1345
1300

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

2001 Cottonwood-Willow and Mesquite Forest

2001 Wetlands and Other Riparian Areas*

Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Lewis Springs Quad (Page 6 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

N

157 Major Stream and River Mile Locations

San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

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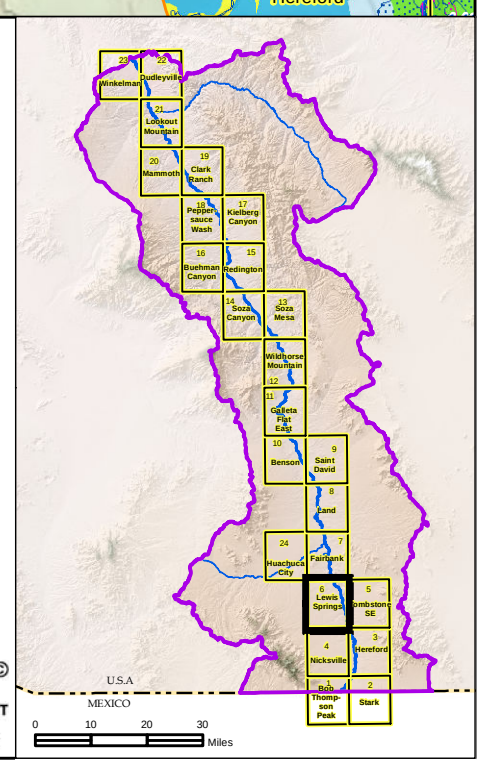

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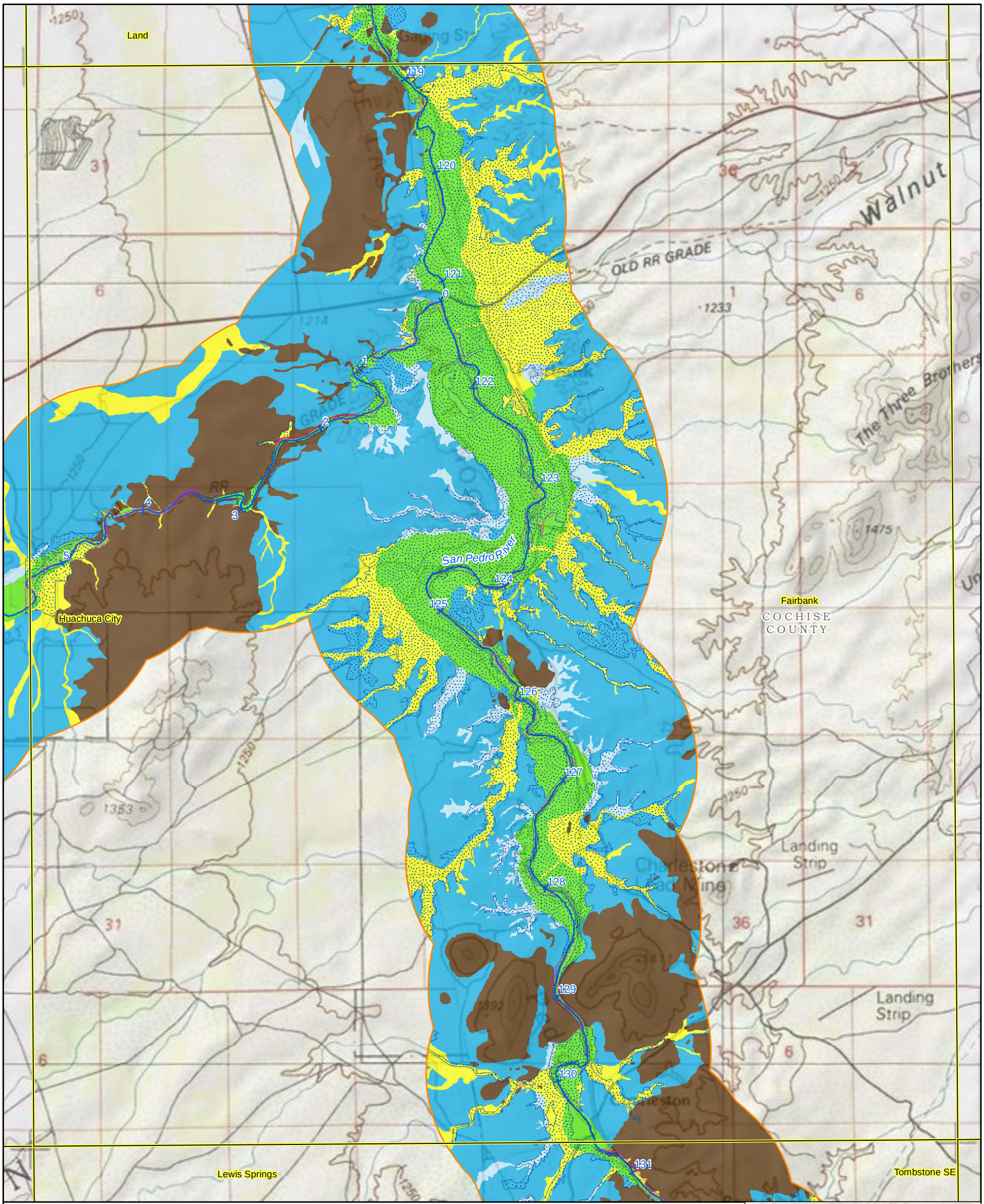


0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

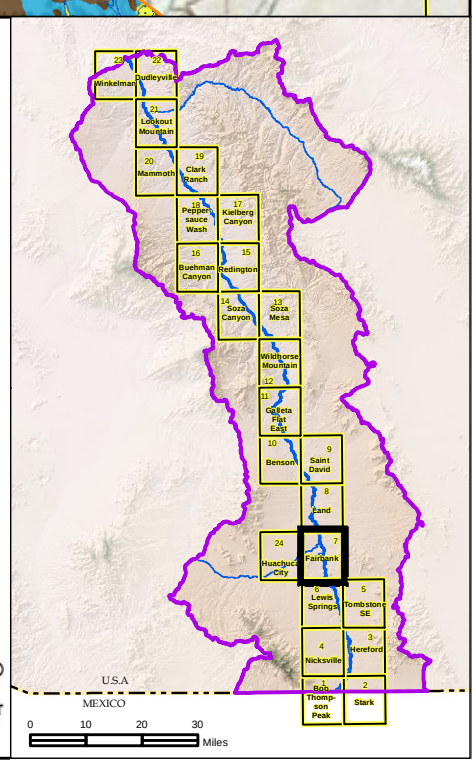
Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Fairbank Quad (Page 7 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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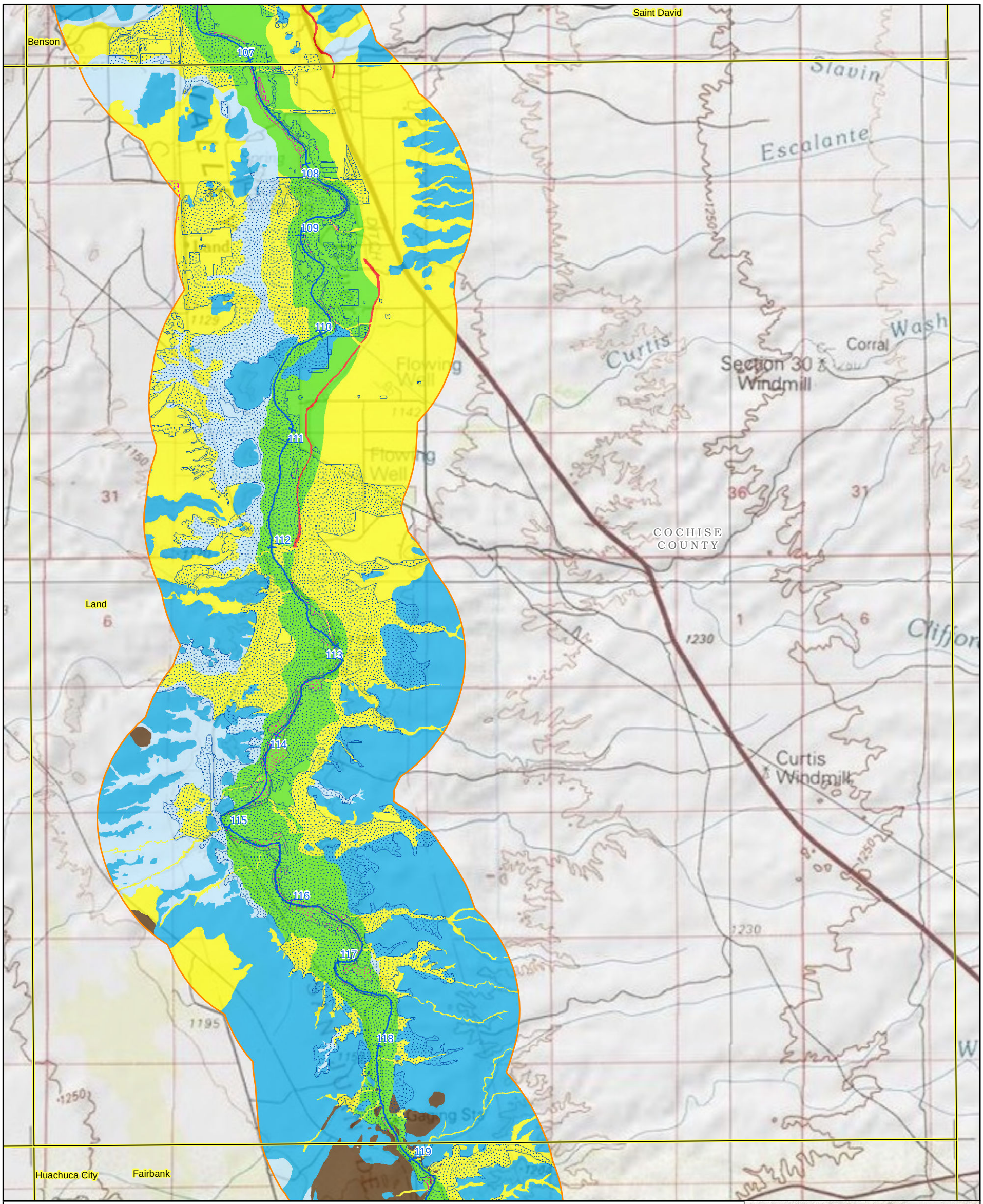


Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Land Quad (Page 8 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

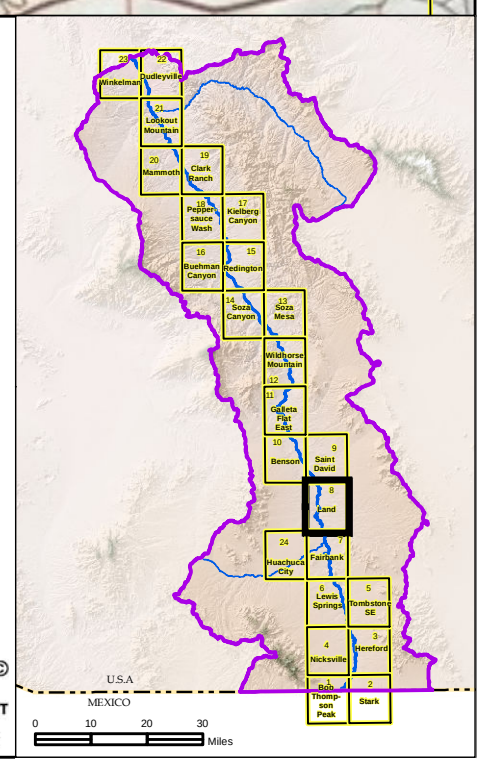
- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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Galleta Flat East

Saint David

Benson

Land

Substa

Sheep Wash

Fenner

Sibyl

Lonesome Valley

COCHISE COUNTY

Dragoon

Saint David

Slavin

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Saint David Quad (Page 9 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

N

157 Major Stream and River Mile Locations

San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

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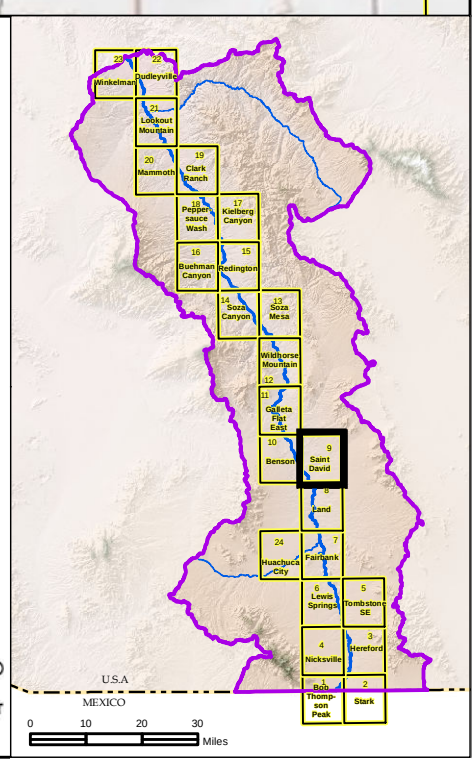

Galleta Flat East

Benson

Saint David

Land

COCHISE COUNTY

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Benson Quad (Page 10 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N

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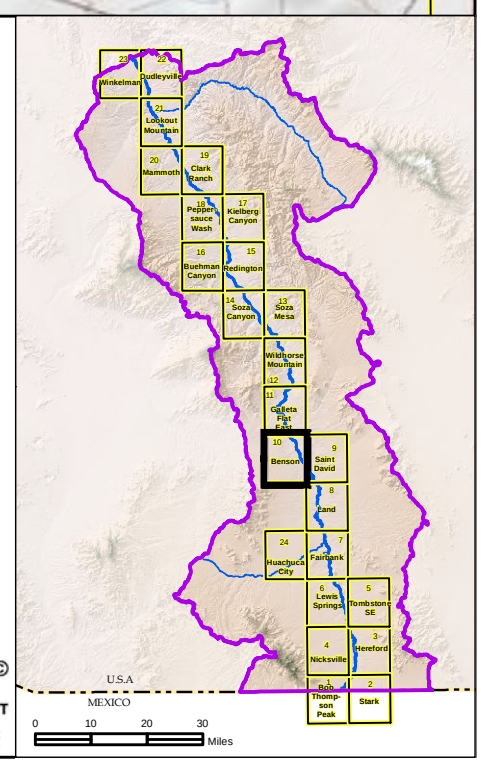
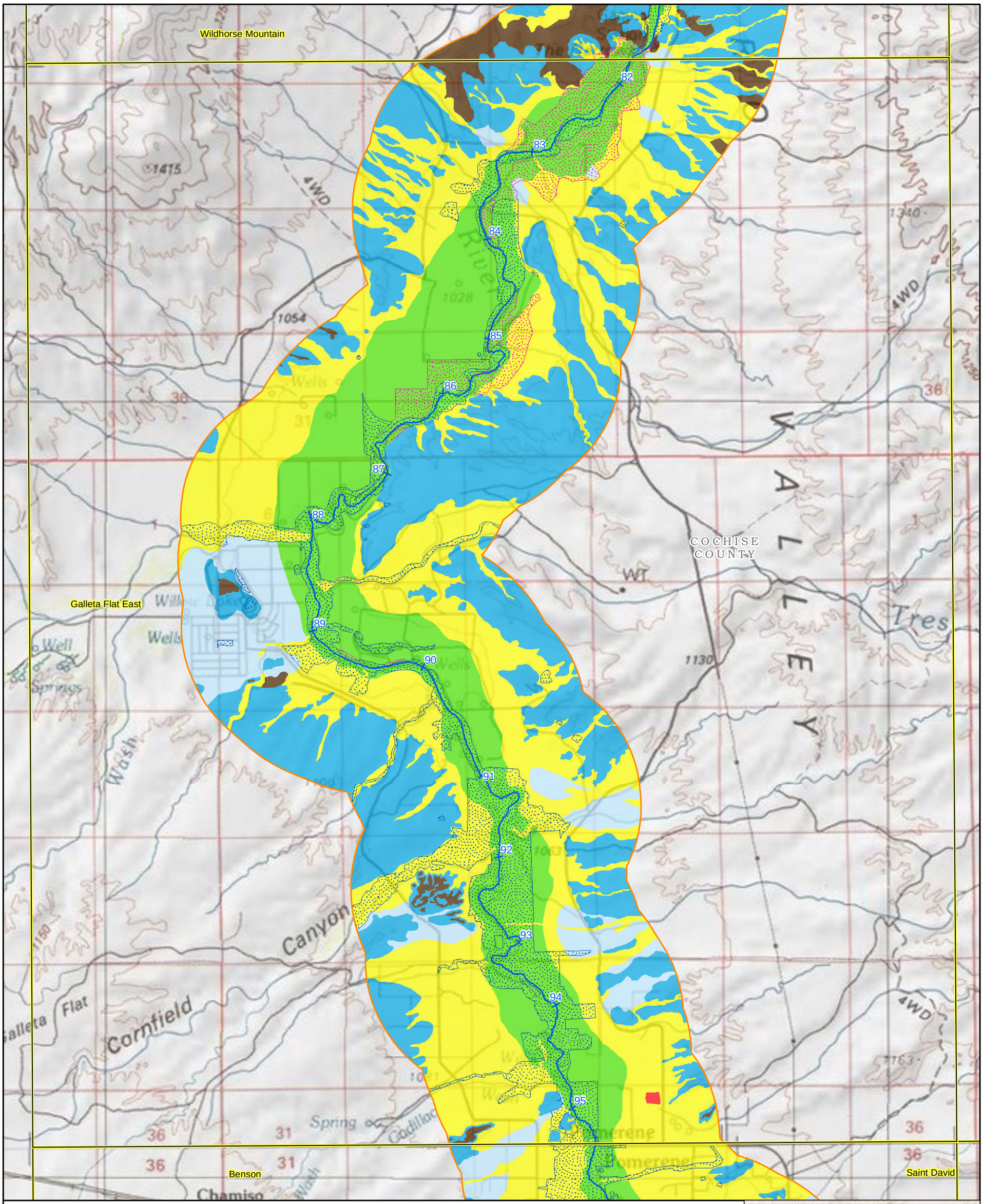




0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

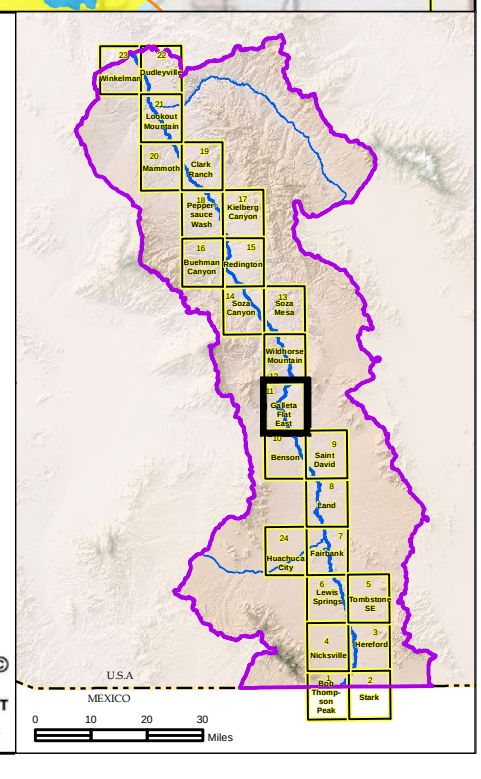
Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Galleta Flat East Quad (Page 11 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

N

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



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Soza Mesa
Soza Canyon
Wildhorse Mountain
Galleta Flat East
Palomas
COCHISE COUNTY
Water Tank
Diamond B Spring
Creek
Wildhorse Mtn
4WD
Well
Bedrock
71
72
73
74
75
76
77
78
79
80
81
82

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Wildhorse Mountain Quad (Page 12 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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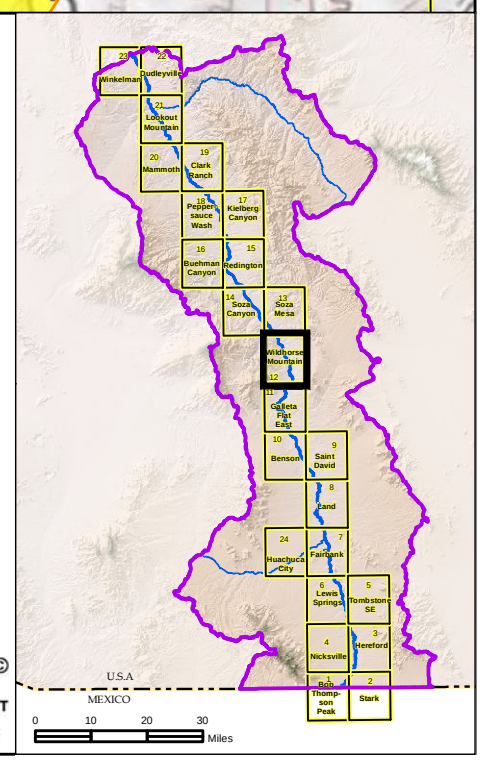


Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Soza Mesa Quad (Page 13 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

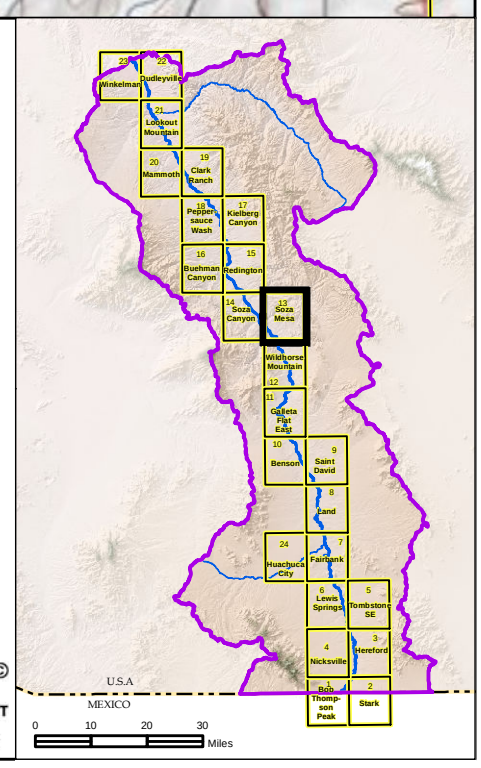
- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Soza Canyon Quad (Page 14 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

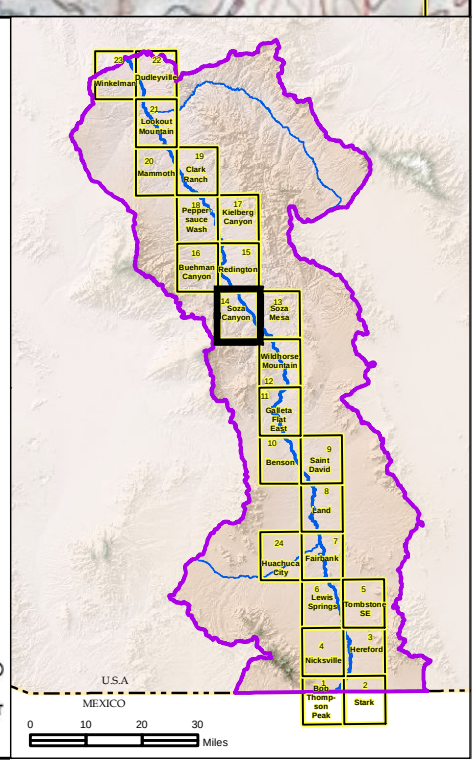
- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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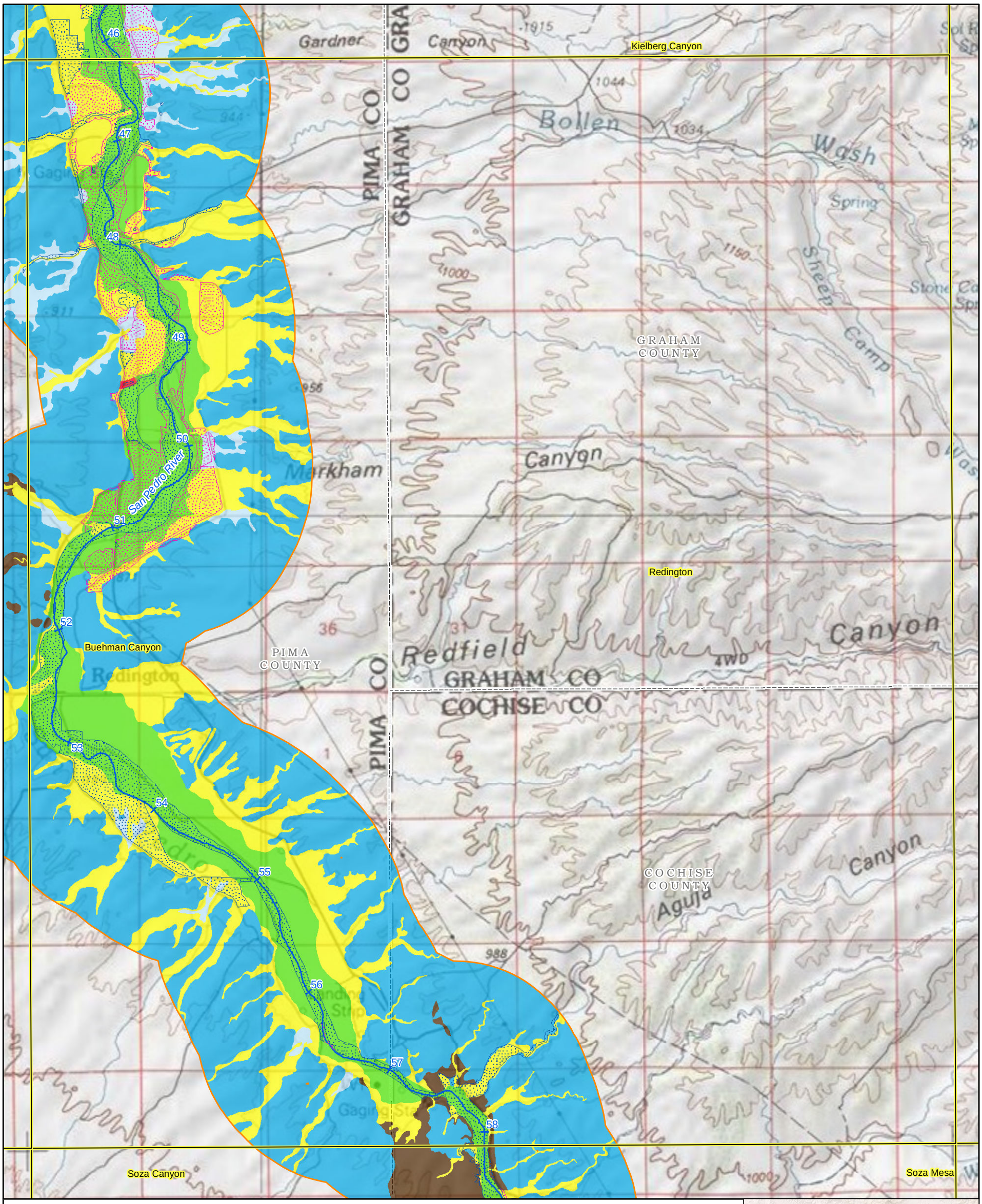


0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Redington Quad (Page 15 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

N

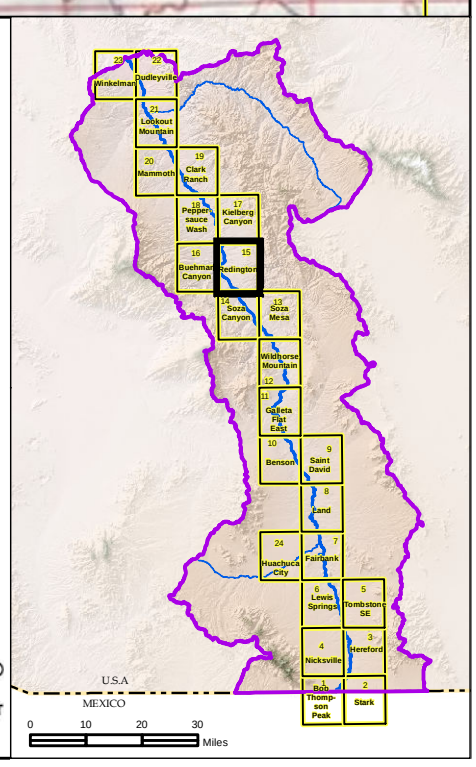
157 Major Stream and River Mile Locations

San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary



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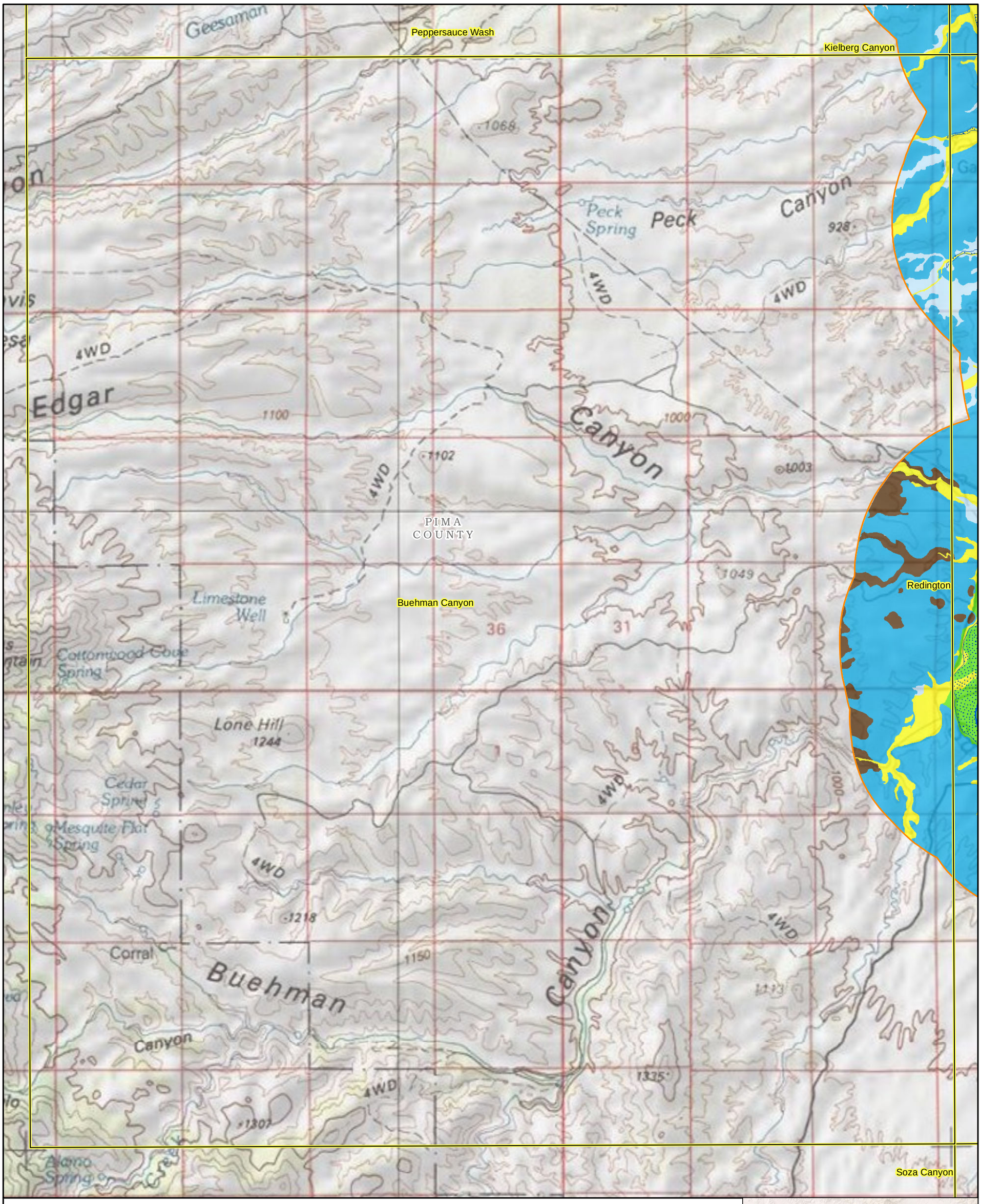


0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

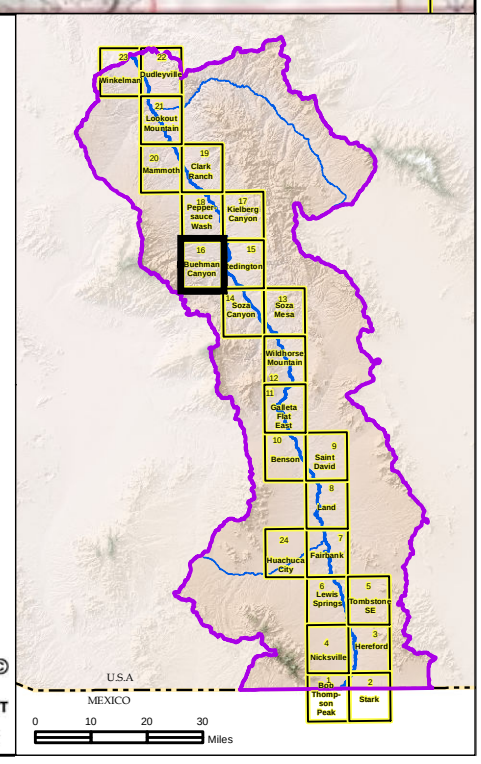
Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Buehman Canyon Quad (Page 16 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

N

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary



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Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Kielberg Canyon Quad (Page 17 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

N

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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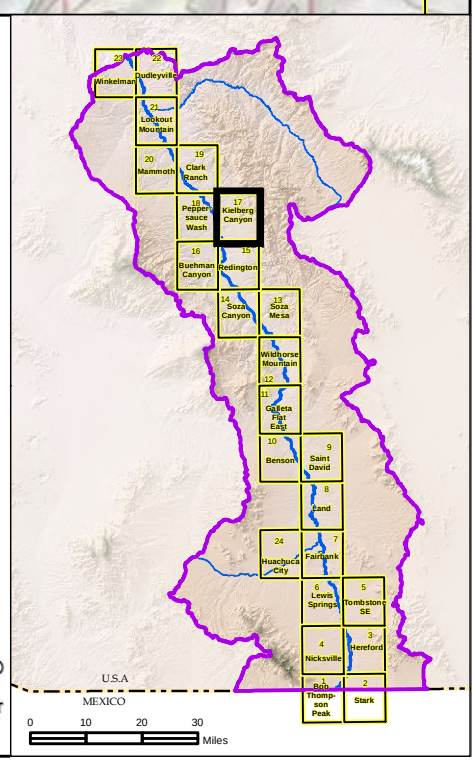

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Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Peppersauce Wash Quad (Page 18 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

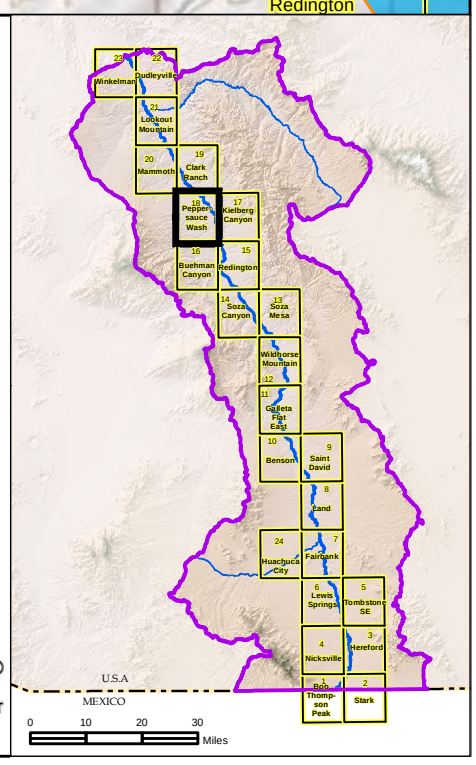
Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.
Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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Lookout Mountain
Canyon
Well
1174
90
Mulberry Spring
Copper
Wash
Wash
26
27
Mammoth
28
29
30
31
32
33
34
Mulberry
PINAL COUNTY
36
31
Clark Ranch
Scanlon
Wash
1000
1
6
Clark
Wash
James
Gust
James
Gust
Little
Wash
913
Flowing Well
880
Tailings Pond
Tailings Pond
Peppersauce Wash
Kielberg Canyon

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Clark Ranch Quad (Page 19 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

157 Major Stream and River Mile Locations

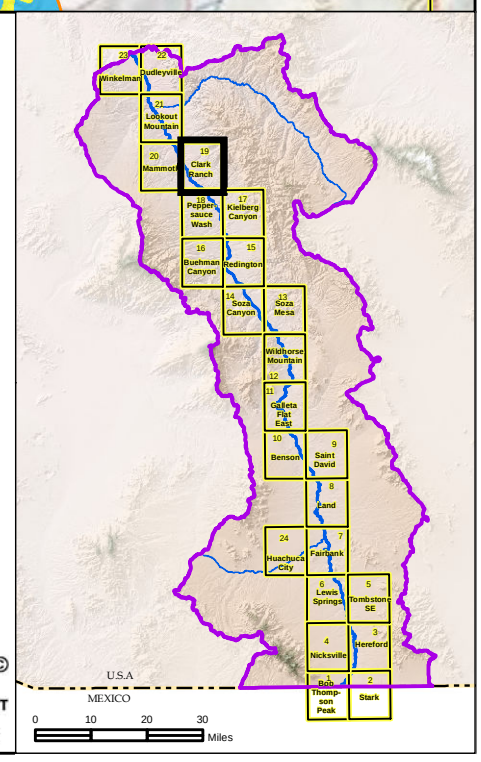
San Pedro River Watershed

USGS Topo Quad Boundary

County

International Boundary

N



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Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Mammoth Quad (Page 20 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

Lookout Mountain
Pearl Mine
Tar Mine
Signal Peak
Wash
Hills
4WD
Mammoth
PINAL COUNTY
Clark Ranch
Peppersauce Wash
San Pedro River
22
23
24
25
26
27

0 0.5 1 1.5 2 Kilometers
0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

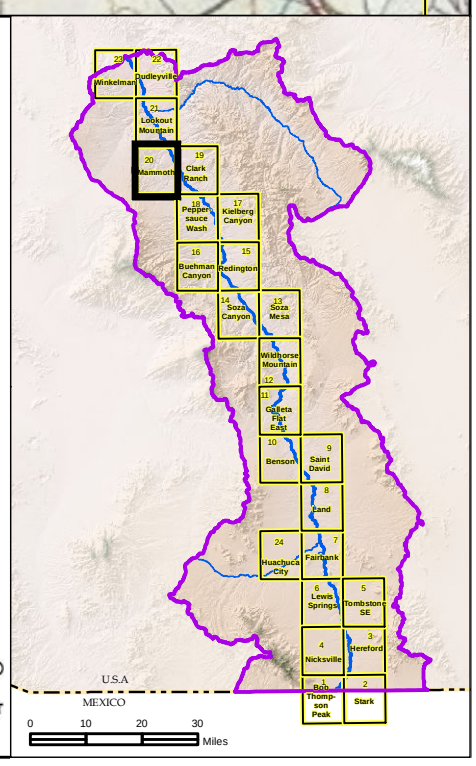
Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.
Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Lookout Mountain Quad (Page 21 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

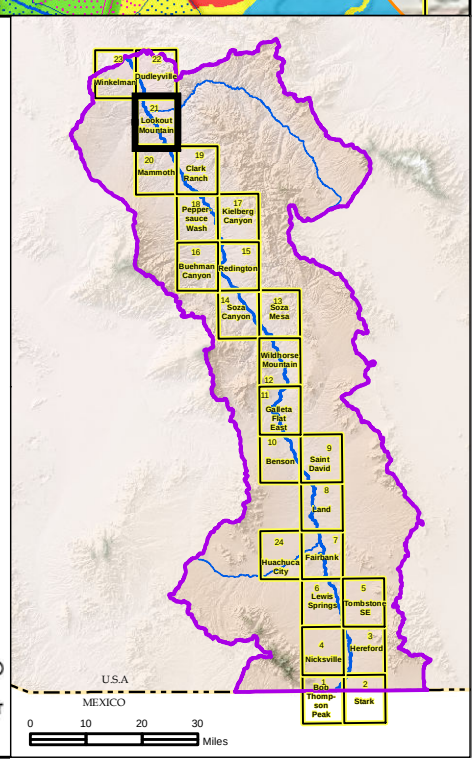
- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service
Dudleyville Quad (Page 22 of 24)

Response to Comments and Objections
Filed on ADWR's June 2009 Subflow Zone
Delineation Report for the
San Pedro River Watershed

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2001 Cottonwood-Willow and Mesquite Forest
- 2001 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

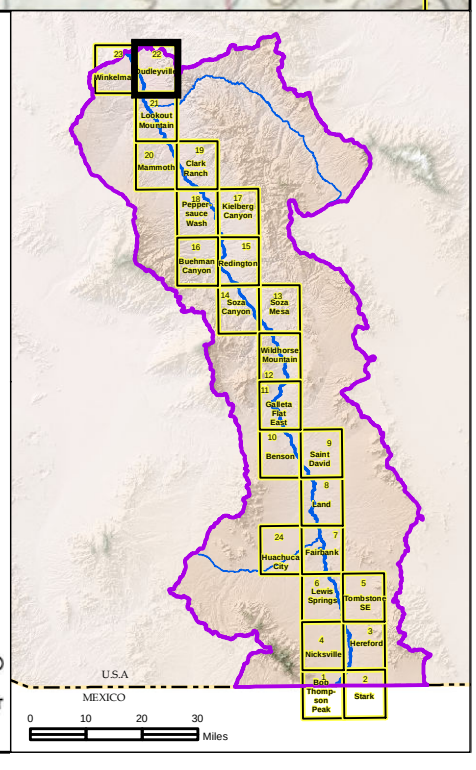
- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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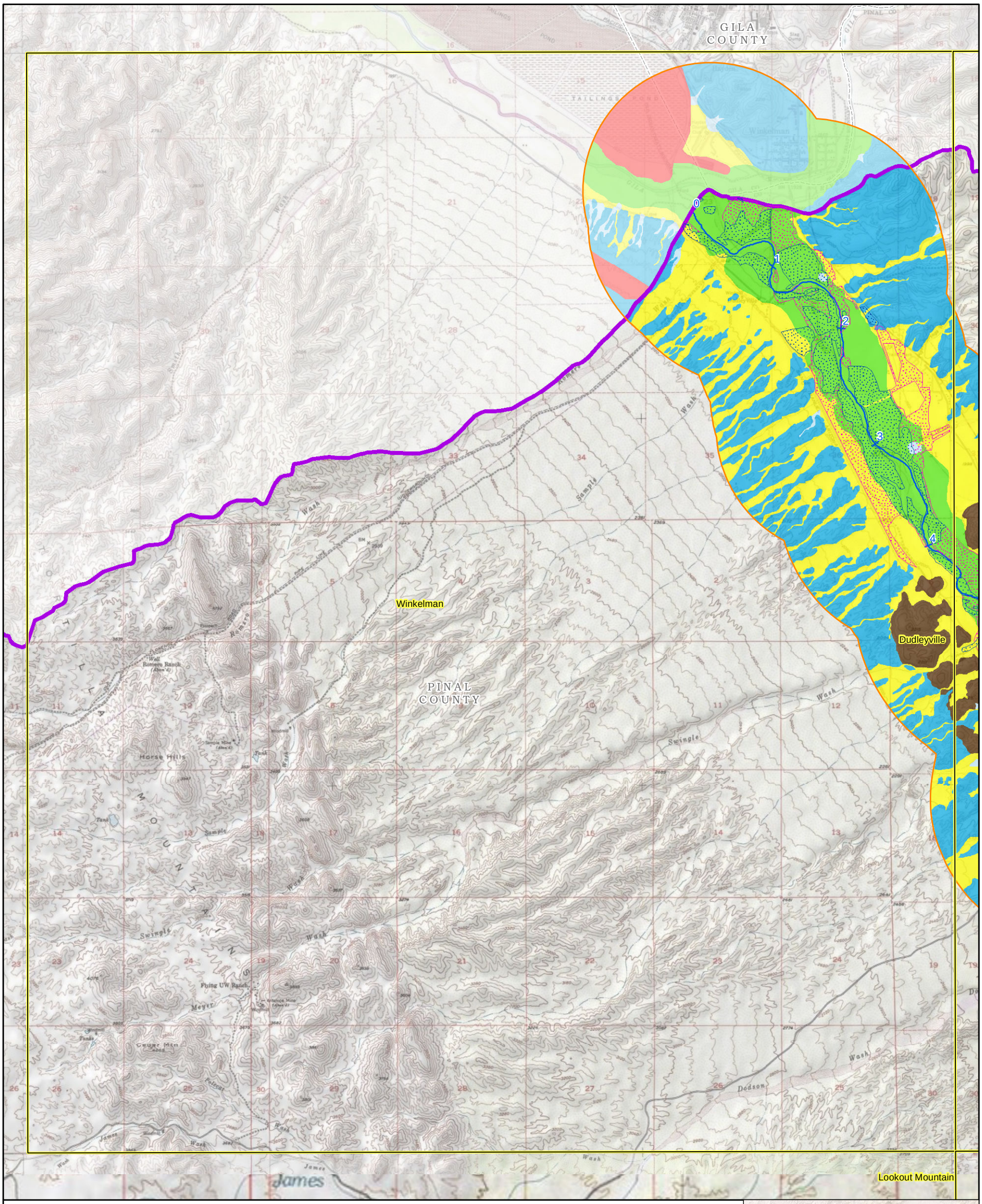


0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 2005 Cottonwood-Willow and Mesquite Forest
- 2005 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

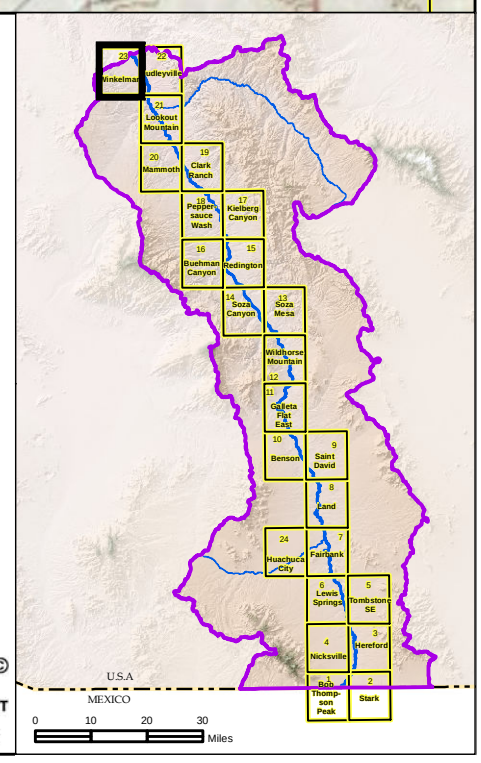
Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Winkelman Quad (Page 23 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

N



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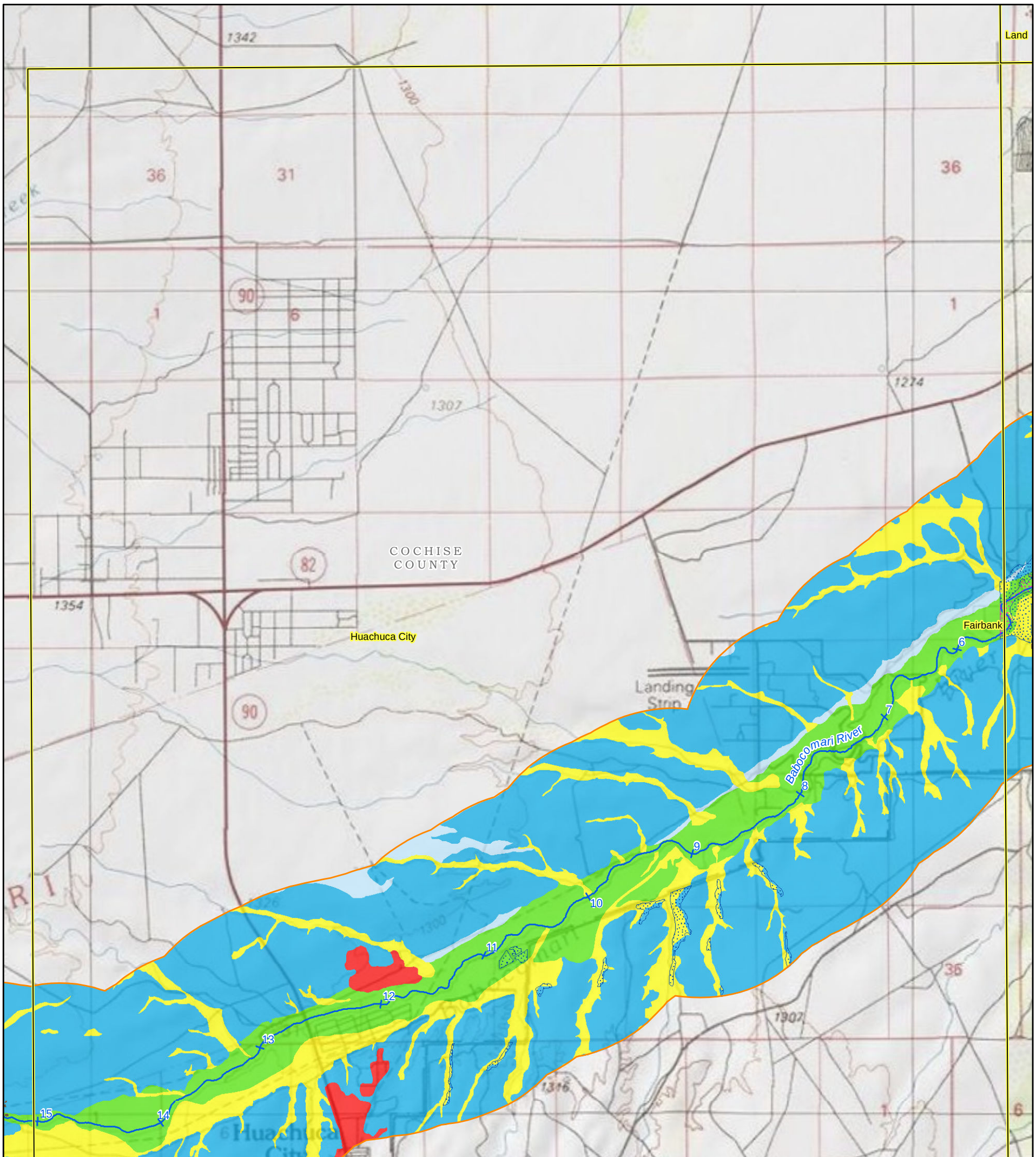

0 0.5 1 1.5 2 Kilometers

0 0.5 1 1.5 2 Miles

Legend

- 1996 Cottonwood-Willow and Mesquite Forest
- 1996 Wetlands and Other Riparian Areas*
- Surficial Geology Mapped by AZGS (2009)

Generalized Geologic Units

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium (THA)
- Holocene Basin Fill
- Older Basin Filll
- Bedrock
- Disturbed (unit not determined)

*Includes salt cedar forest, sacaton grass, and riparian scrub-shrub.

Base Map: USGS 1:24,000 Topo

Appendix E
Surficial Geology of Riparian Areas and Wetlands Mapped by the U.S. Fish and Wildlife Service

Huachuca City Quad (Page 24 of 24)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

N

- 157 Major Stream and River Mile Locations
- San Pedro River Watershed
- USGS Topo Quad Boundary
- County
- International Boundary

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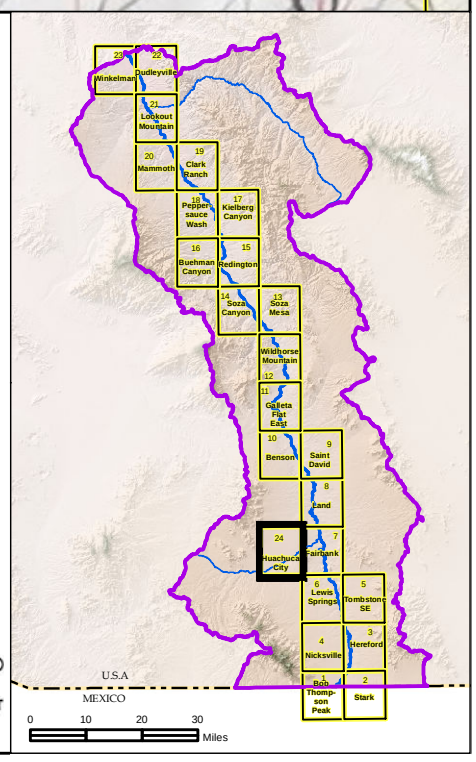
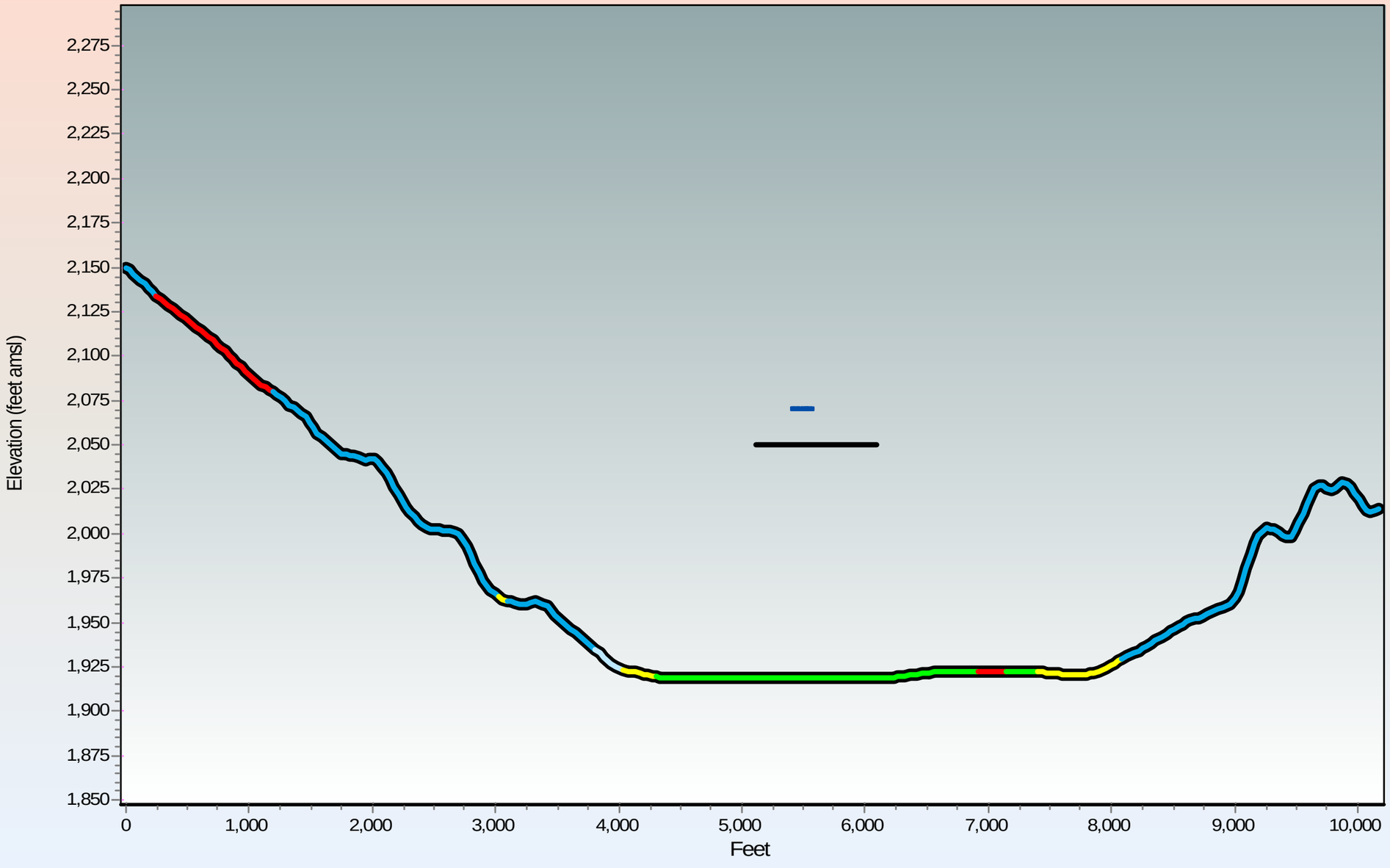
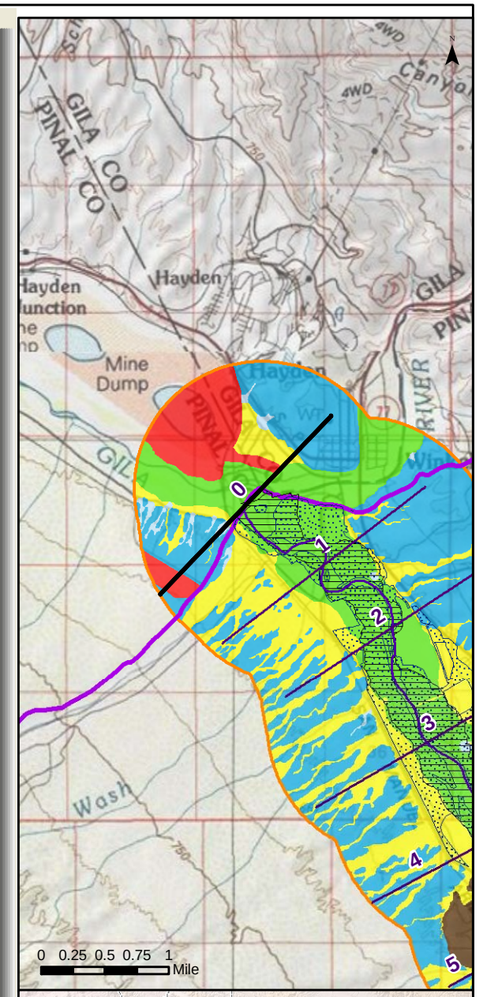


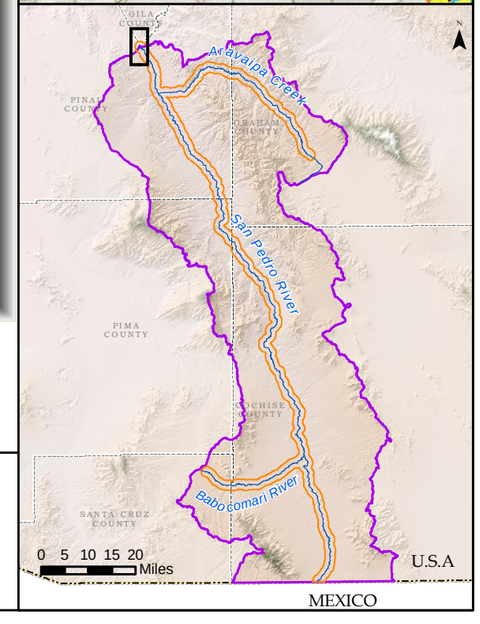
APPENDIX F

Floodplain Cross Sections

San Pedro River Cross Sections







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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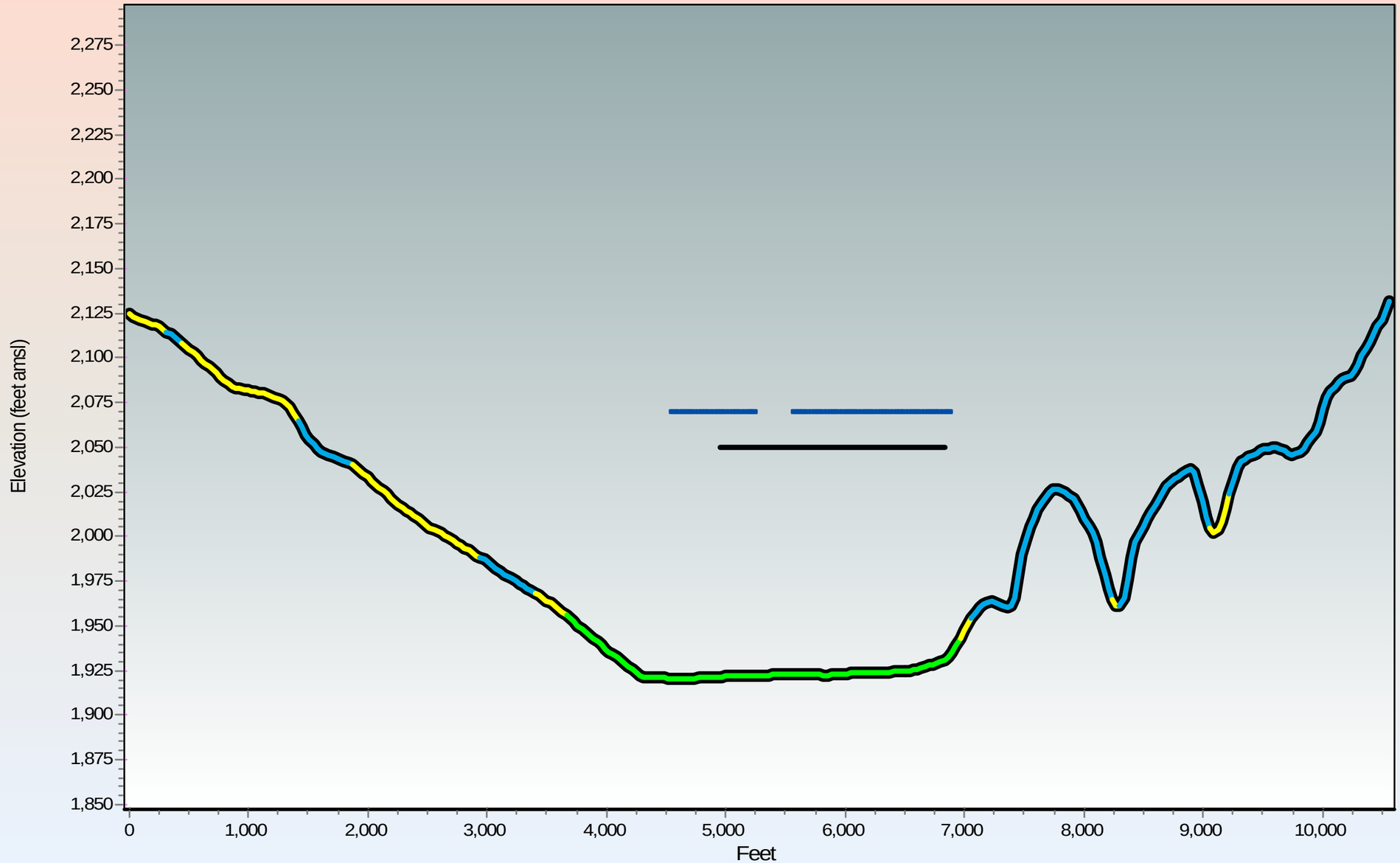
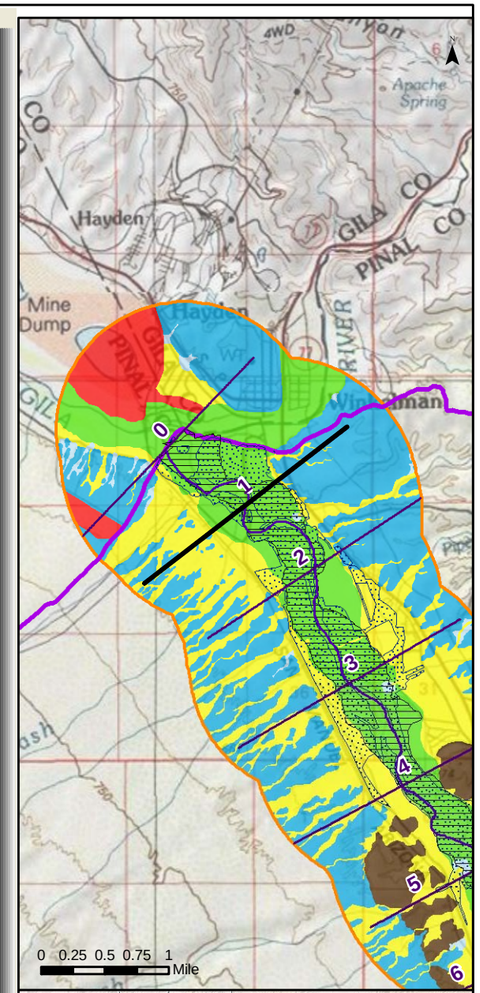
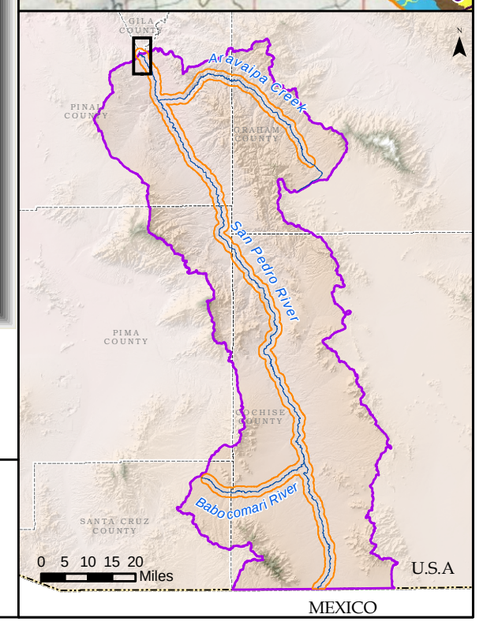
Appendix F
San Pedro River Cross Section at Mile 000
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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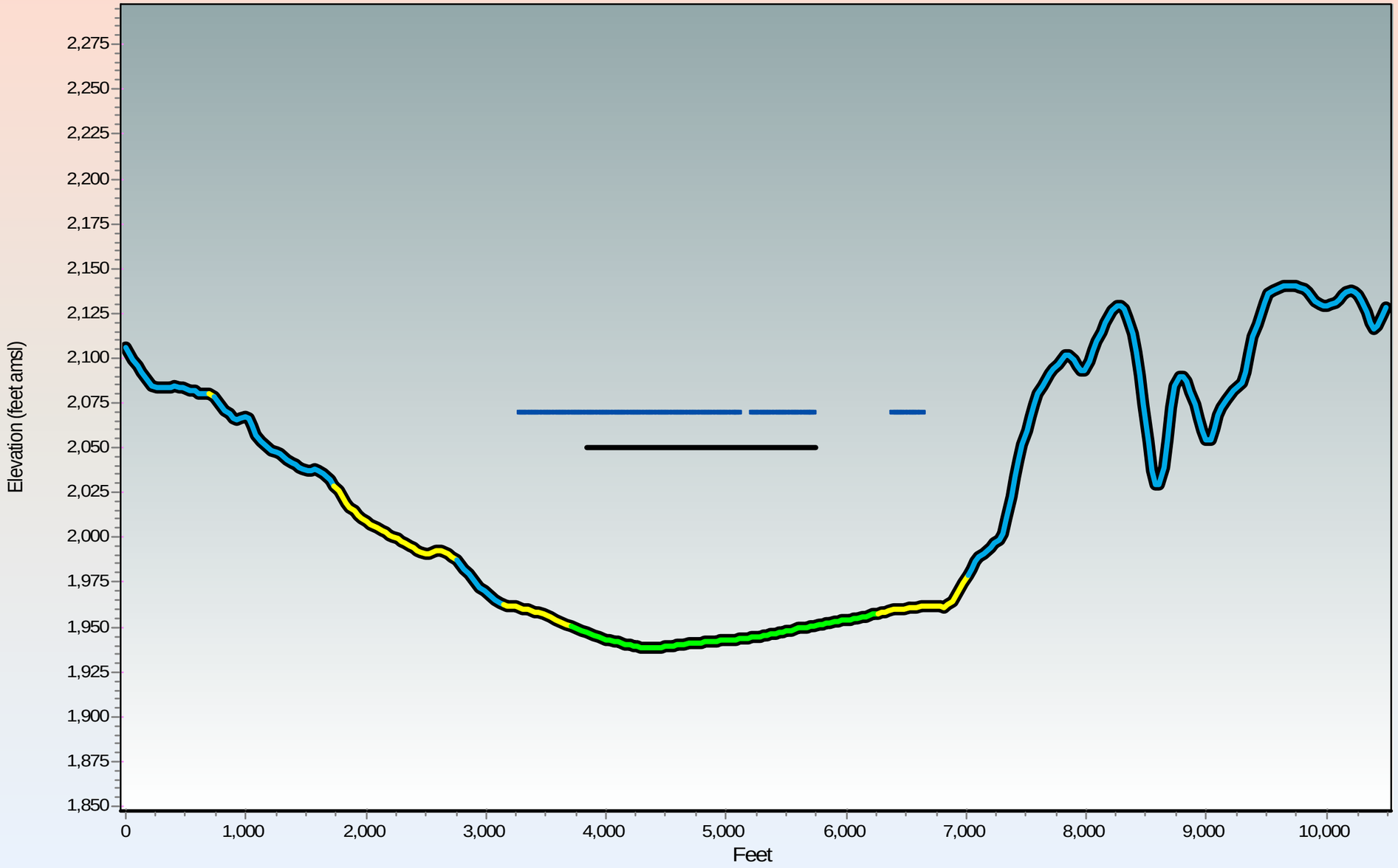
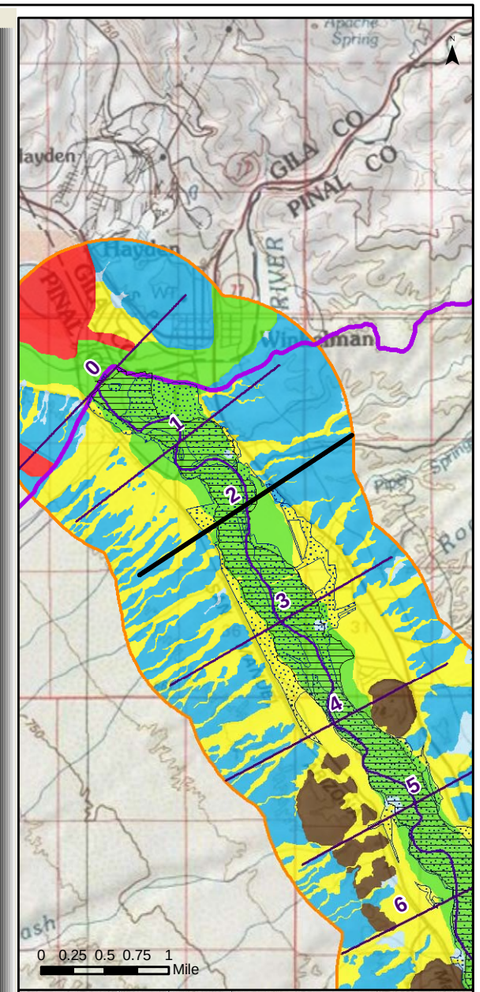
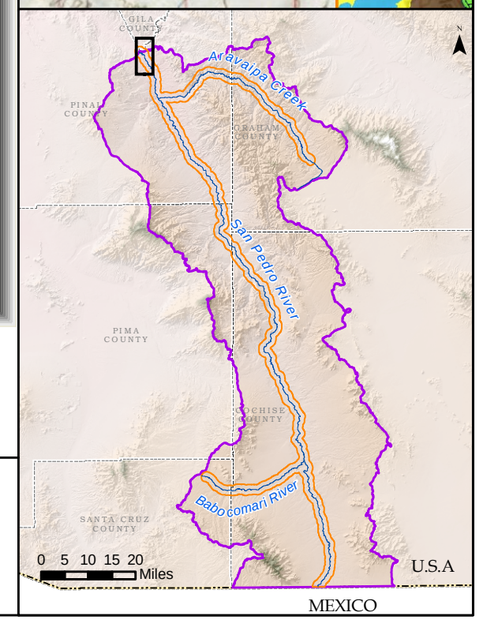
Appendix F
San Pedro River Cross Section at Mile 001
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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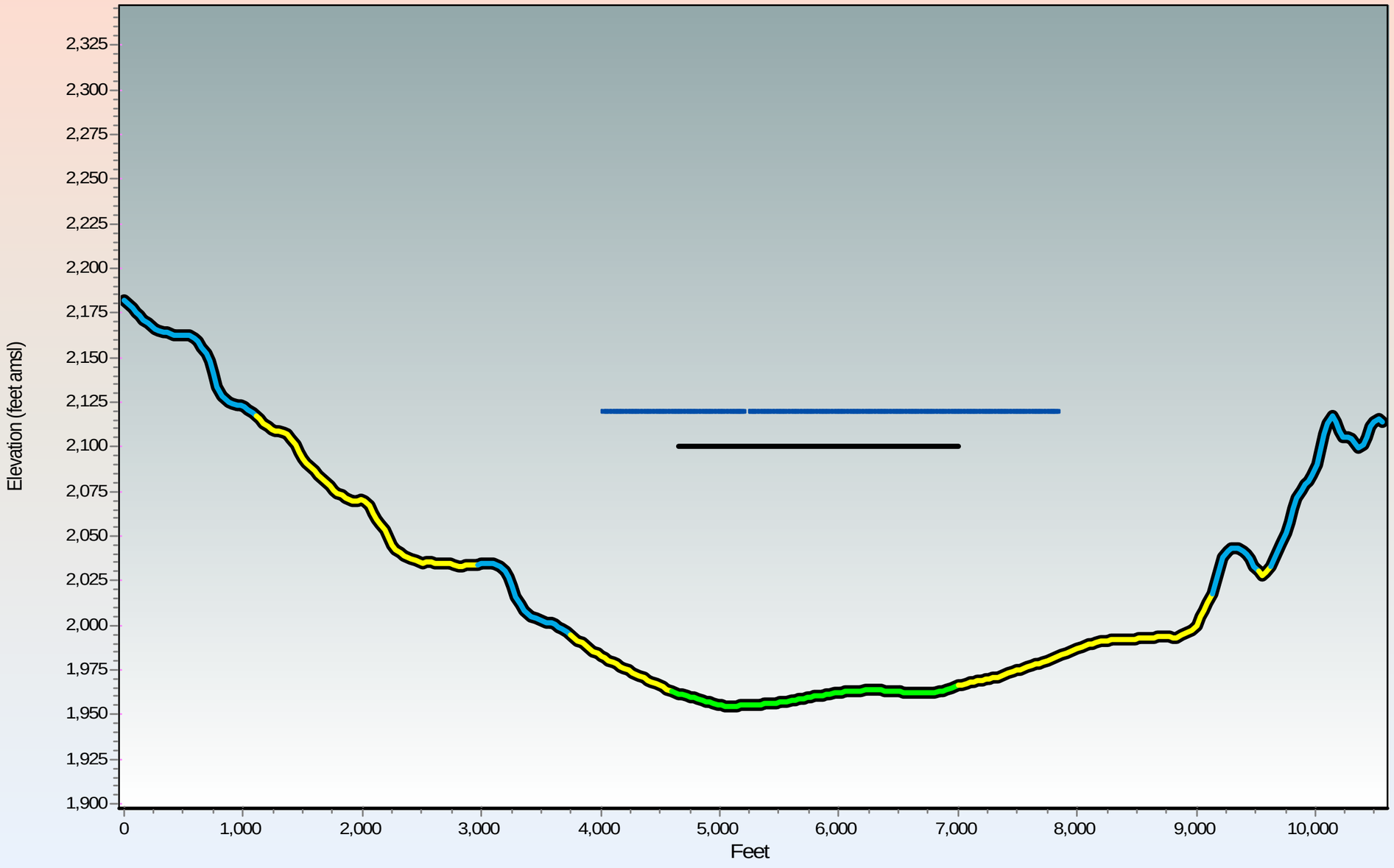
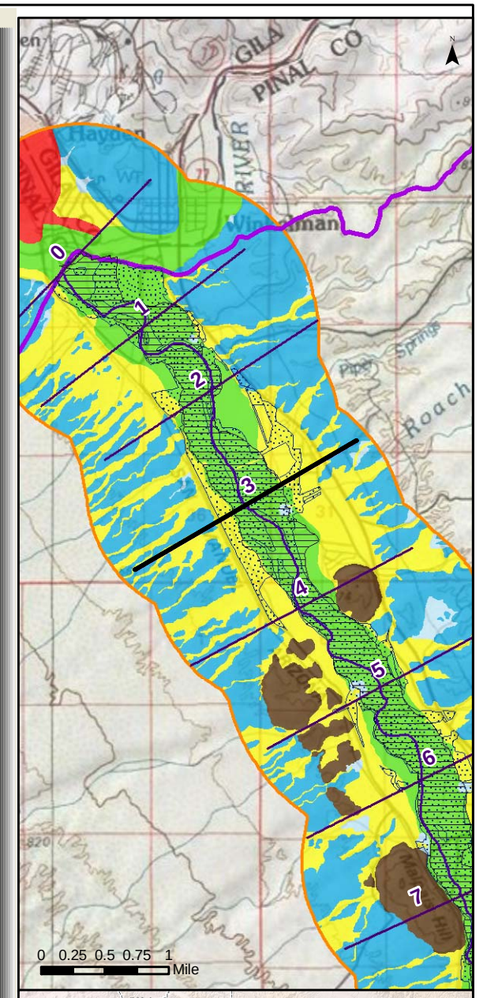
Appendix F

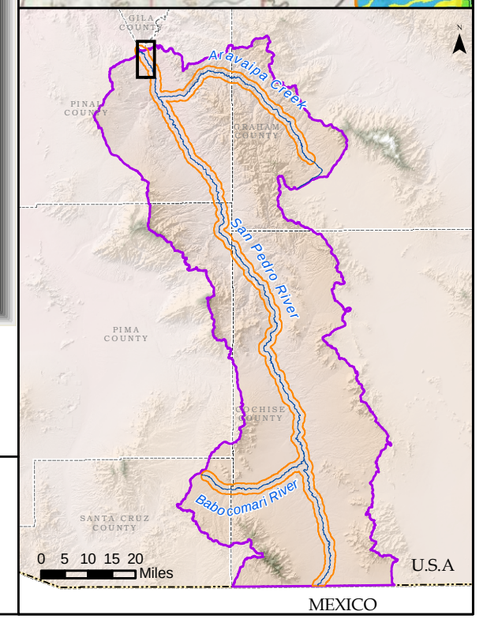
San Pedro River Cross Section at Mile 002

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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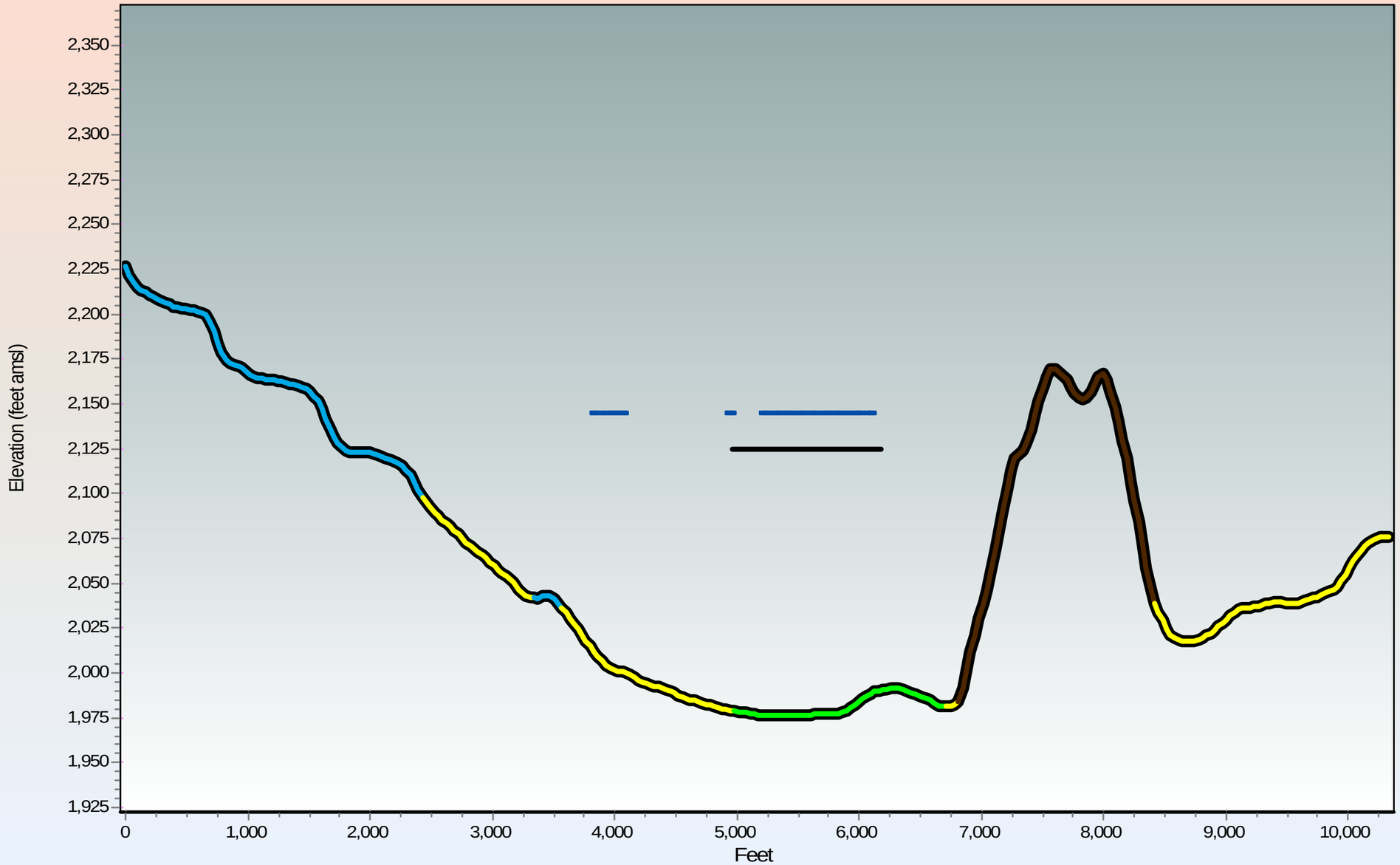
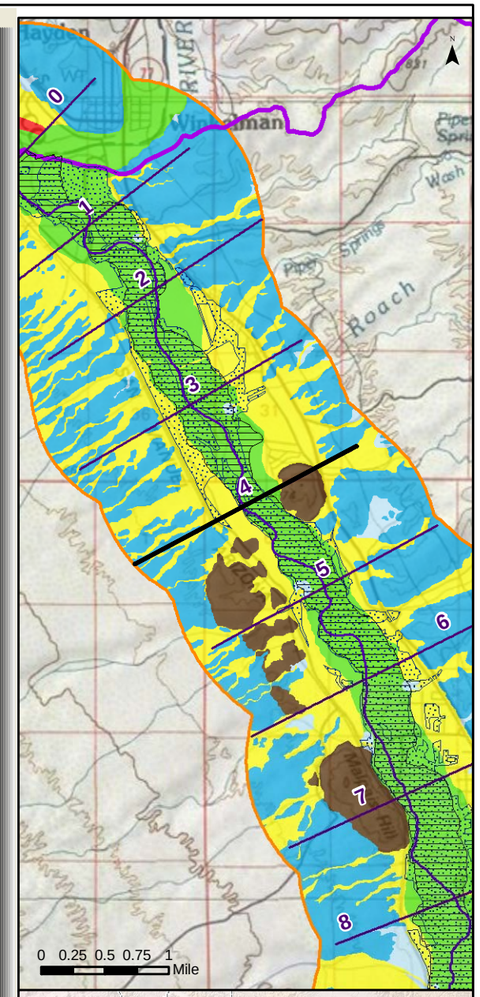
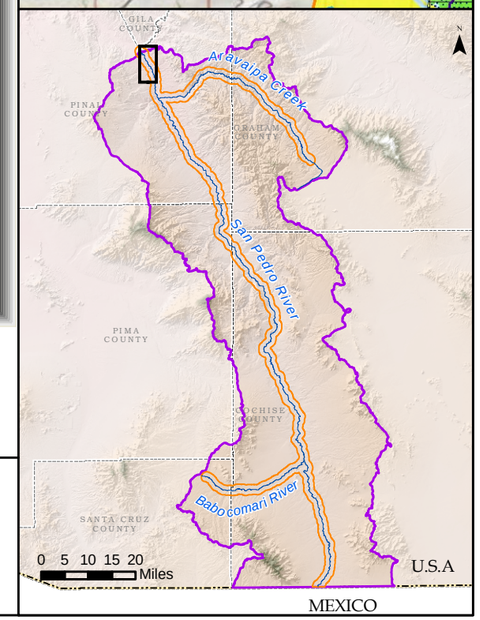
Appendix F
San Pedro River Cross Section at Mile 003
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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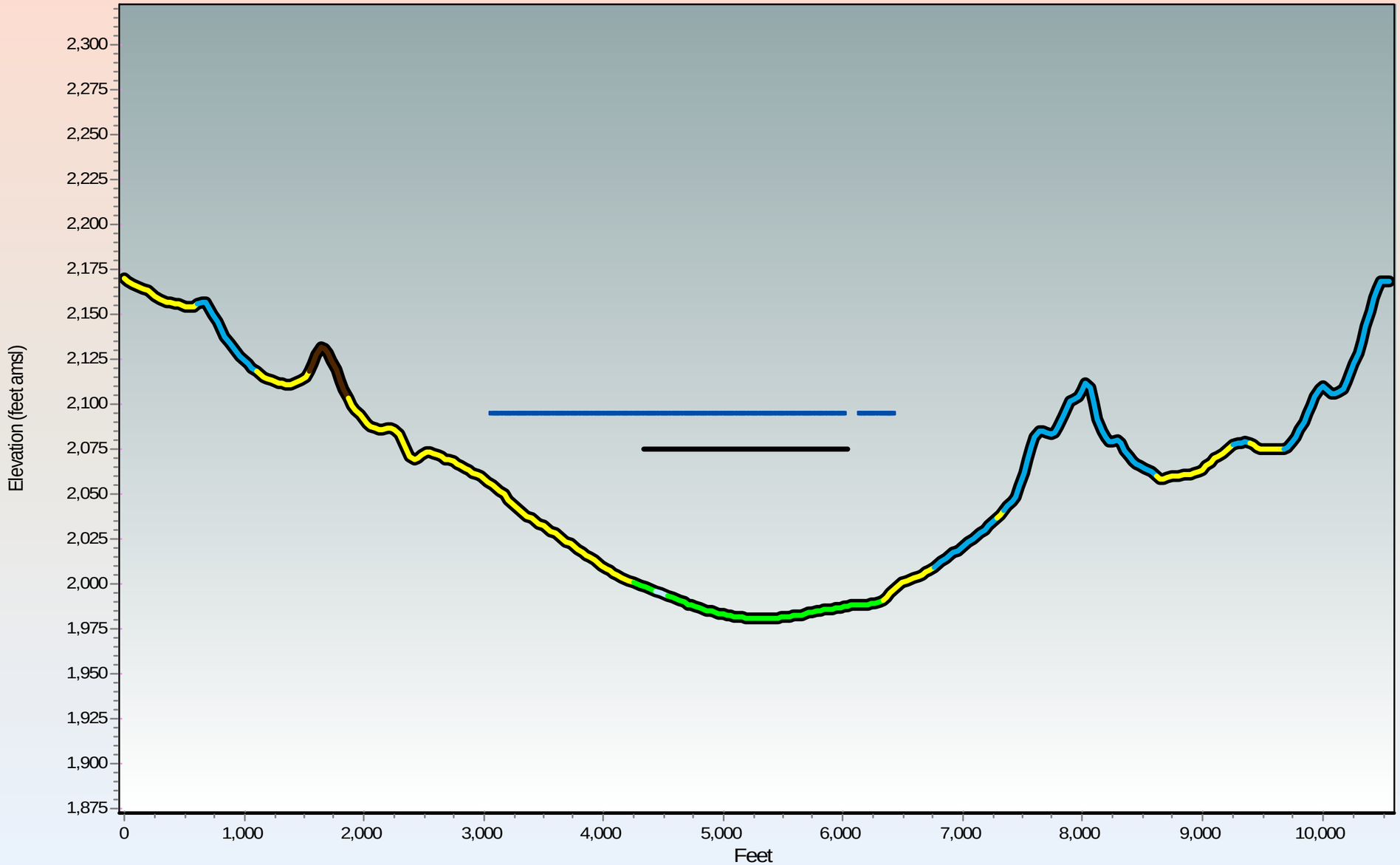
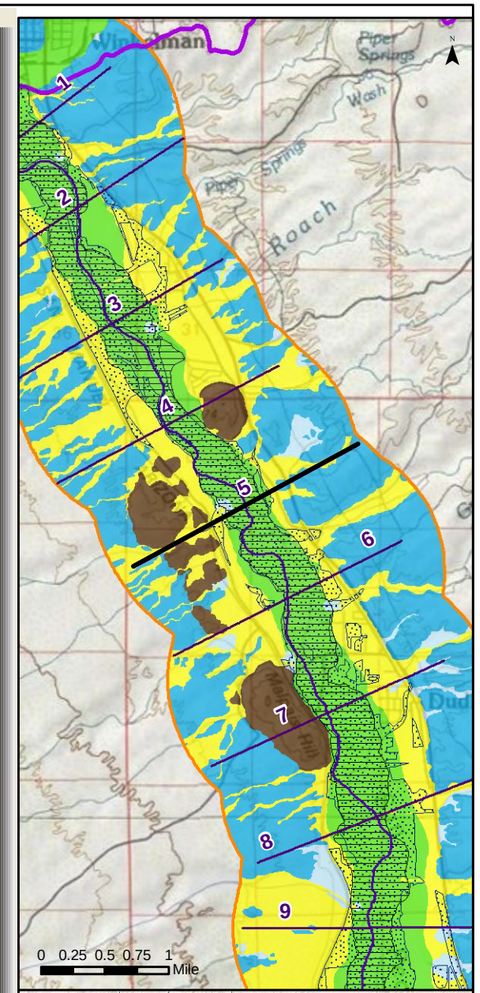
Appendix F

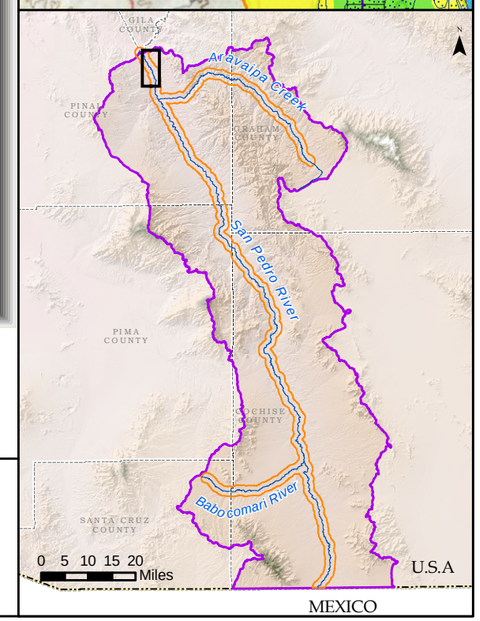
San Pedro River Cross Section at Mile 004

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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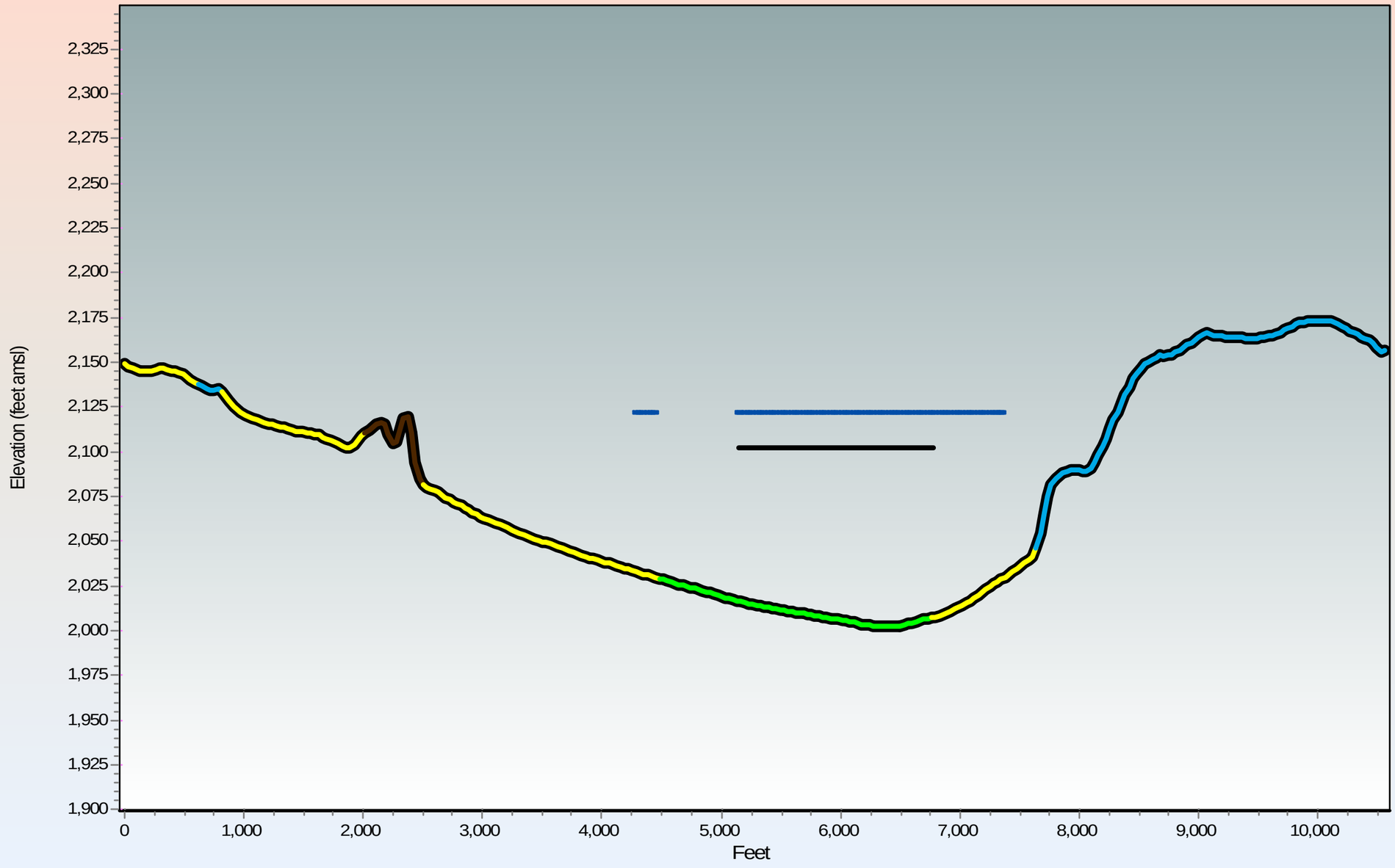
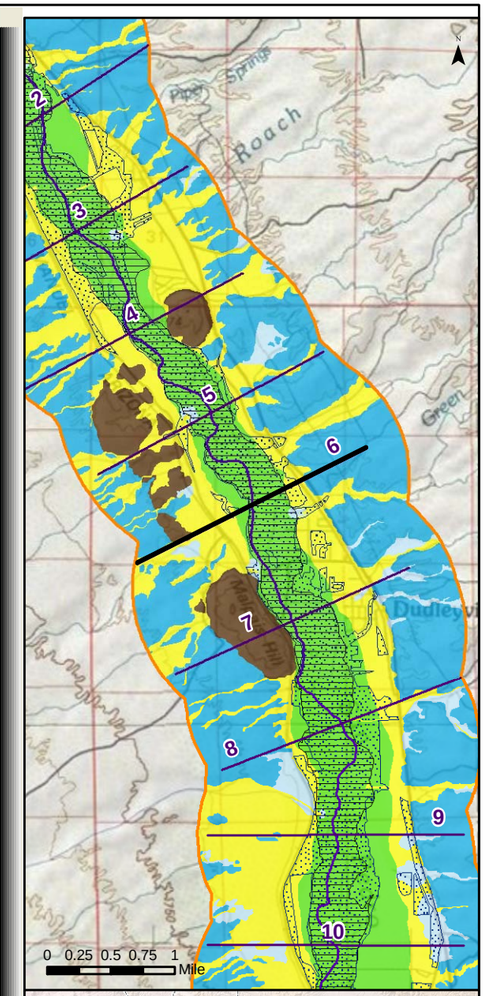
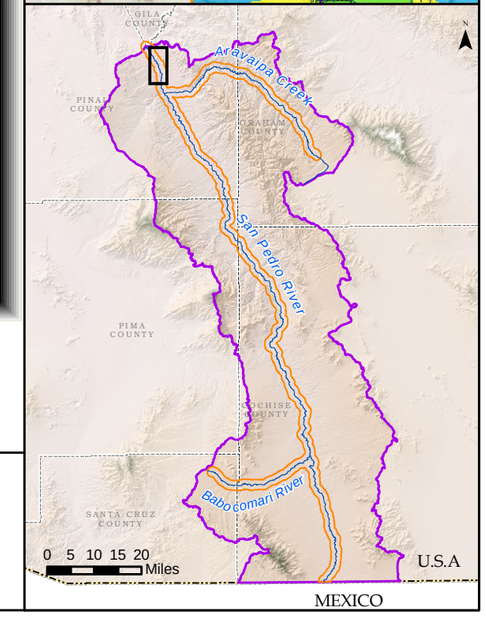
Appendix F
San Pedro River Cross Section at Mile 005
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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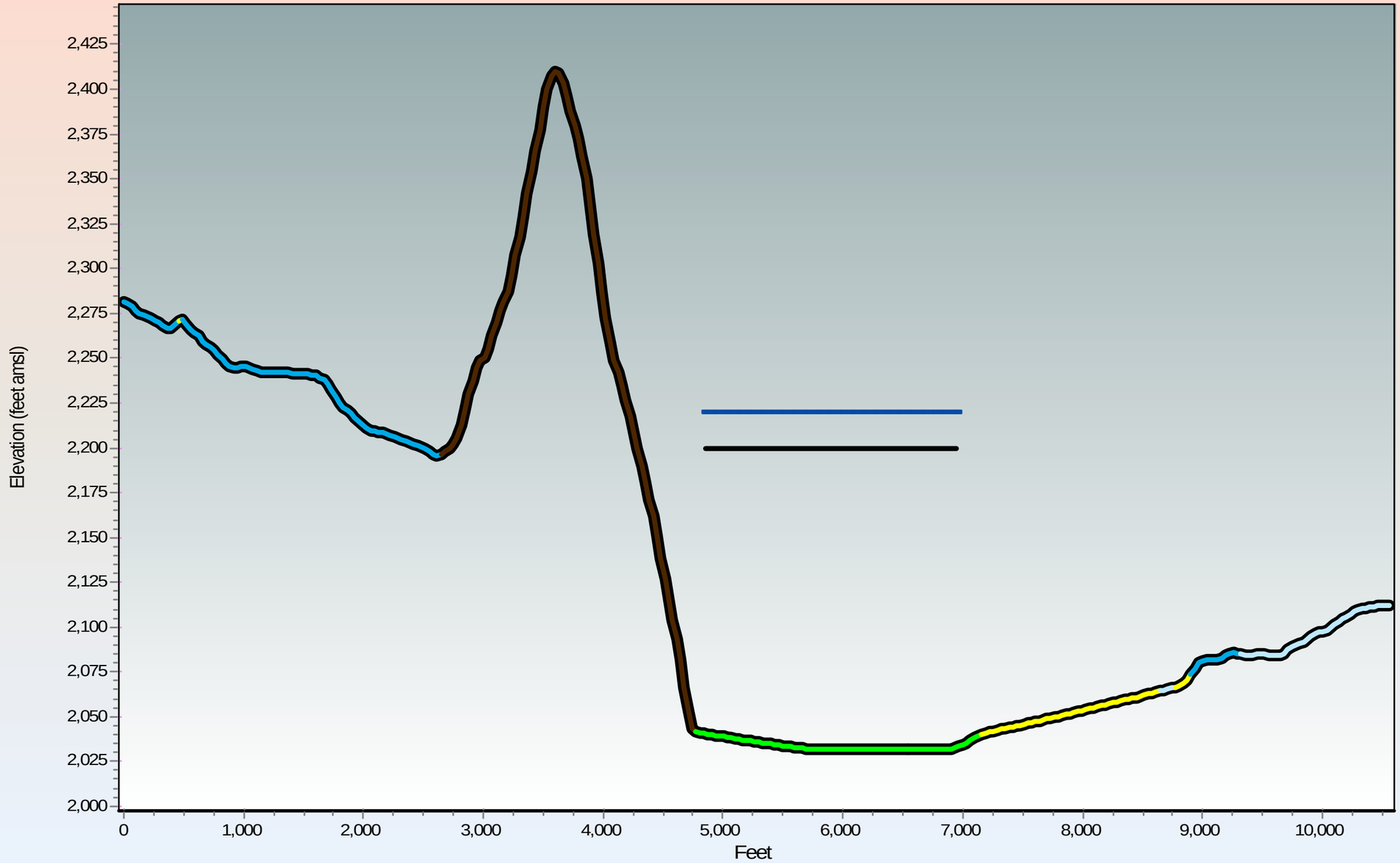
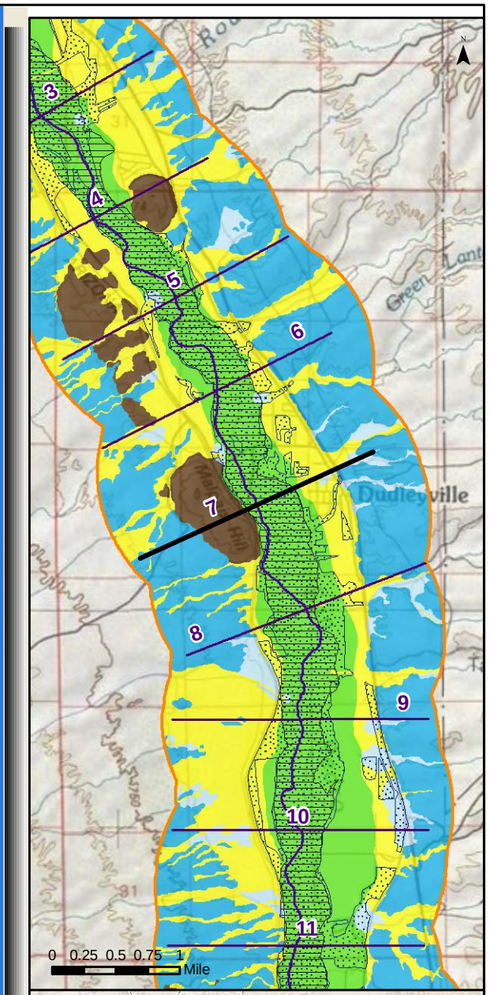
Appendix F

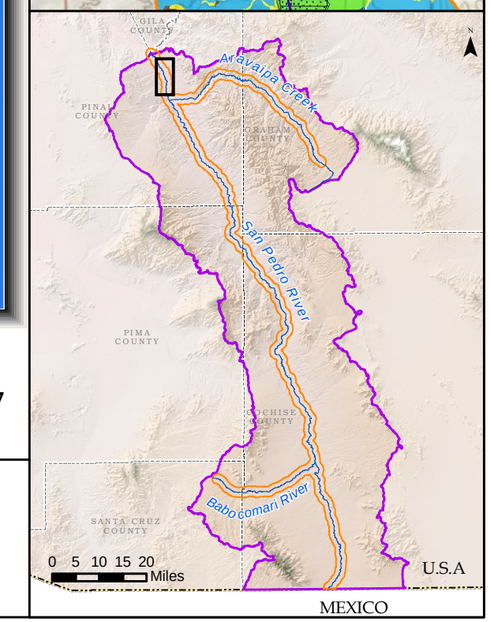
San Pedro River Cross Section at Mile 006

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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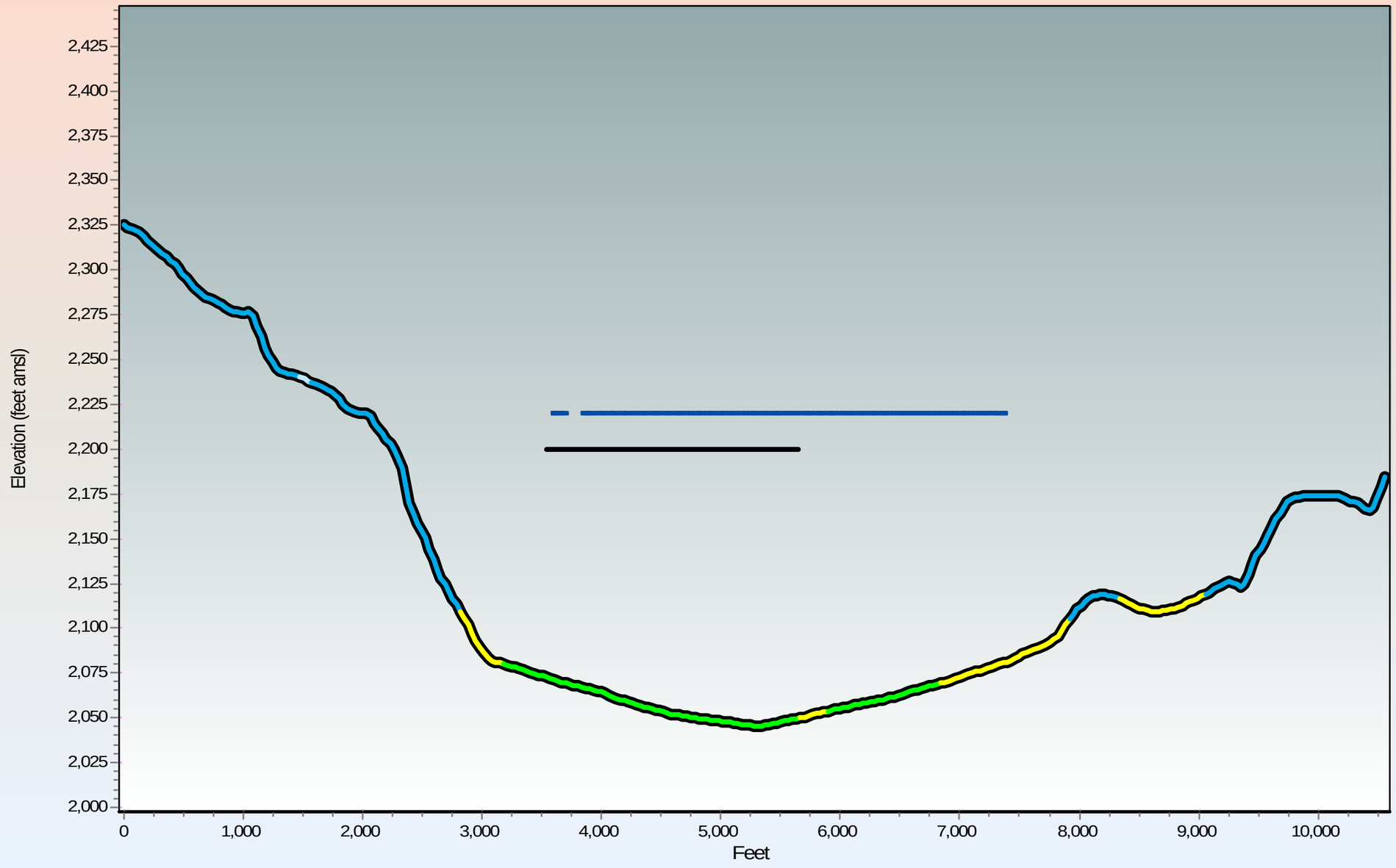
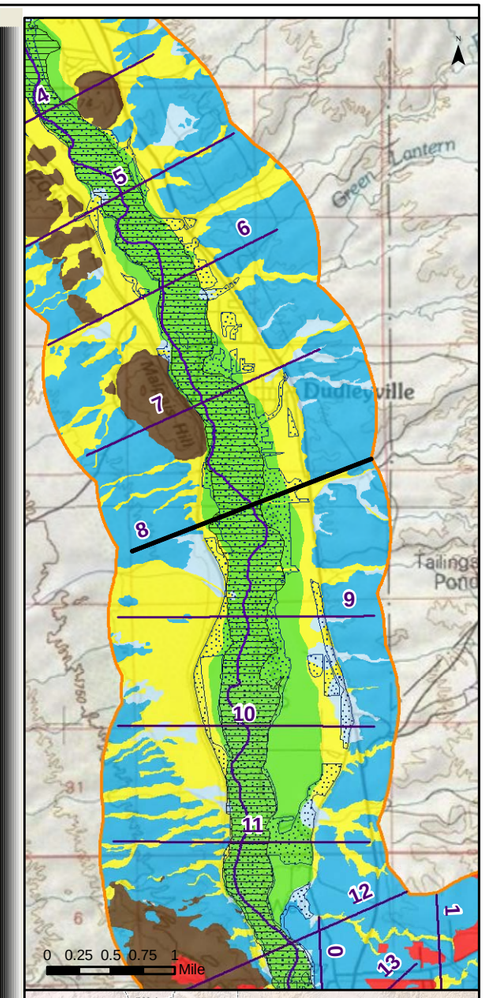
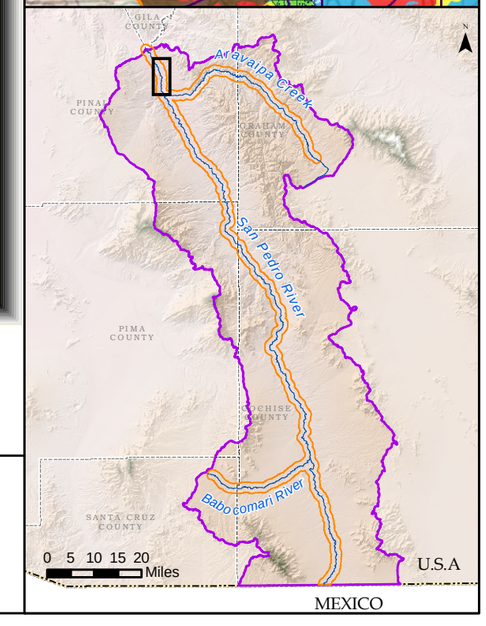
Appendix F
San Pedro River Cross Section at Mile 007
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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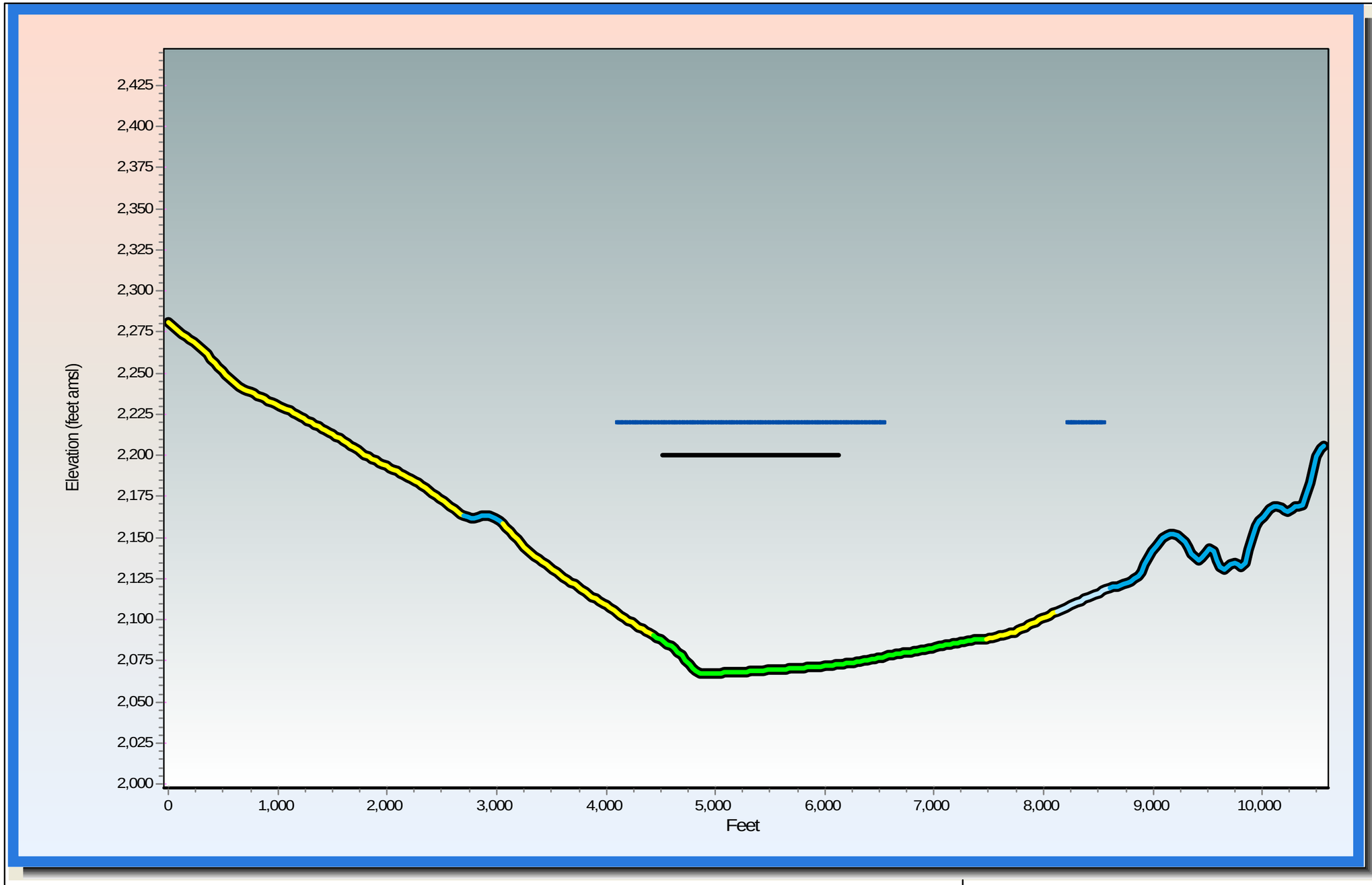
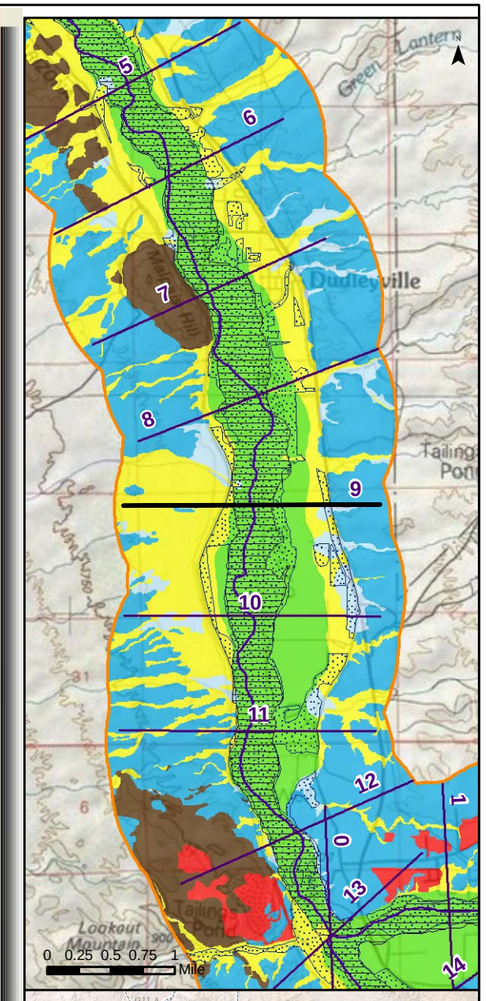
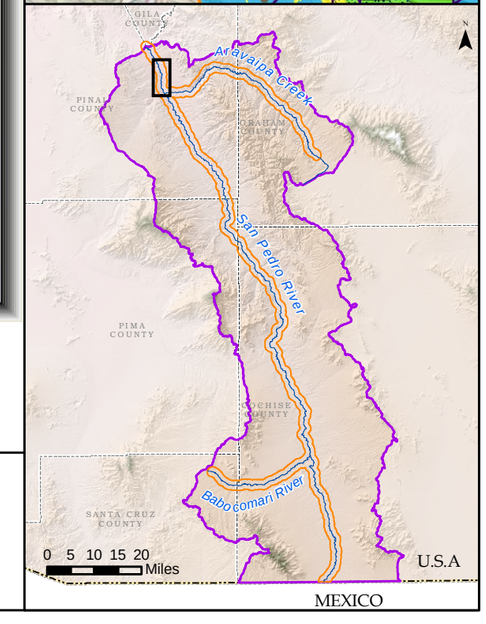
Appendix F
San Pedro River Cross Section at Mile 008
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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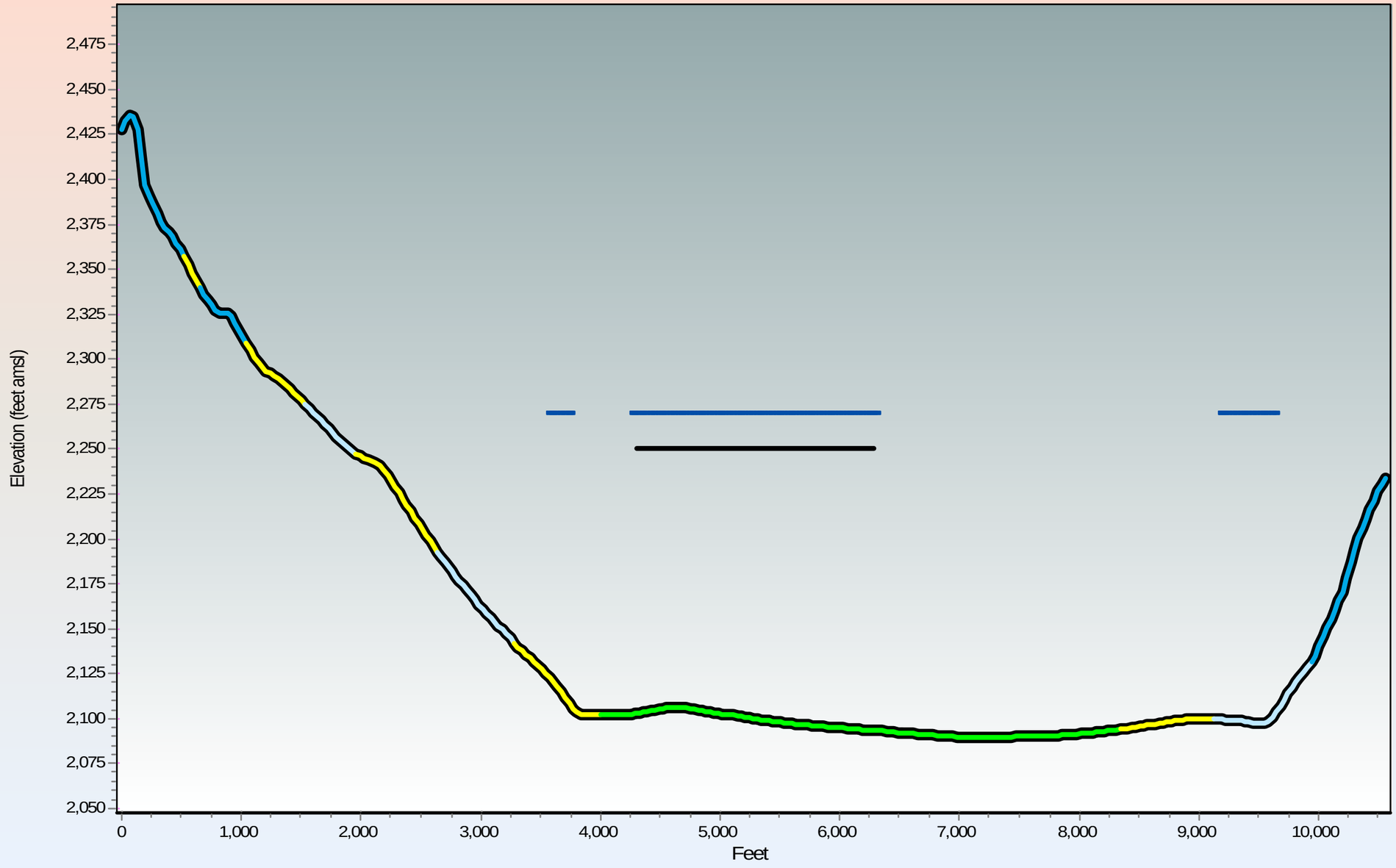
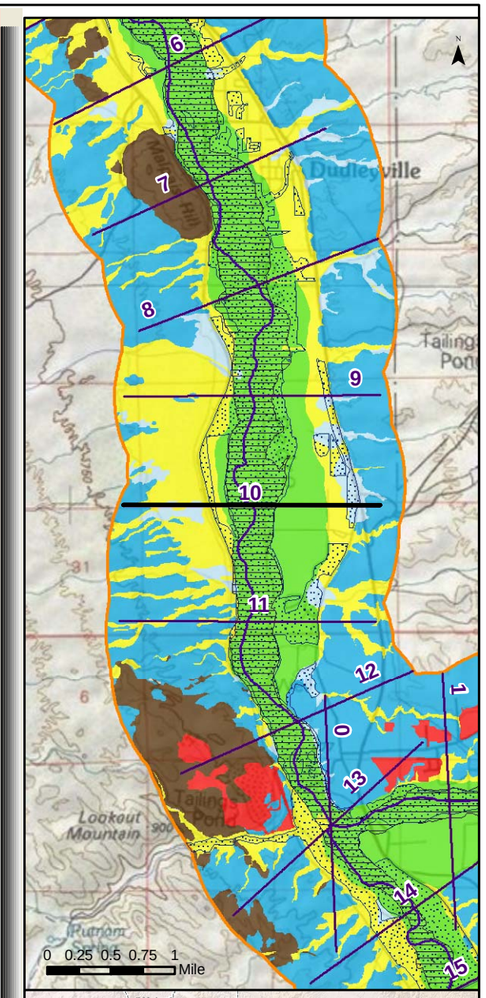
Appendix F

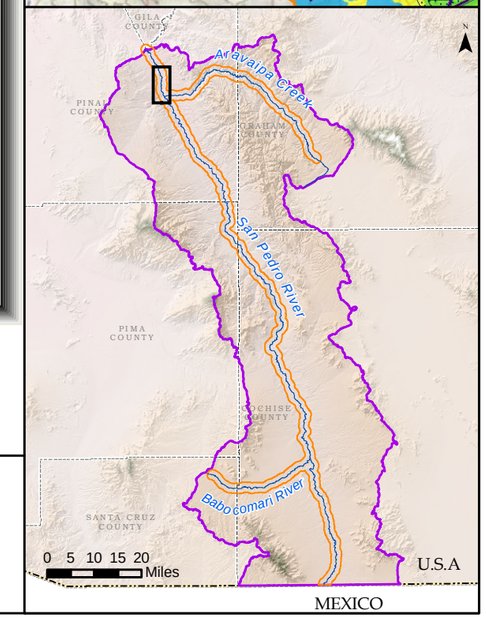
San Pedro River Cross Section at Mile 009

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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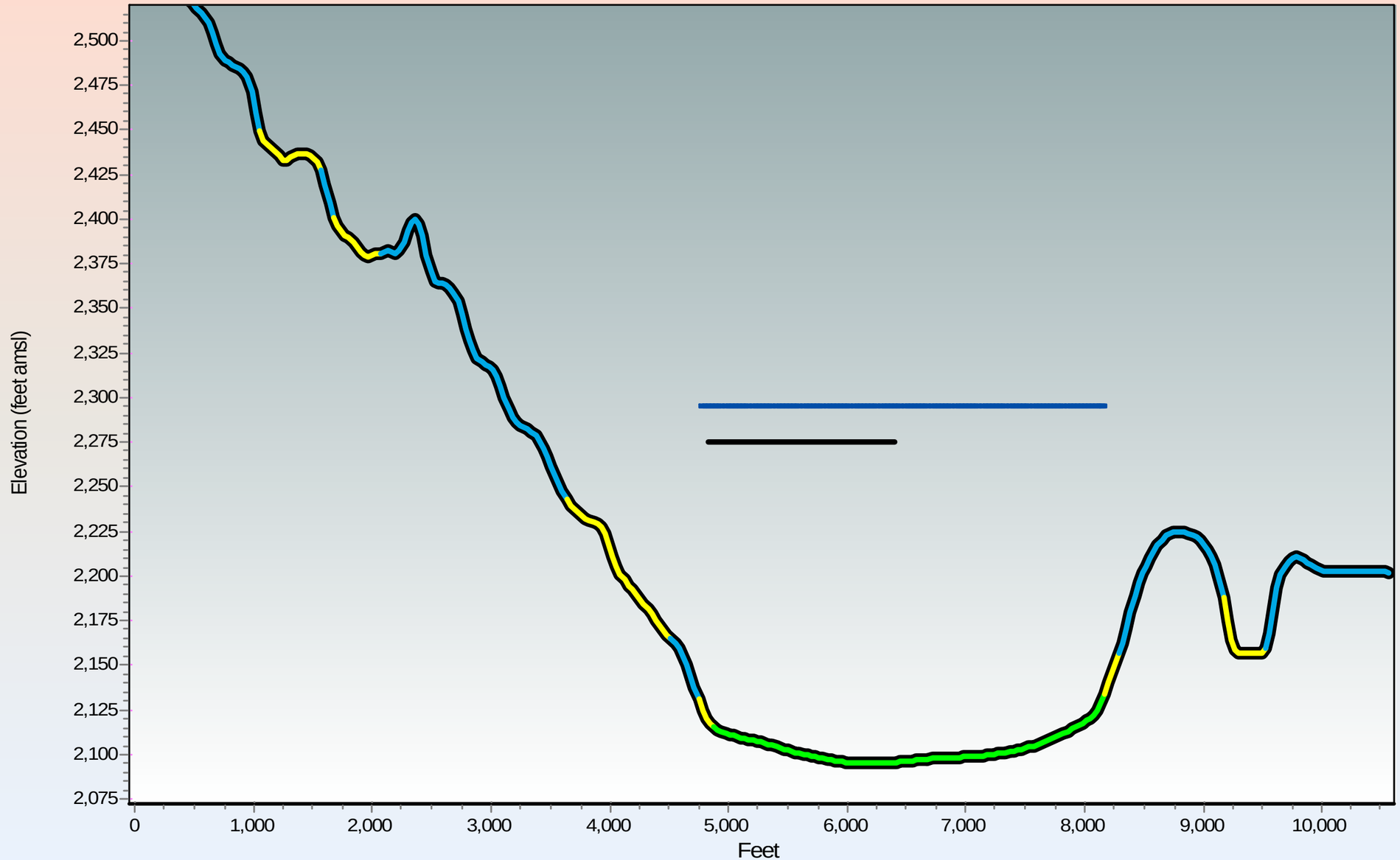
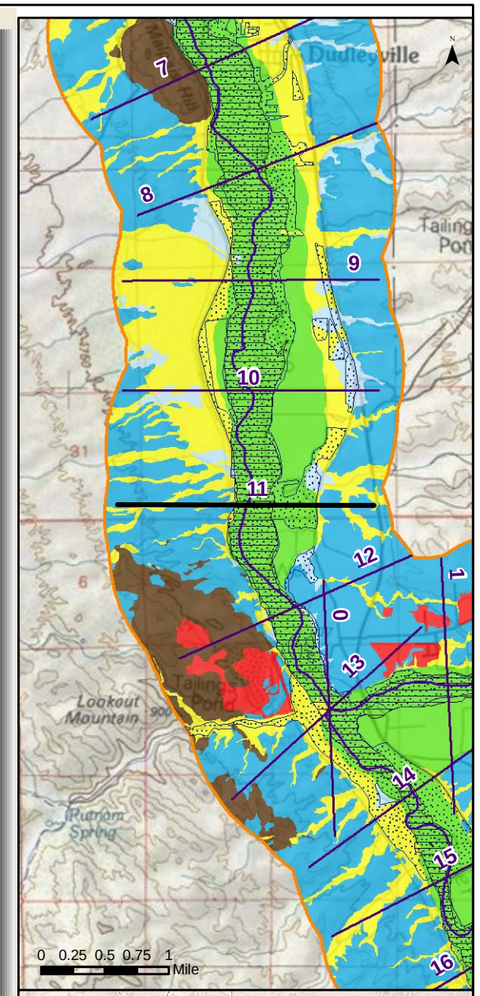
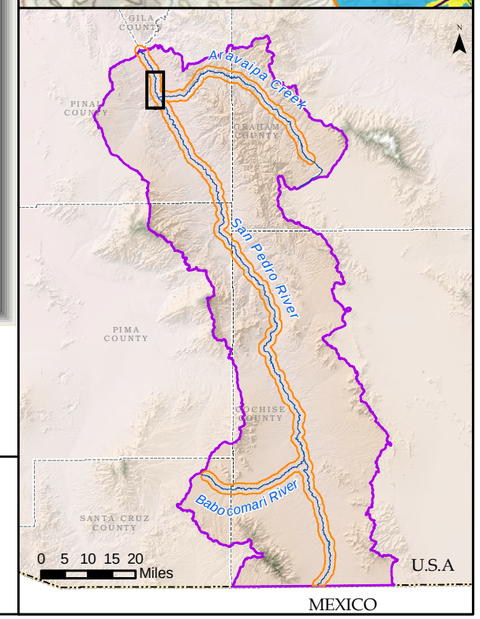
Appendix F
San Pedro River Cross Section at Mile 010
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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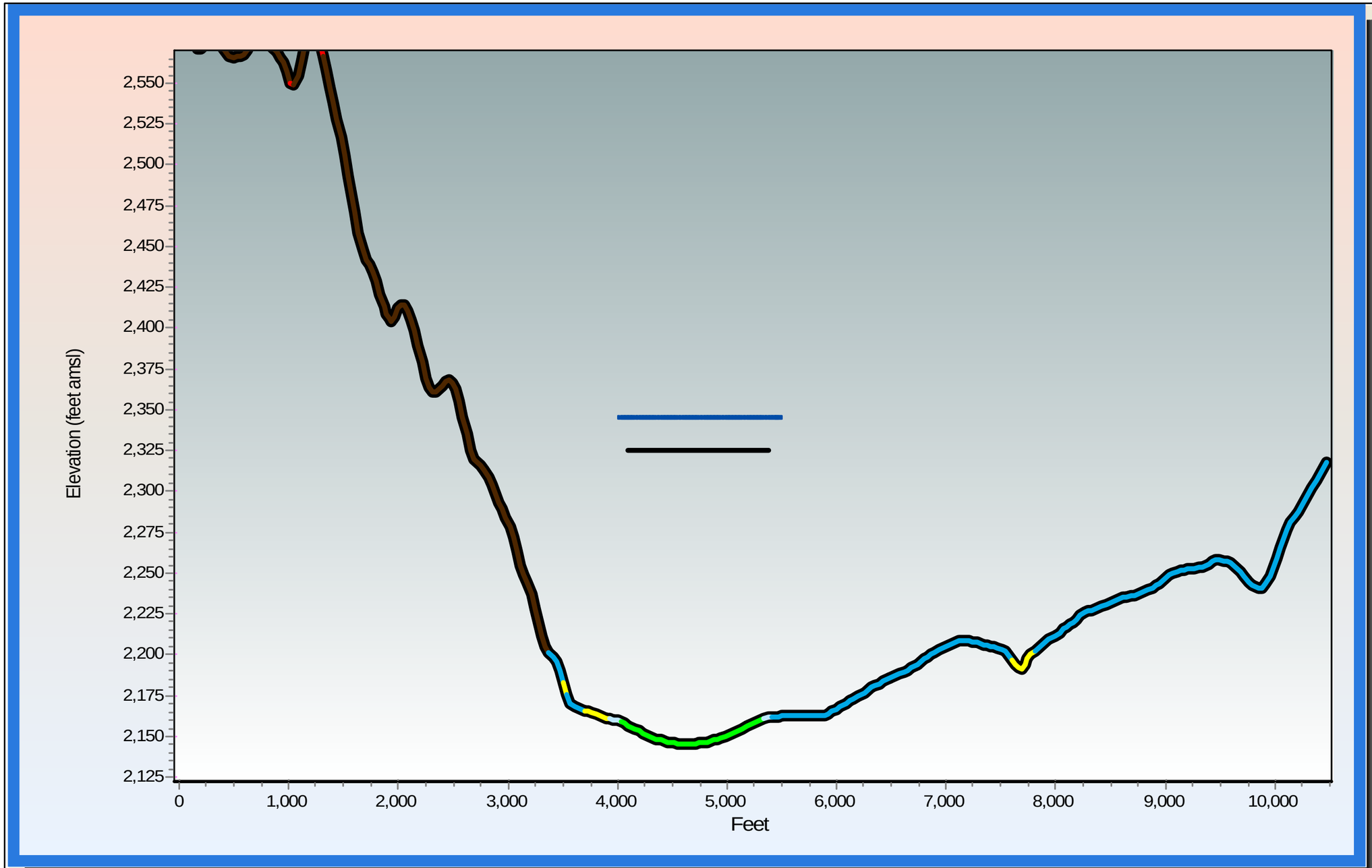
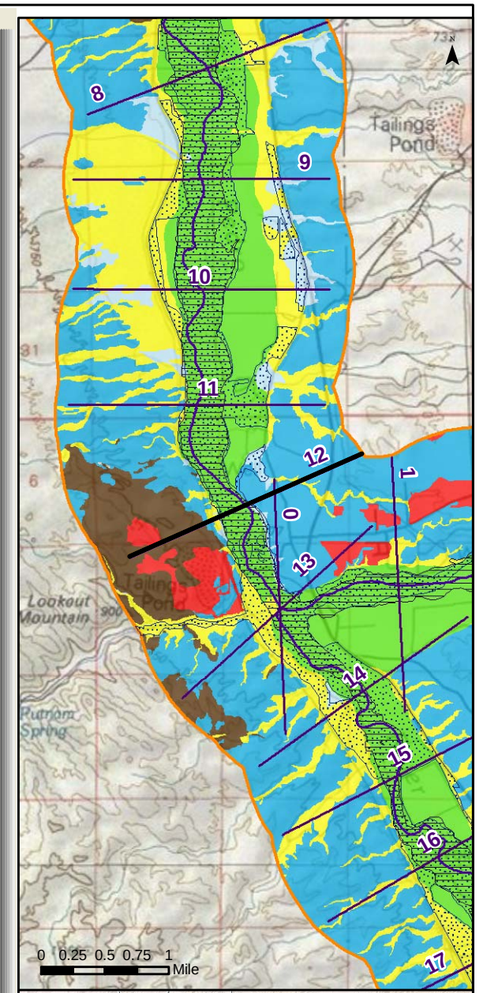
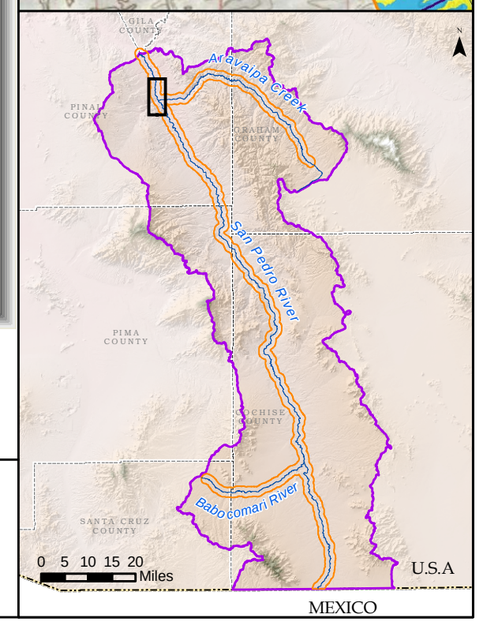
Appendix F
San Pedro River Cross Section at Mile 011
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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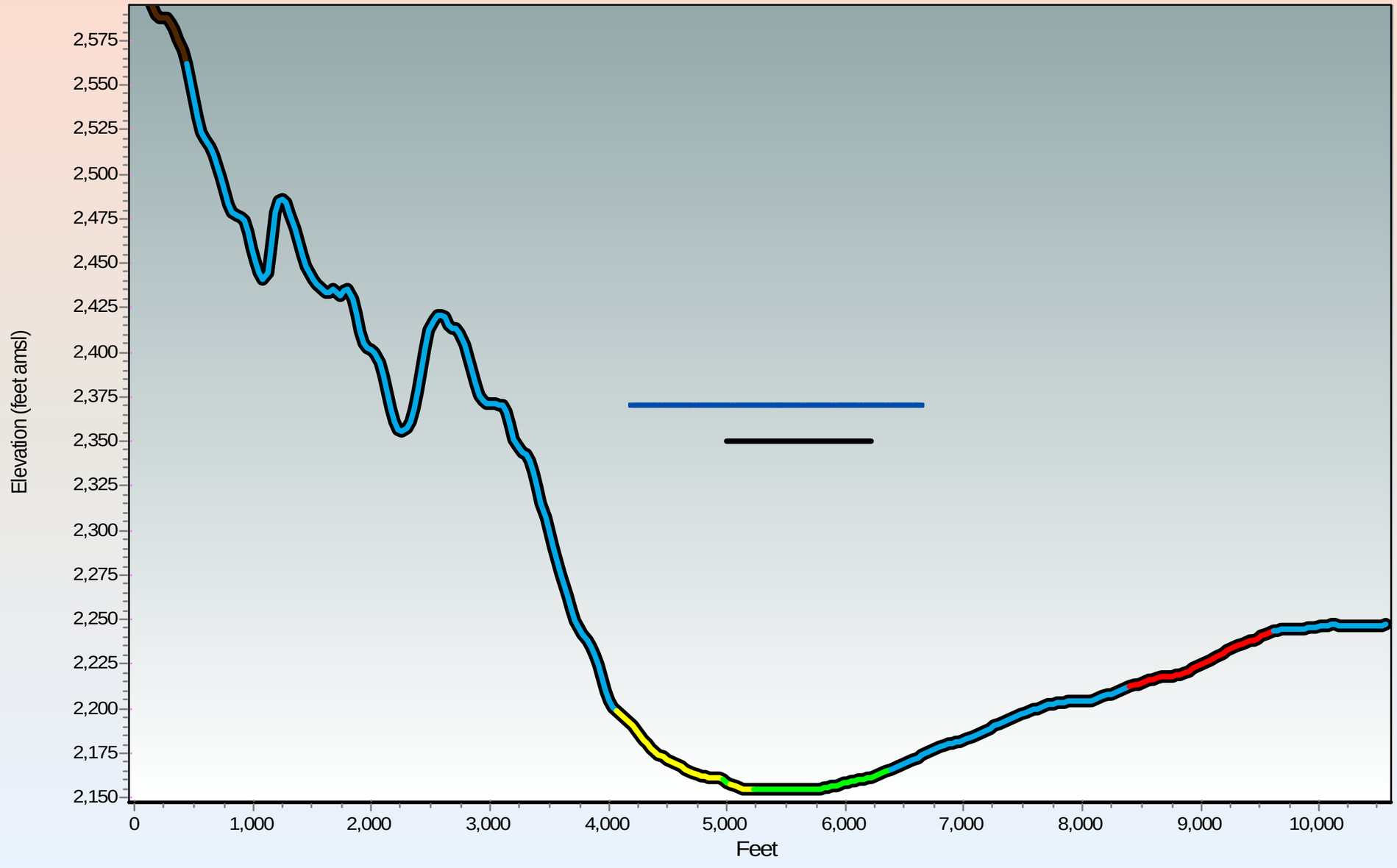
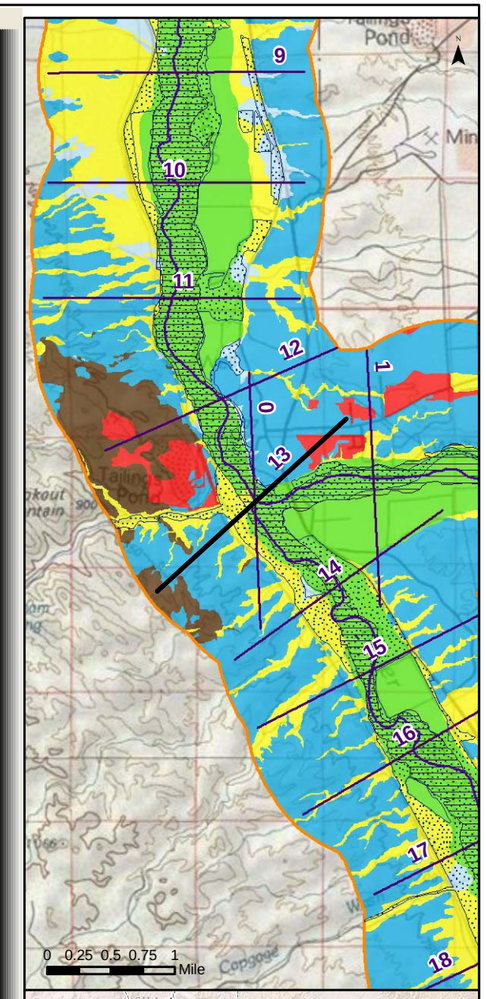
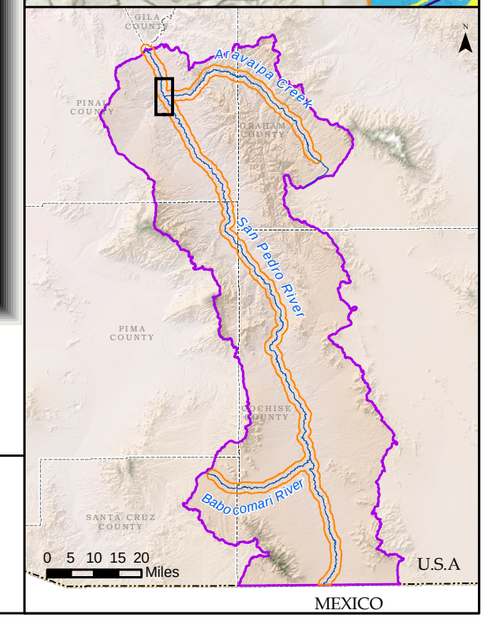
Appendix F
San Pedro River Cross Section at Mile 012
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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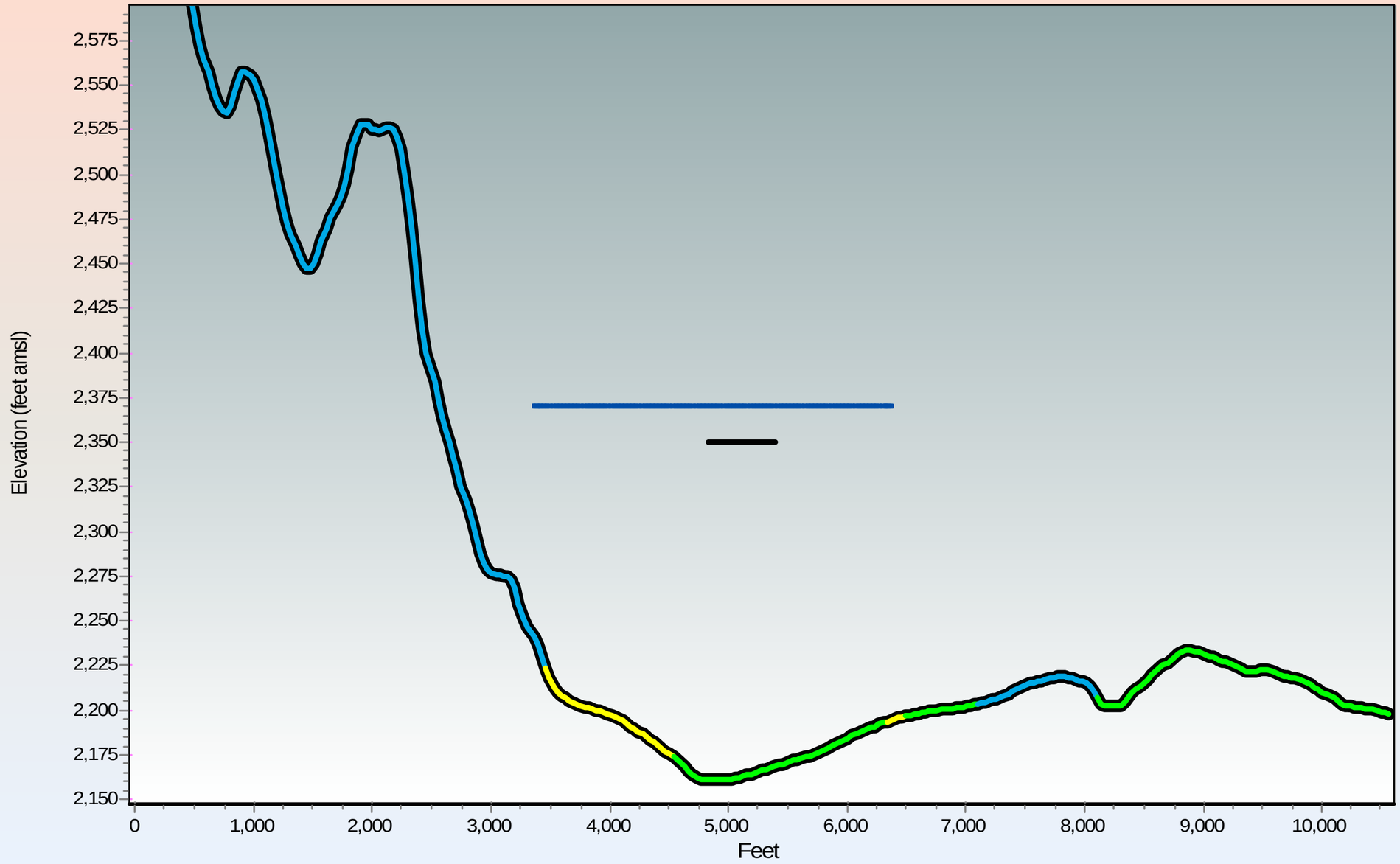
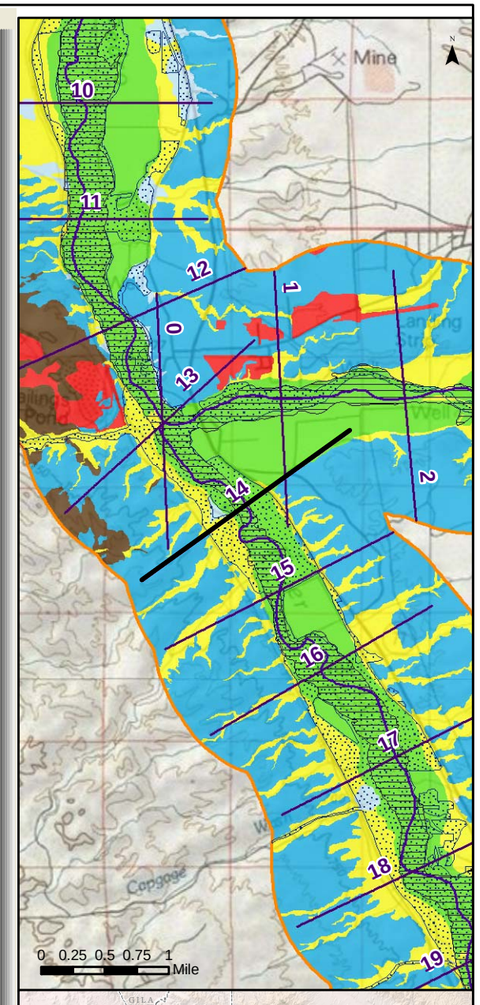
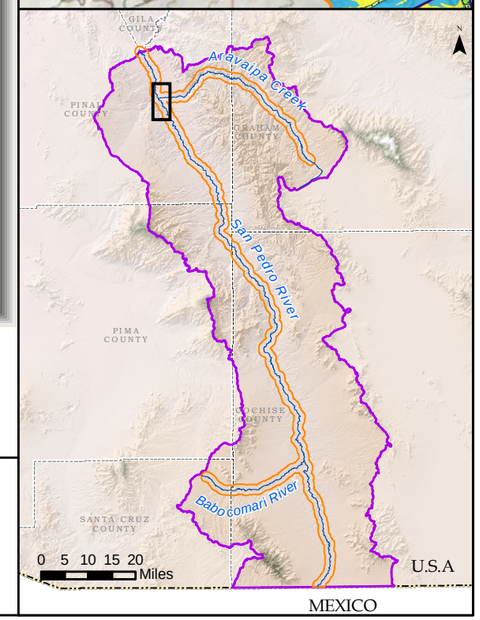
Appendix F
San Pedro River Cross Section at Mile 013
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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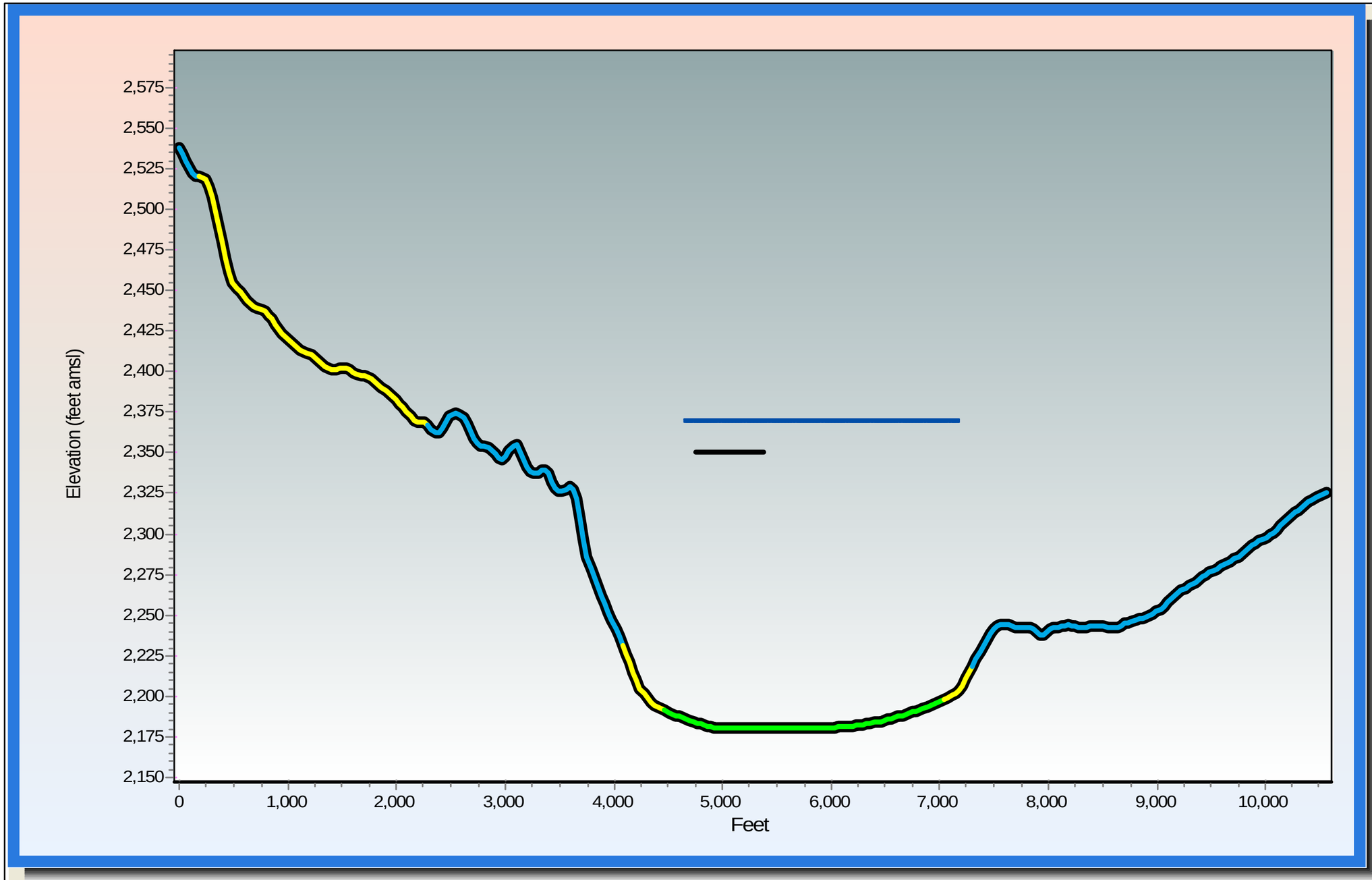
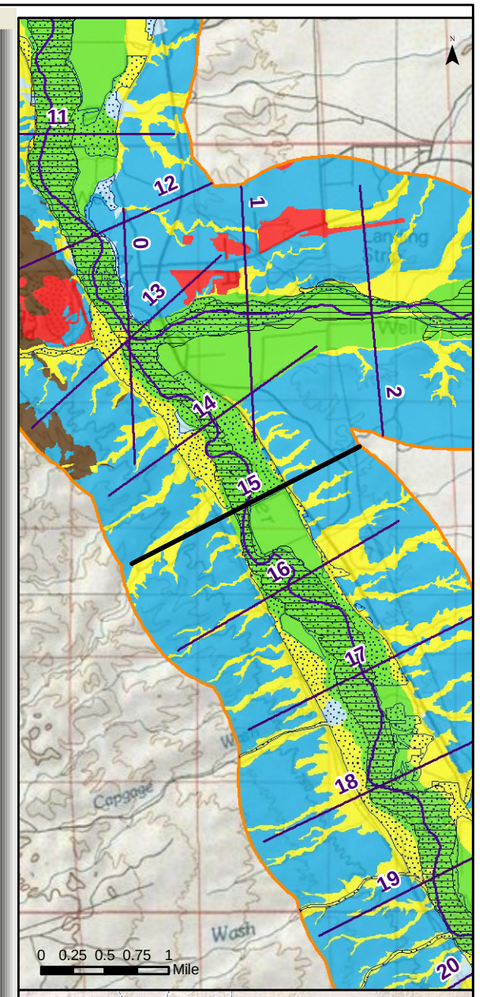
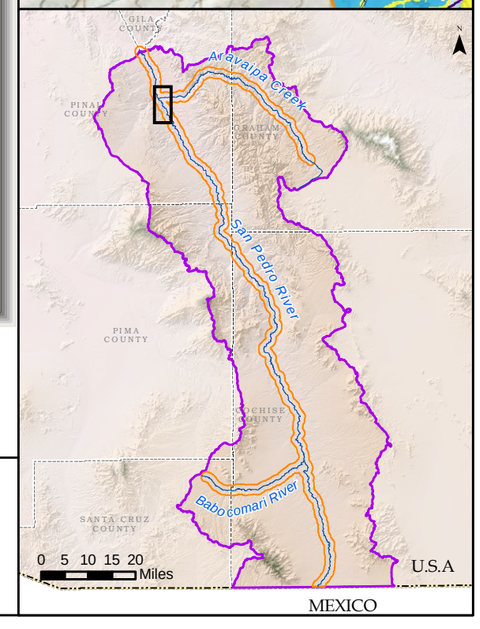
Appendix F
San Pedro River Cross Section at Mile 014
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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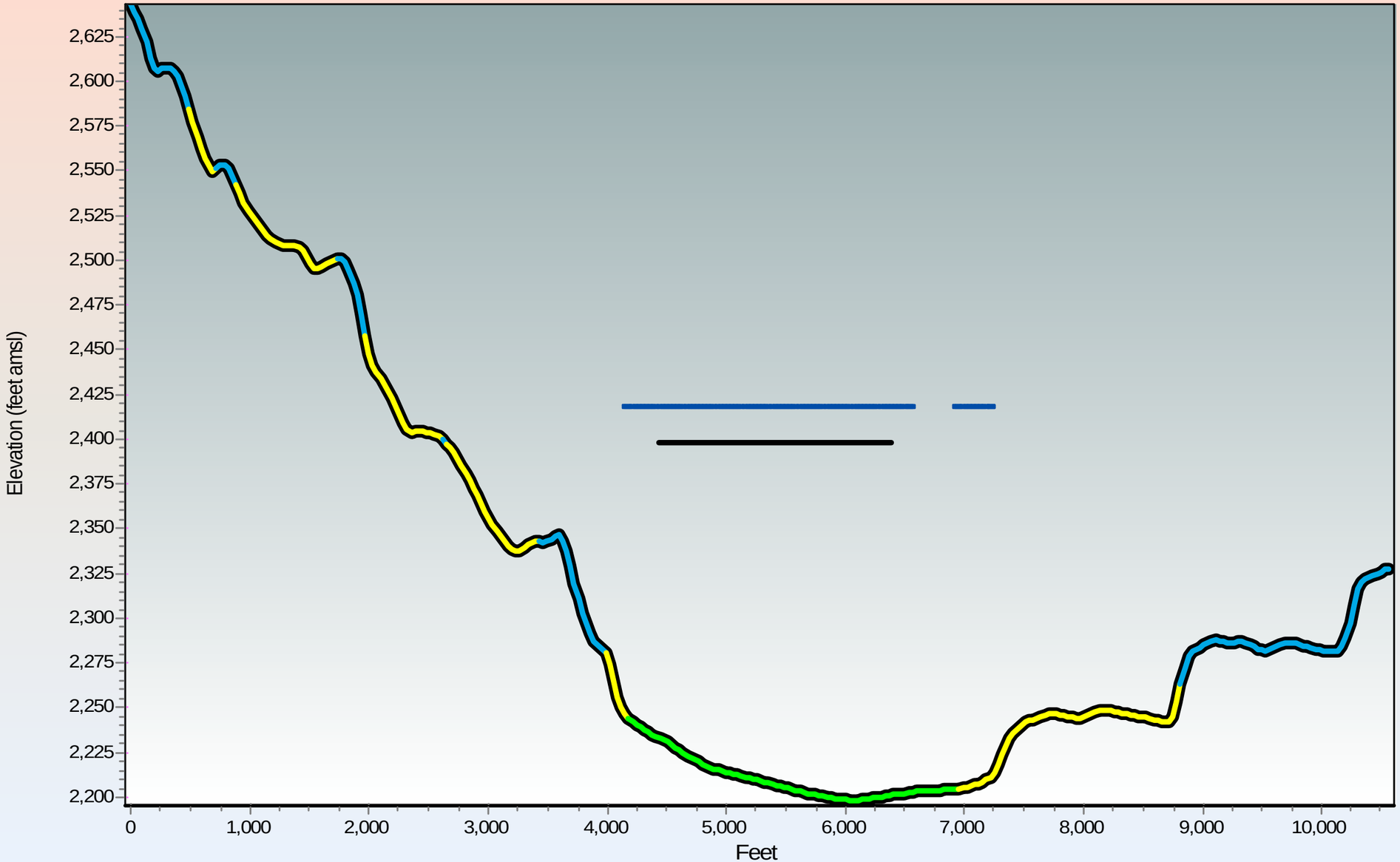
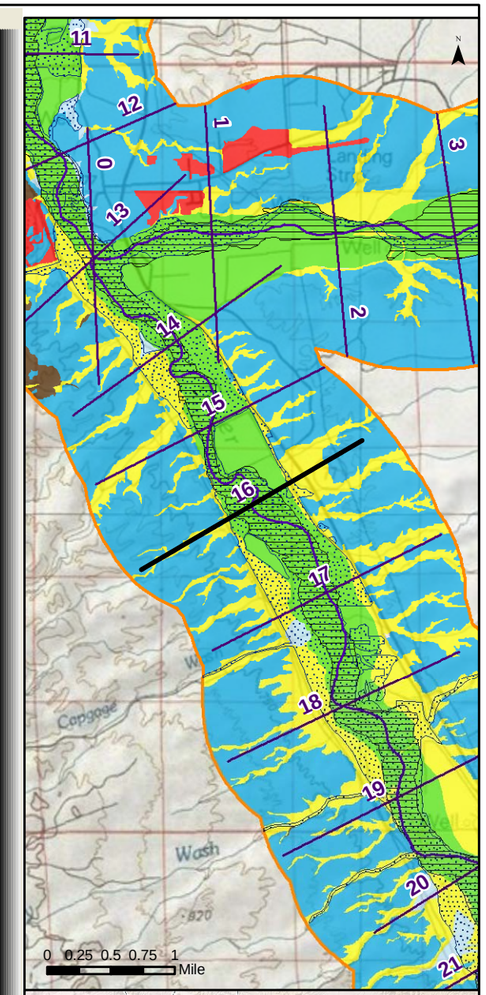
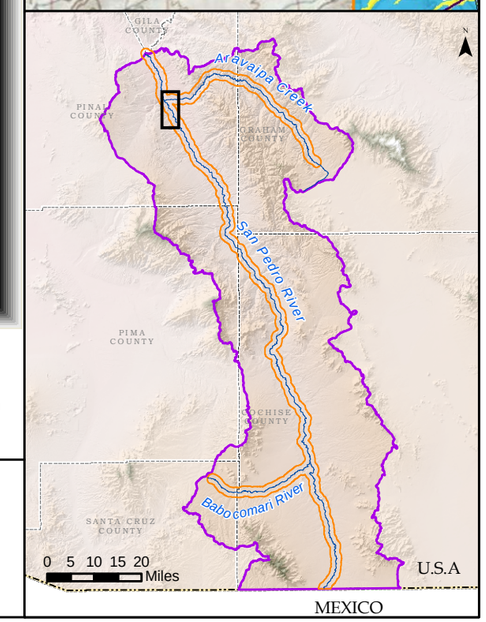
Appendix F
San Pedro River Cross Section at Mile 015
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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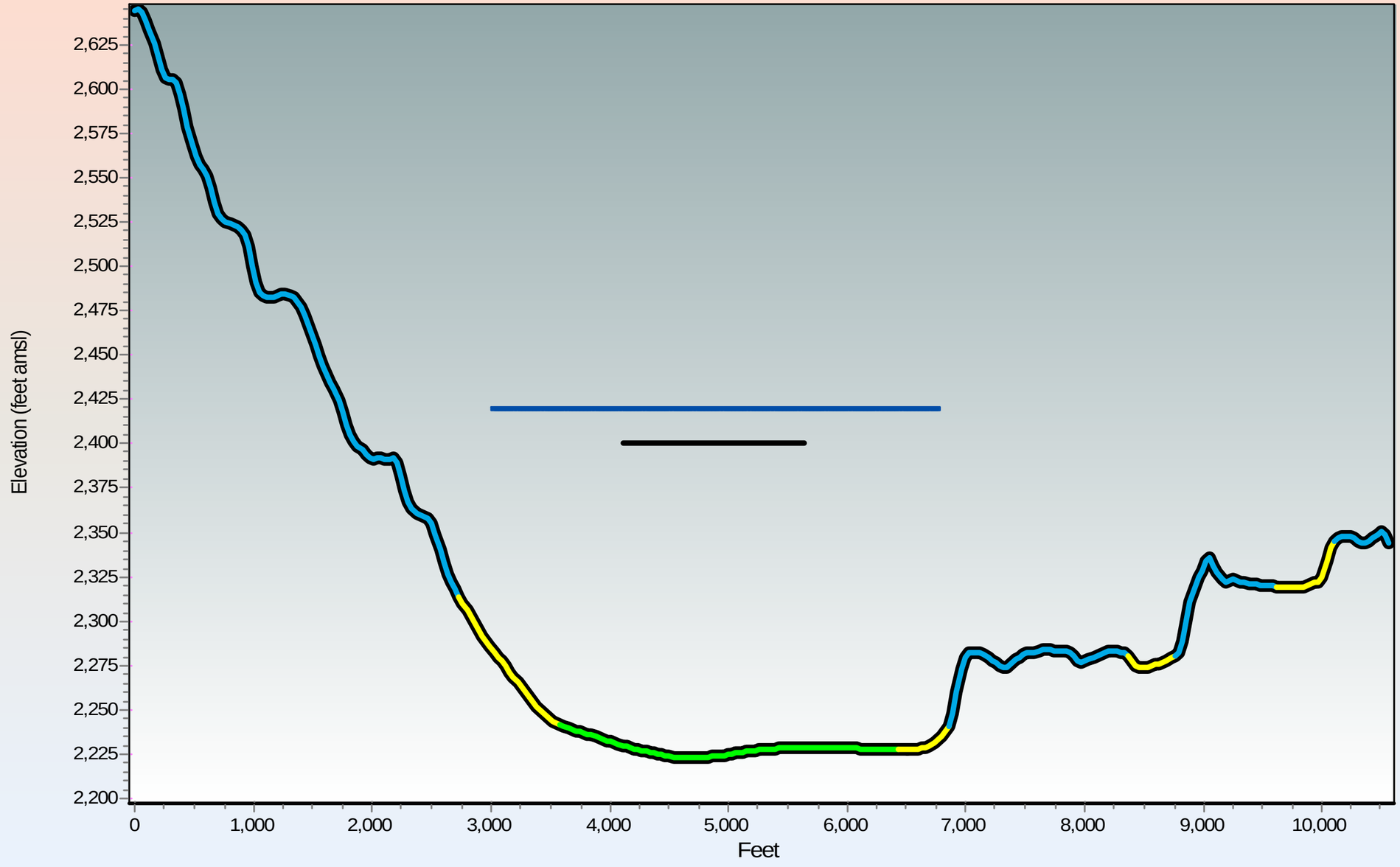
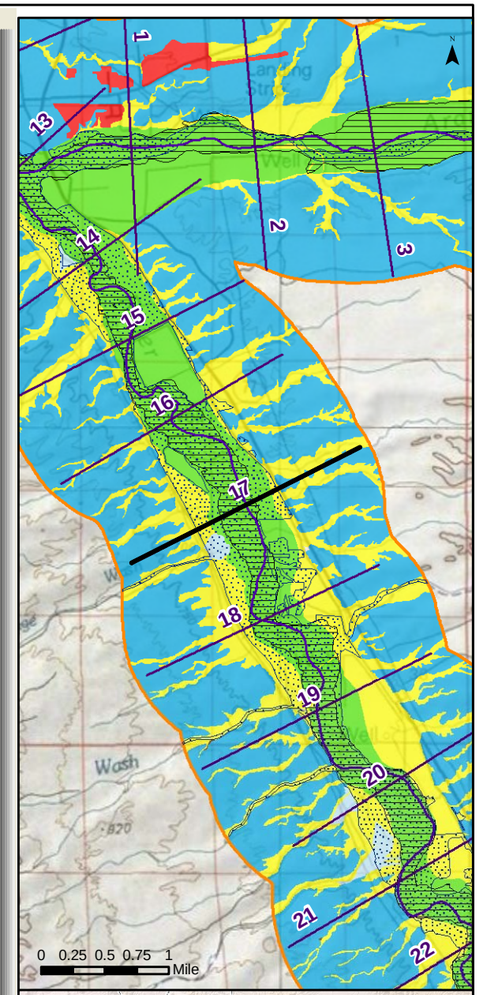
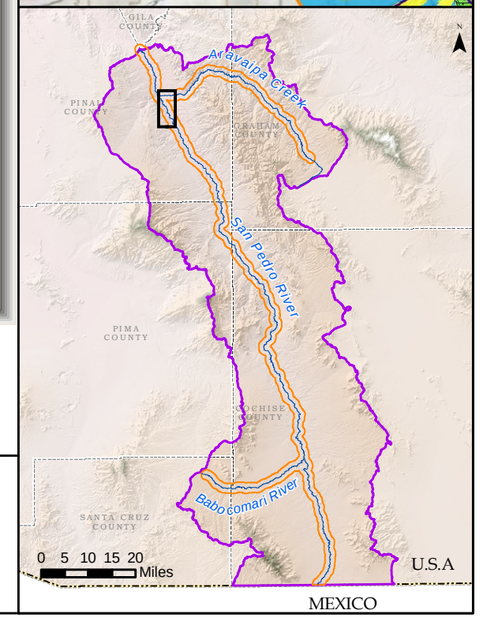
Appendix F
San Pedro River Cross Section at Mile 016
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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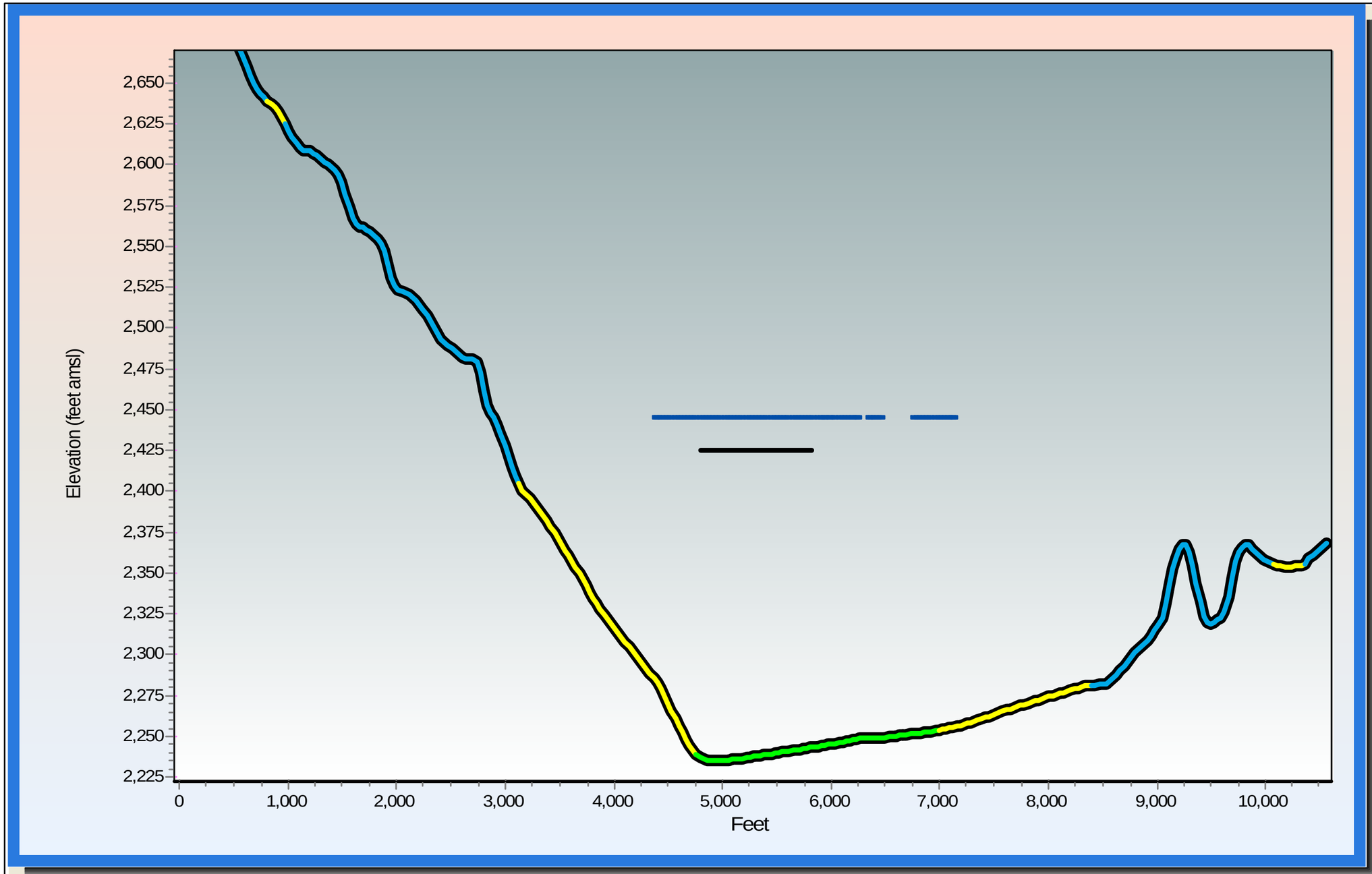
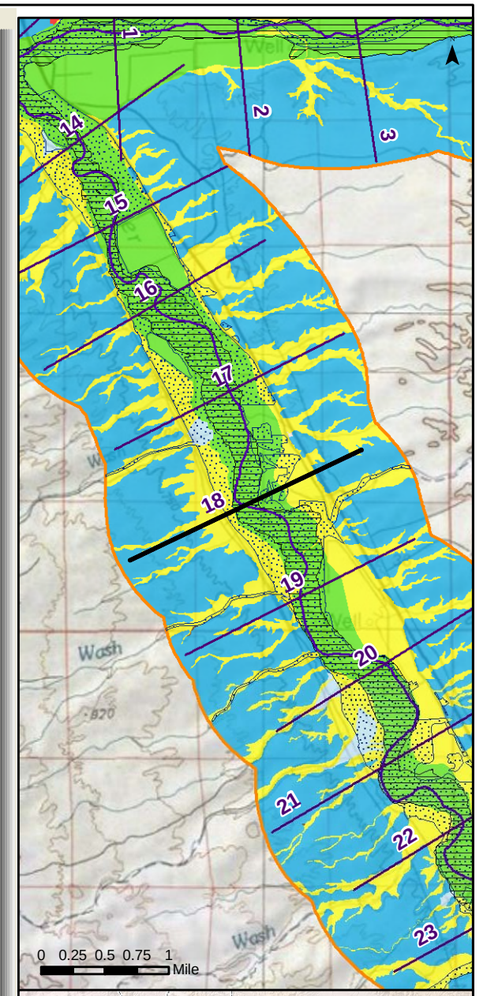
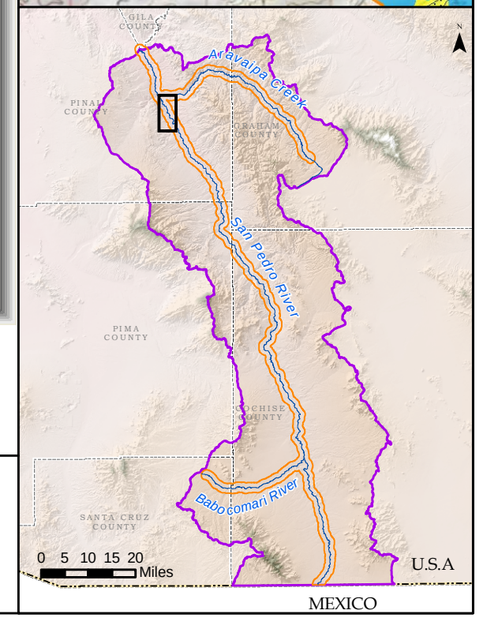
Appendix F
San Pedro River Cross Section at Mile 017
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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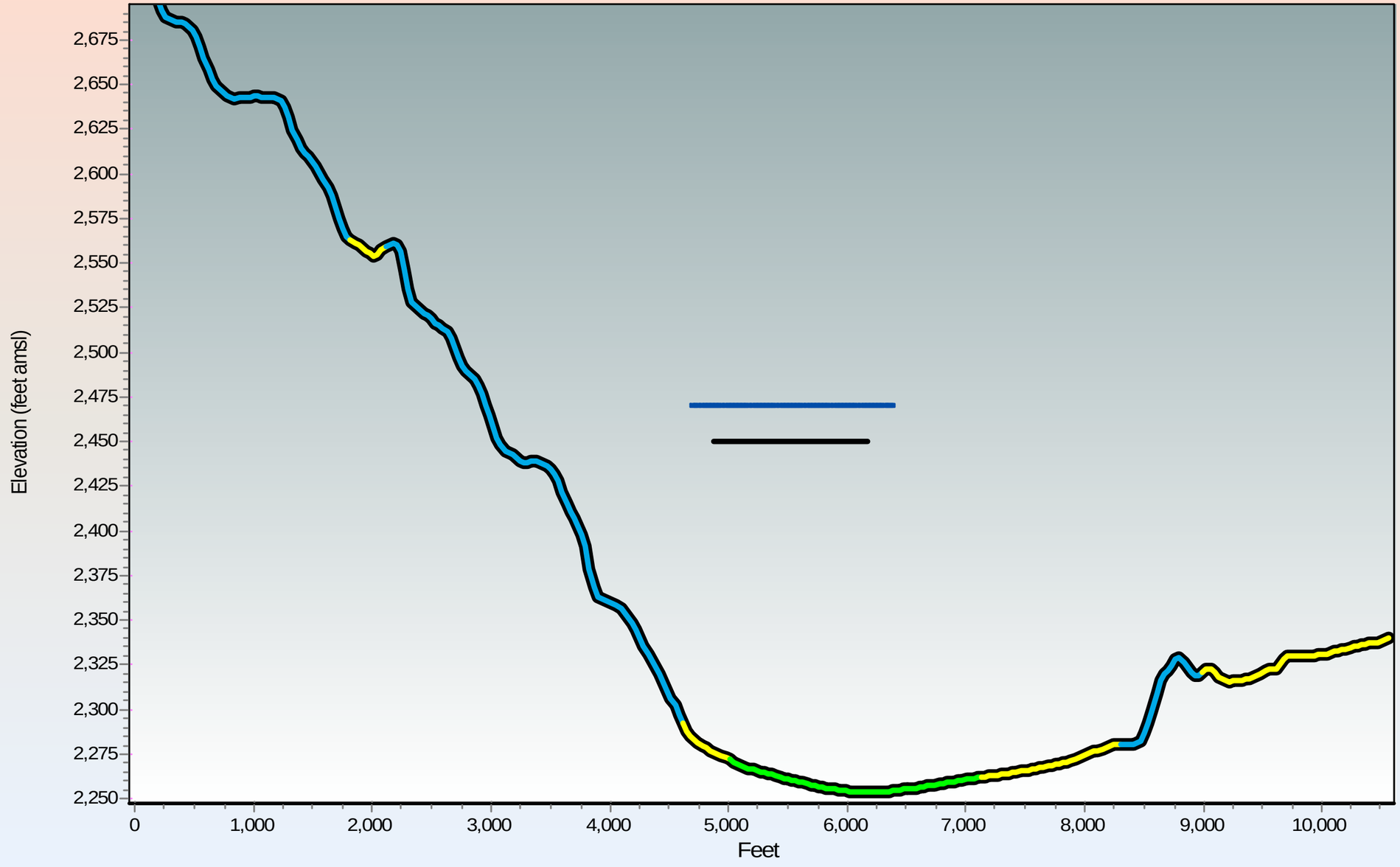
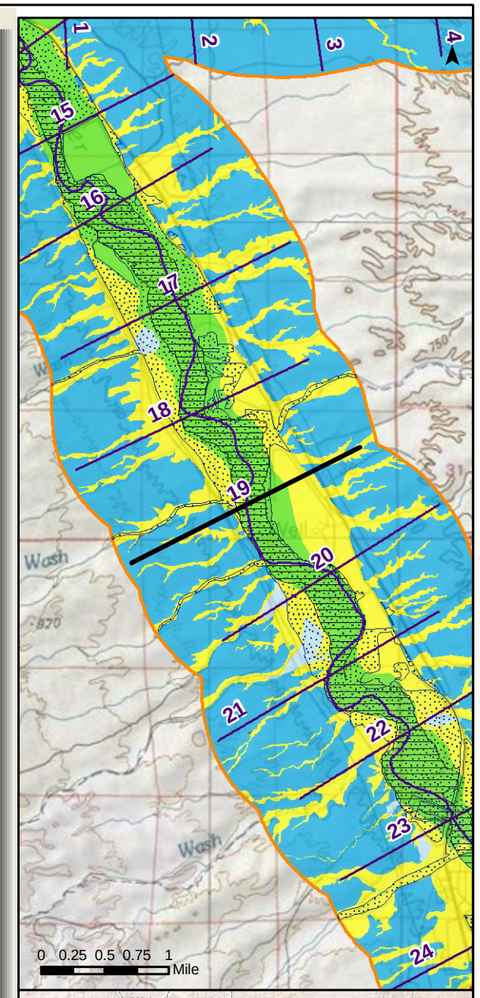
Appendix F

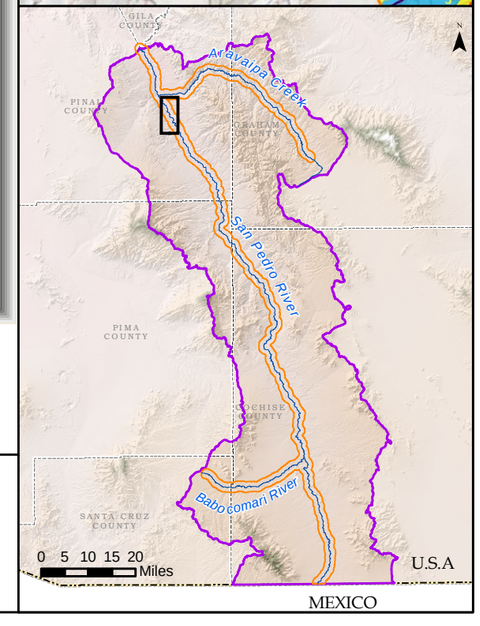
San Pedro River Cross Section at Mile 018

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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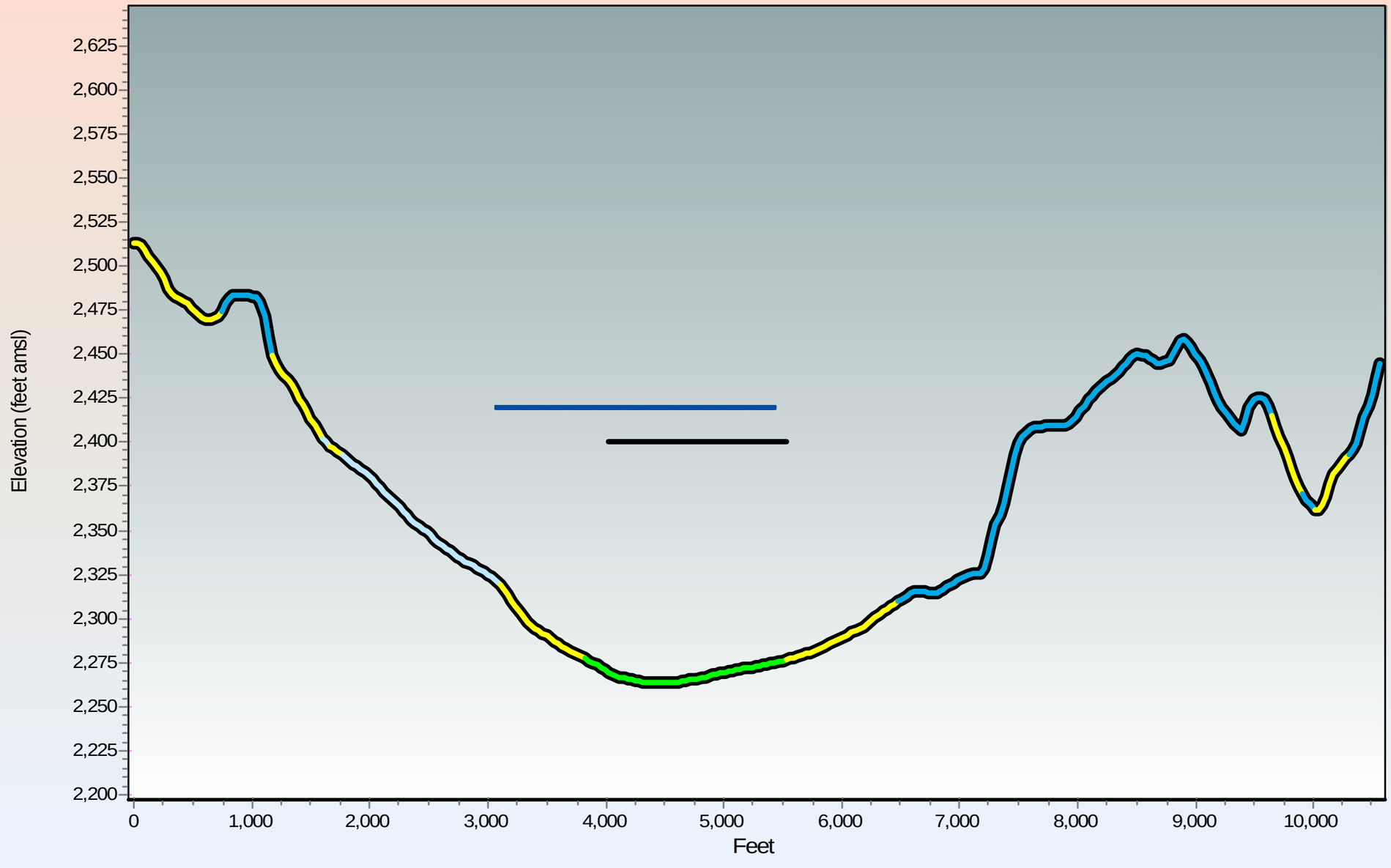
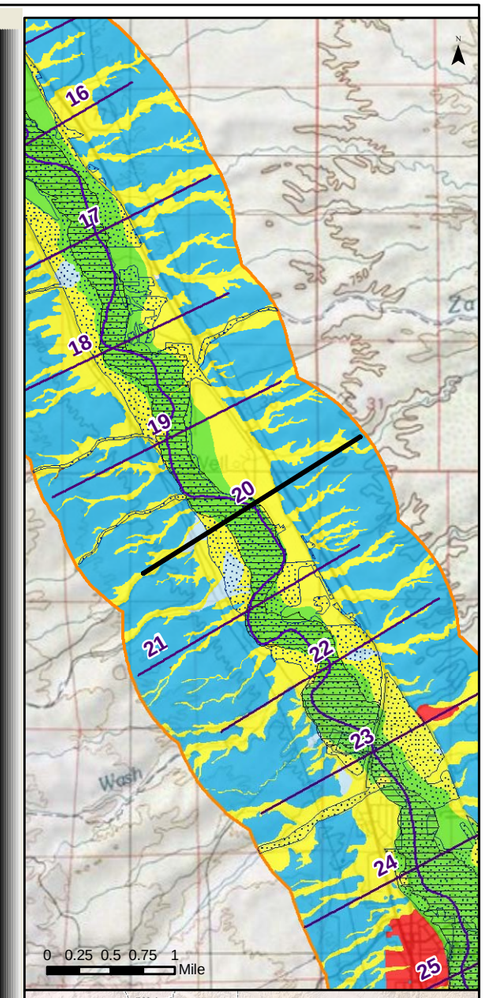
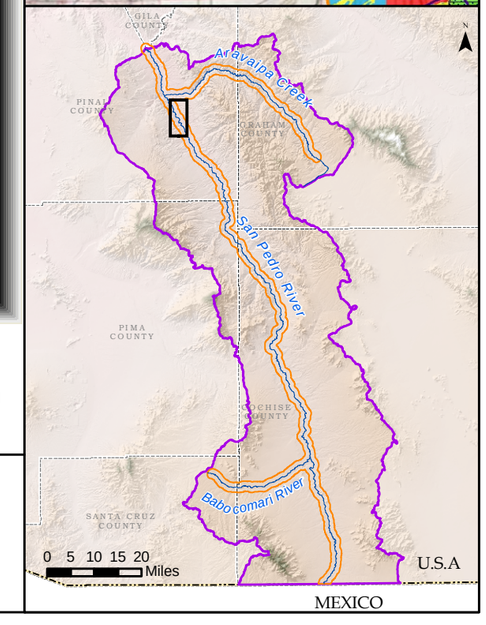
Appendix F
San Pedro River Cross Section at Mile 019
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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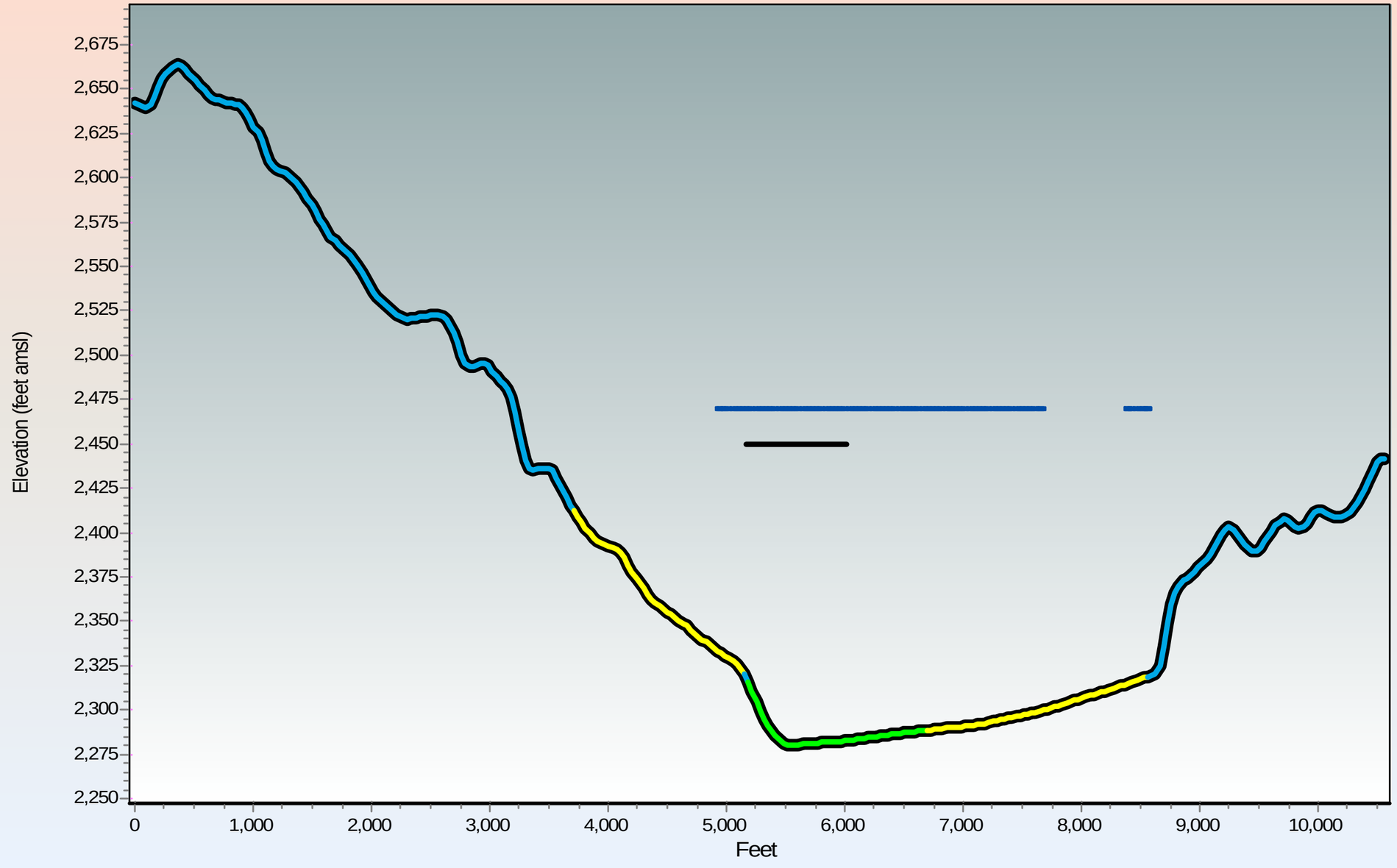
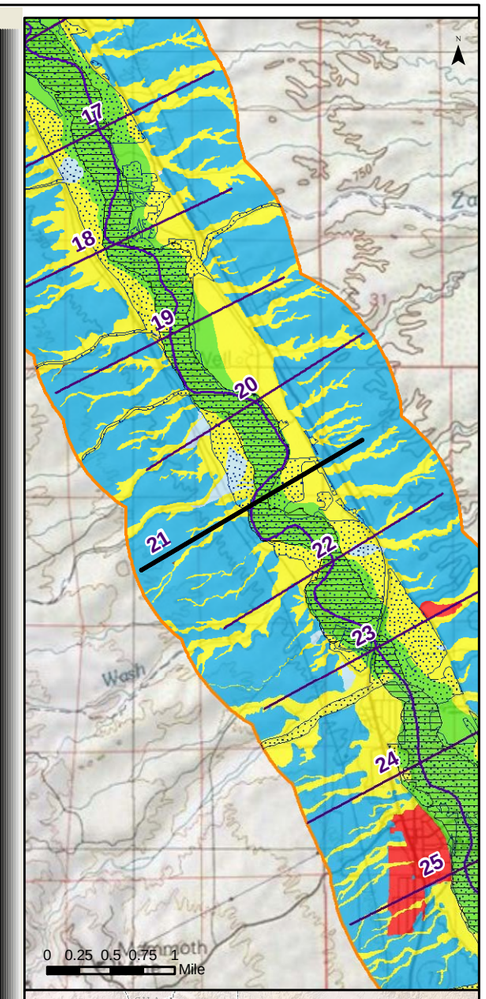
Appendix F

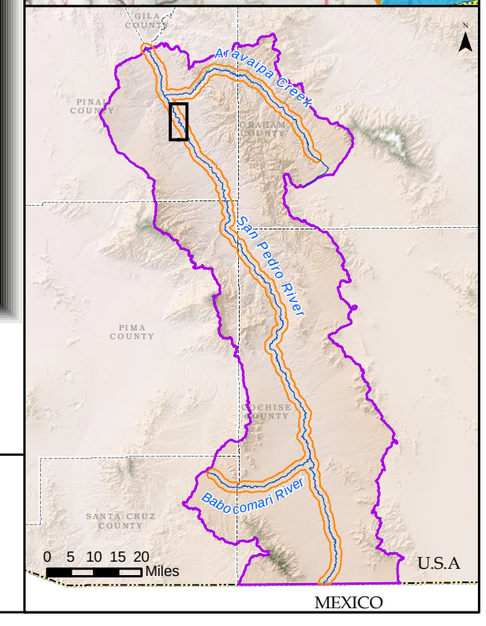
San Pedro River Cross Section at Mile 020

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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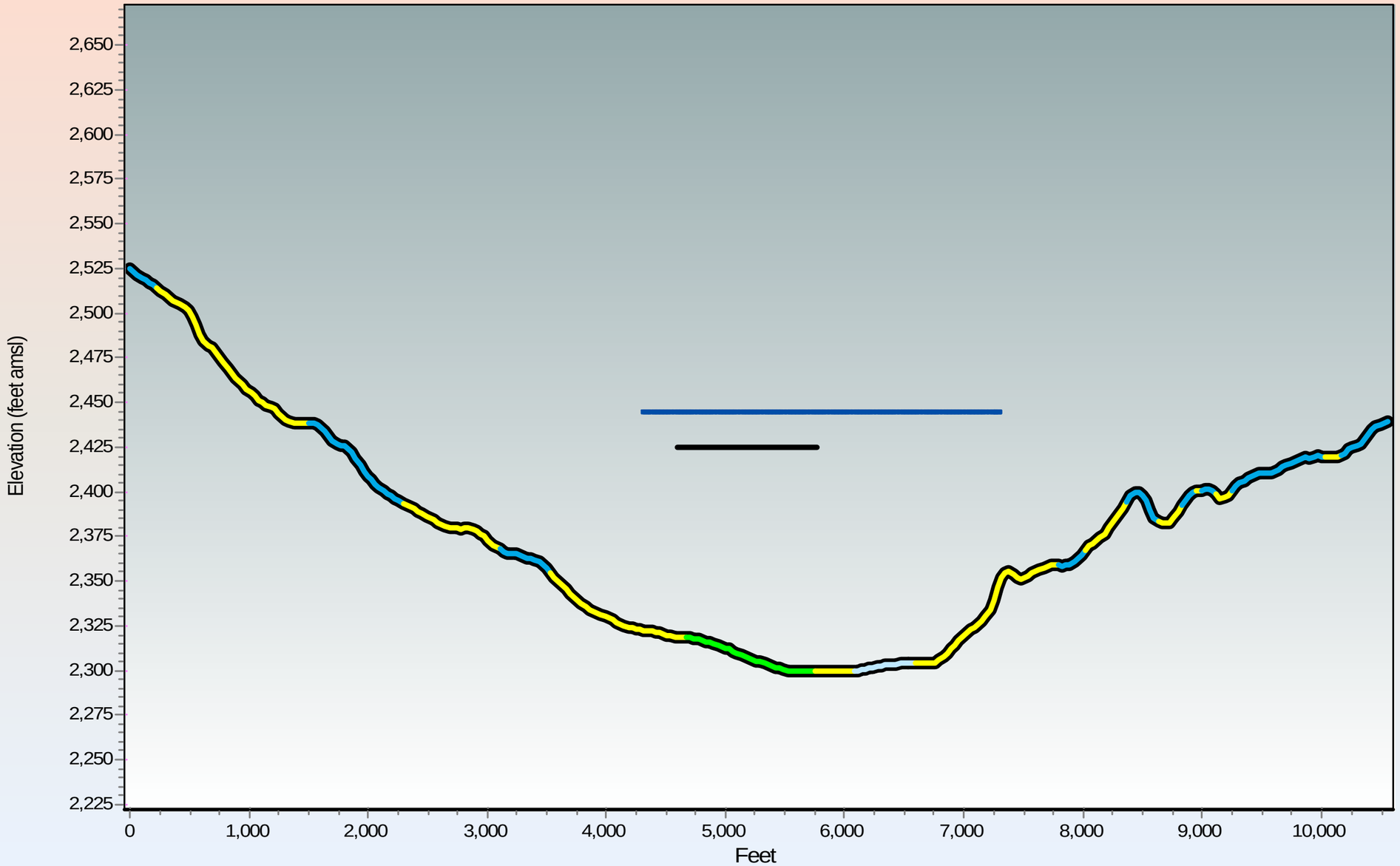
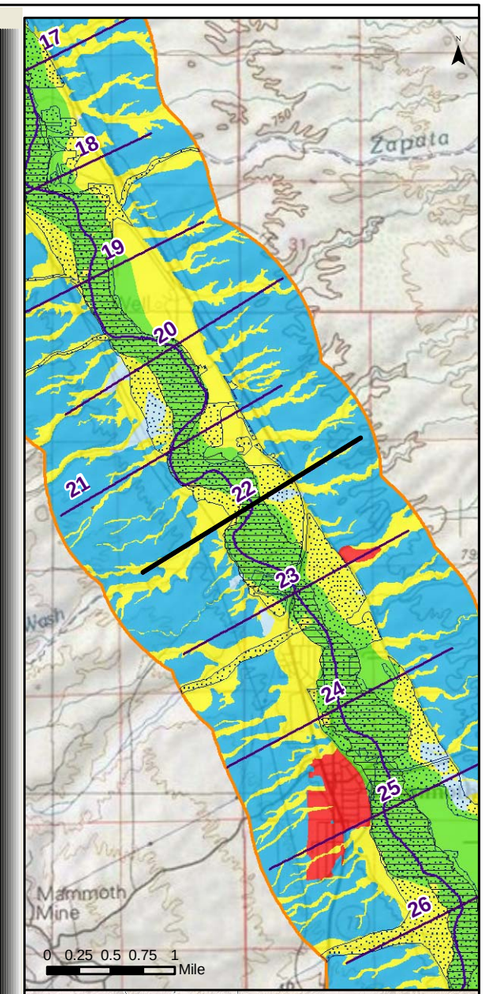
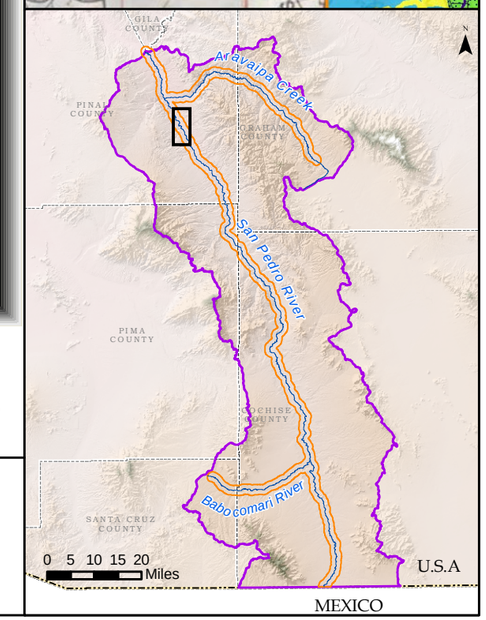
Appendix F
San Pedro River Cross Section at Mile 021
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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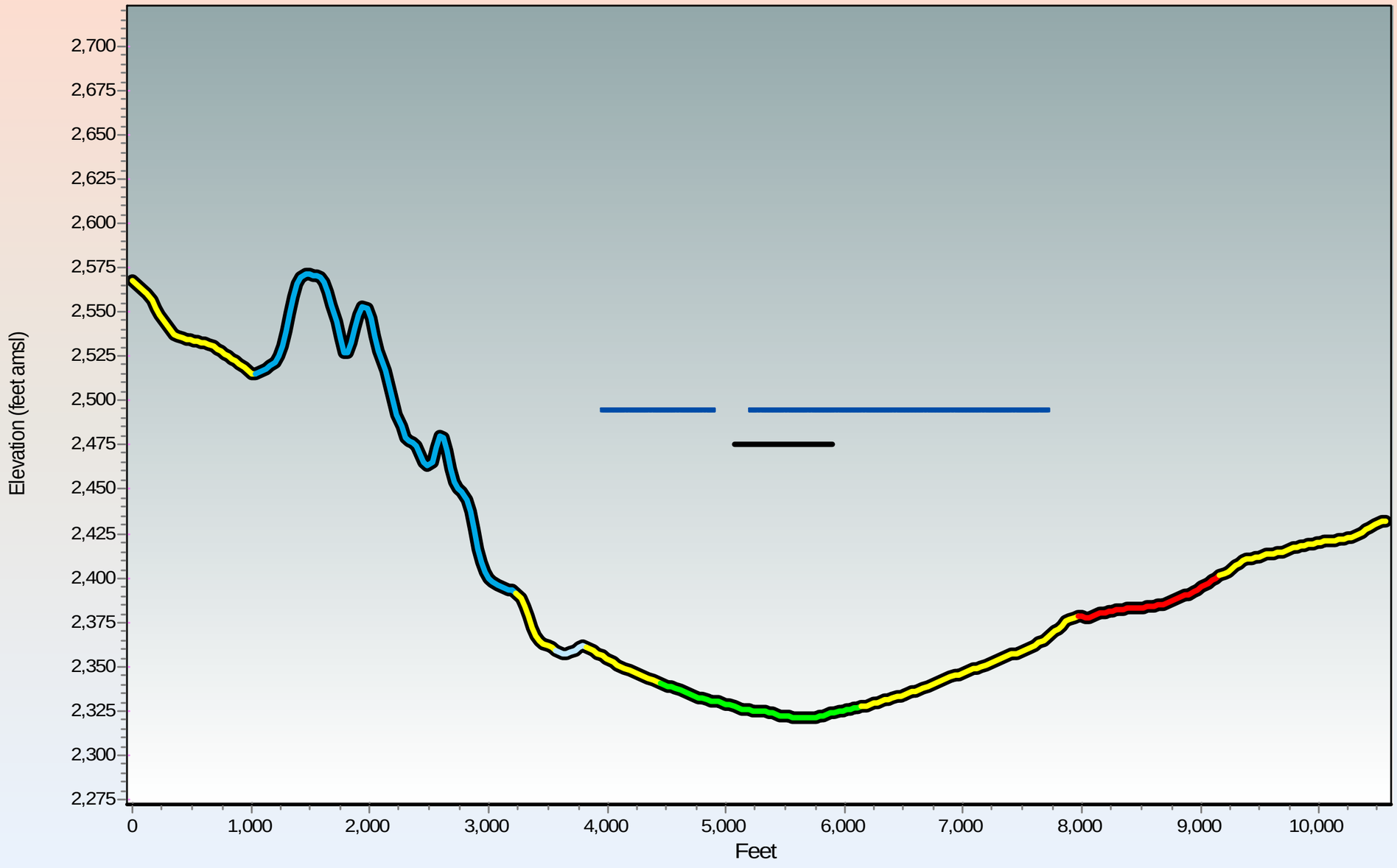
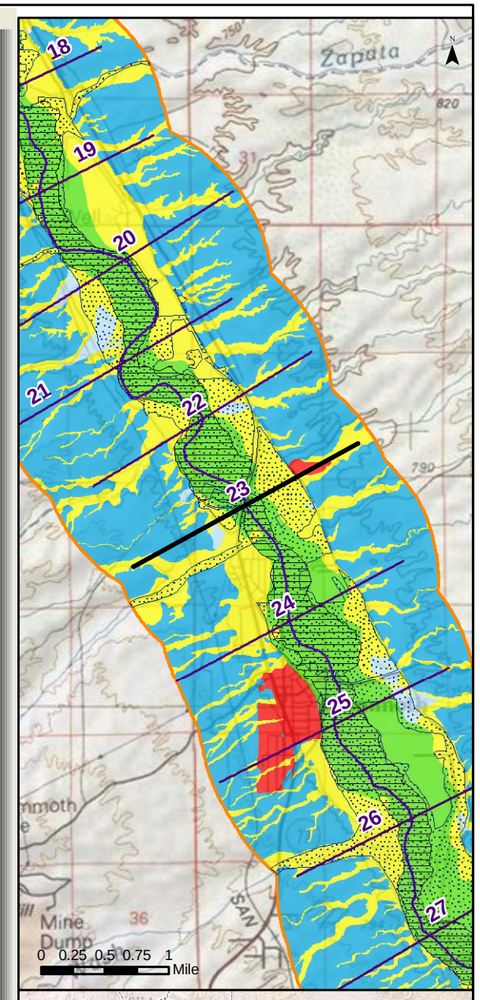
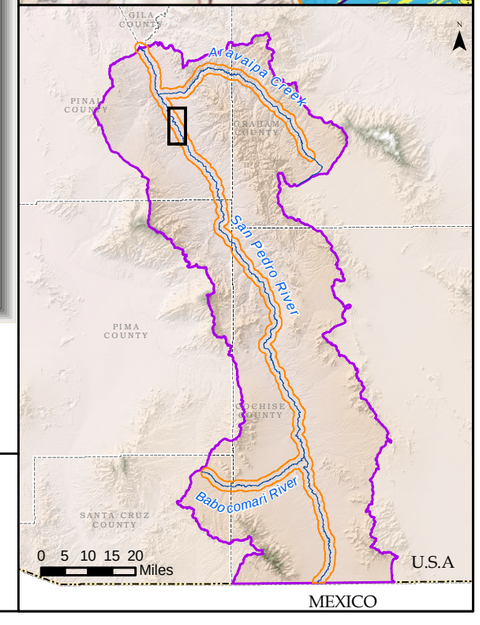
Appendix F
San Pedro River Cross Section at Mile 022
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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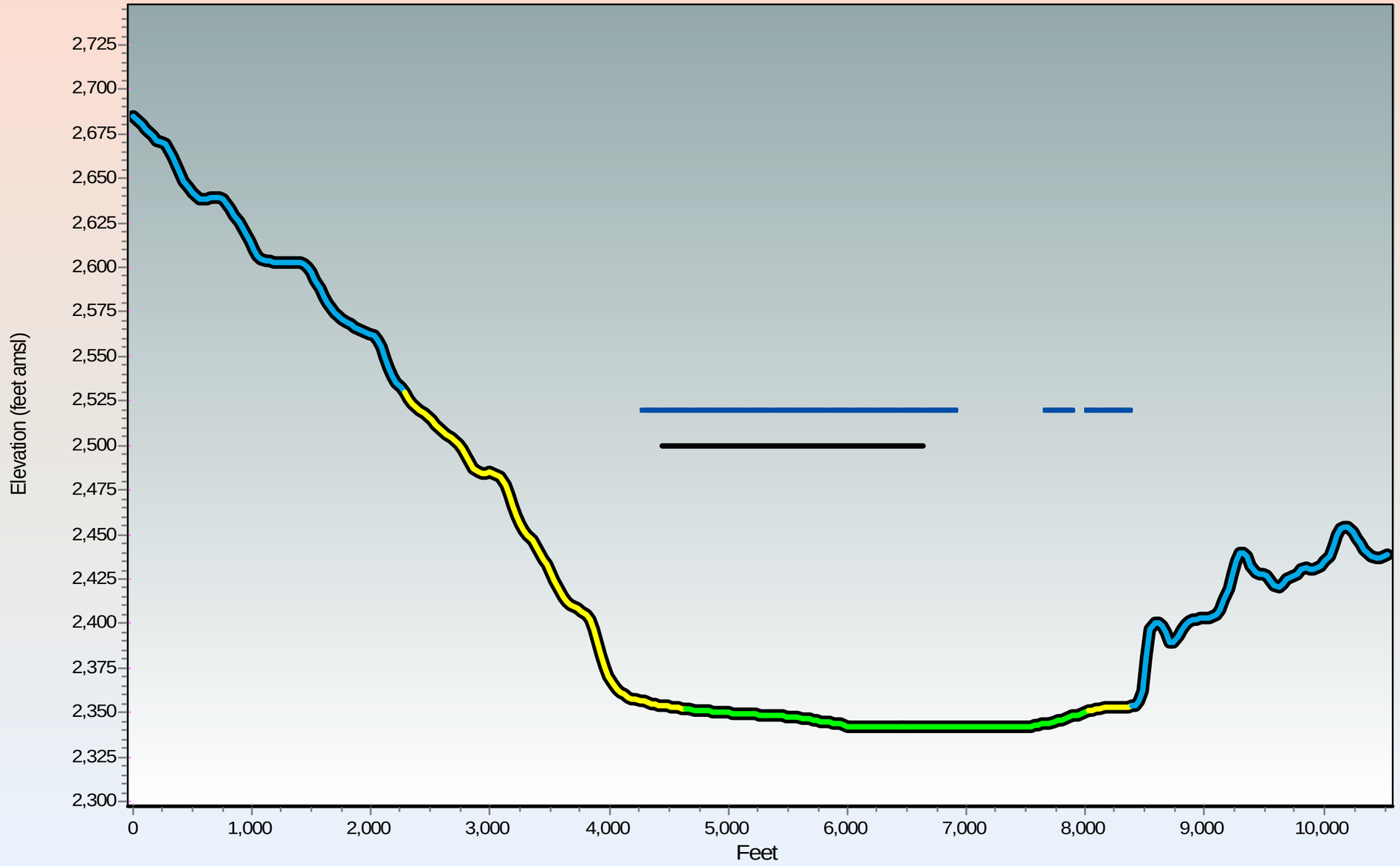
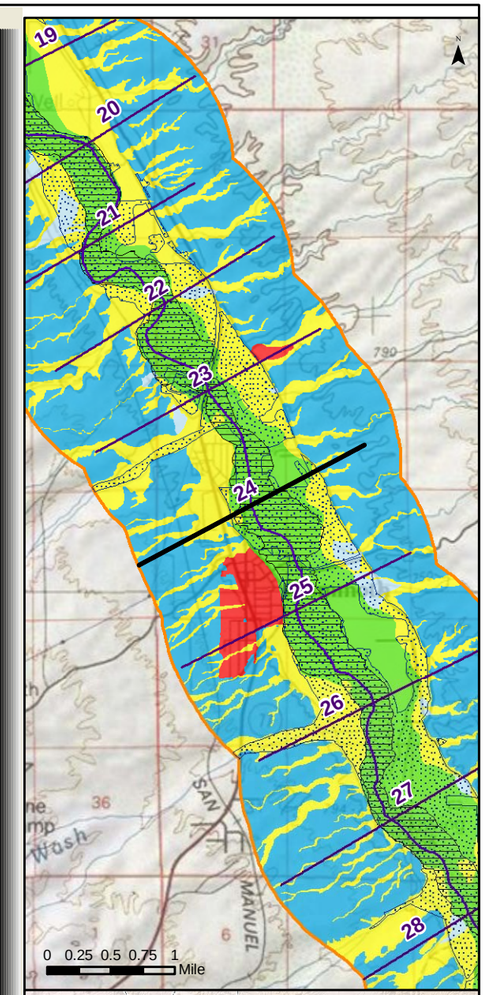
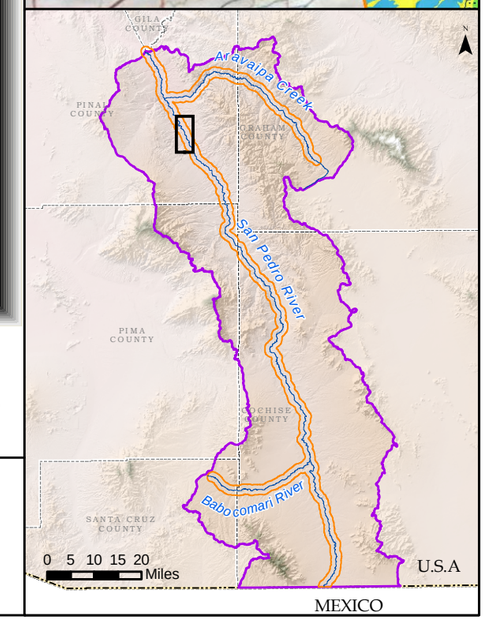
Appendix F
San Pedro River Cross Section at Mile 023
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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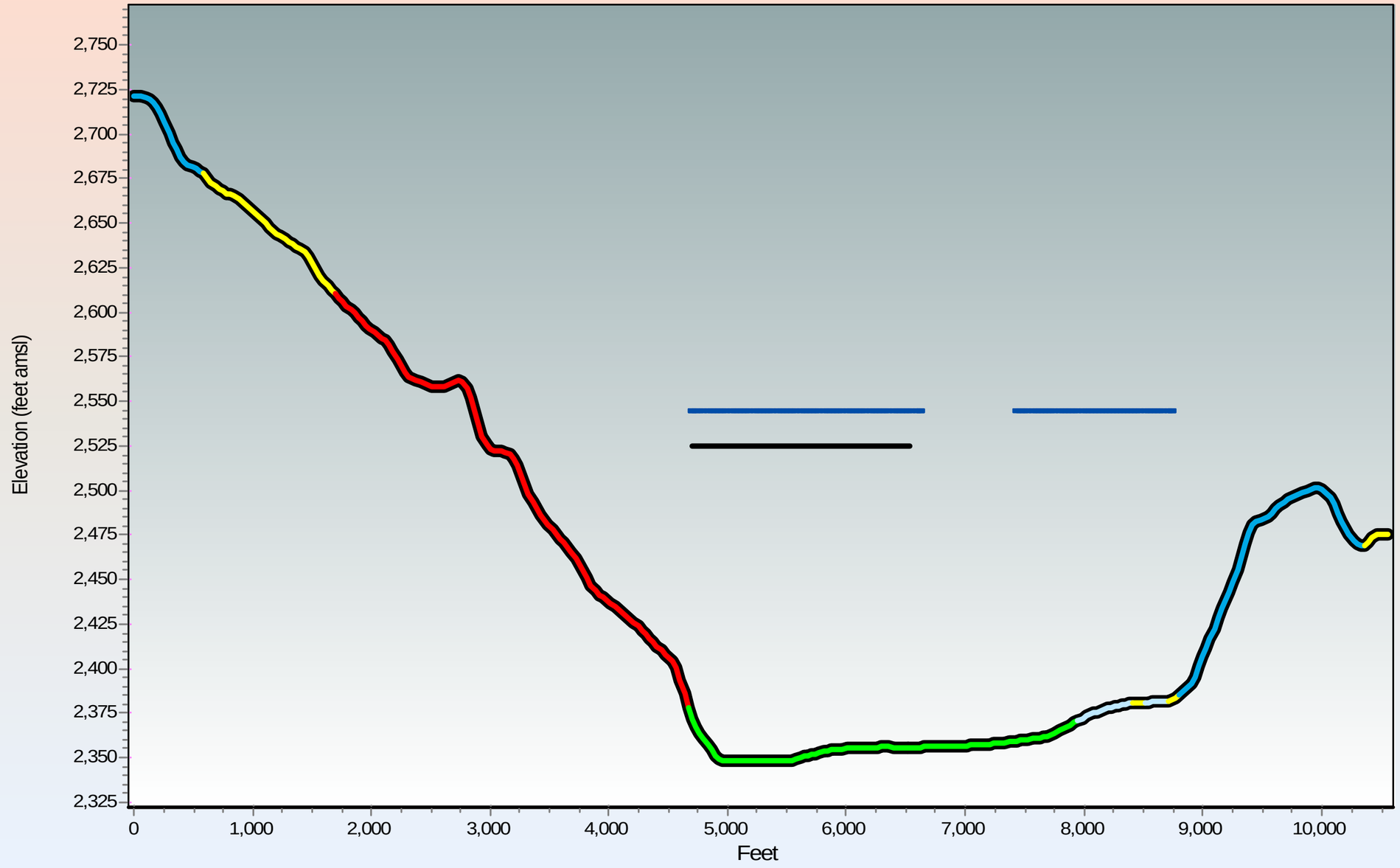
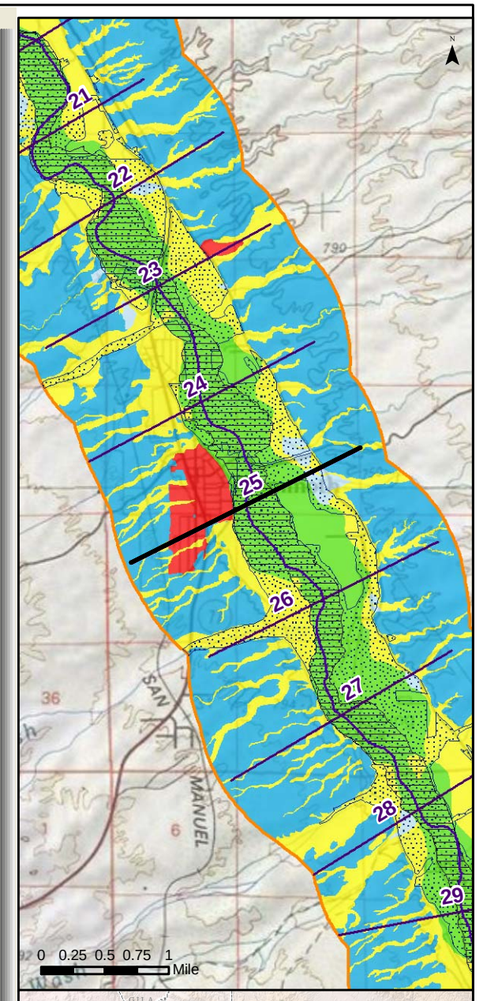
Appendix F

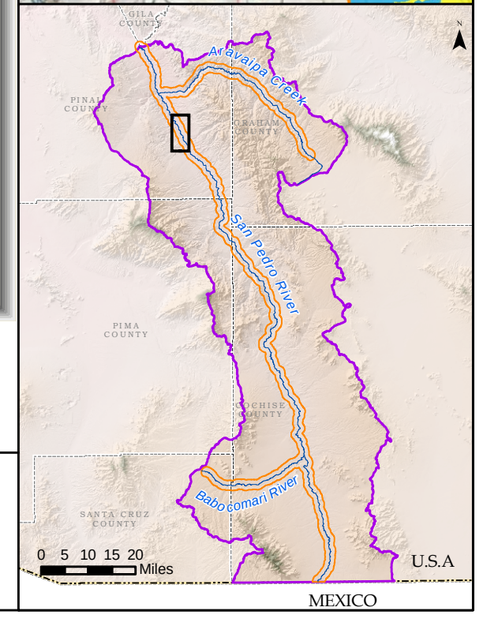
San Pedro River Cross Section at Mile 024

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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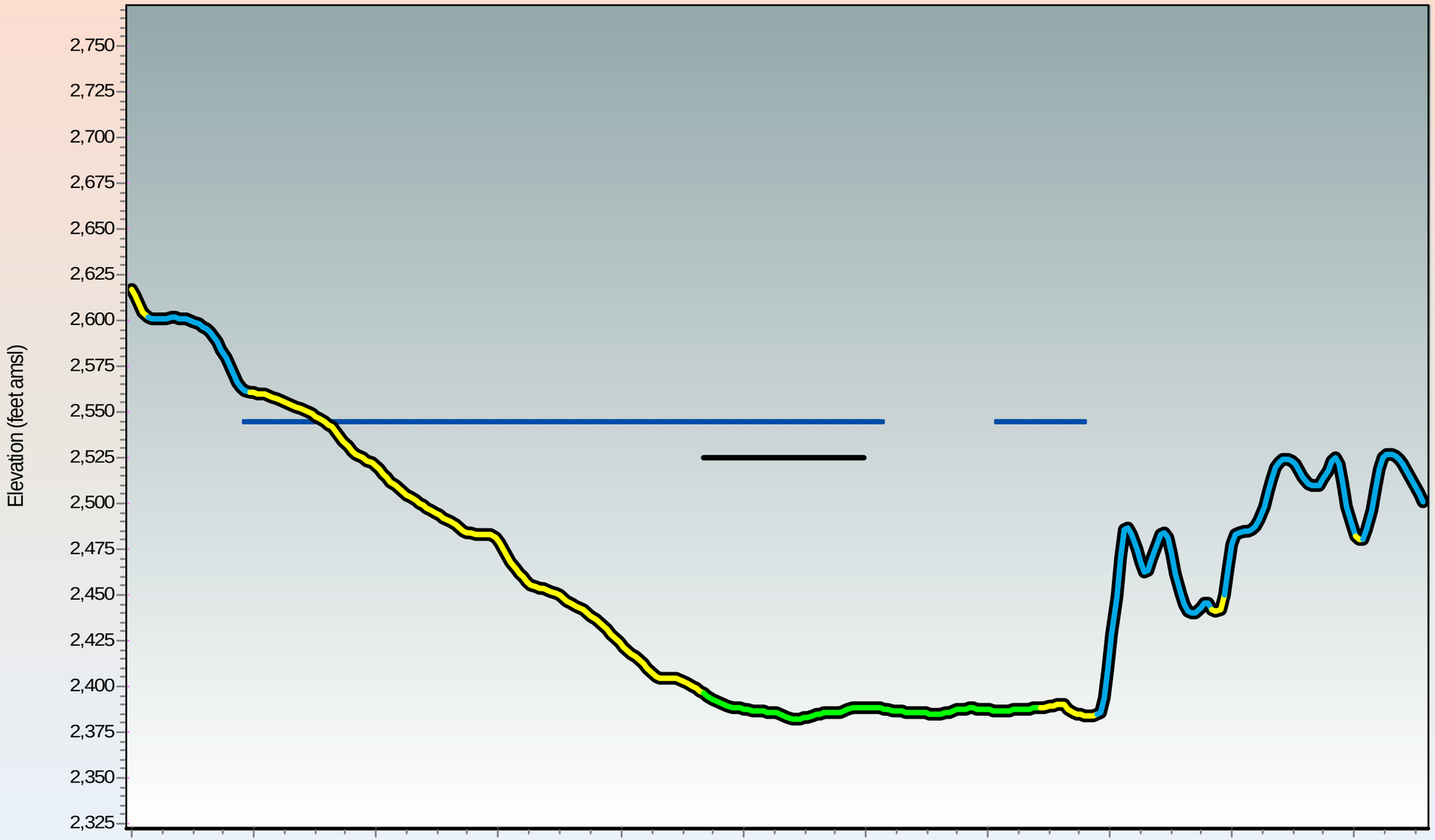
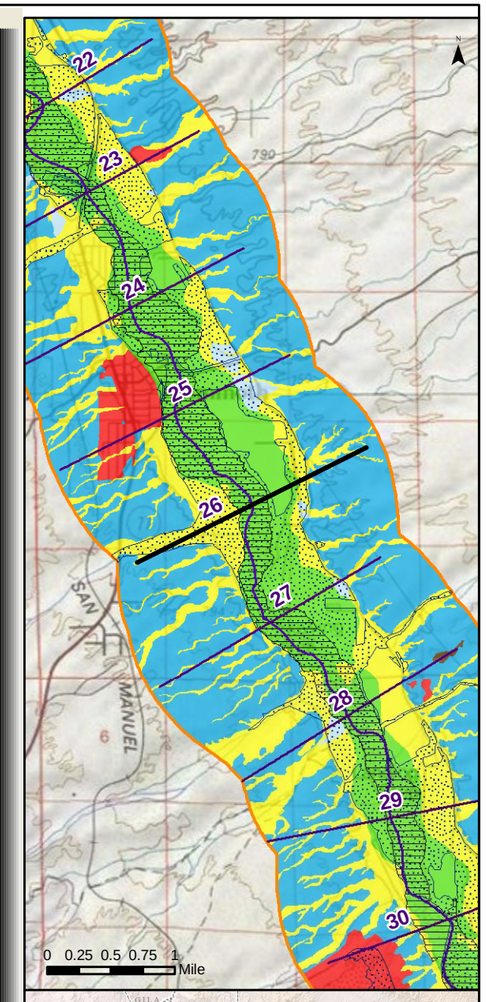
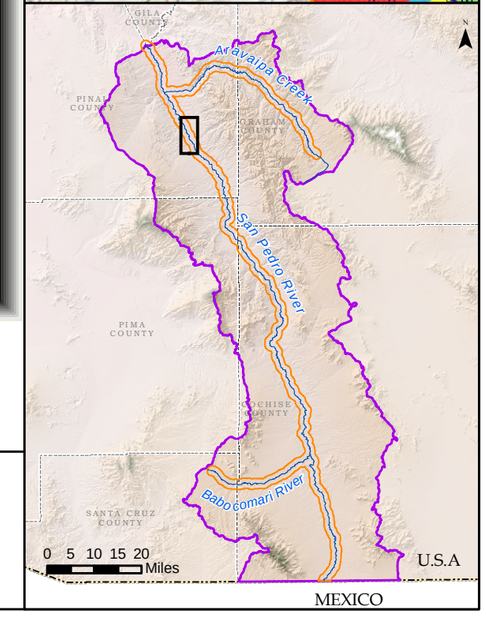
Appendix F
San Pedro River Cross Section at Mile 025
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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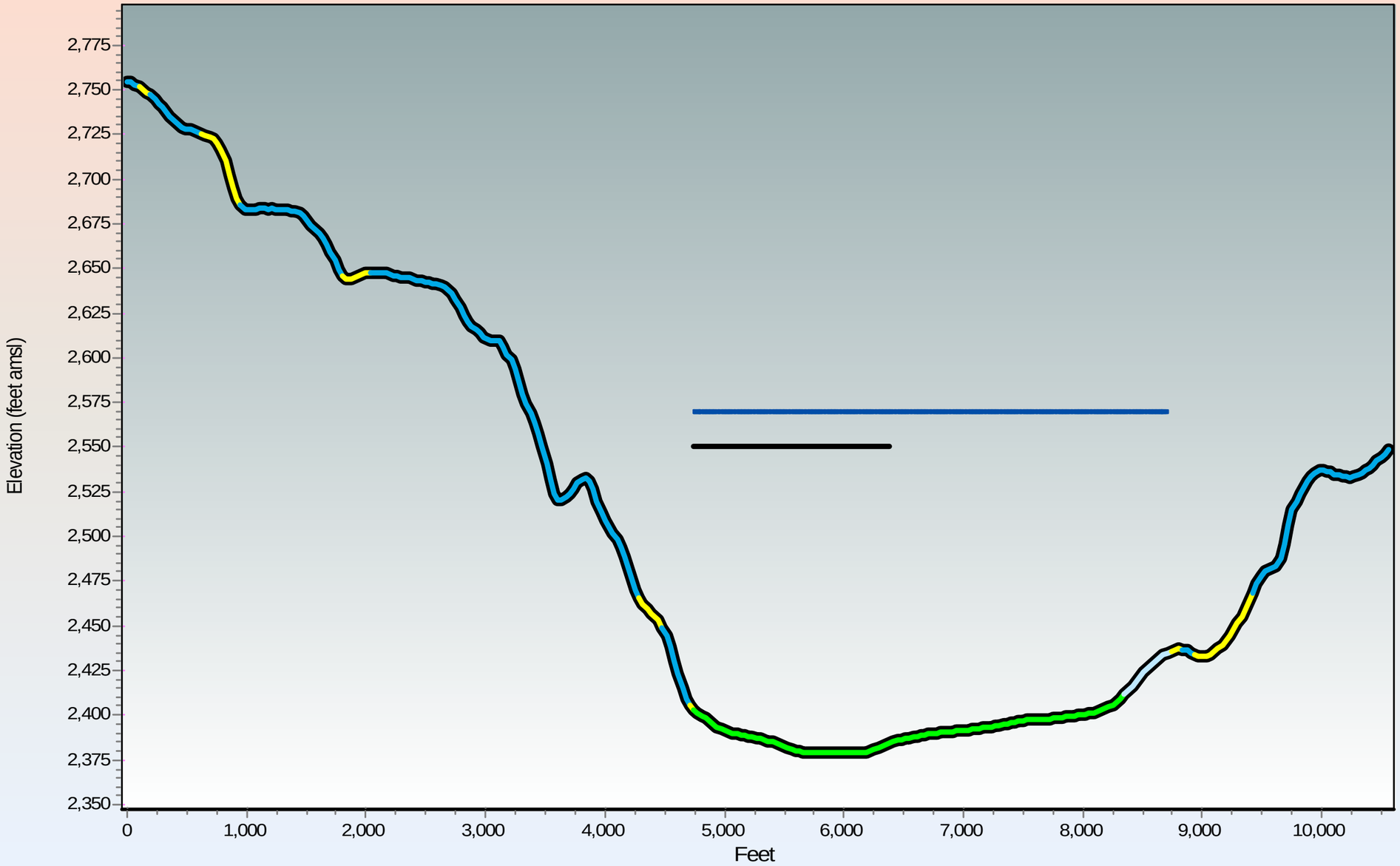
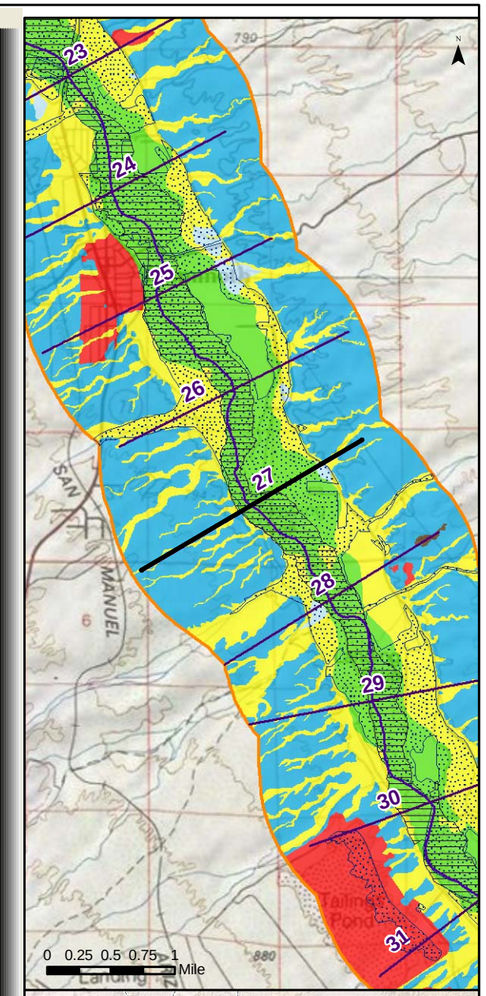
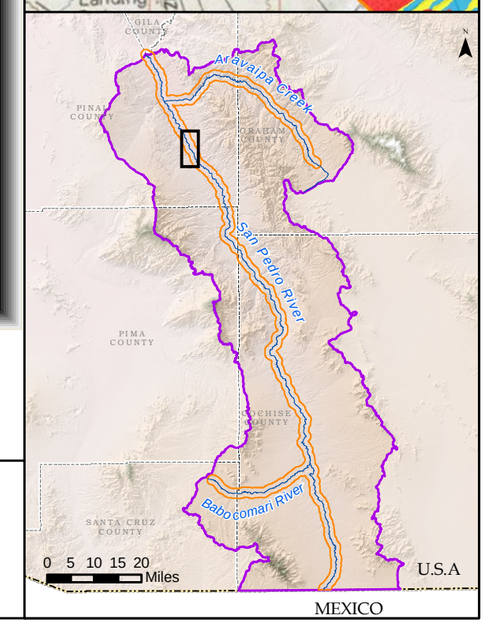
Appendix F
San Pedro River Cross Section at Mile 026
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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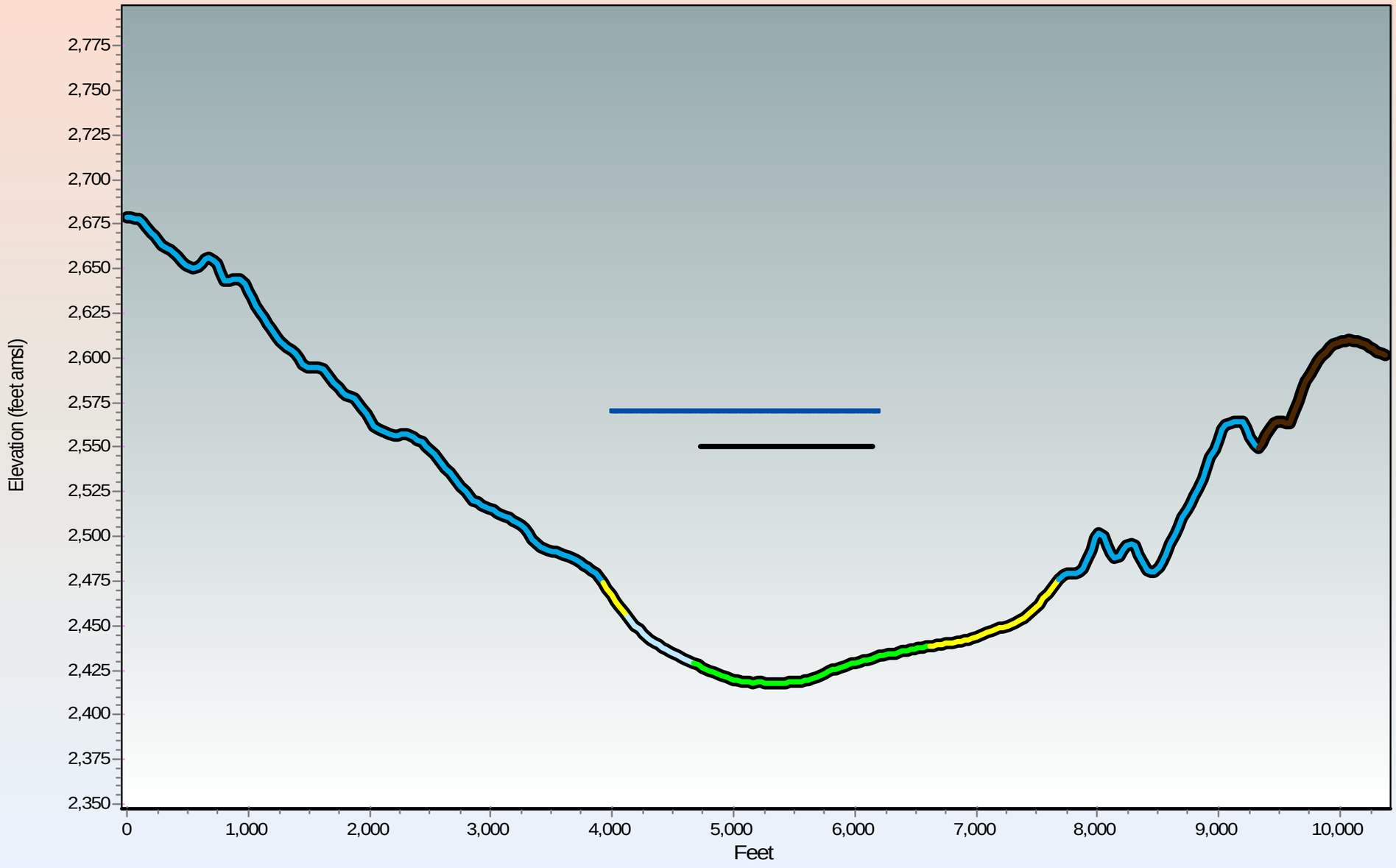
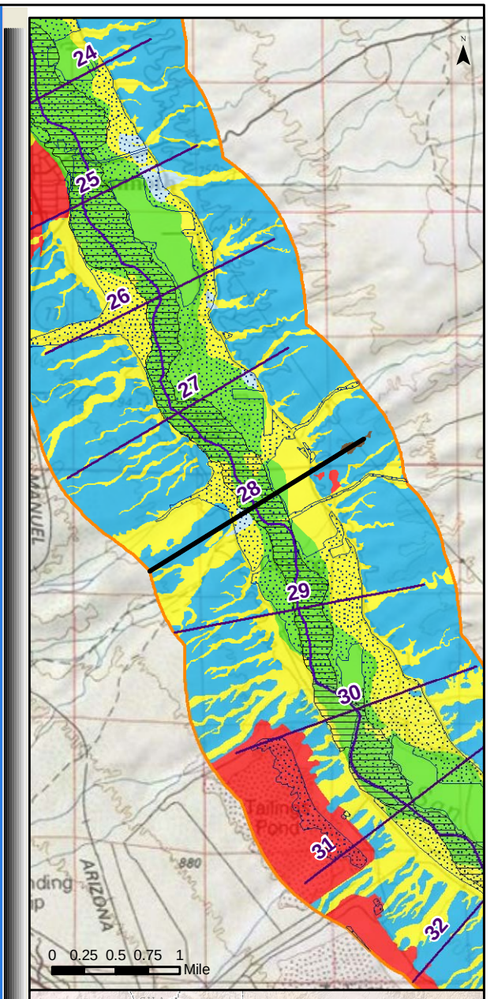
Appendix F

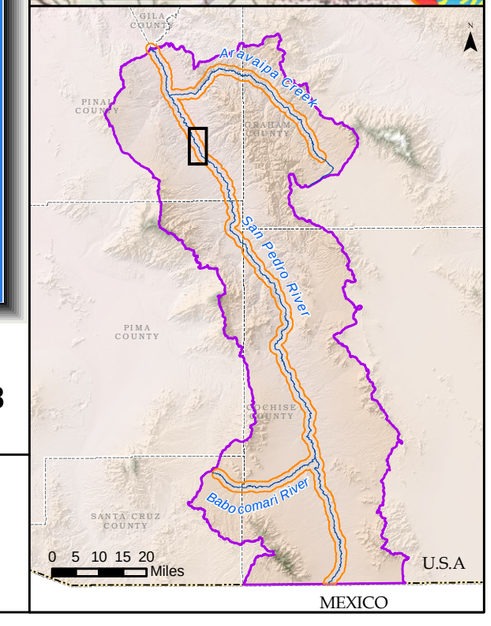
San Pedro River Cross Section at Mile 027

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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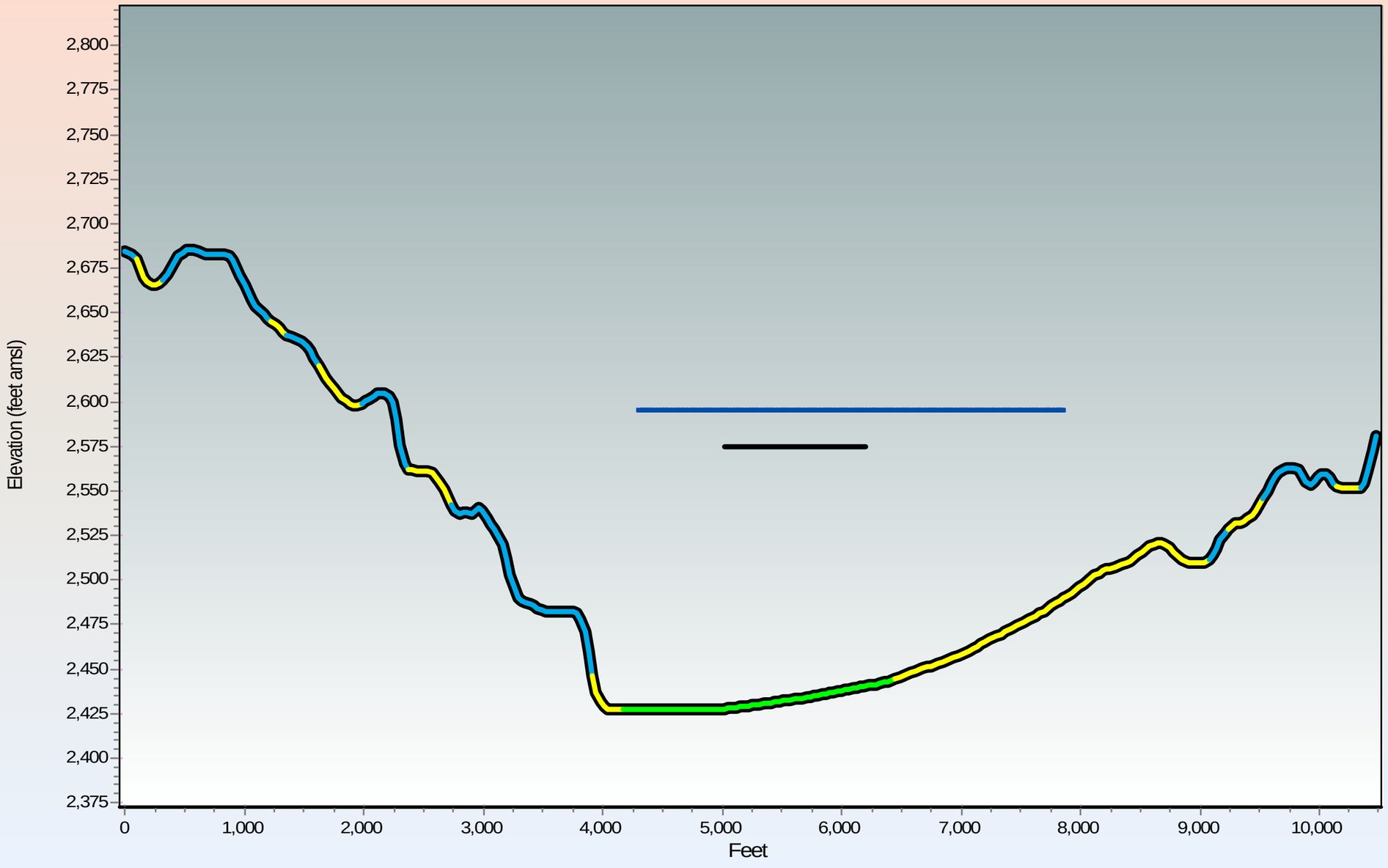
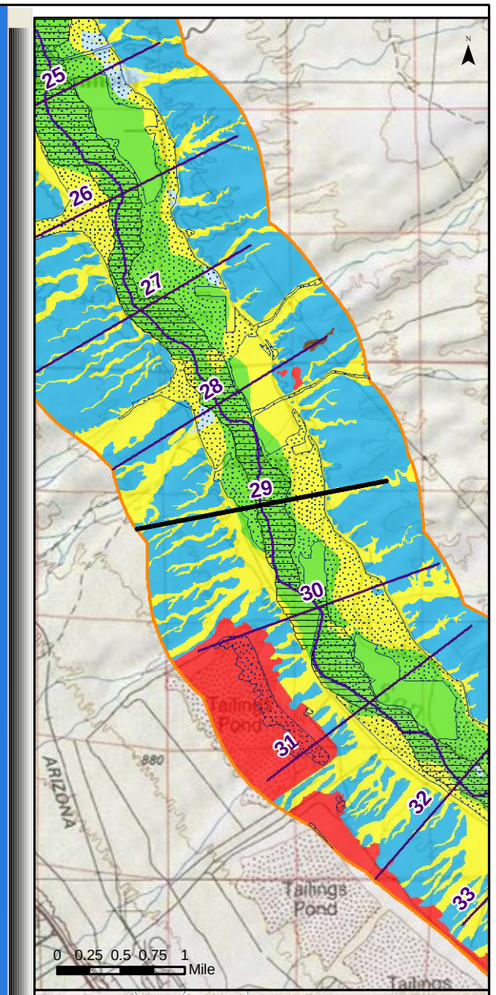
Appendix F

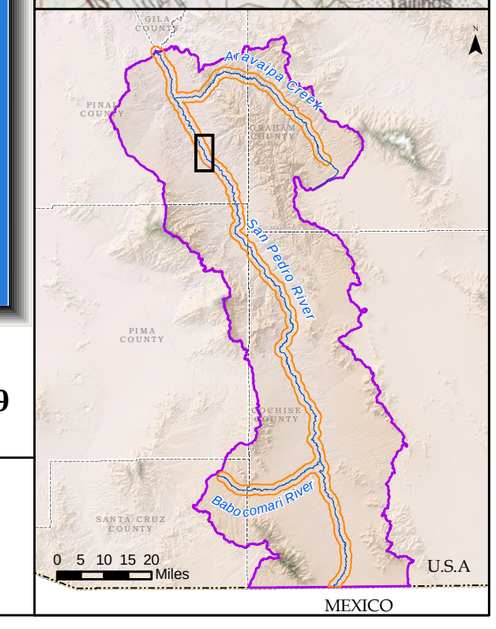
San Pedro River Cross Section at Mile 028

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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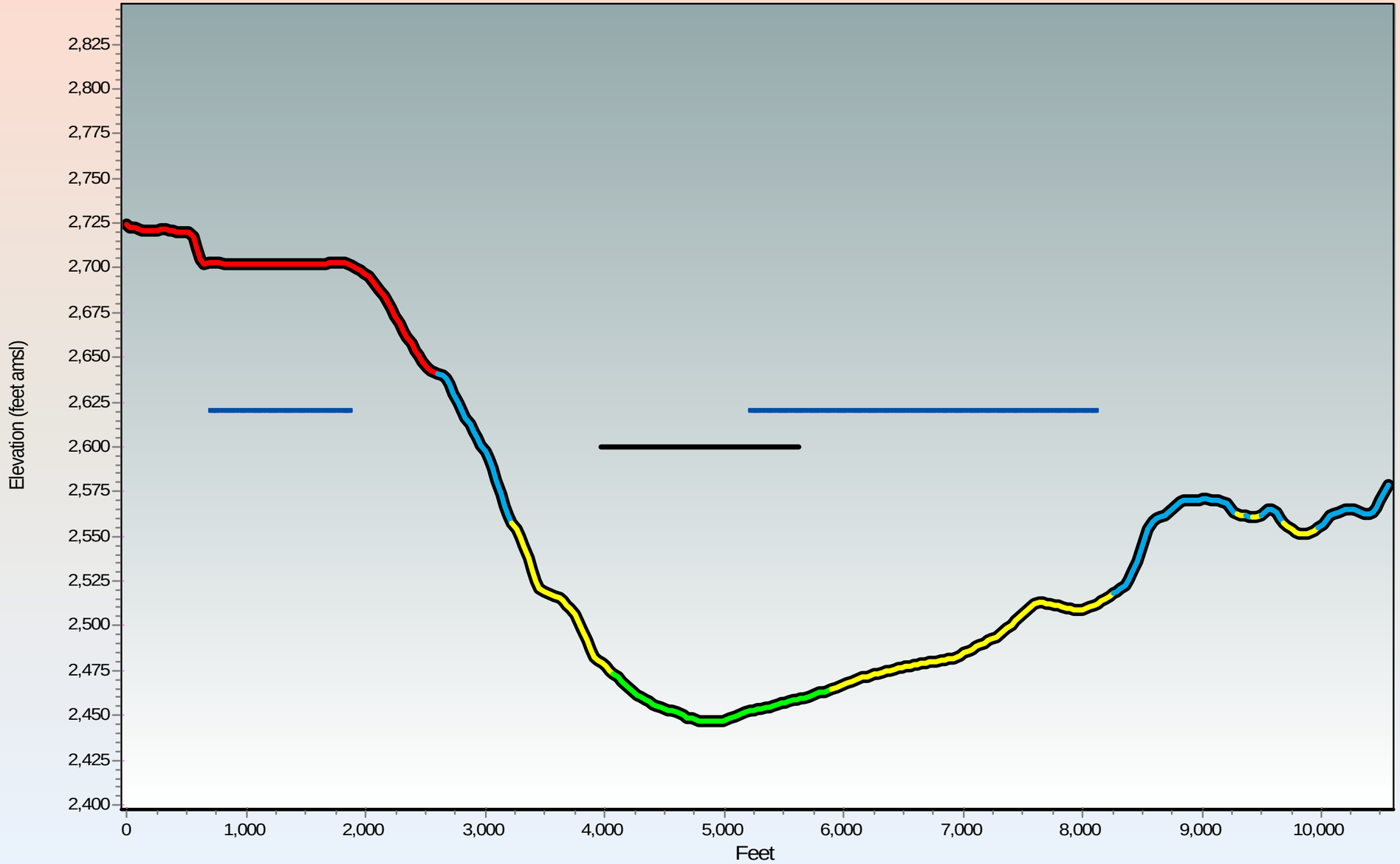
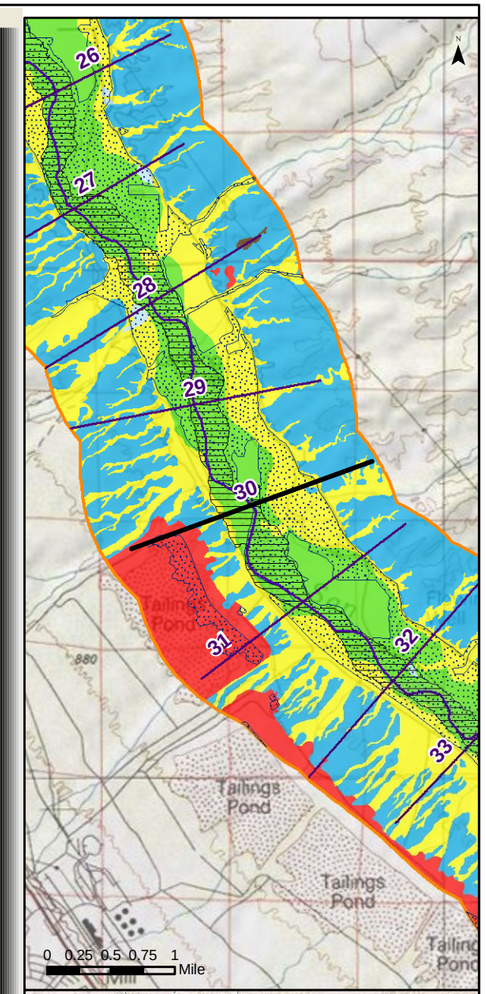
Appendix F

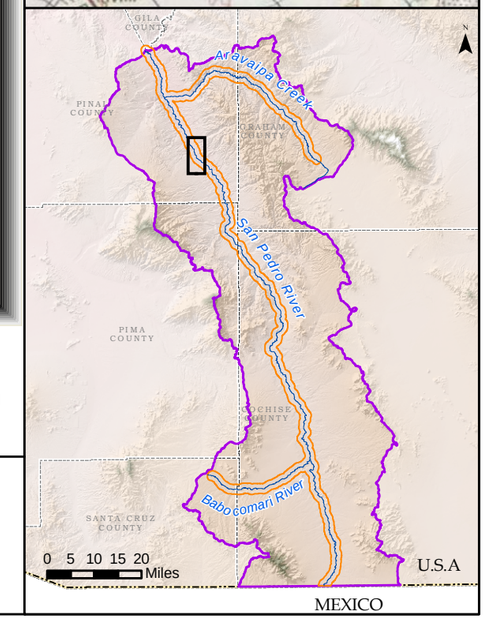
San Pedro River Cross Section at Mile 029

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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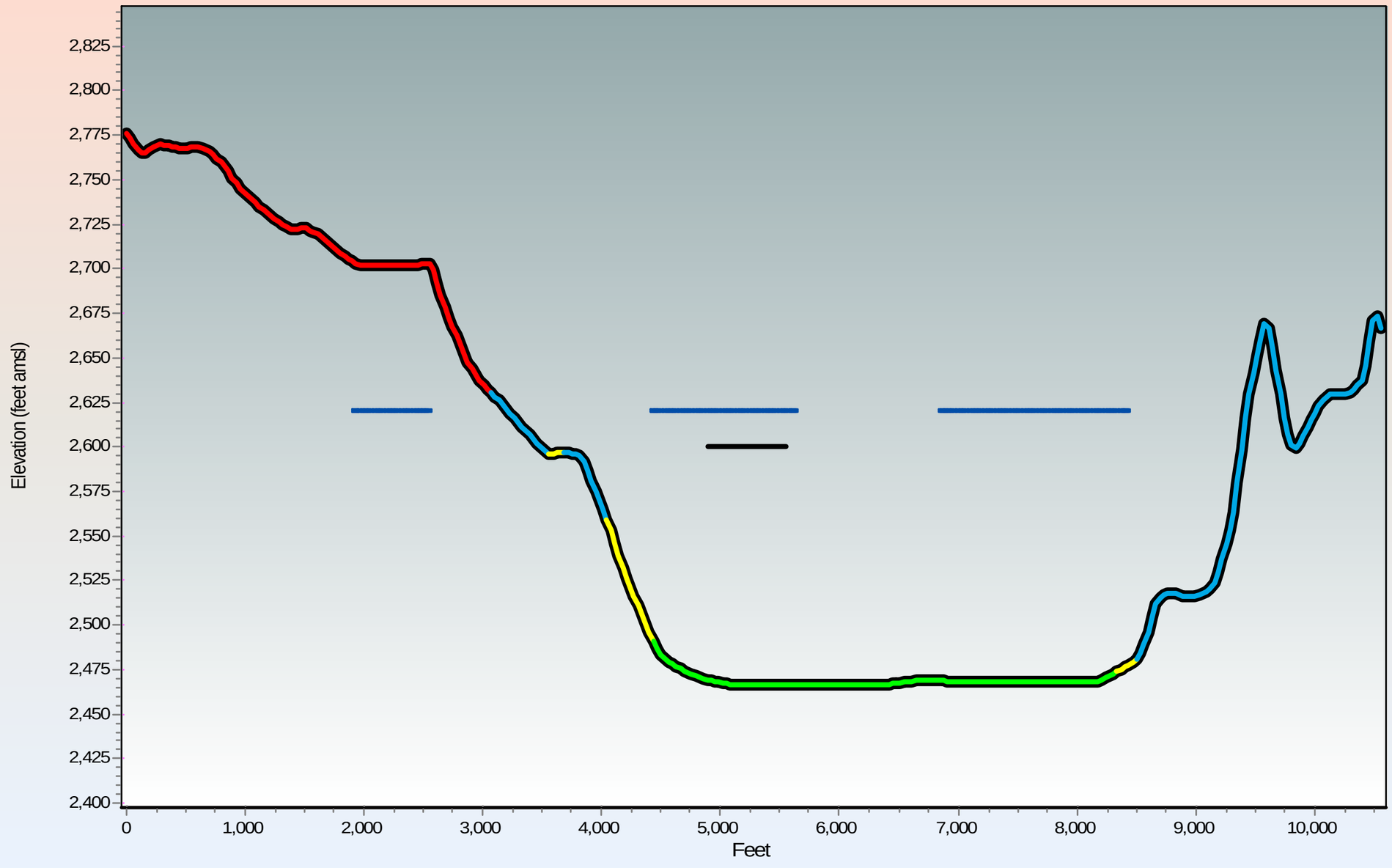
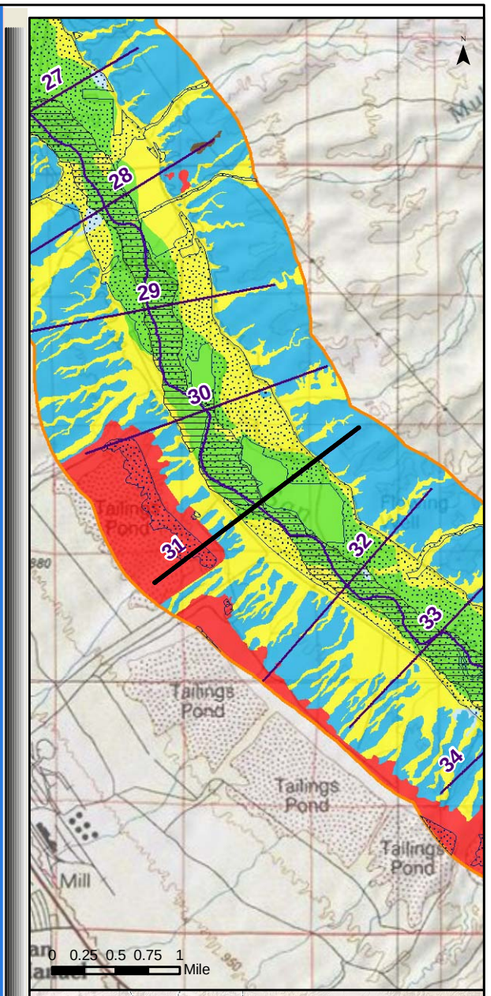
Appendix F

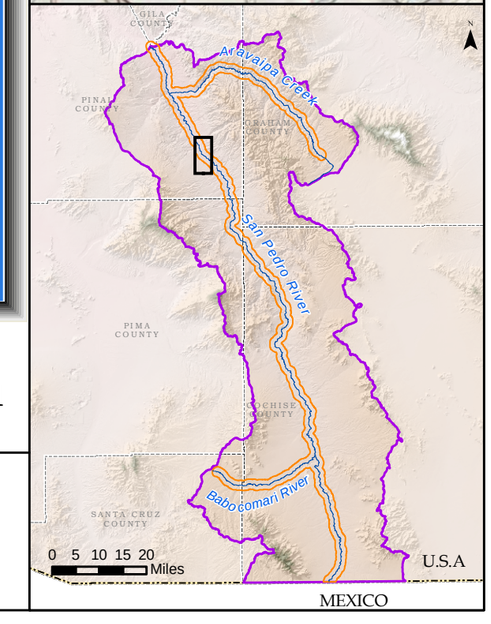
San Pedro River Cross Section at Mile 030

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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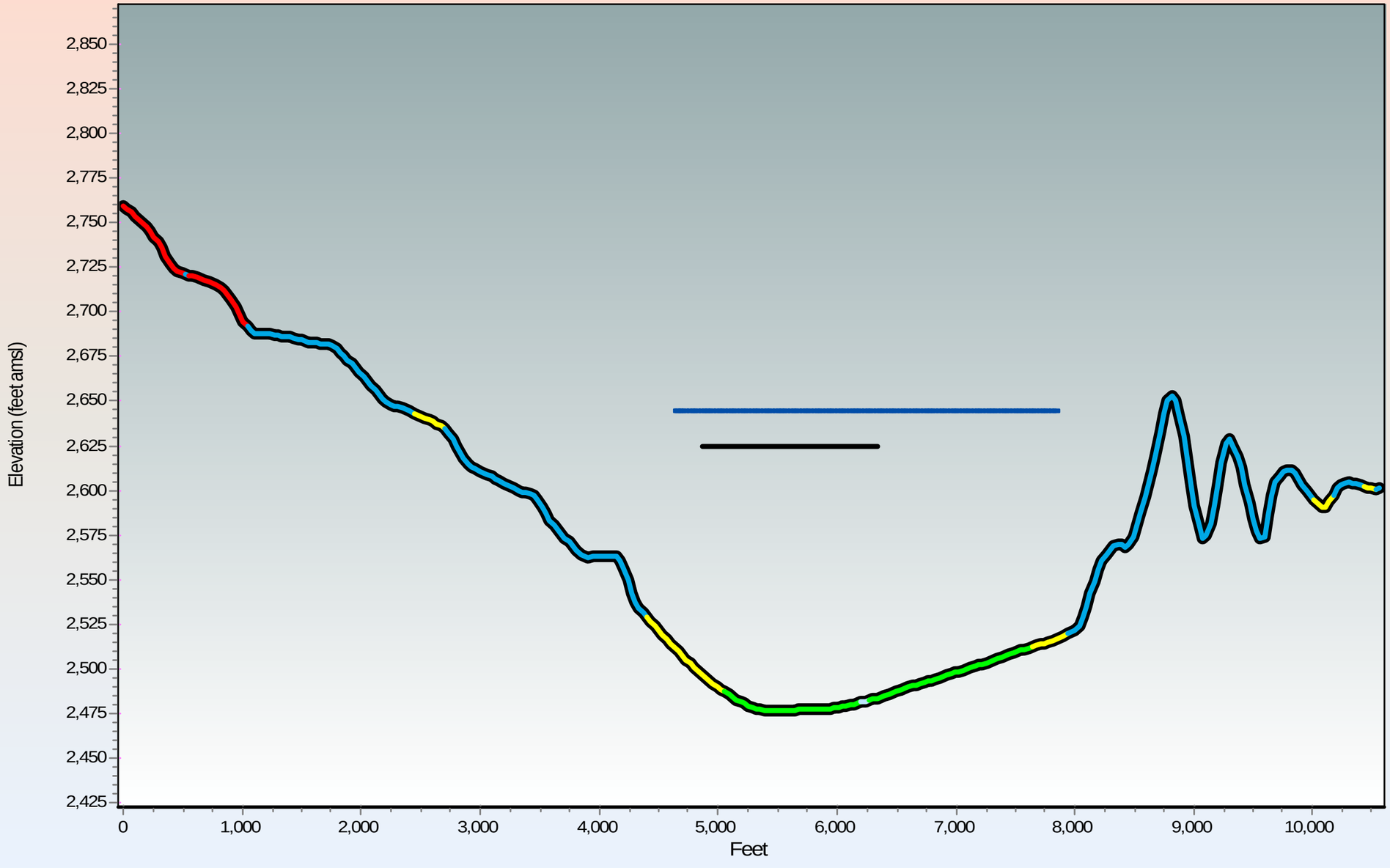
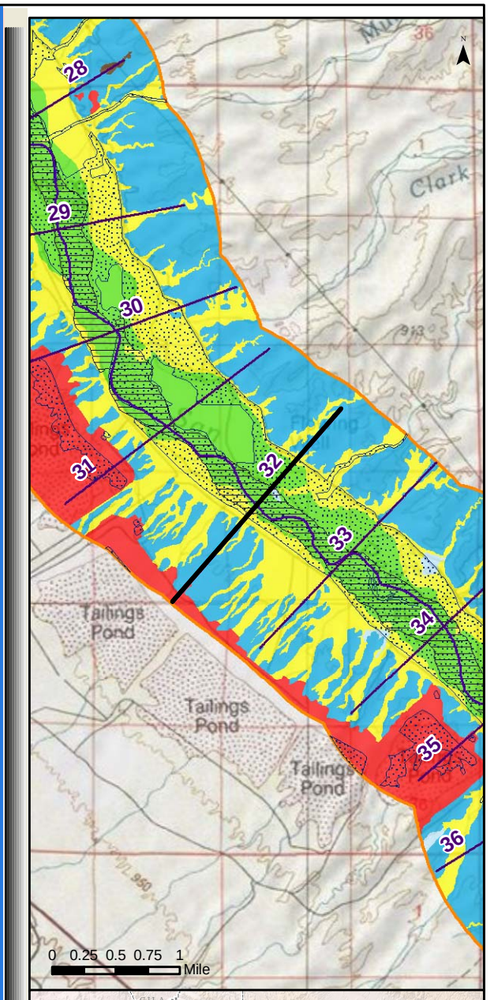
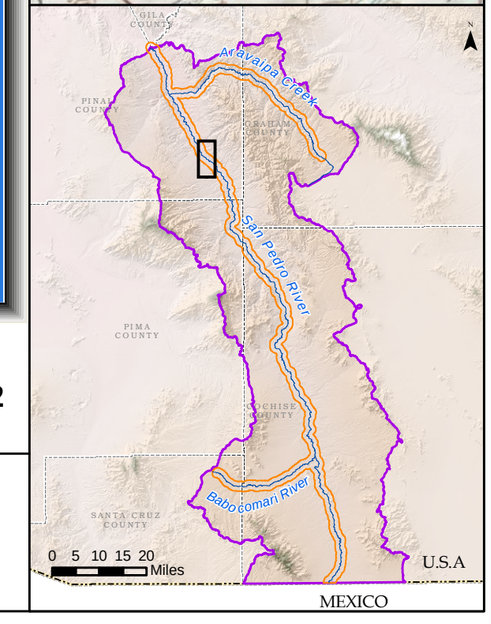
Appendix F
San Pedro River Cross Section at Mile 031
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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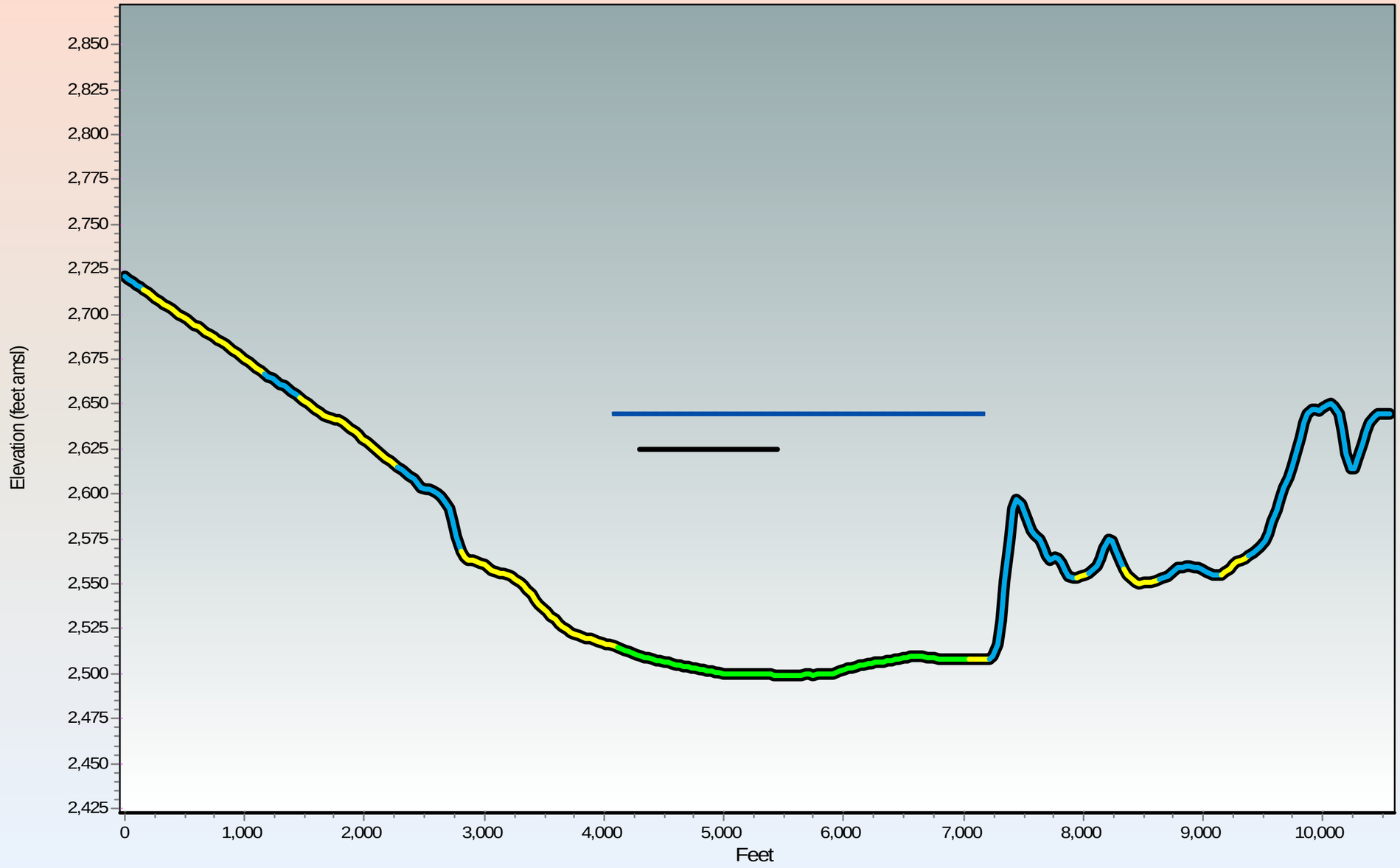
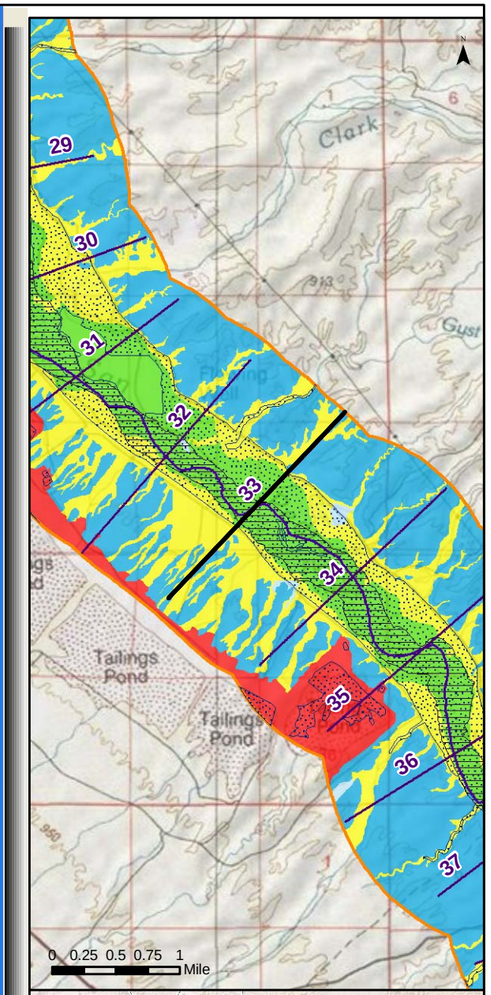
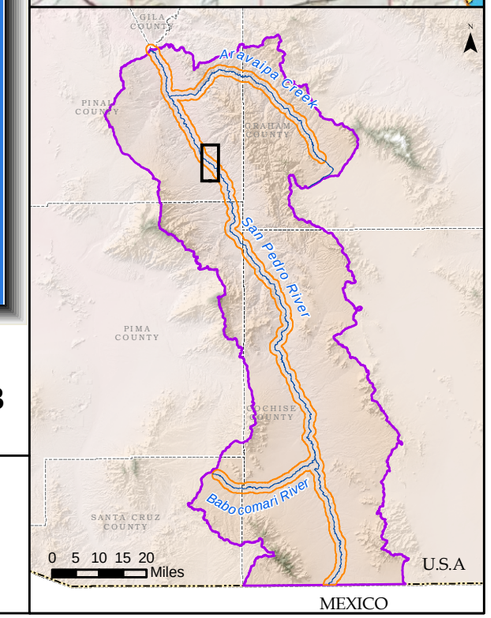
Appendix F
San Pedro River Cross Section at Mile 032
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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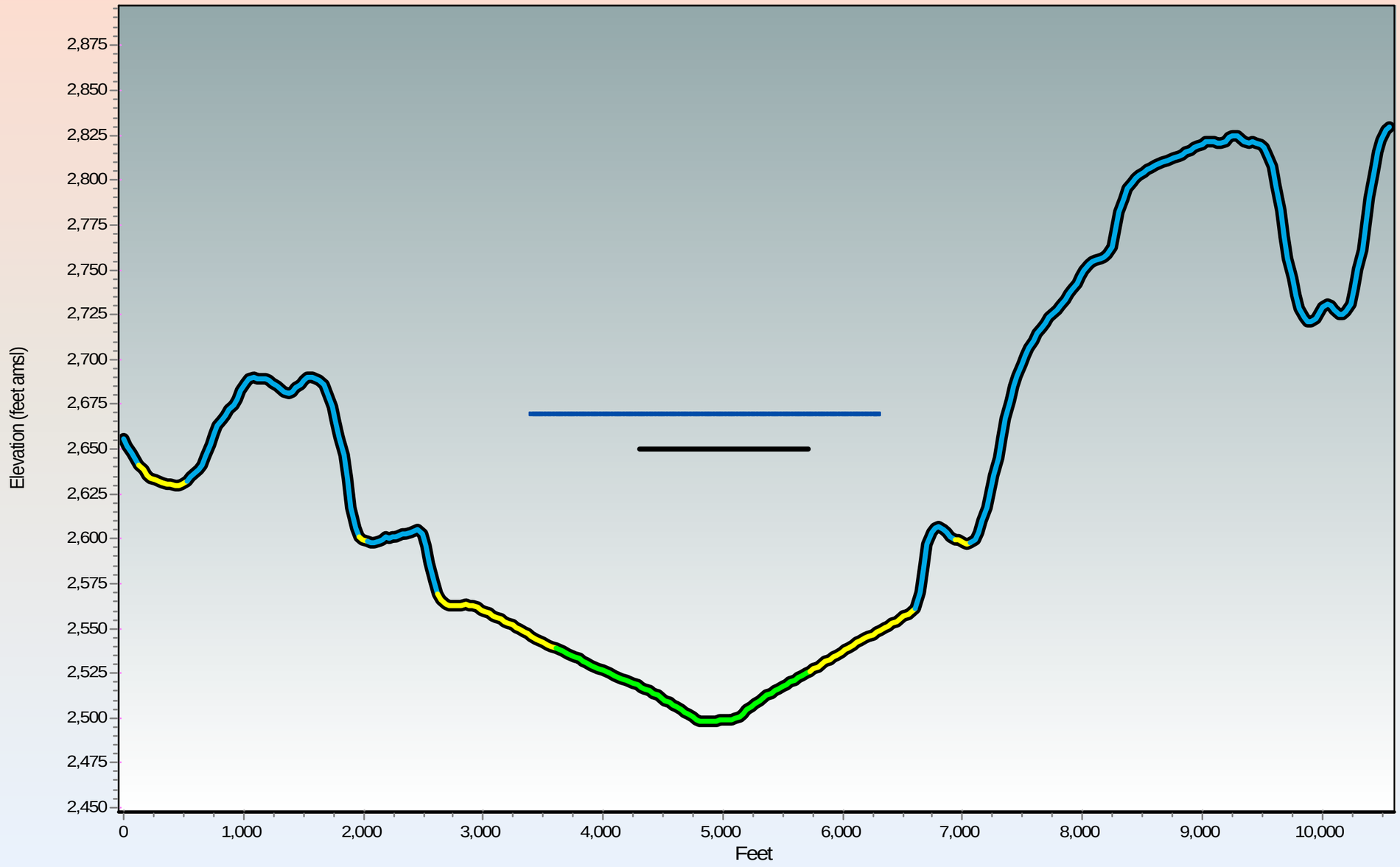
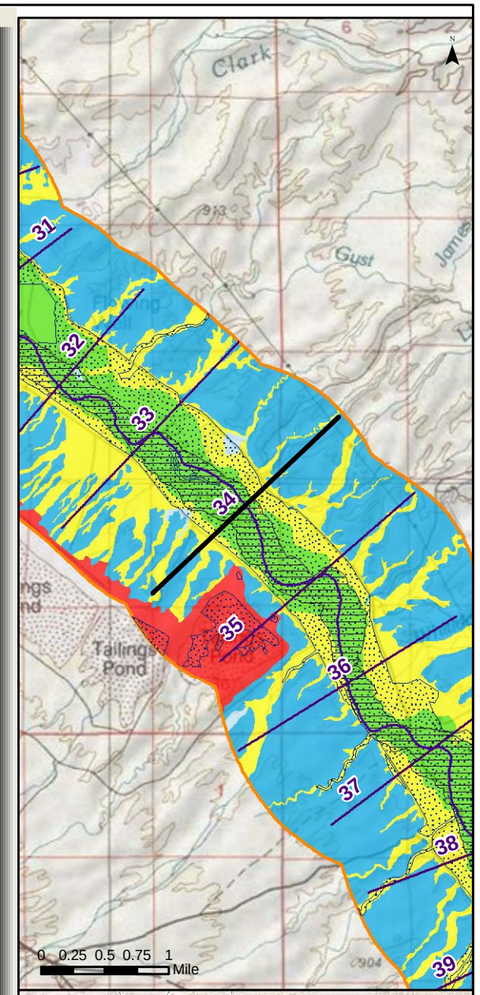
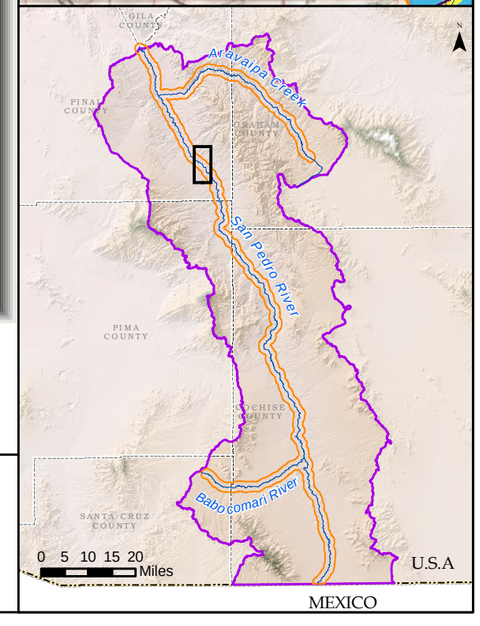
Appendix F
San Pedro River Cross Section at Mile 033
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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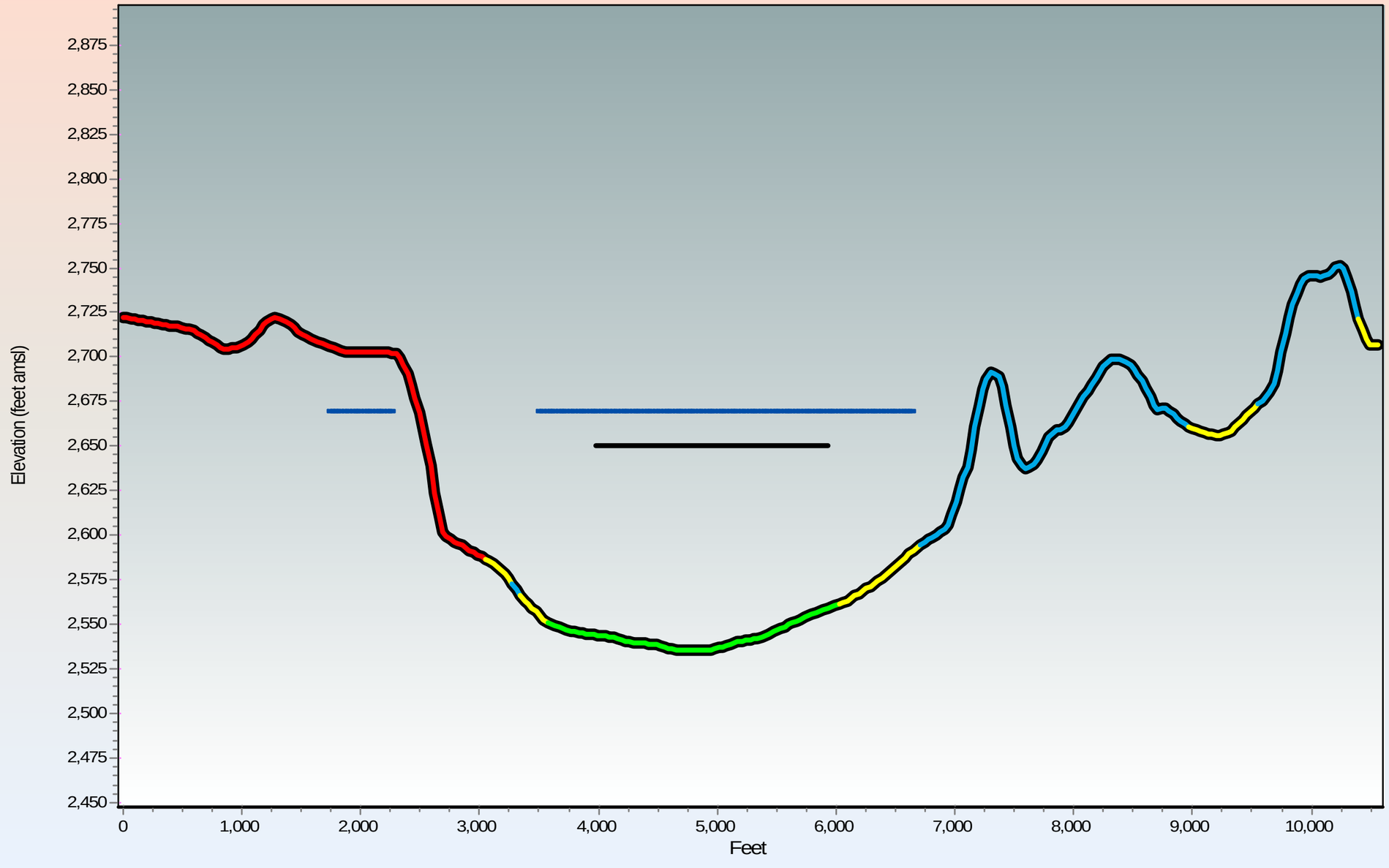
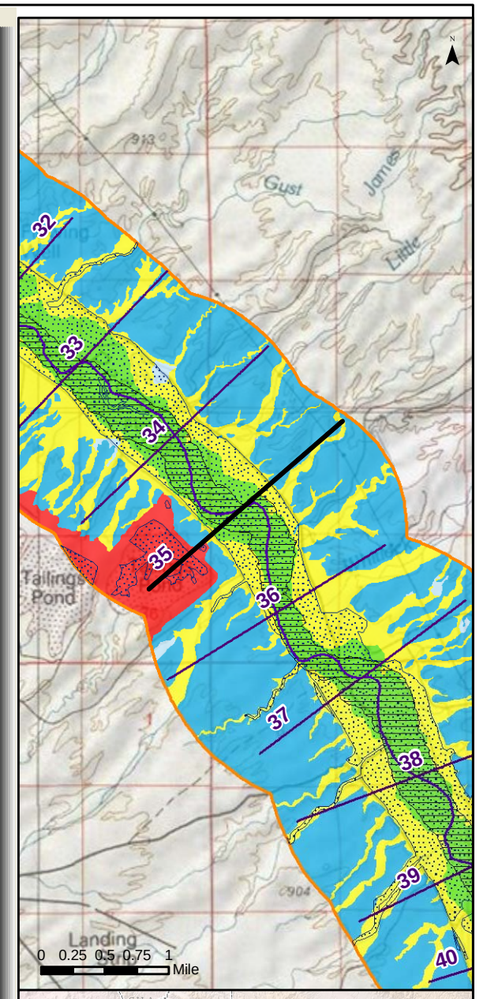
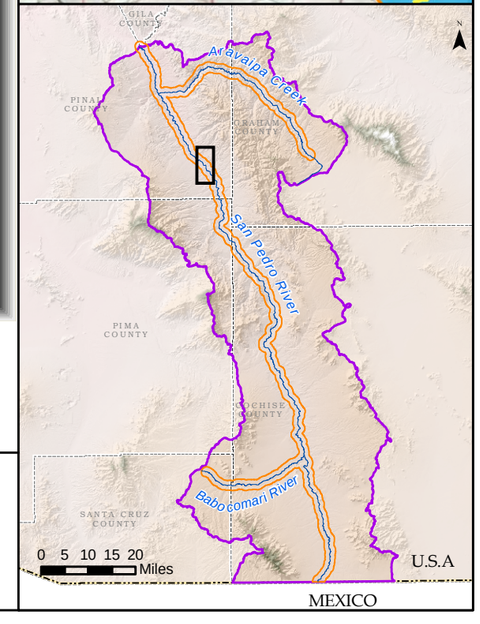
Appendix F
San Pedro River Cross Section at Mile 034
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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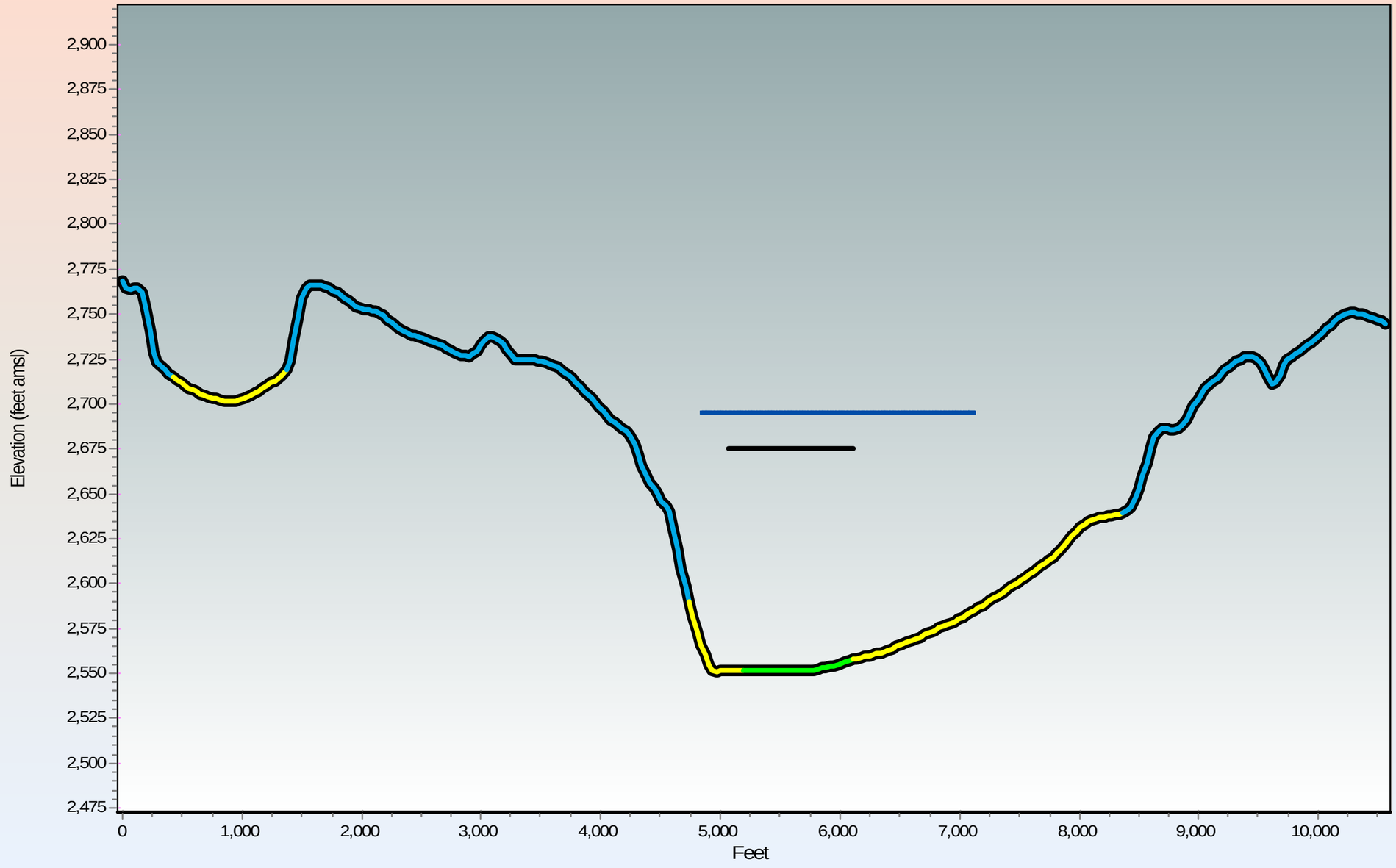
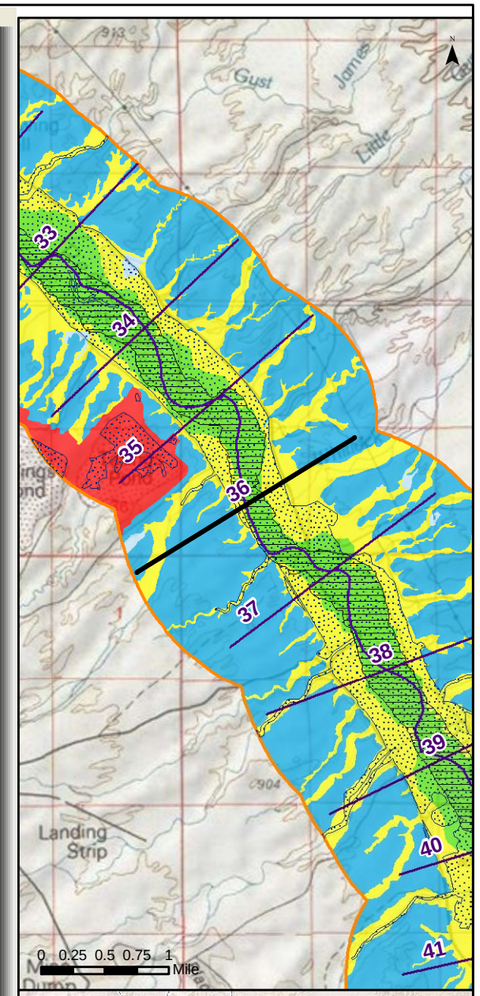
Appendix F

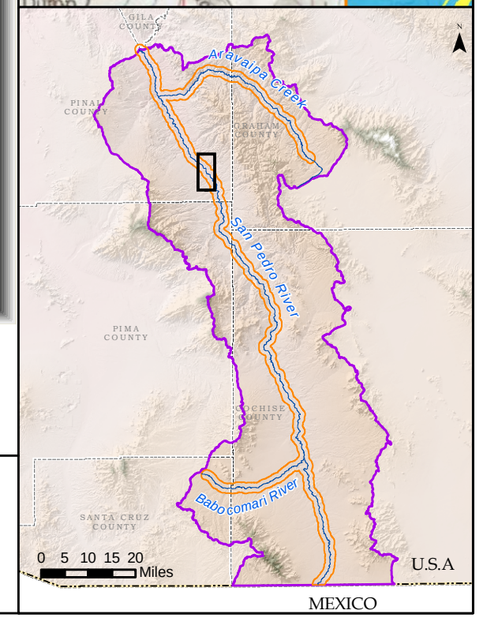
San Pedro River Cross Section at Mile 035

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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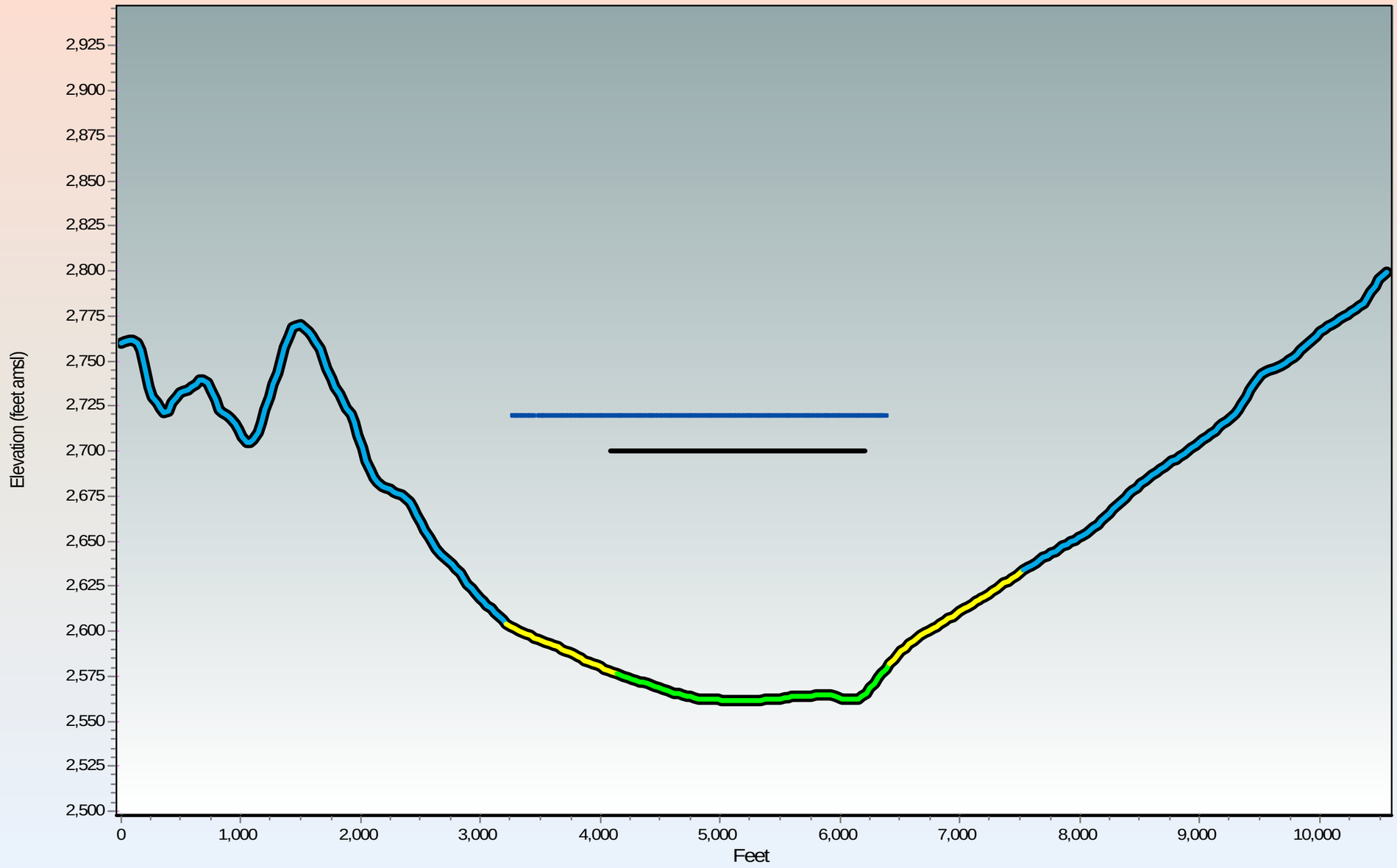
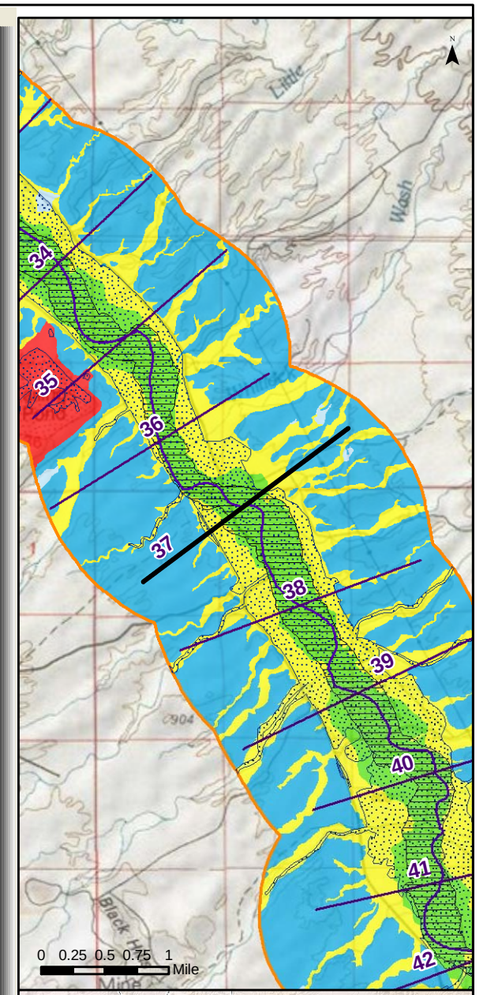
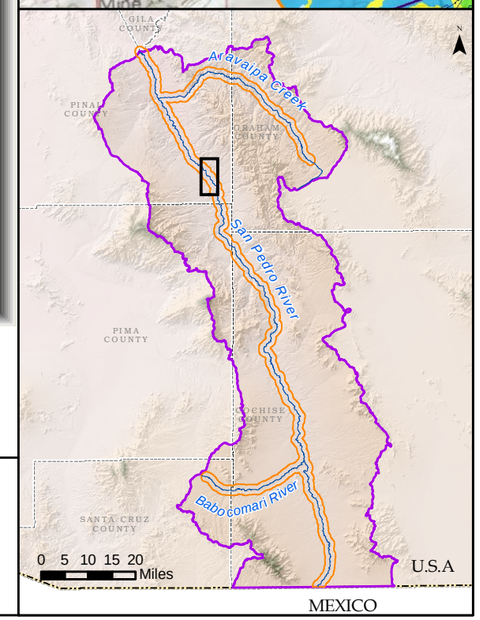
Appendix F
San Pedro River Cross Section at Mile 036
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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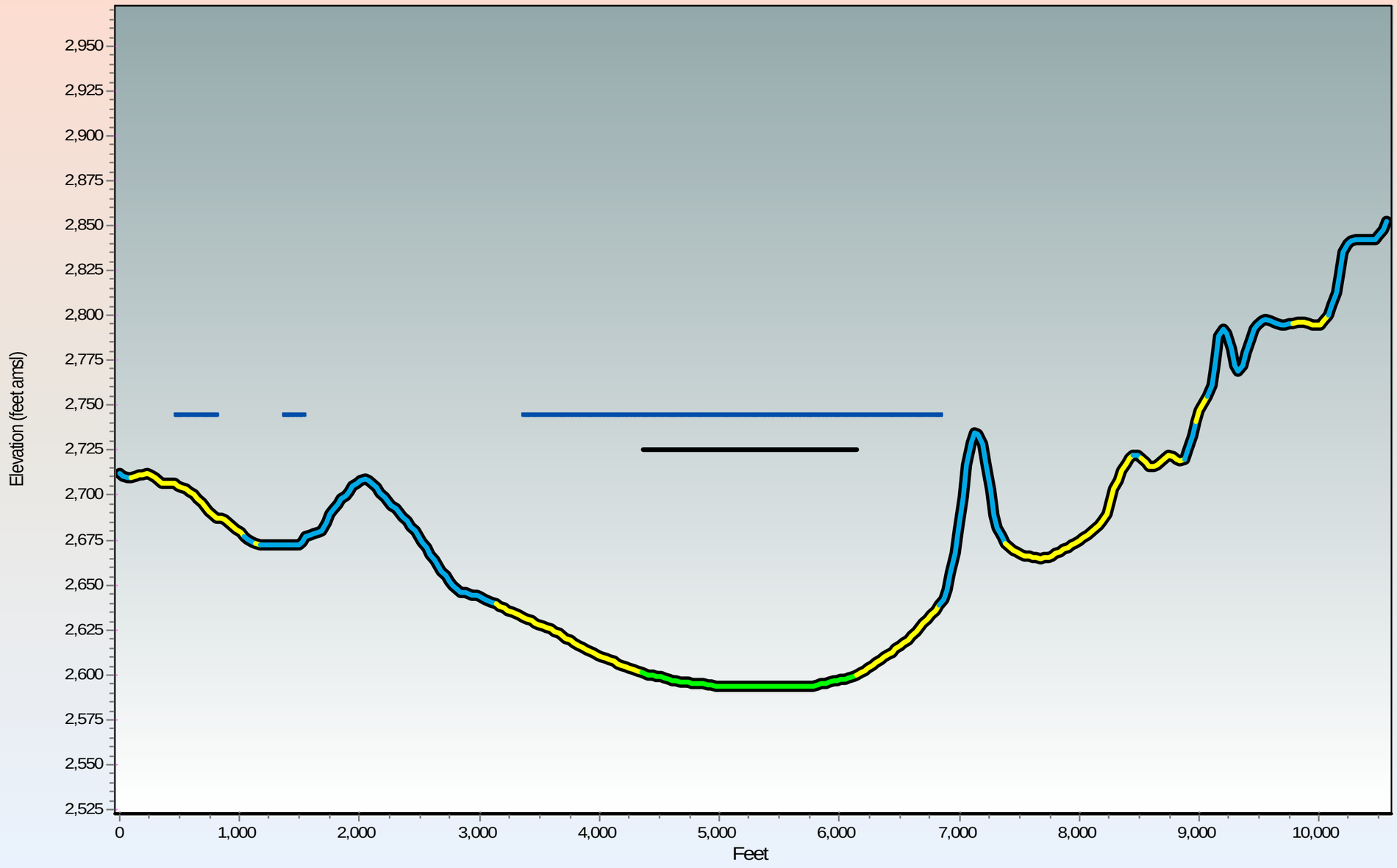
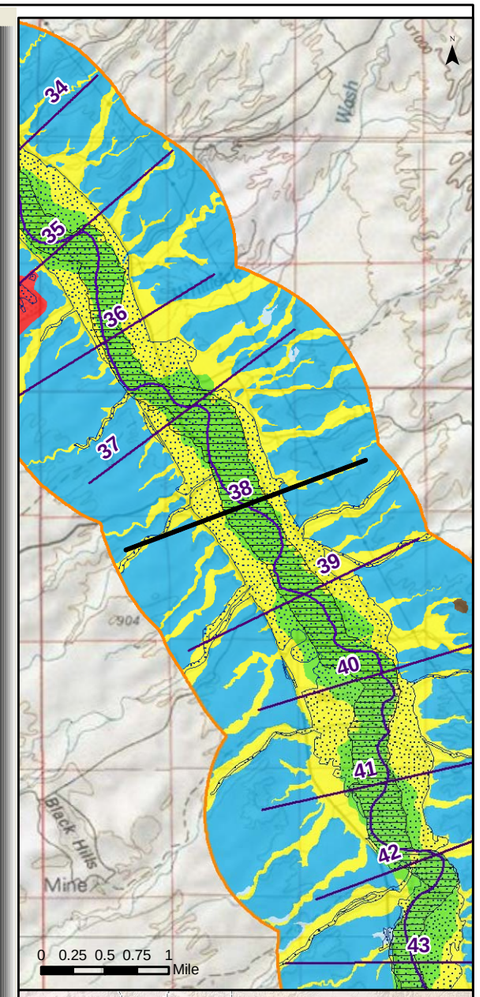
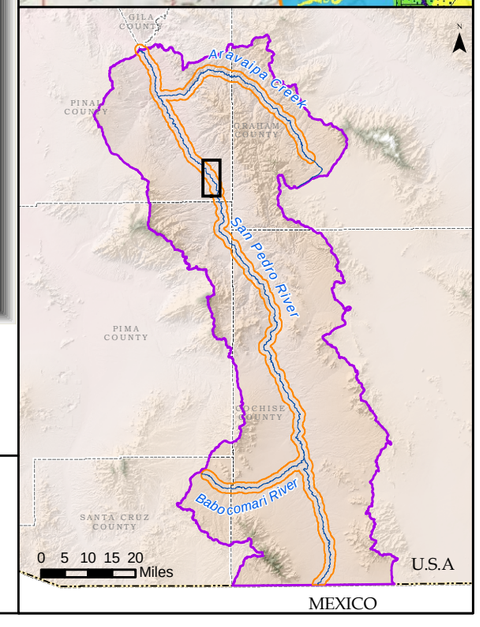
Appendix F
San Pedro River Cross Section at Mile 037
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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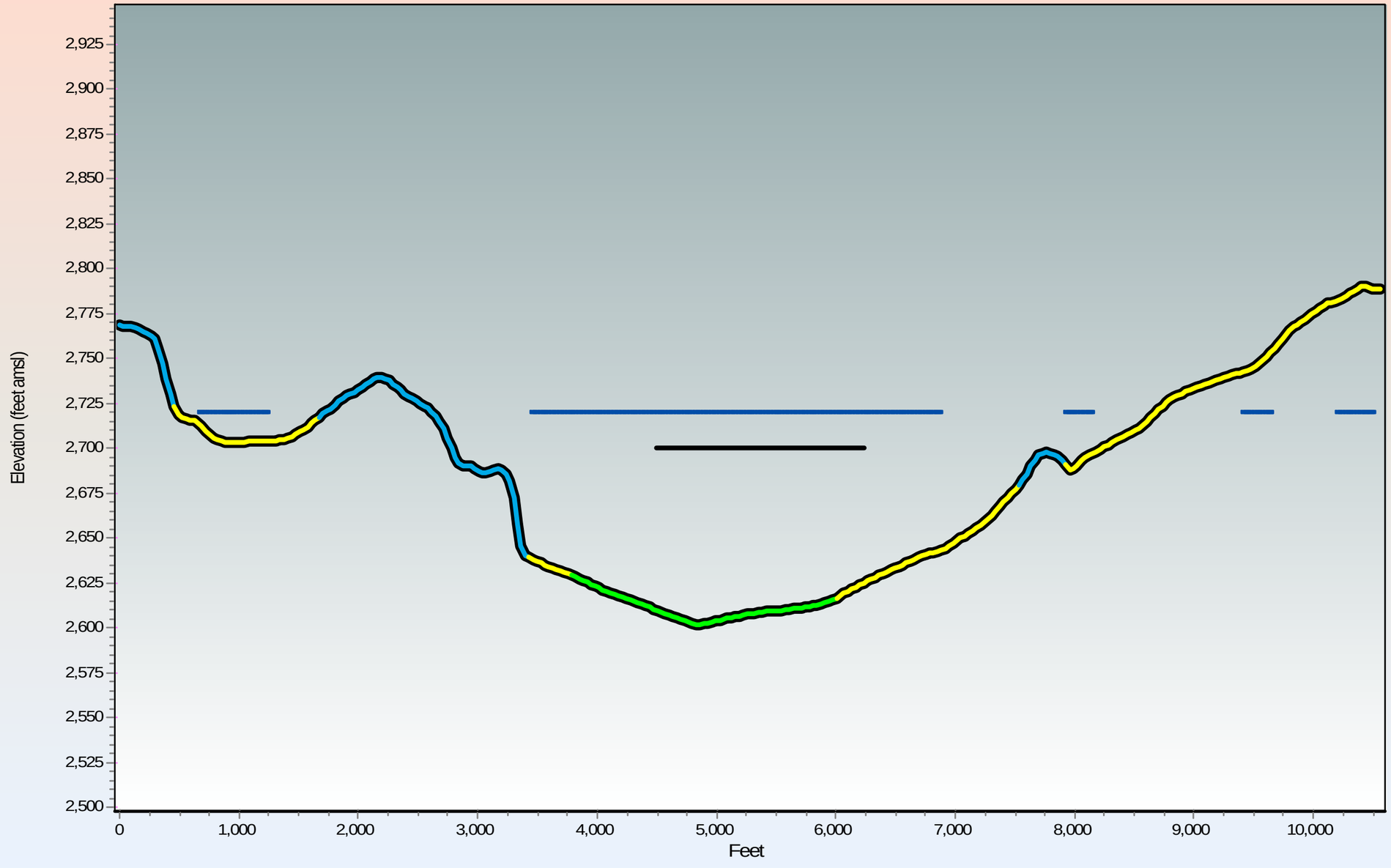
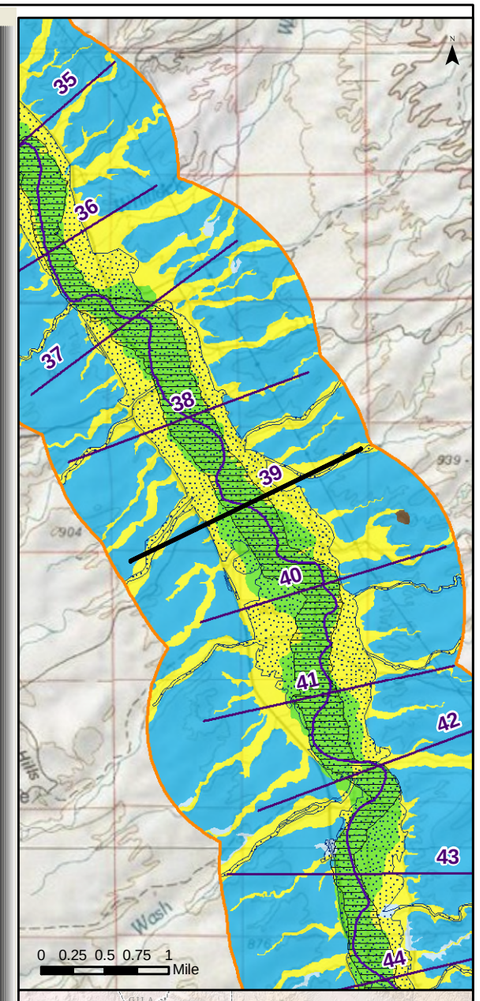
Appendix F

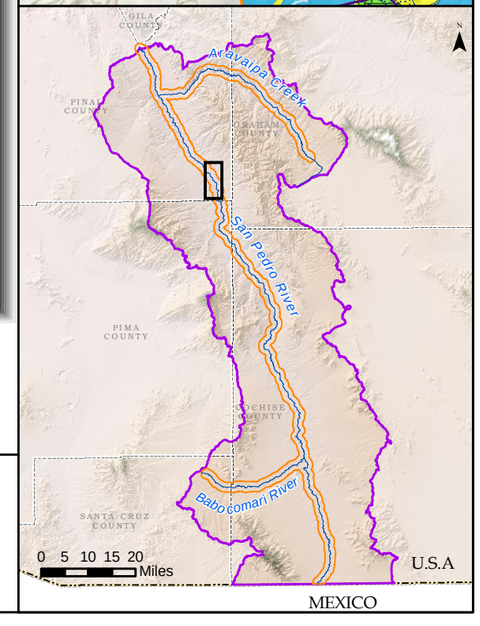
San Pedro River Cross Section at Mile 038

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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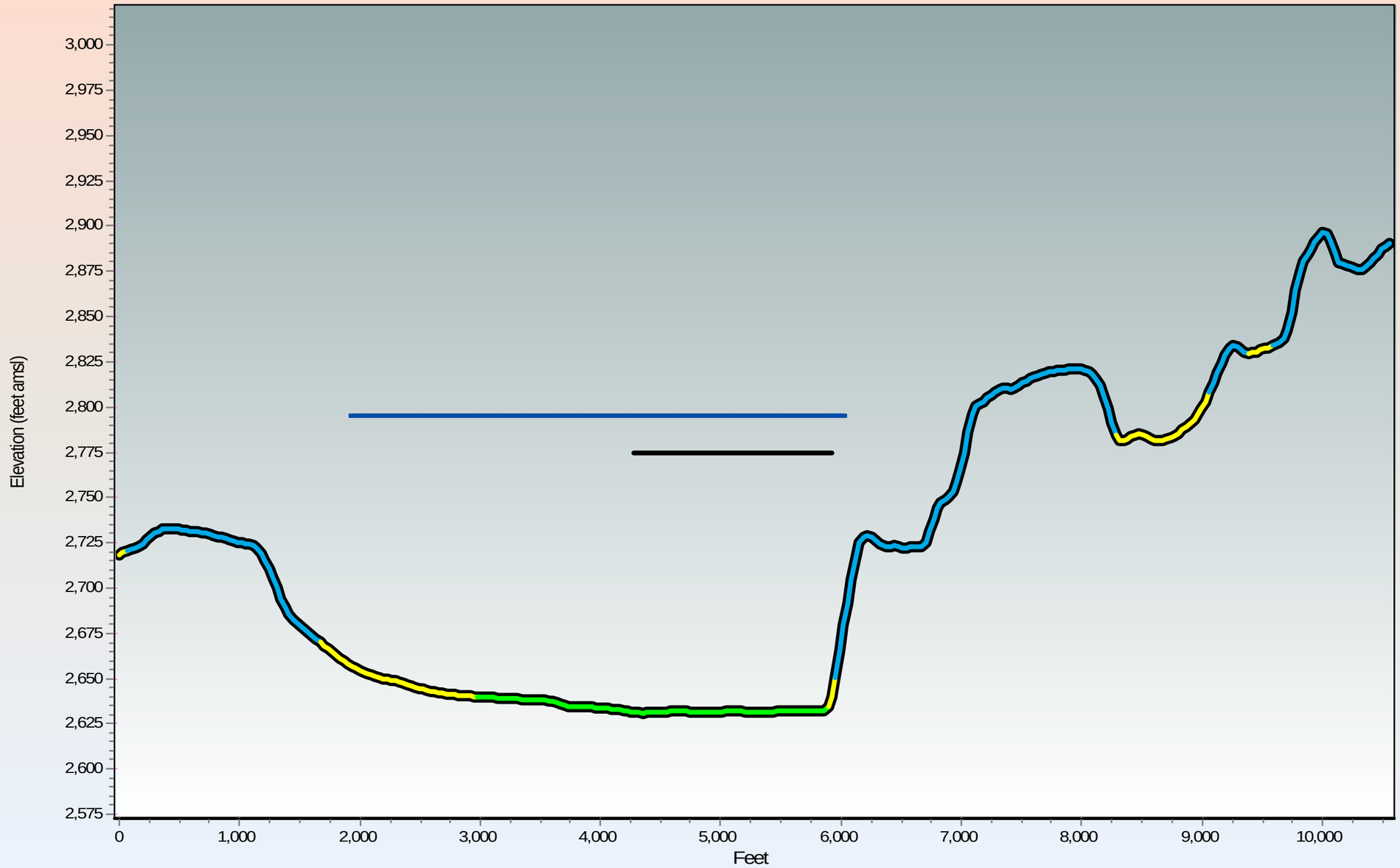
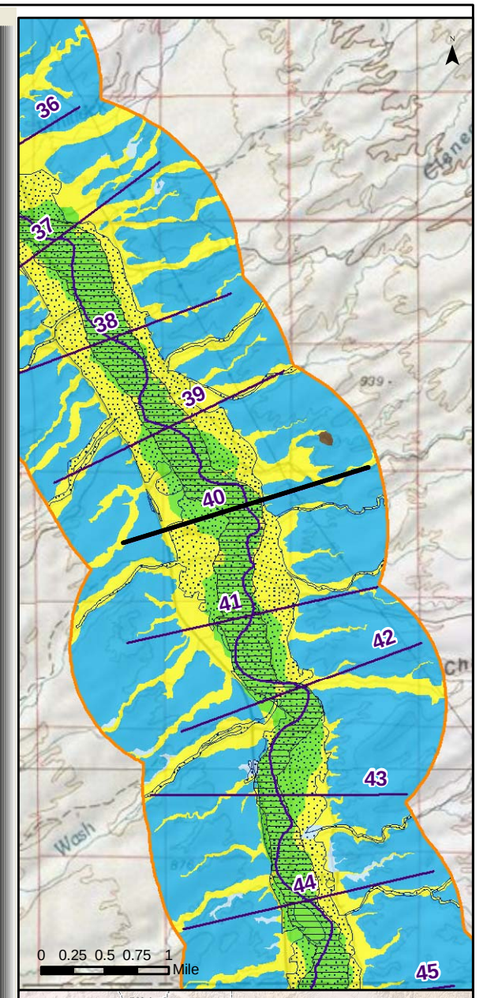
Appendix F

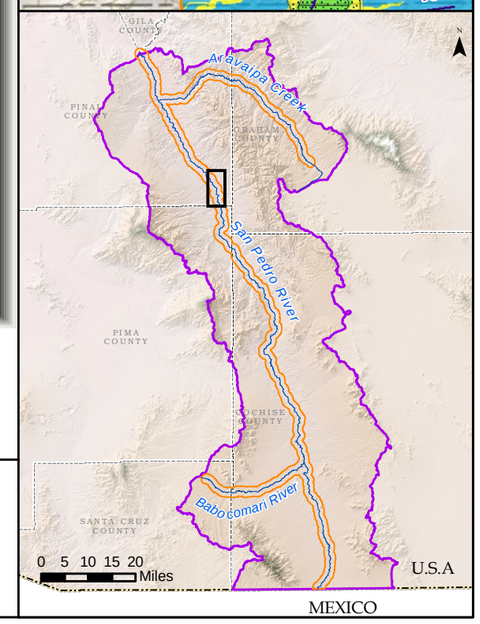
San Pedro River Cross Section at Mile 039

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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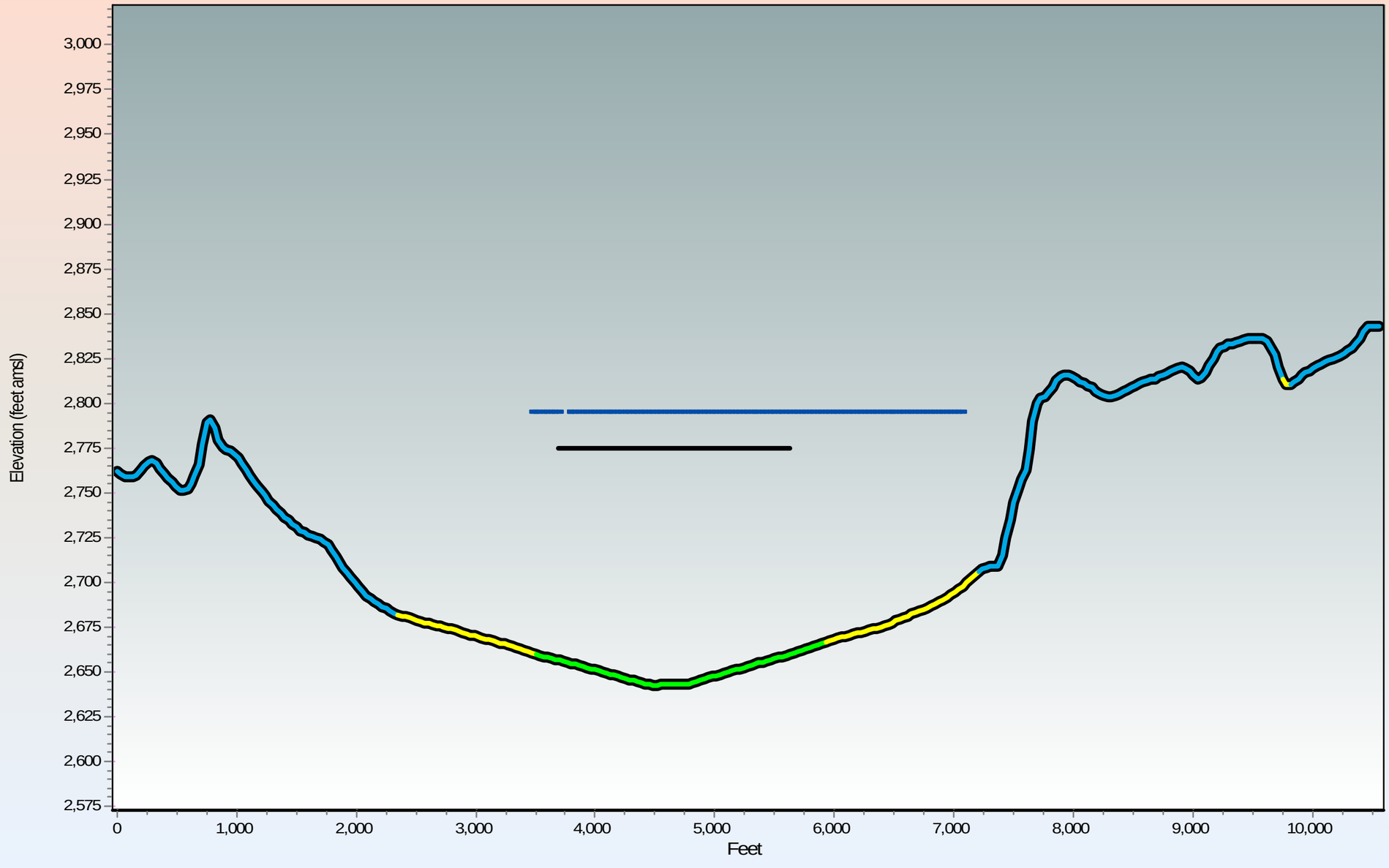
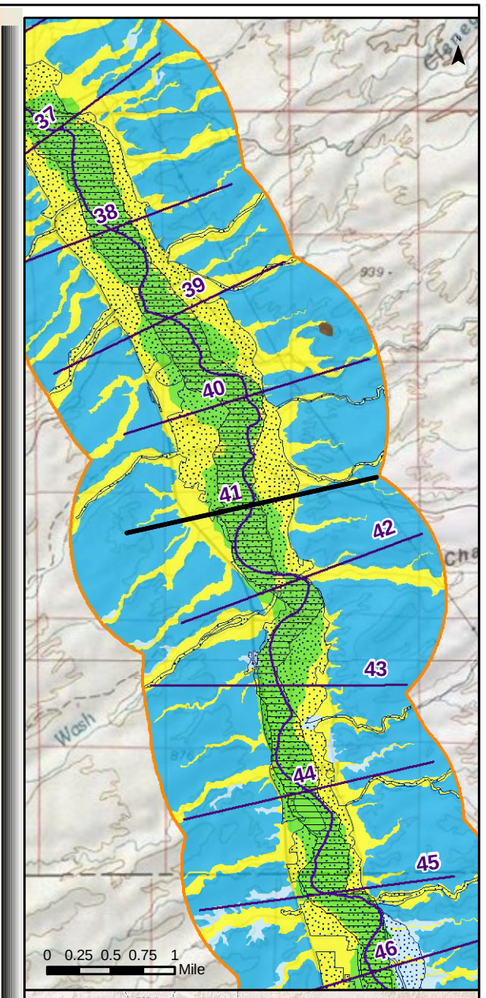
Appendix F

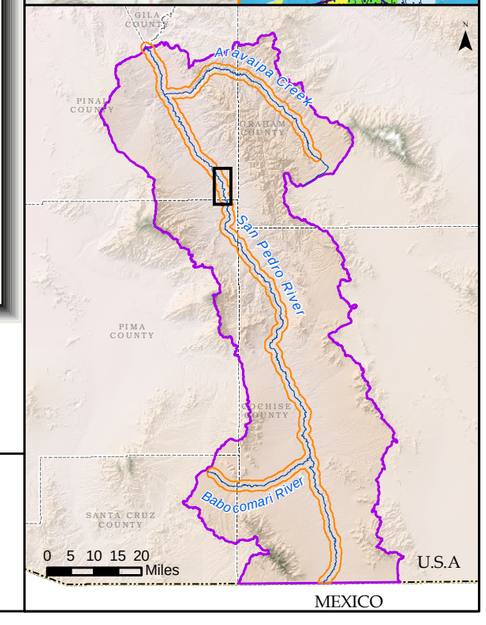
San Pedro River Cross Section at Mile 040

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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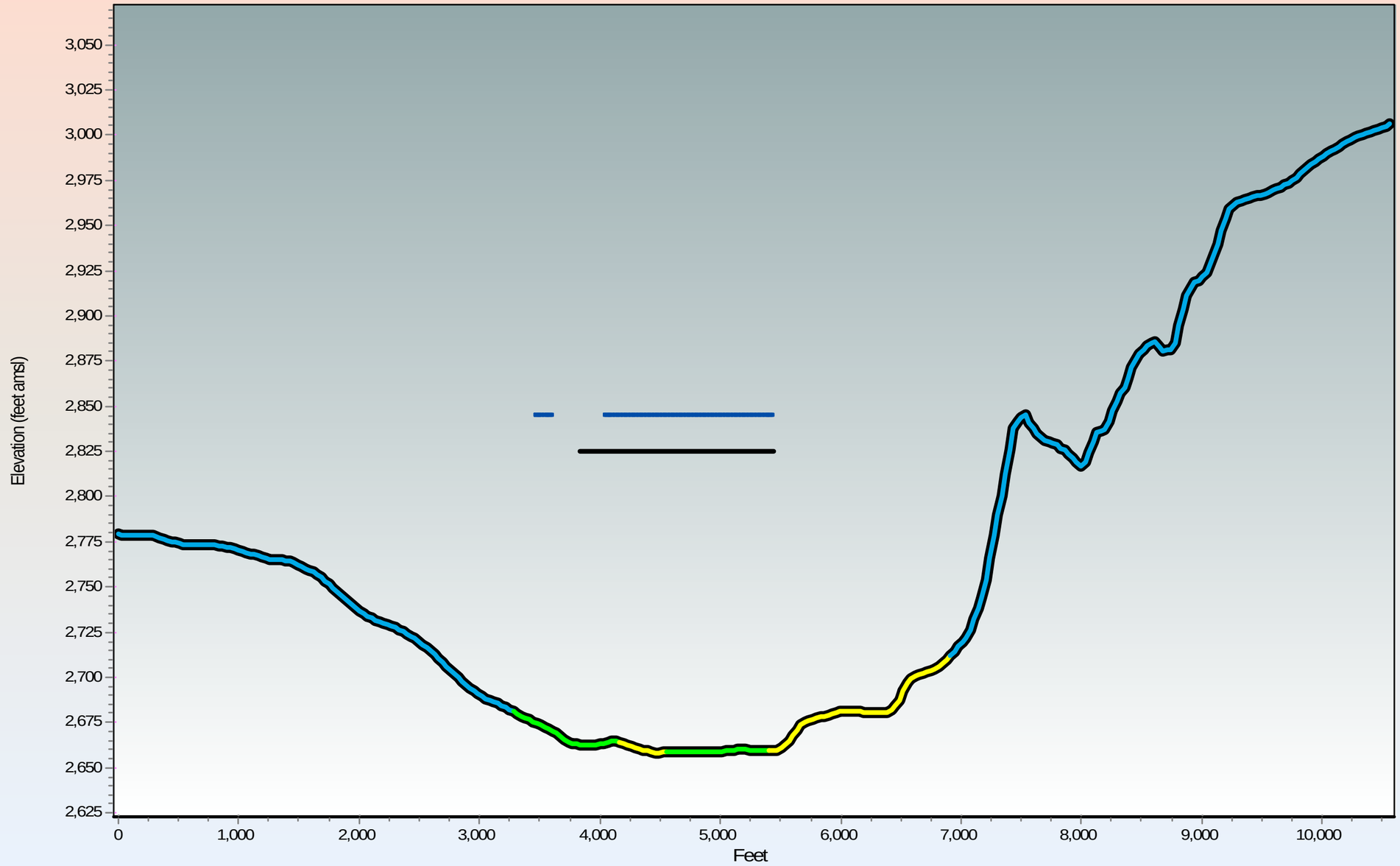
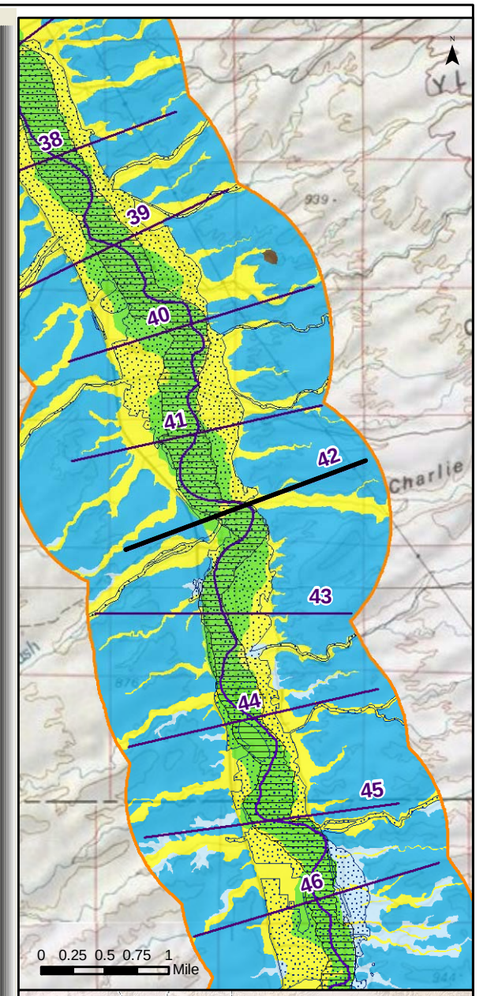
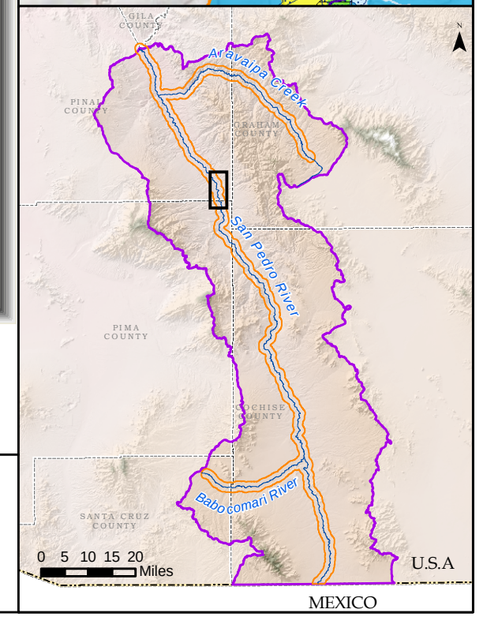
Appendix F
San Pedro River Cross Section at Mile 041
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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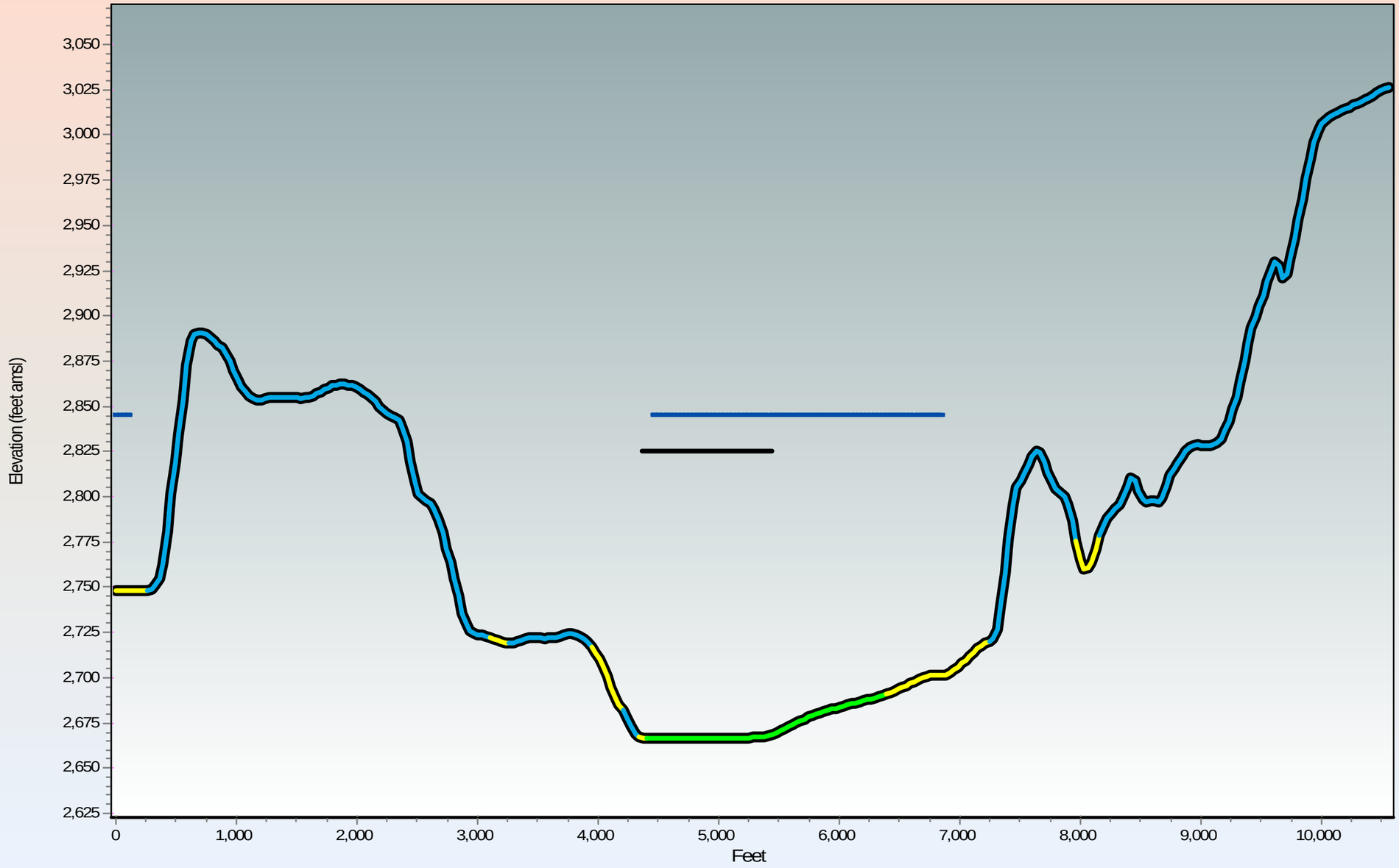
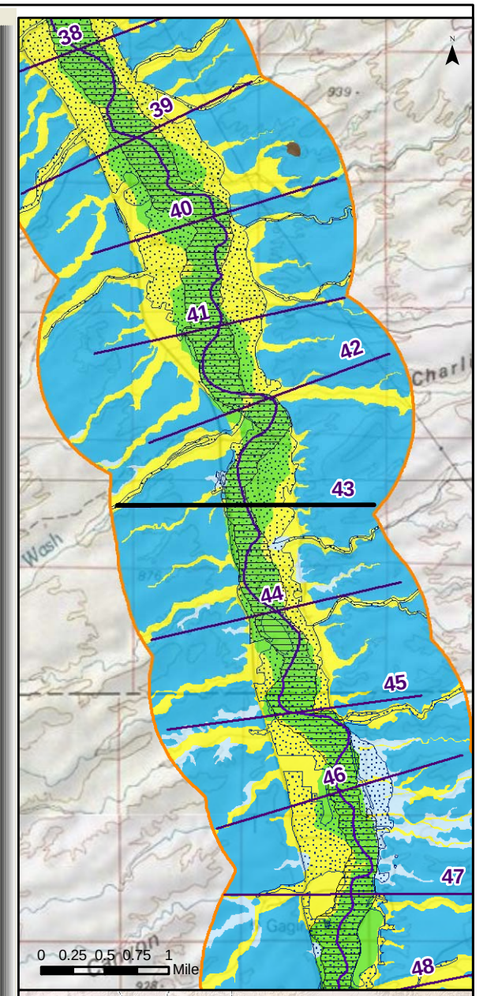
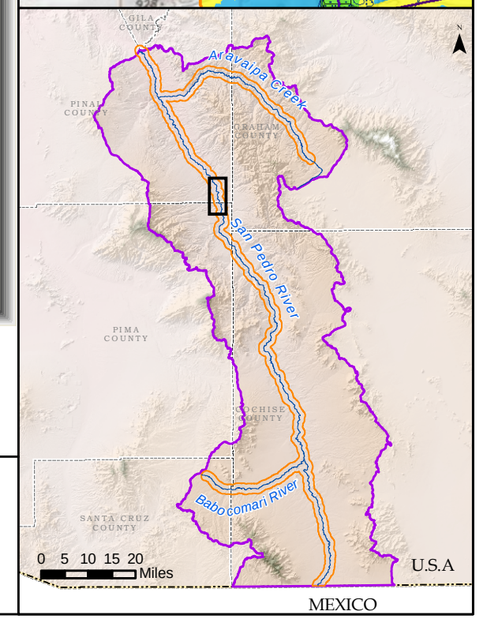
Appendix F
San Pedro River Cross Section at Mile 042
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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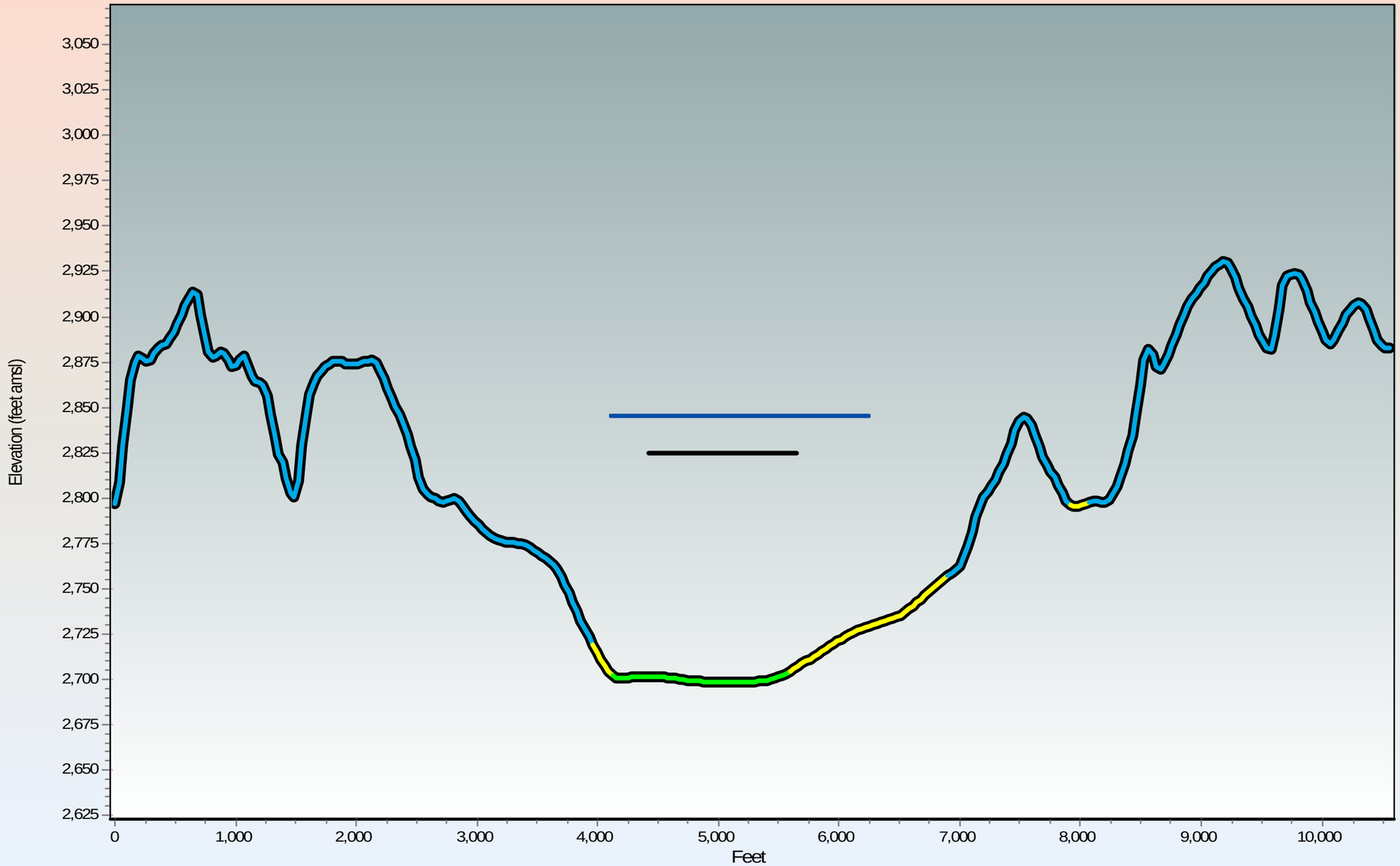
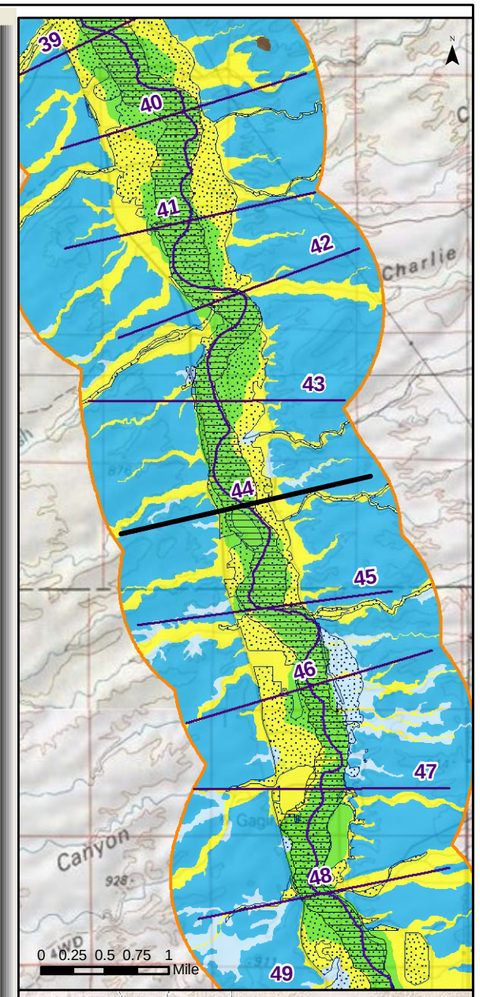
Appendix F

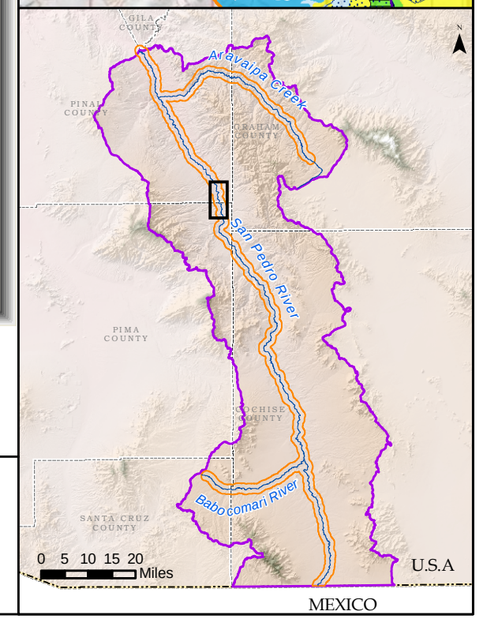
San Pedro River Cross Section at Mile 043

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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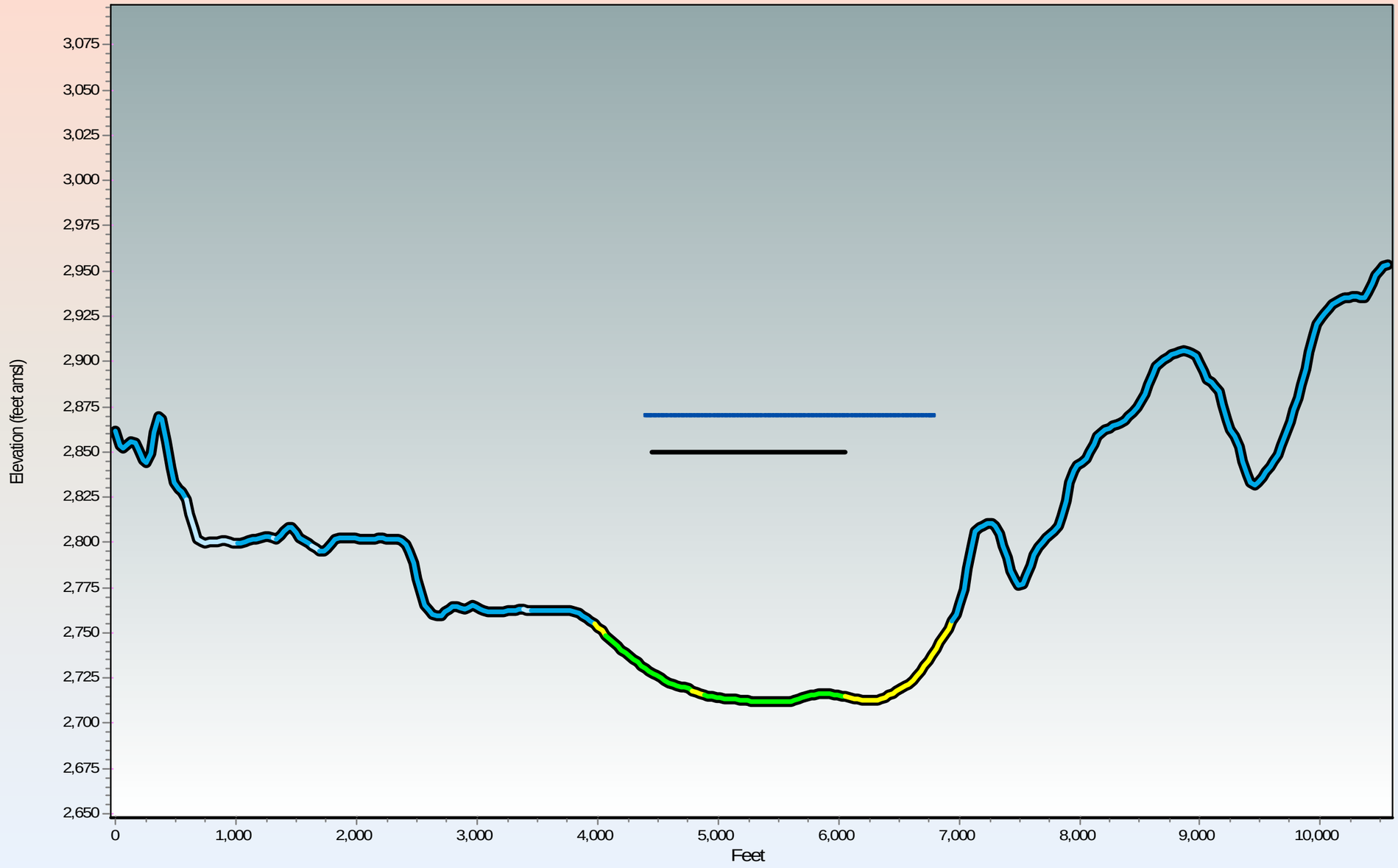
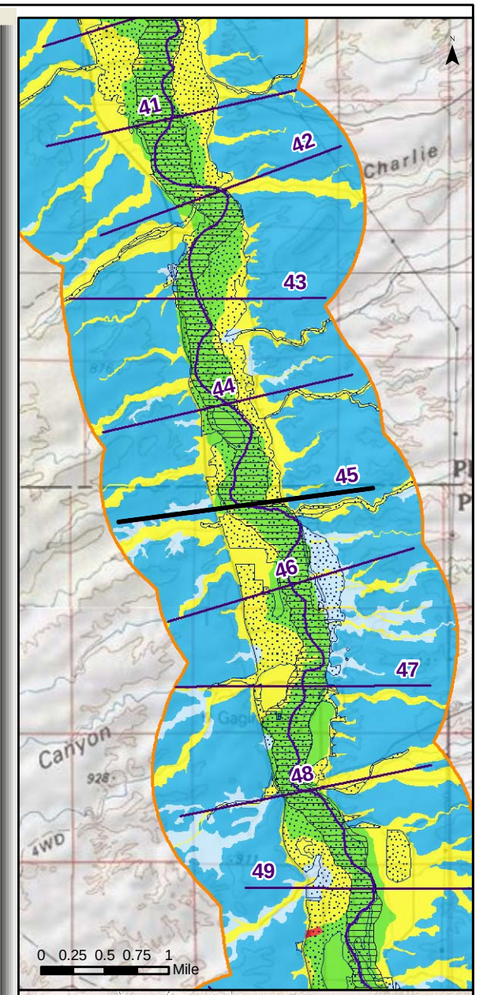
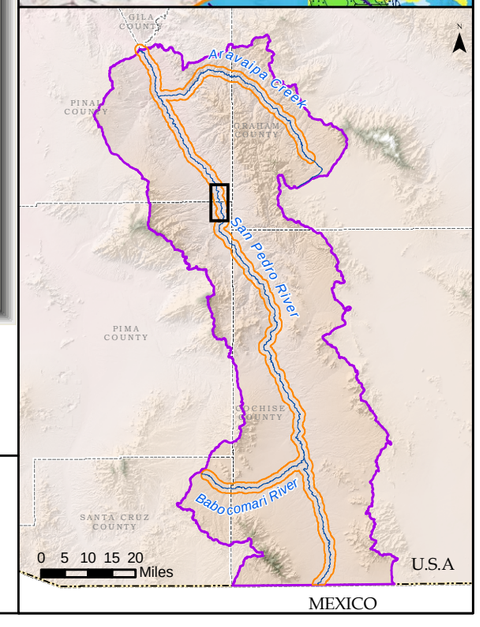
Appendix F
San Pedro River Cross Section at Mile 044
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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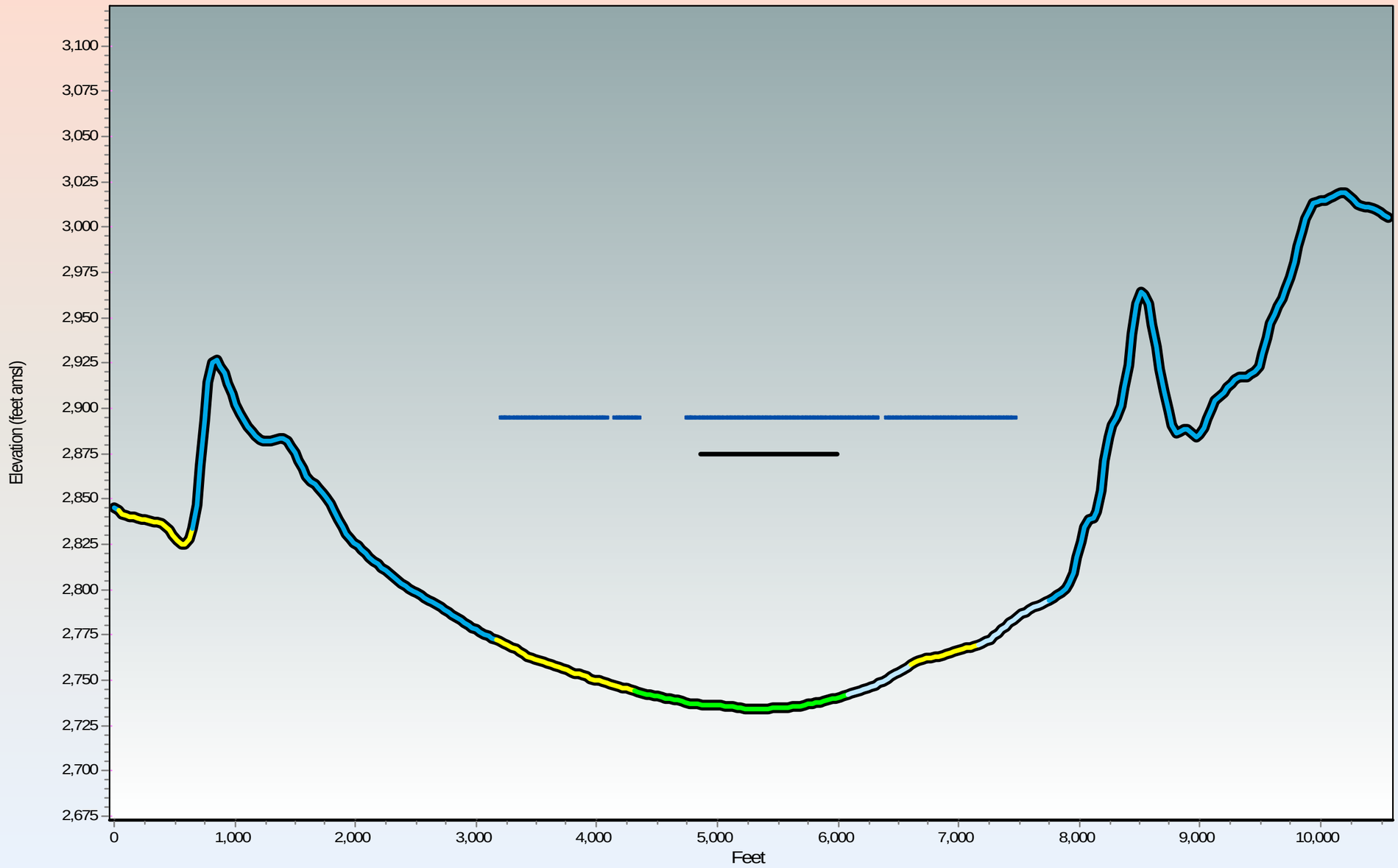
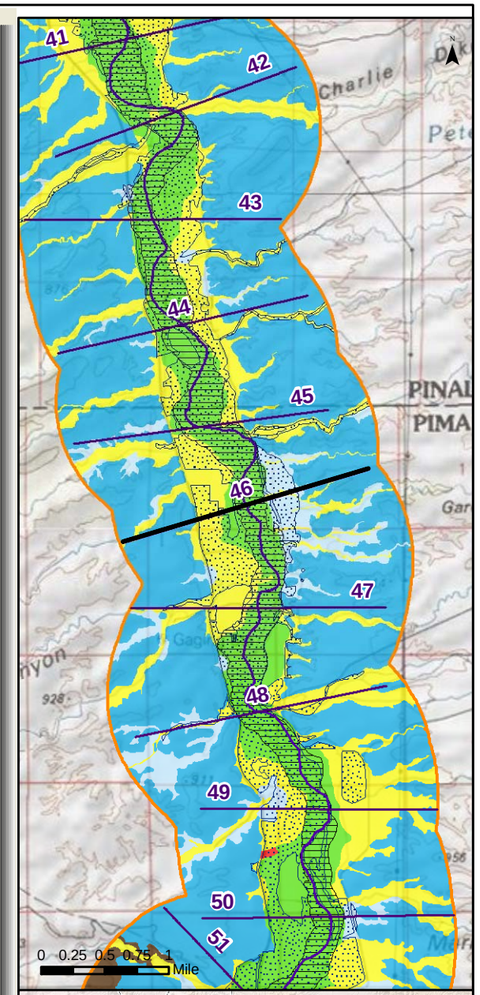
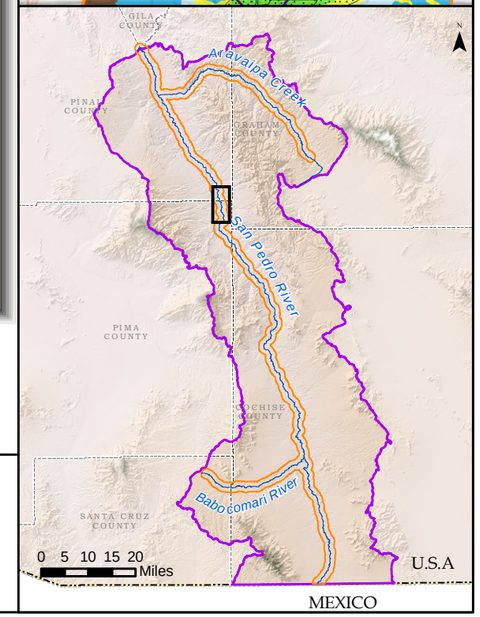
Appendix F
San Pedro River Cross Section at Mile 045
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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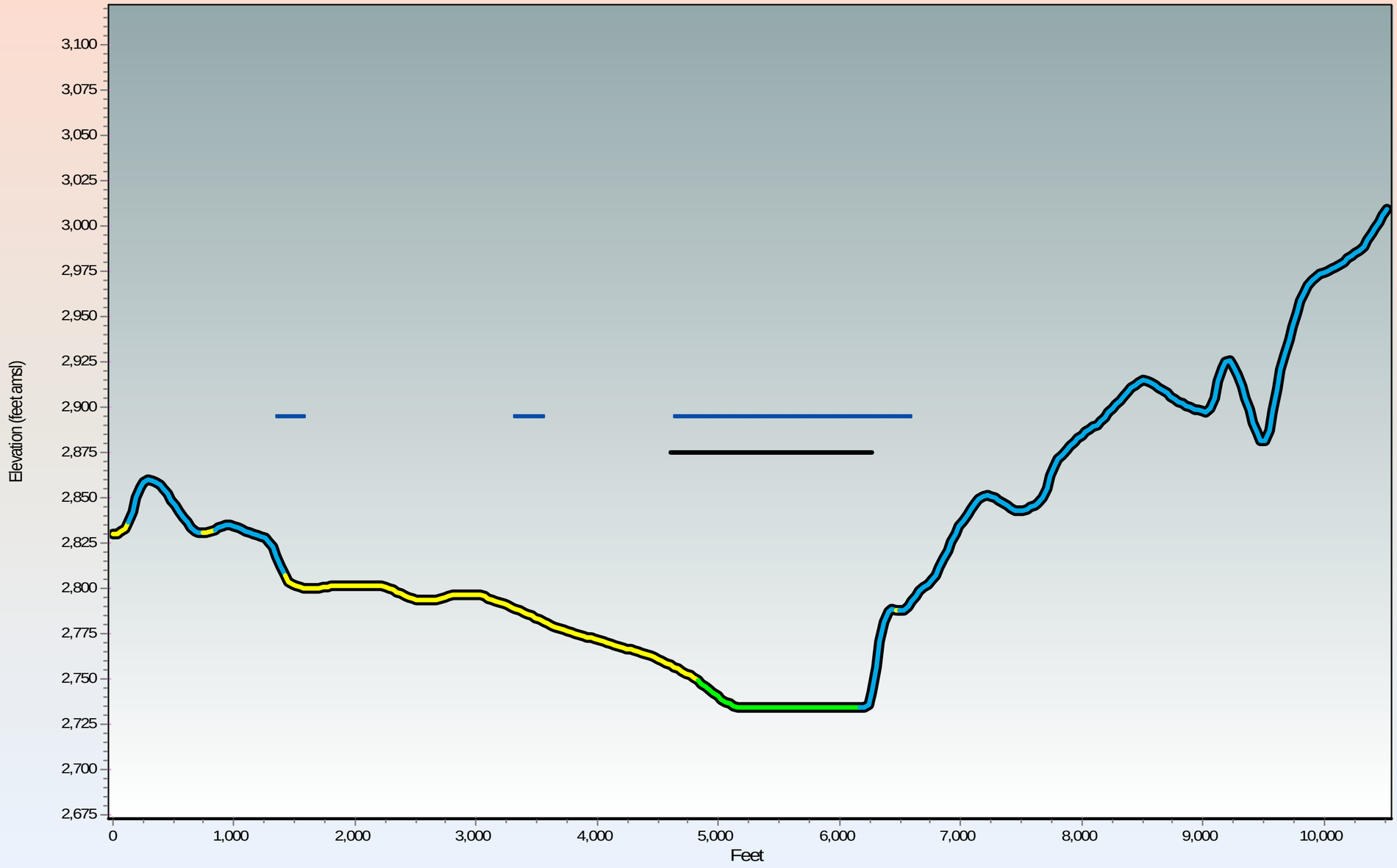
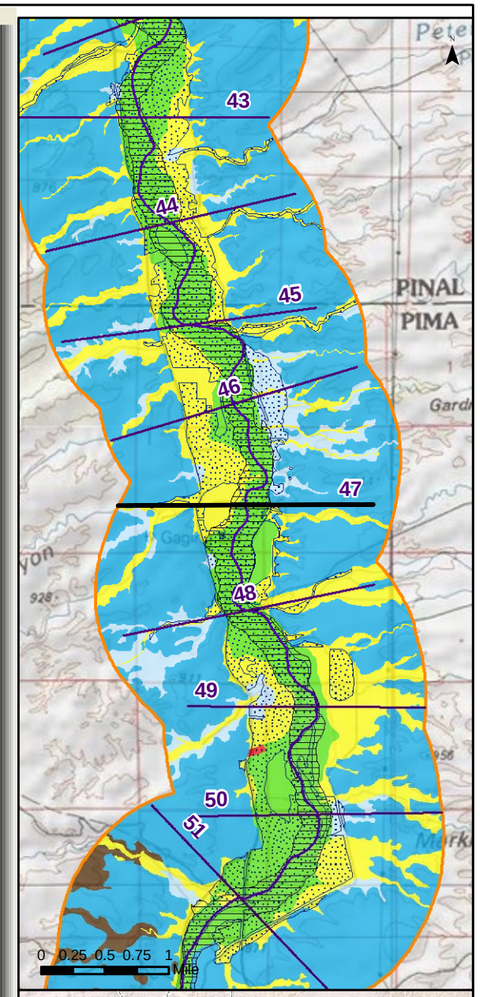
Appendix F

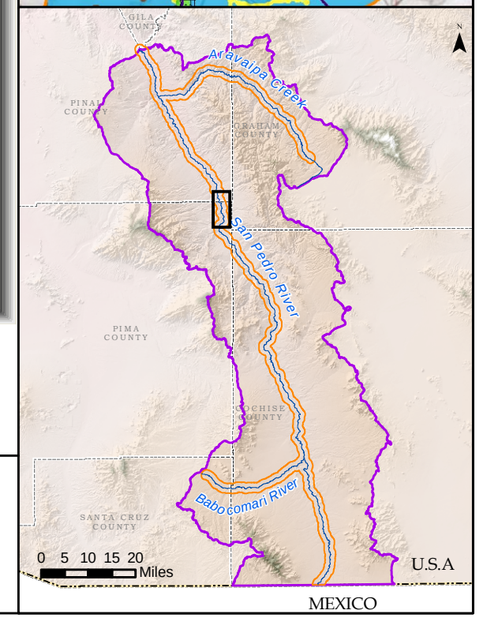
San Pedro River Cross Section at Mile 046

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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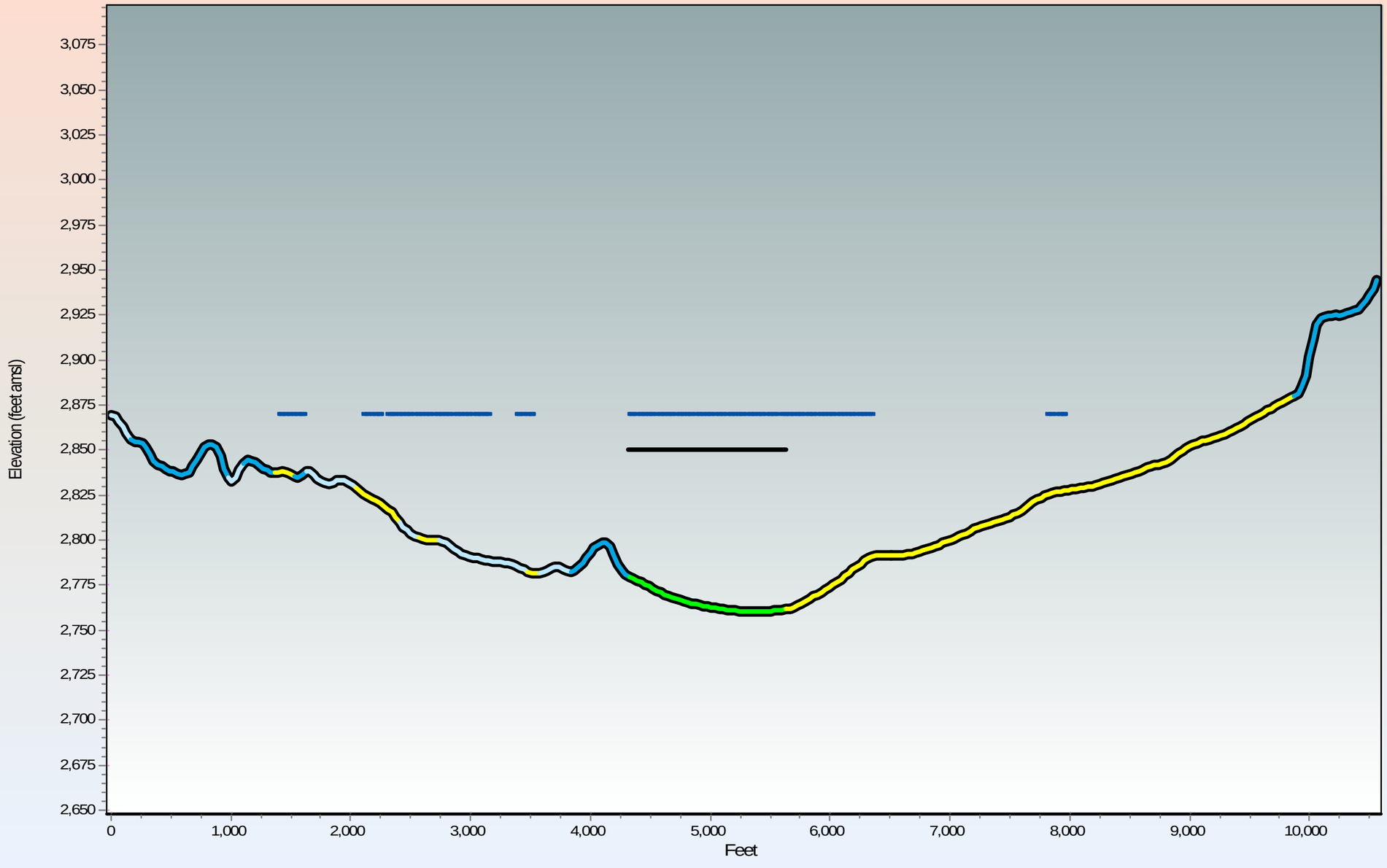
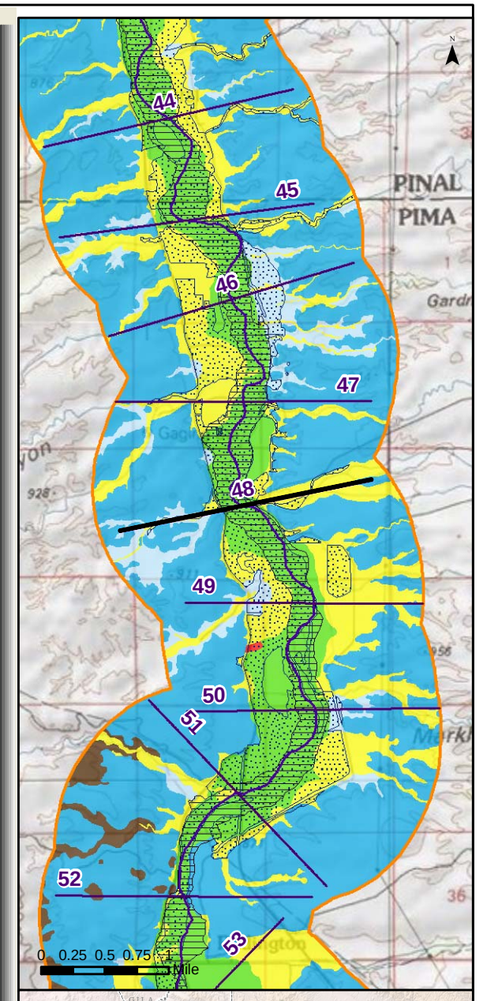
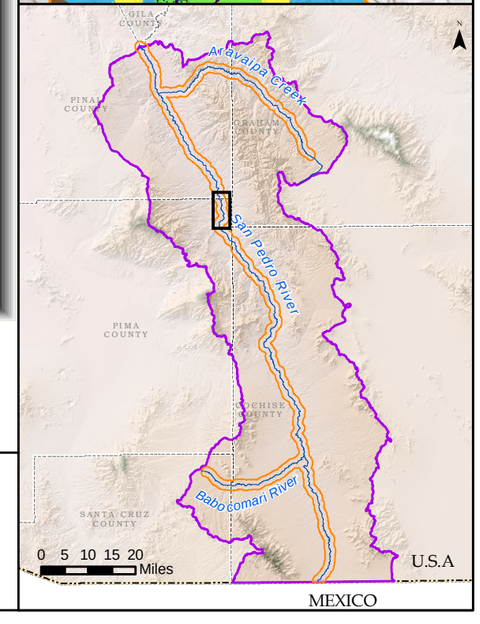
Appendix F
San Pedro River Cross Section at Mile 047
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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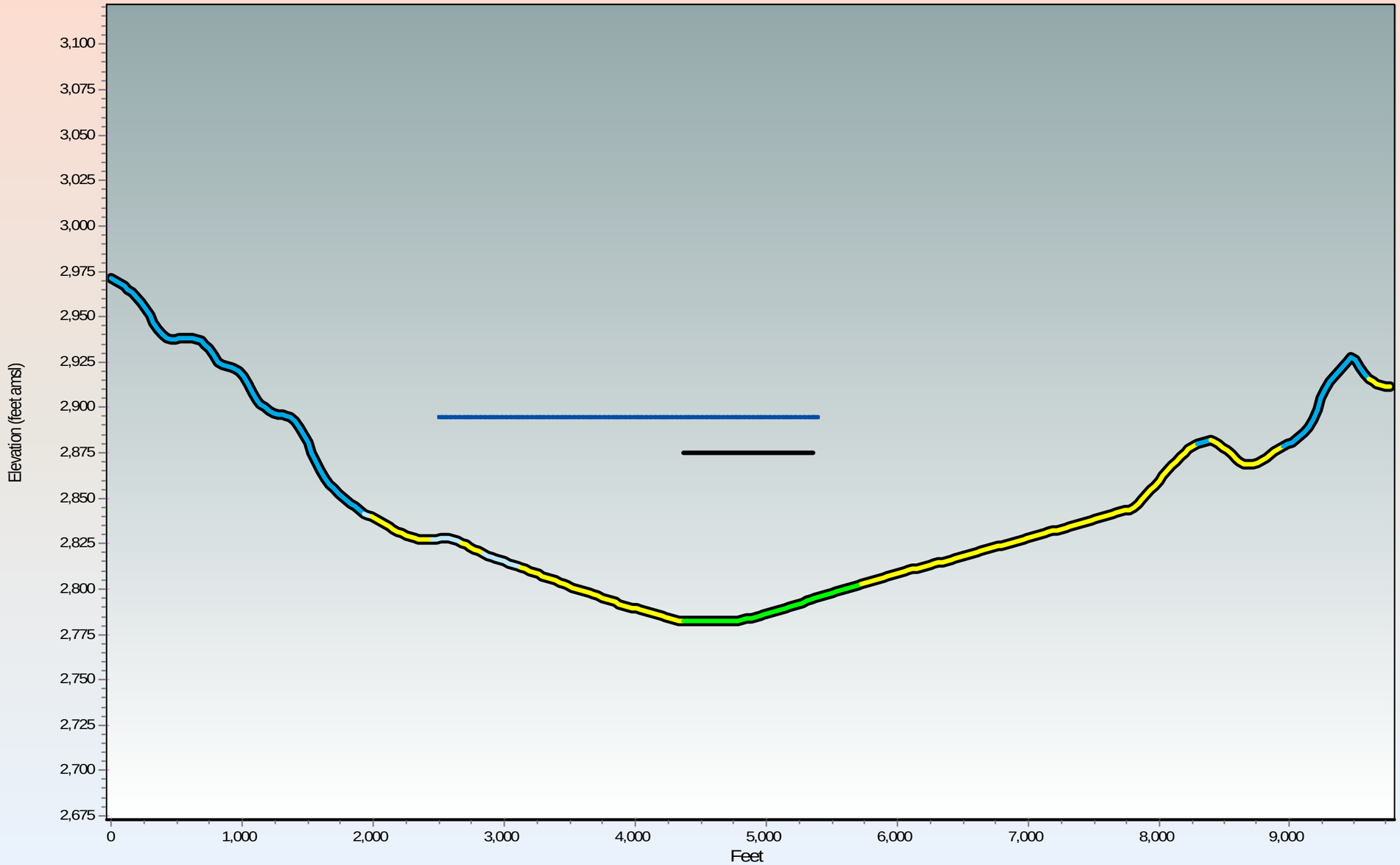
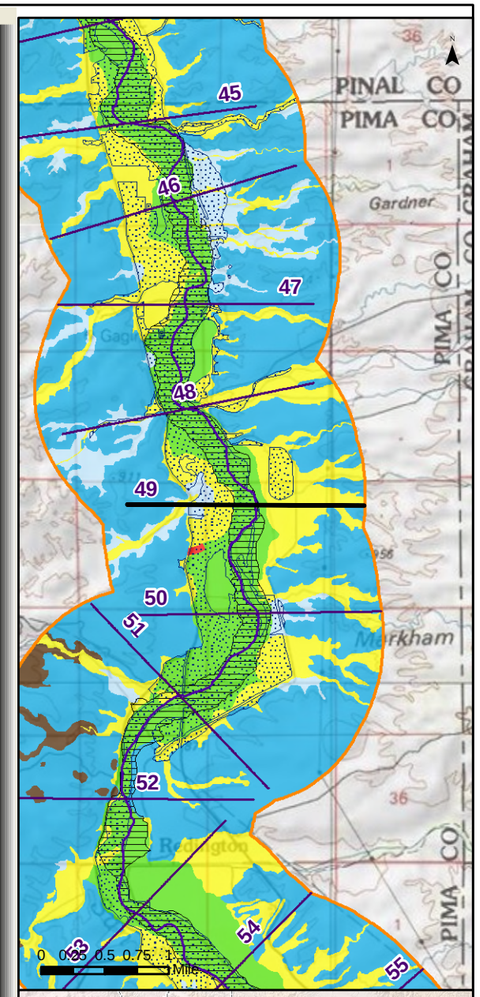
Appendix F

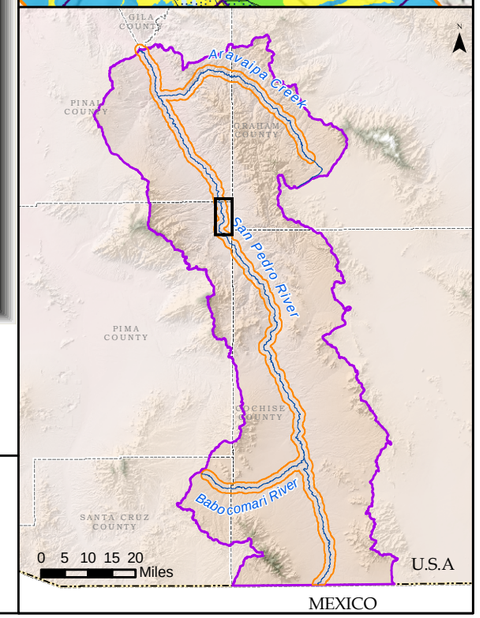
San Pedro River Cross Section at Mile 048

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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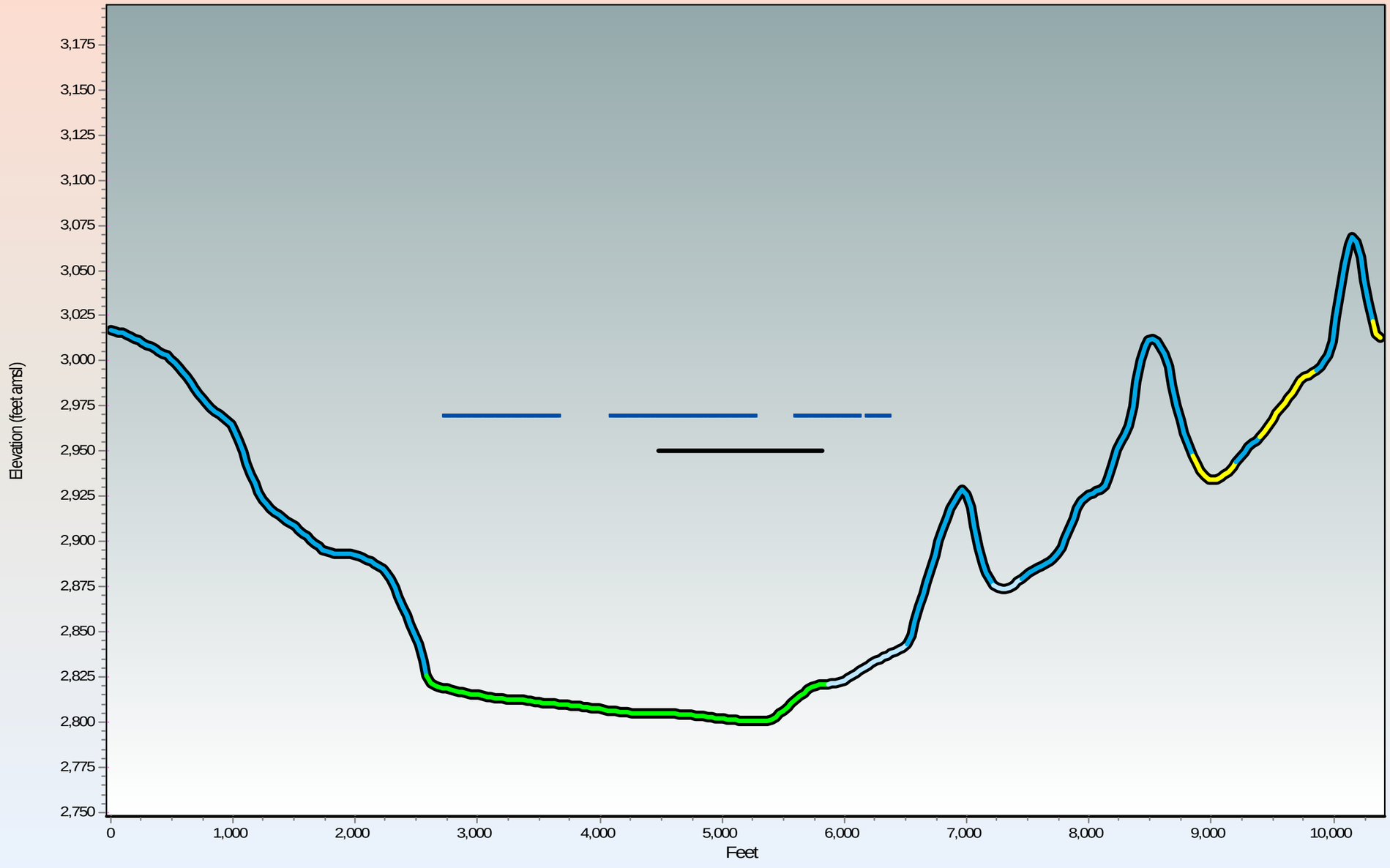
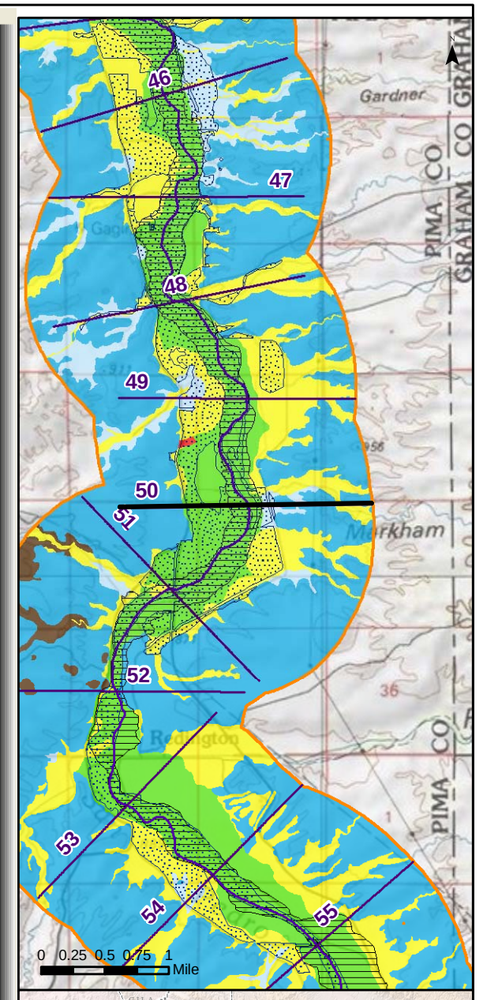
Appendix F

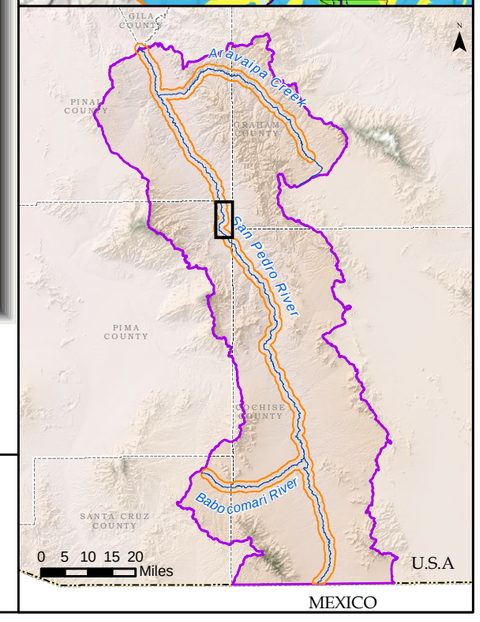
San Pedro River Cross Section at Mile 049

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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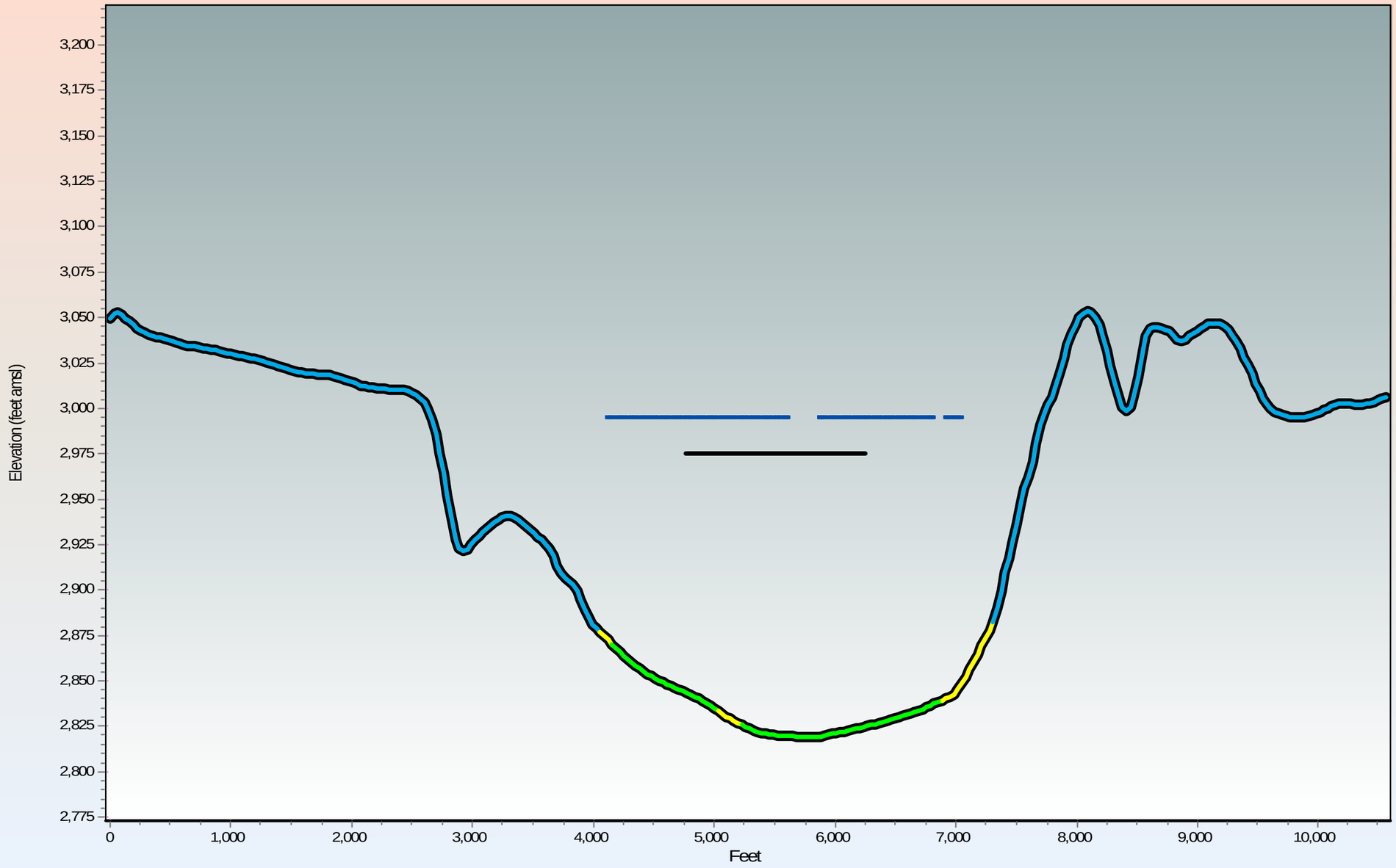
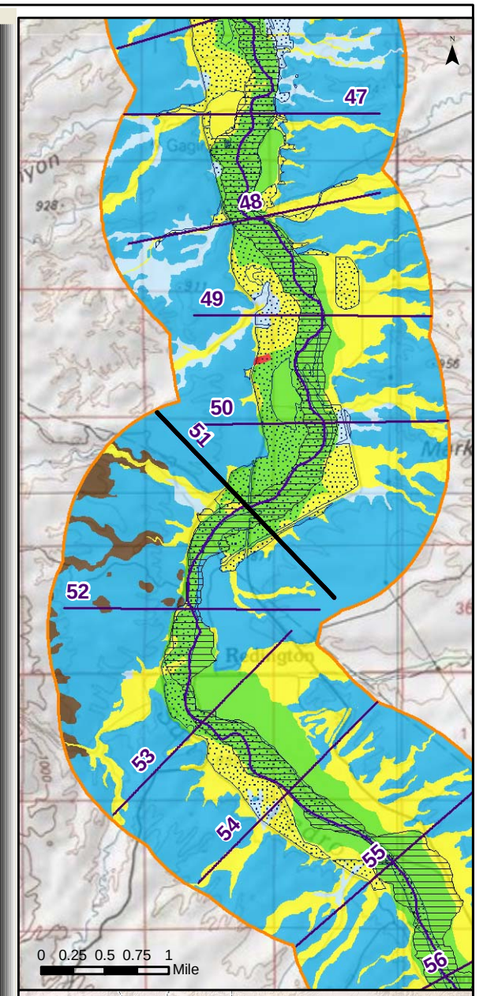
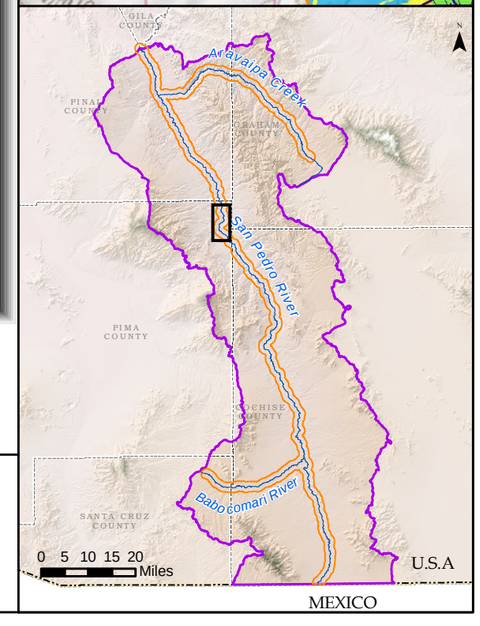
Appendix F
San Pedro River Cross Section at Mile 050
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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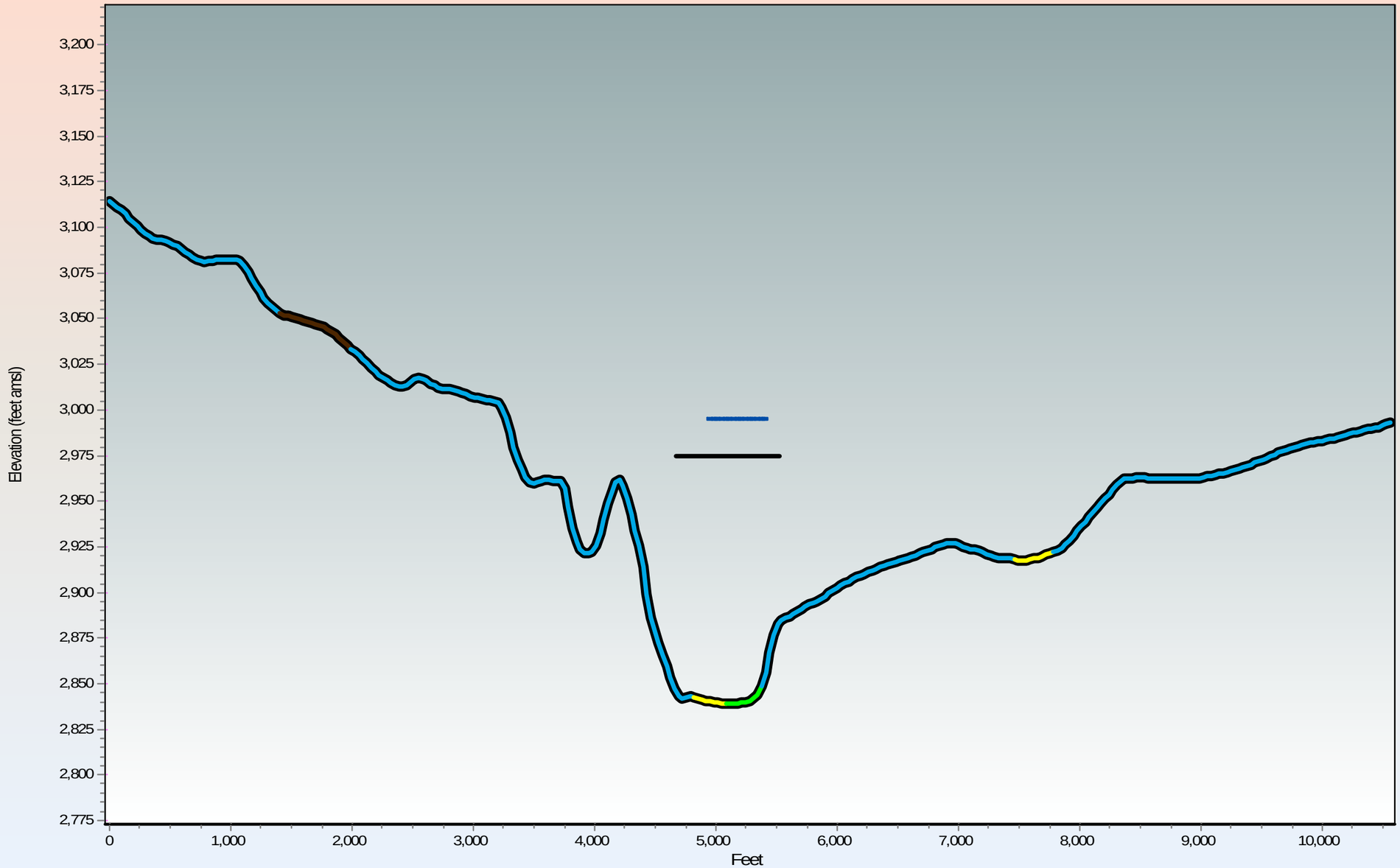
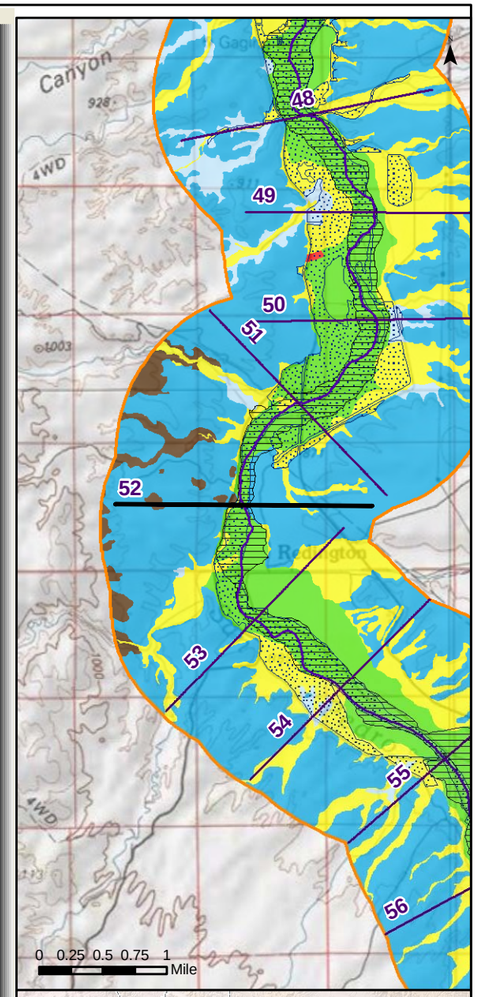
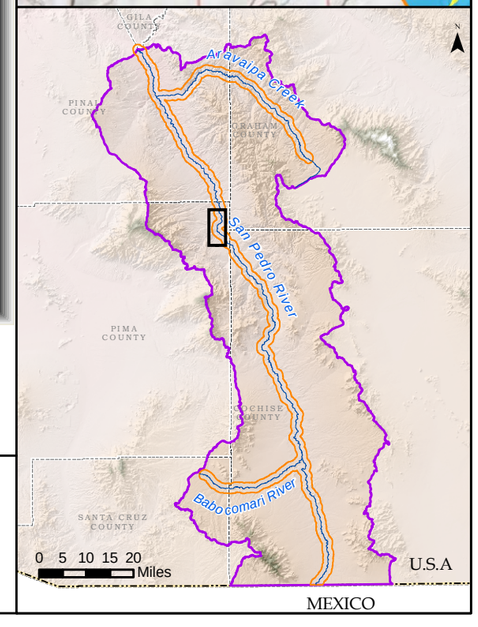
Appendix F
San Pedro River Cross Section at Mile 051
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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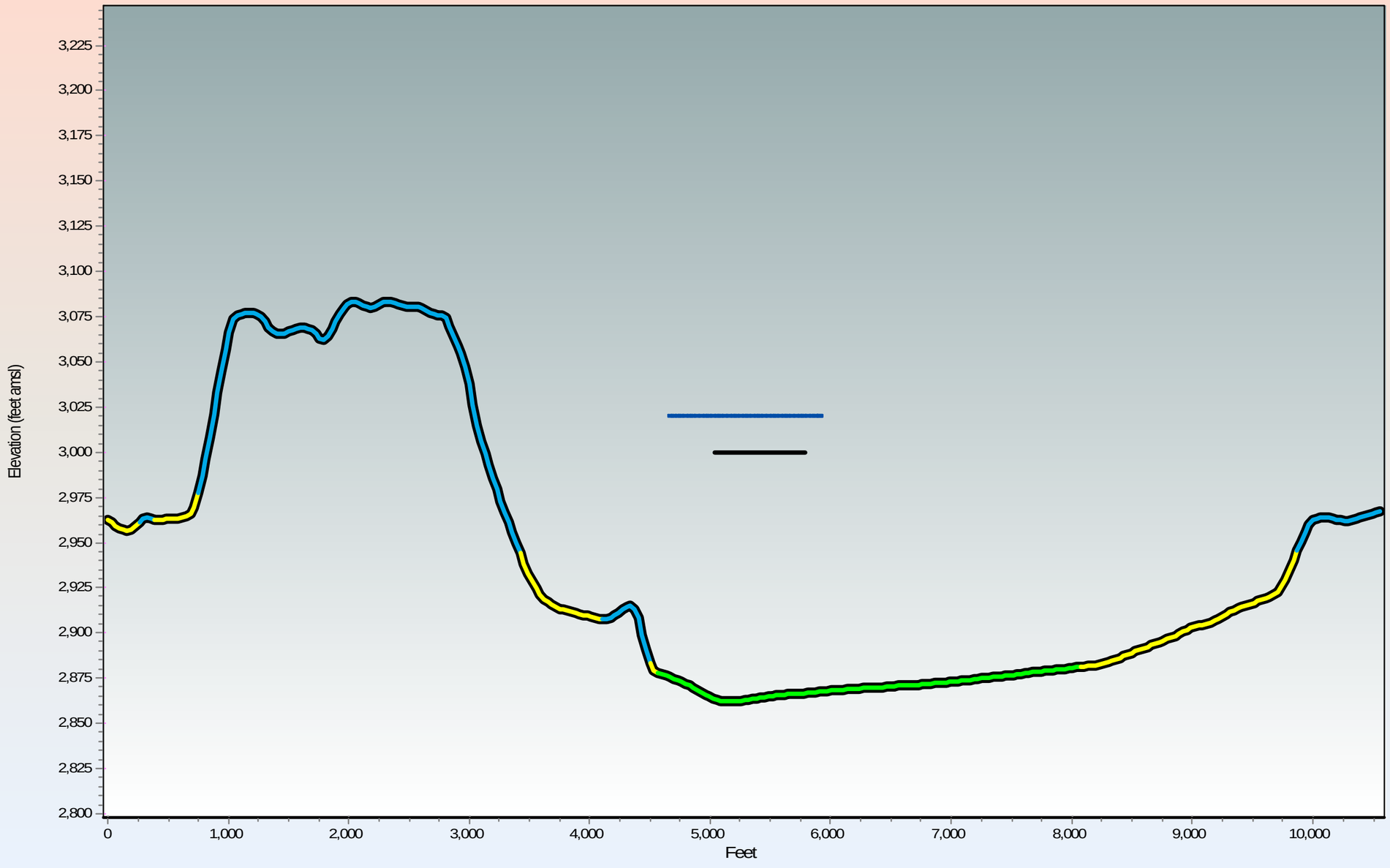
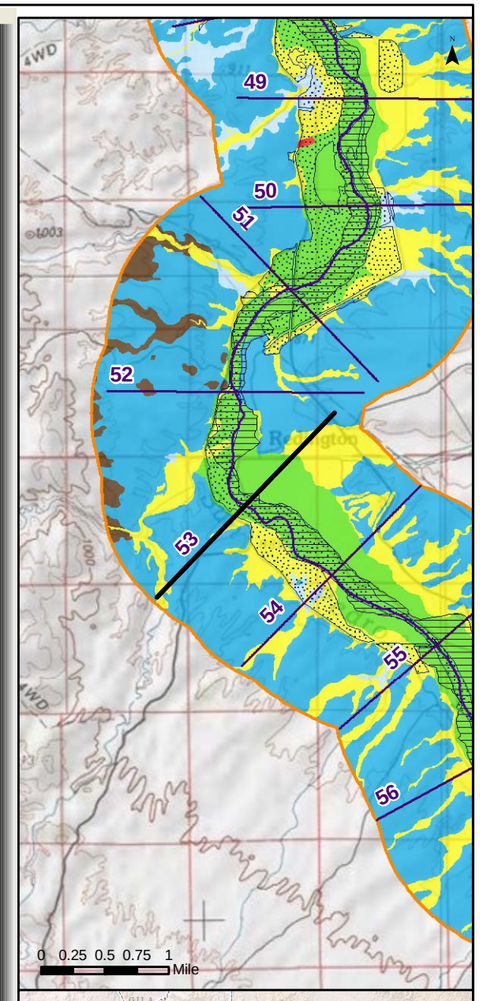
Appendix F

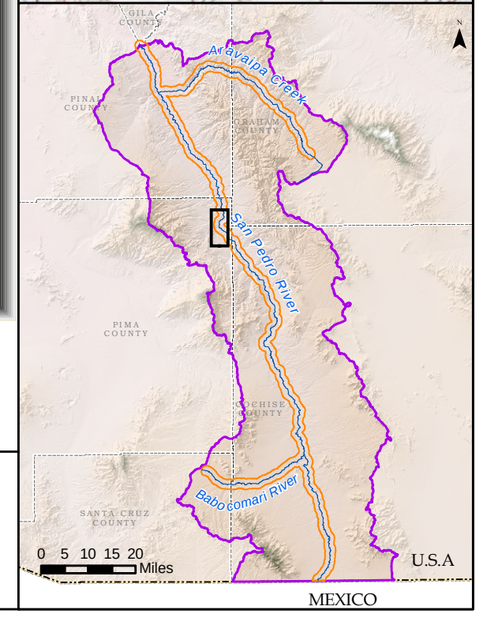
San Pedro River Cross Section at Mile 052

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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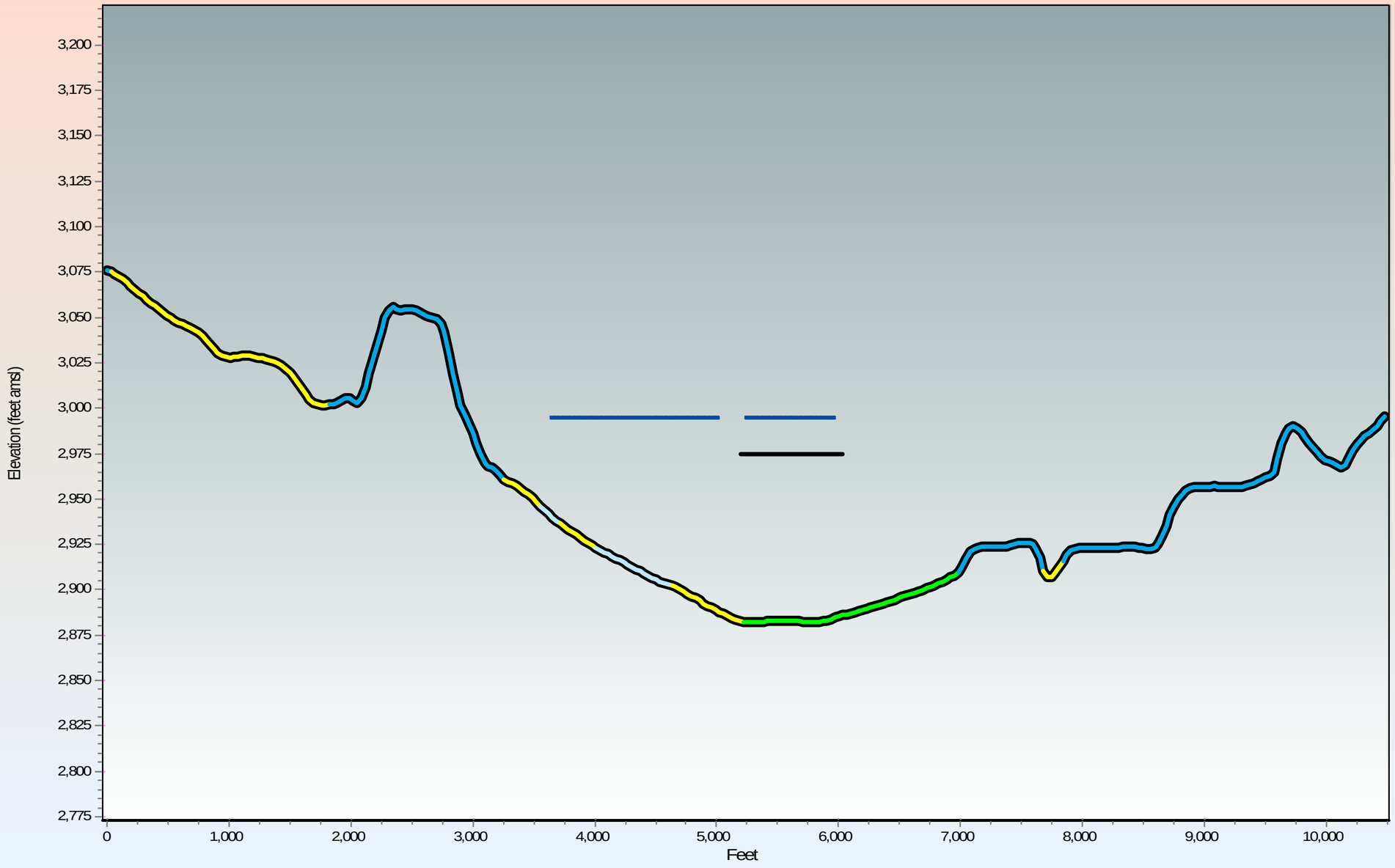
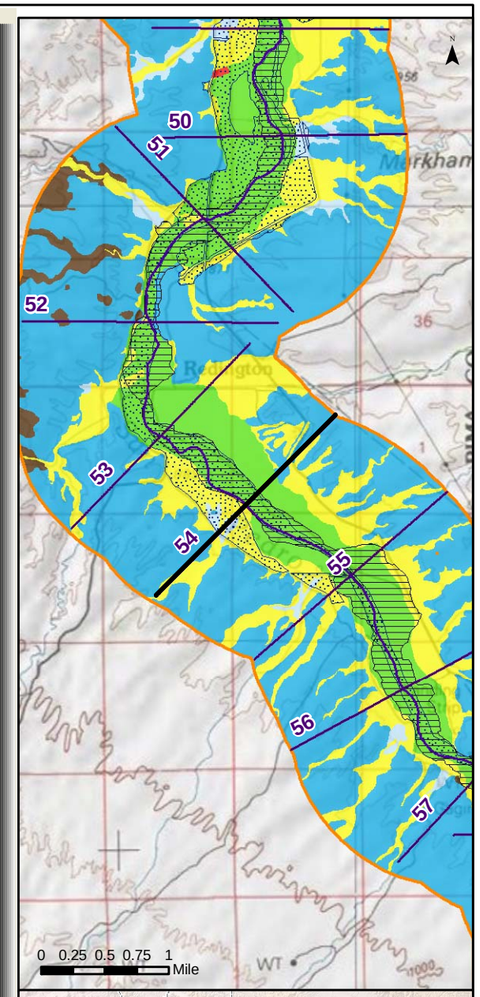
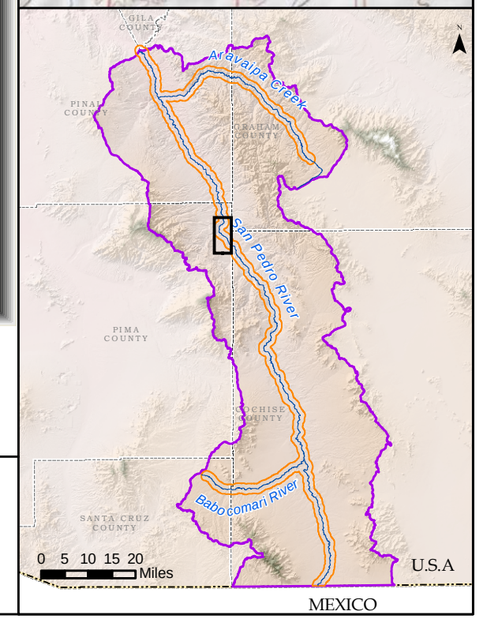
Appendix F
San Pedro River Cross Section at Mile 053
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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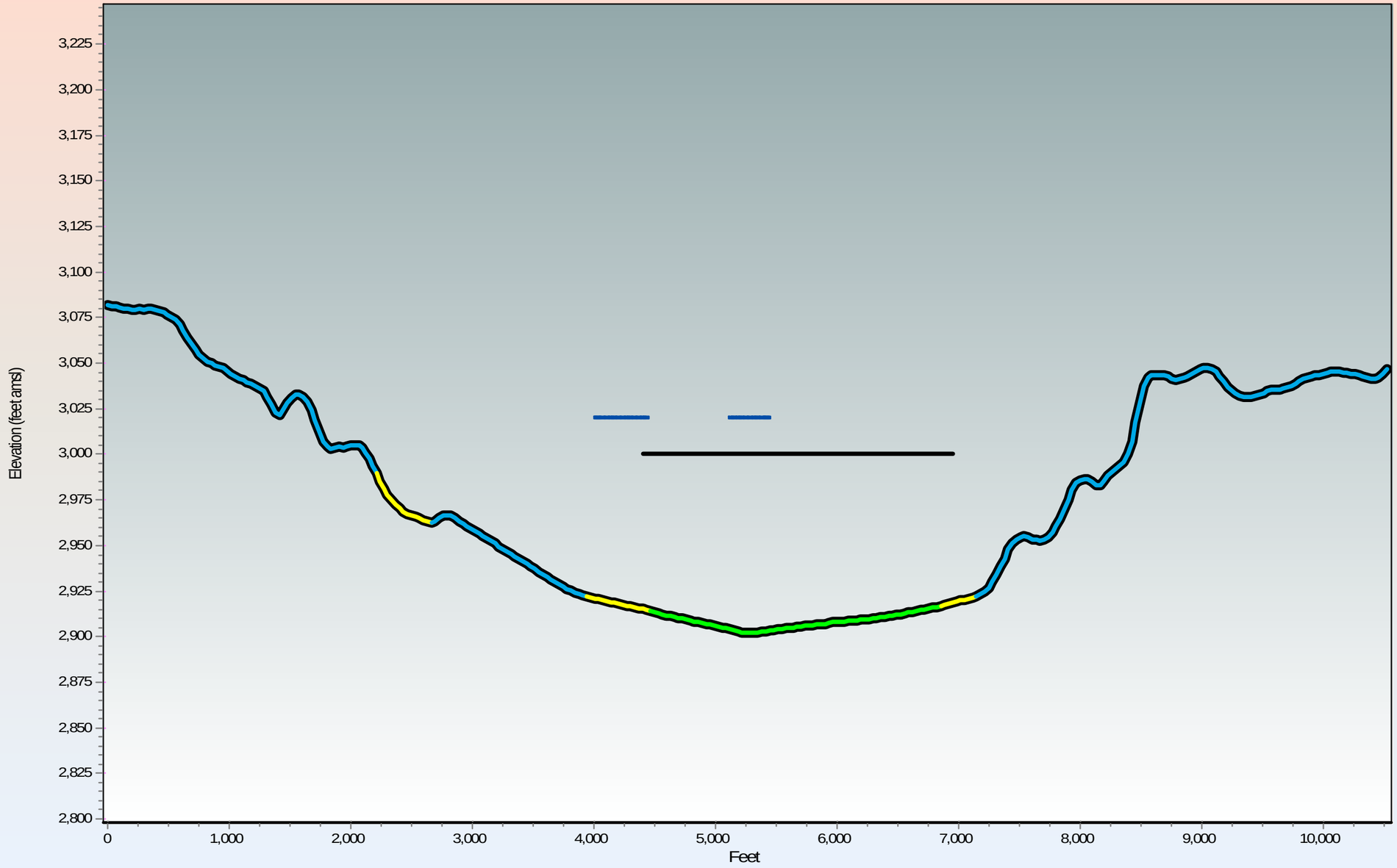
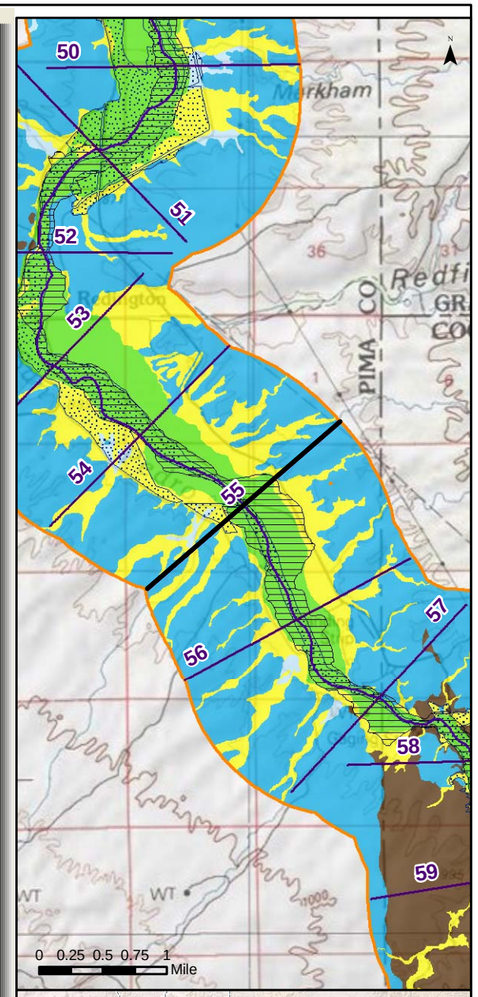
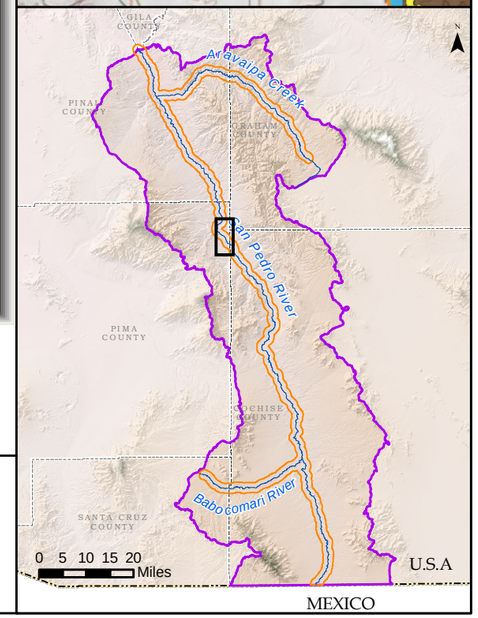
Appendix F
San Pedro River Cross Section at Mile 054
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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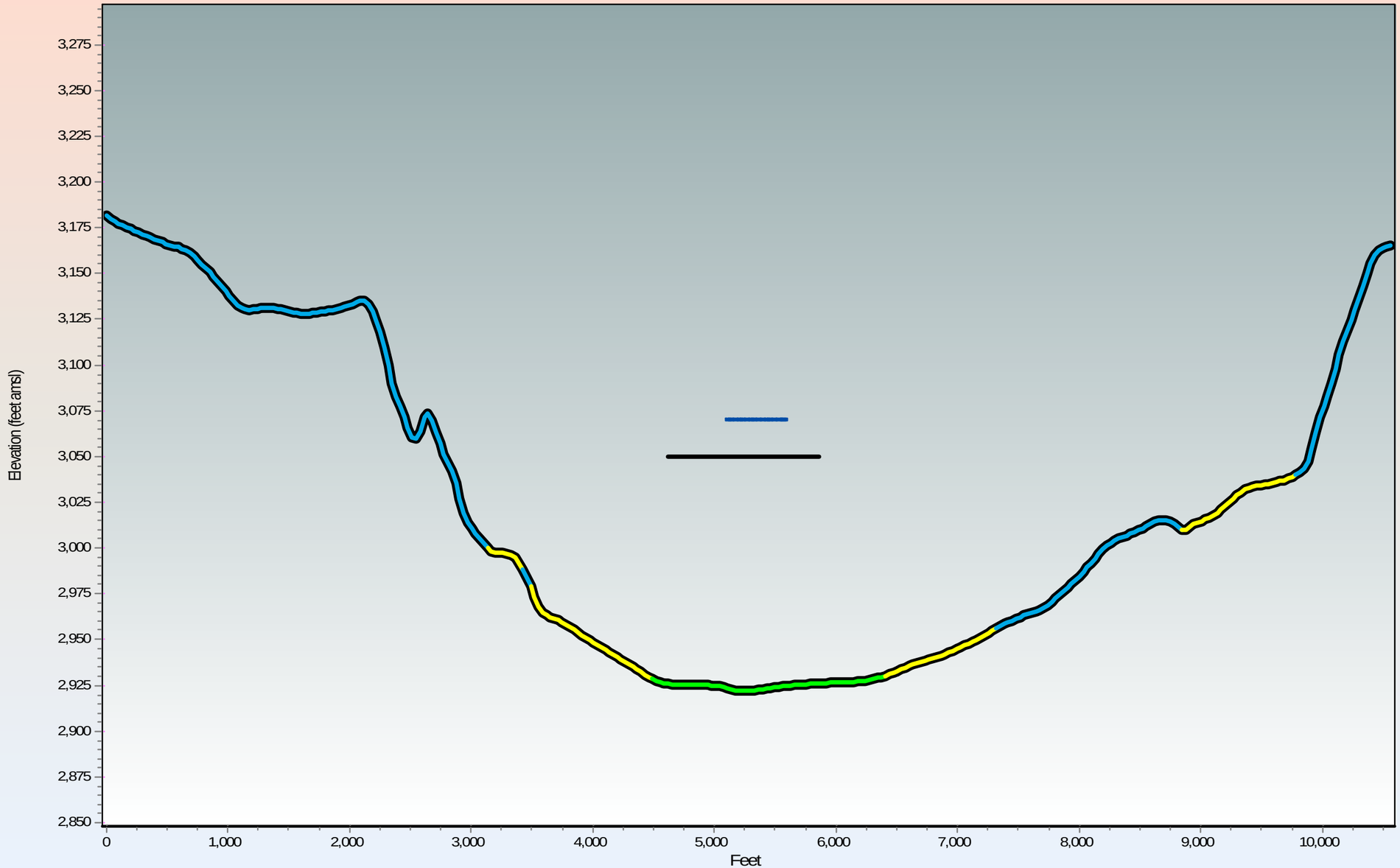
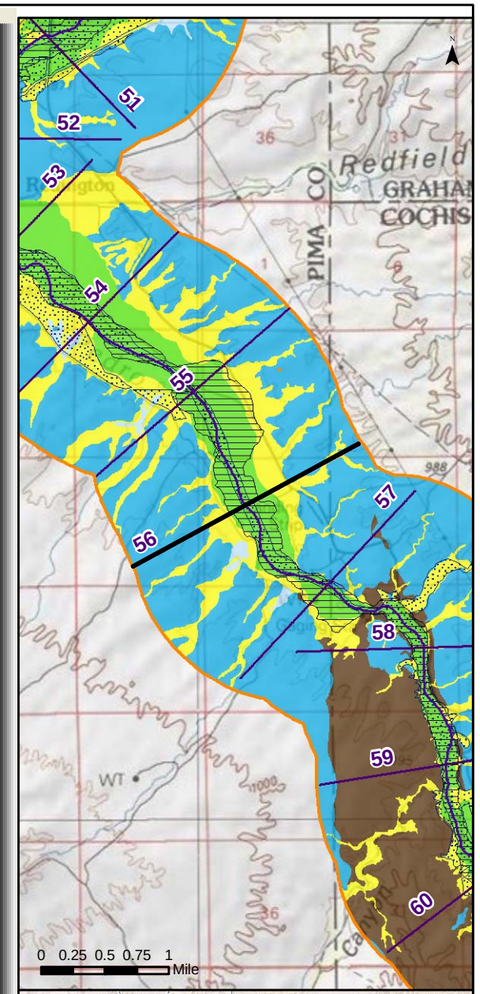
Appendix F

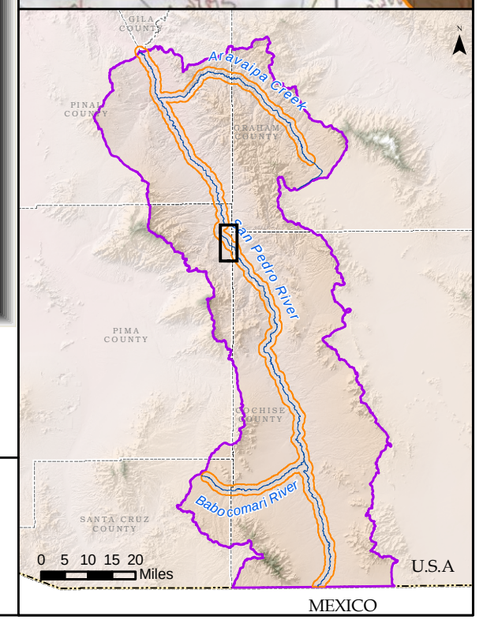
San Pedro River Cross Section at Mile 055

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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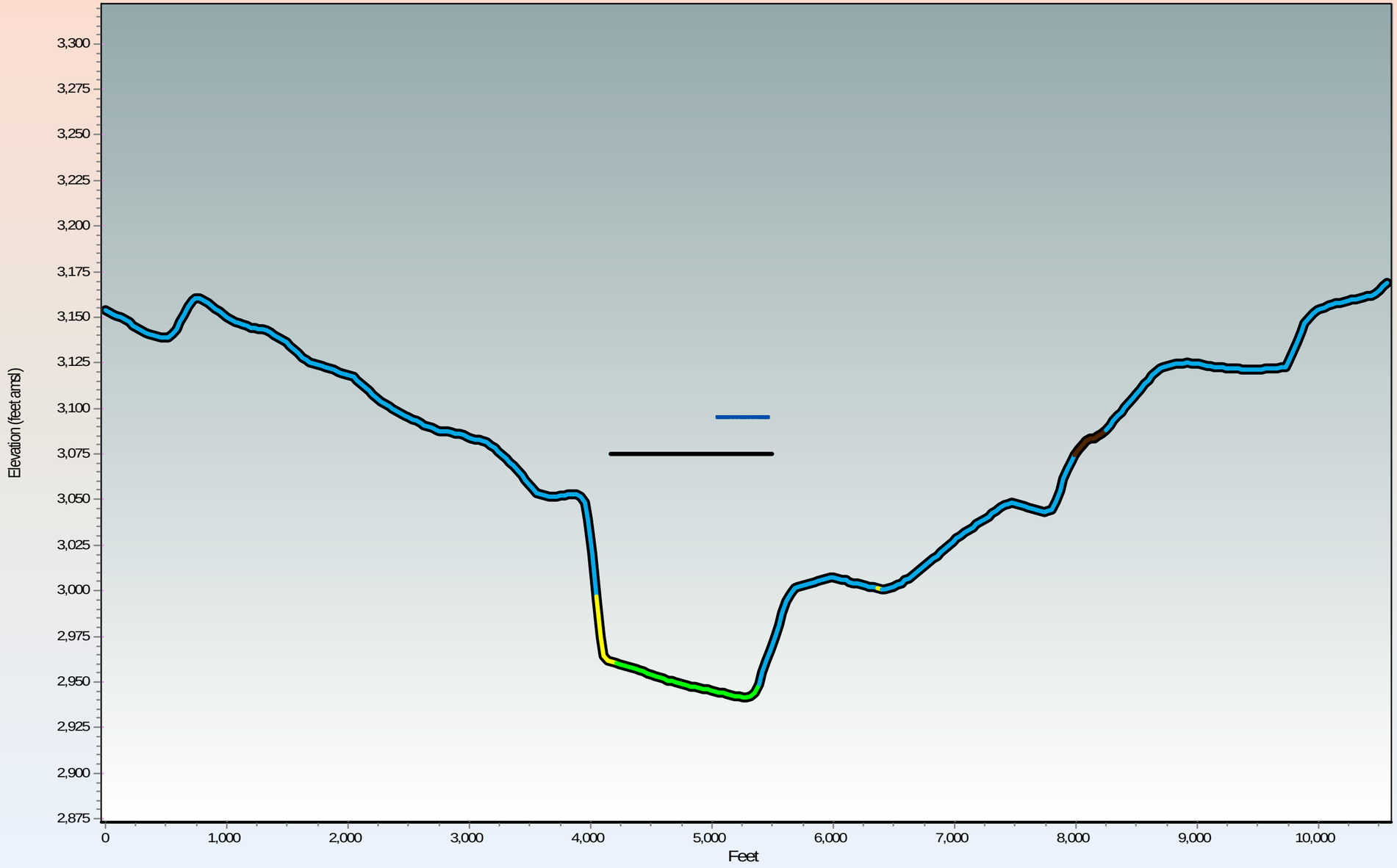
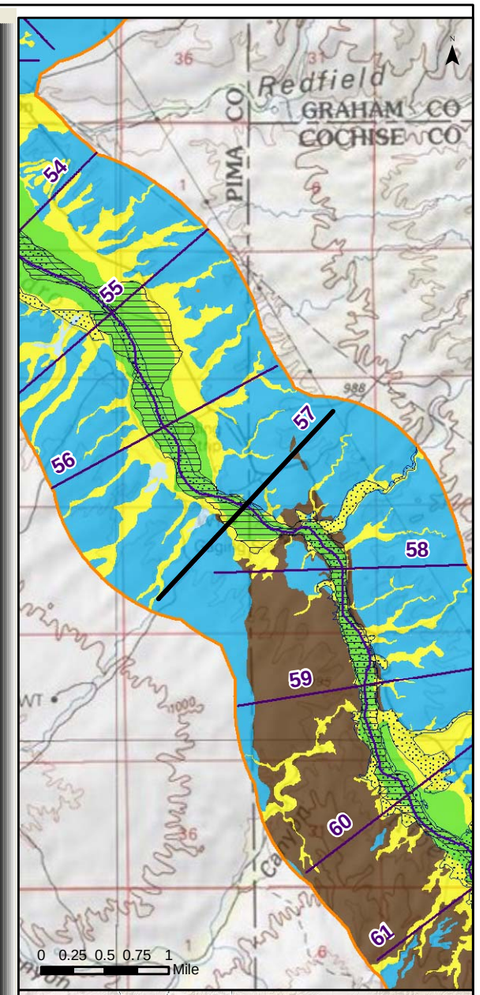
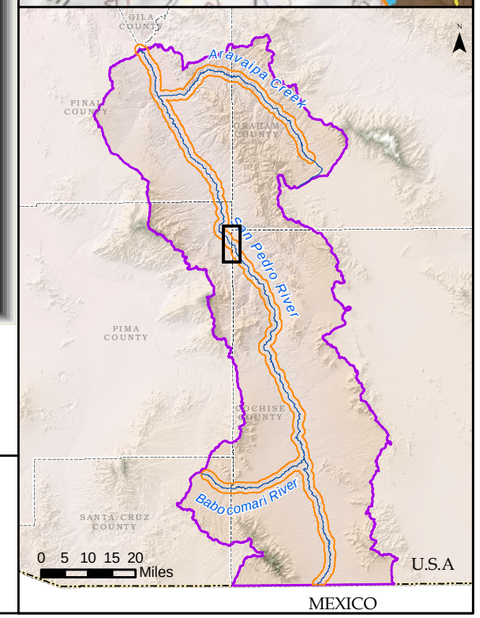
Appendix F
San Pedro River Cross Section at Mile 056
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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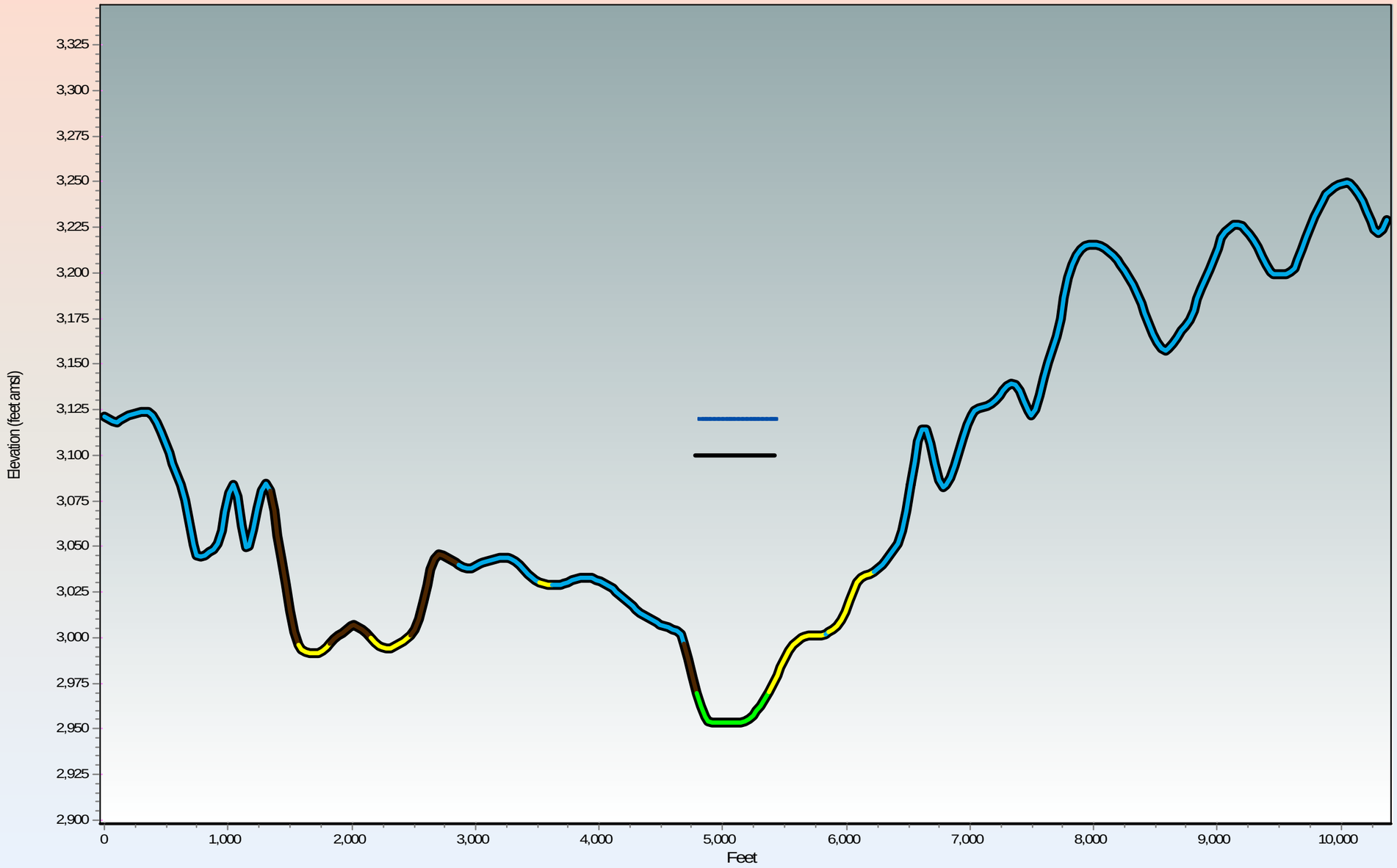
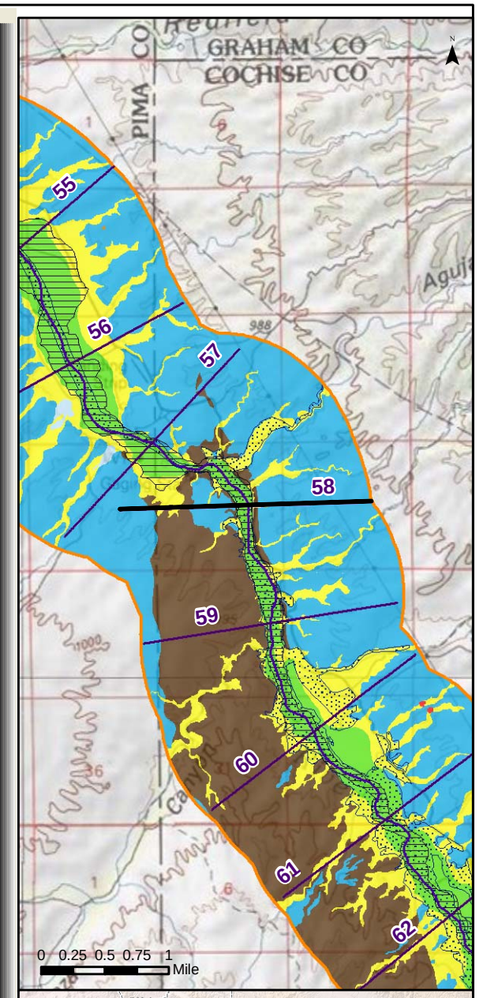
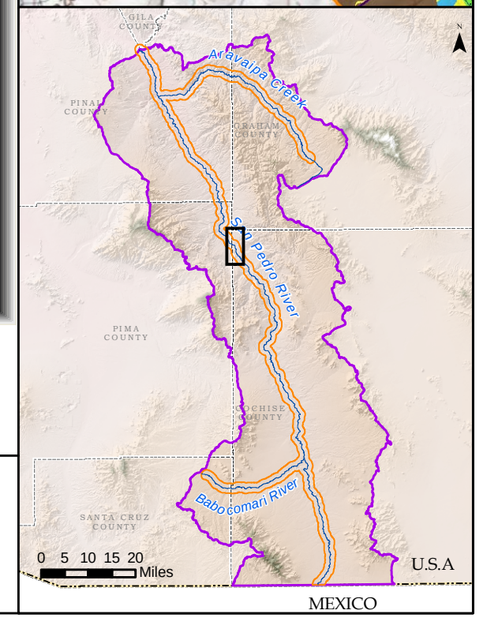
Appendix F
San Pedro River Cross Section at Mile 057
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Lateral extent of USFWS Riparian Area/Wetland

Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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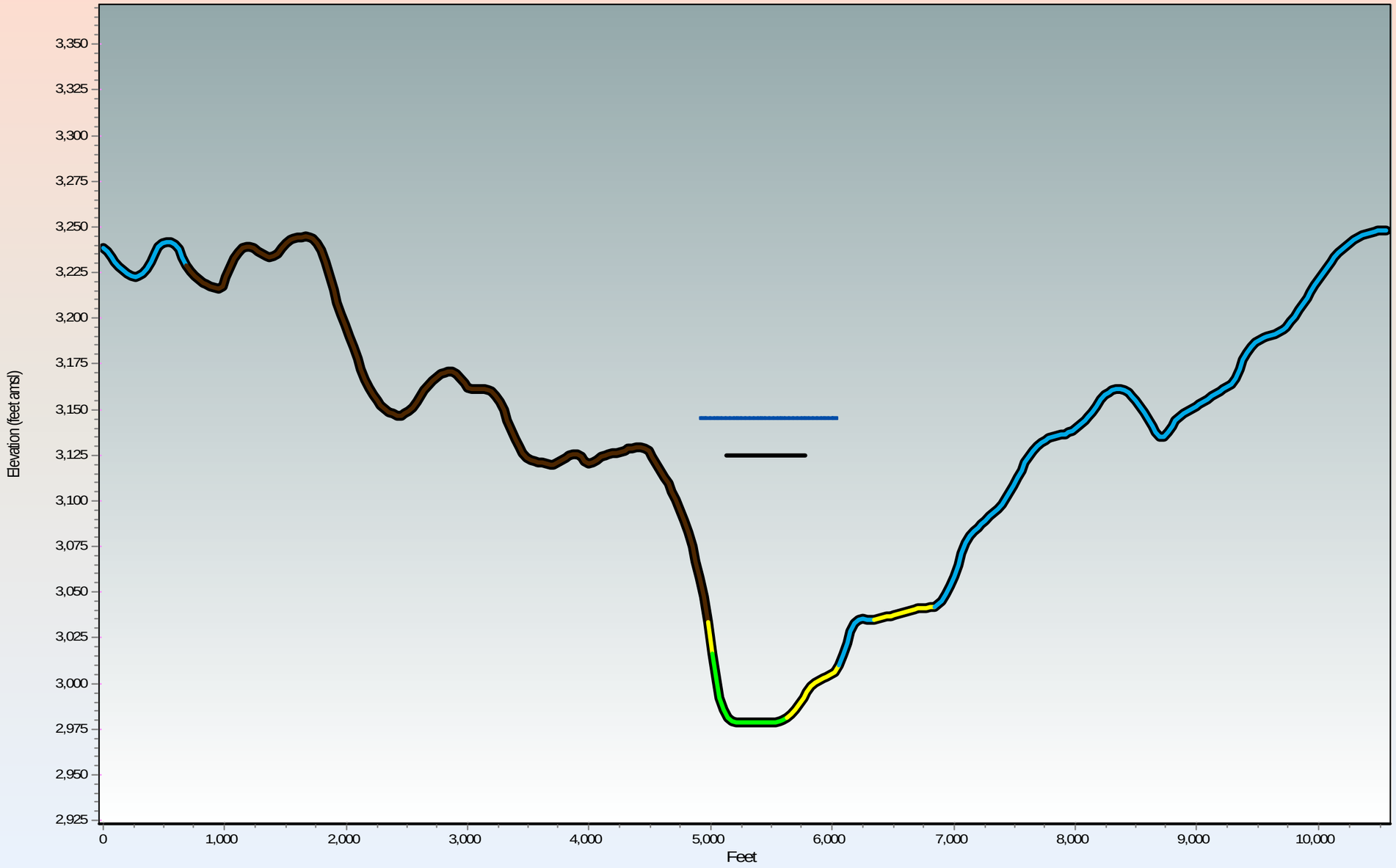
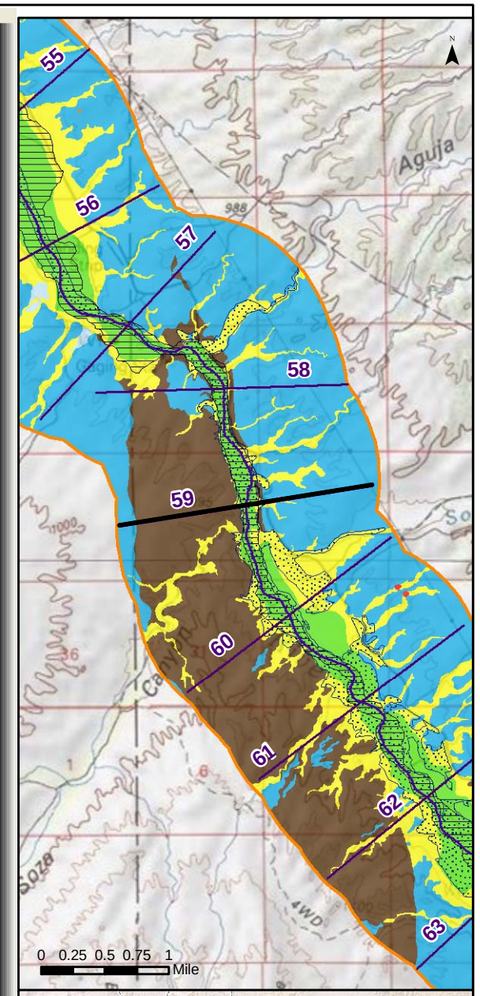
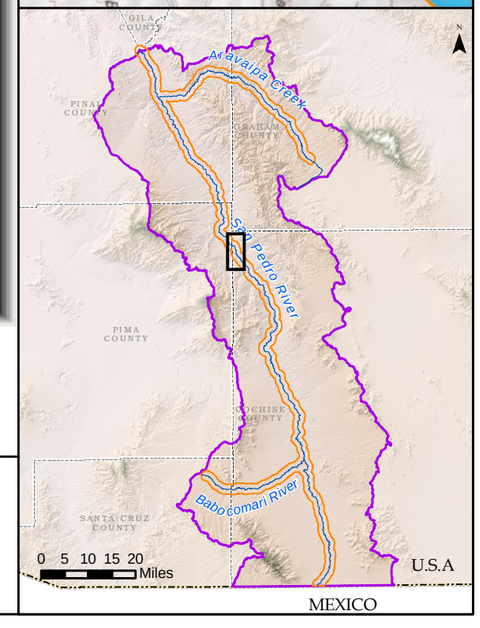
Appendix F
San Pedro River Cross Section at Mile 058
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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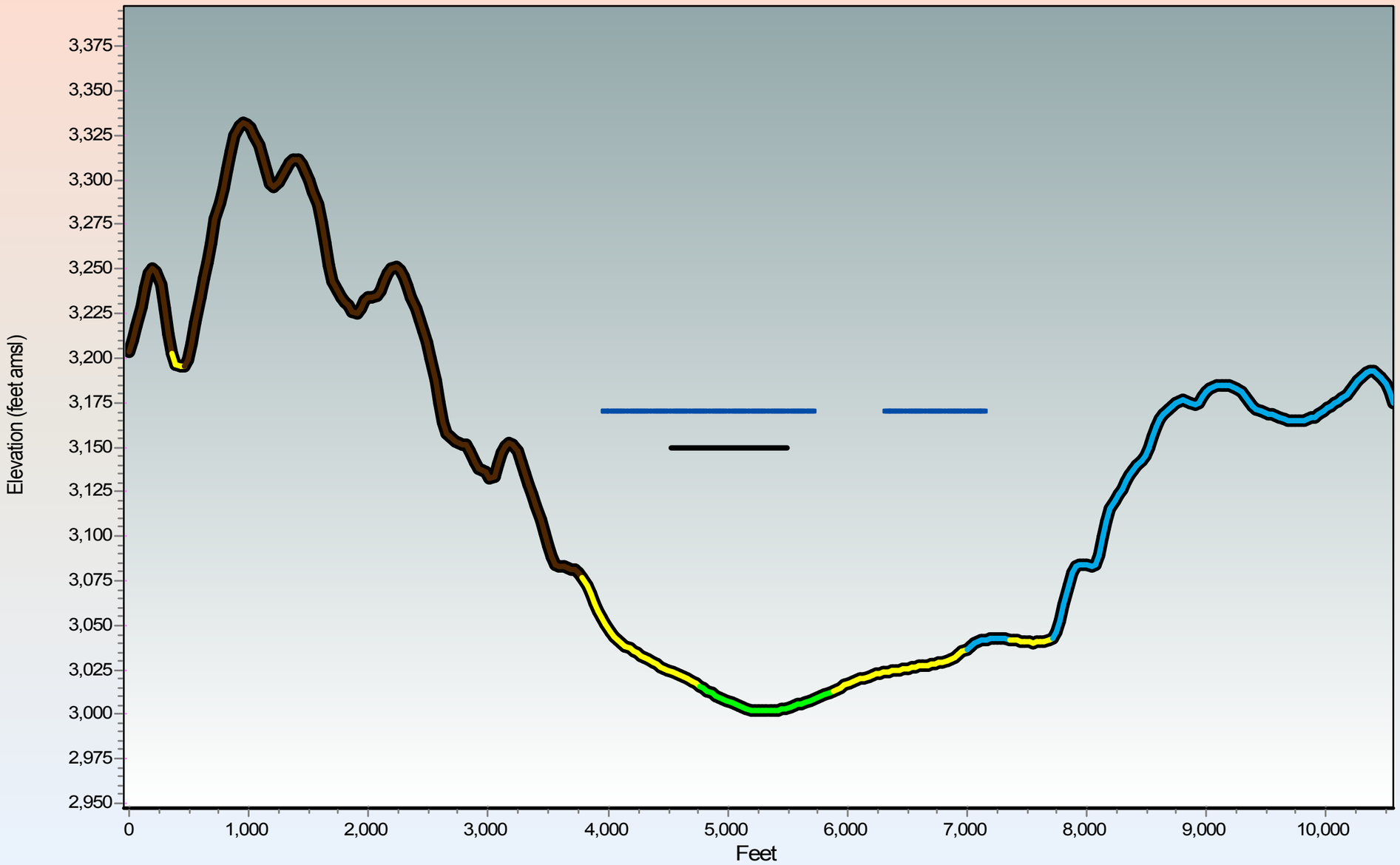
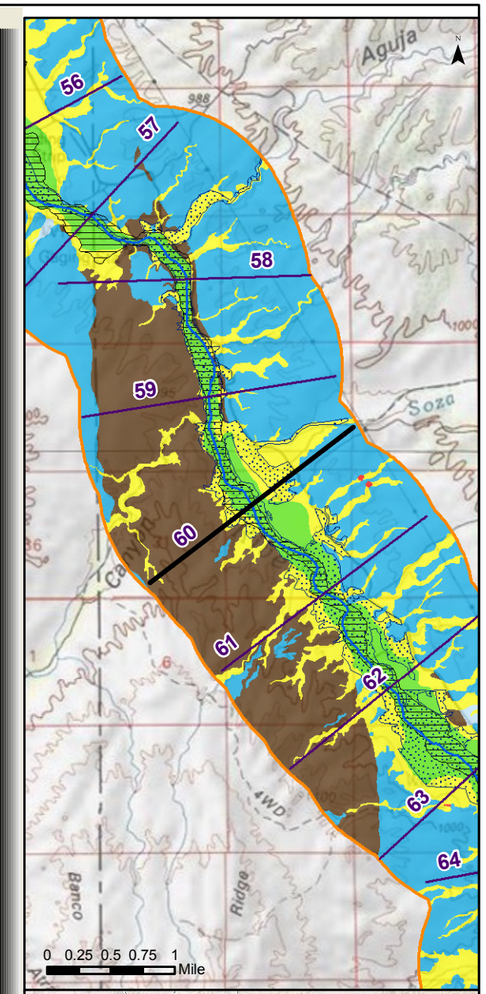
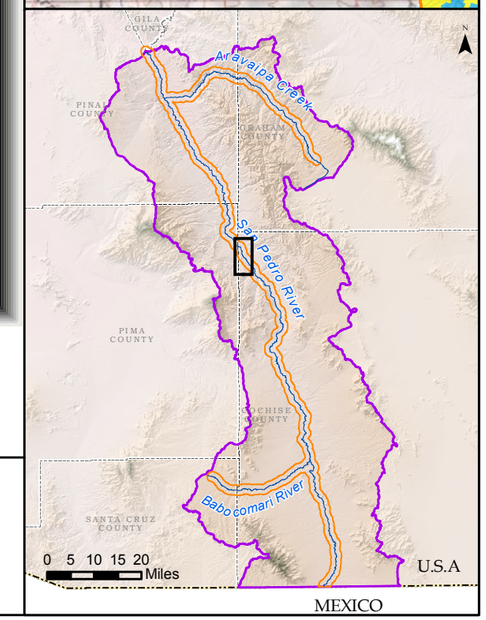
Appendix F
San Pedro River Cross Section at Mile 059
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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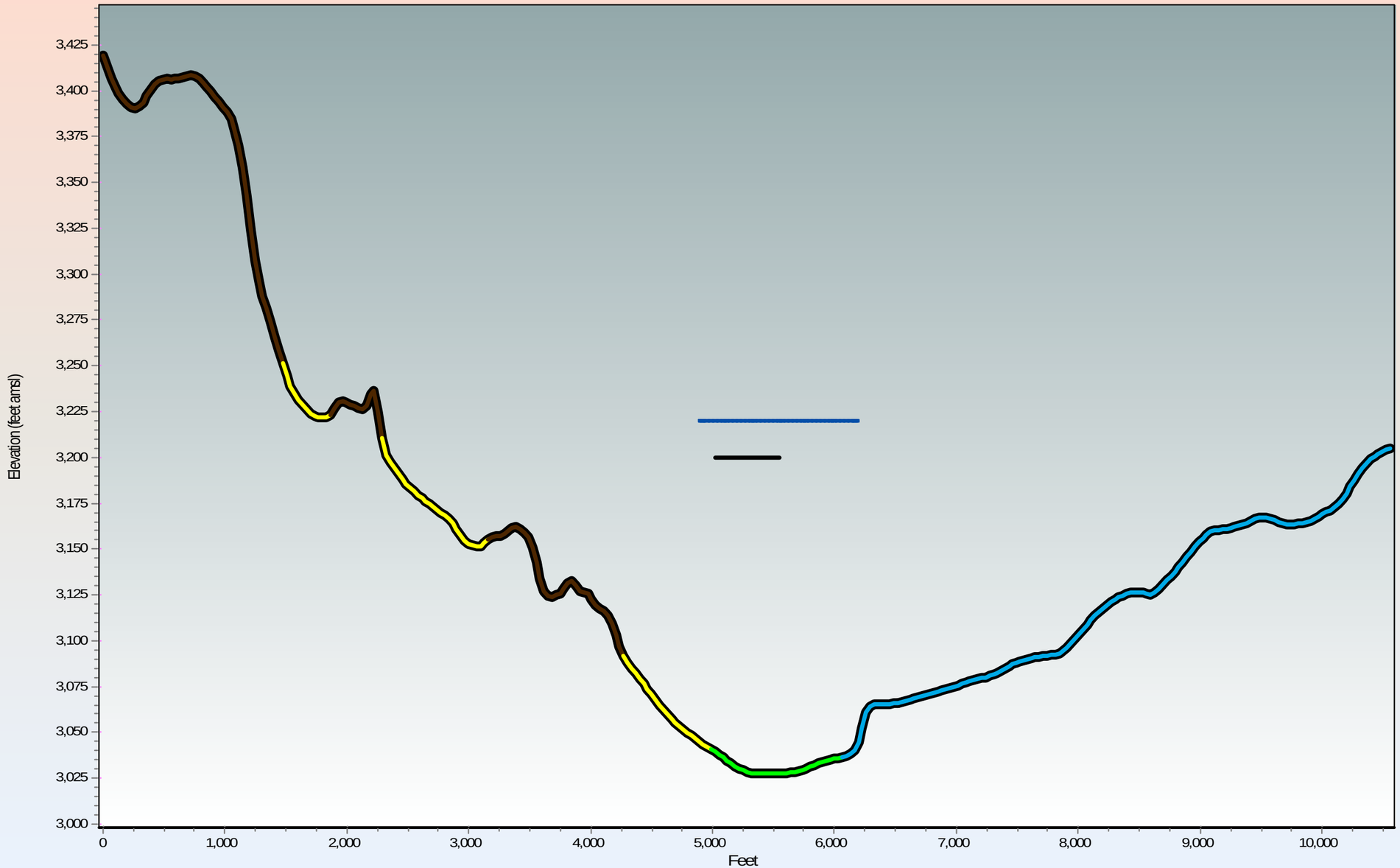
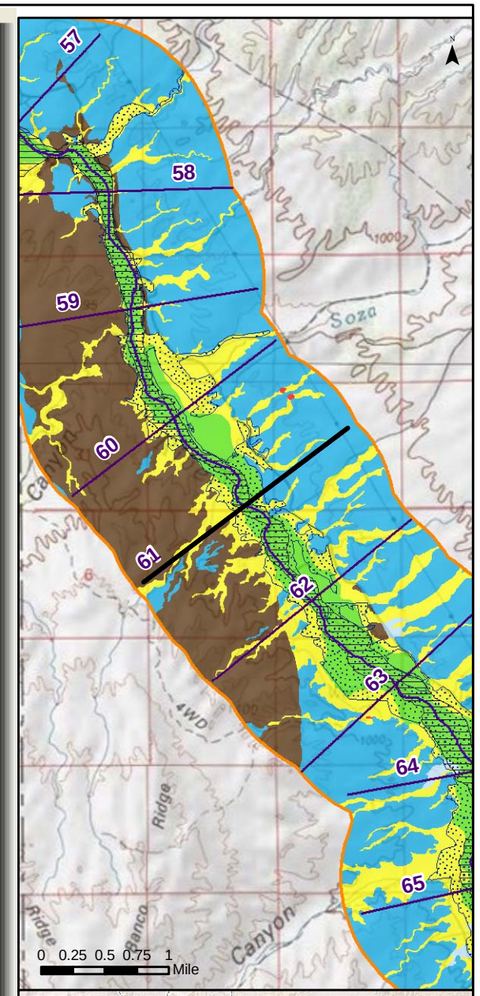
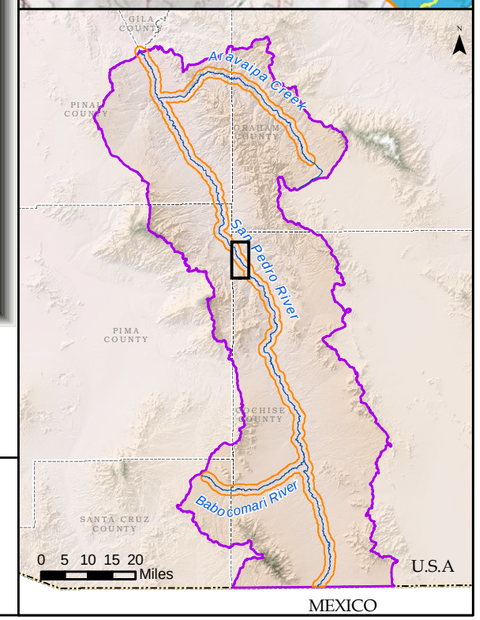
Appendix F
San Pedro River Cross Section at Mile 060
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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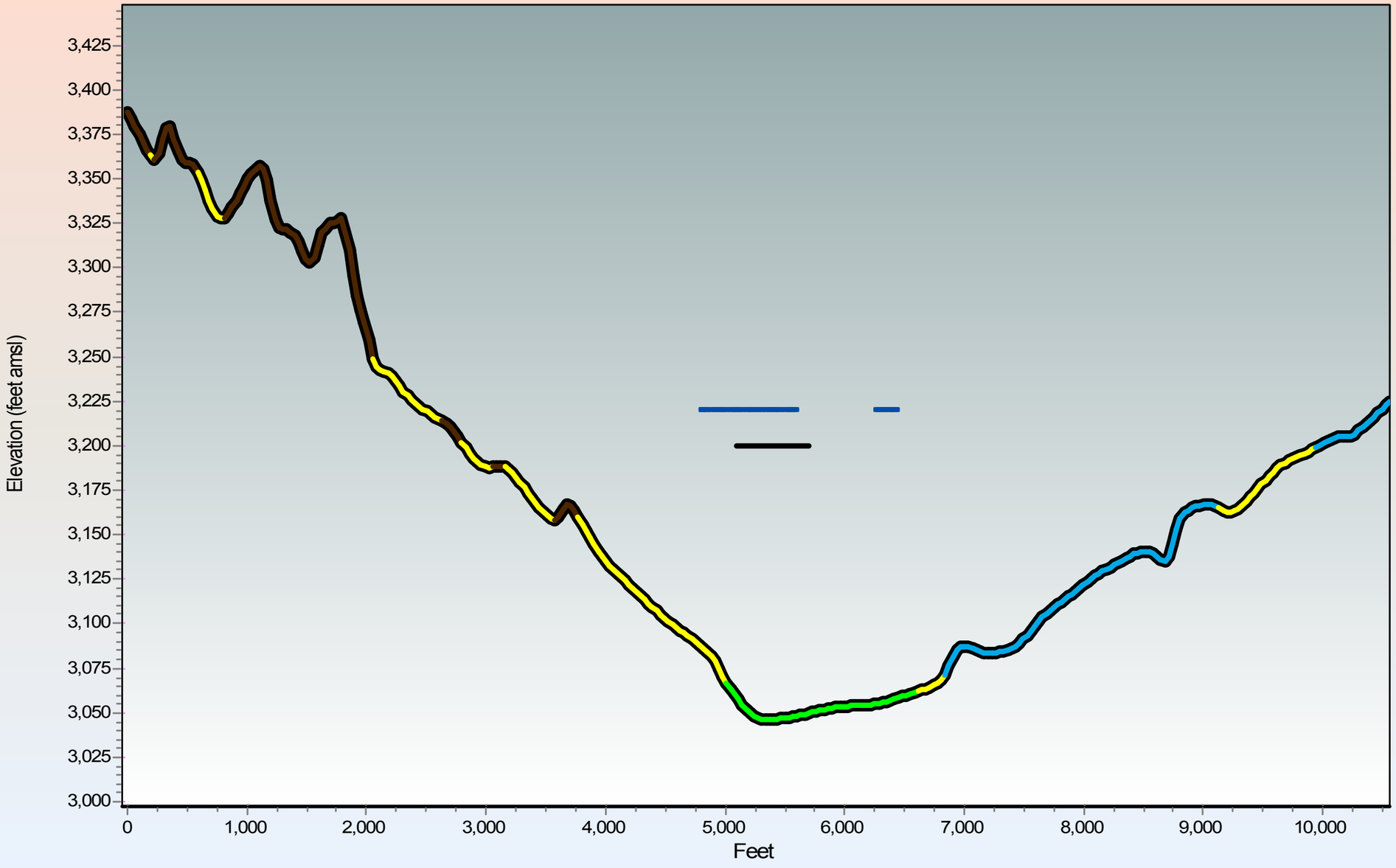
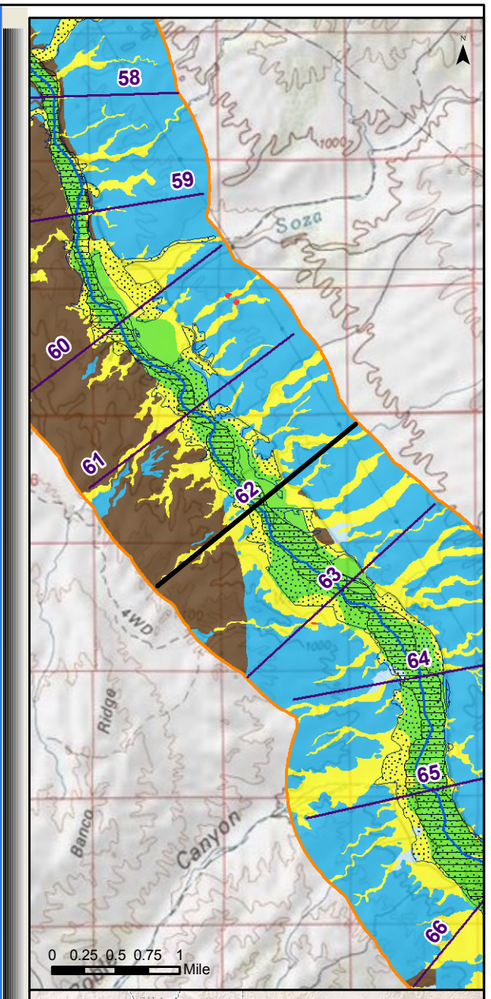
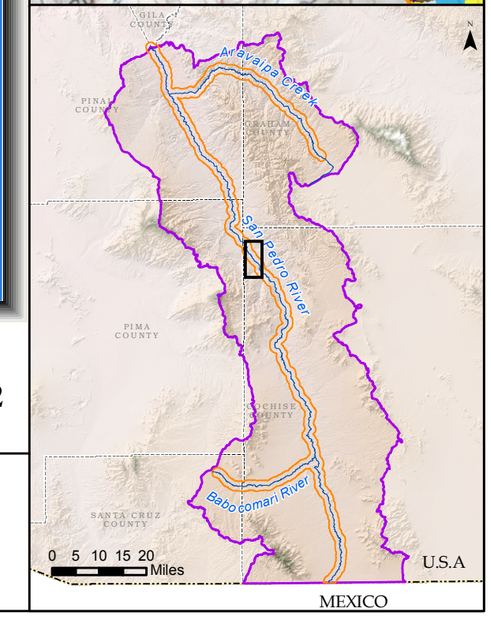
Appendix F
San Pedro River Cross Section at Mile 061
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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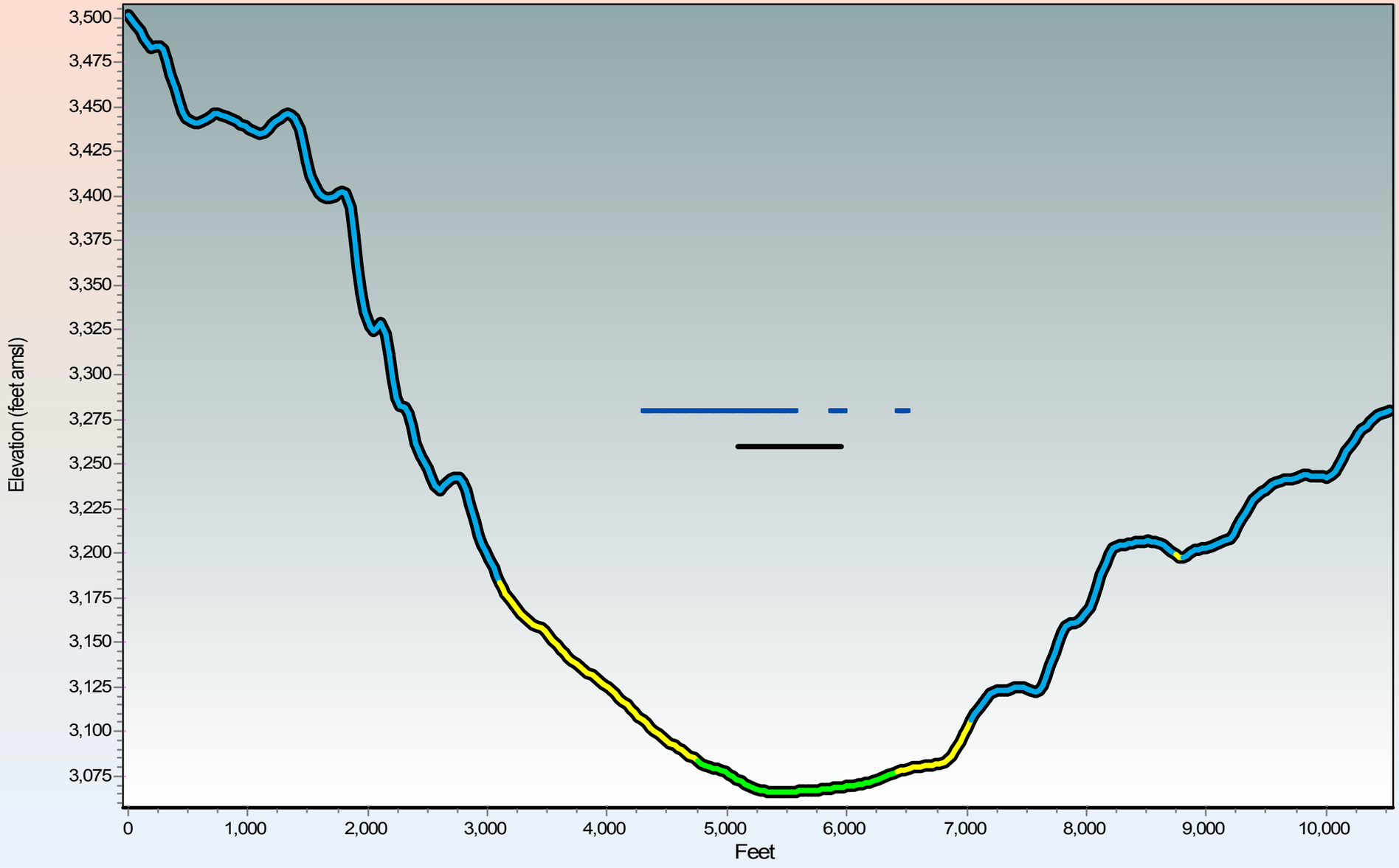
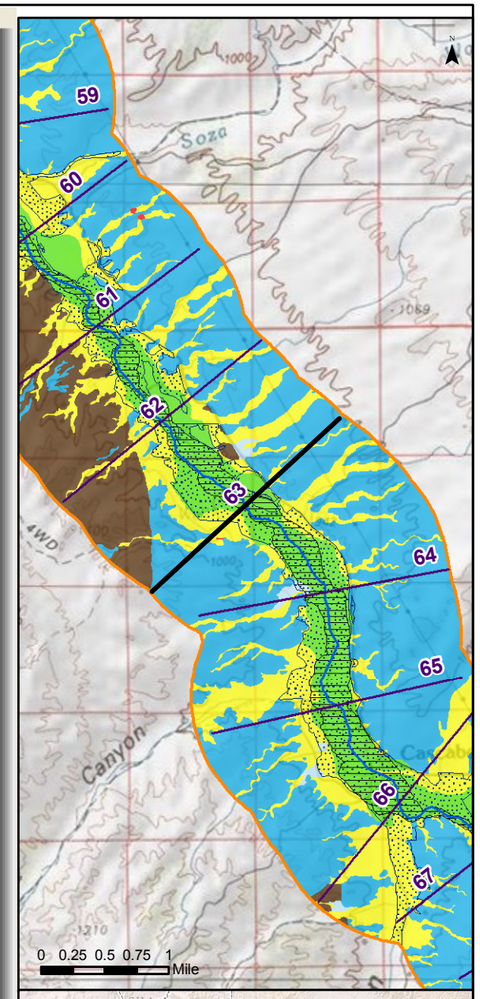
Appendix F

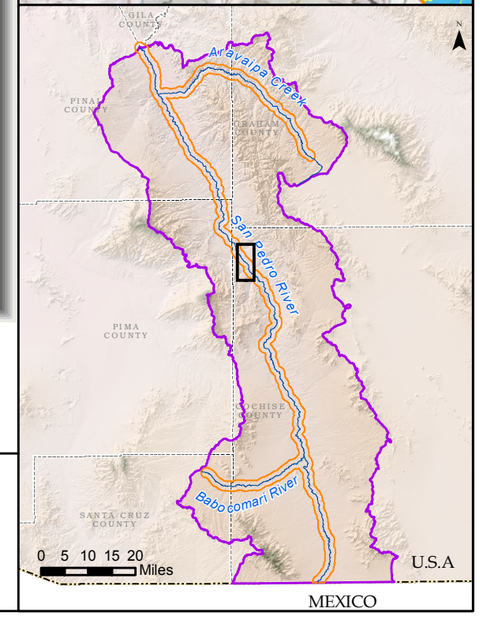
San Pedro River Cross Section at Mile 062

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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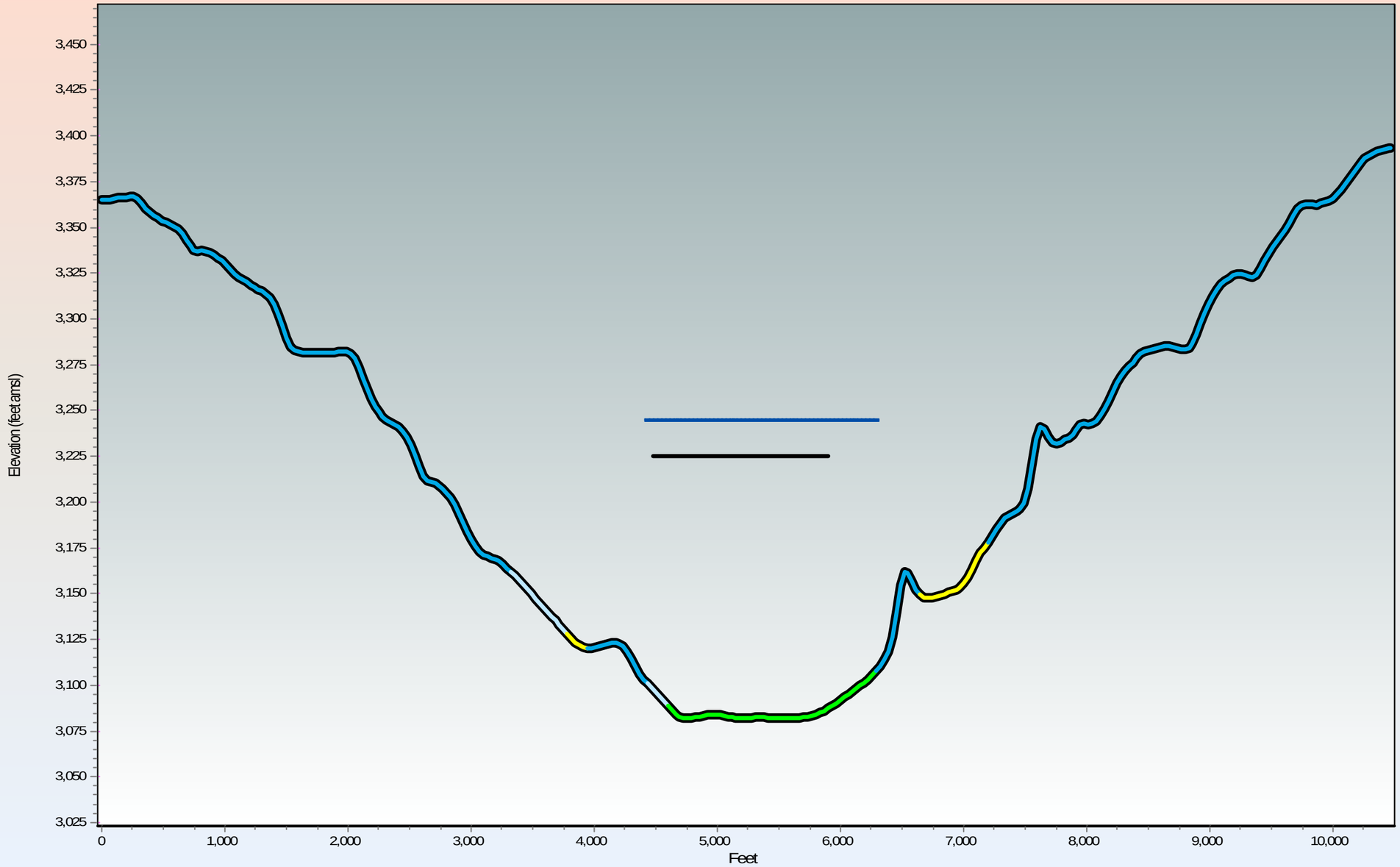
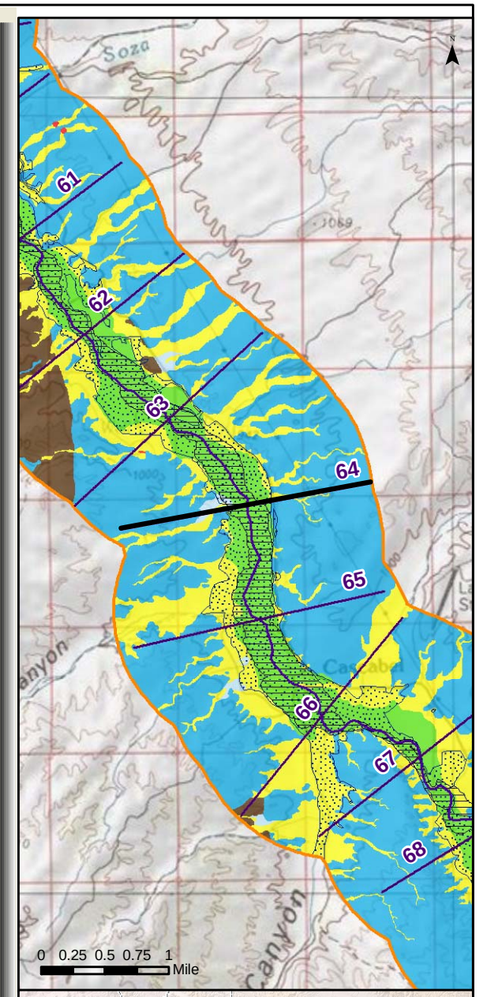
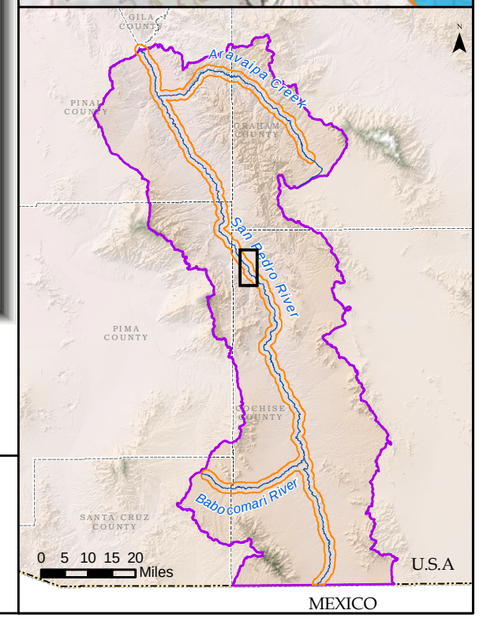
Appendix F
San Pedro River Cross Section at Mile 063
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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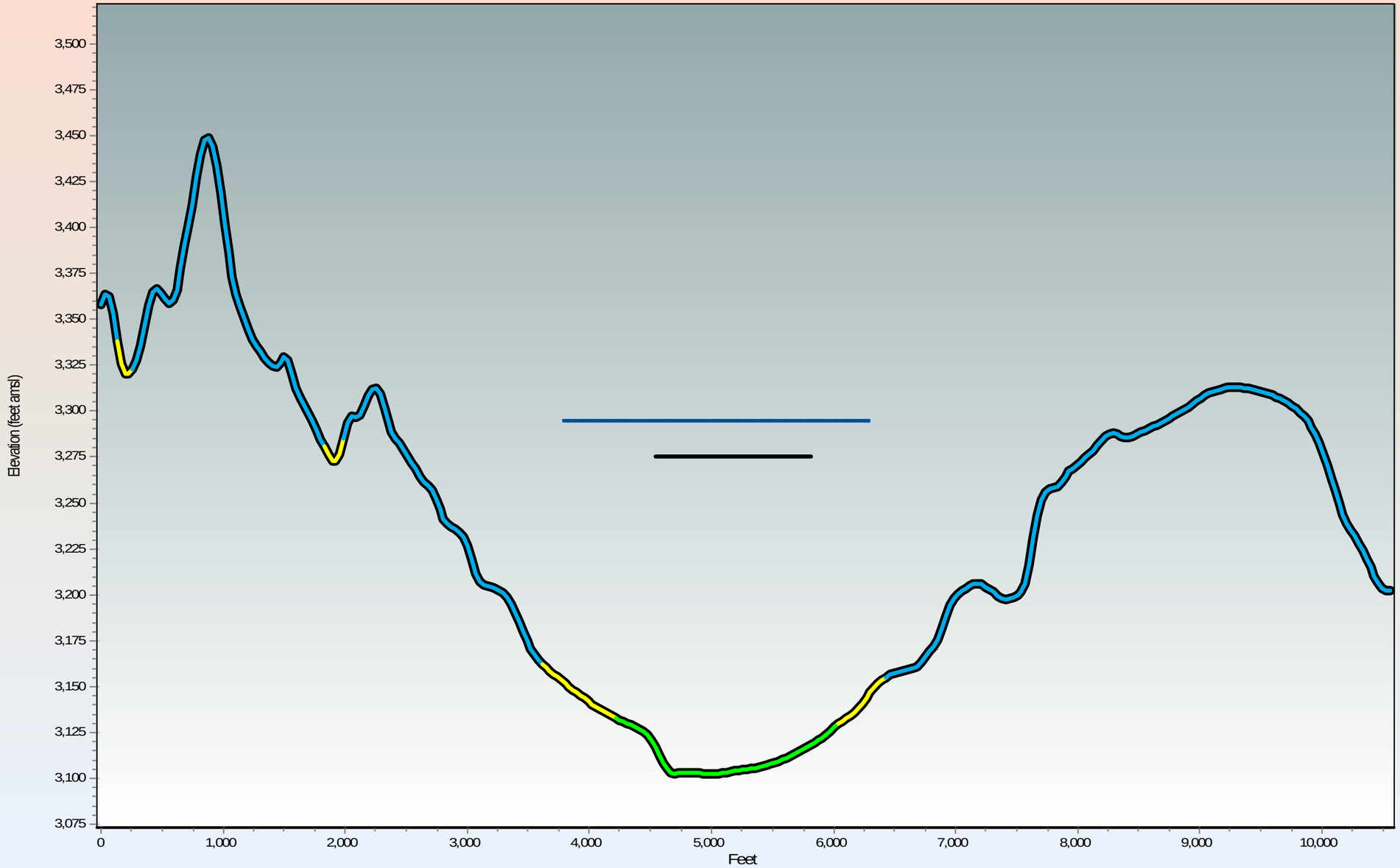
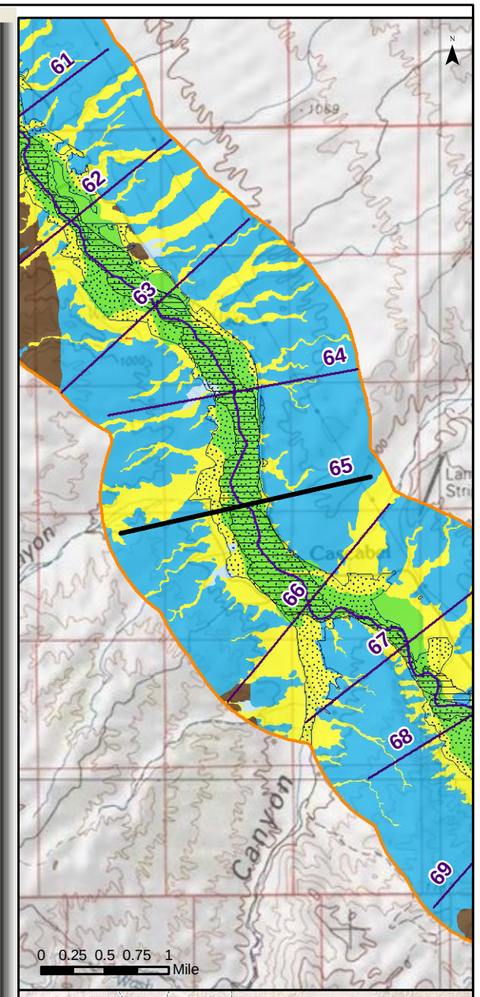
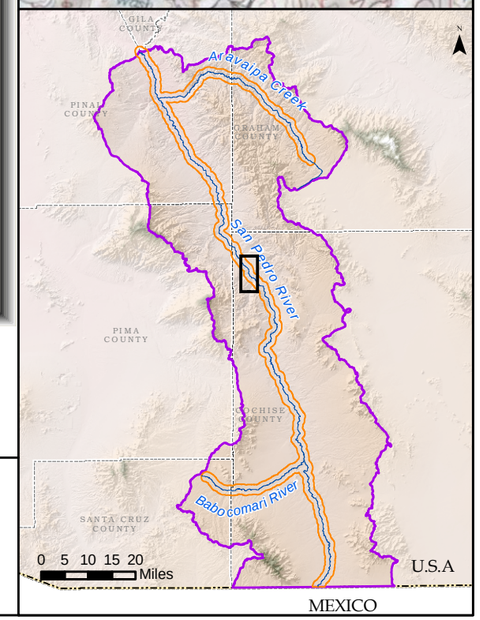
Appendix F
San Pedro River Cross Section at Mile 064
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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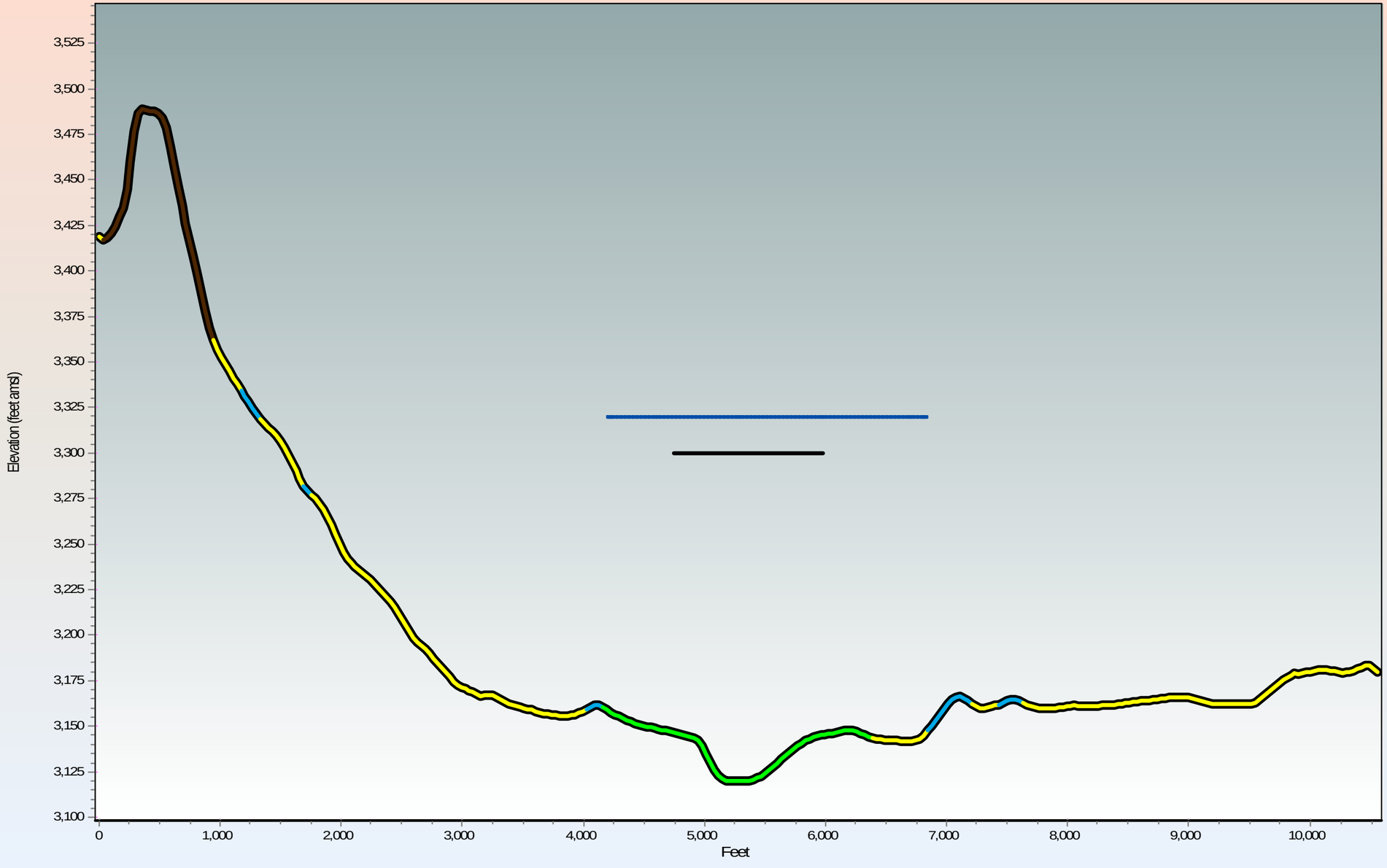
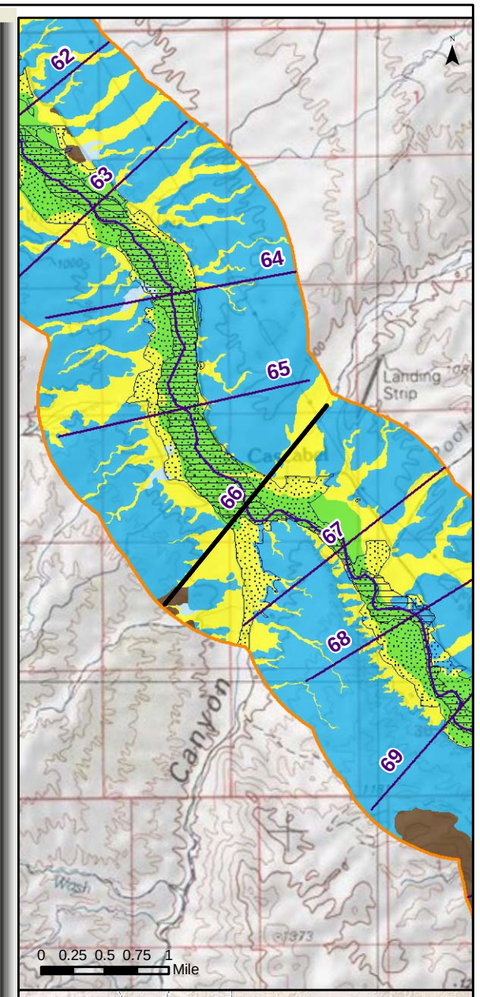
Appendix F

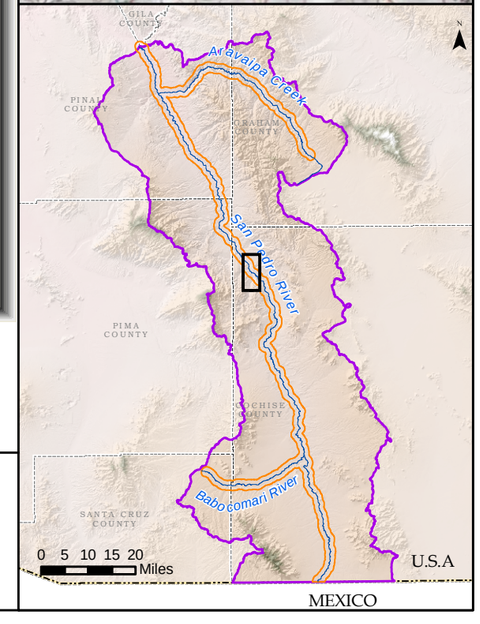
San Pedro River Cross Section at Mile 065

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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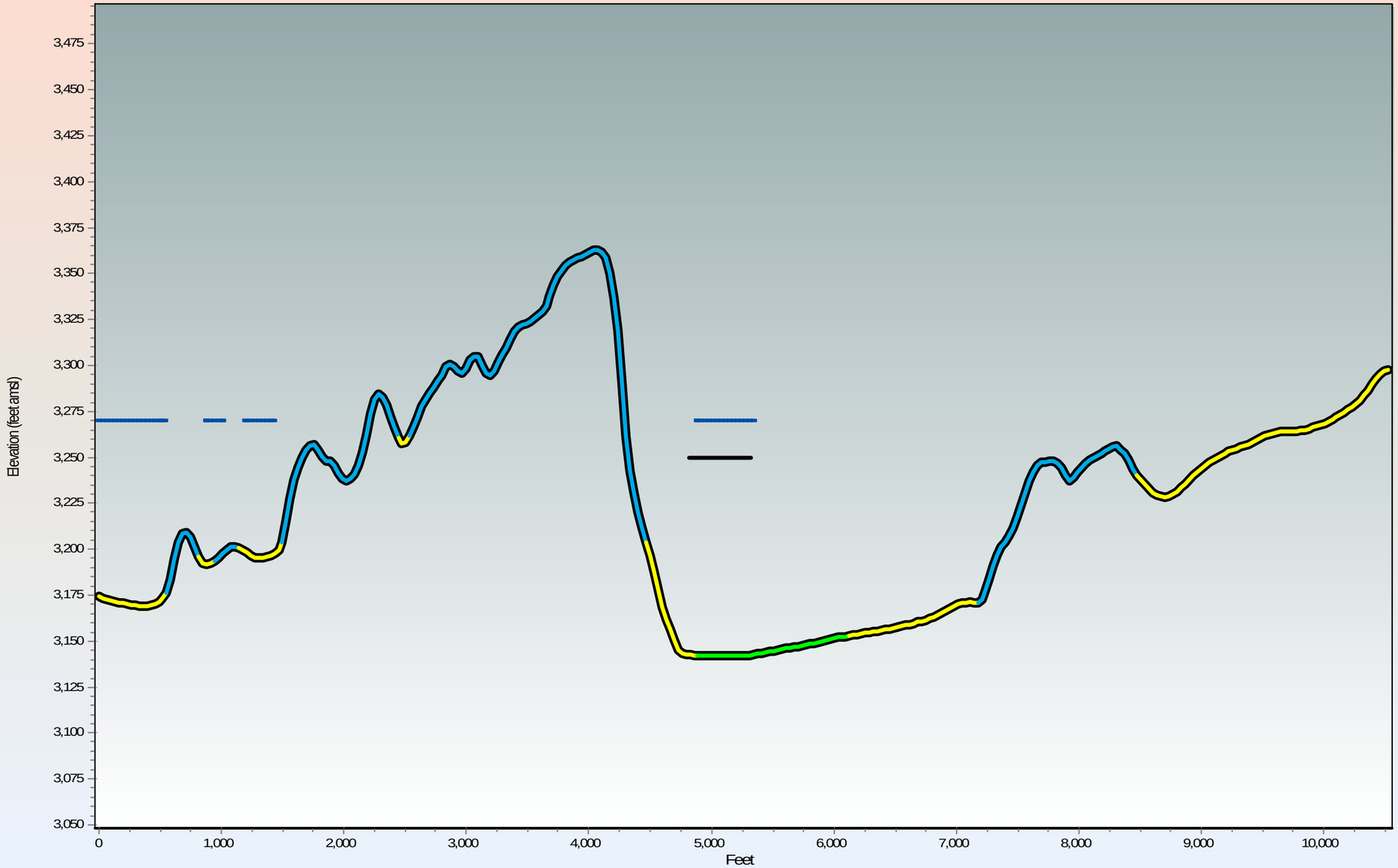
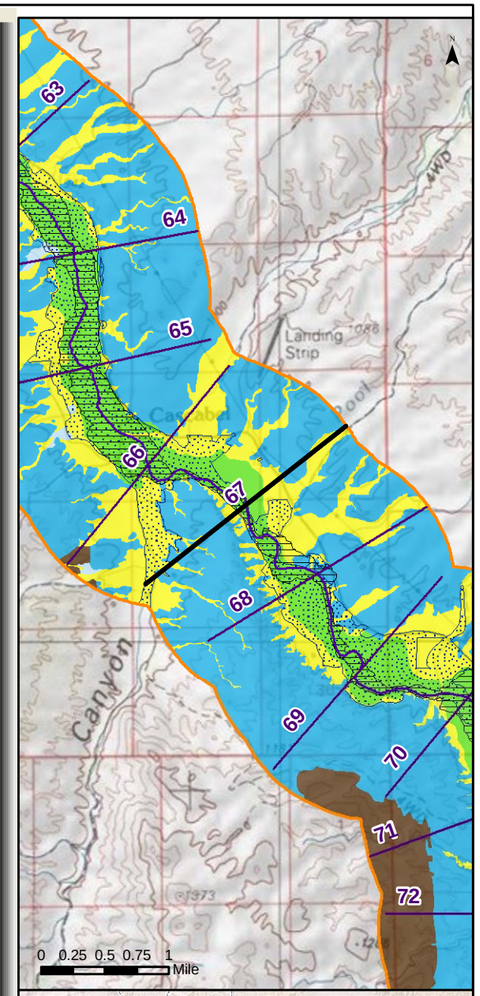
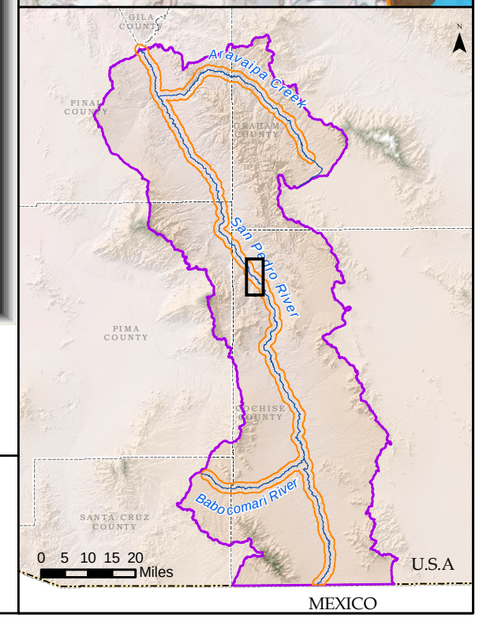
Appendix F
San Pedro River Cross Section at Mile 066
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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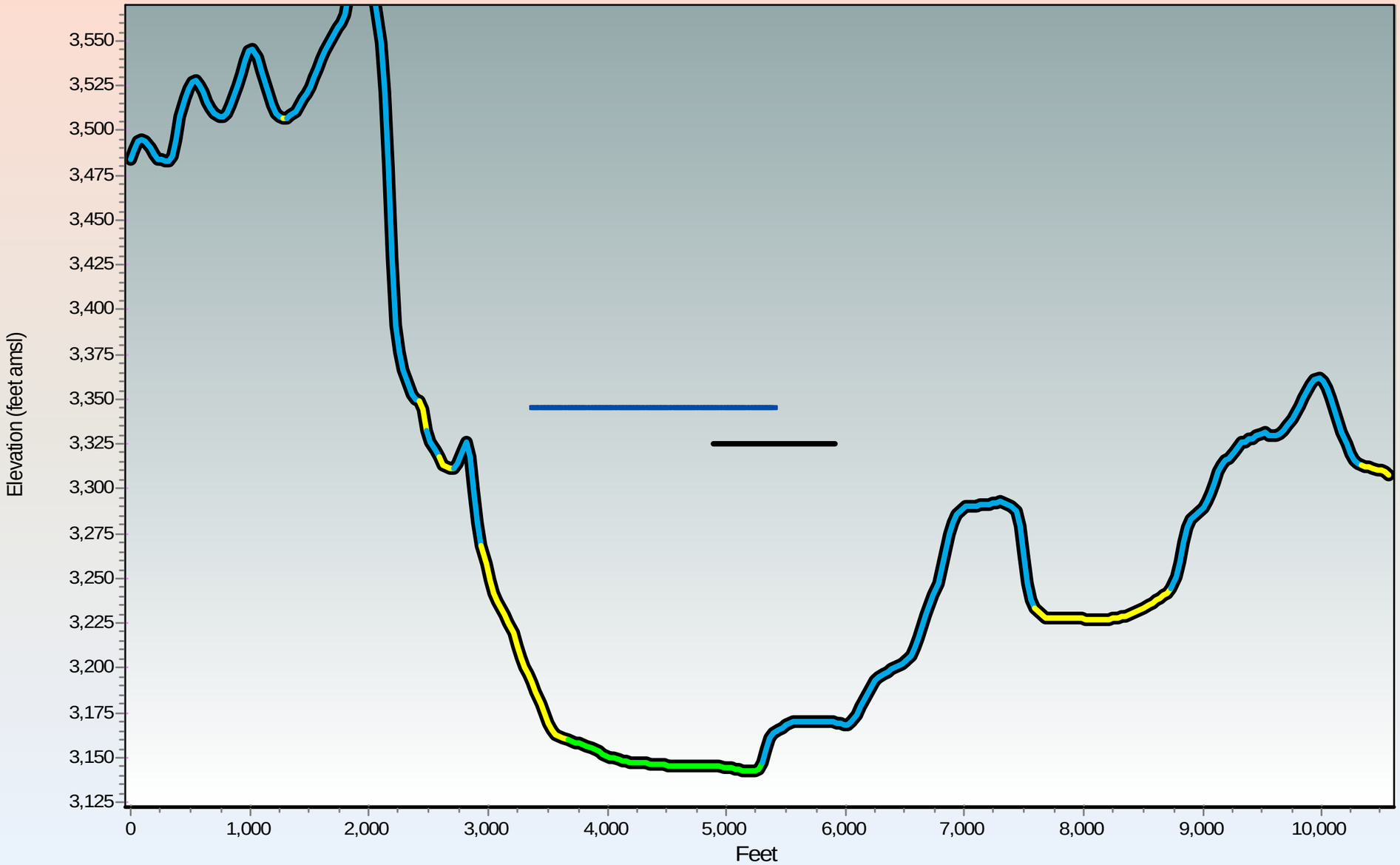
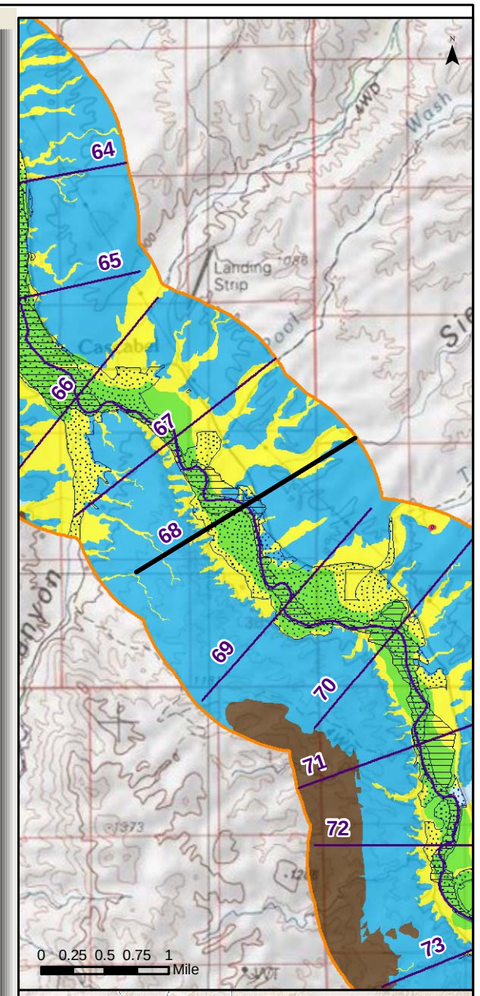
Appendix F

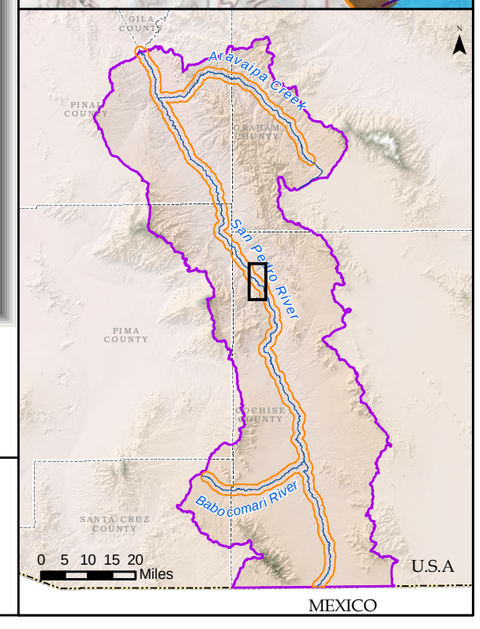
San Pedro River Cross Section at Mile 067

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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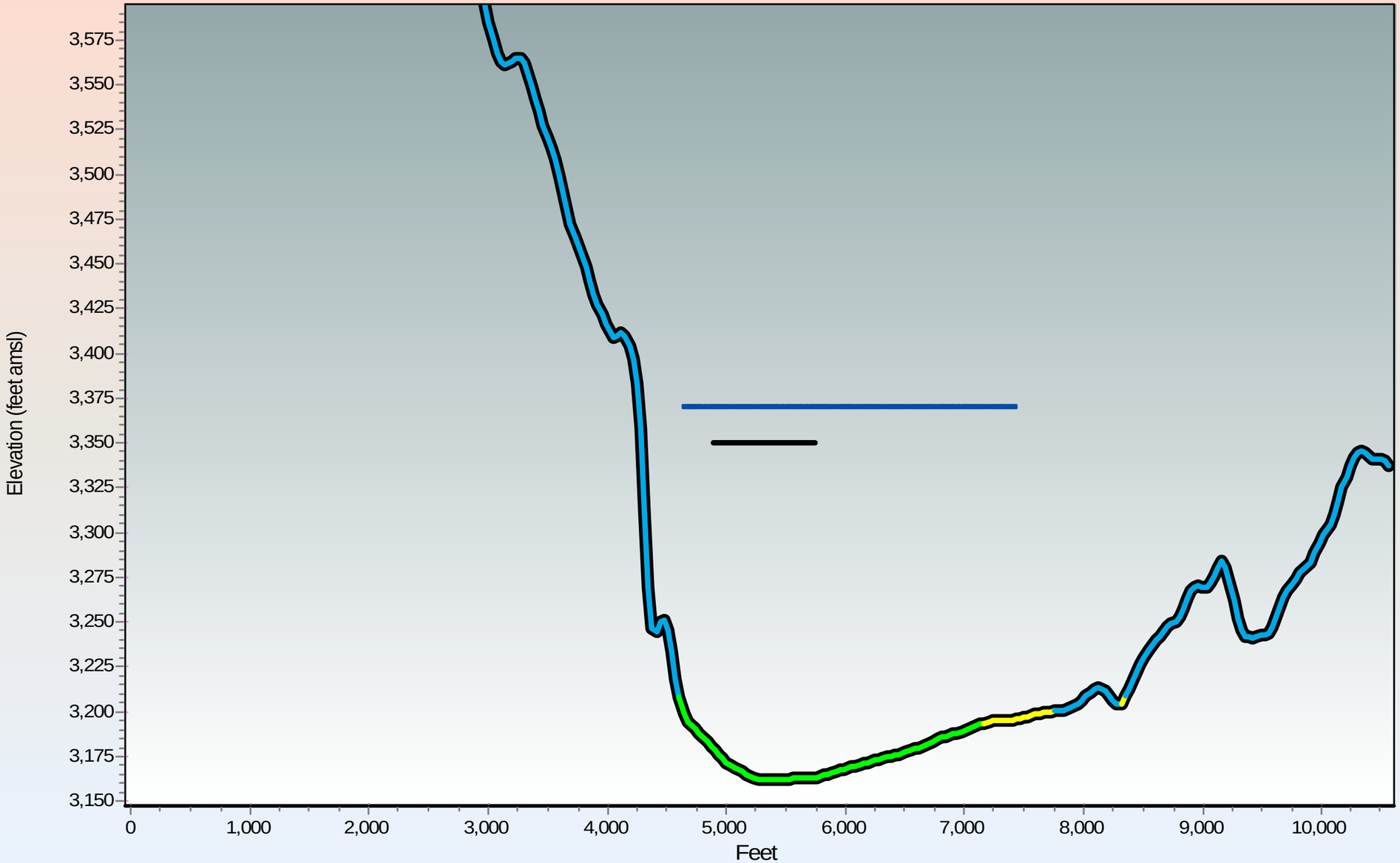
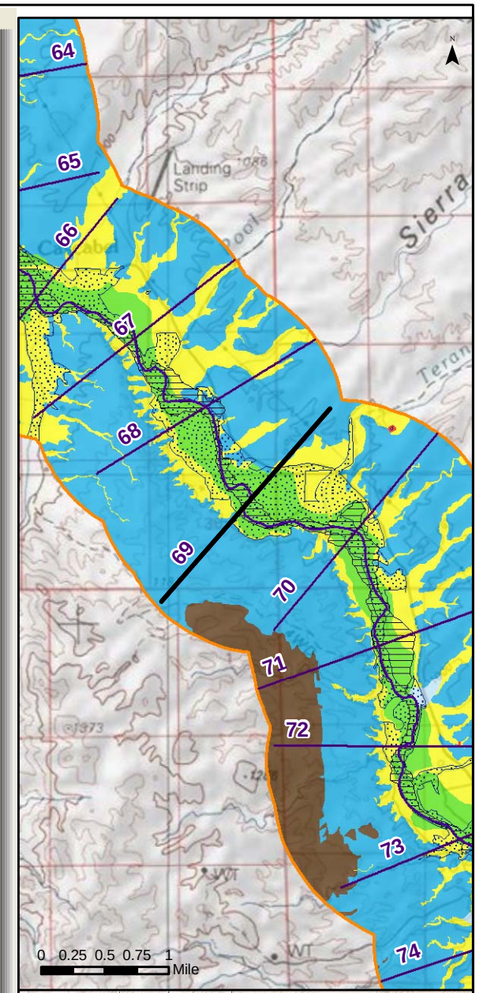
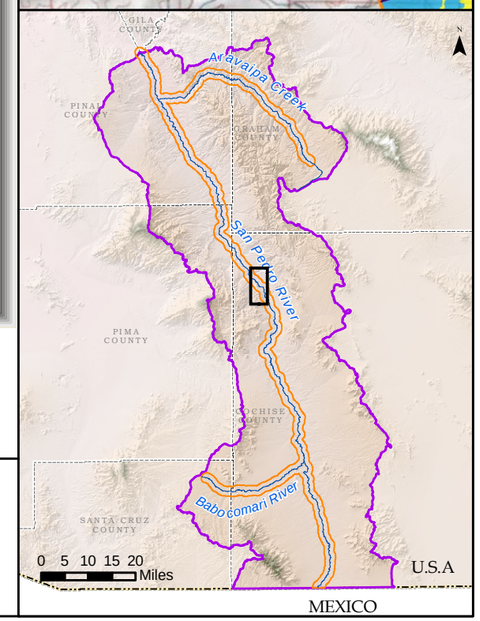
Appendix F
San Pedro River Cross Section at Mile 068
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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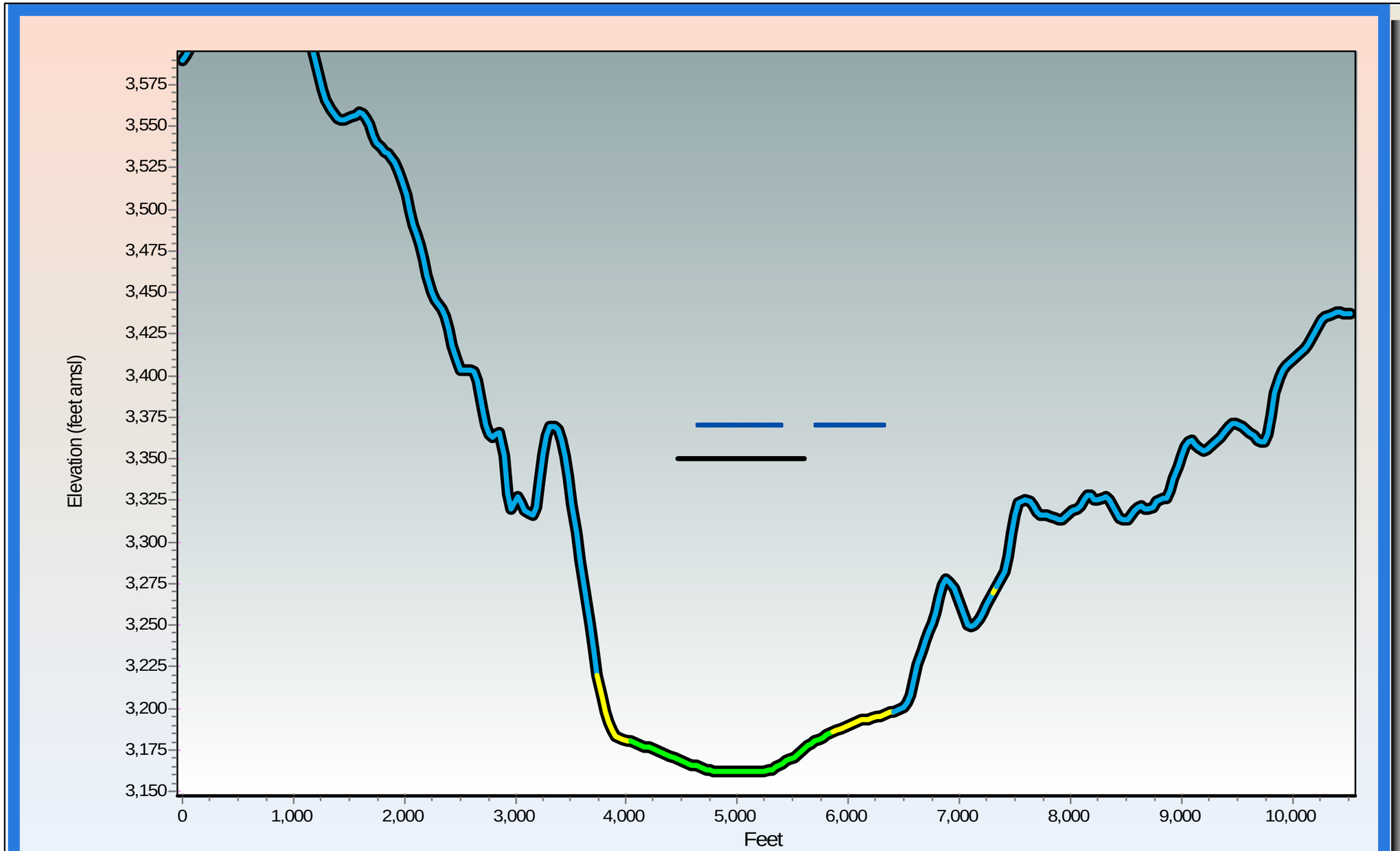
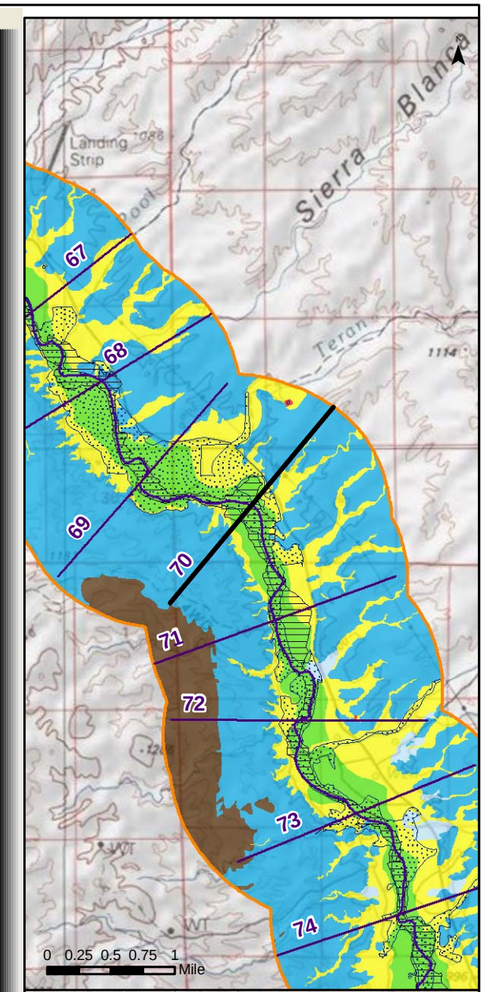
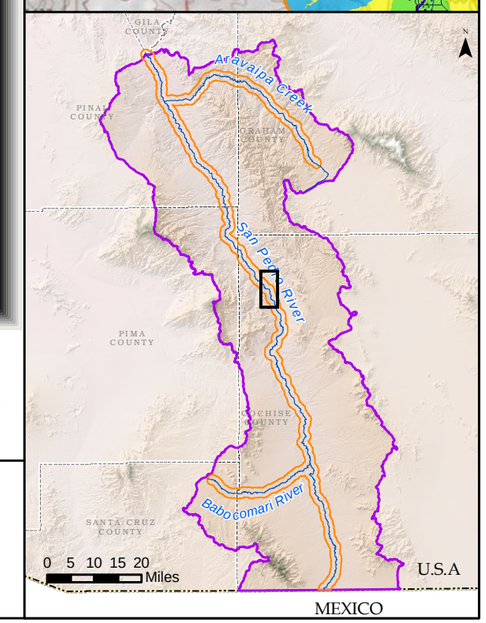
Appendix F
San Pedro River Cross Section at Mile 069
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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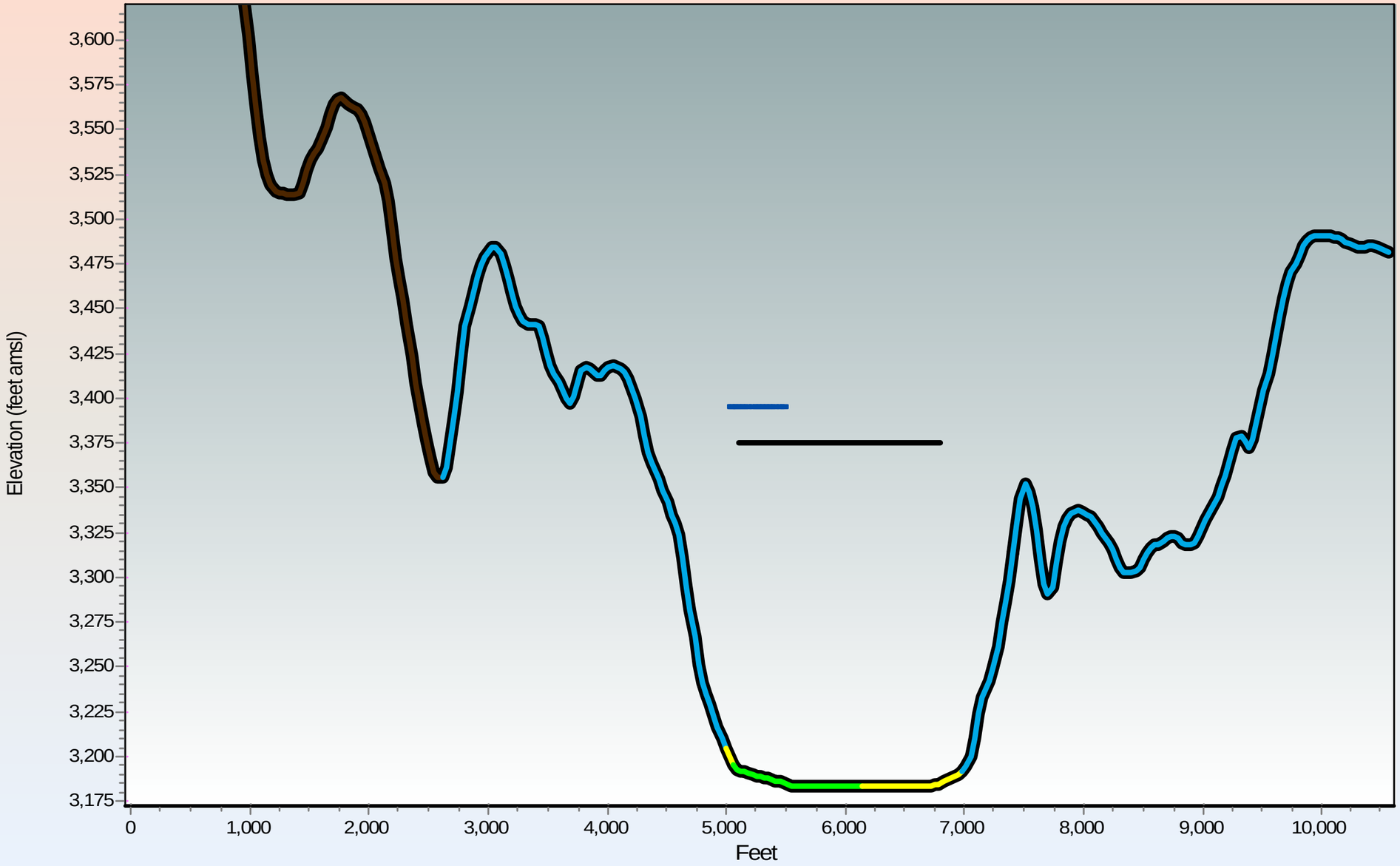
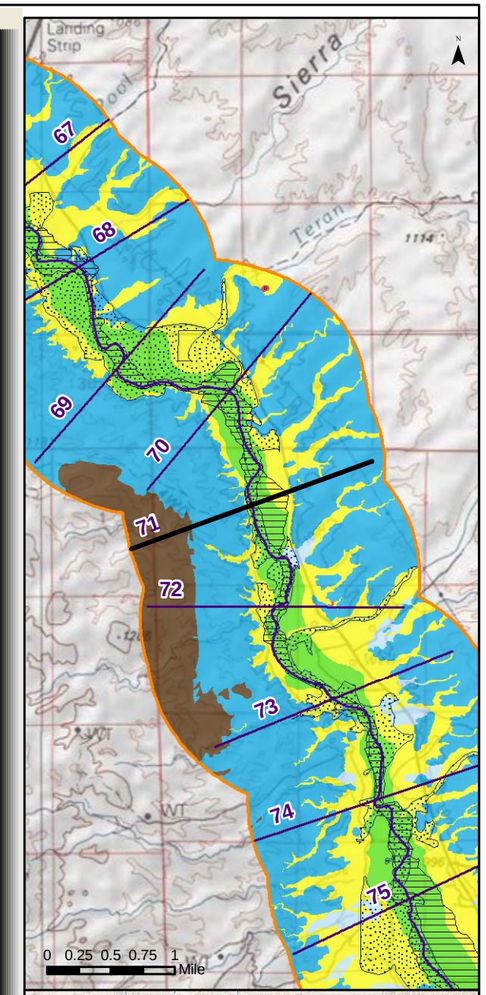
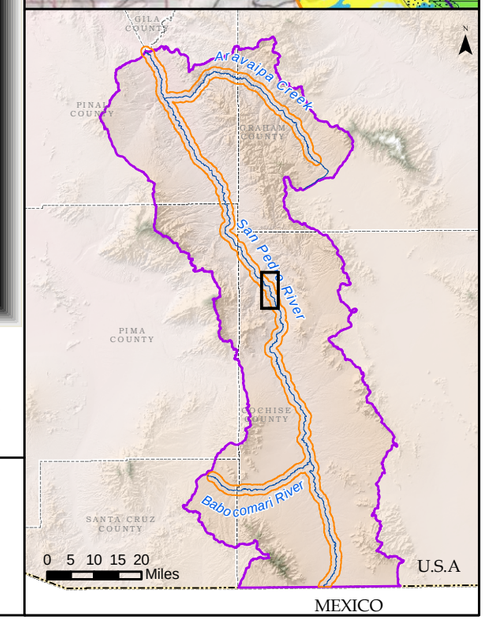
Appendix F
San Pedro River Cross Section at Mile 070
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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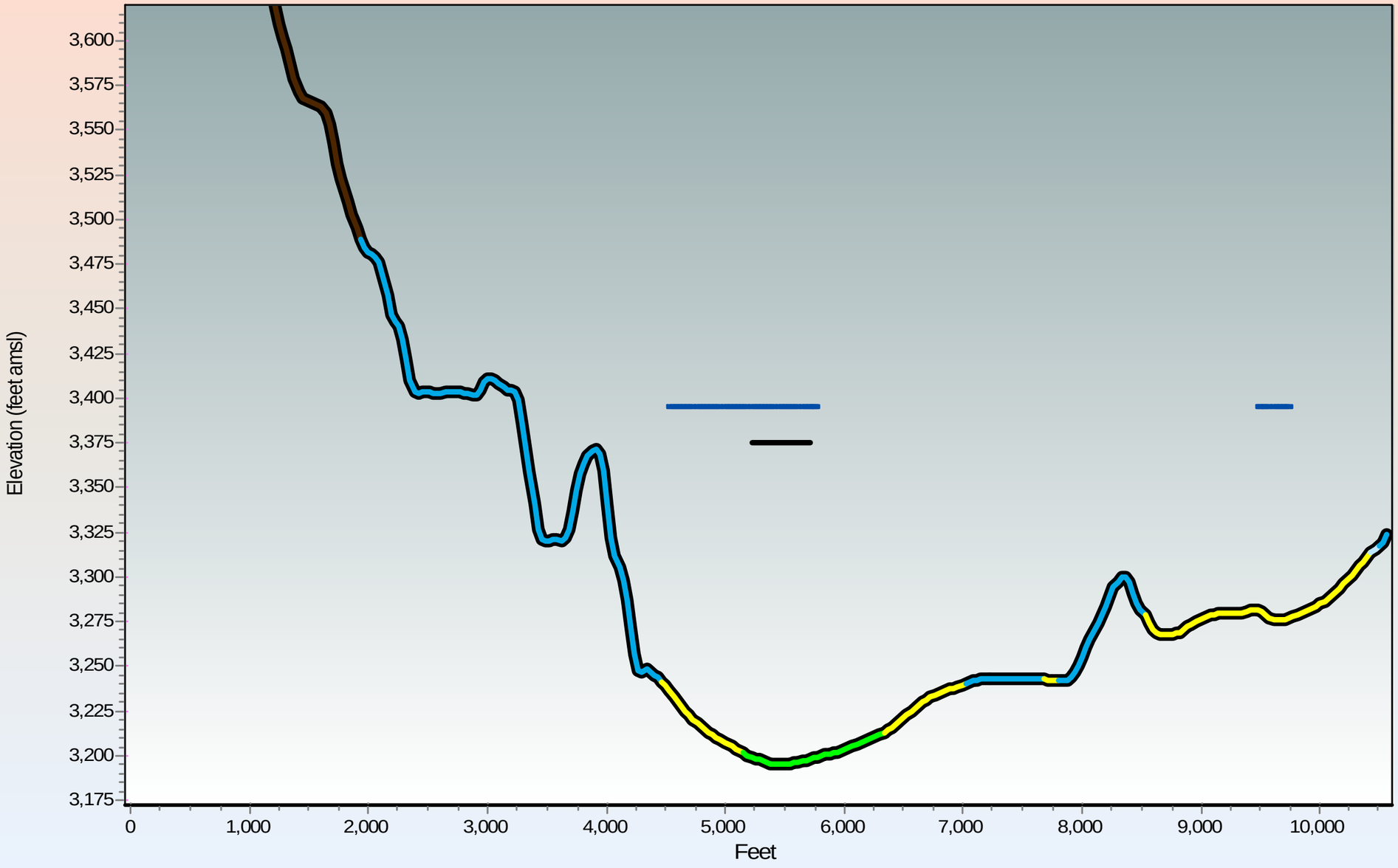
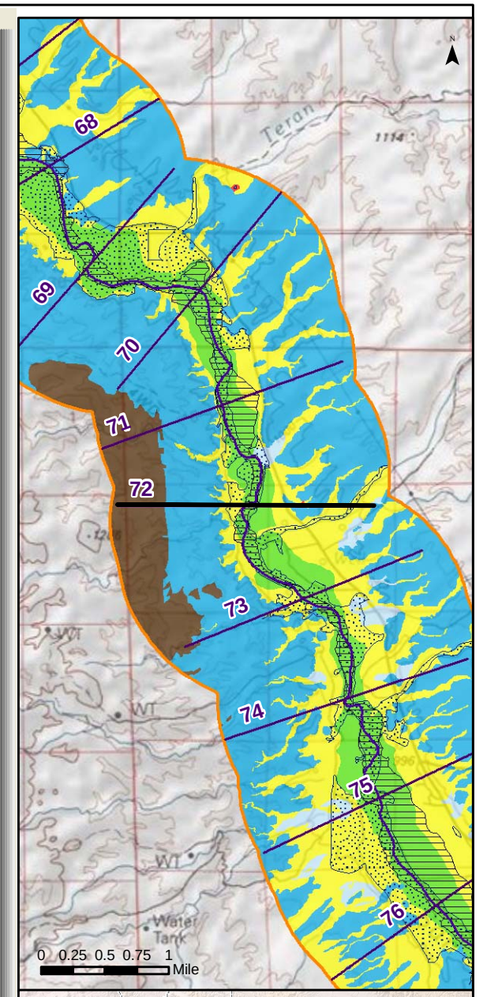
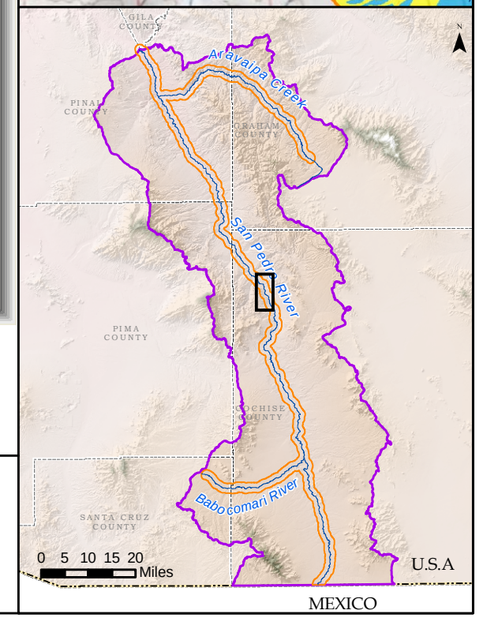
Appendix F
San Pedro River Cross Section at Mile 071
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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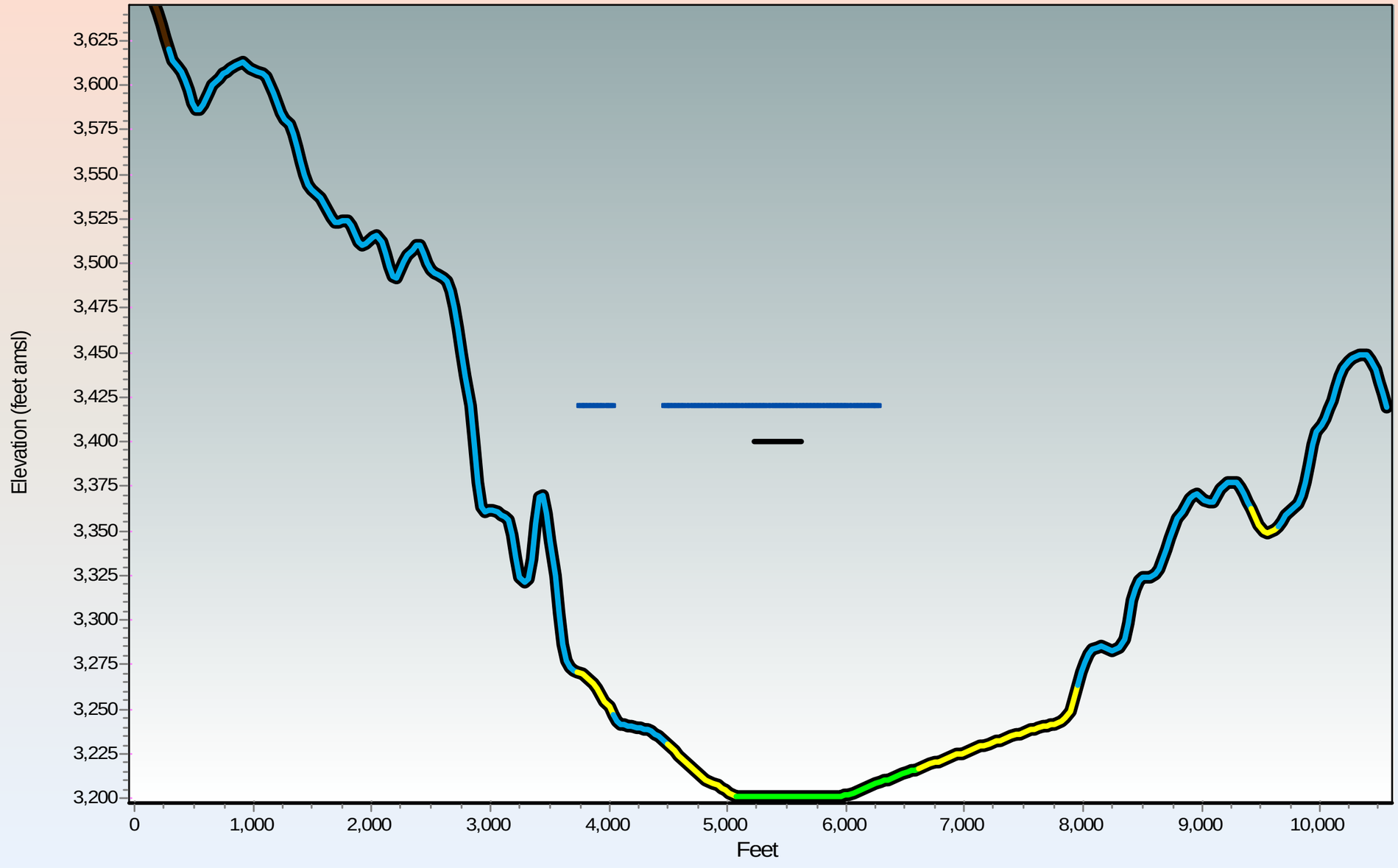
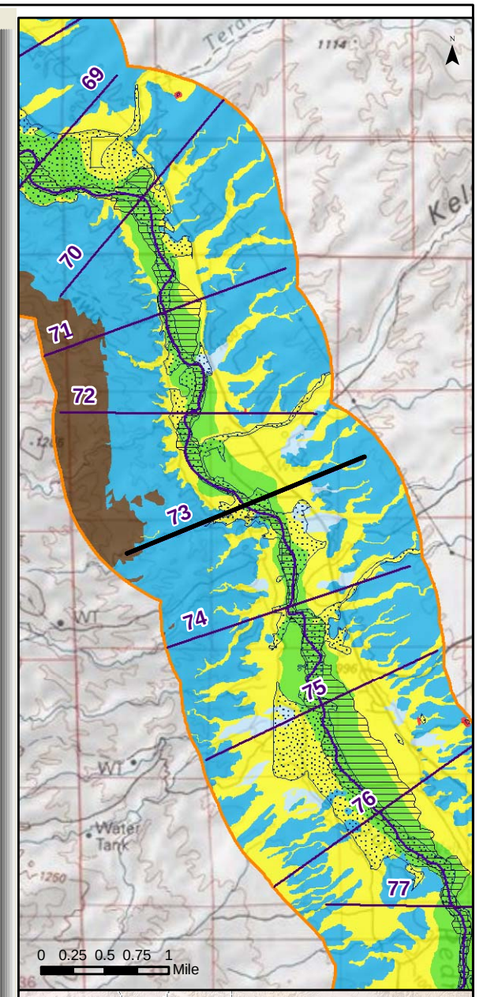
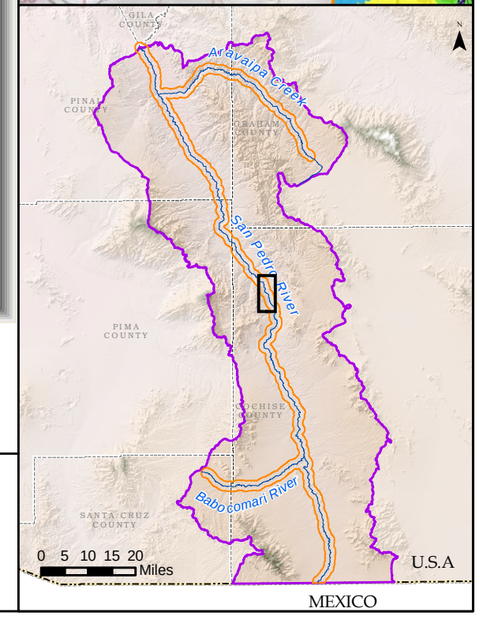
Appendix F
San Pedro River Cross Section at Mile 072
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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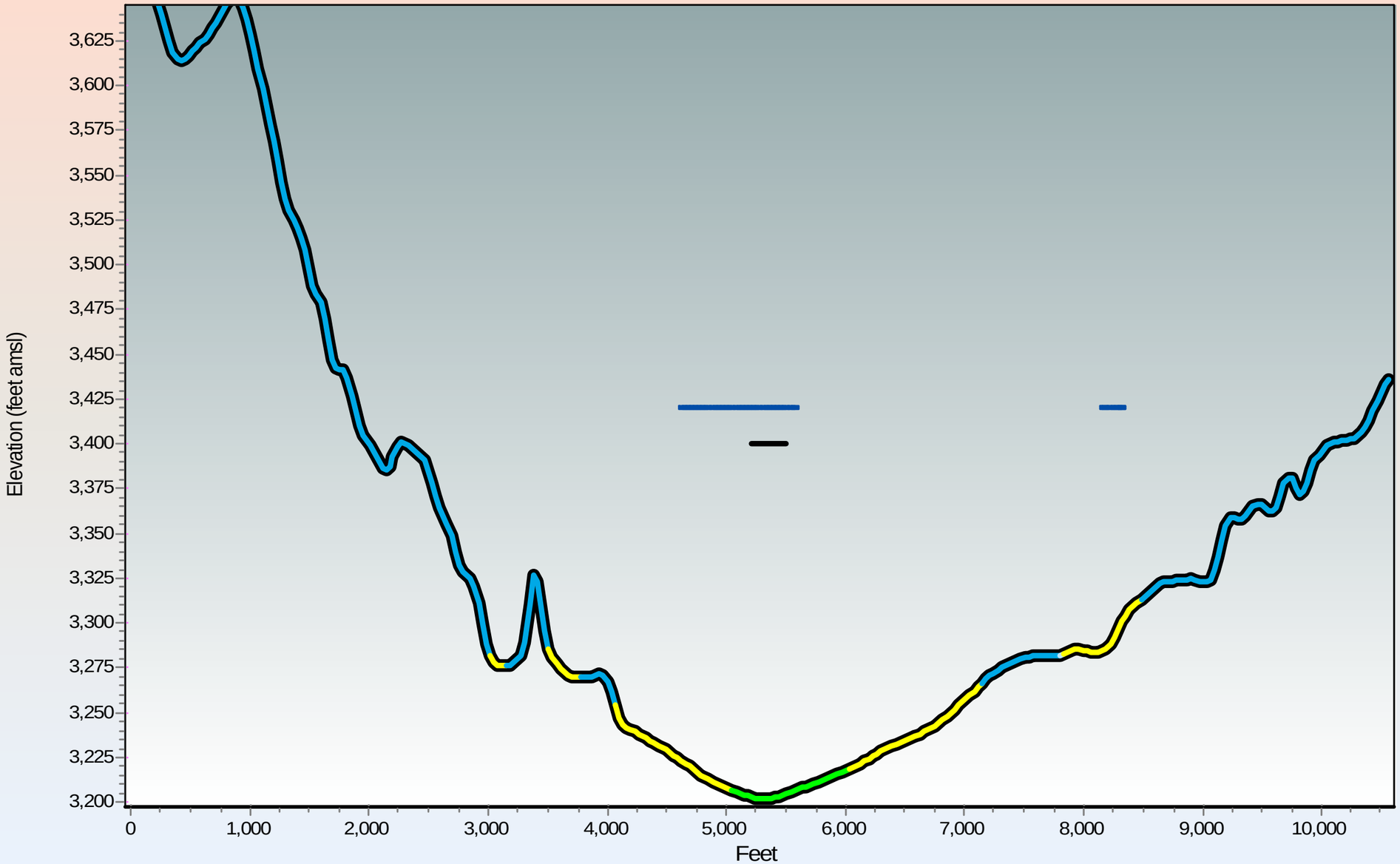
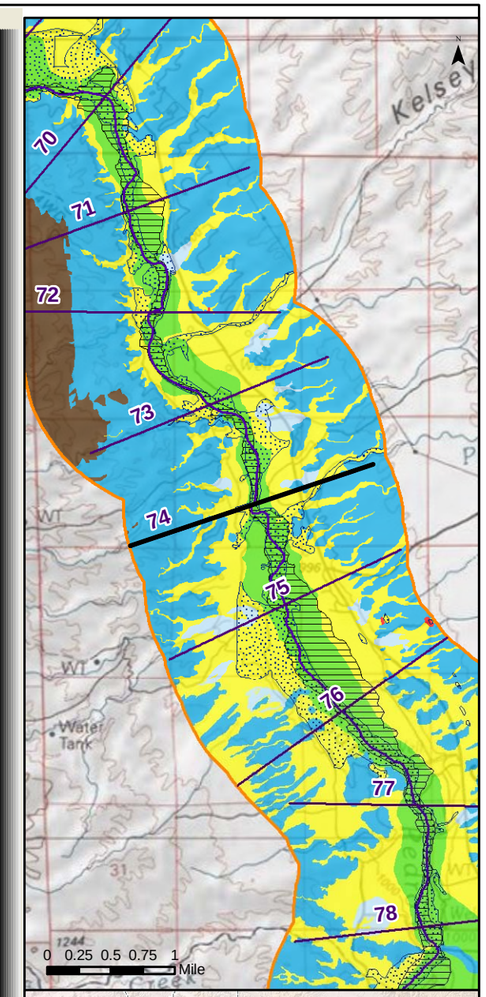
Appendix F

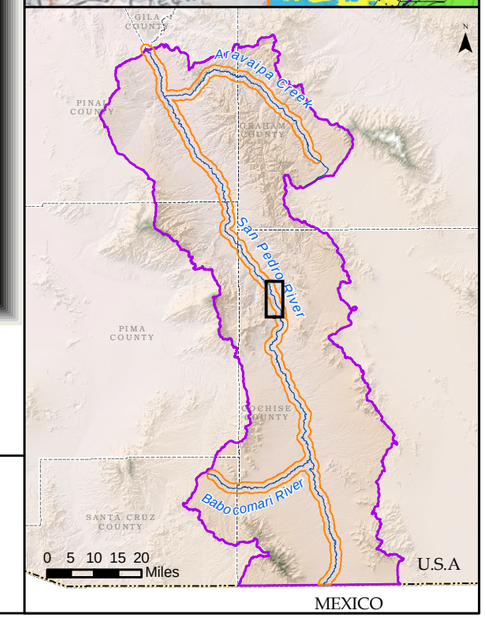
San Pedro River Cross Section at Mile 073

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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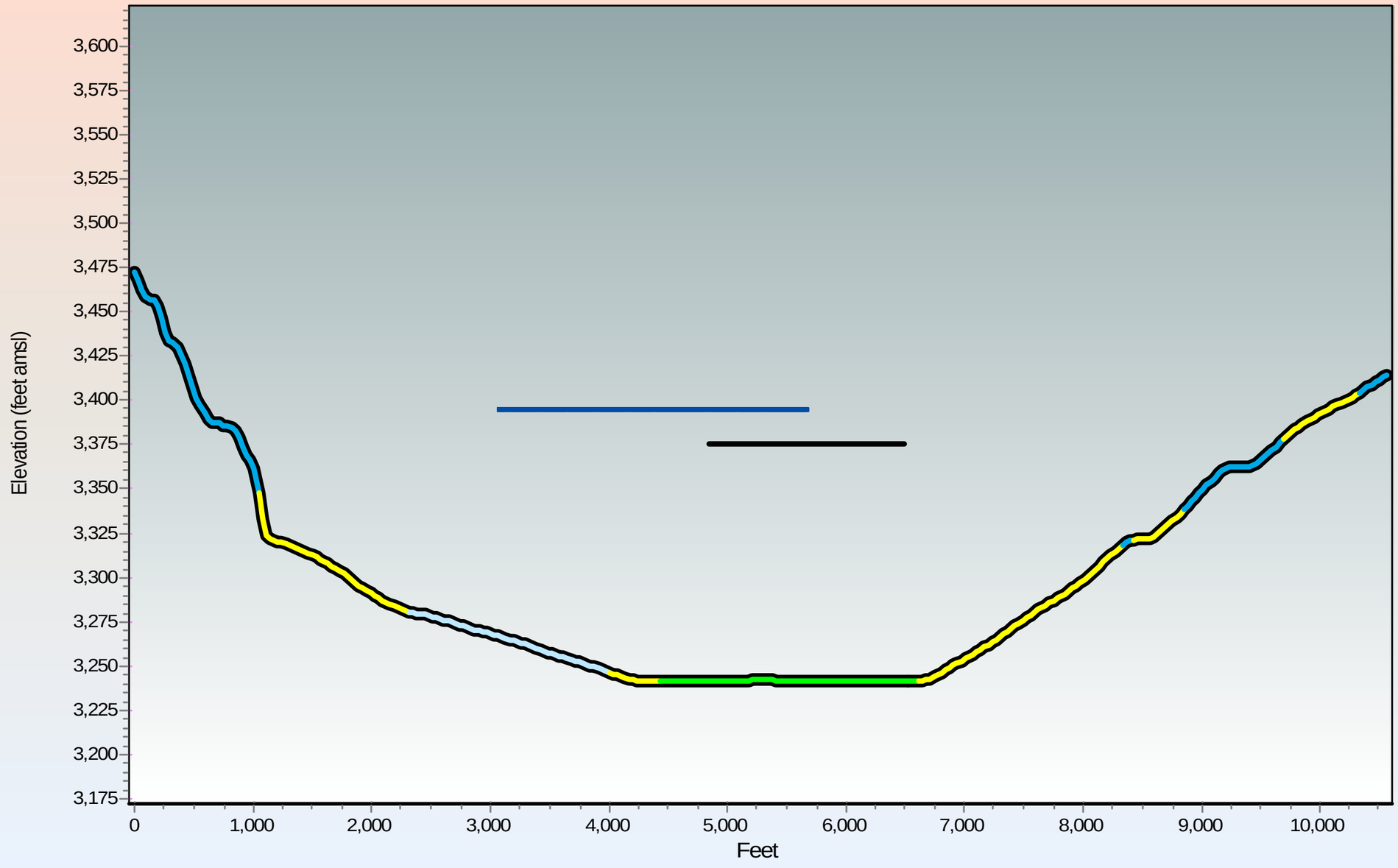
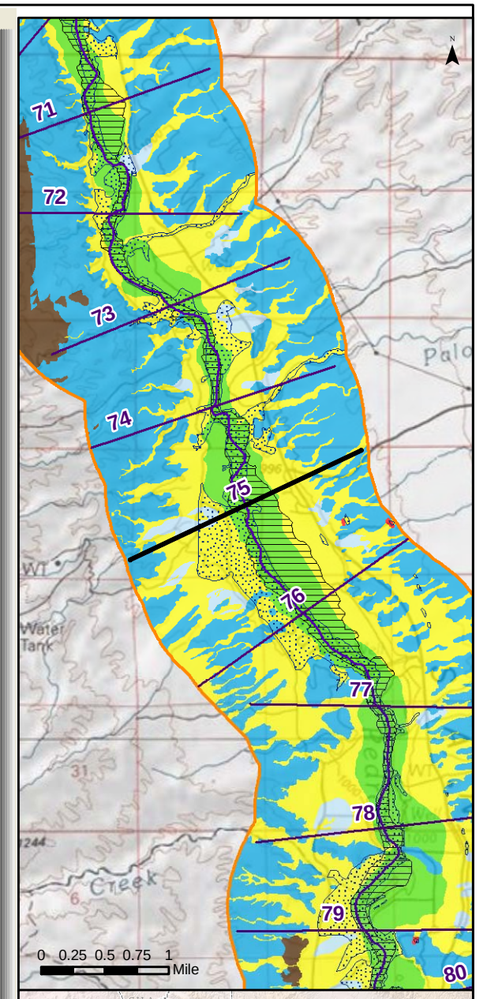
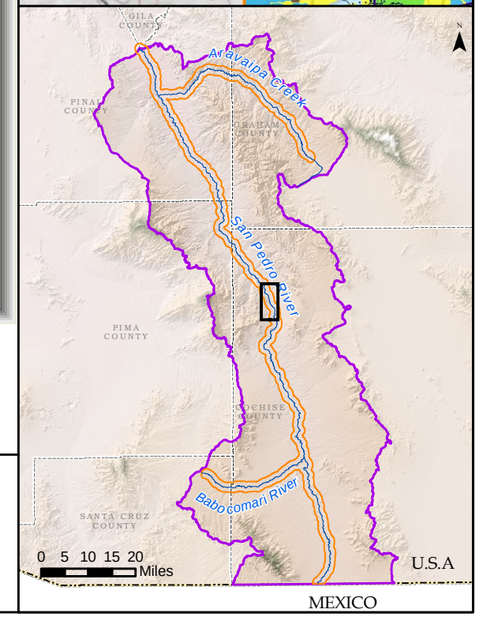
Appendix F
San Pedro River Cross Section at Mile 074
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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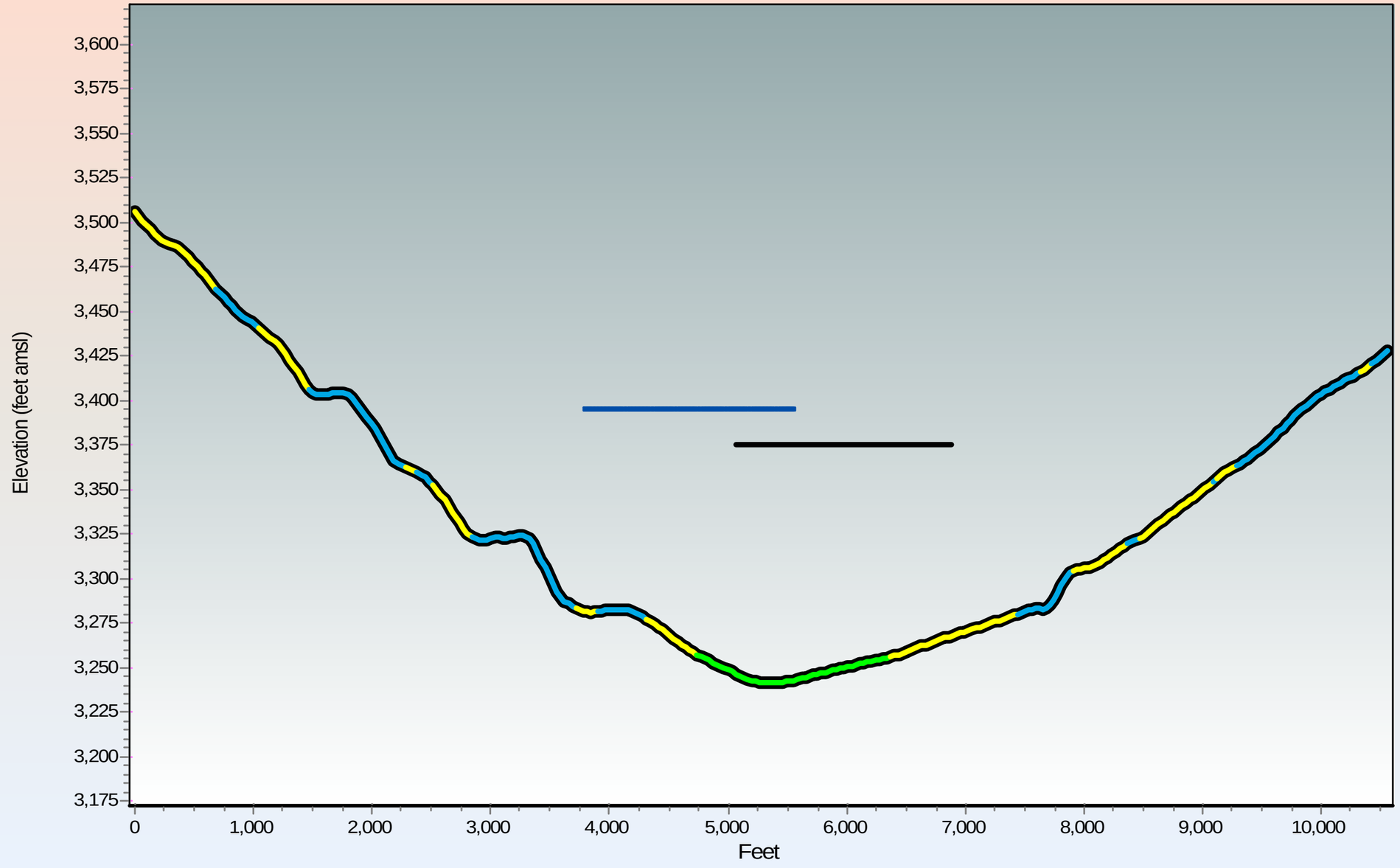
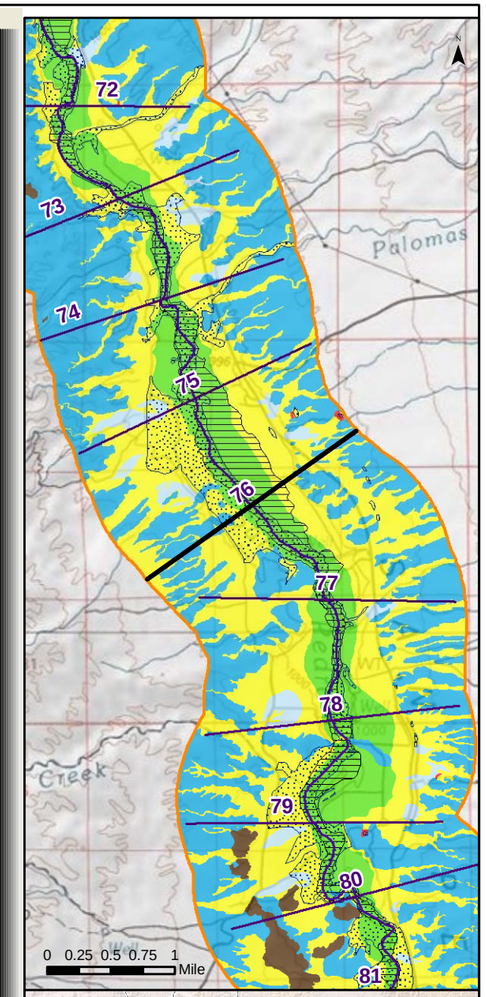
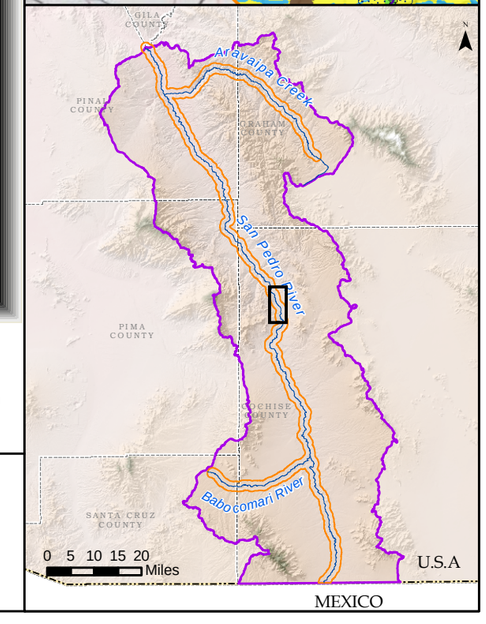
Appendix F
San Pedro River Cross Section at Mile 075
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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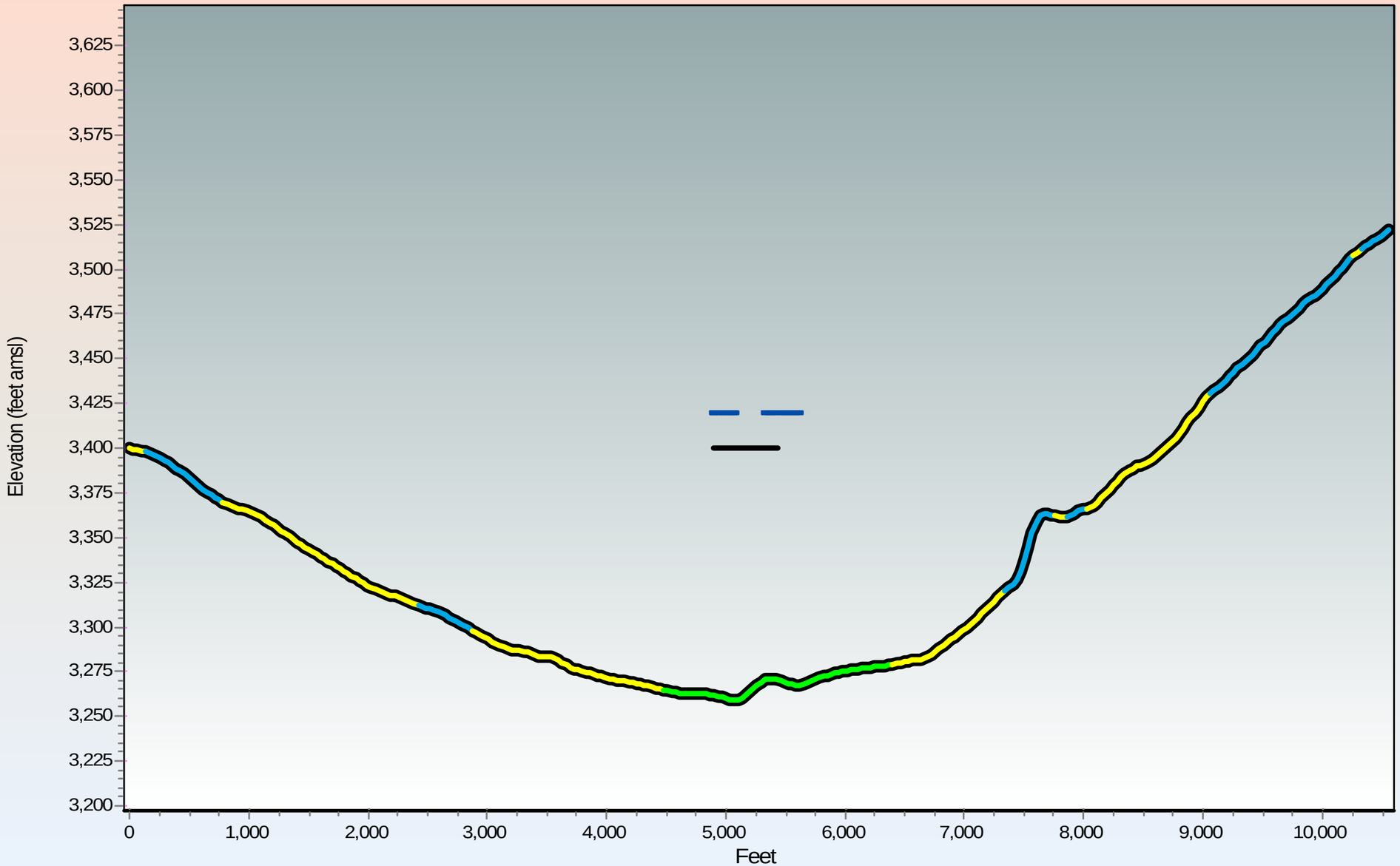
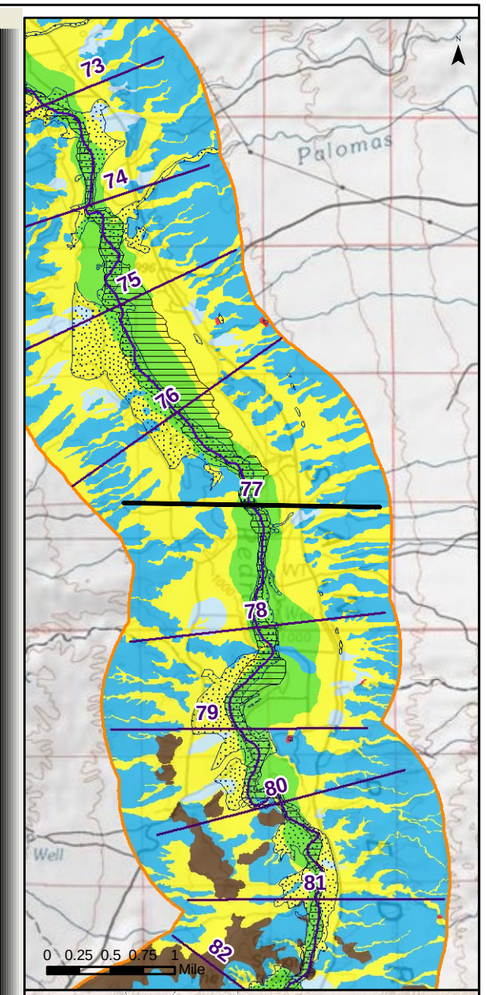
Appendix F

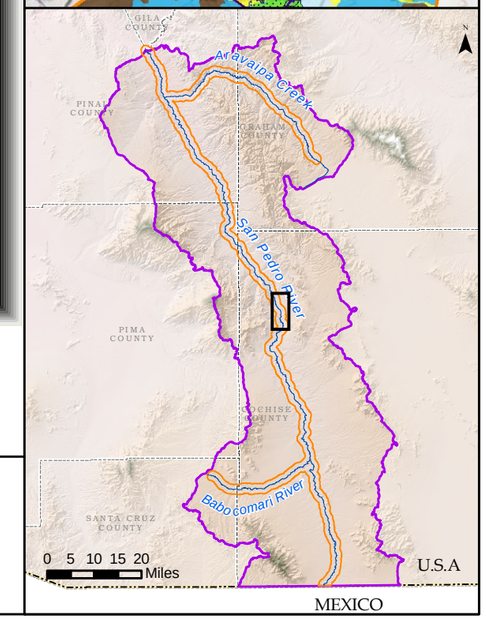
San Pedro River Cross Section at Mile 076

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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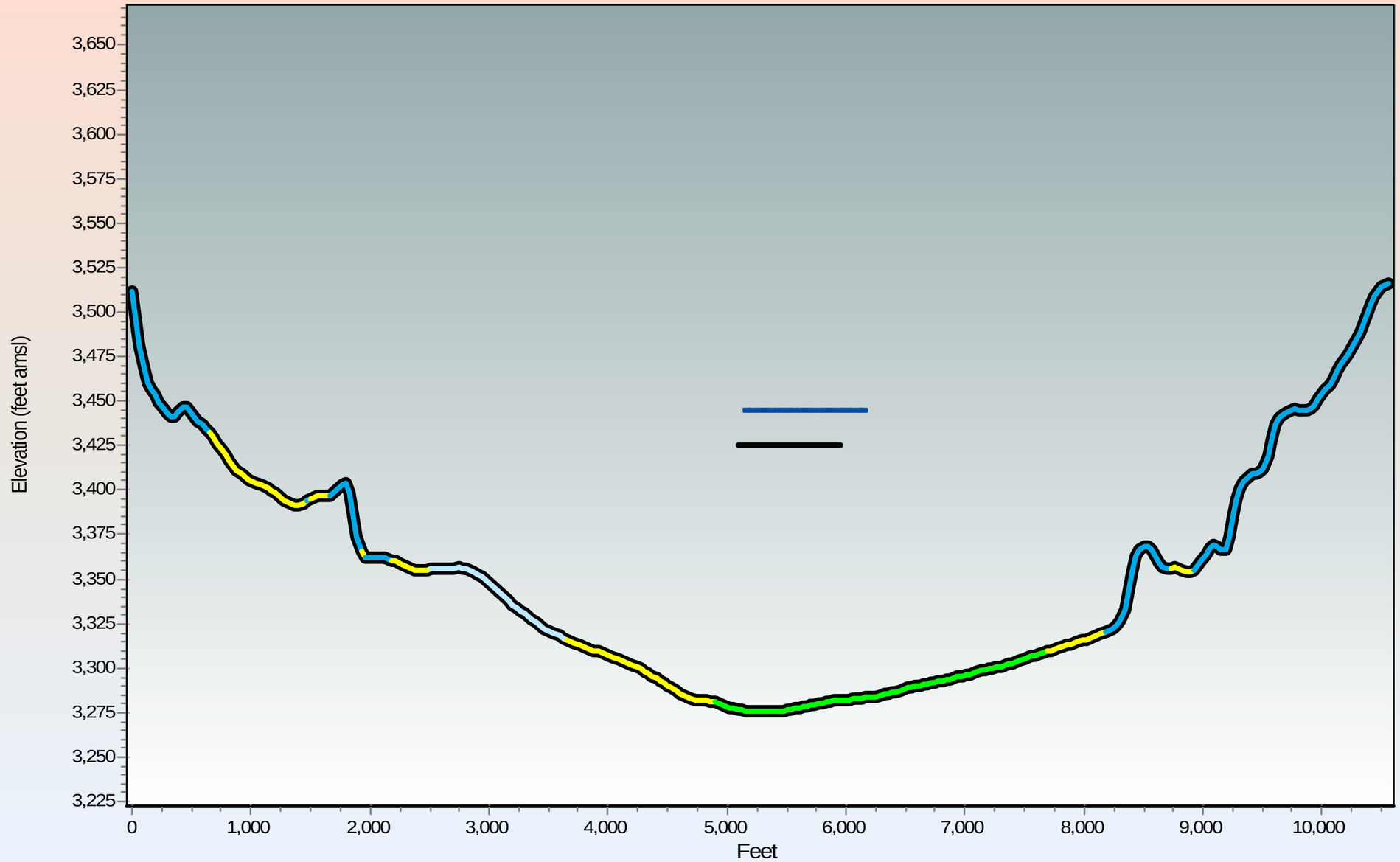
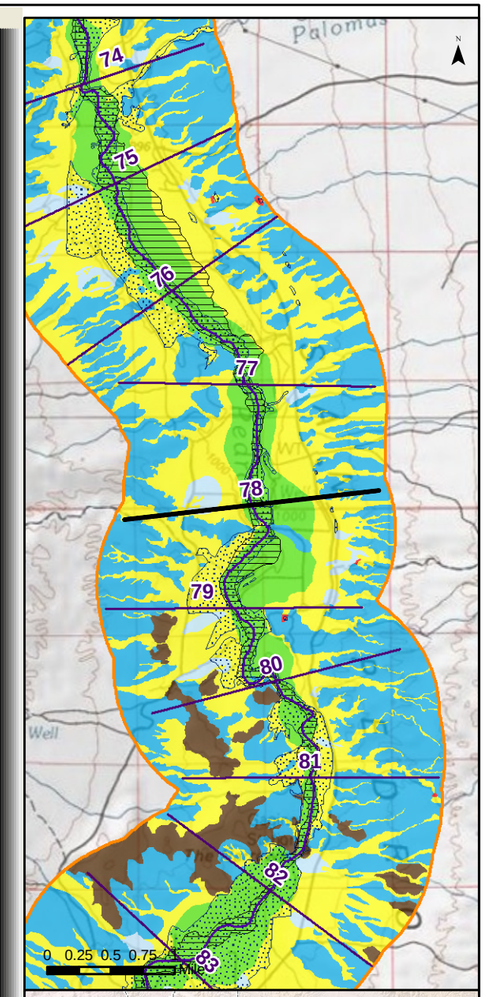
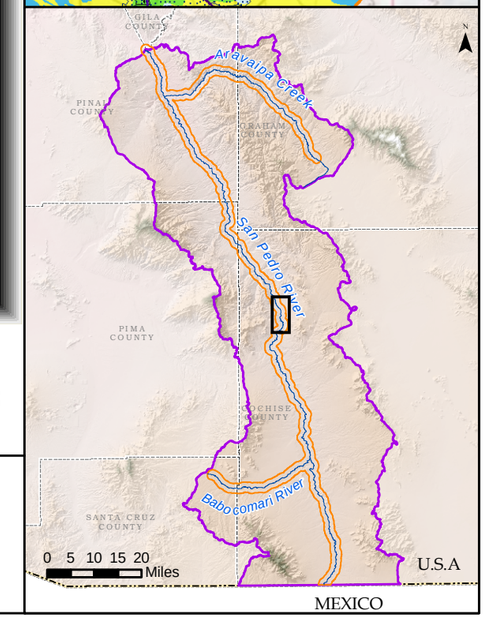
Appendix F
San Pedro River Cross Section at Mile 077
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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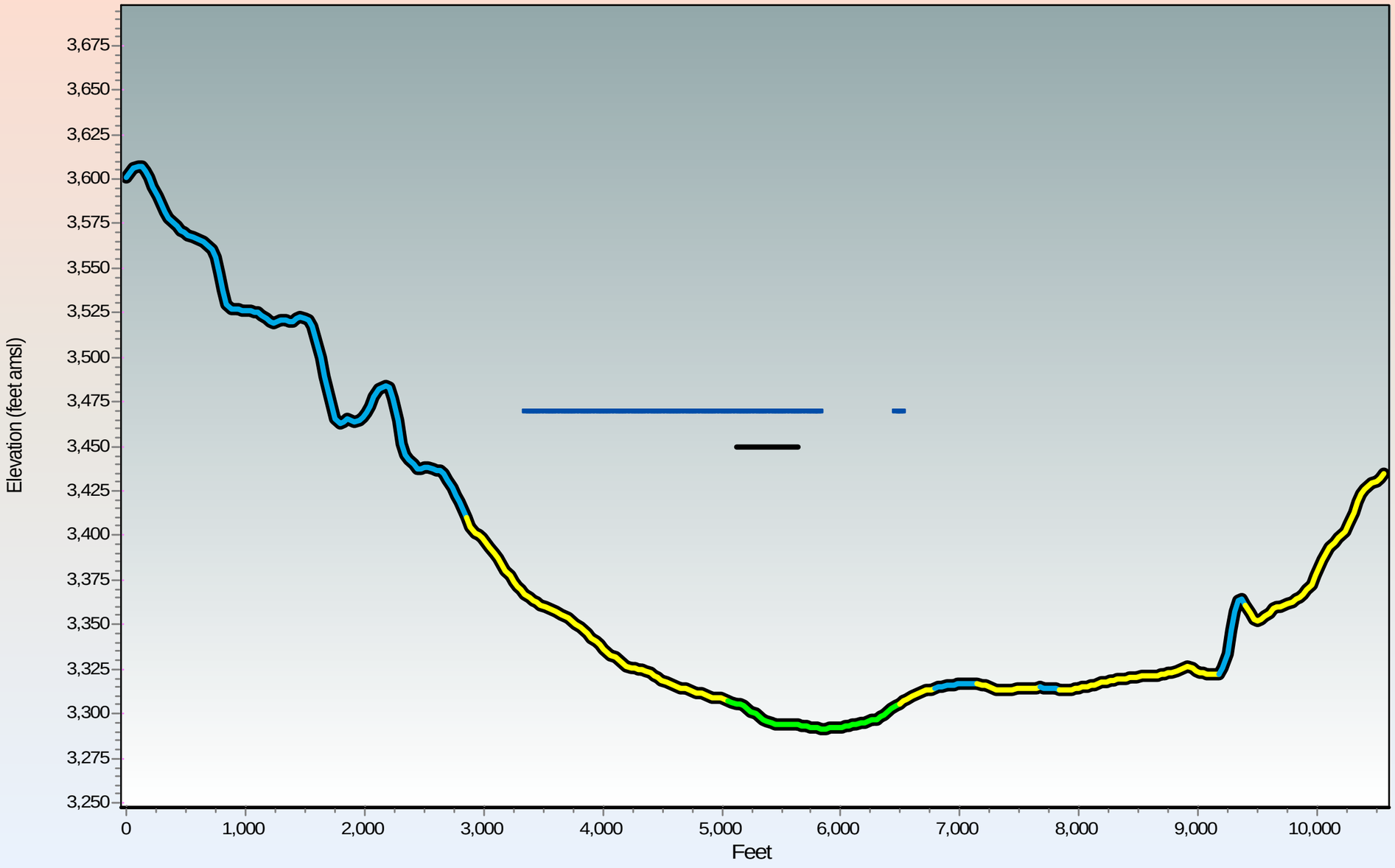
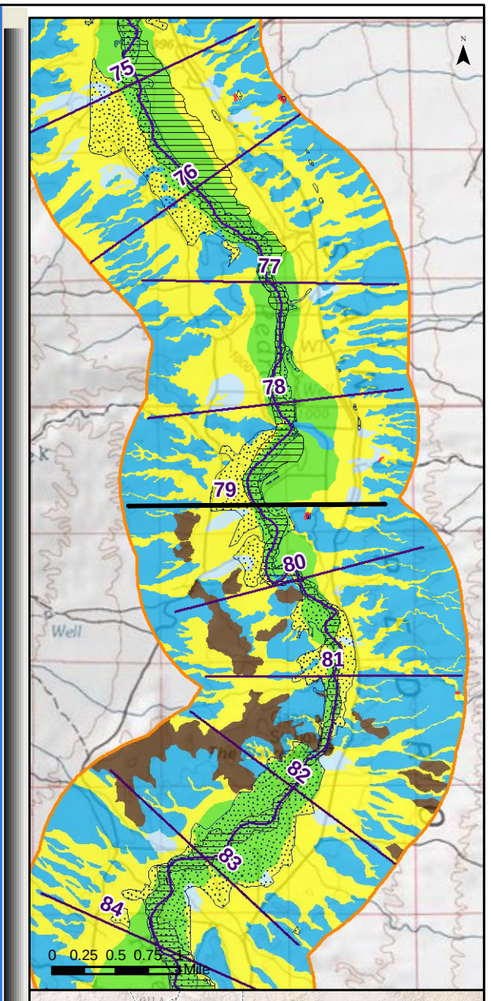
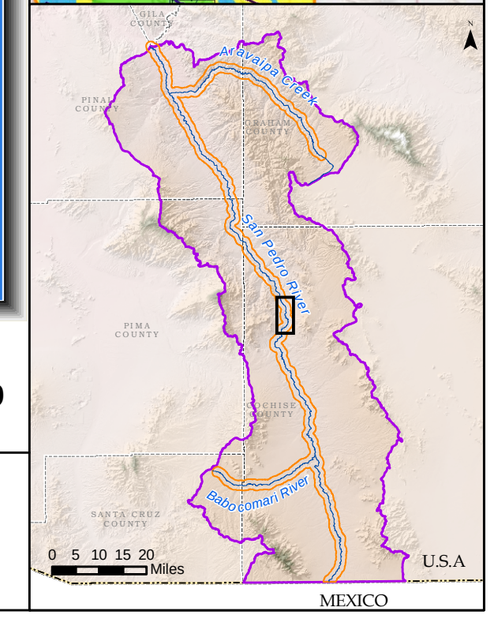
Appendix F
San Pedro River Cross Section at Mile 078
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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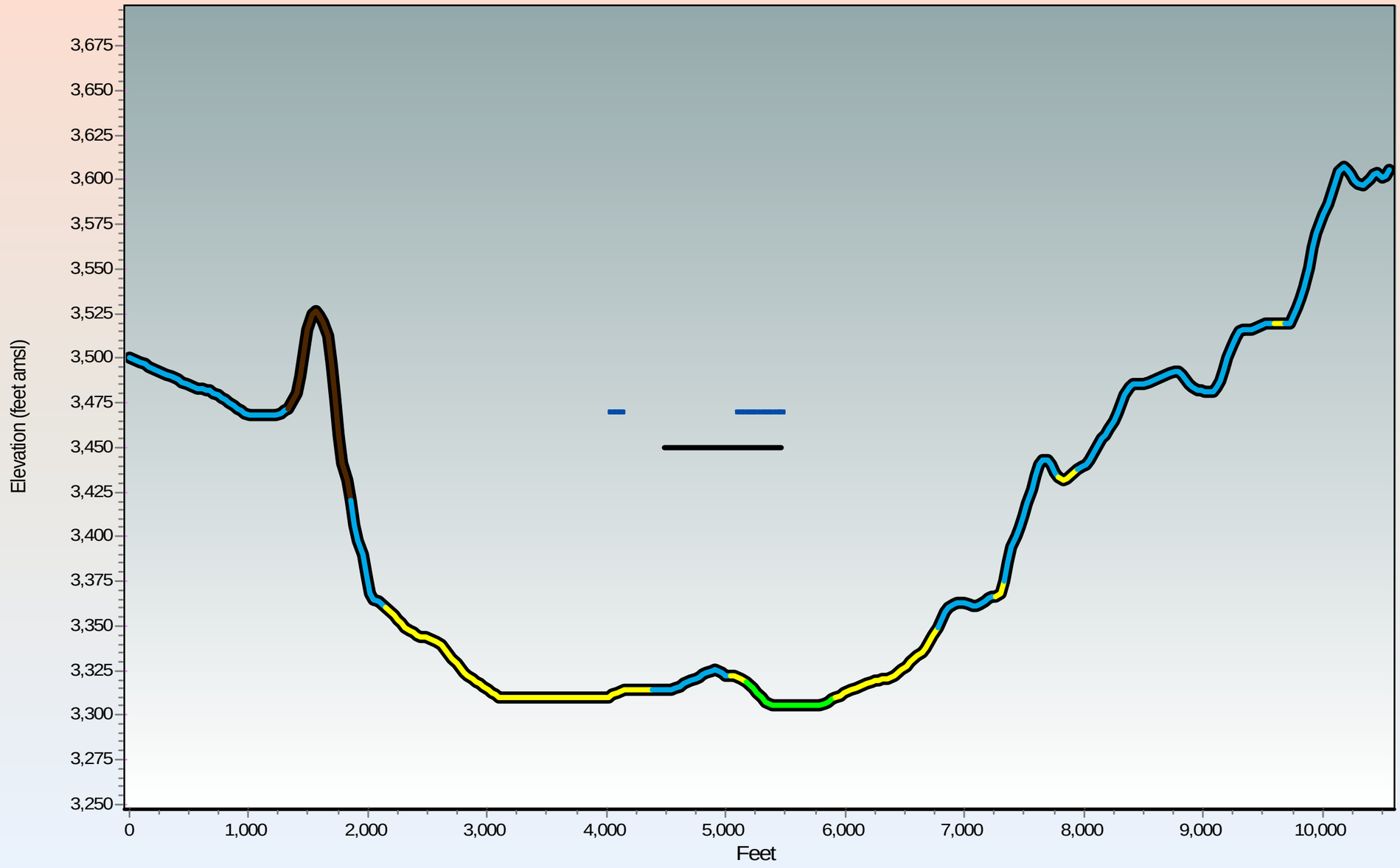
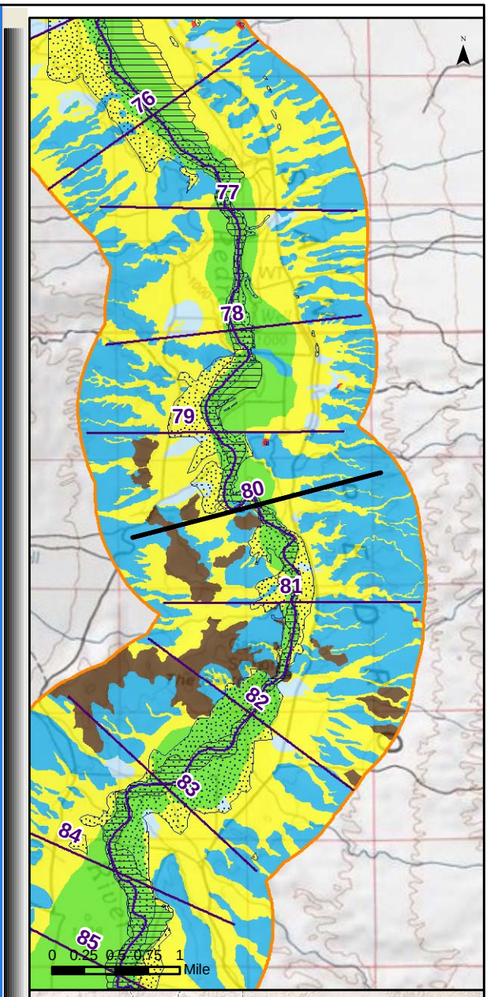
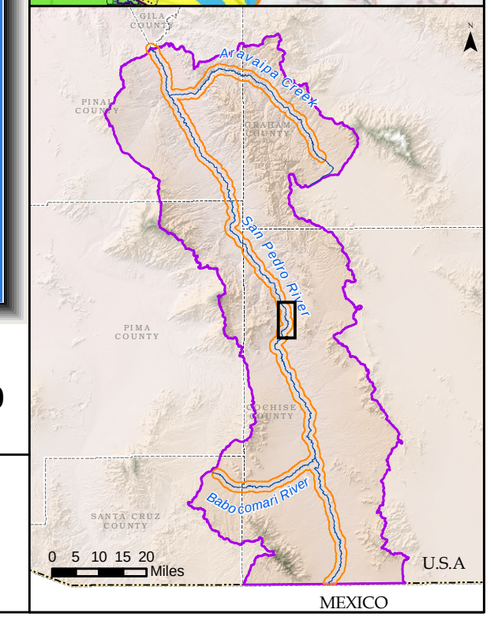
Appendix F
San Pedro River Cross Section at Mile 079
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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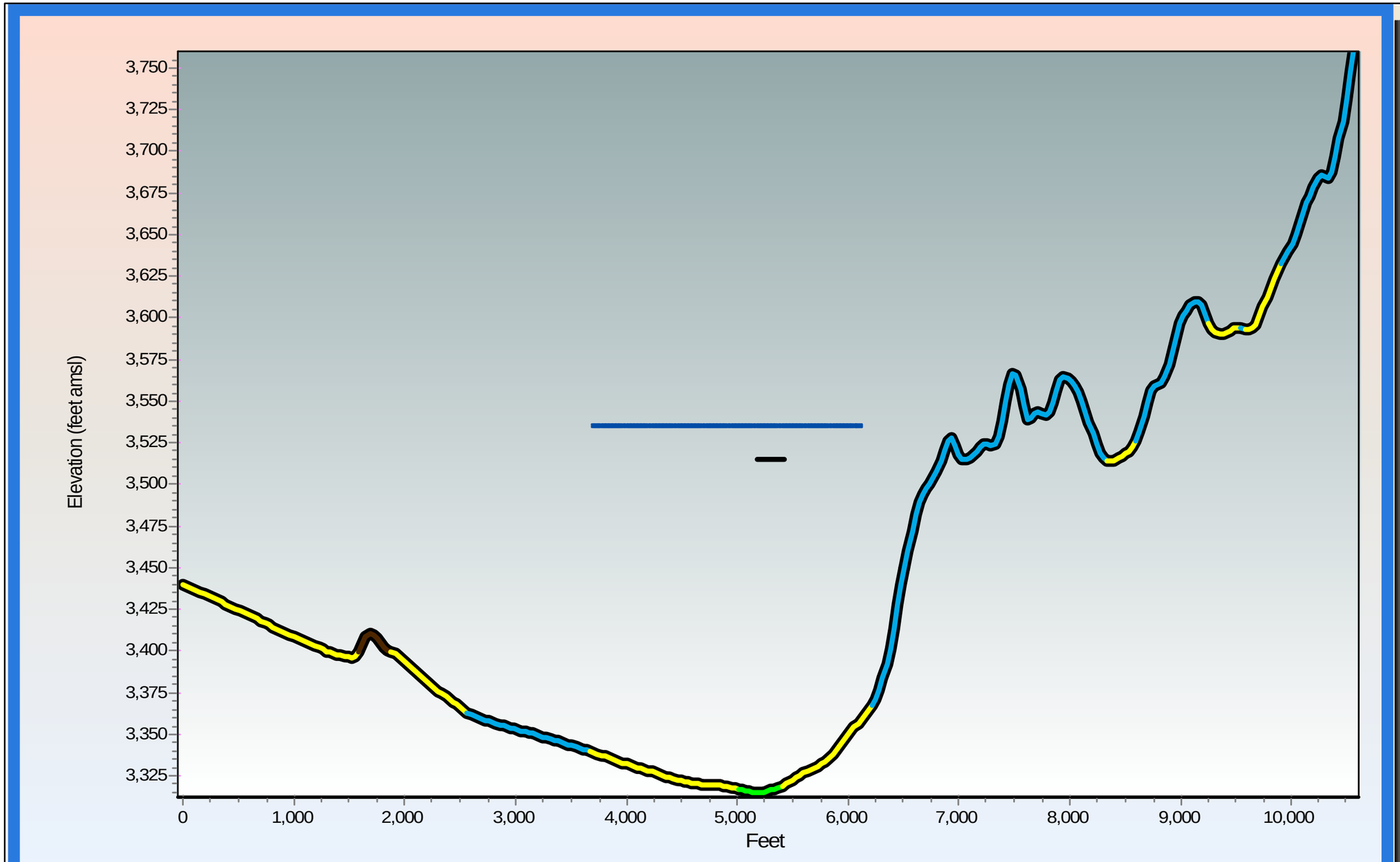
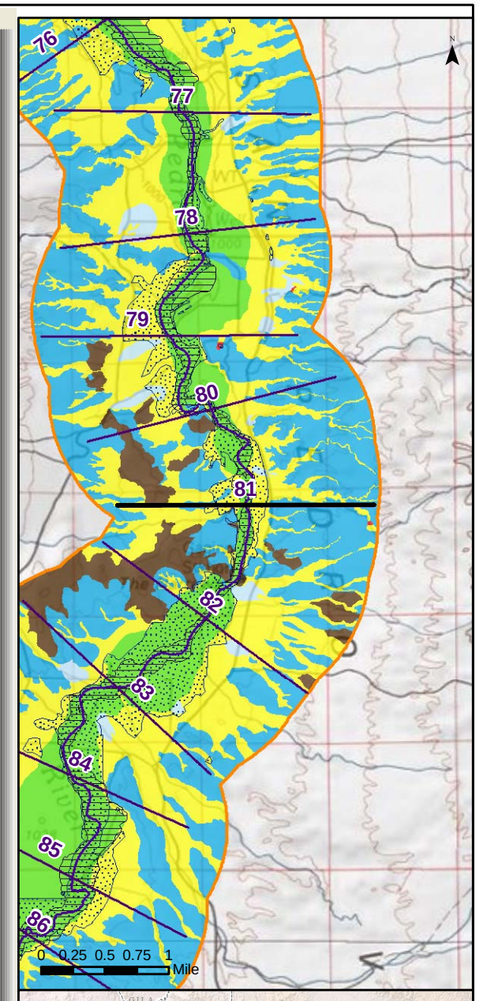
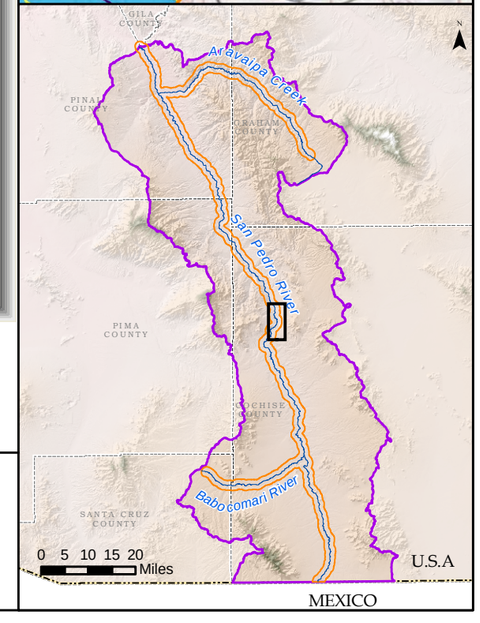
Appendix F
San Pedro River Cross Section at Mile 080
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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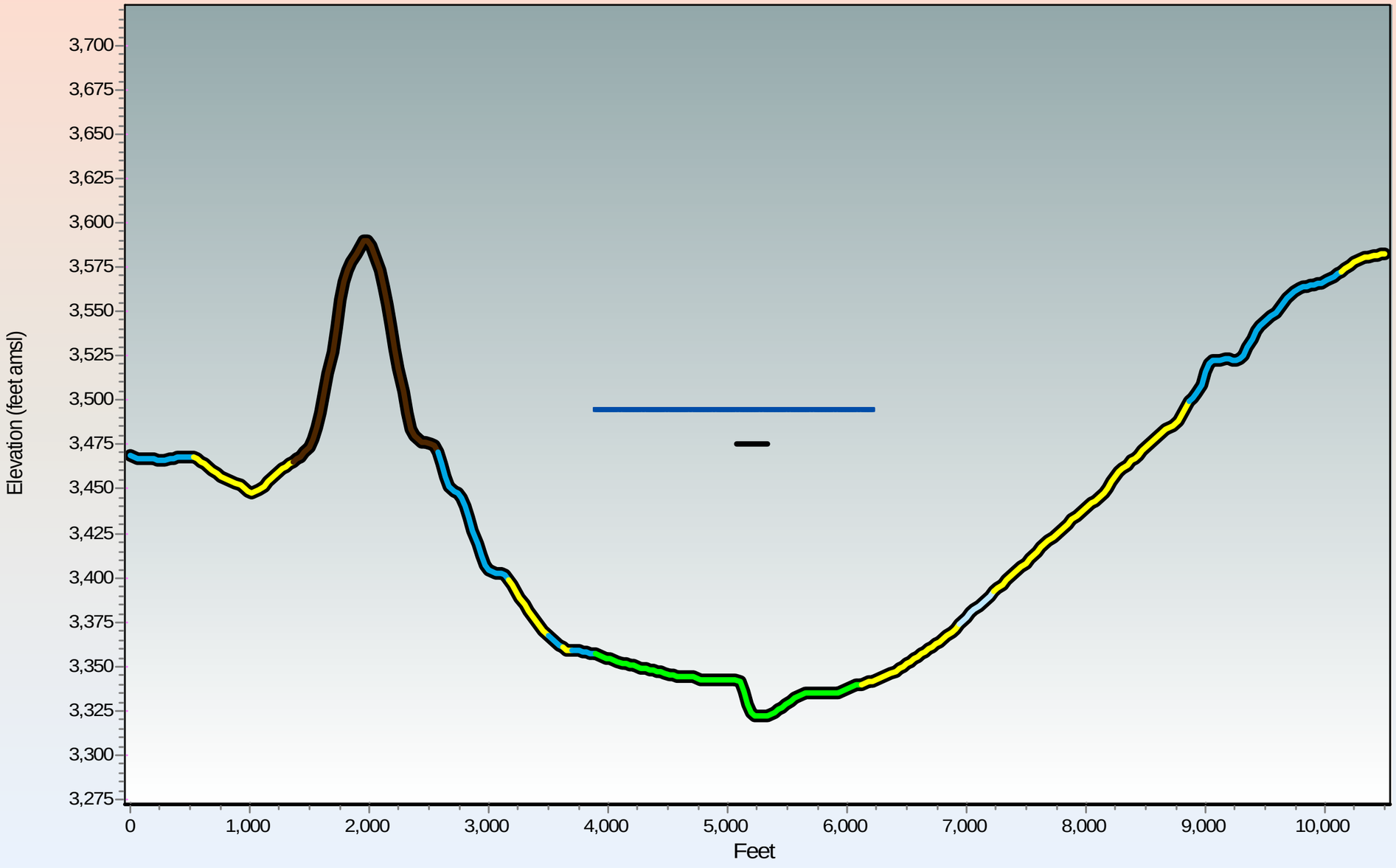
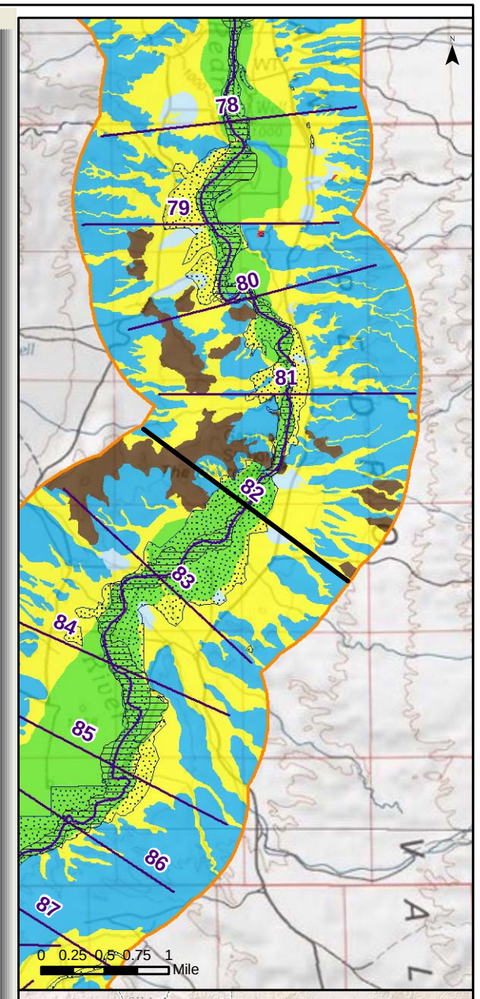
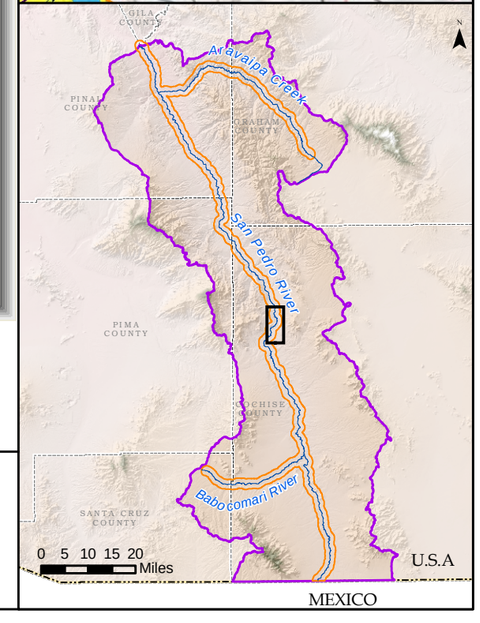
Appendix F
San Pedro River Cross Section at Mile 081
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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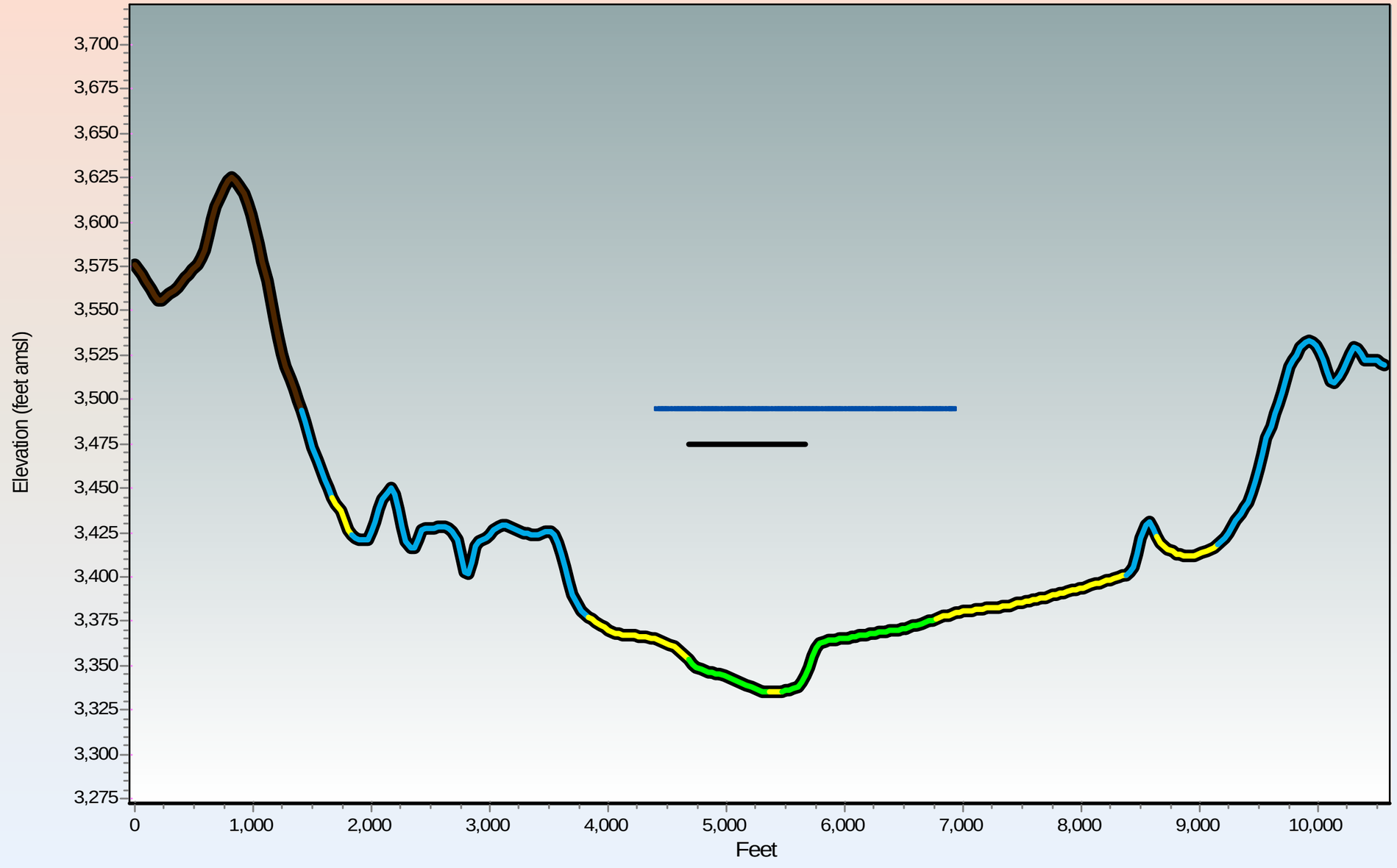
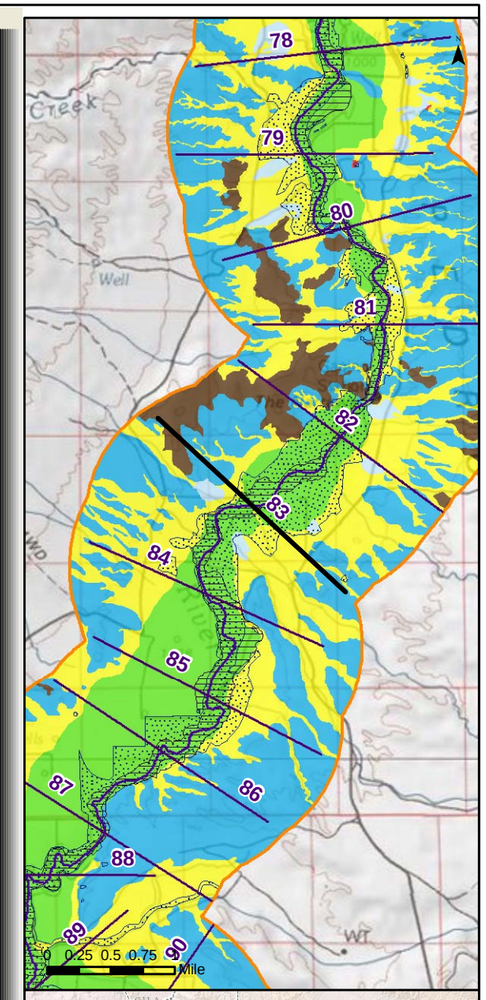
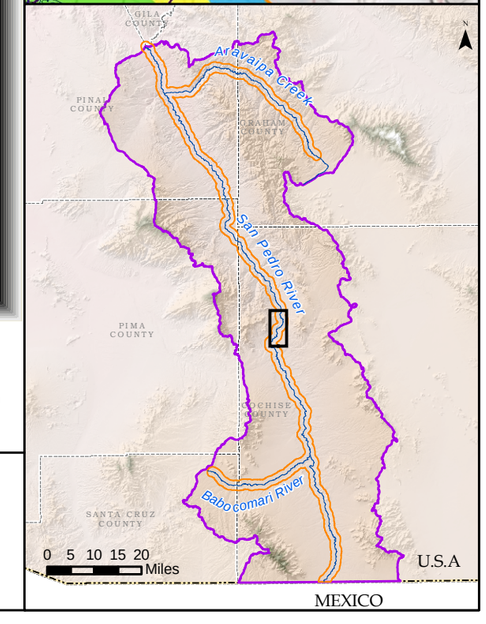
Appendix F
San Pedro River Cross Section at Mile 082
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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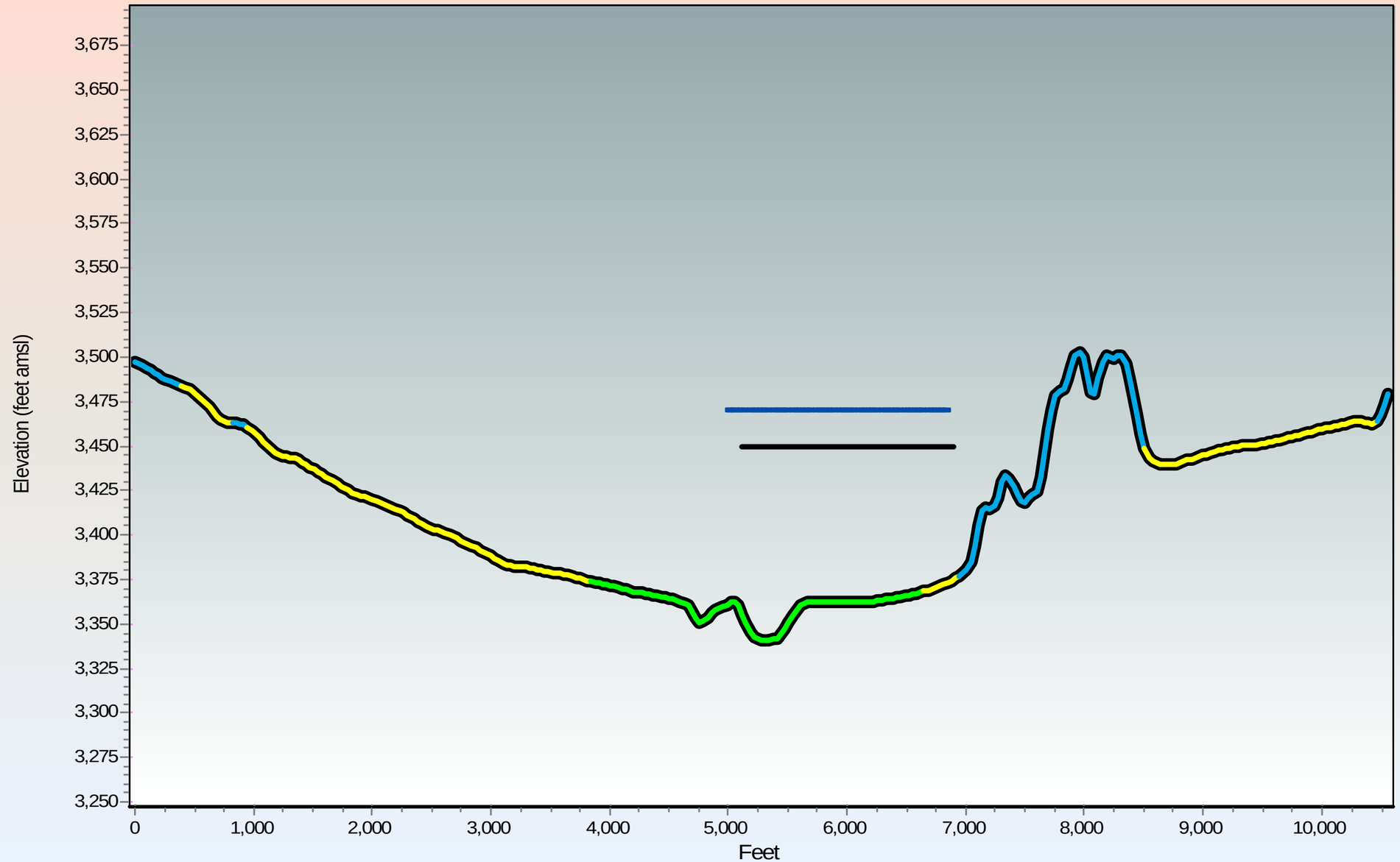
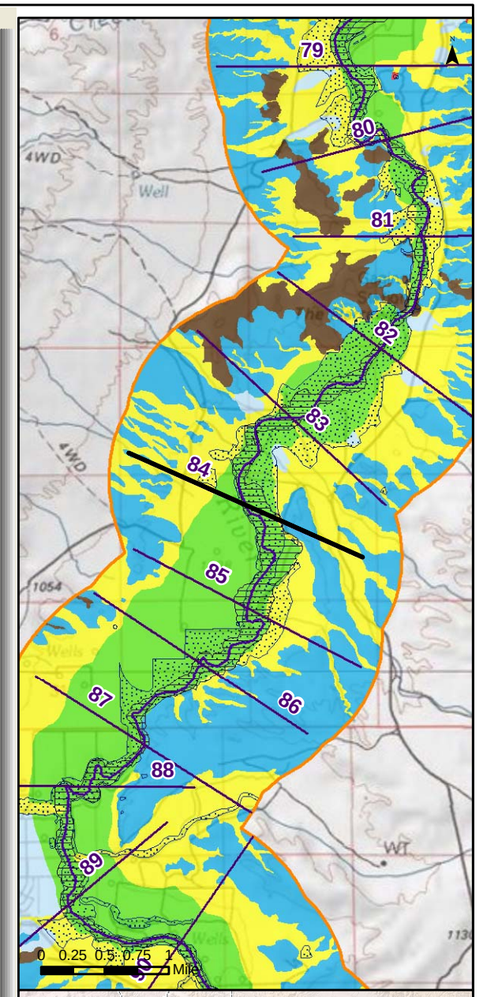
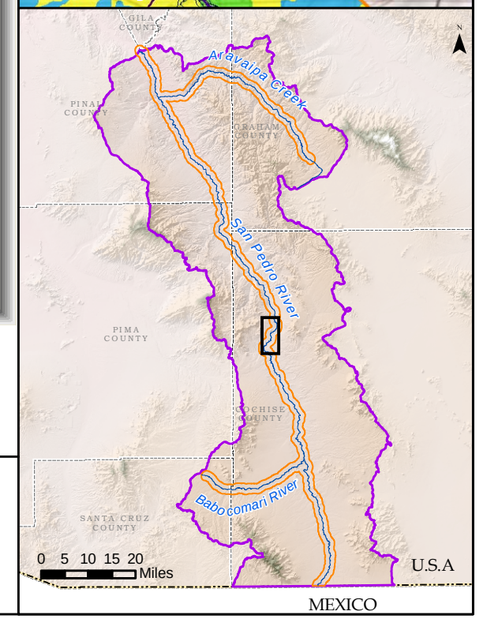
Appendix F
San Pedro River Cross Section at Mile 083
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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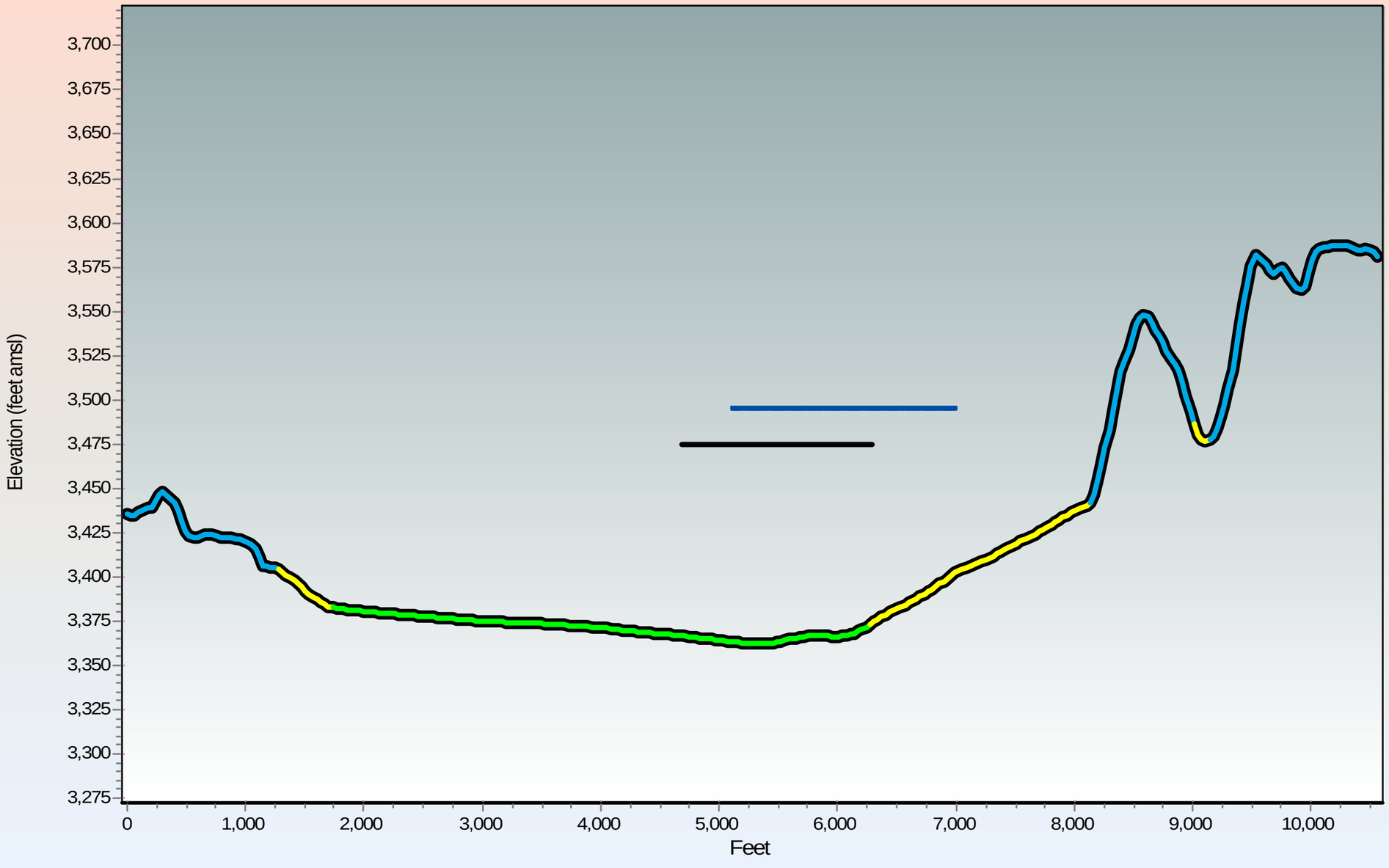
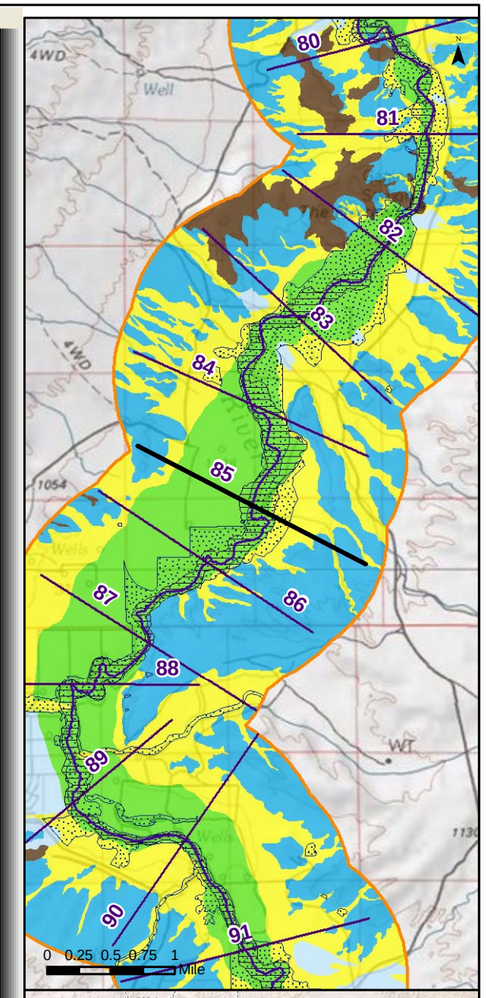
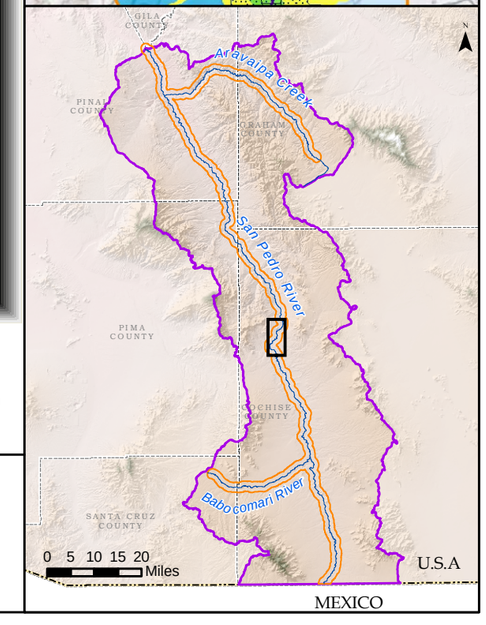
Appendix F
San Pedro River Cross Section at Mile 084
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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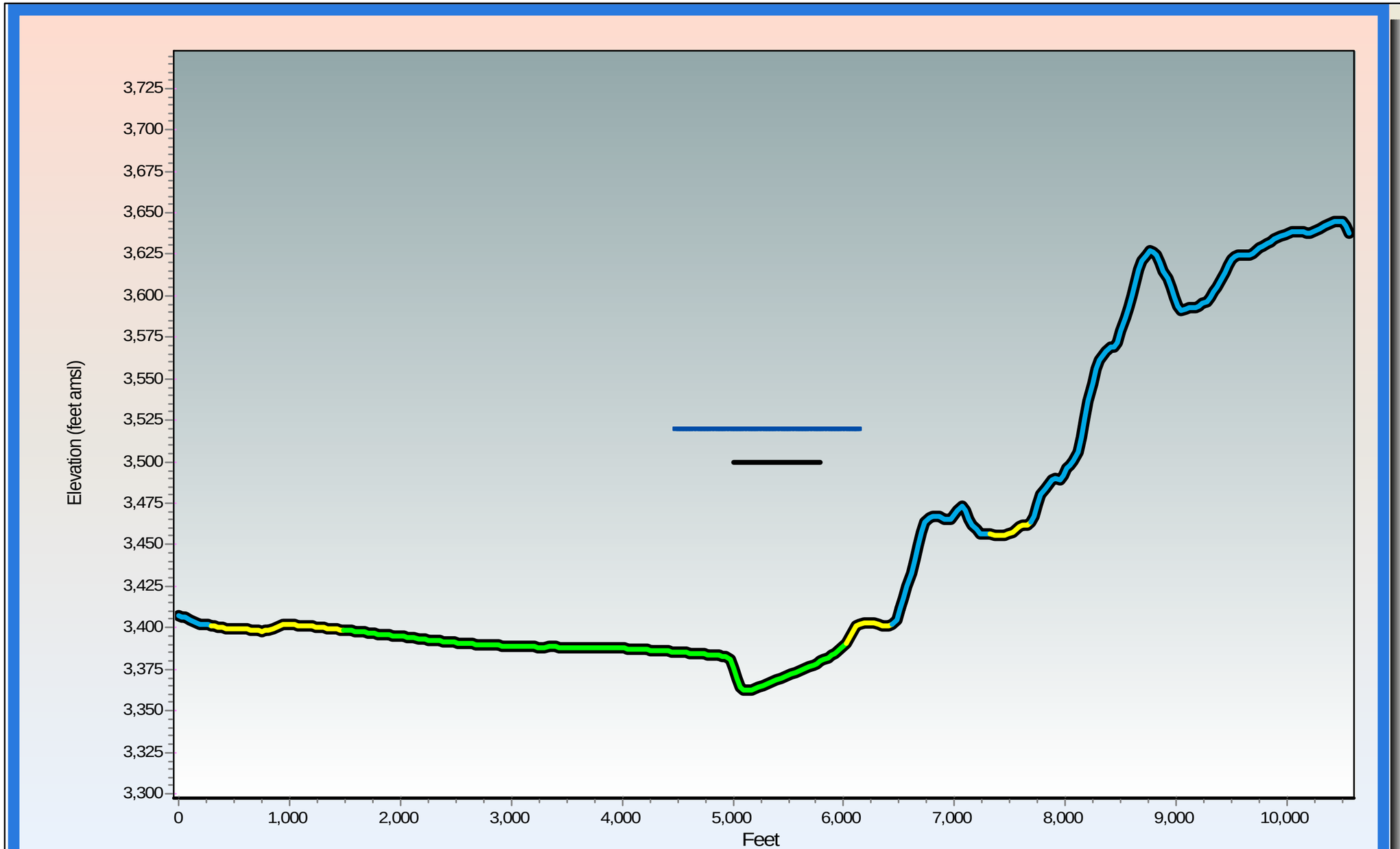
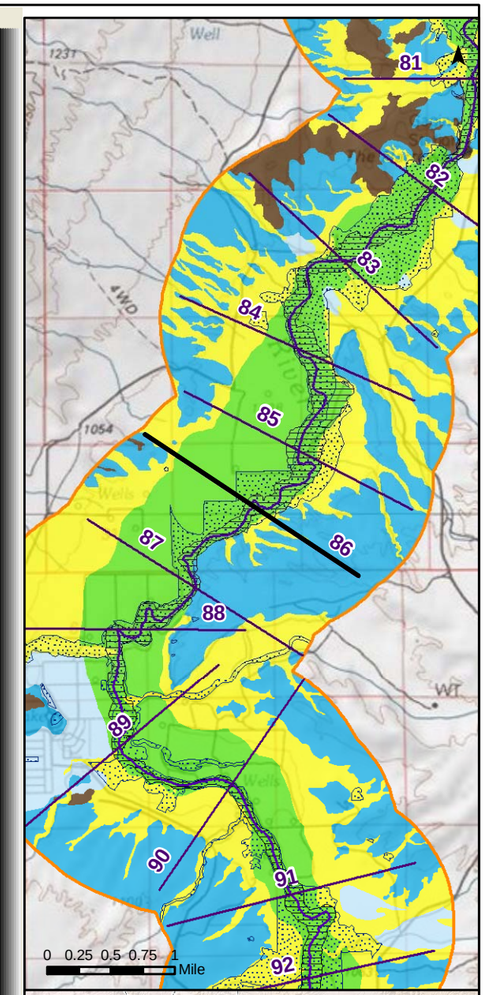
Appendix F

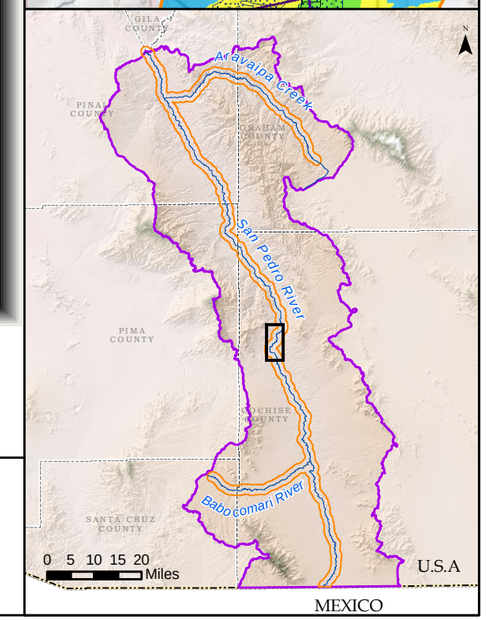
San Pedro River Cross Section at Mile 085

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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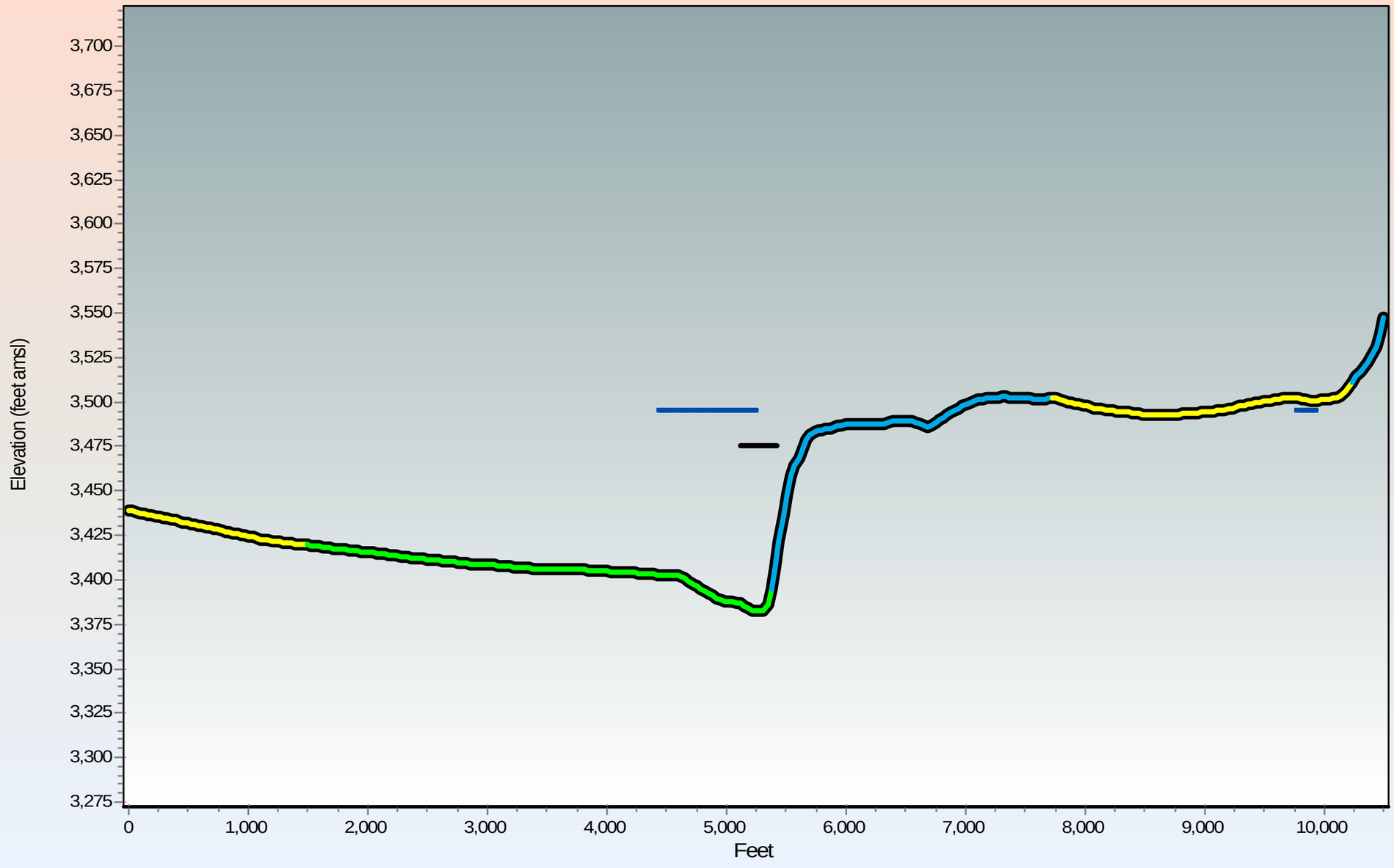
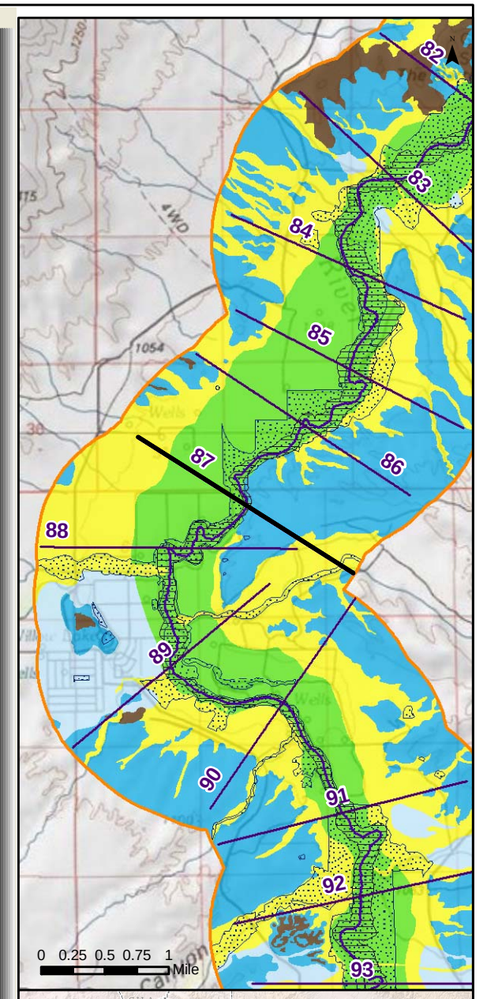
Appendix F

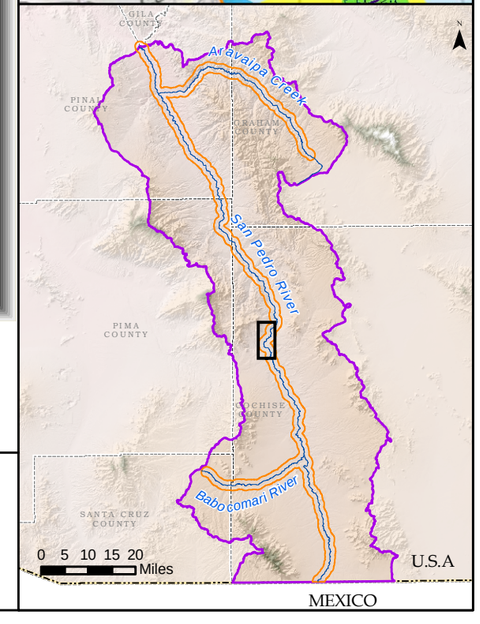
San Pedro River Cross Section at Mile 086

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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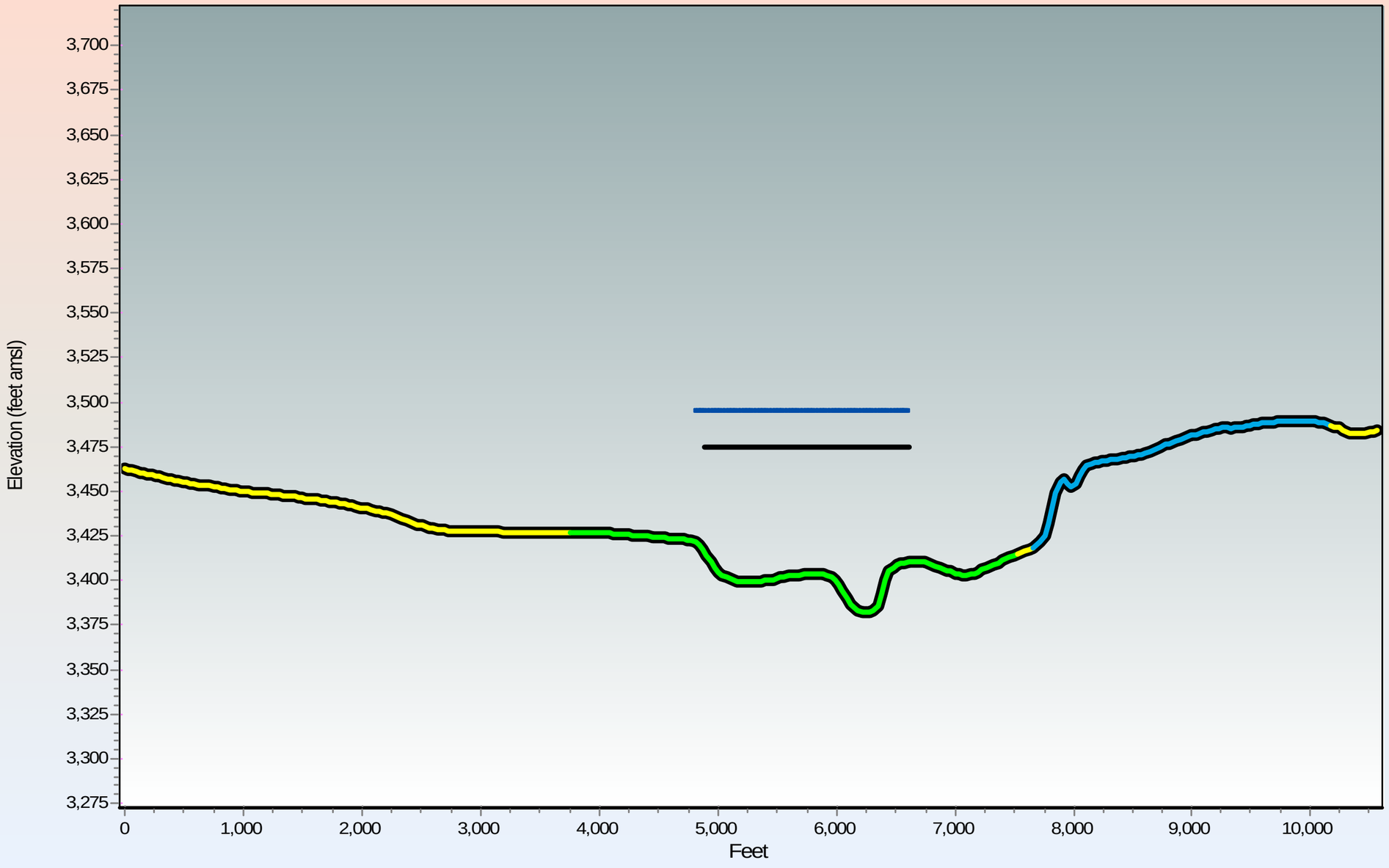
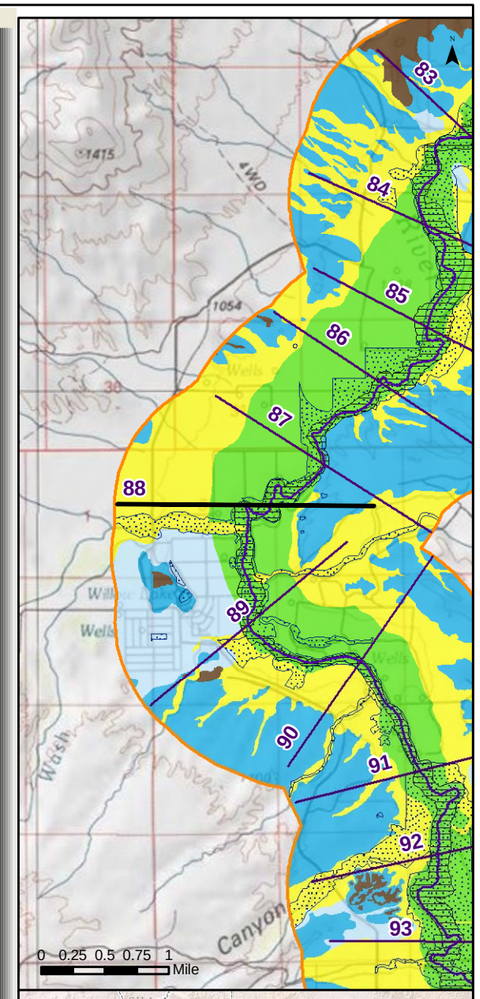
Appendix F

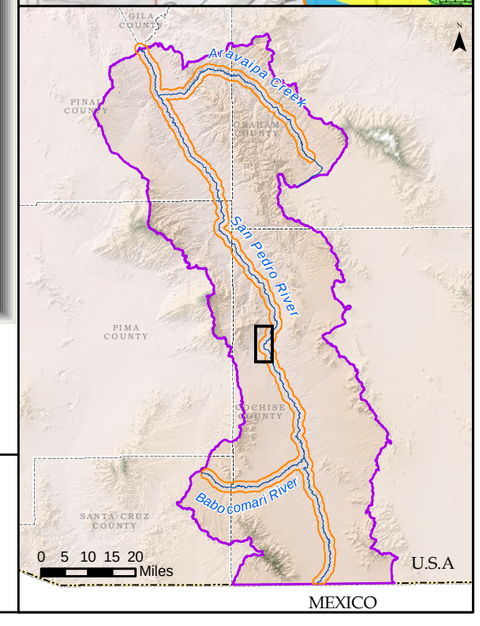
San Pedro River Cross Section at Mile 087

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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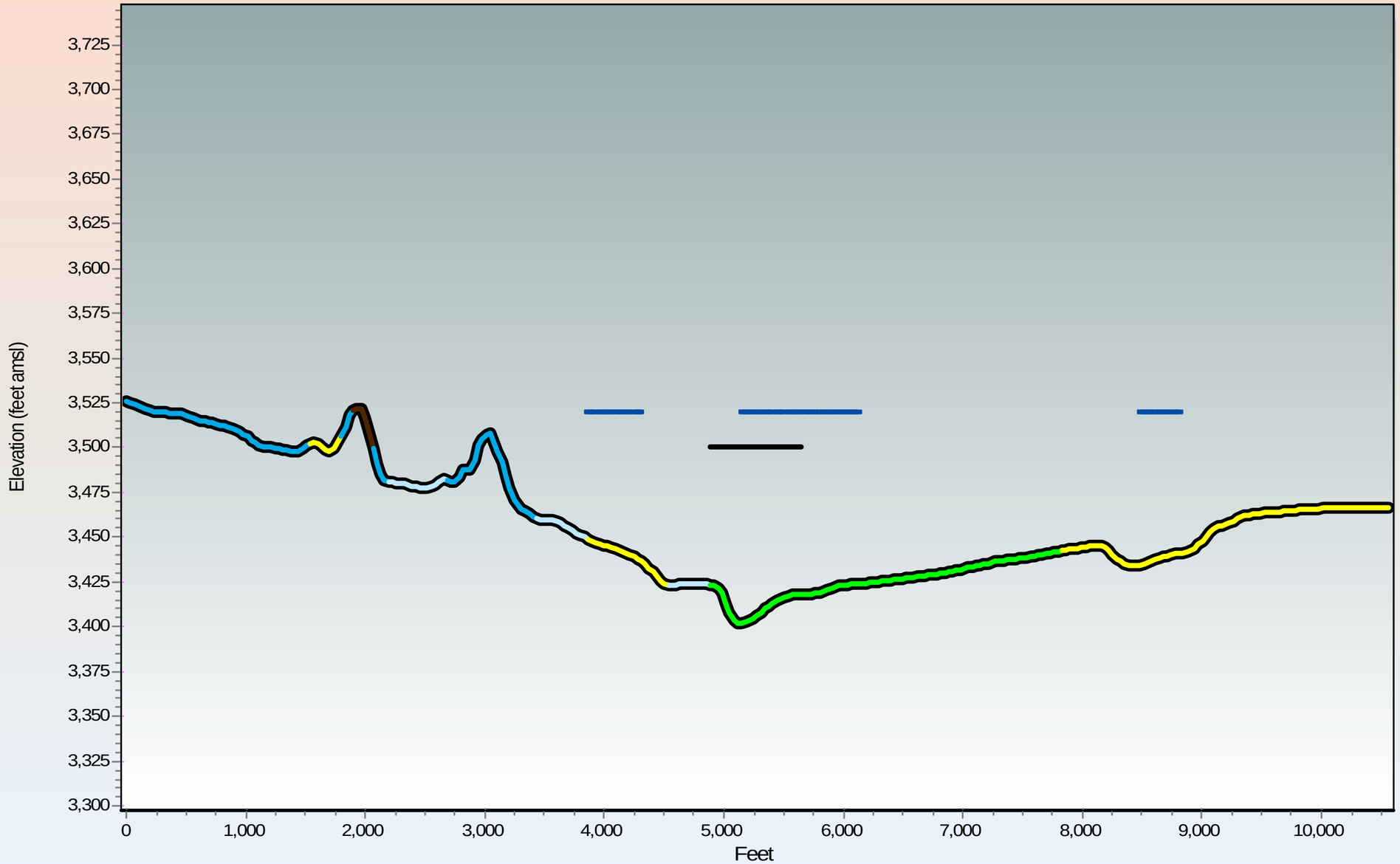
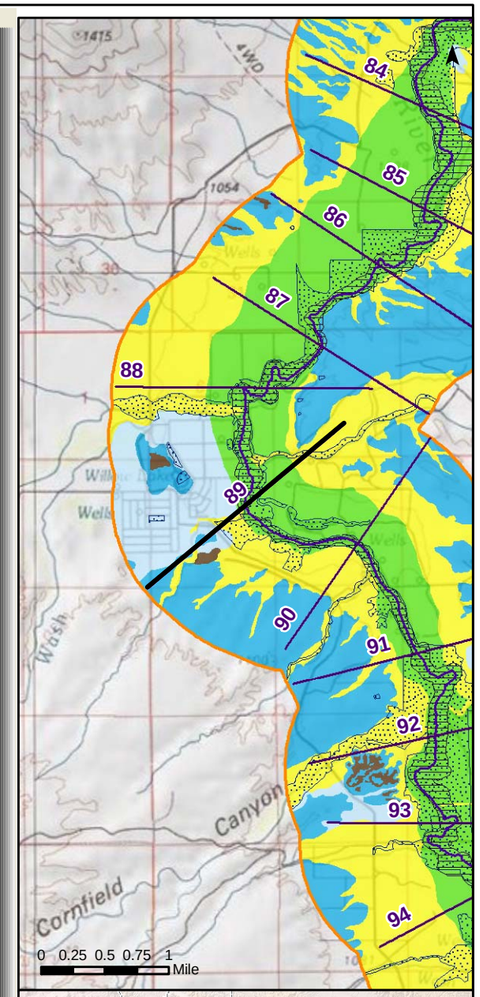
Appendix F

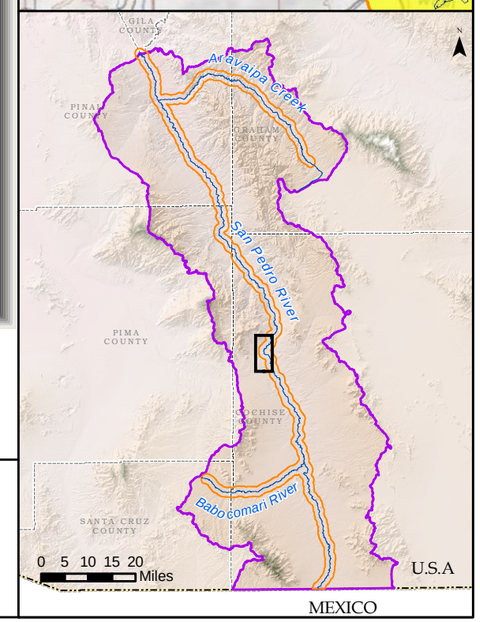
San Pedro River Cross Section at Mile 088

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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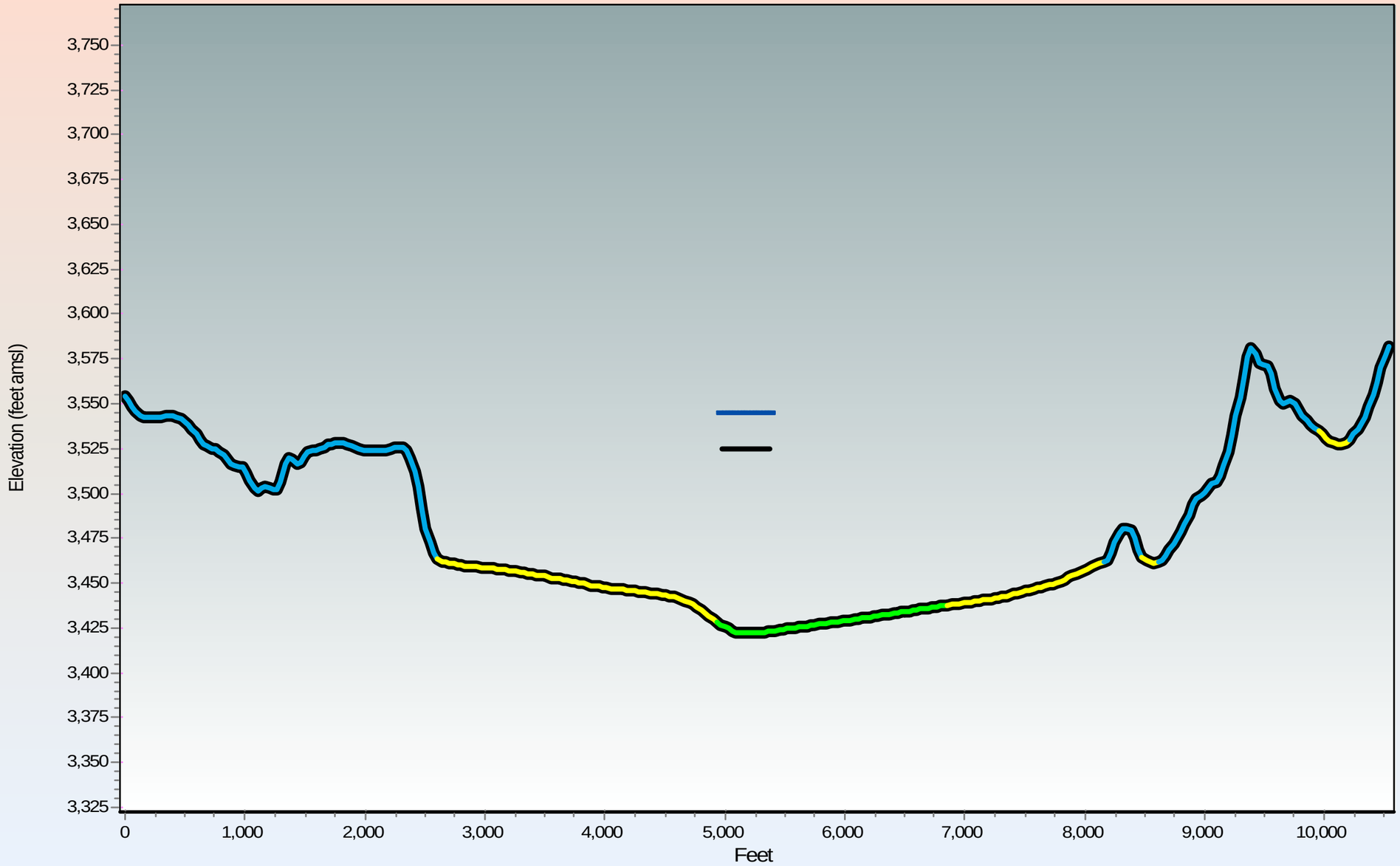
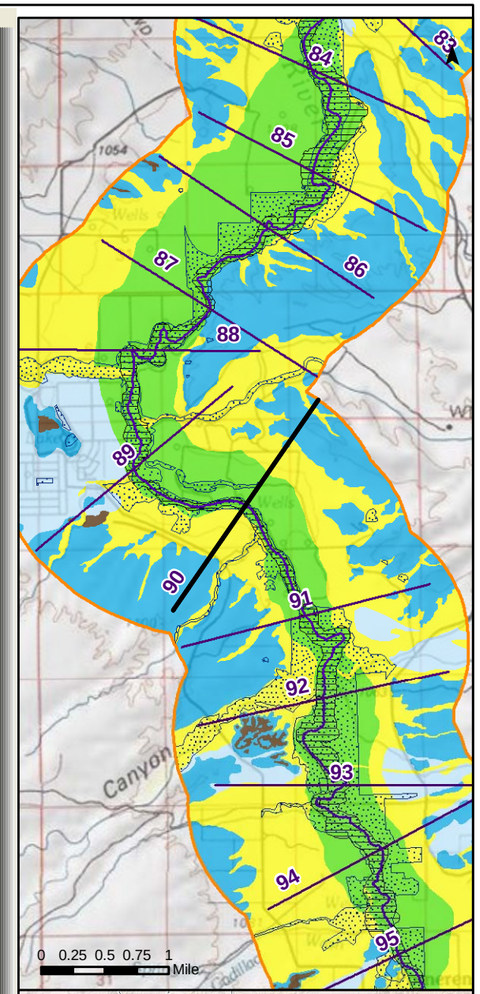
Appendix F

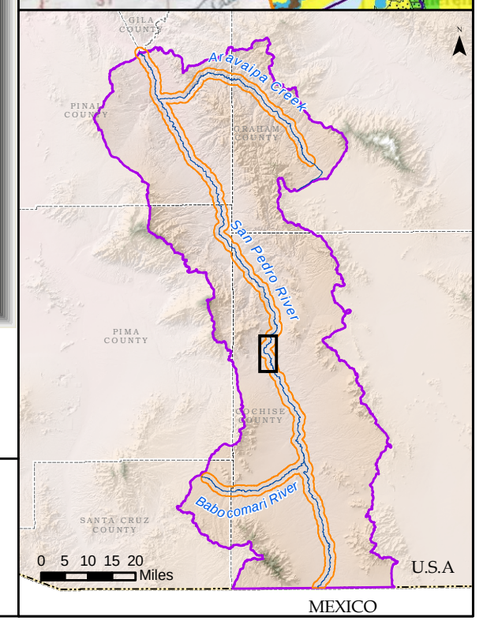
San Pedro River Cross Section at Mile 089

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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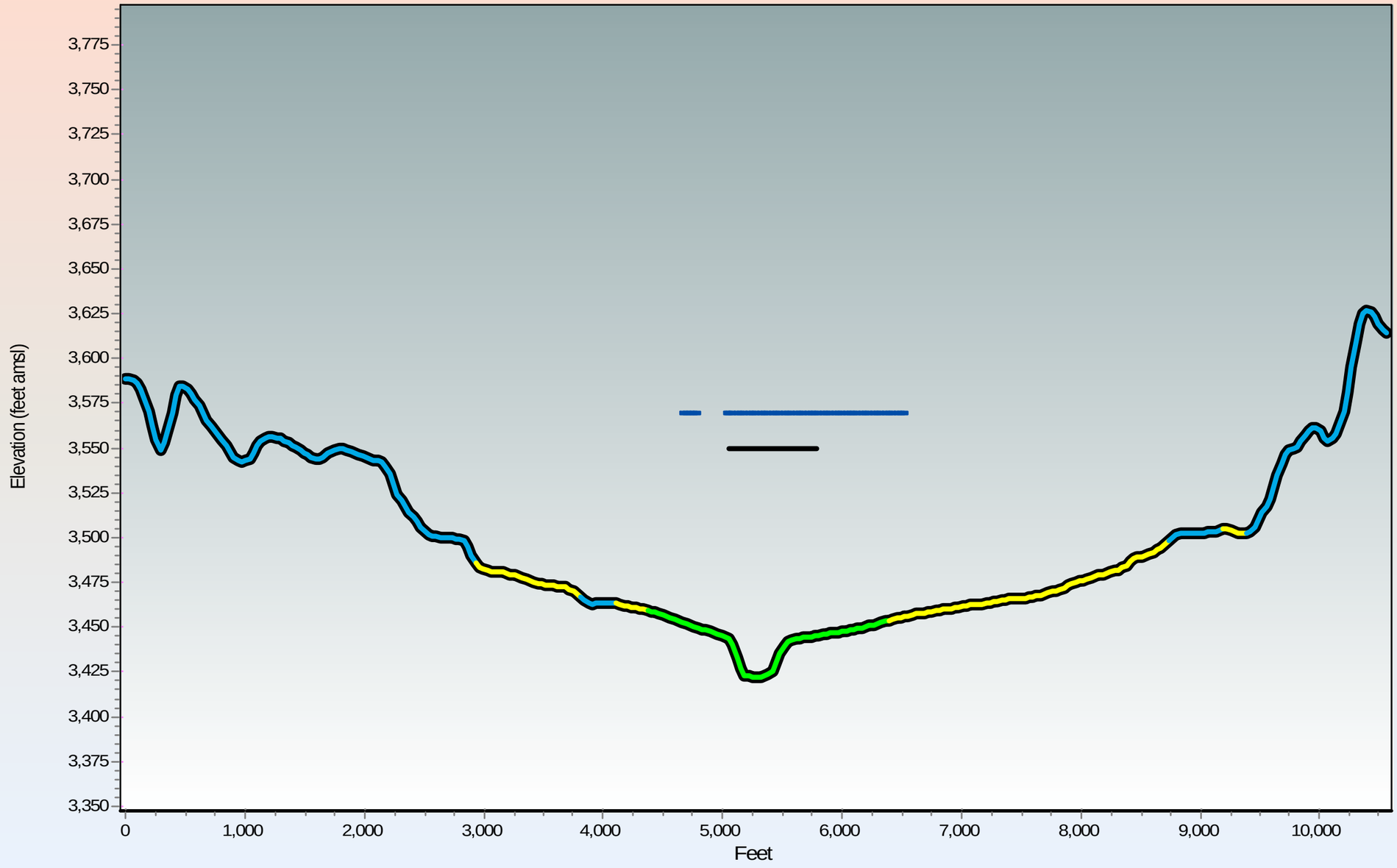
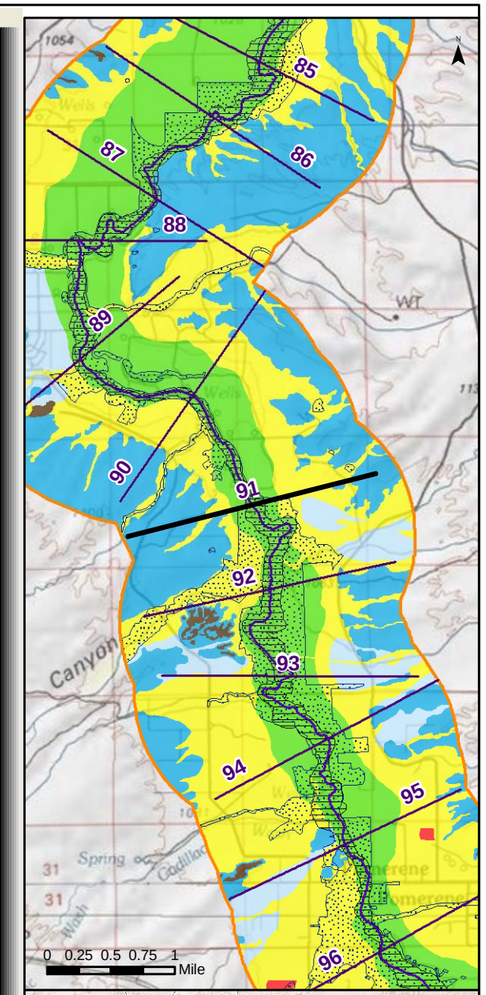
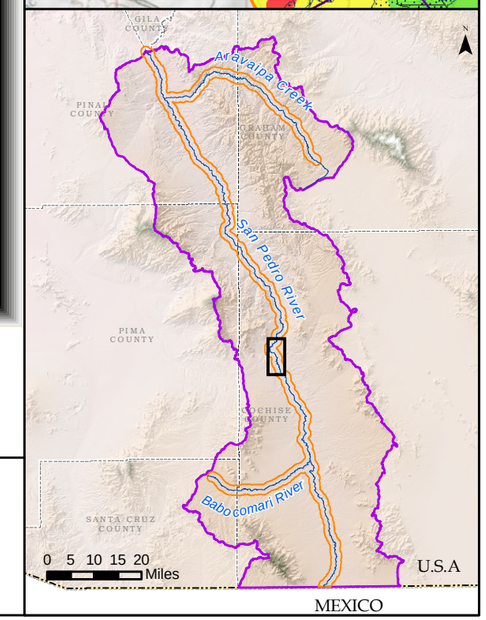
Appendix F
San Pedro River Cross Section at Mile 090
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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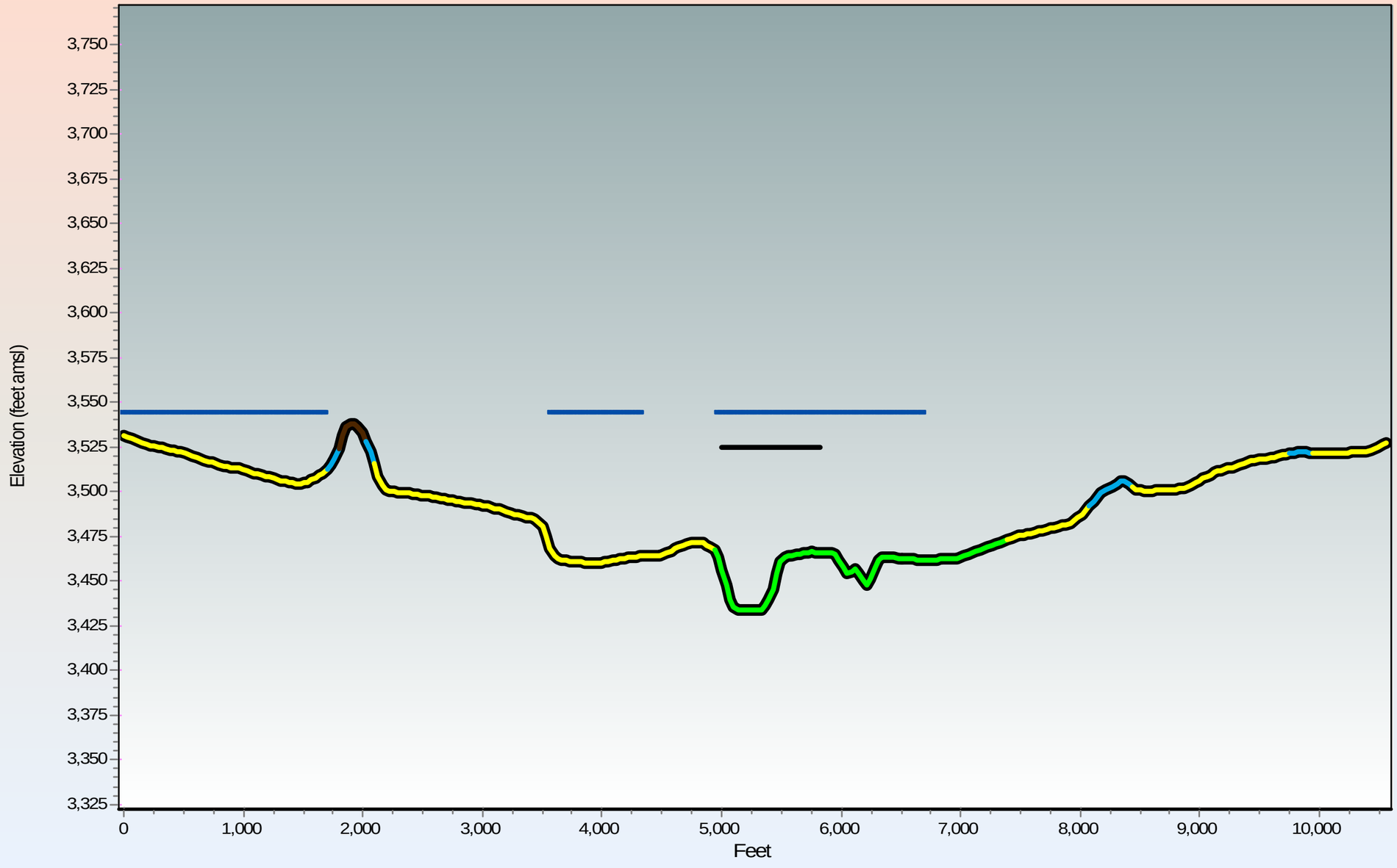
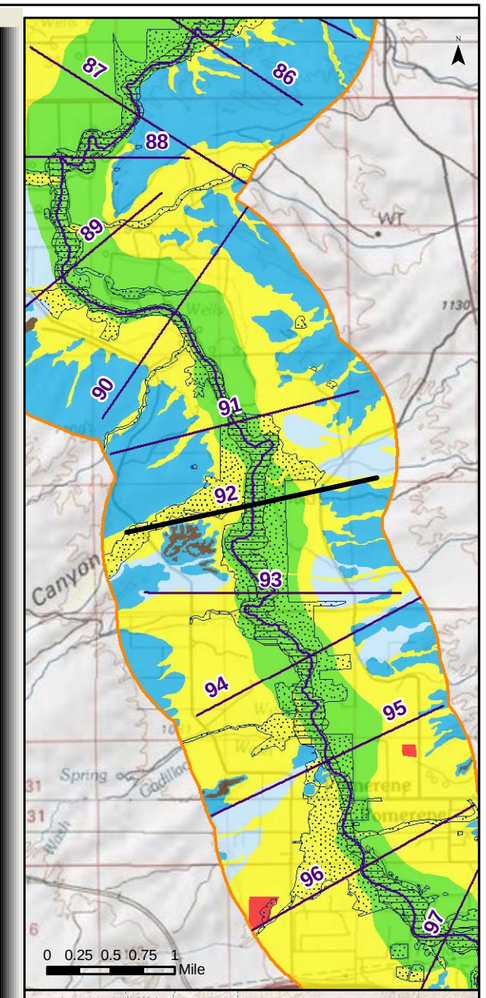
Appendix F

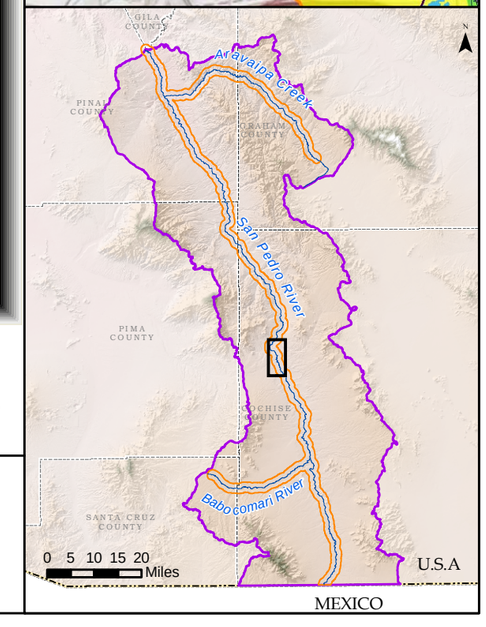
San Pedro River Cross Section at Mile 091

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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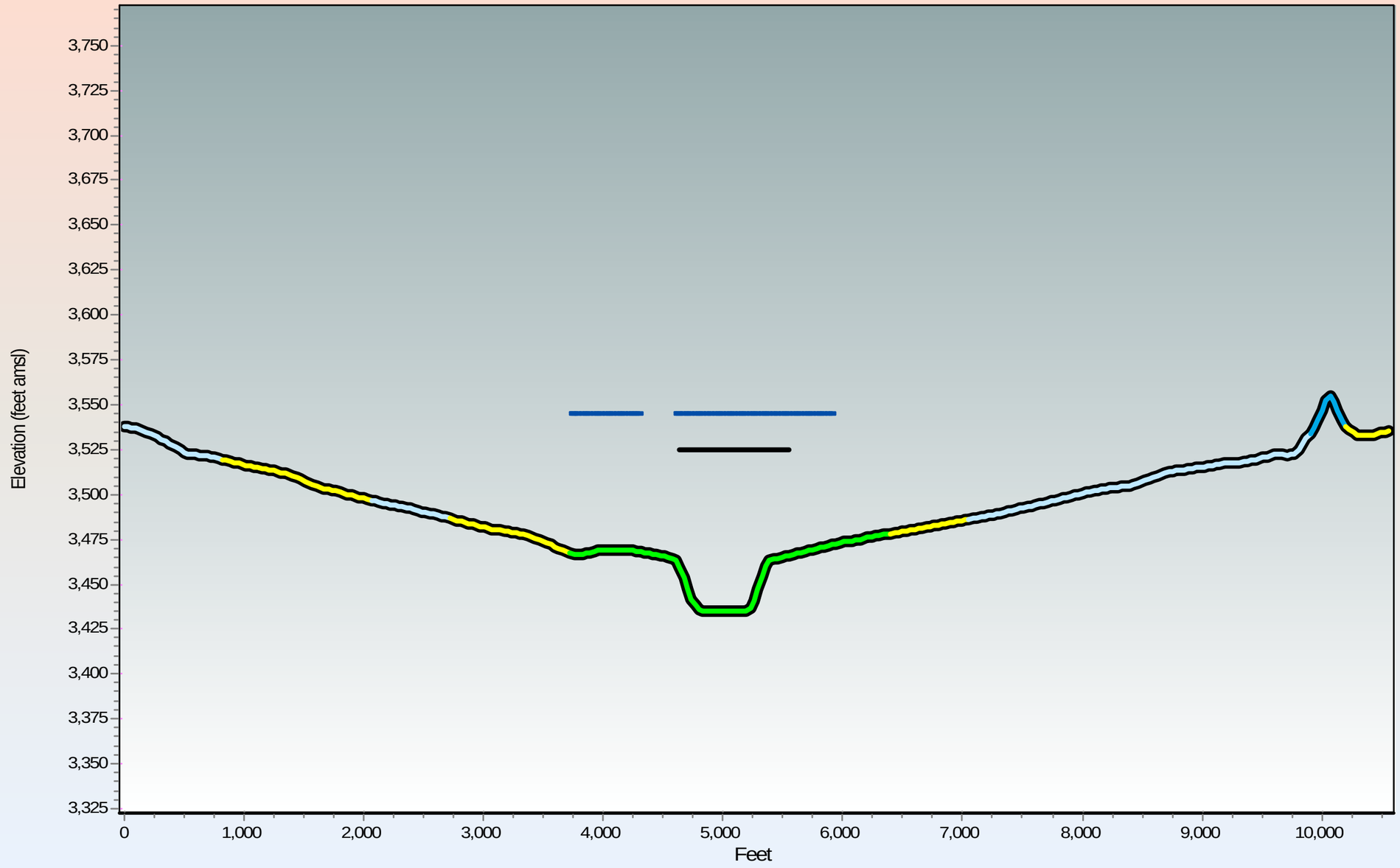
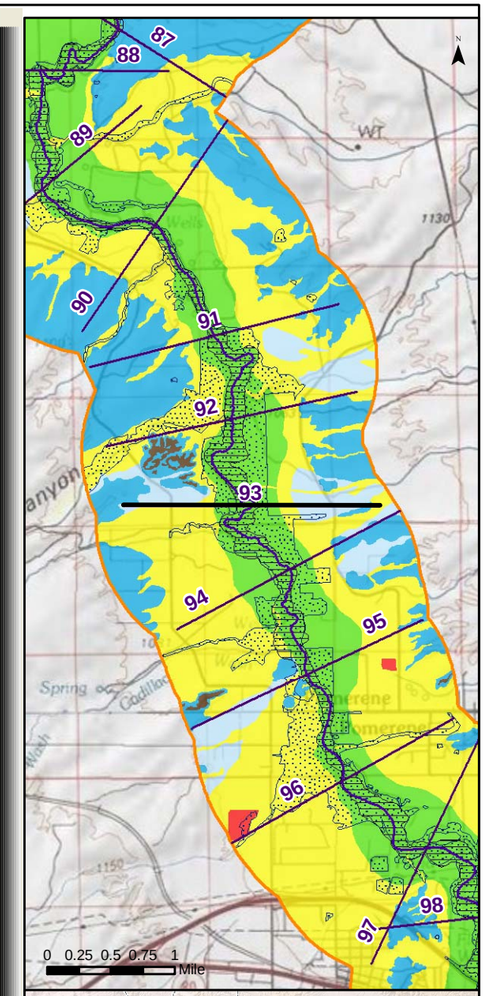
Appendix F

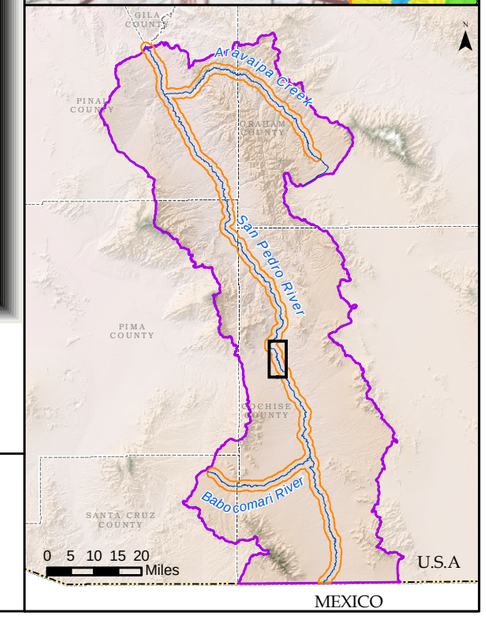
San Pedro River Cross Section at Mile 092

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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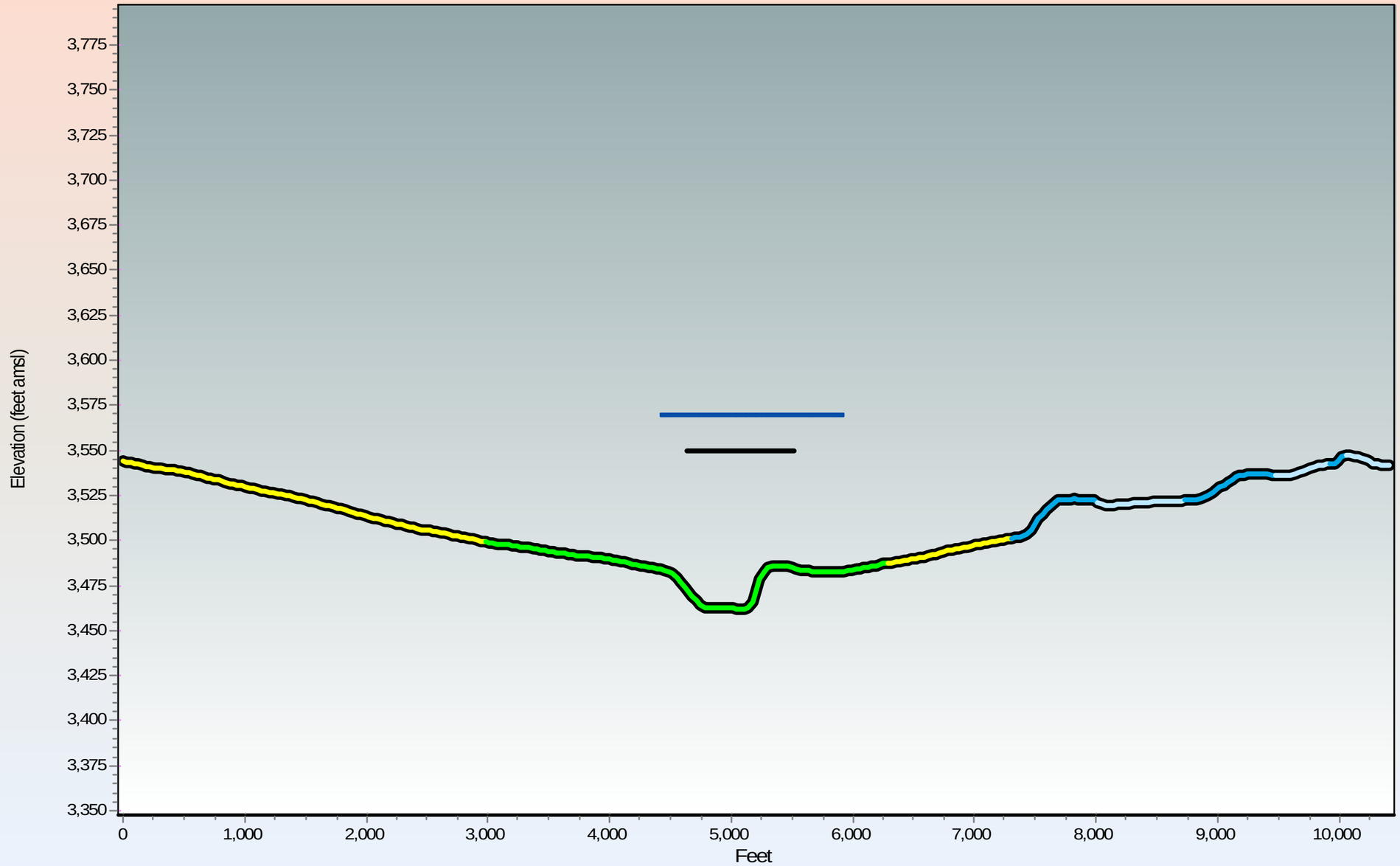
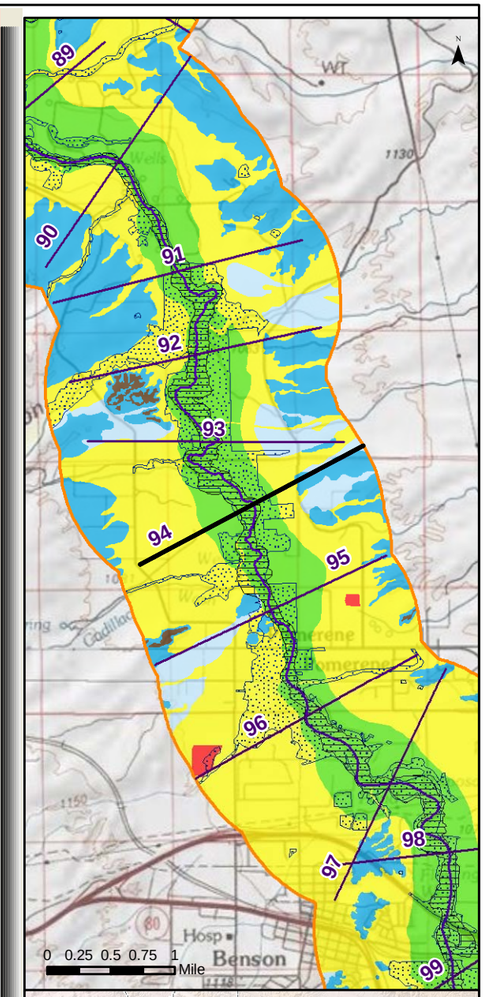
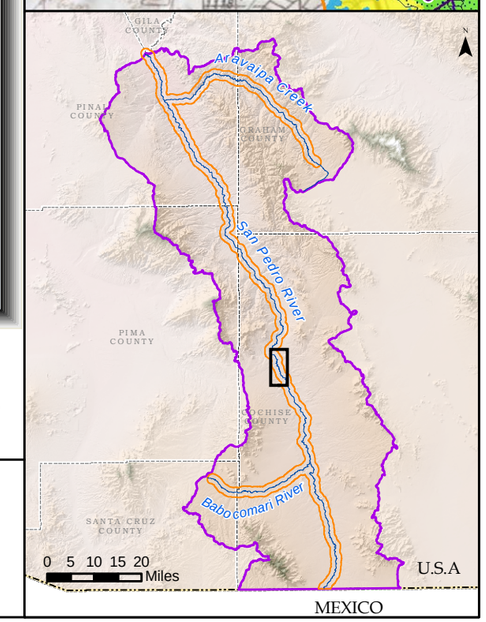
Appendix F
San Pedro River Cross Section at Mile 093
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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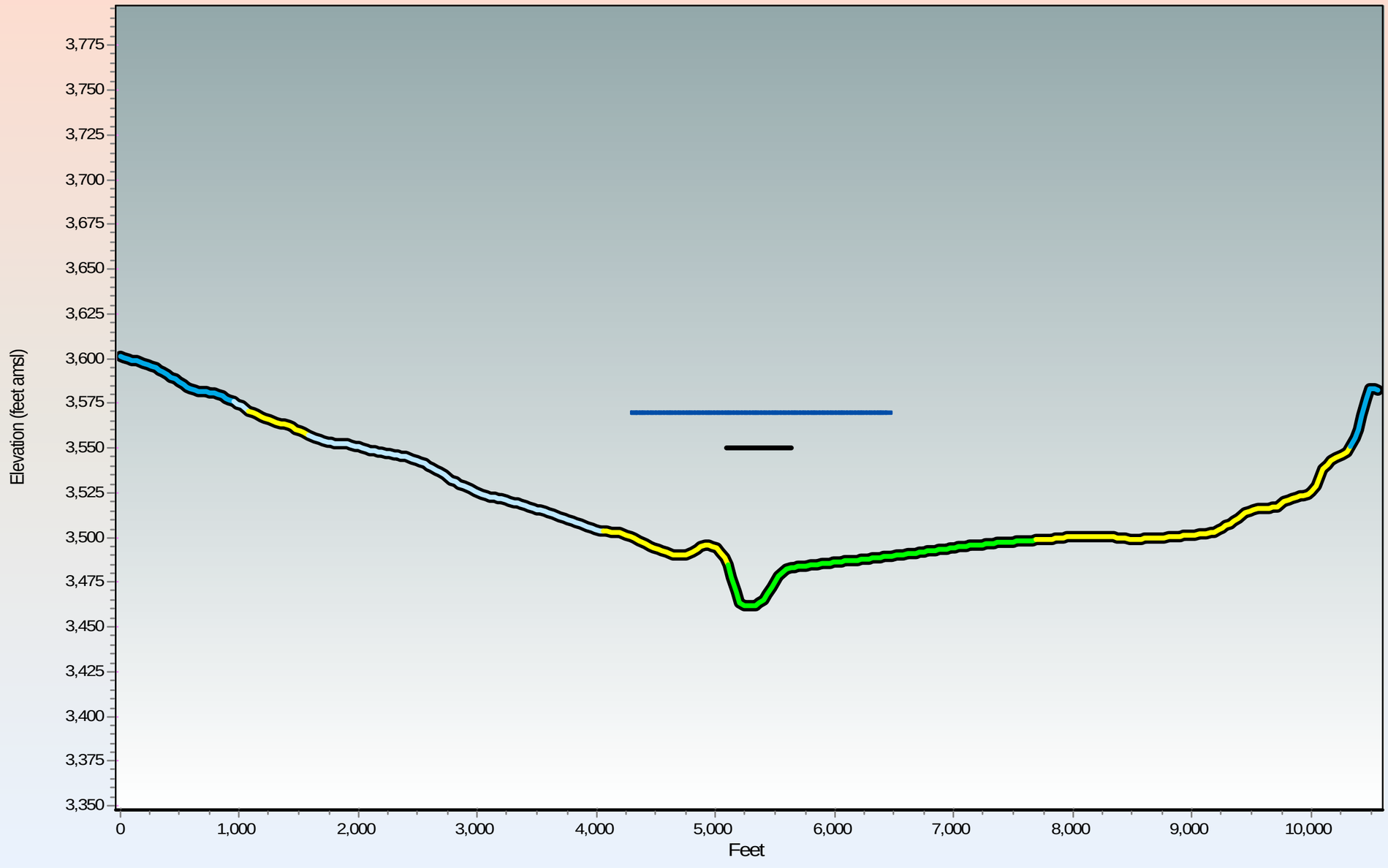
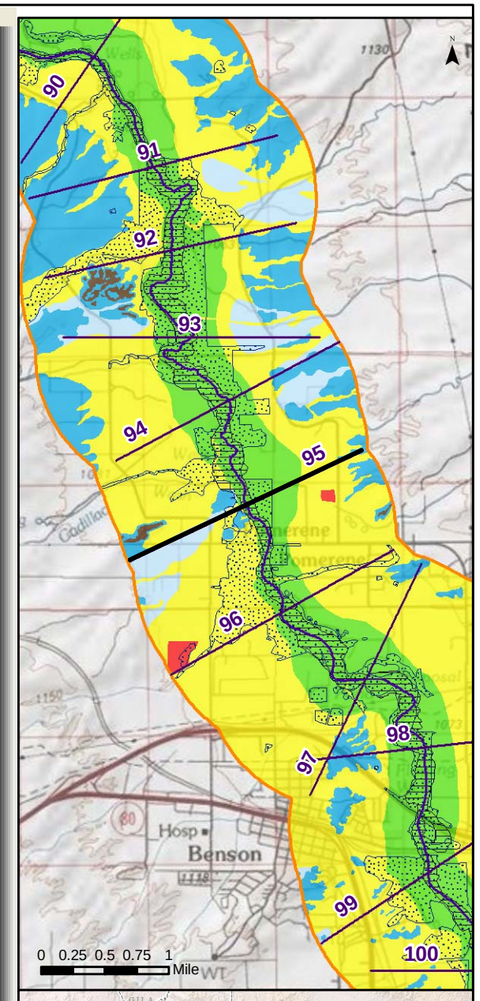
Appendix F

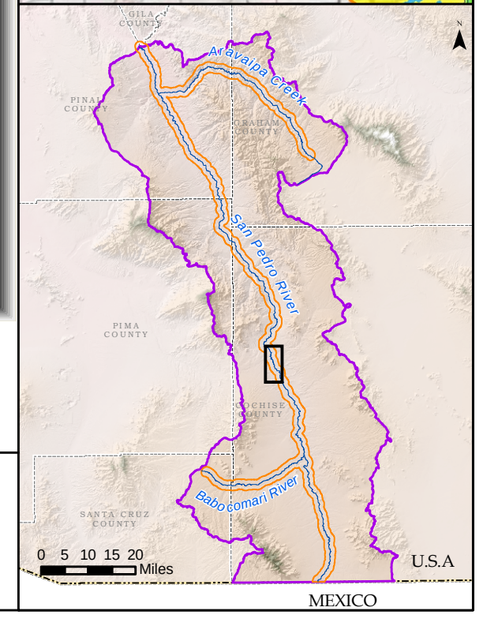
San Pedro River Cross Section at Mile 094

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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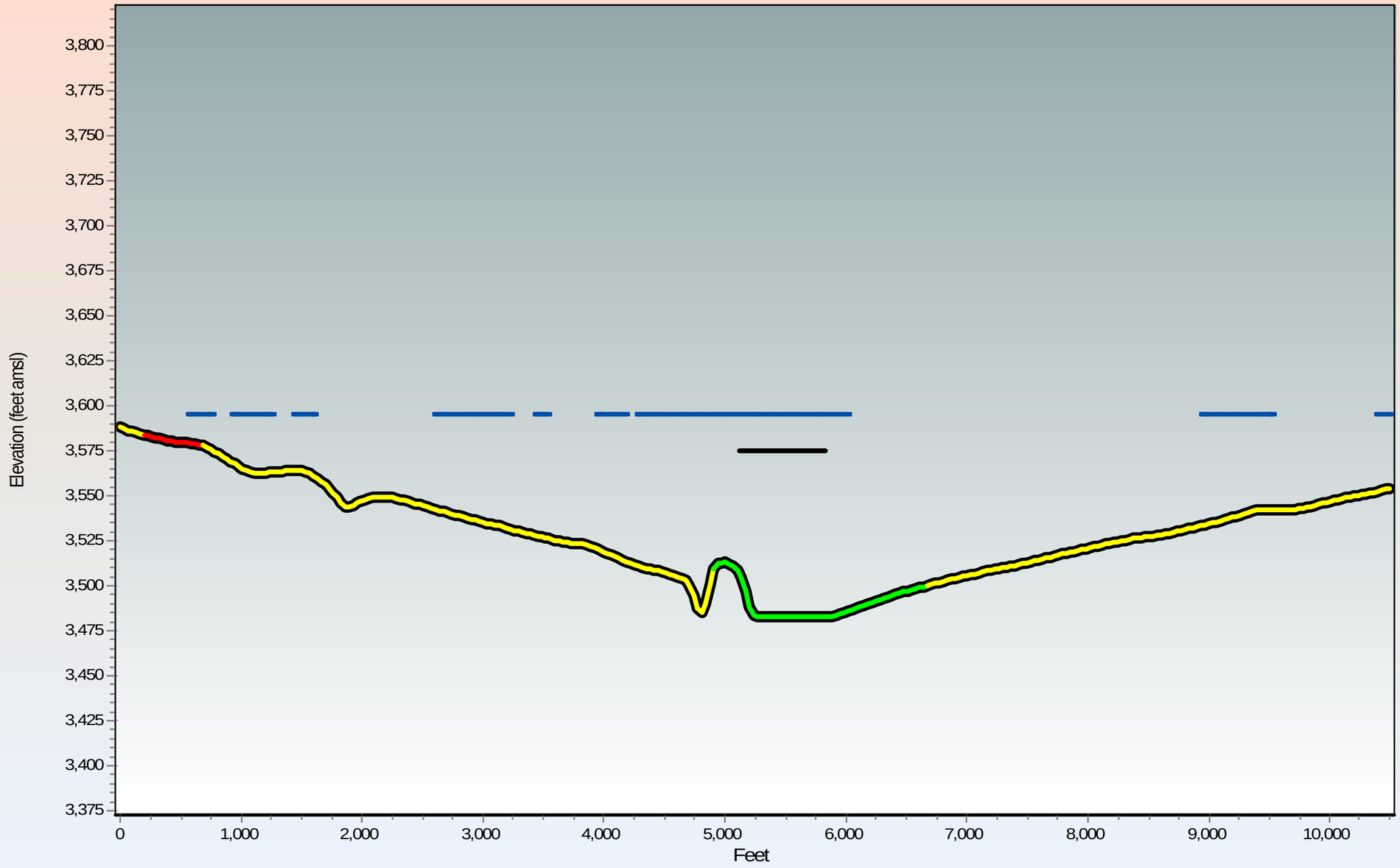
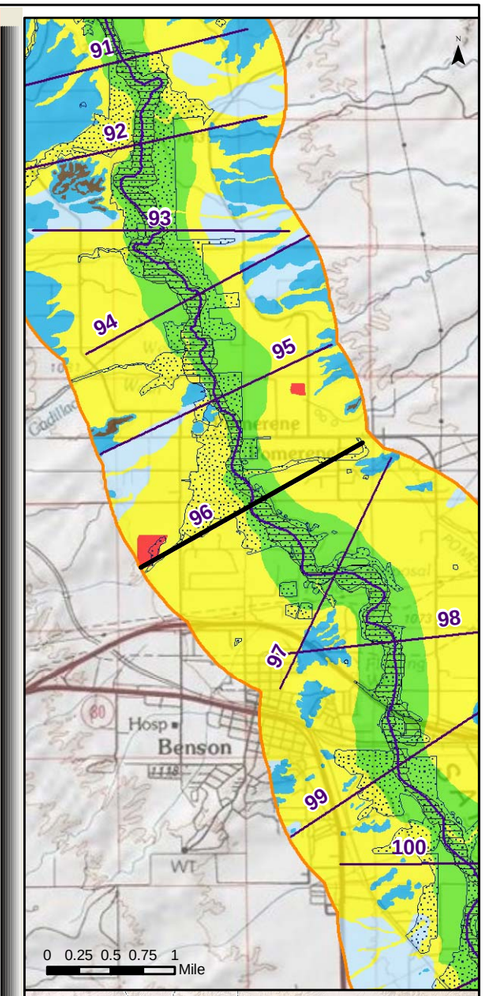
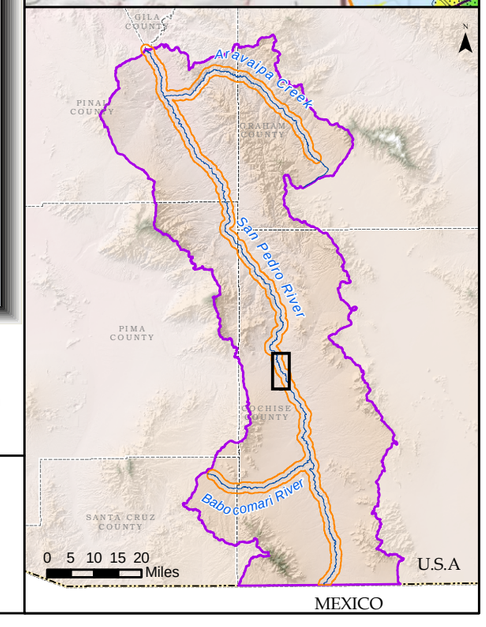
Appendix F
San Pedro River Cross Section at Mile 095
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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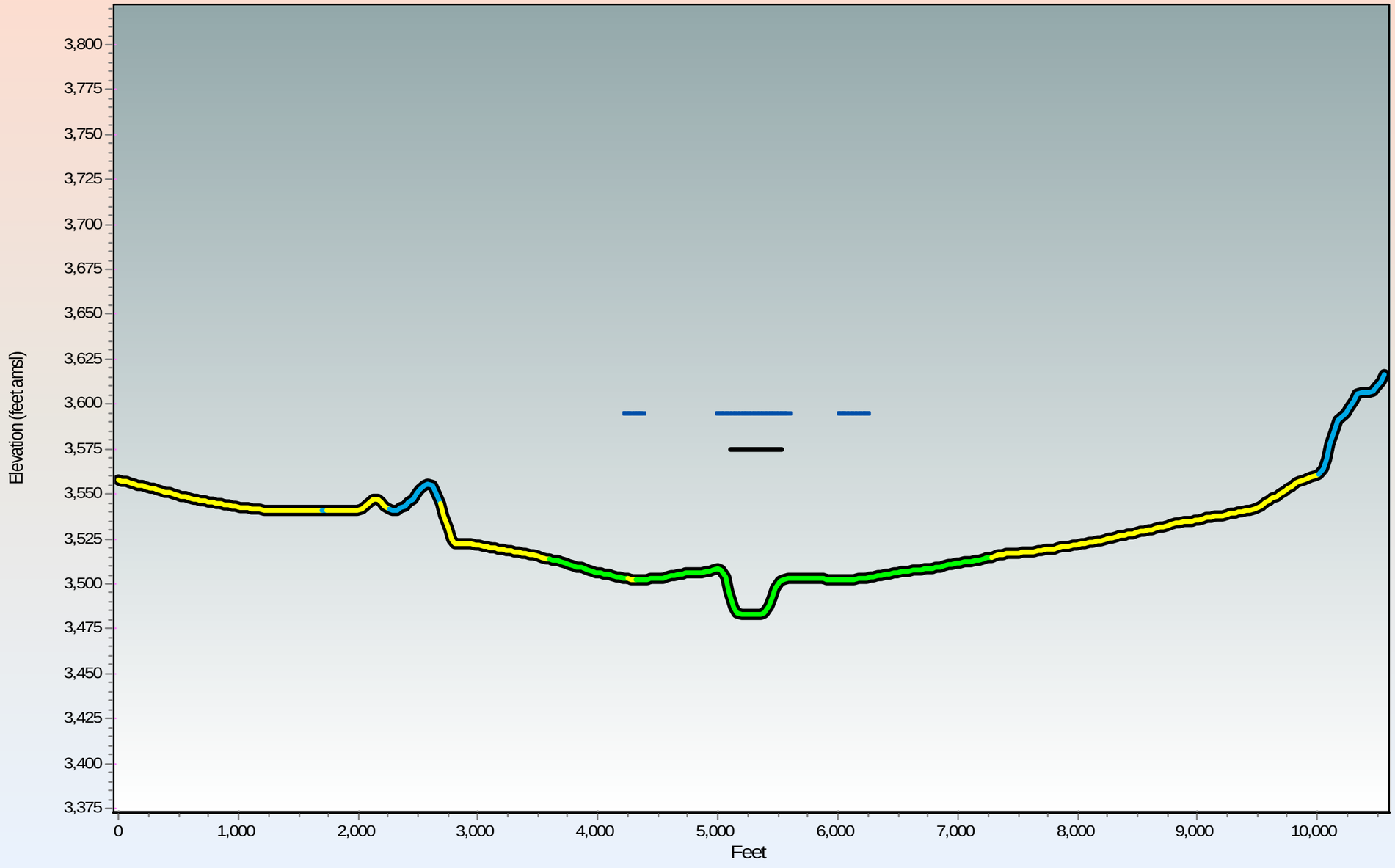
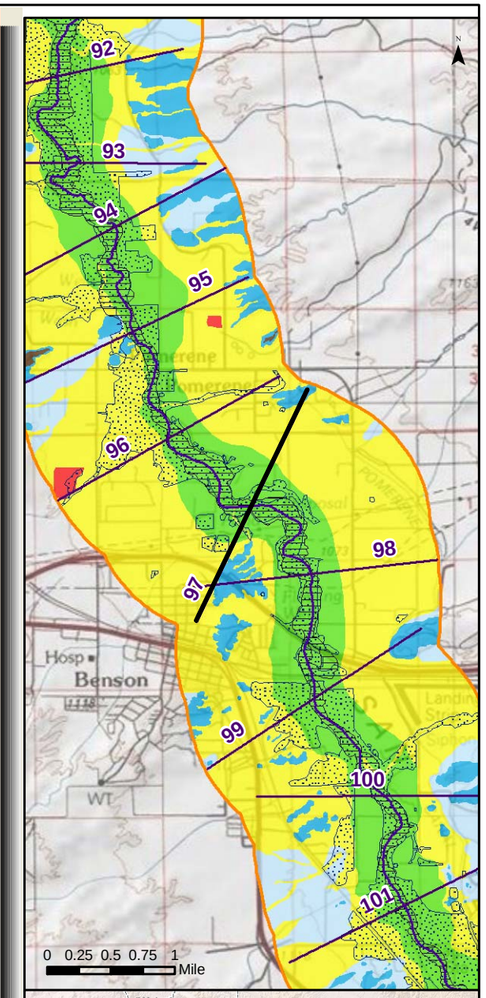
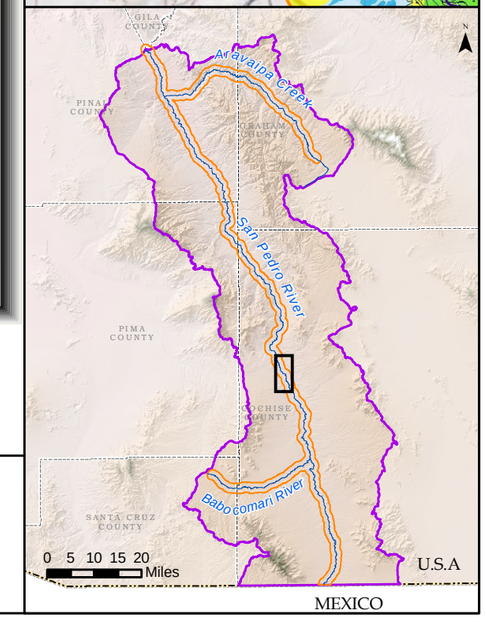
Appendix F
San Pedro River Cross Section at Mile 096
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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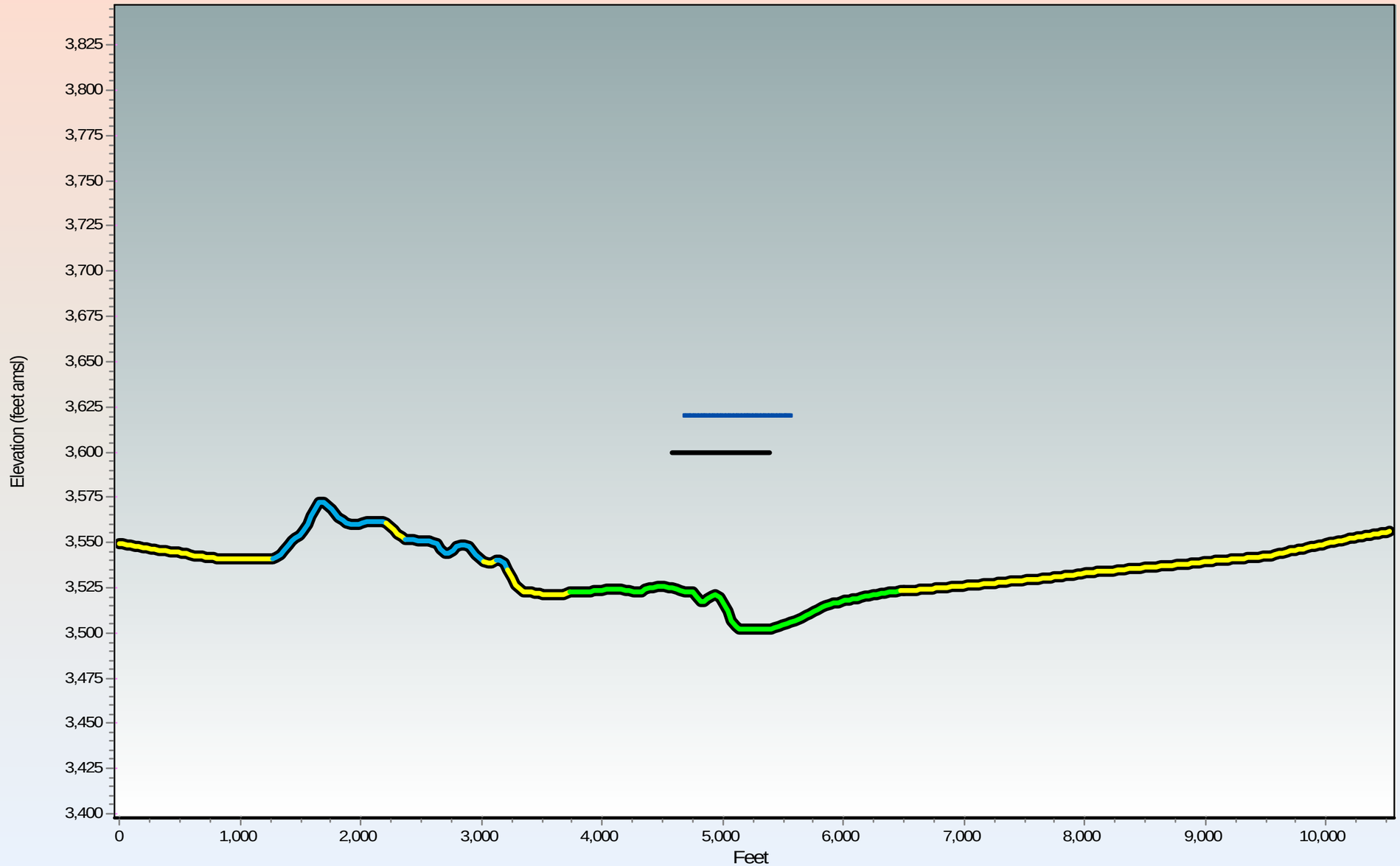
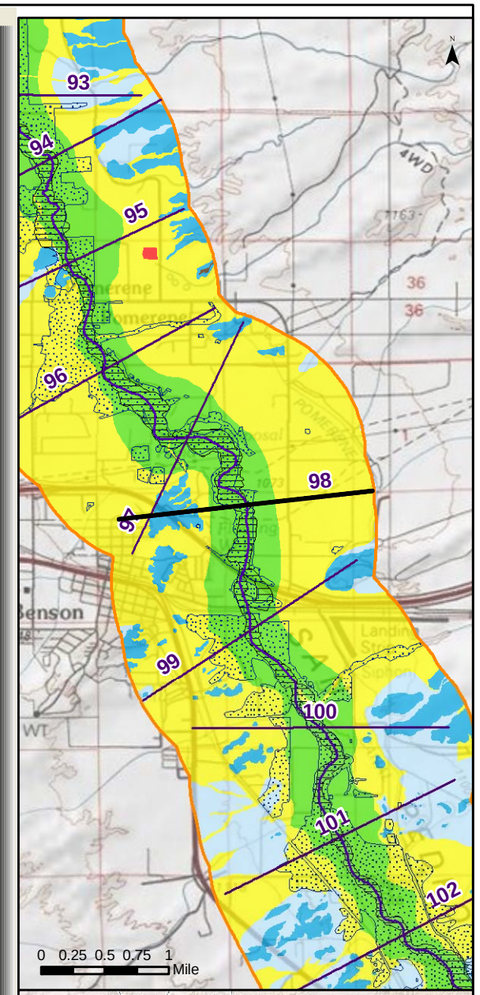
Appendix F

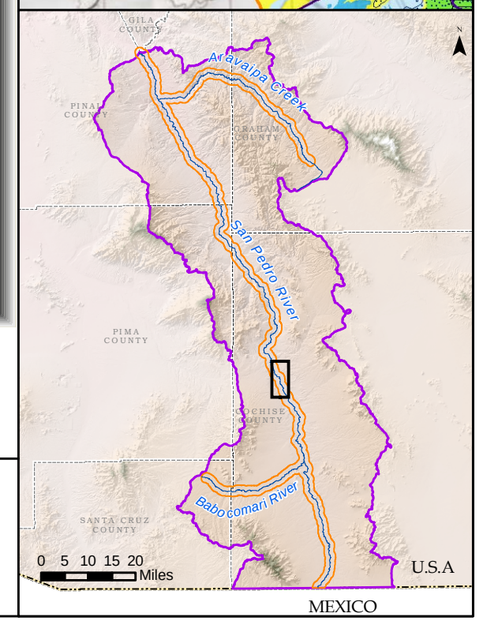
San Pedro River Cross Section at Mile 097

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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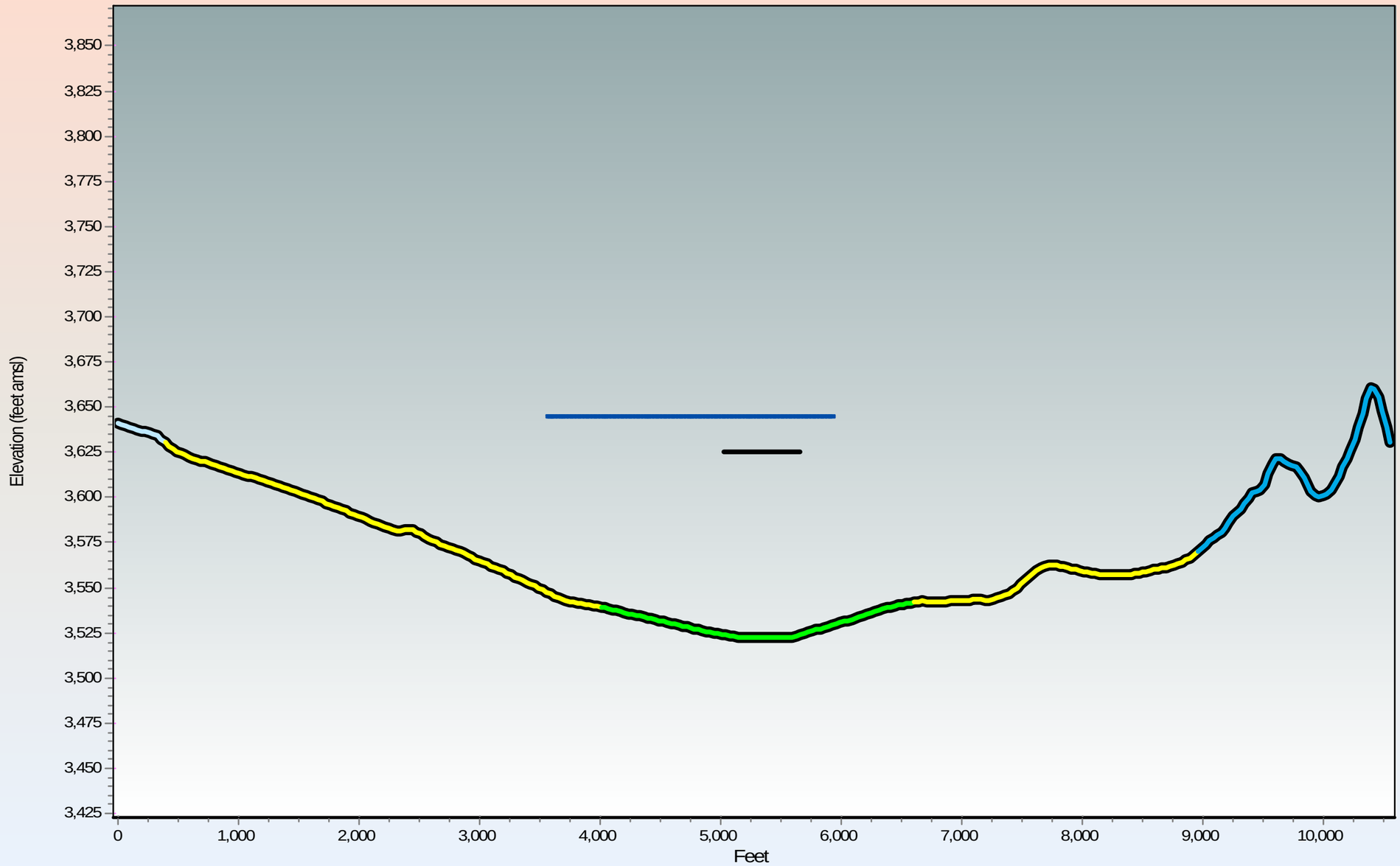
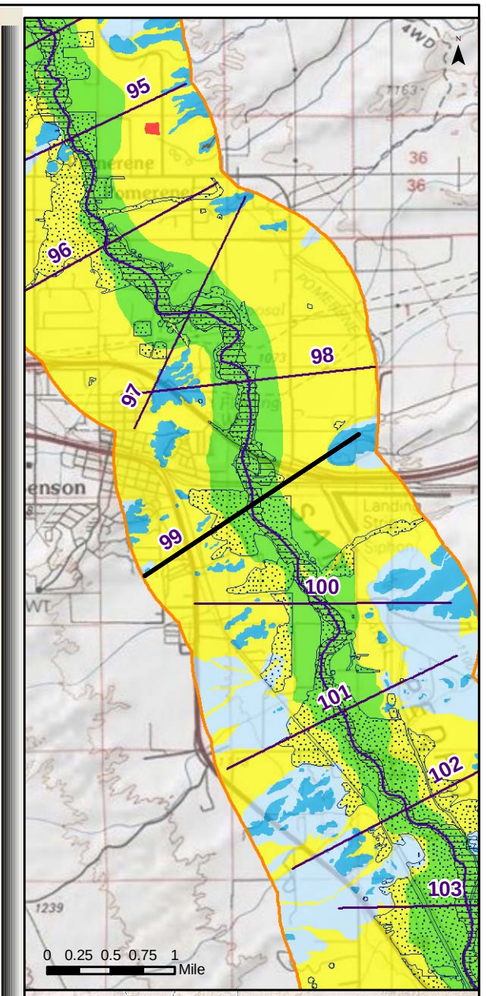
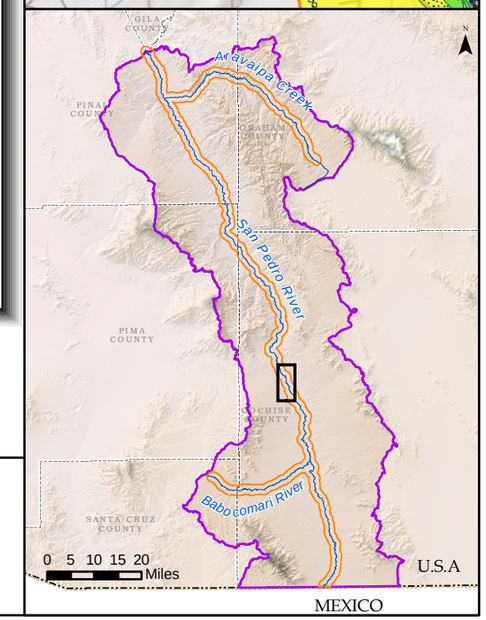
Appendix F
San Pedro River Cross Section at Mile 098
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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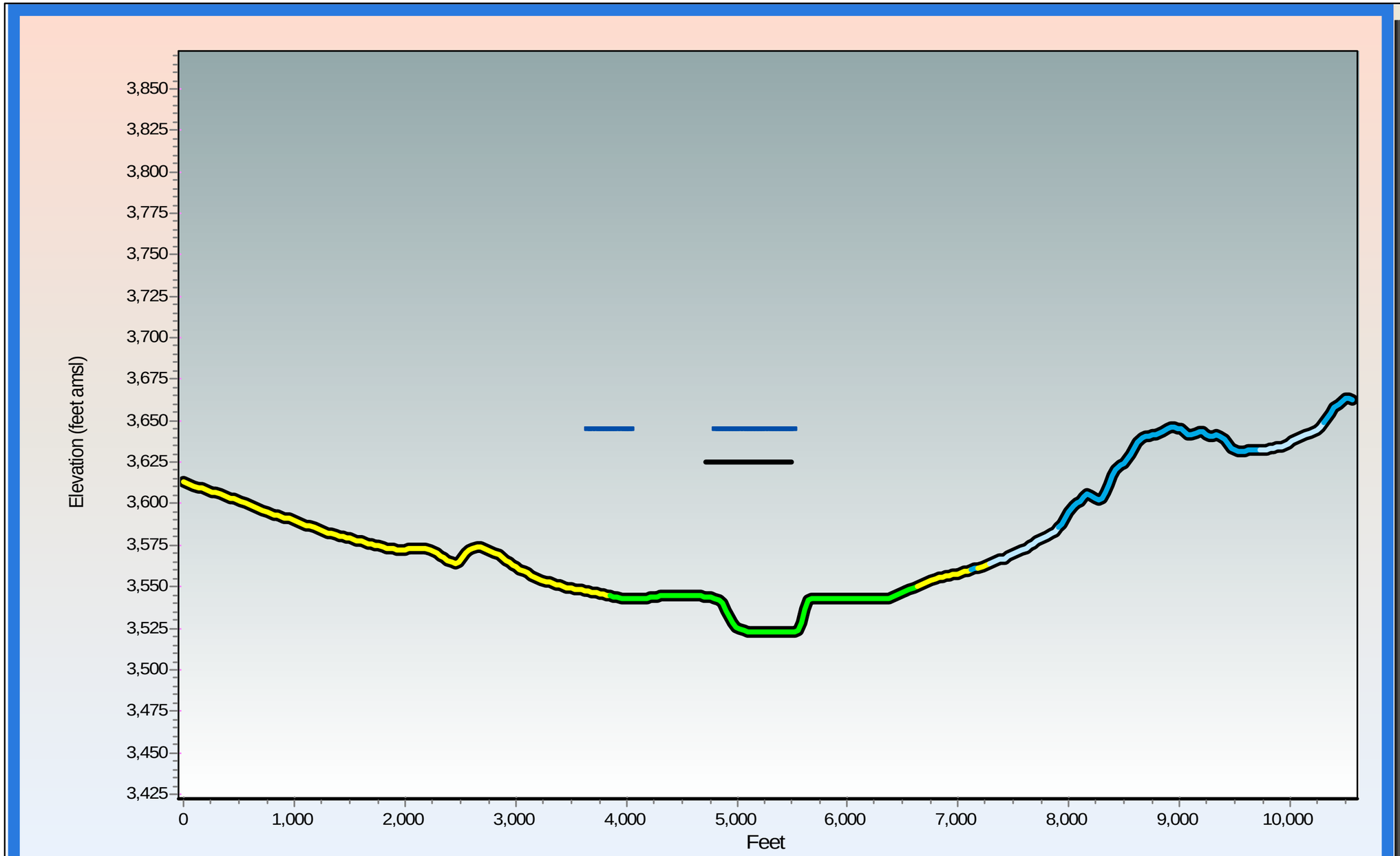
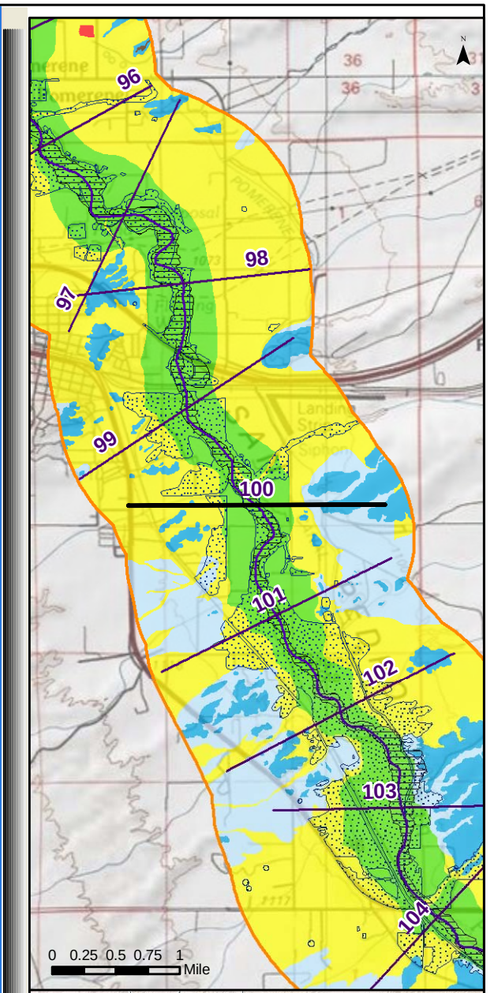
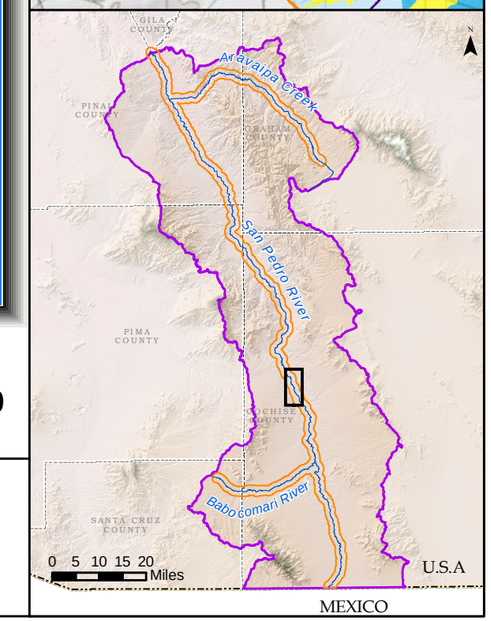
Appendix F
San Pedro River Cross Section at Mile 099
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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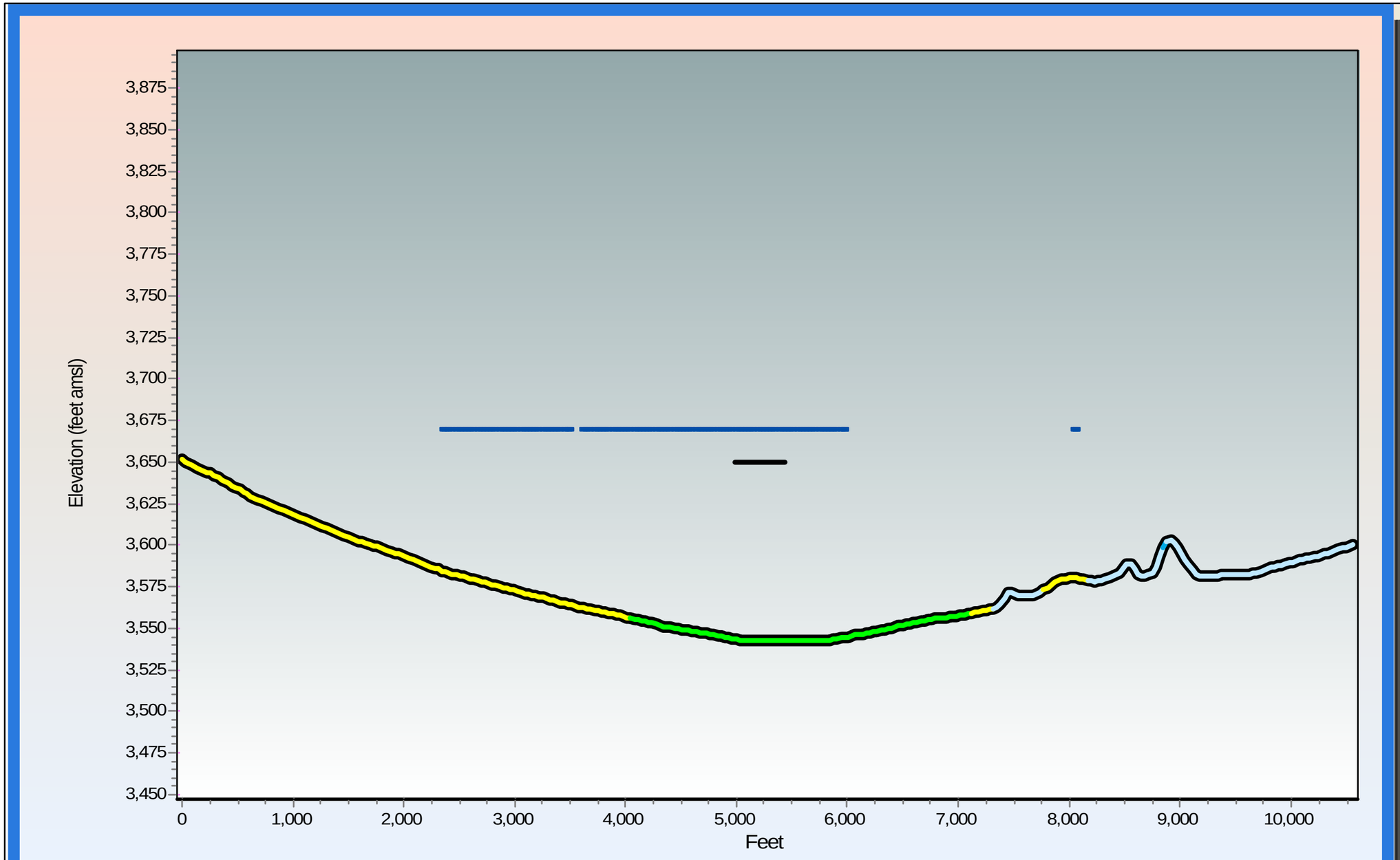
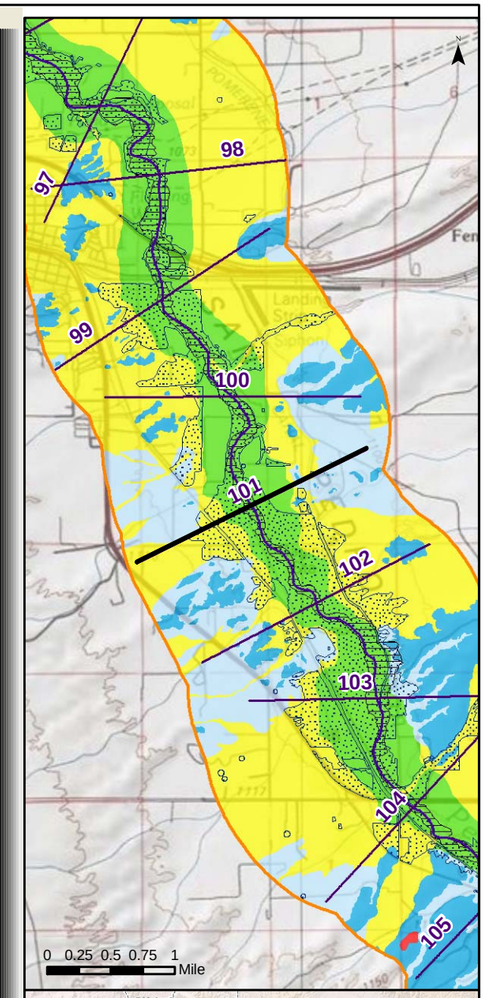
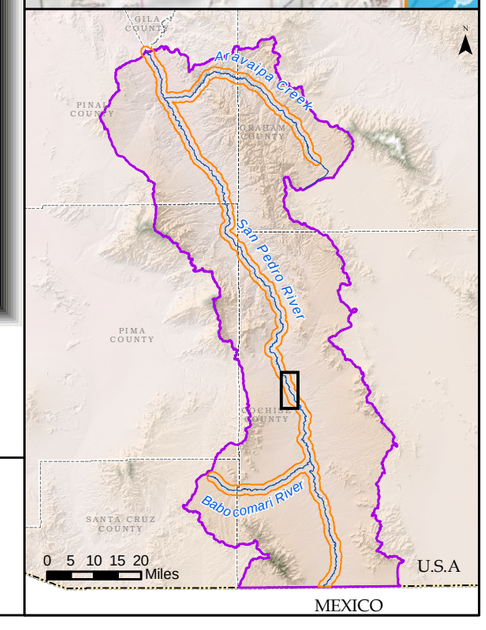
Appendix F
San Pedro River Cross Section at Mile 100
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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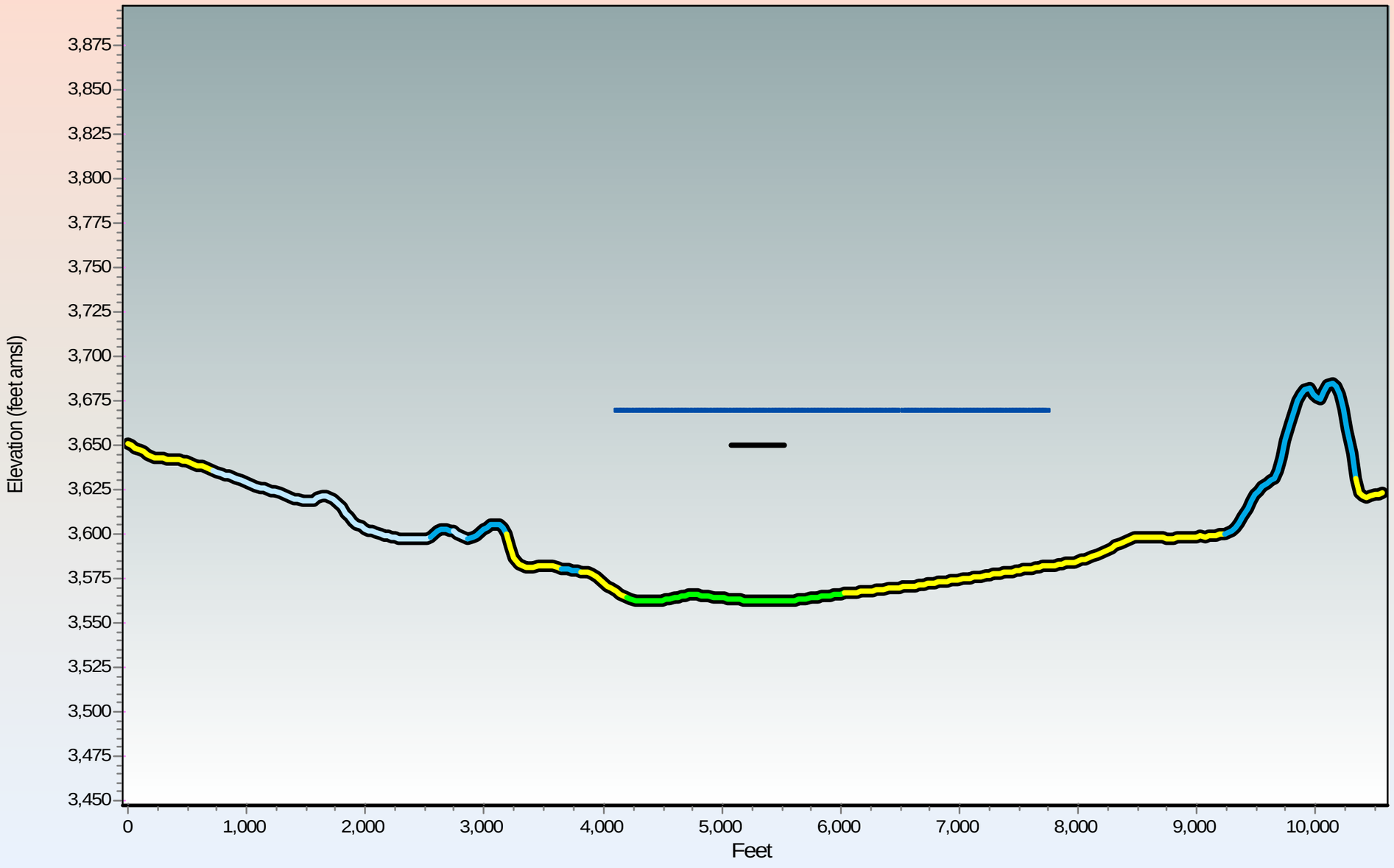
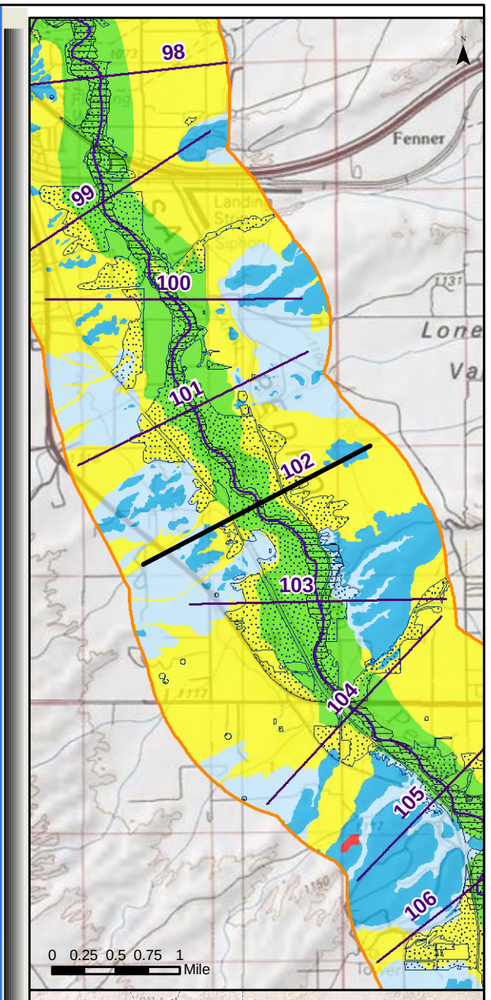
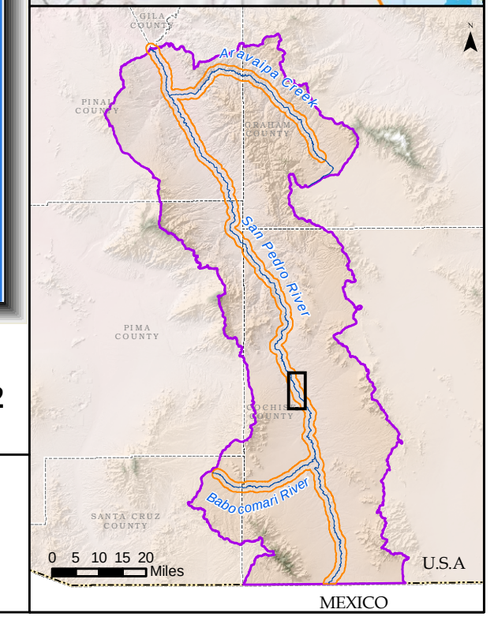
Appendix F
San Pedro River Cross Section at Mile 101
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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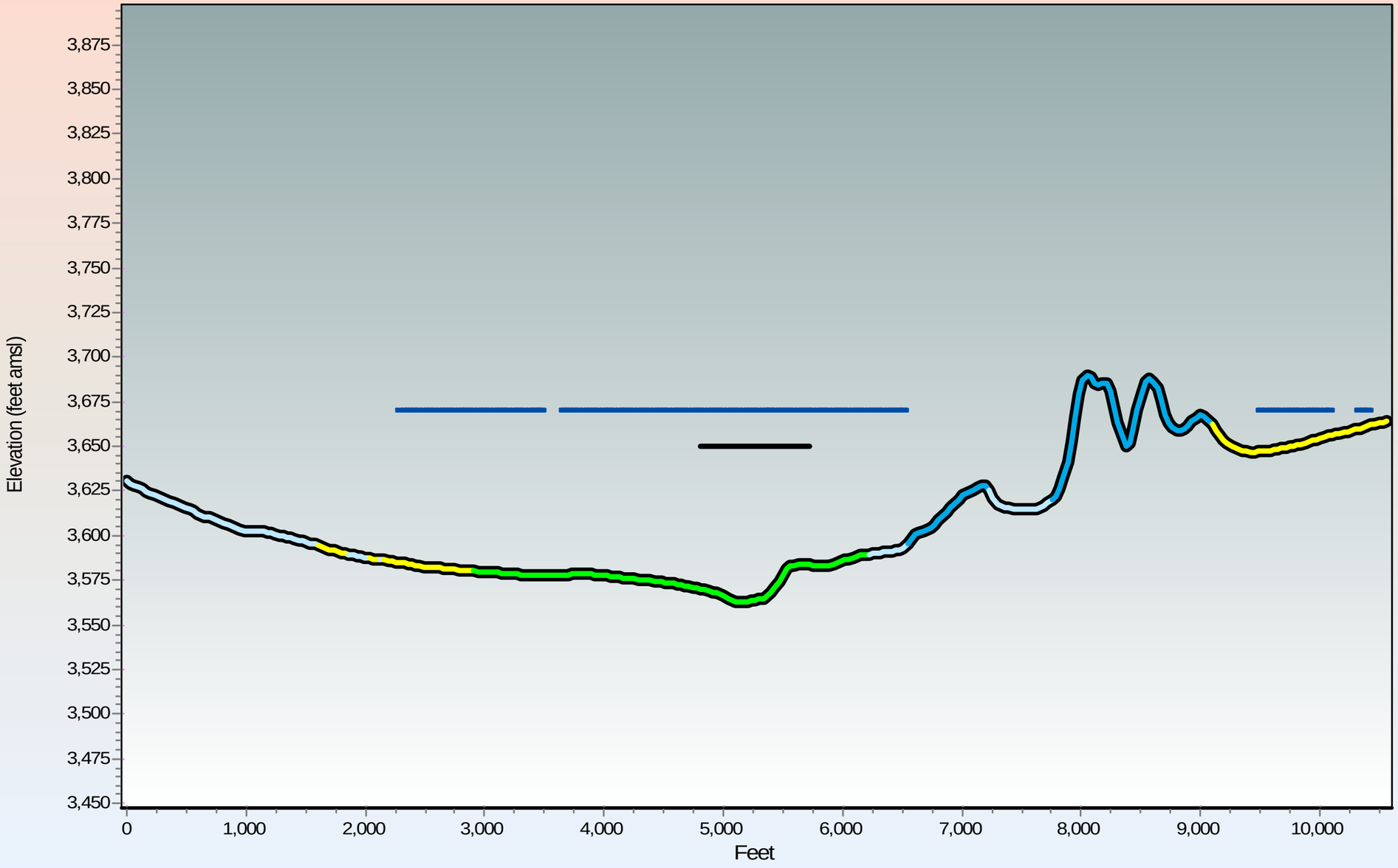
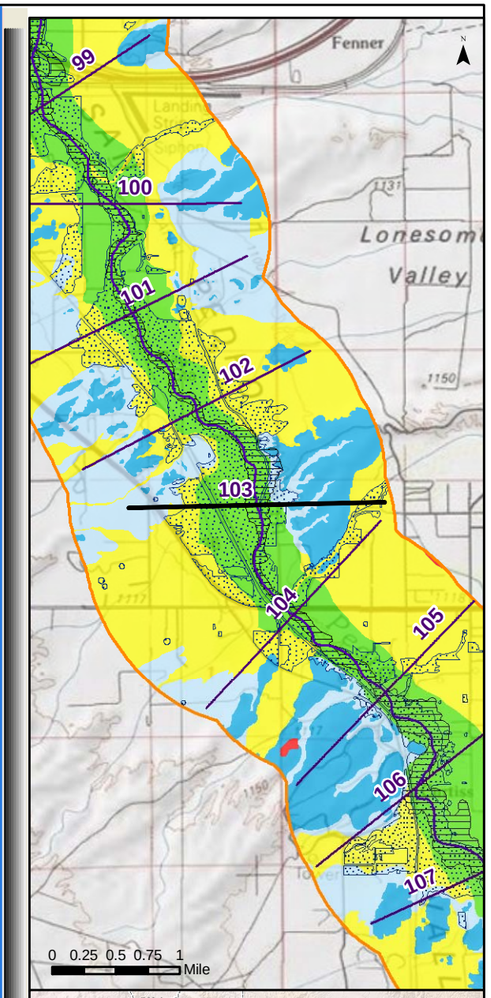
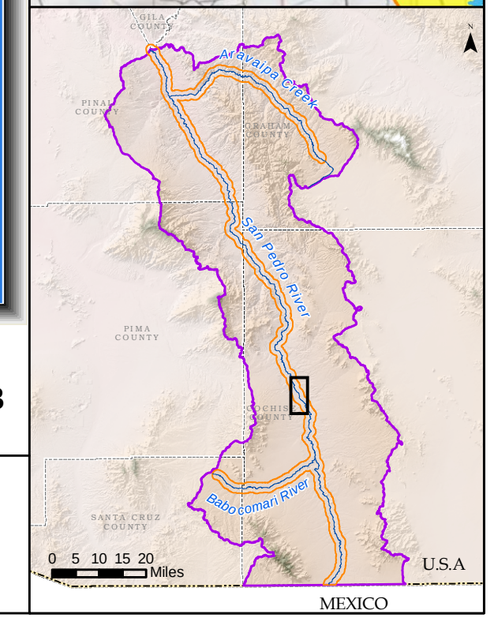
Appendix F
San Pedro River Cross Section at Mile 102
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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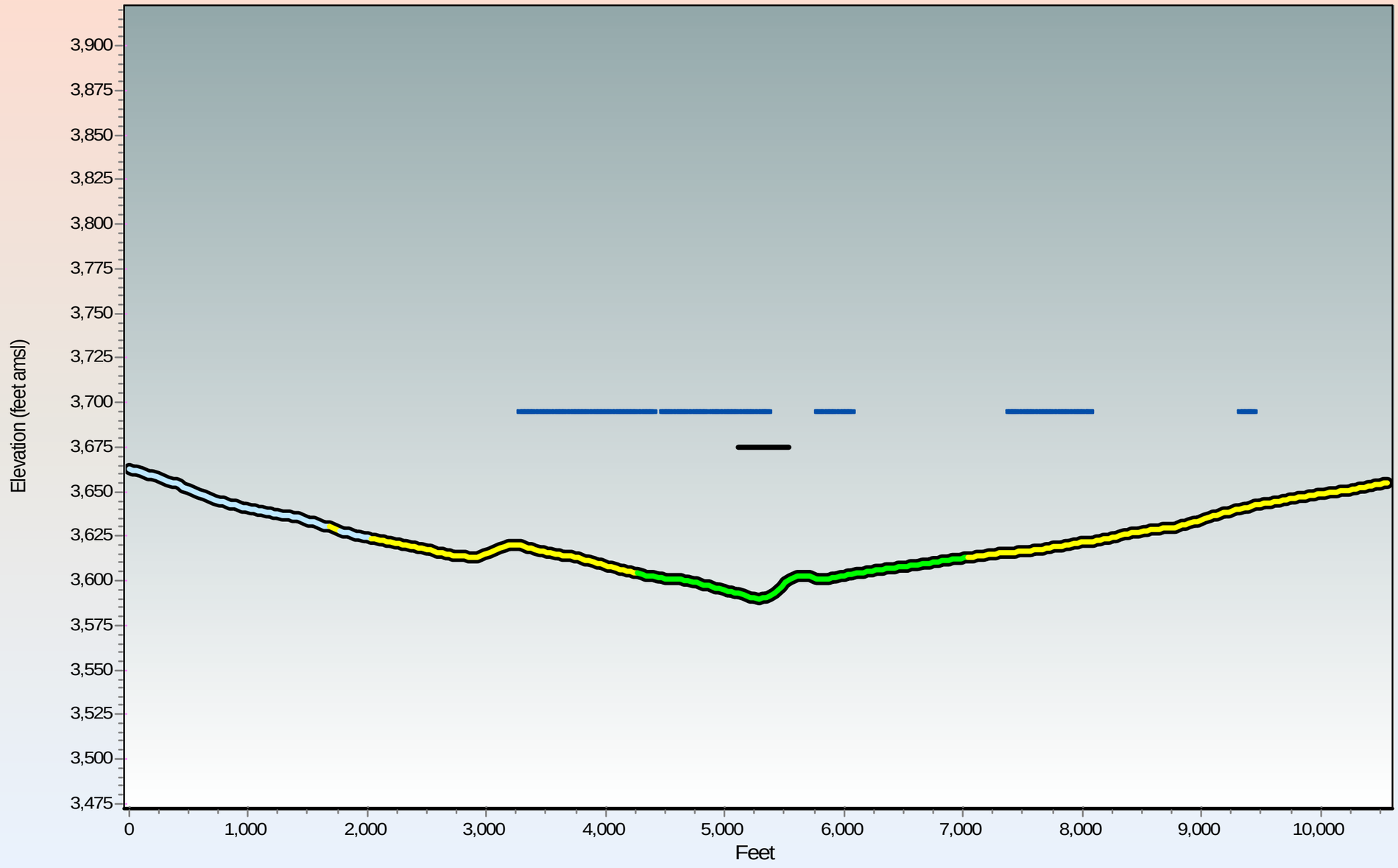
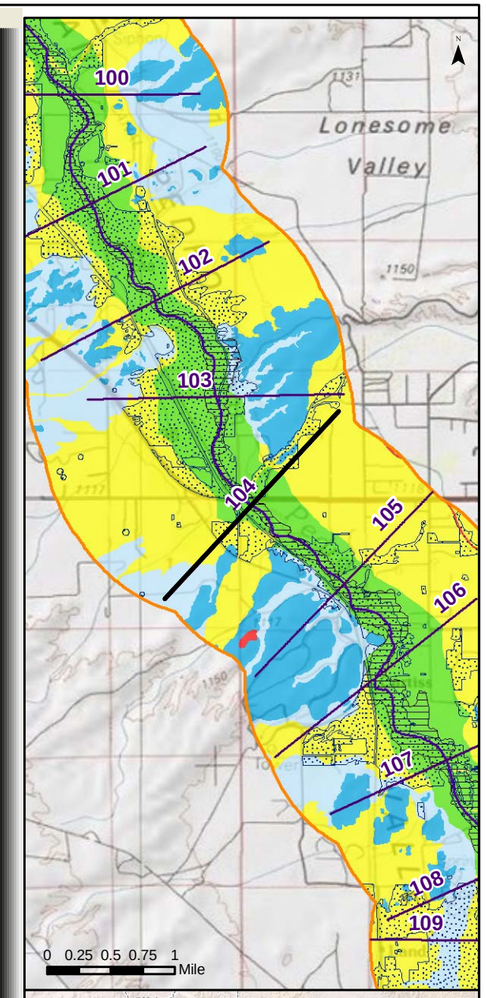
Appendix F

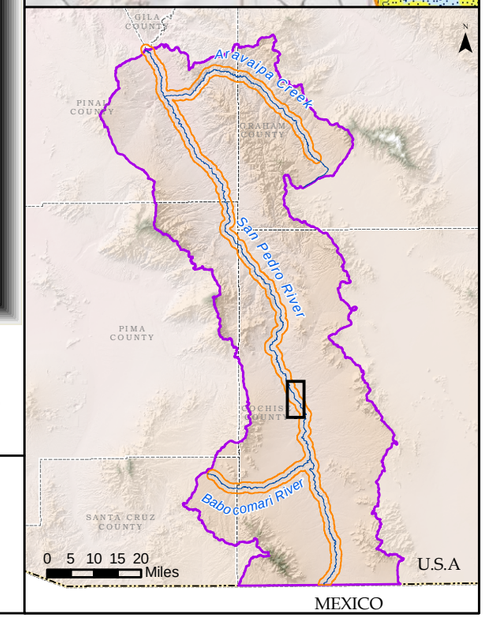
San Pedro River Cross Section at Mile 103

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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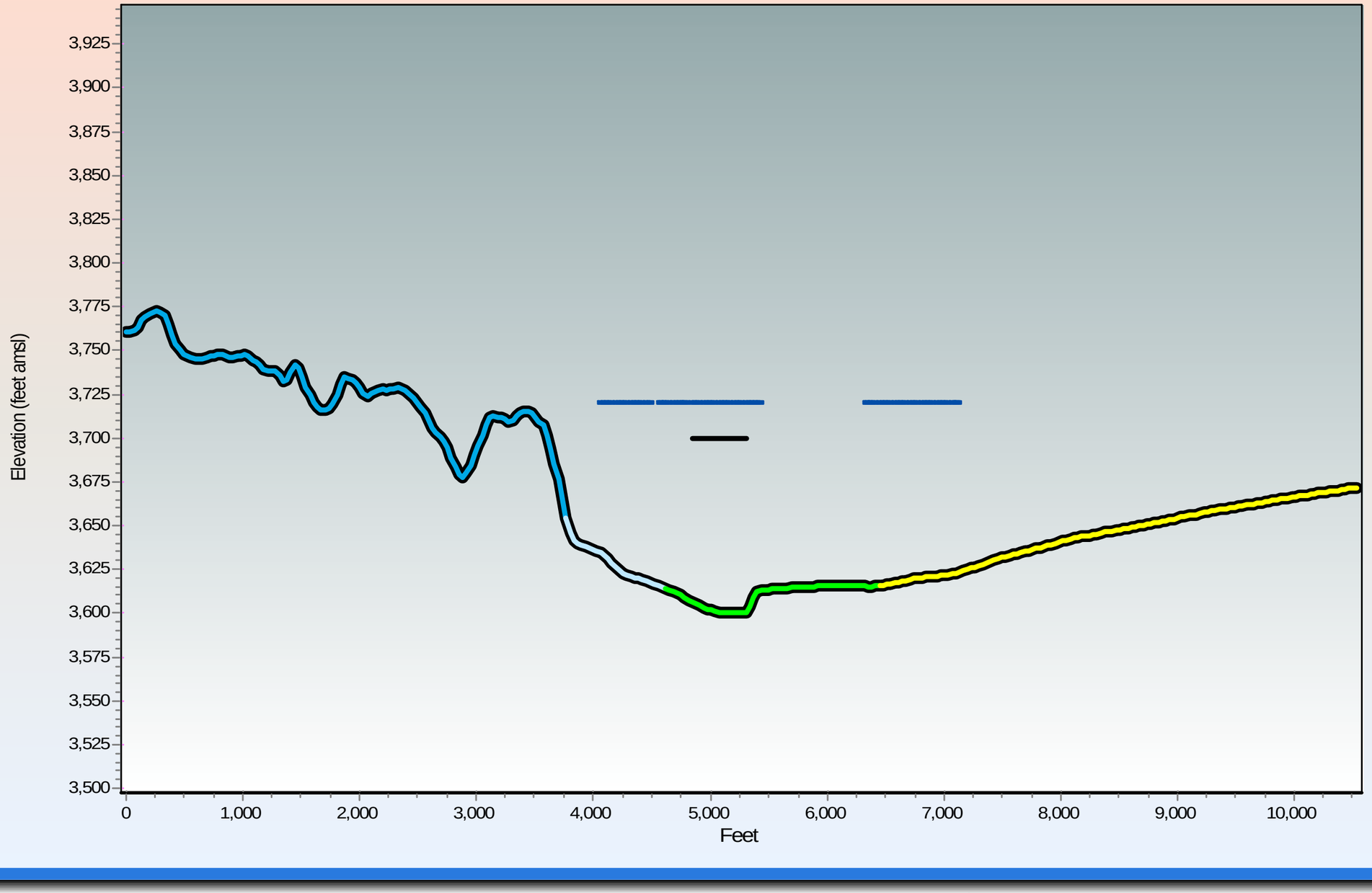
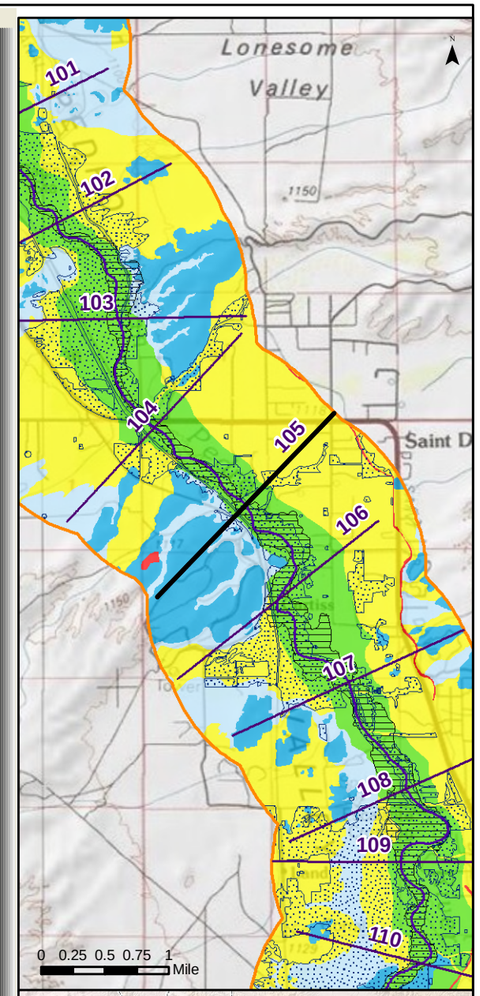
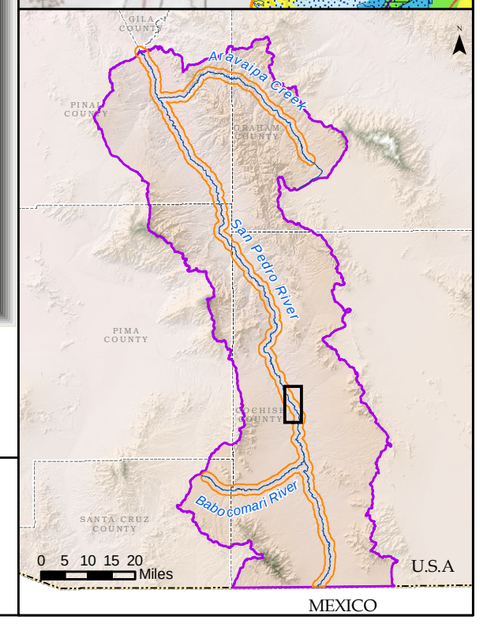
Appendix F
San Pedro River Cross Section at Mile 104
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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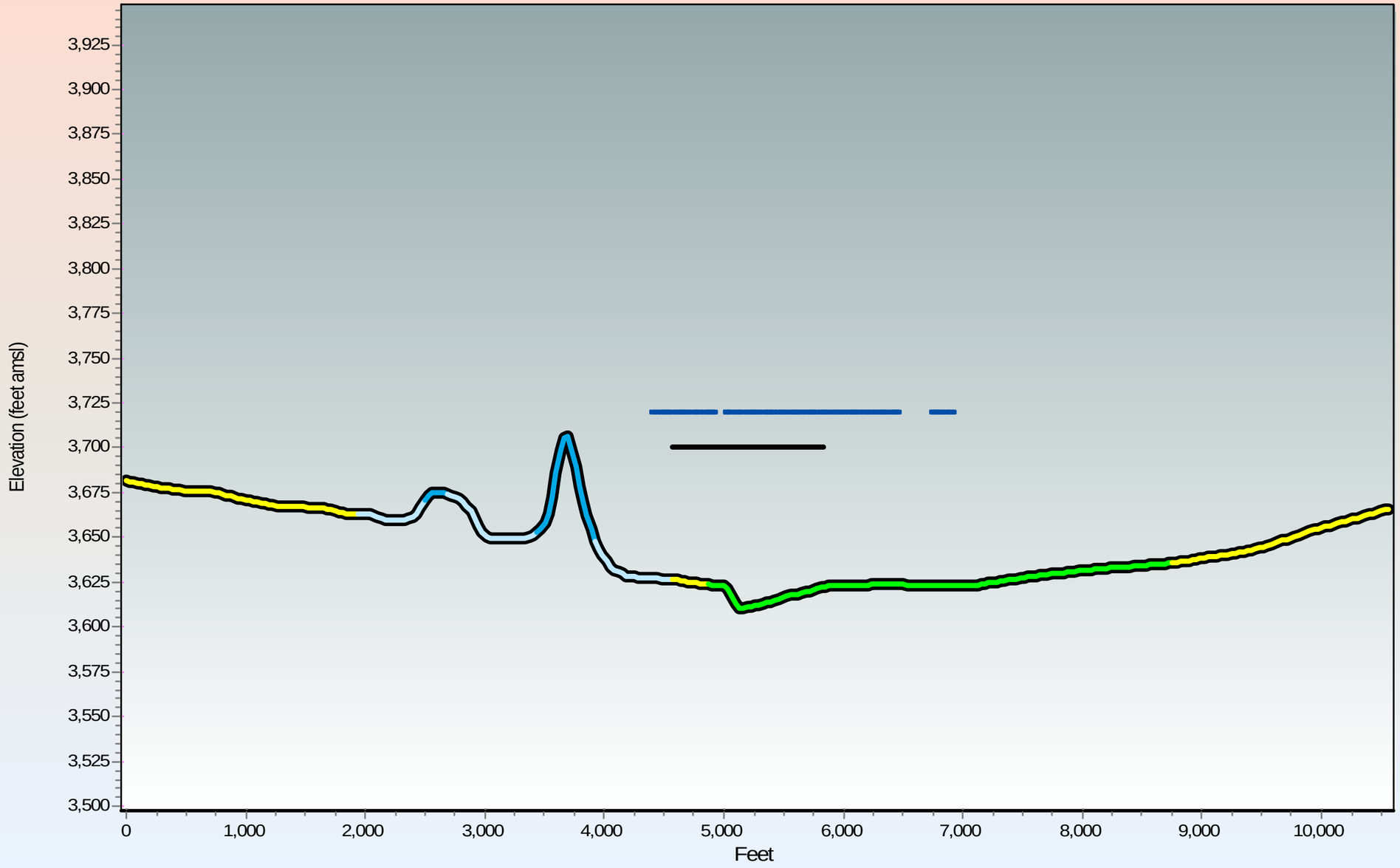
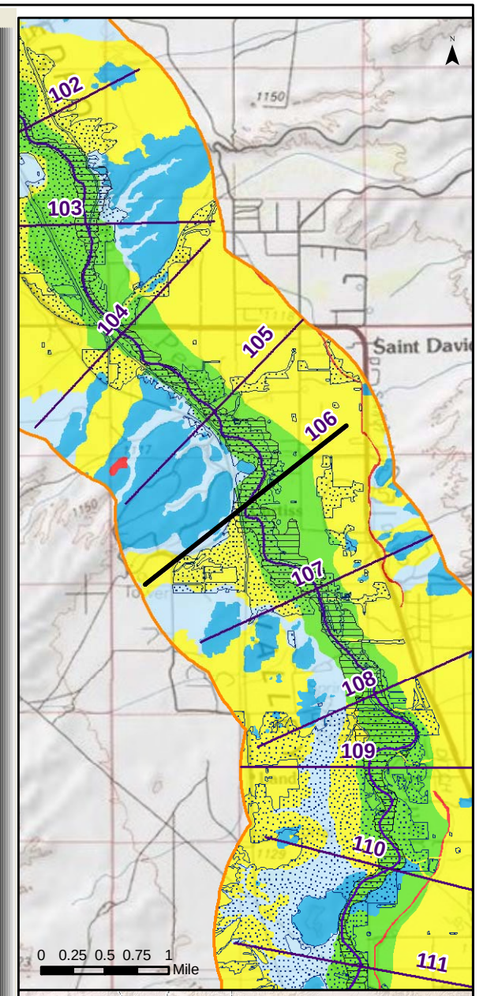
Appendix F

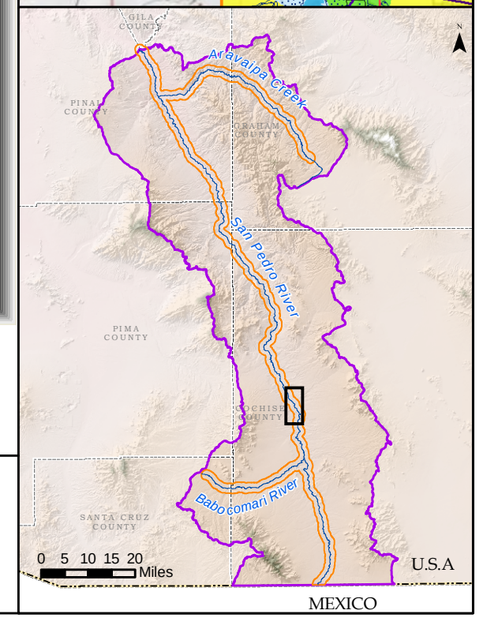
San Pedro River Cross Section at Mile 105

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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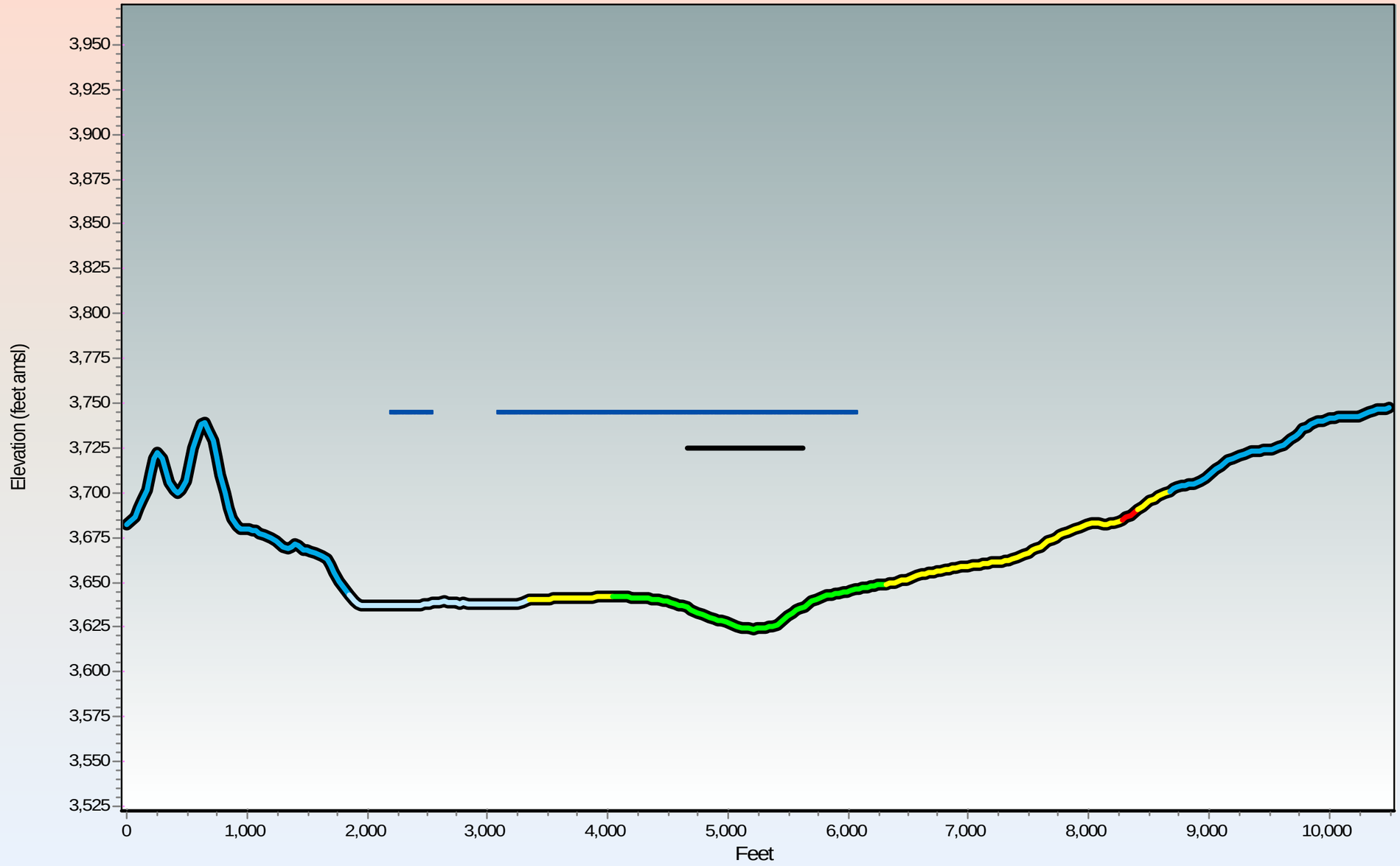
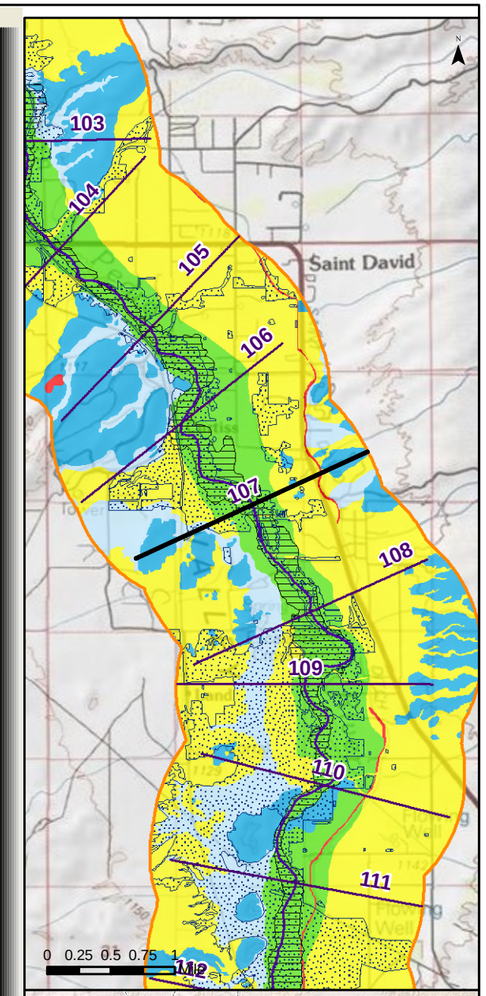
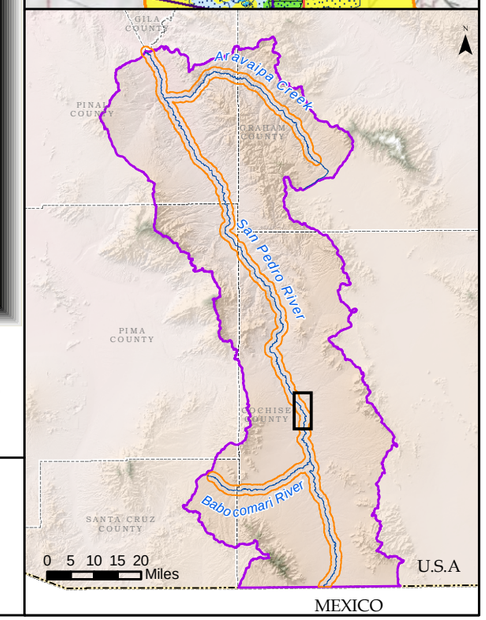
Appendix F
San Pedro River Cross Section at Mile 106
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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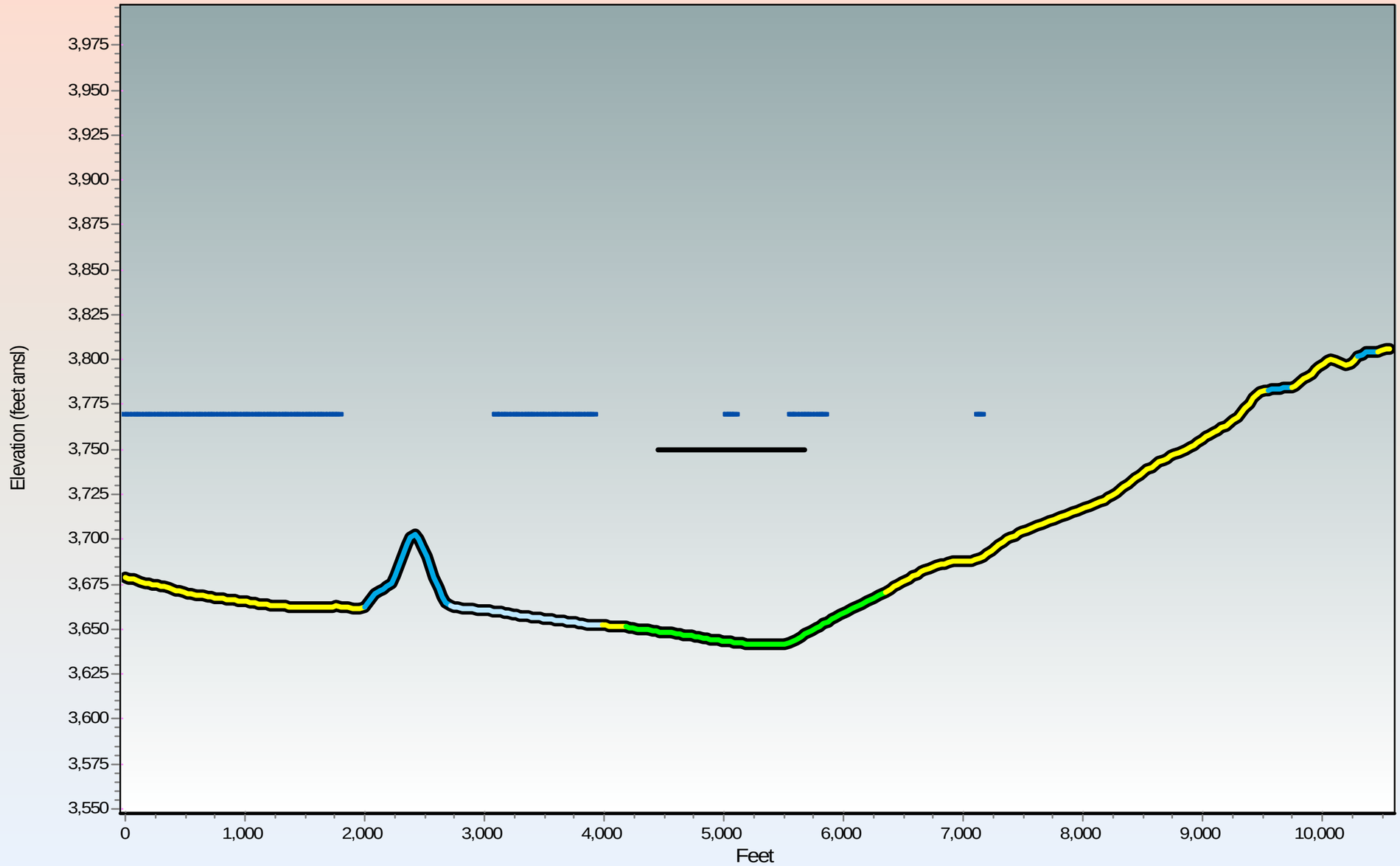
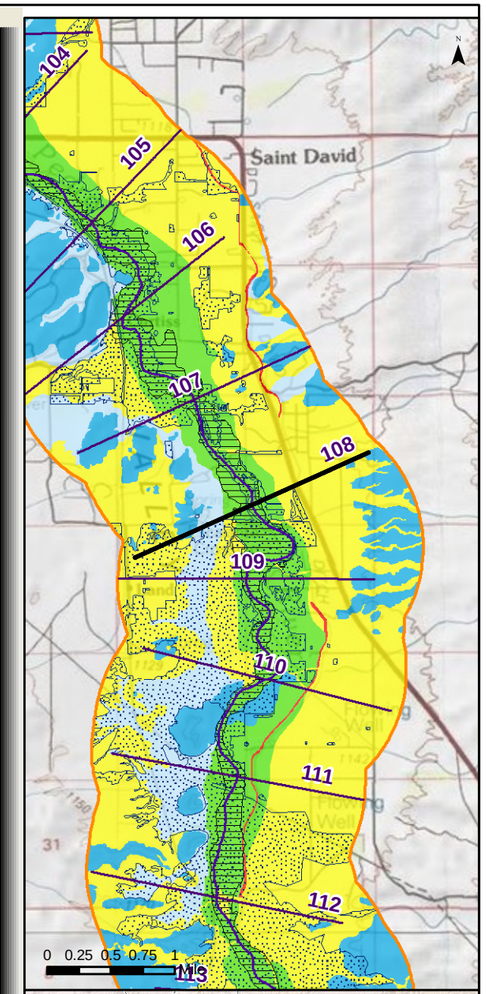
Appendix F

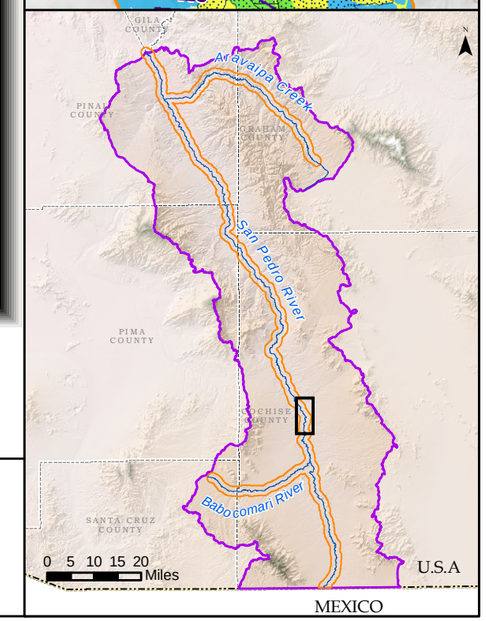
San Pedro River Cross Section at Mile 107

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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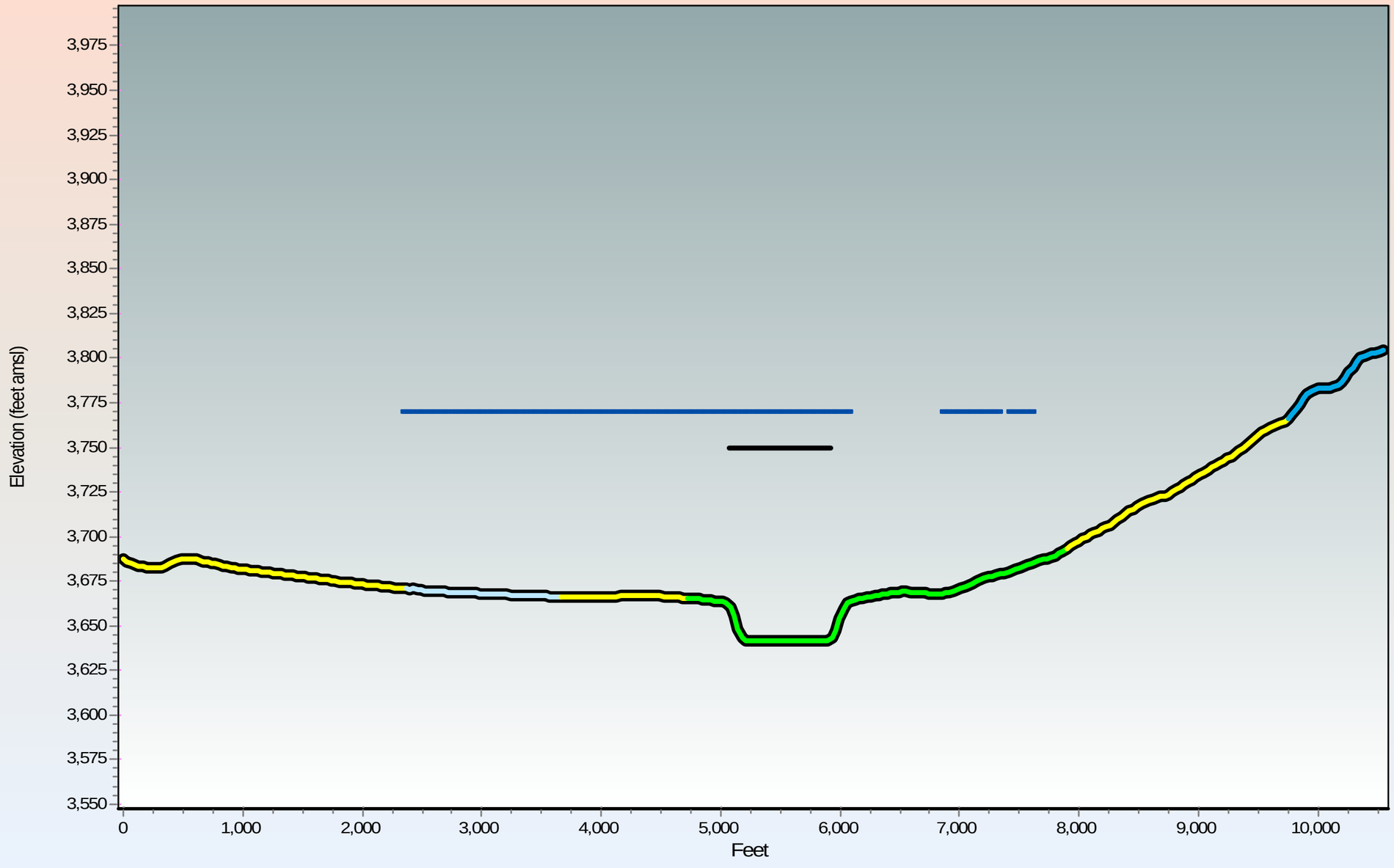
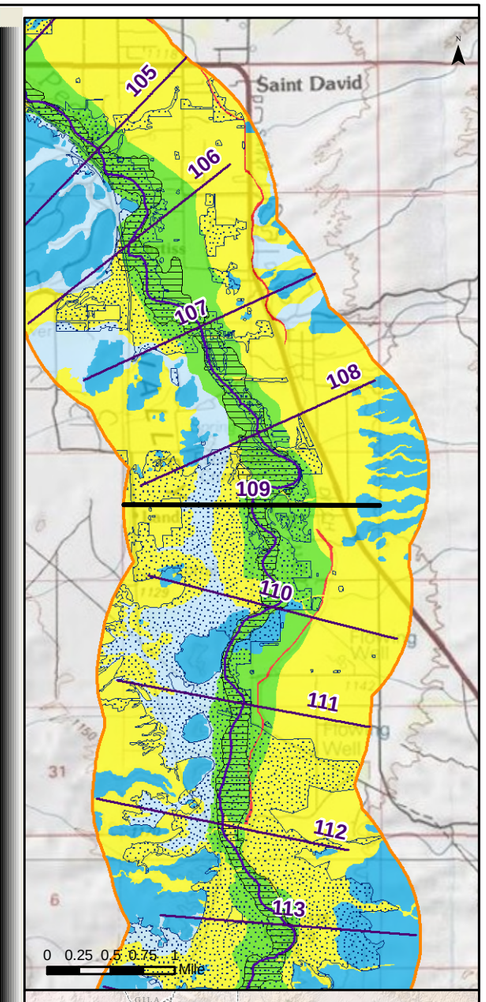
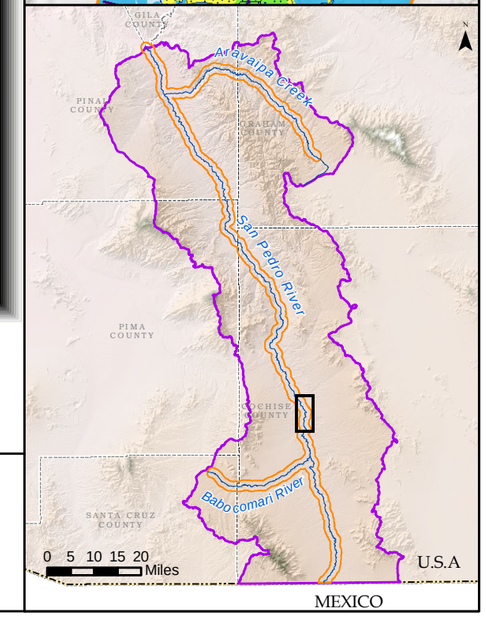
Appendix F
San Pedro River Cross Section at Mile 108
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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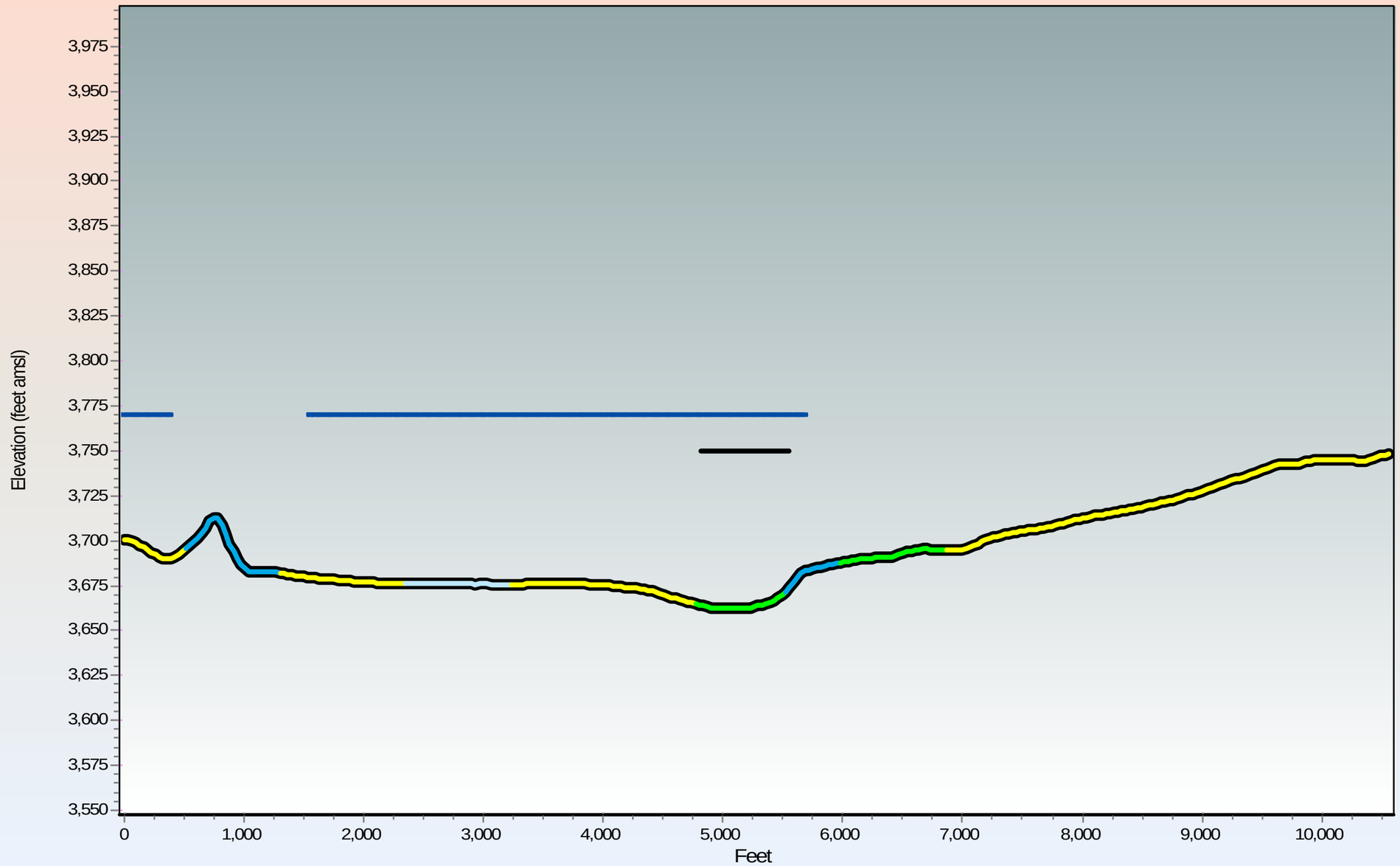
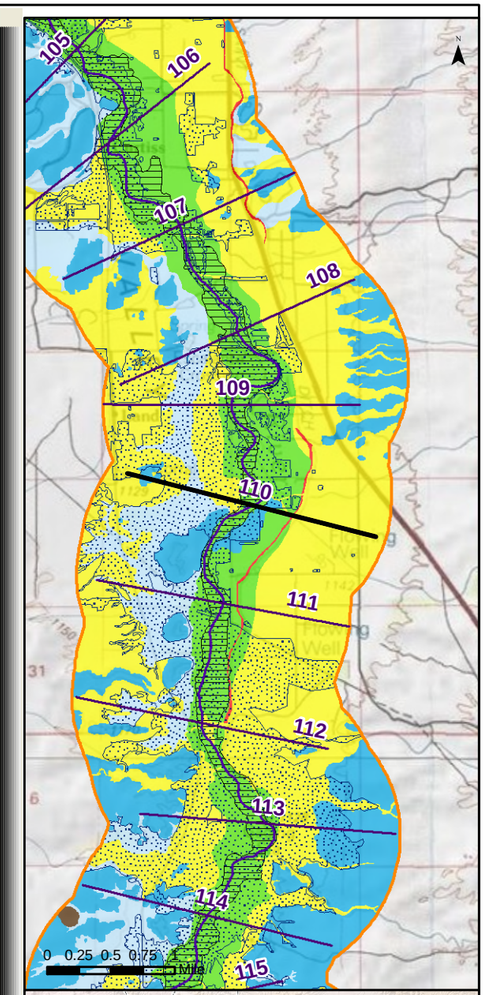
Appendix F

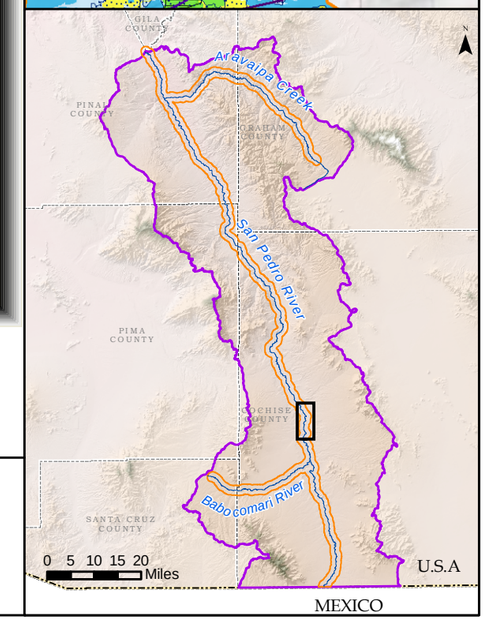
San Pedro River Cross Section at Mile 109

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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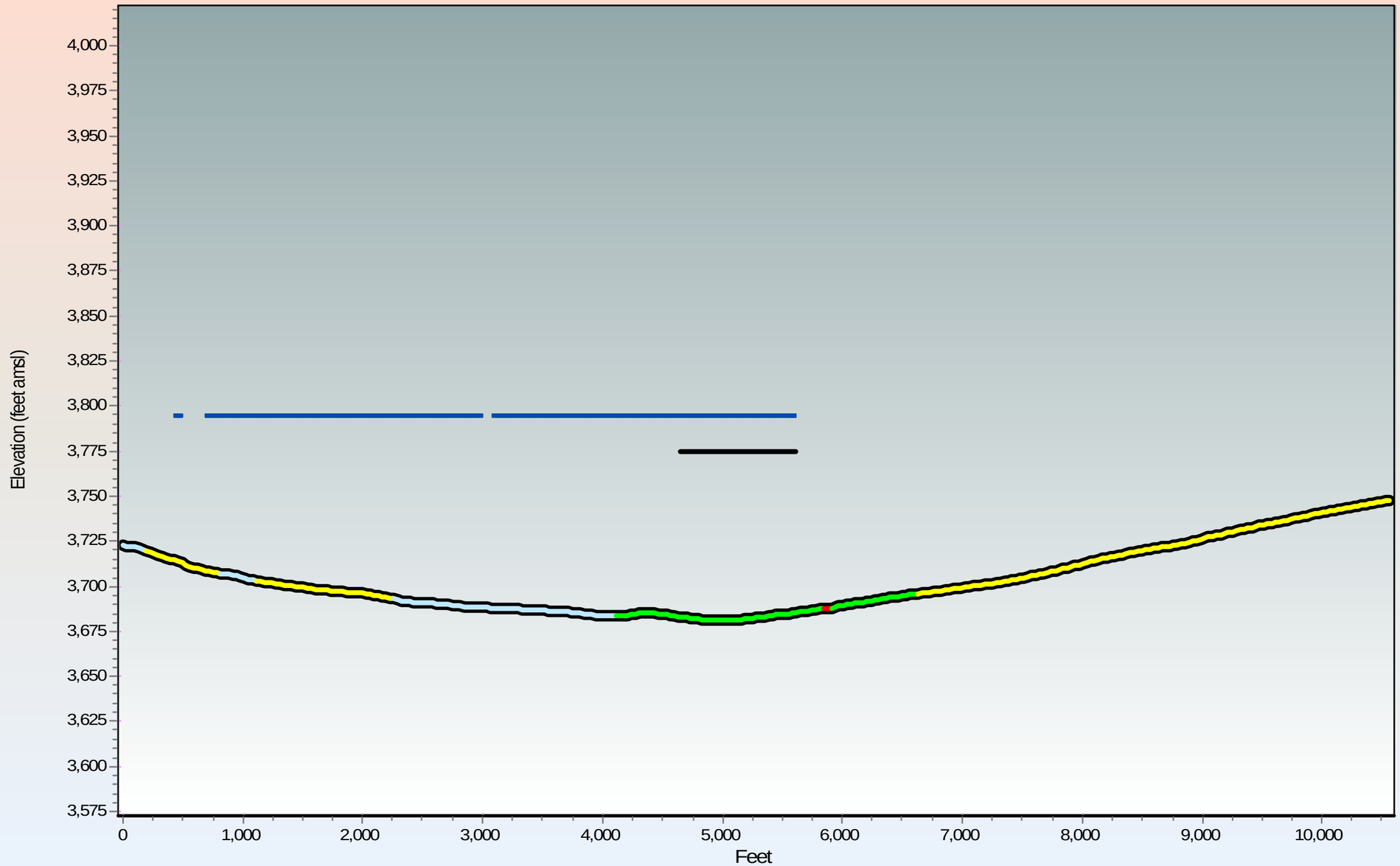
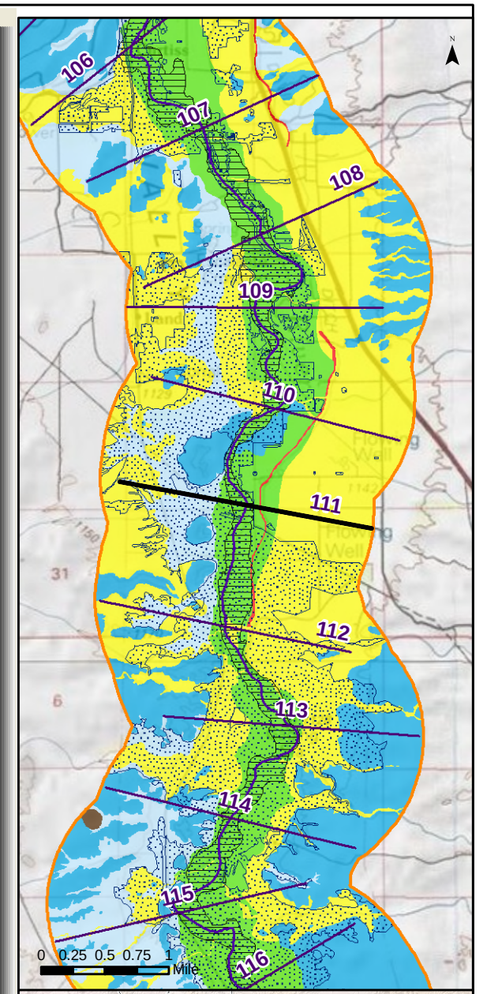
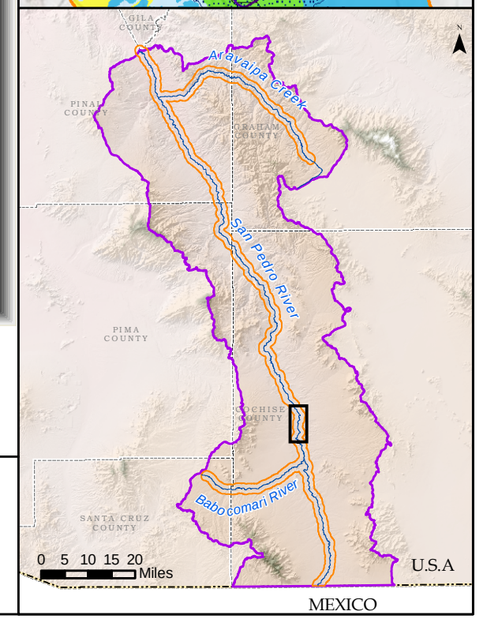
Appendix F
San Pedro River Cross Section at Mile 110
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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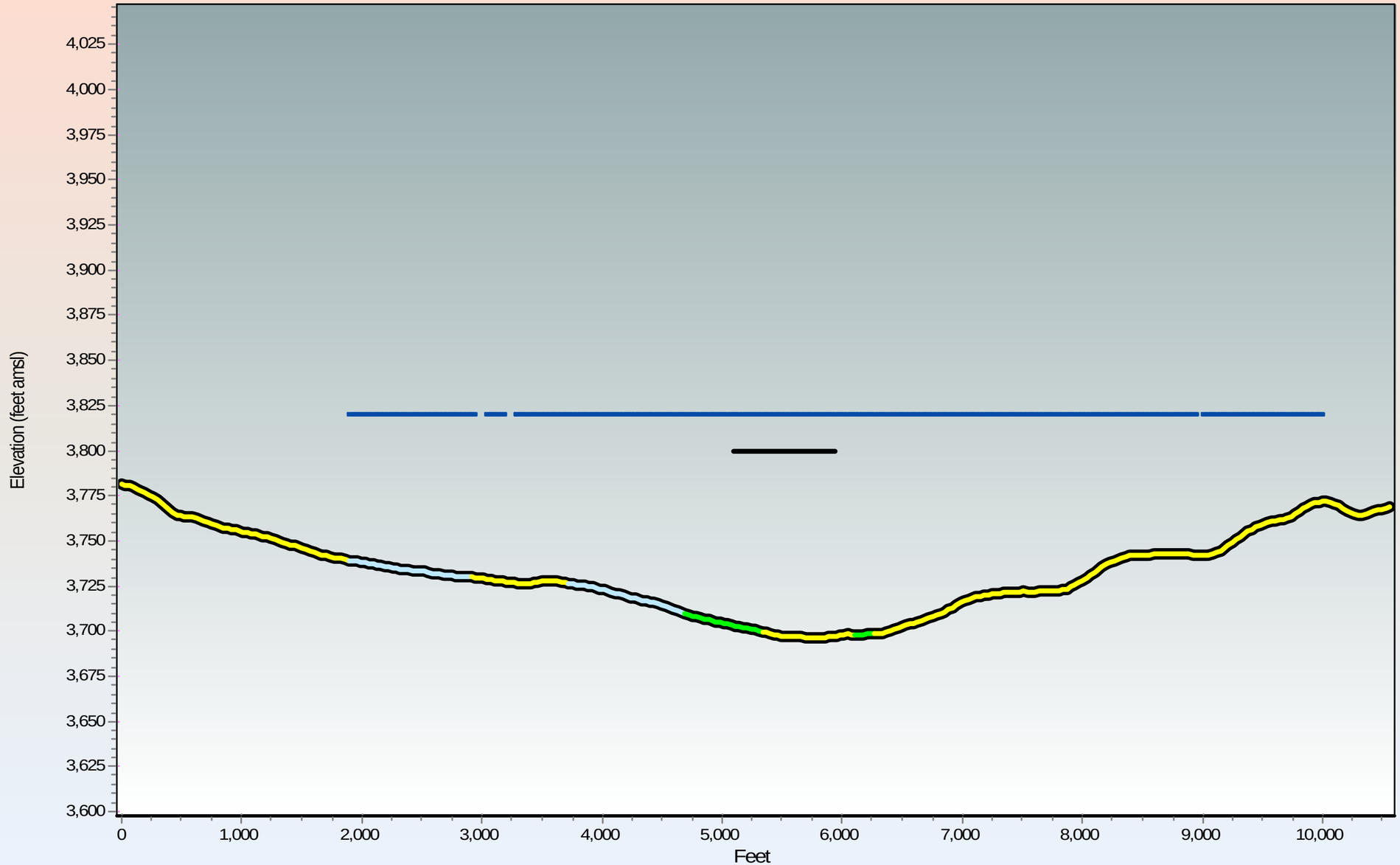
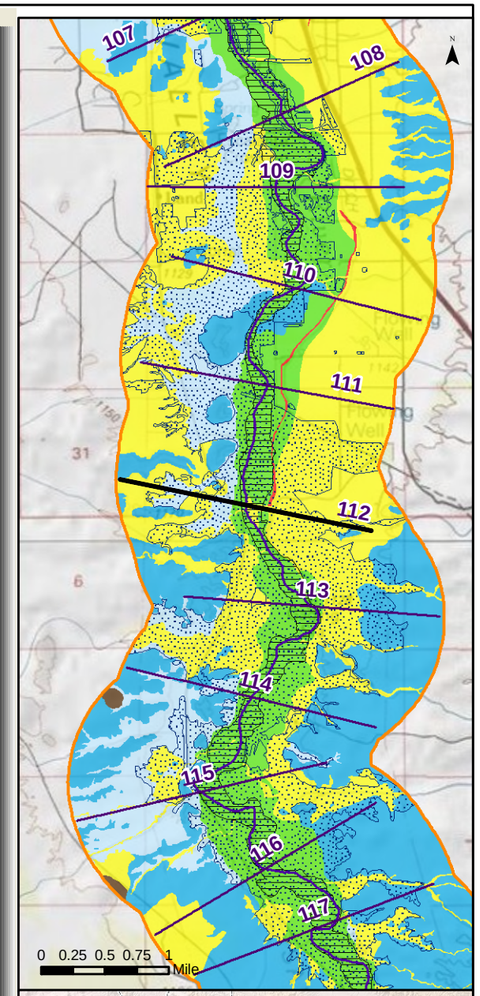
Appendix F

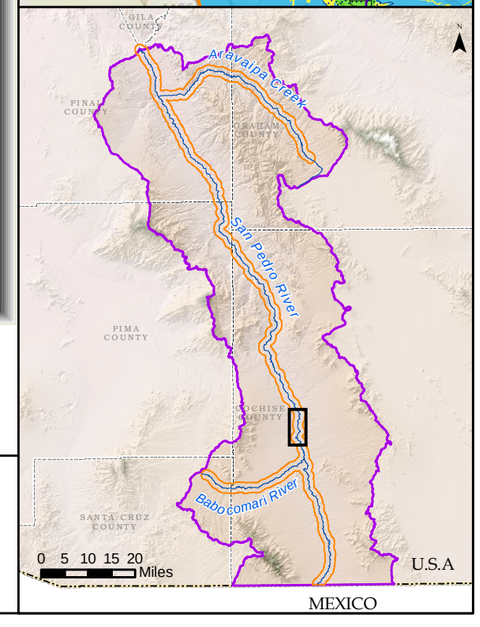
San Pedro River Cross Section at Mile 111

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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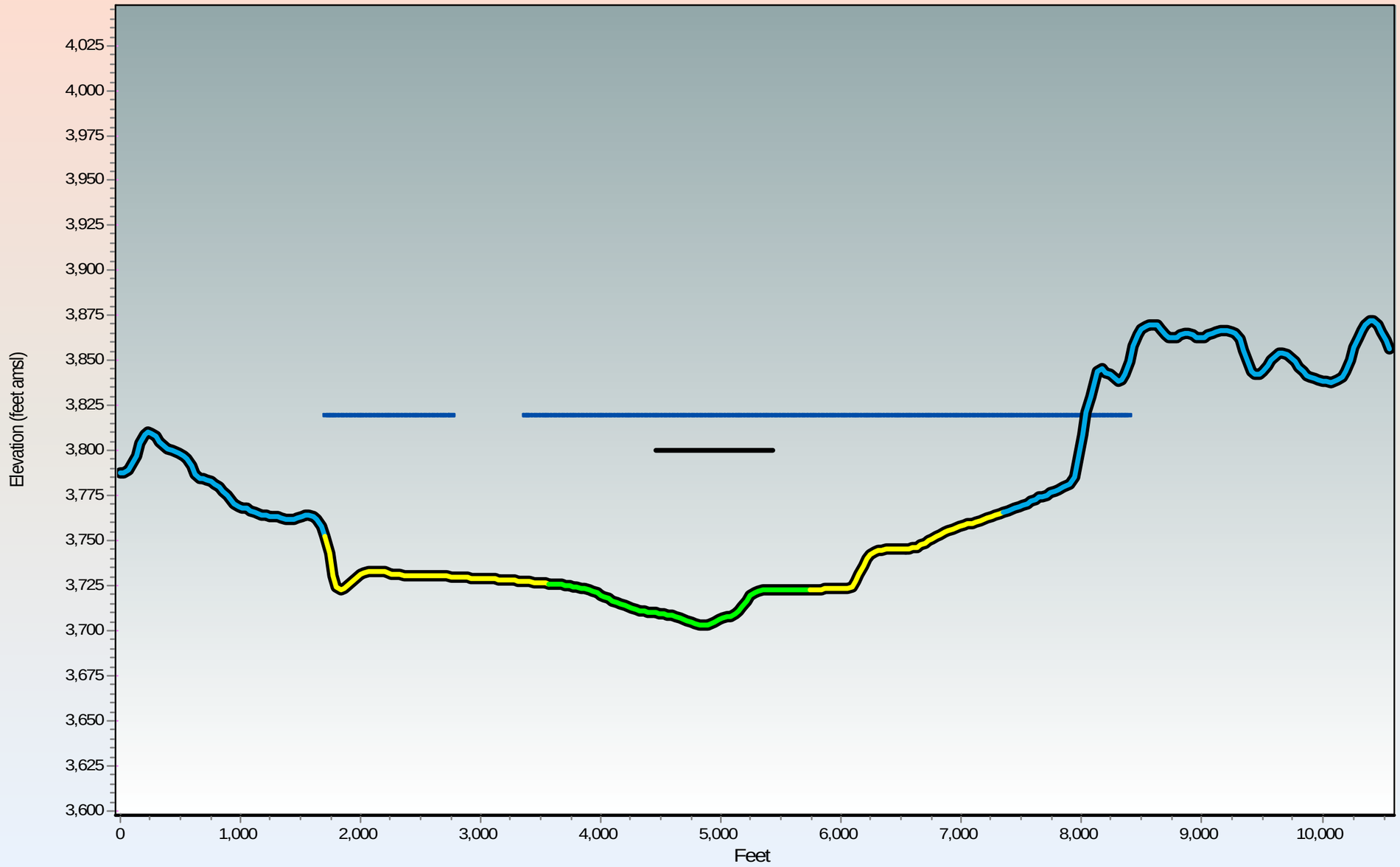
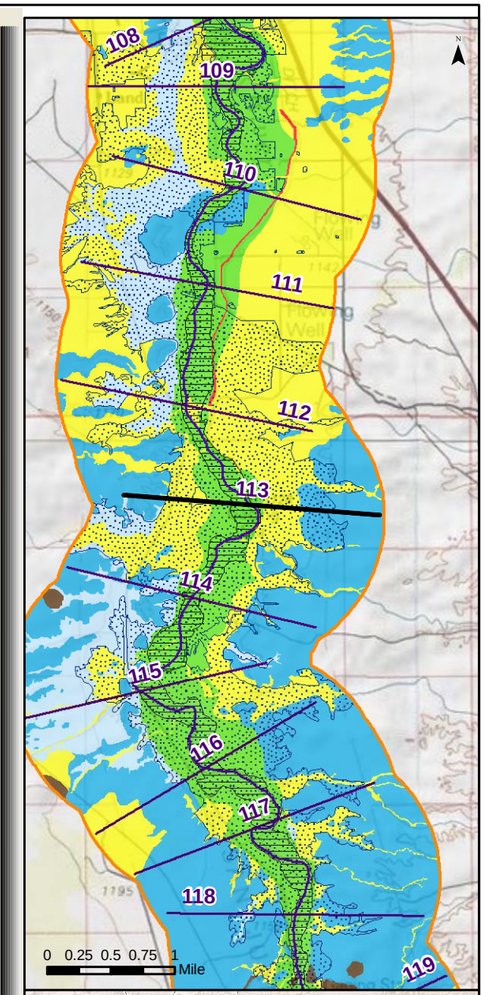
Appendix F

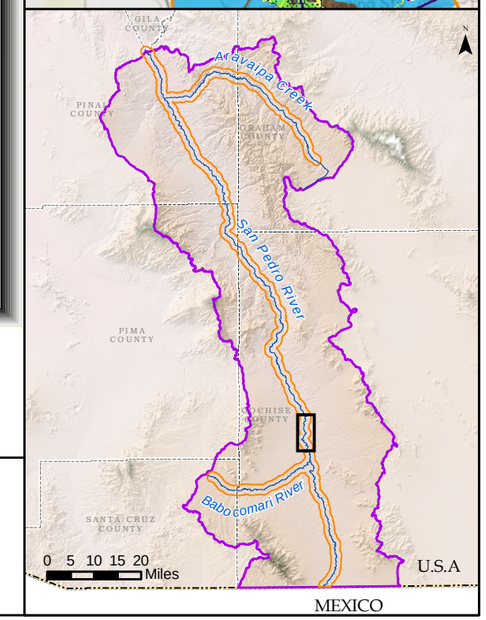
San Pedro River Cross Section at Mile 112

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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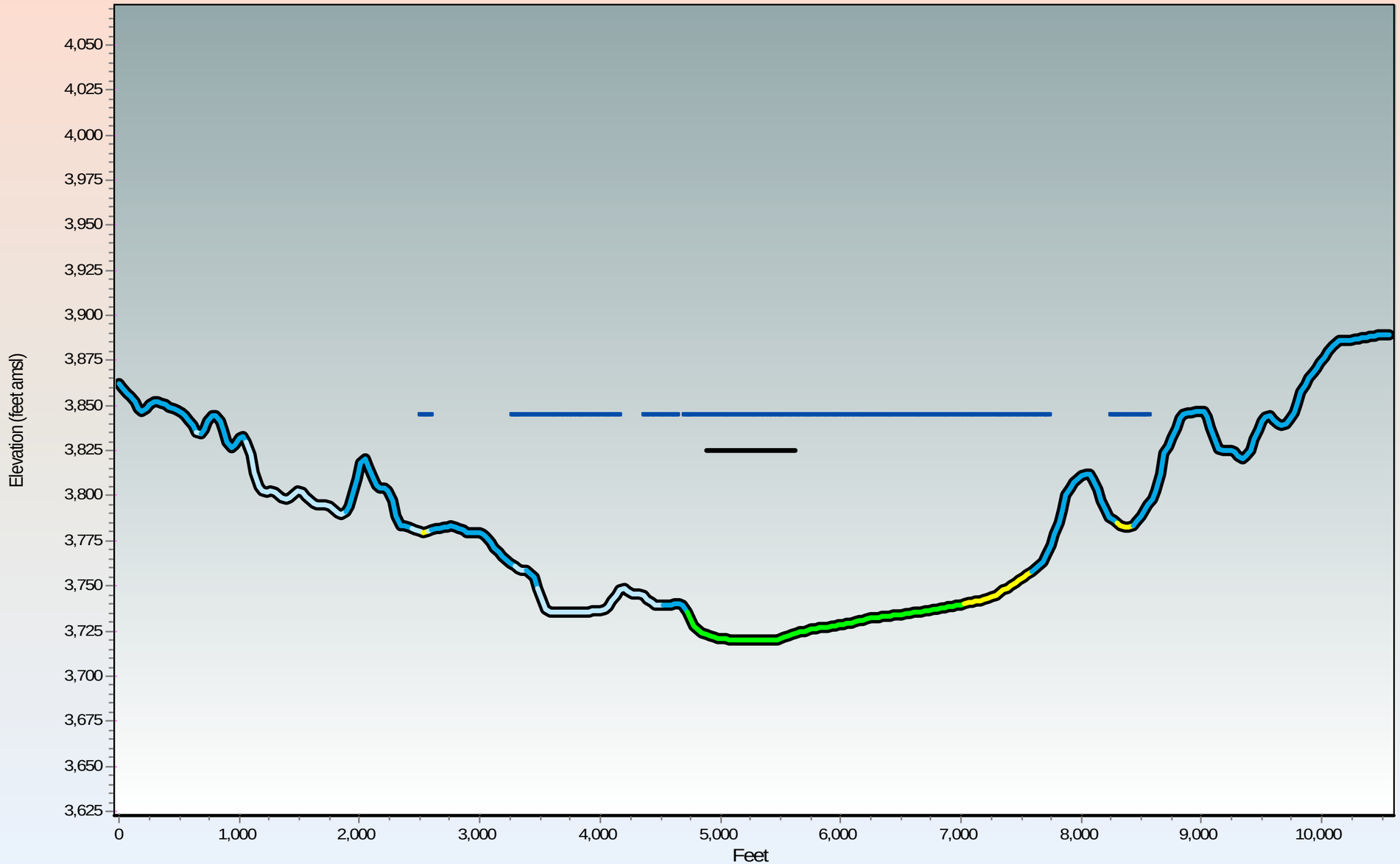
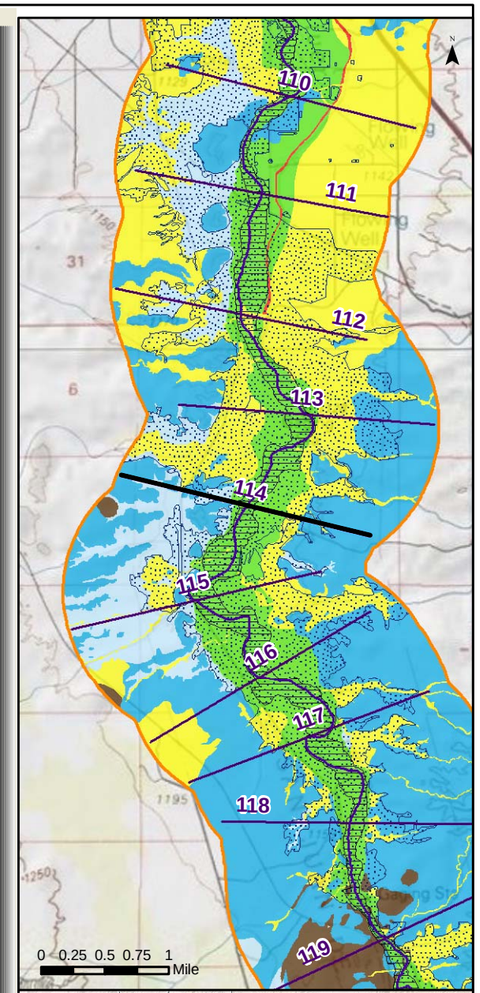
Appendix F

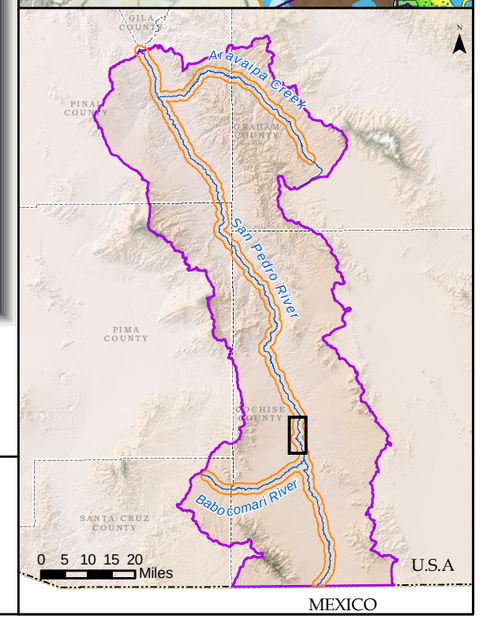
San Pedro River Cross Section at Mile 113

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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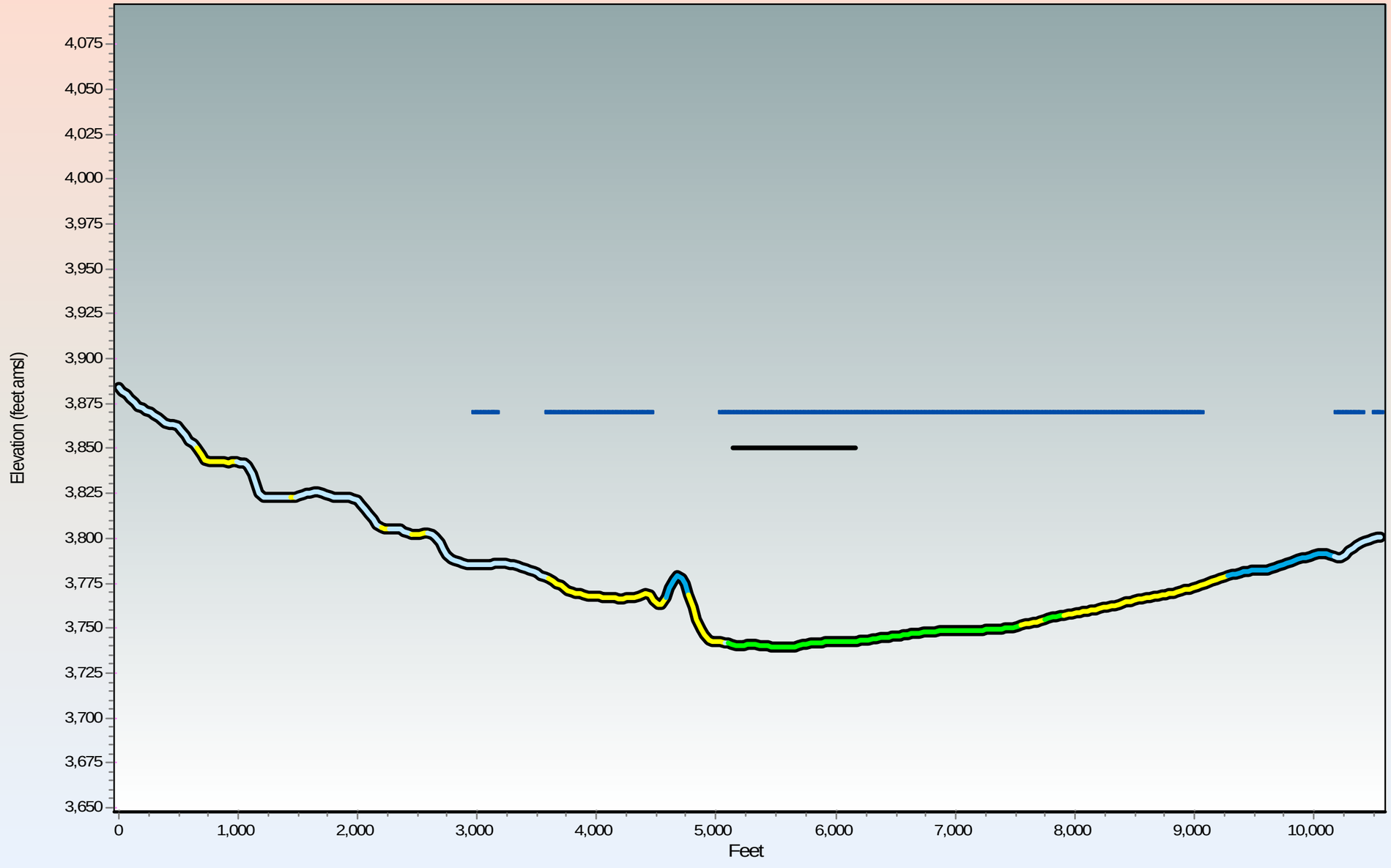
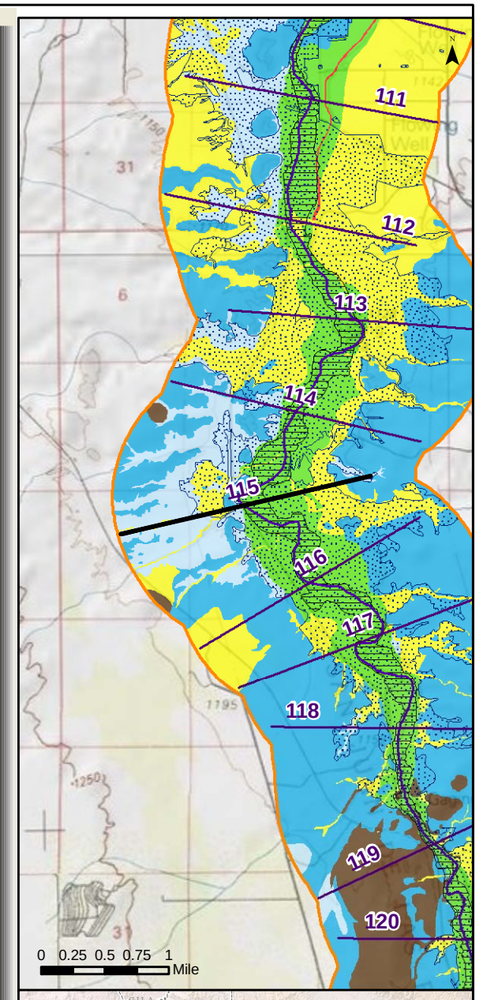
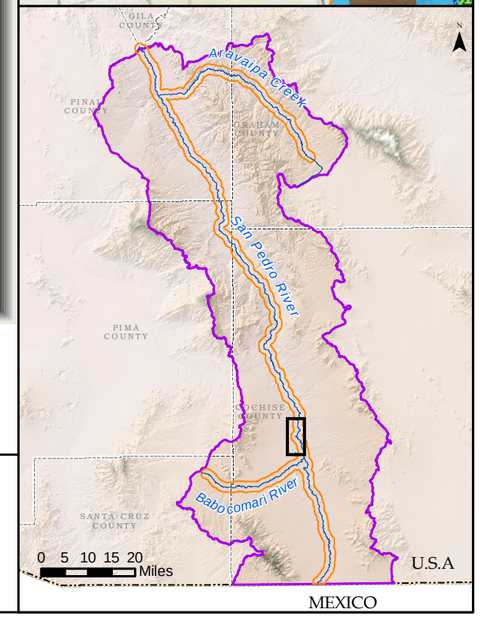
Appendix F
San Pedro River Cross Section at Mile 114
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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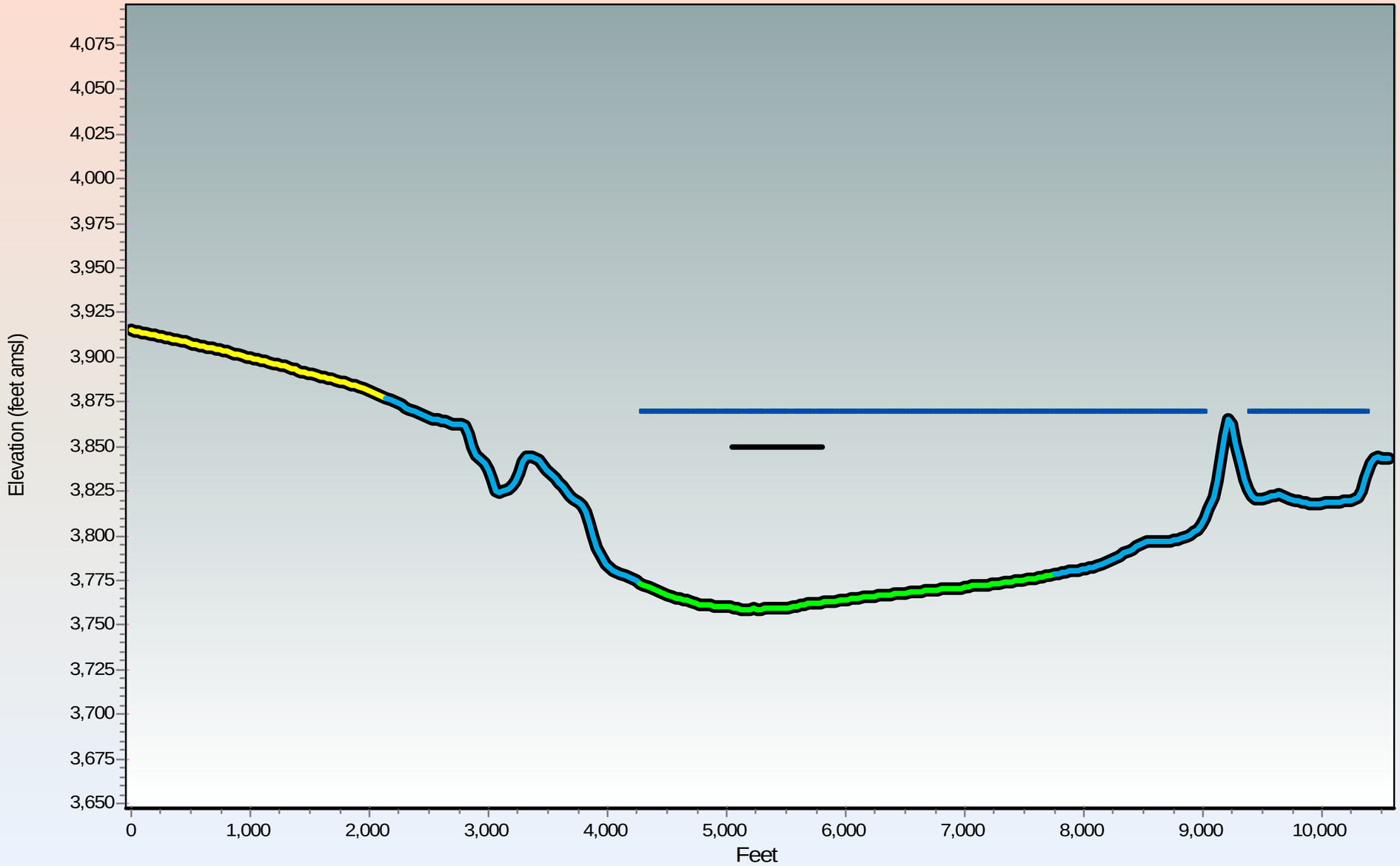
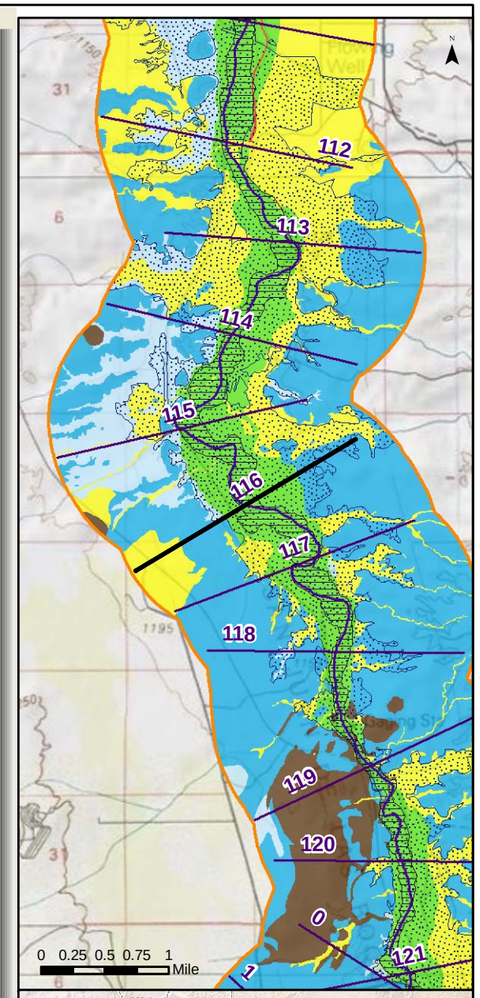
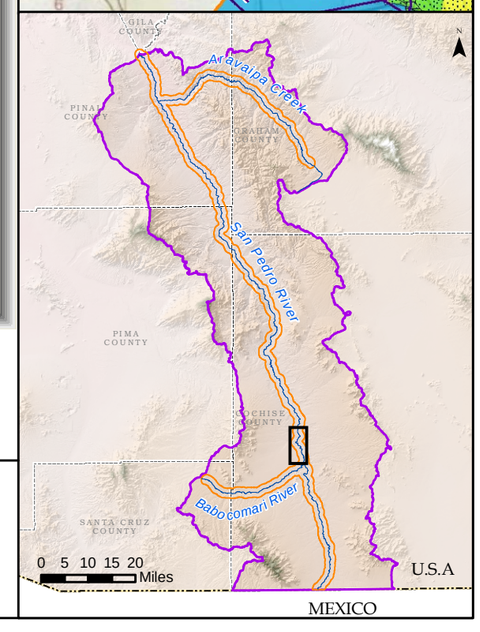
Appendix F
San Pedro River Cross Section at Mile 115
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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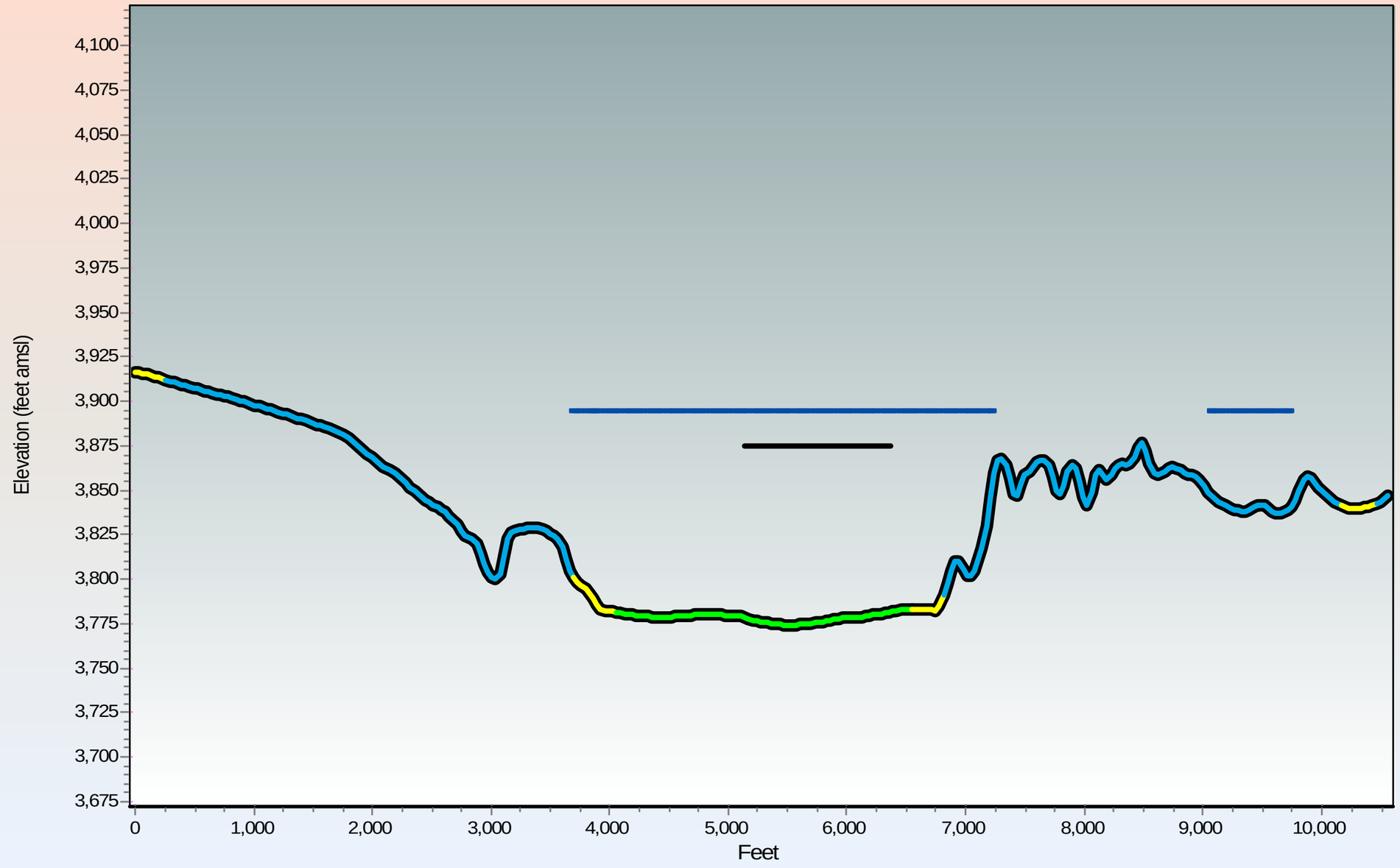
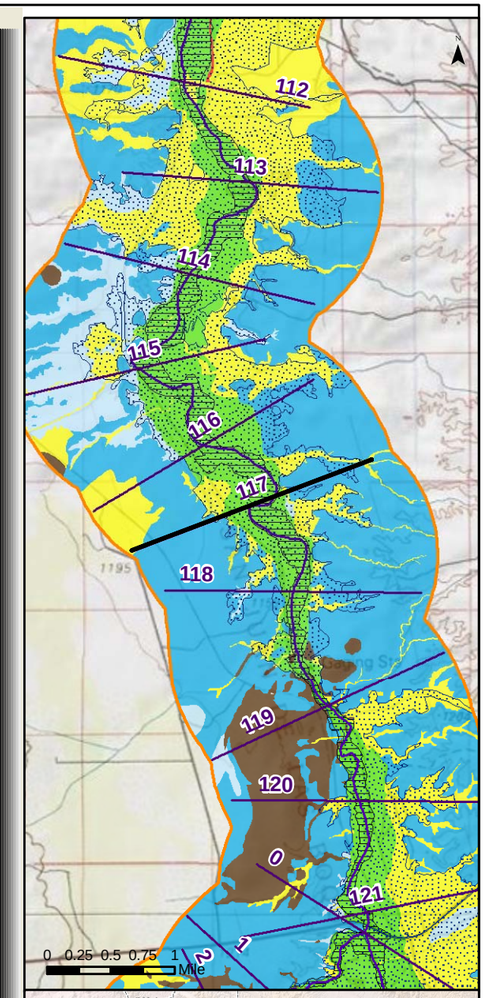
Appendix F

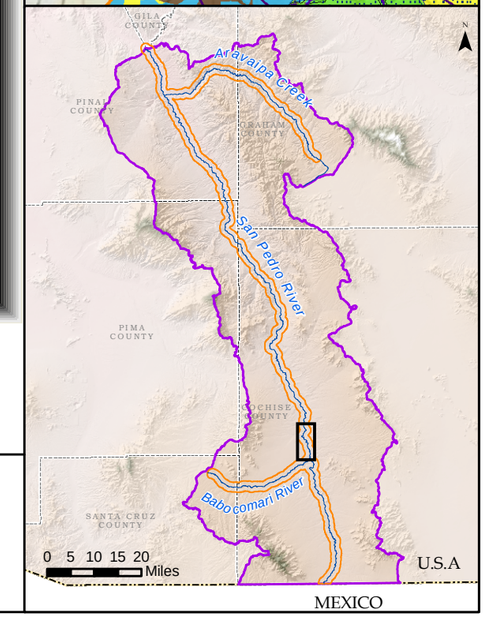
San Pedro River Cross Section at Mile 116

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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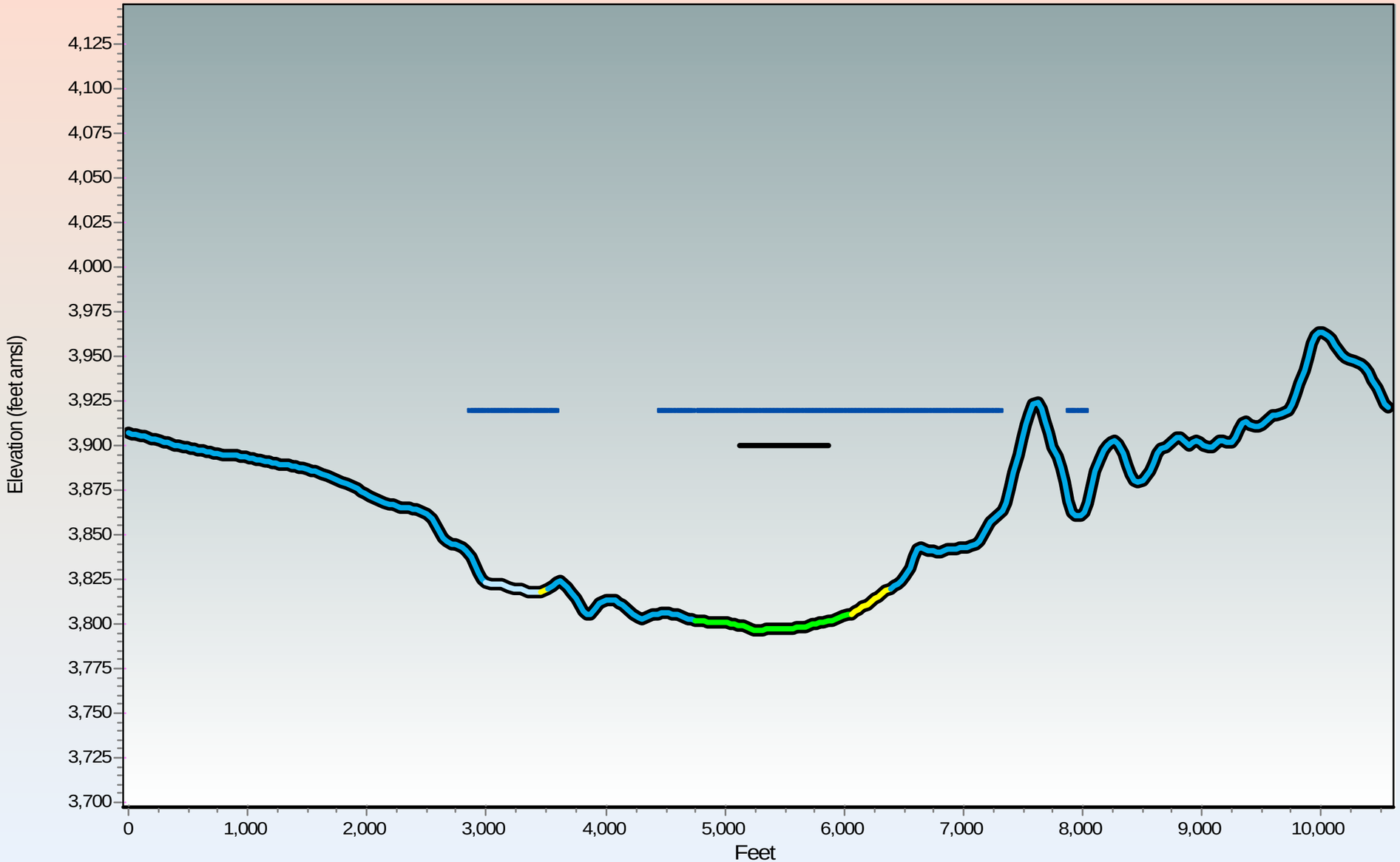
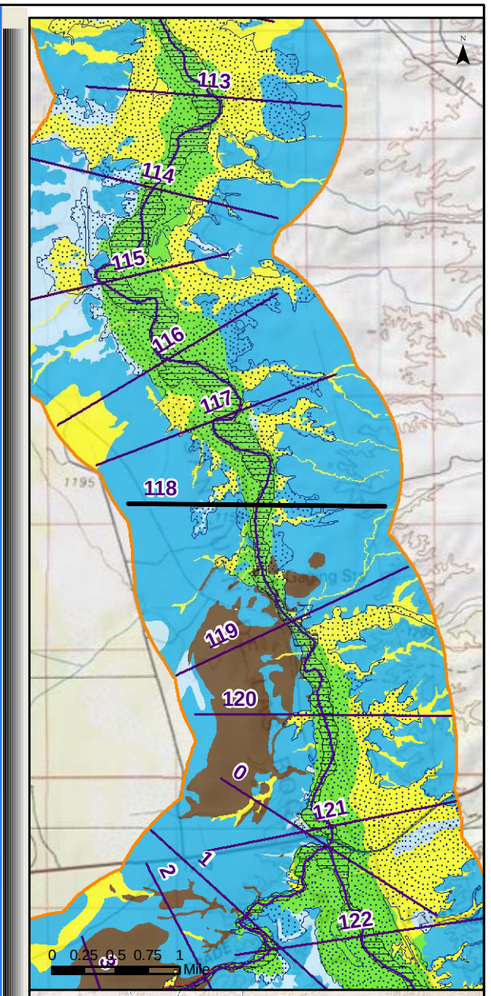
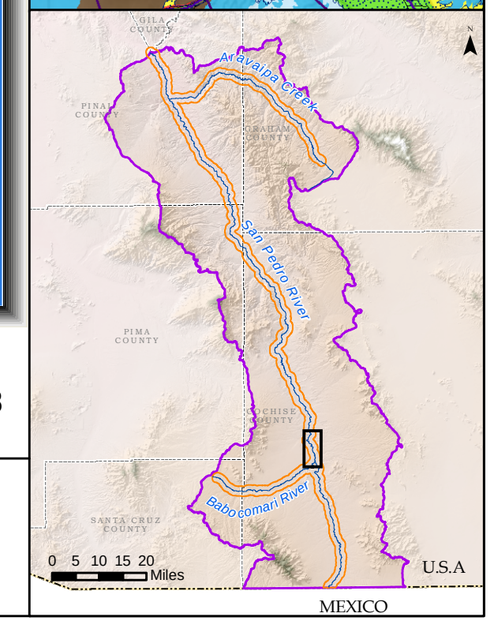
Appendix F
San Pedro River Cross Section at Mile 117
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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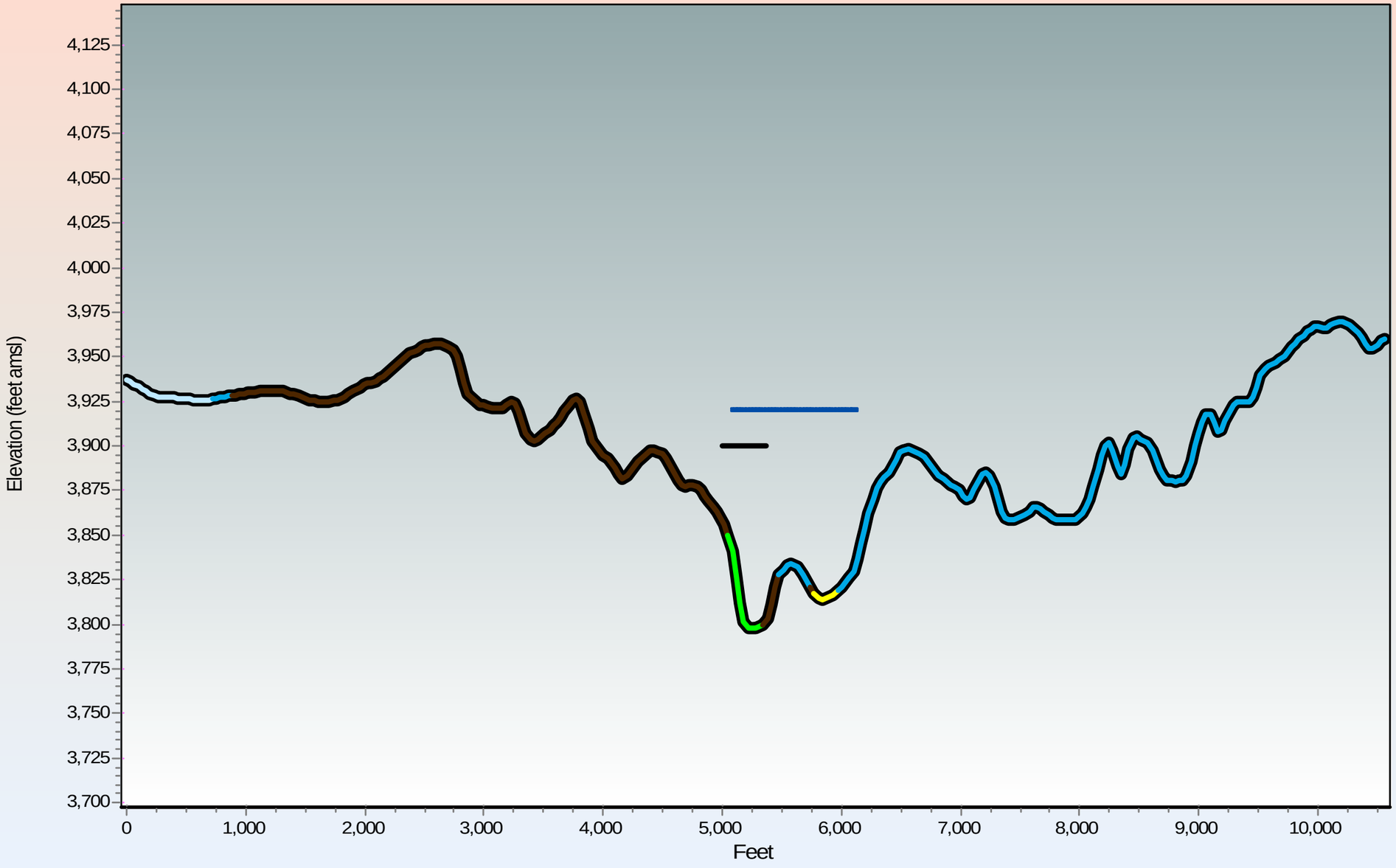
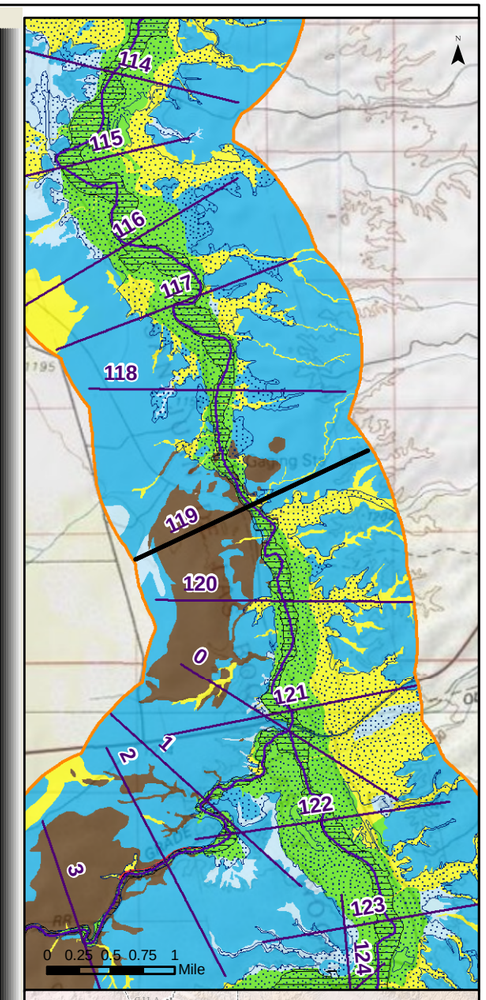
Appendix F

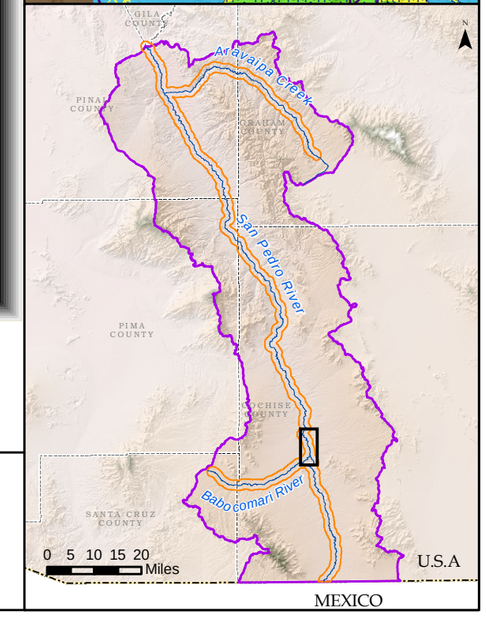
San Pedro River Cross Section at Mile 118

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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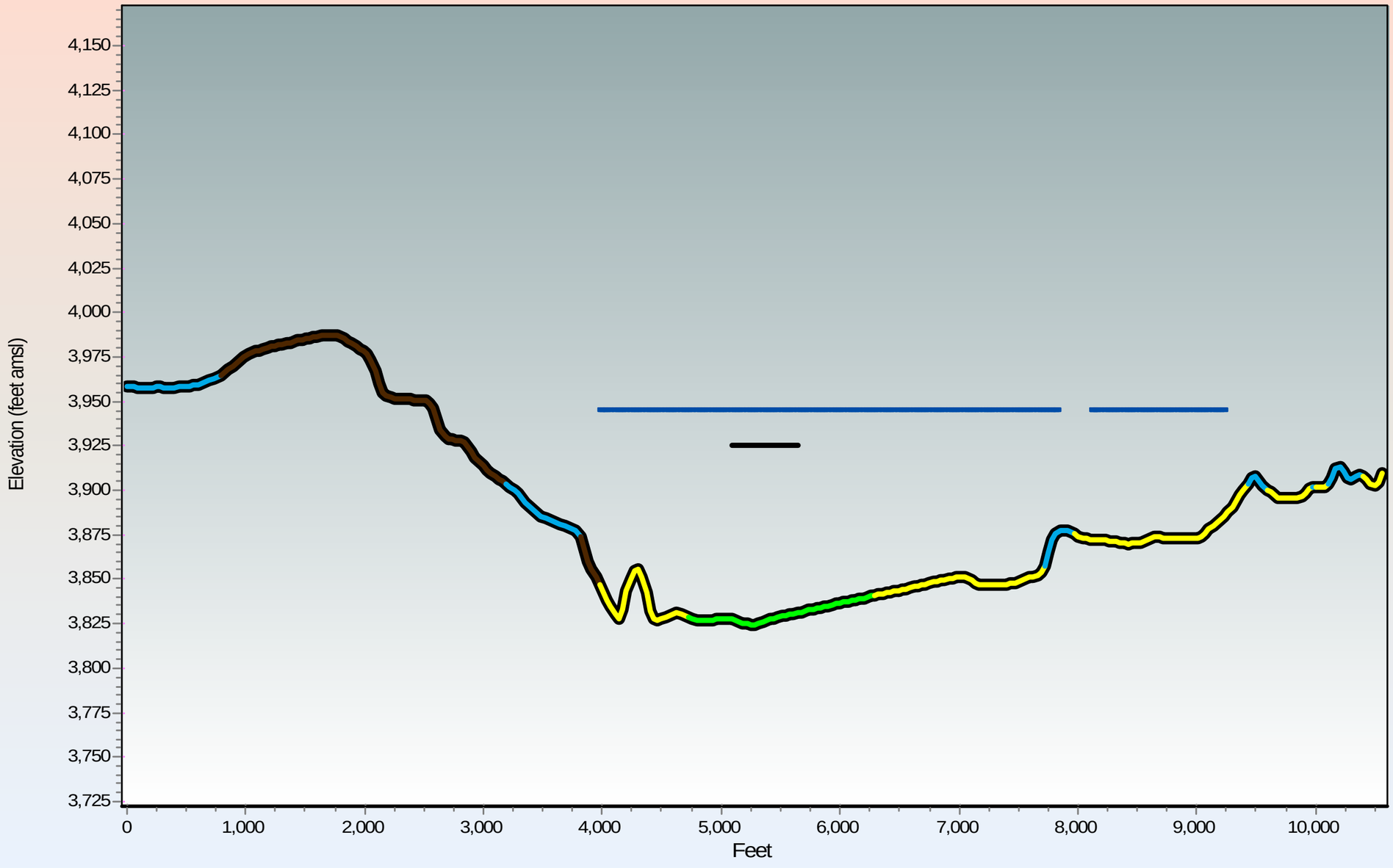
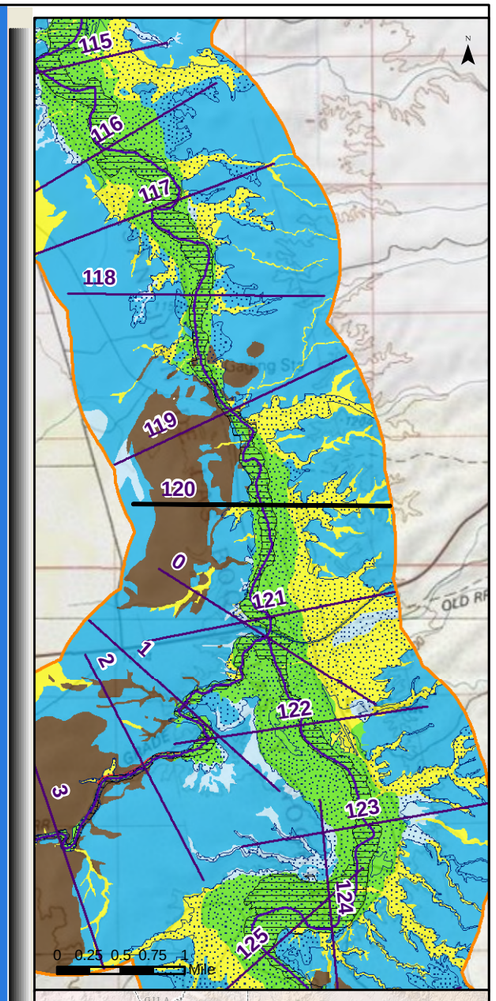
Appendix F

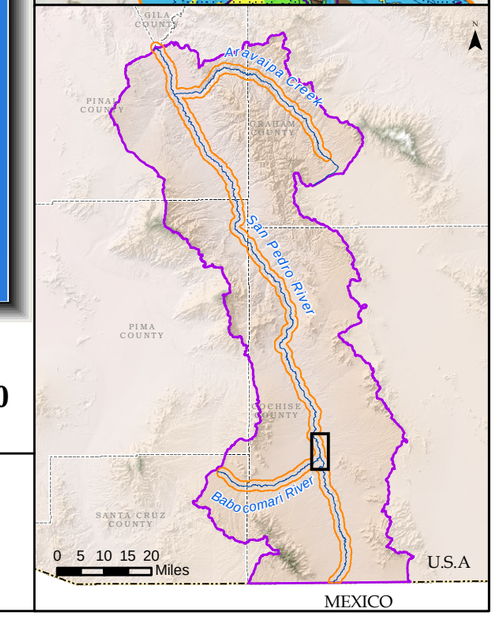
San Pedro River Cross Section at Mile 119

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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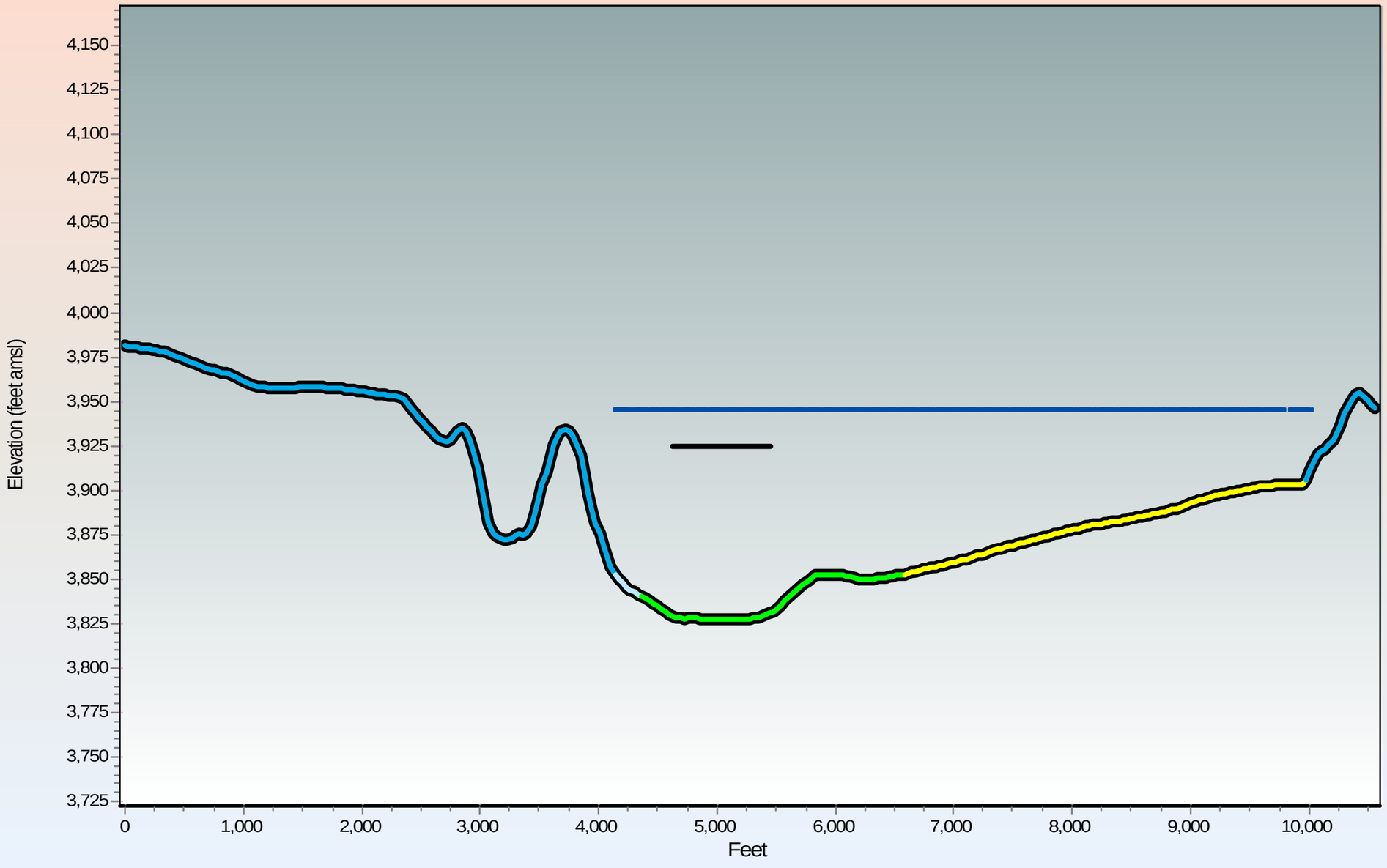
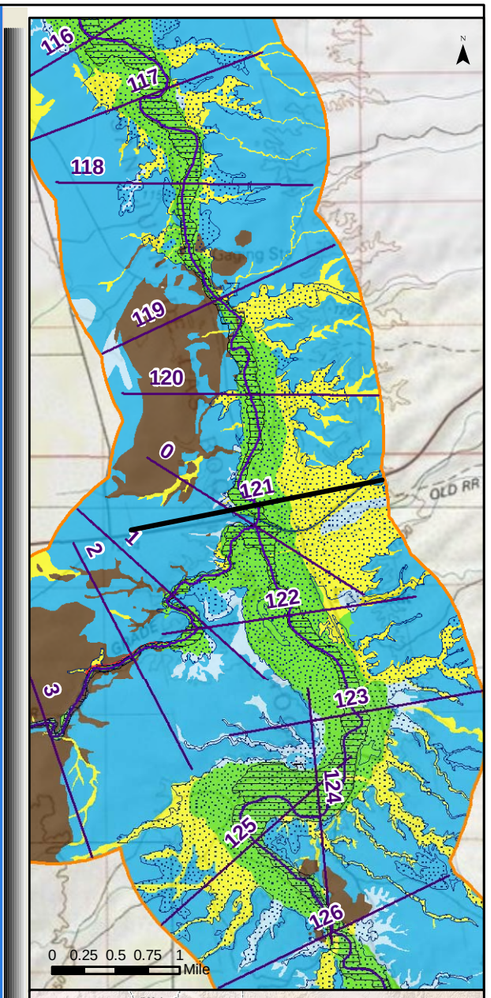
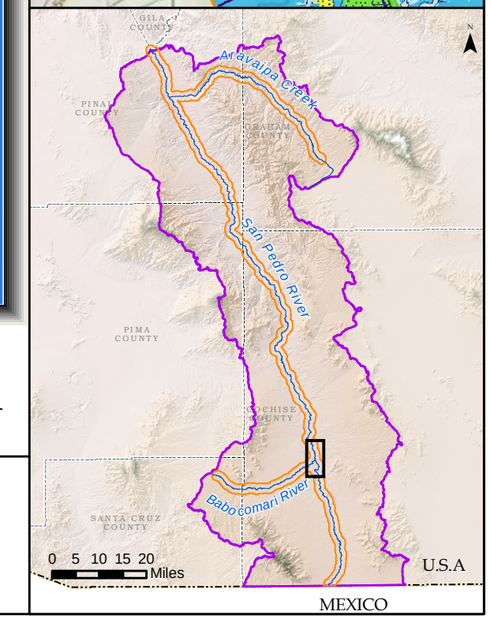
Appendix F
San Pedro River Cross Section at Mile 120
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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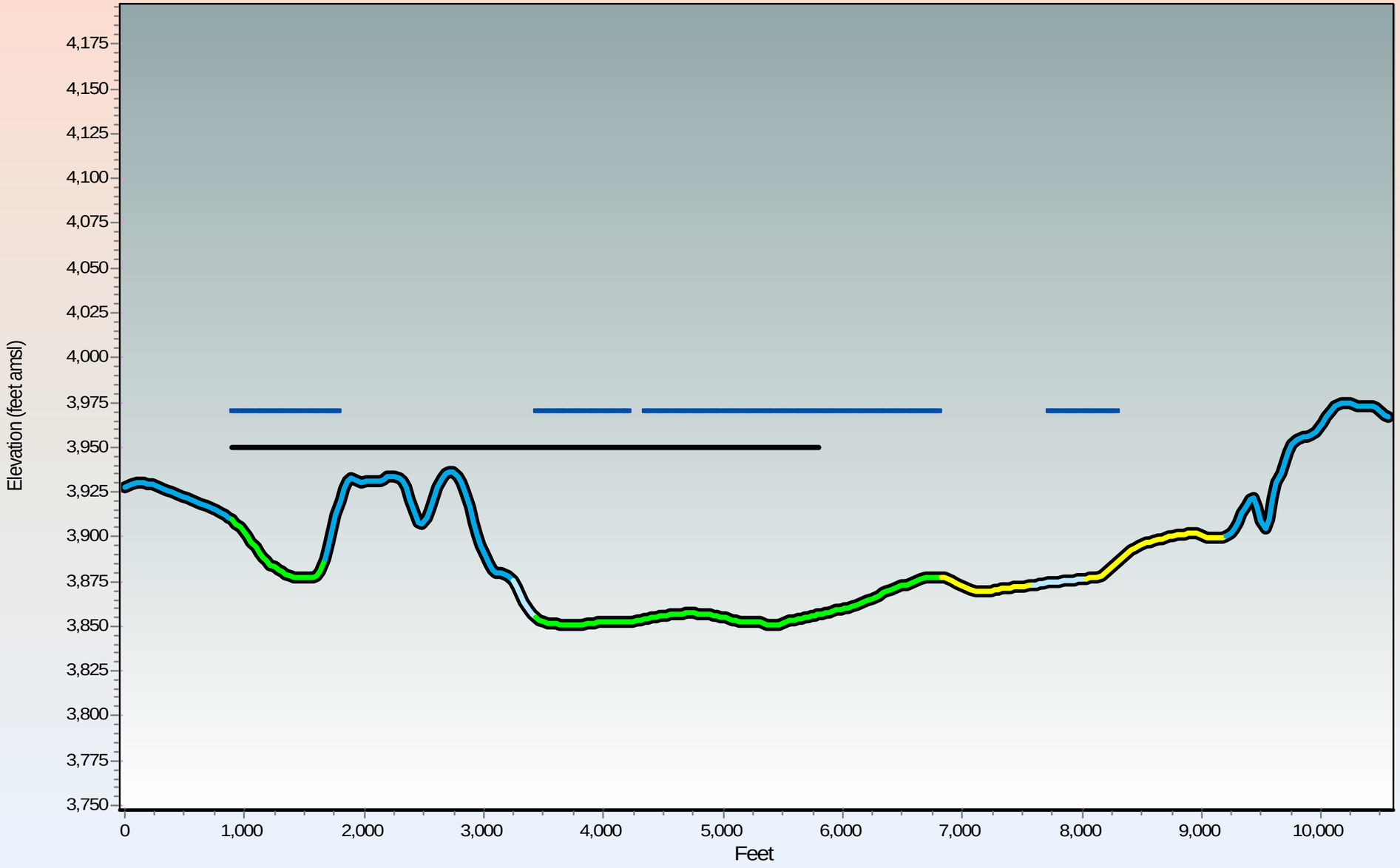
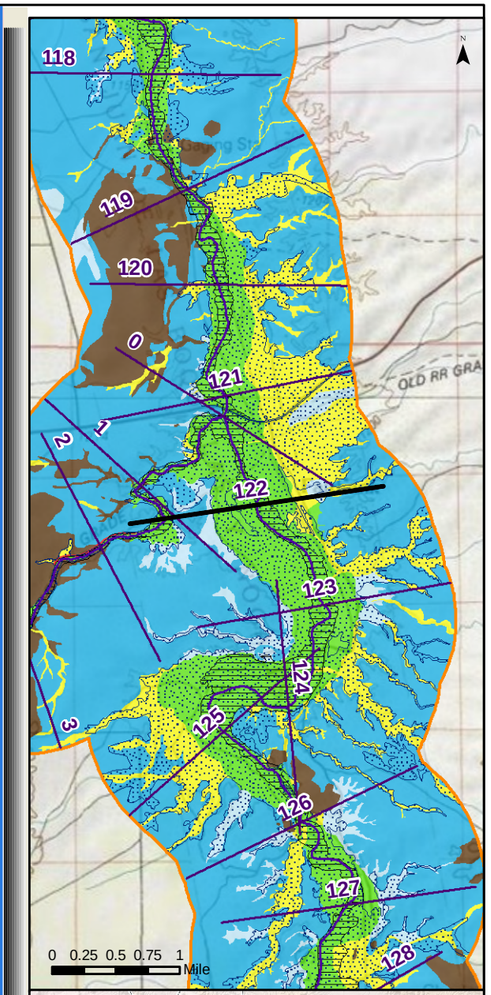
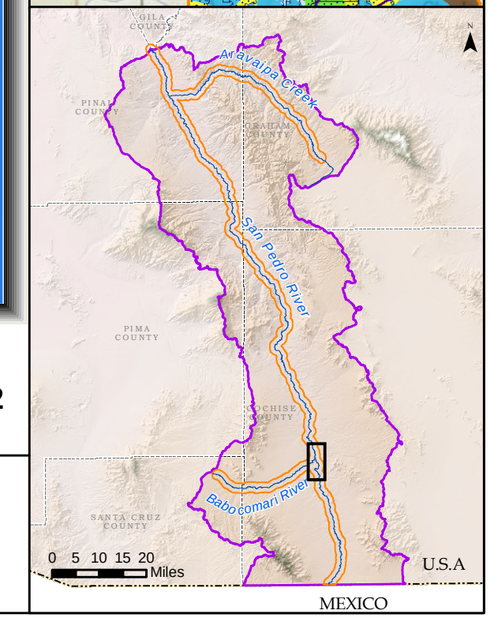
Appendix F
San Pedro River Cross Section at Mile 121
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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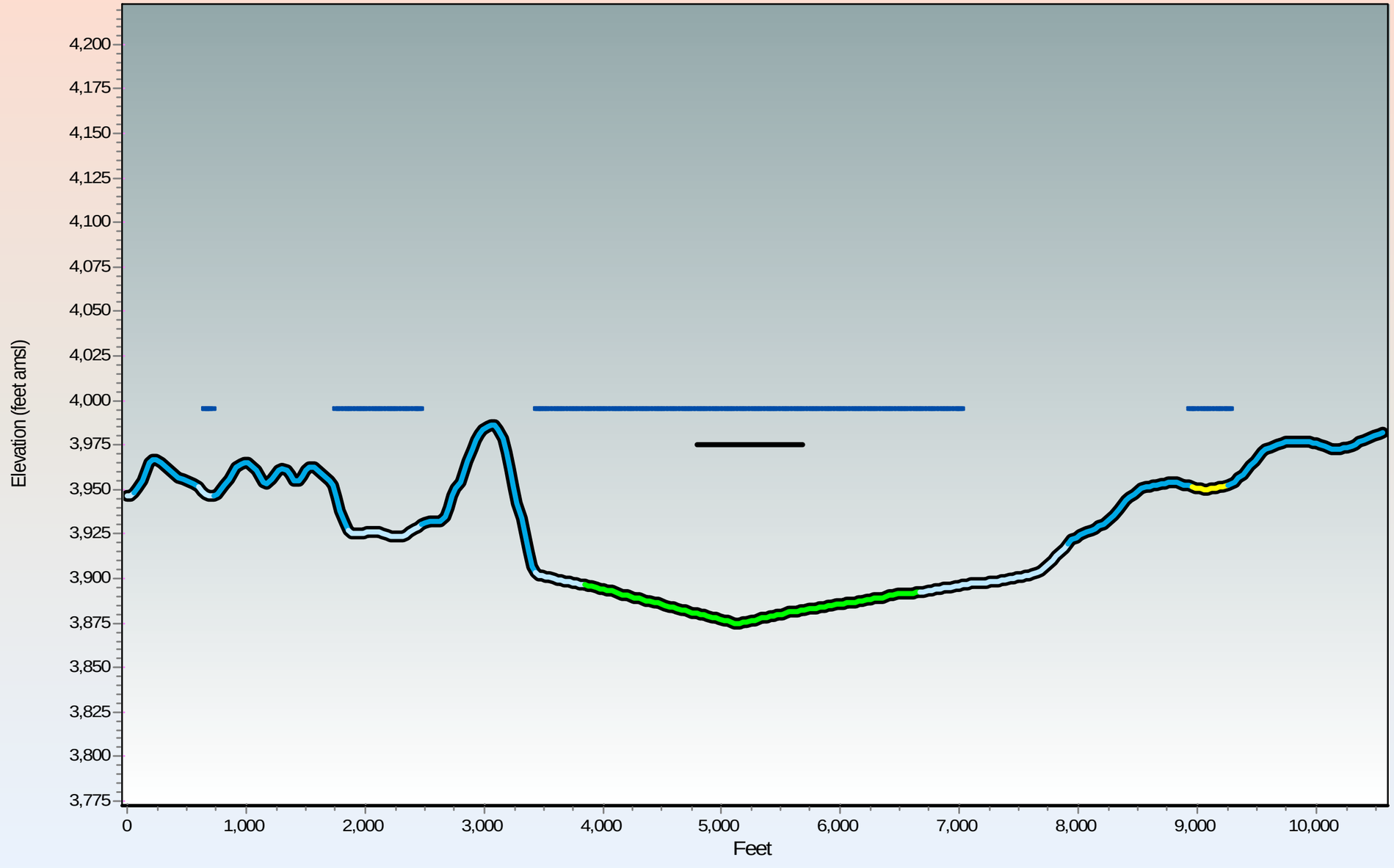
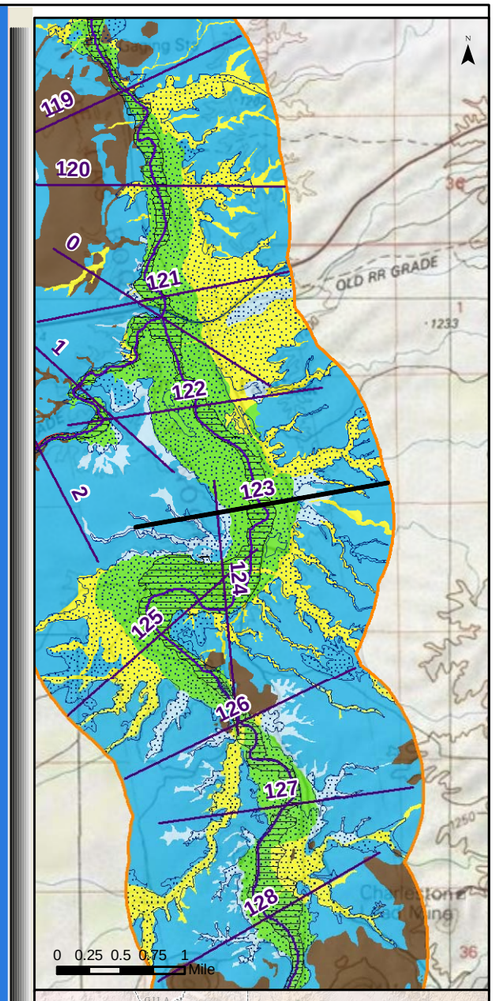
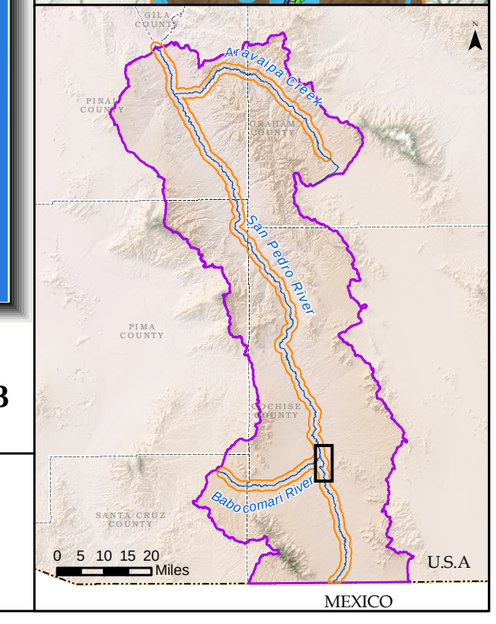
Appendix F
San Pedro River Cross Section at Mile 122
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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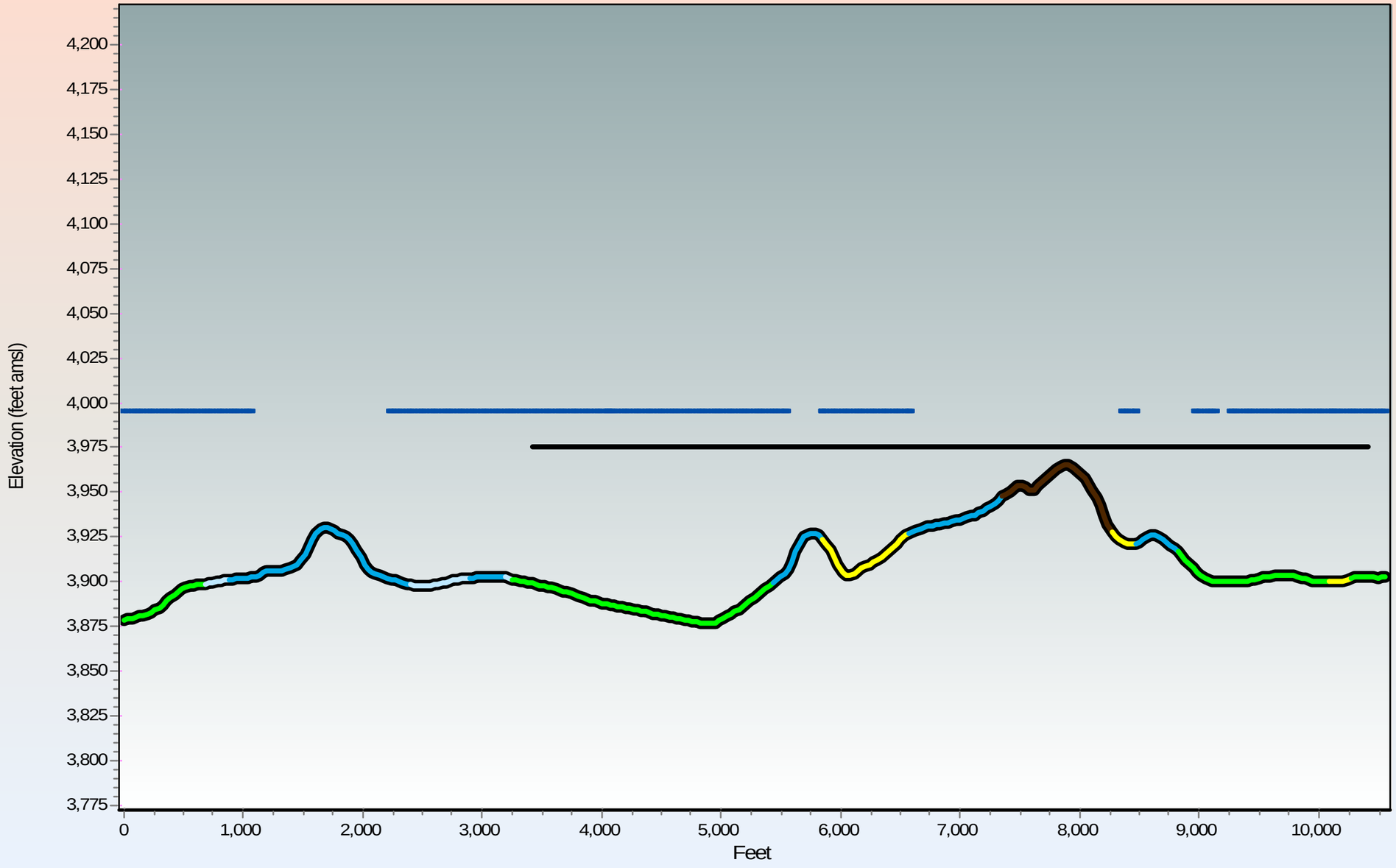
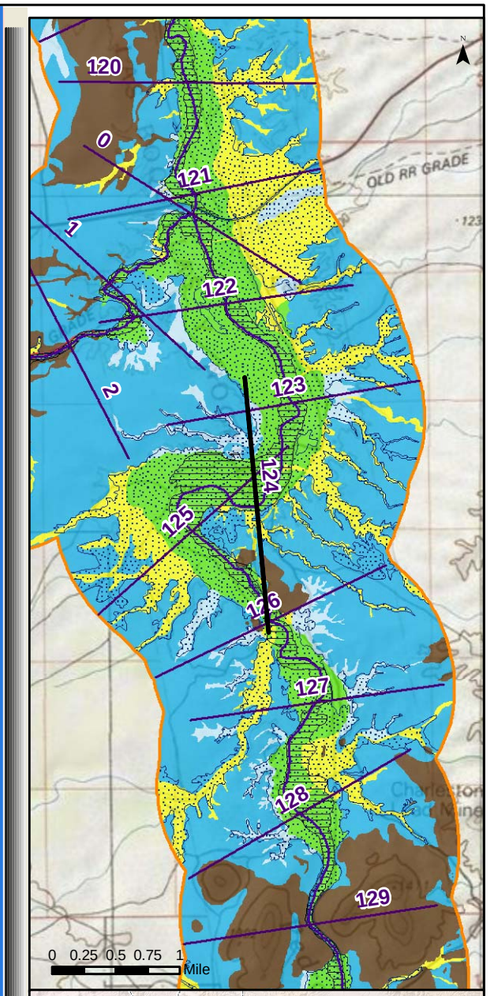
Appendix F

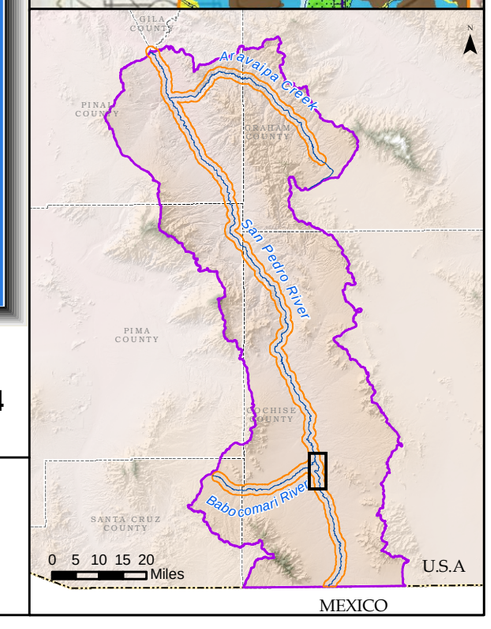
San Pedro River Cross Section at Mile 123

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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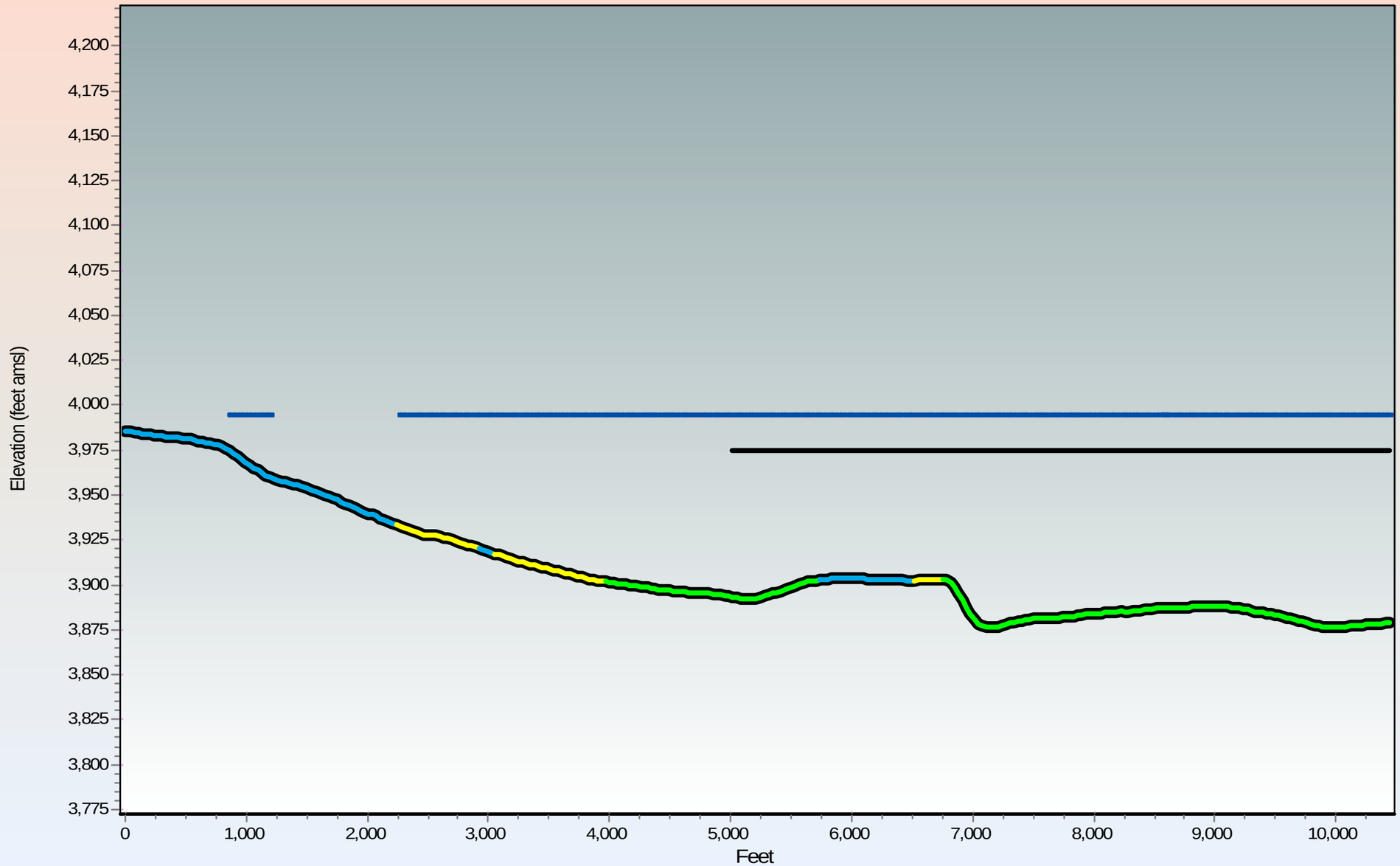
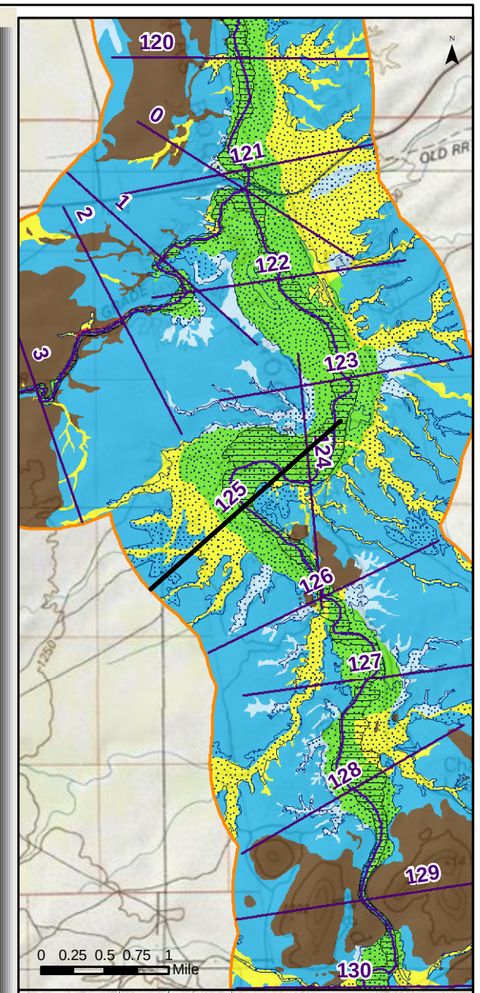
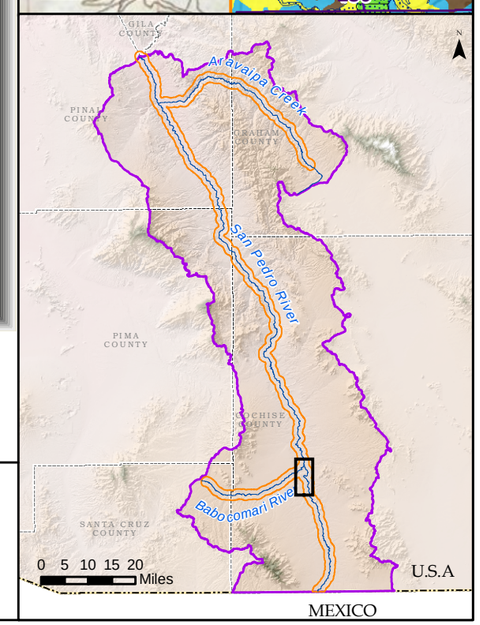
Appendix F
San Pedro River Cross Section at Mile 124
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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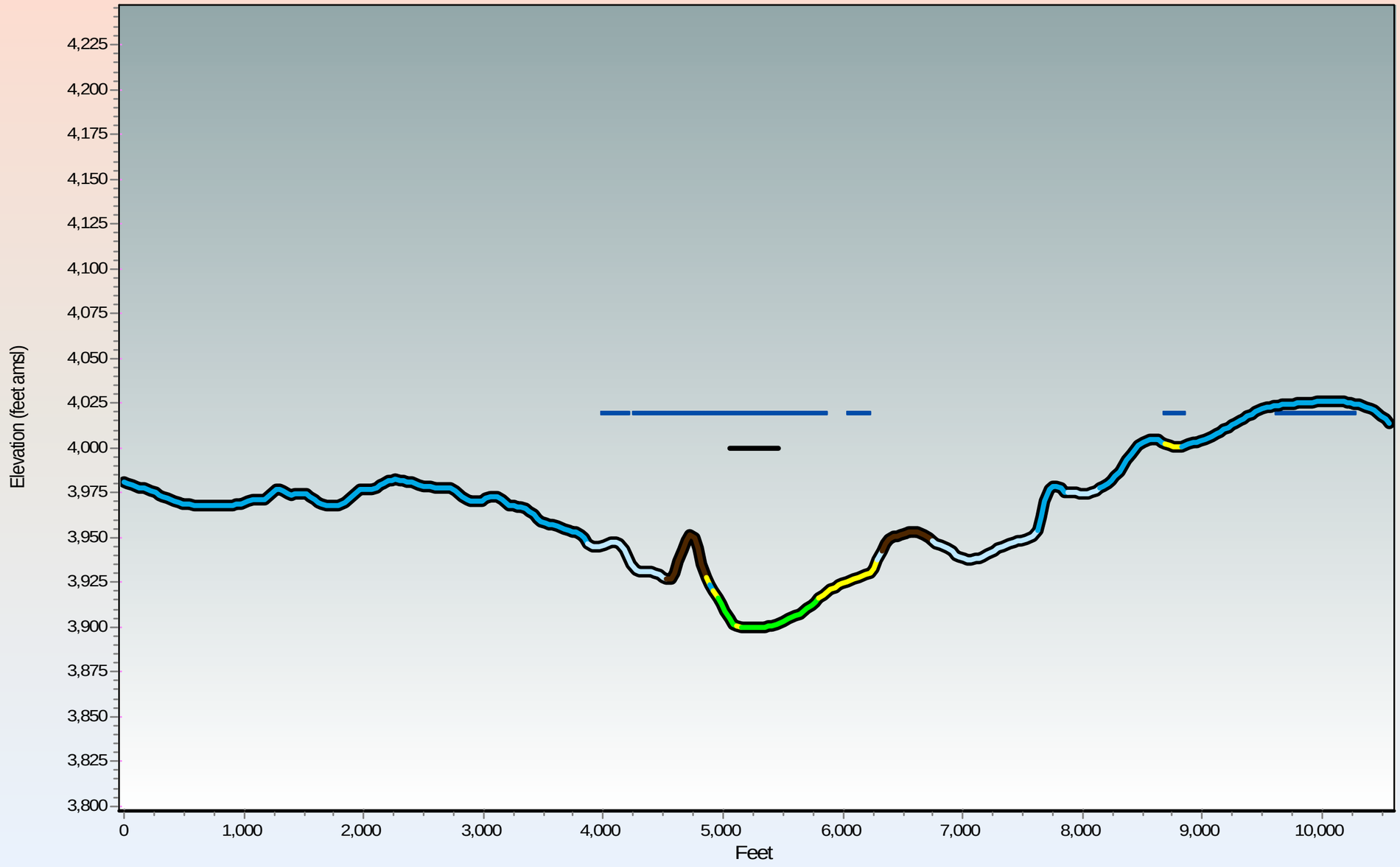
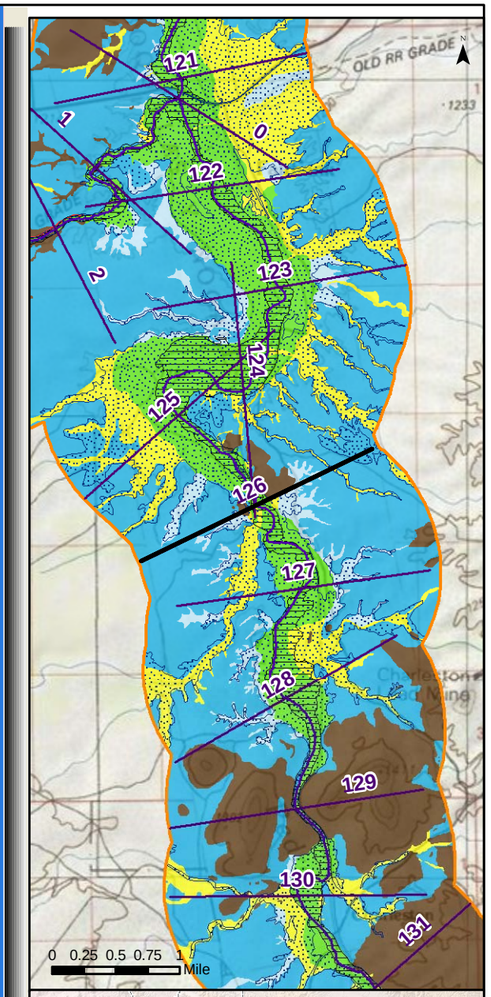
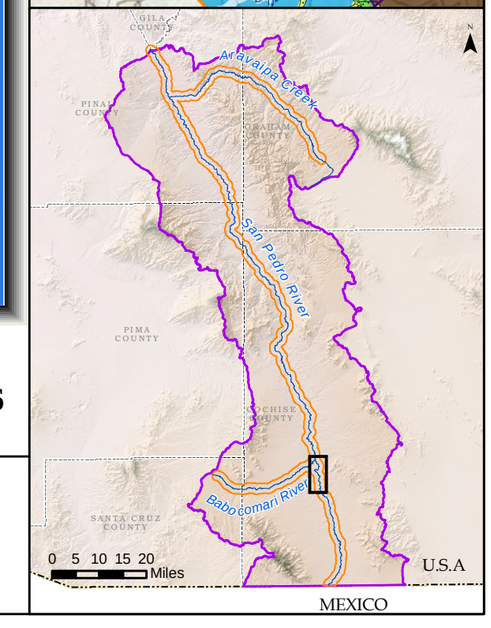
Appendix F
San Pedro River Cross Section at Mile 125
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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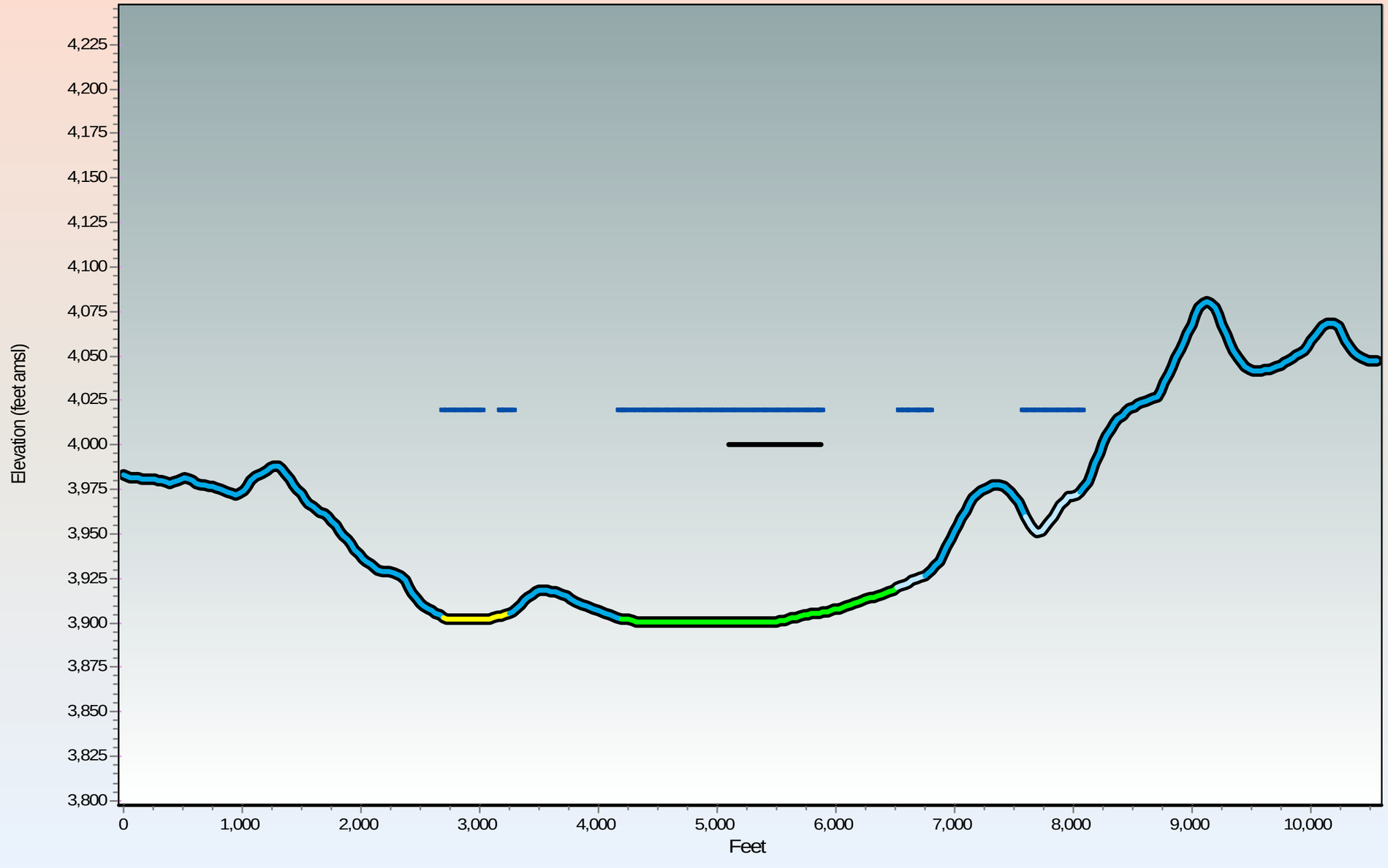
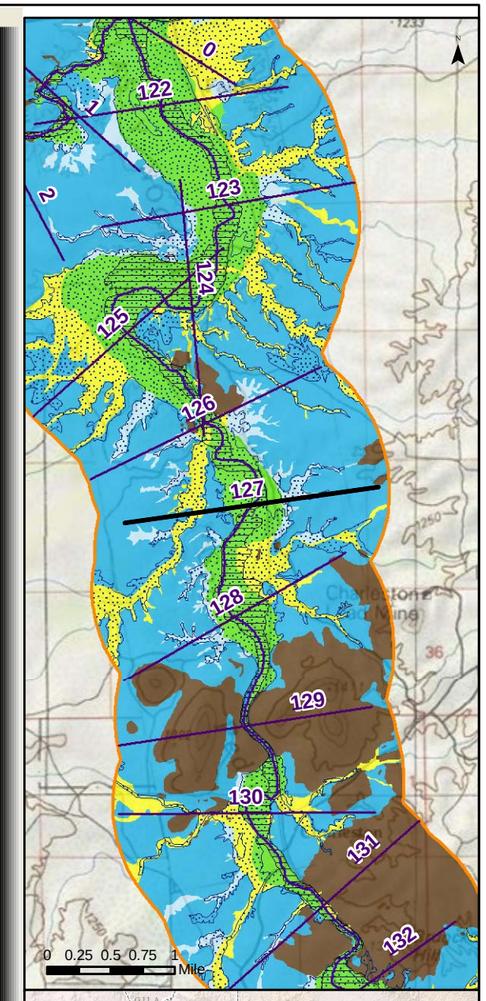
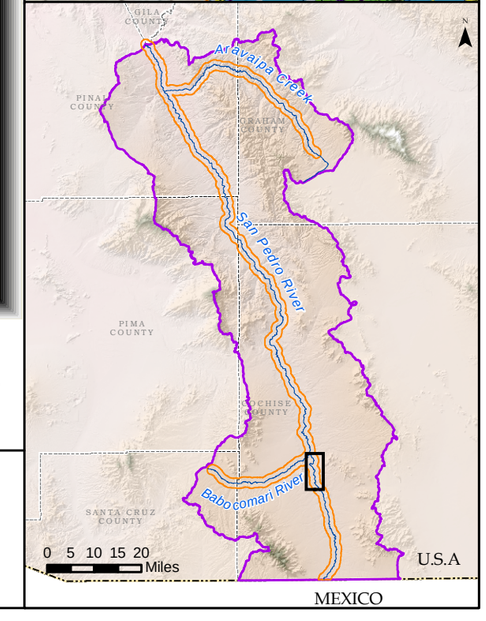
Appendix F
San Pedro River Cross Section at Mile 126
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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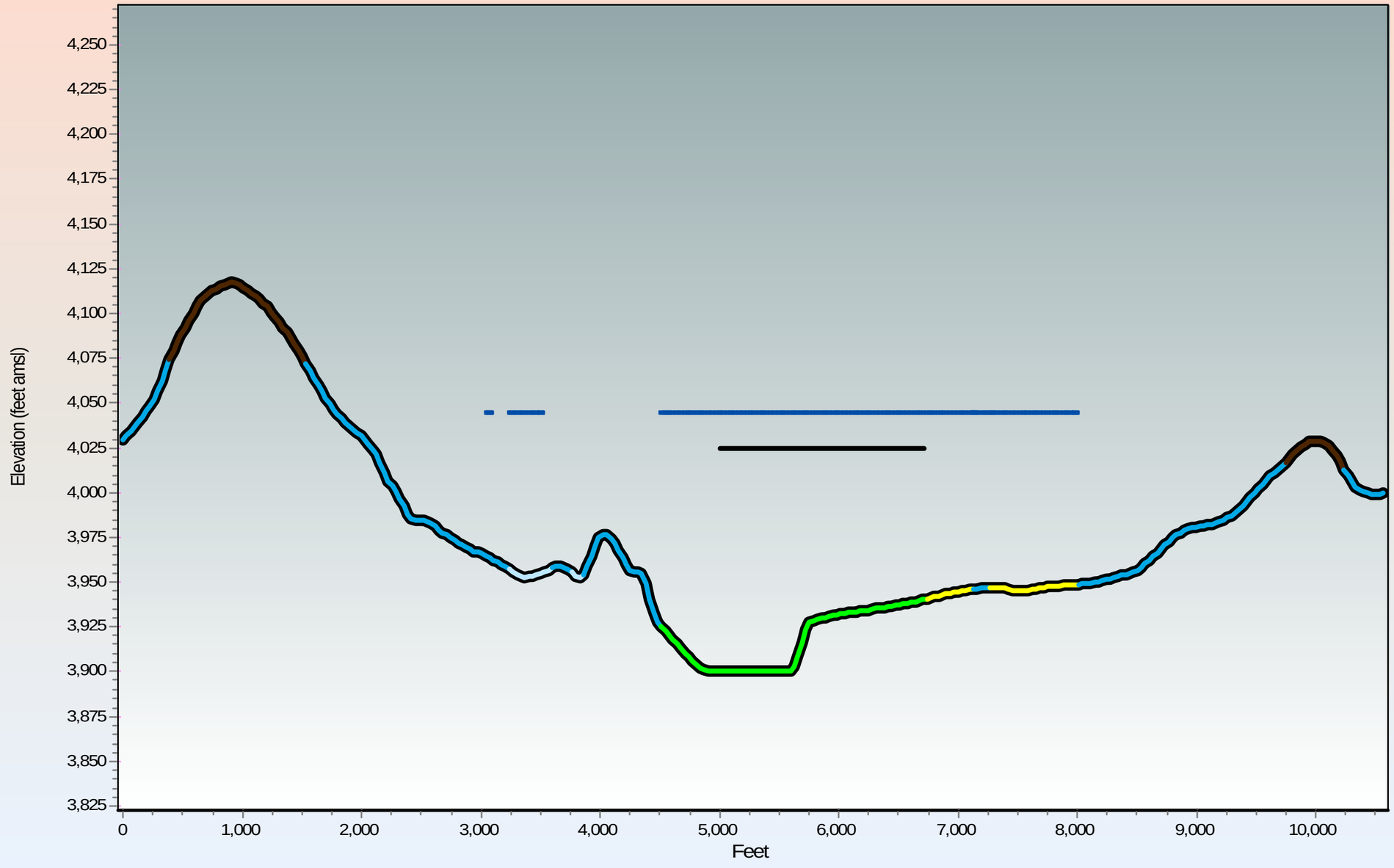
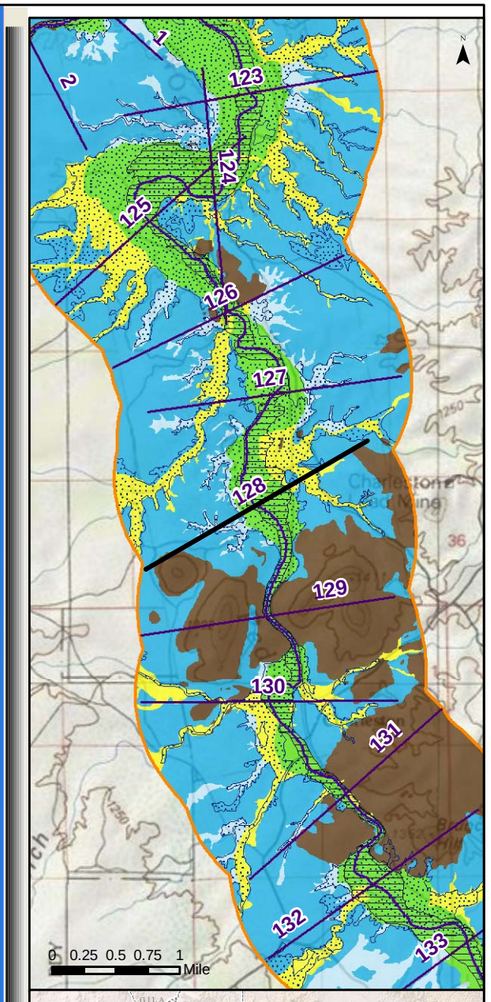
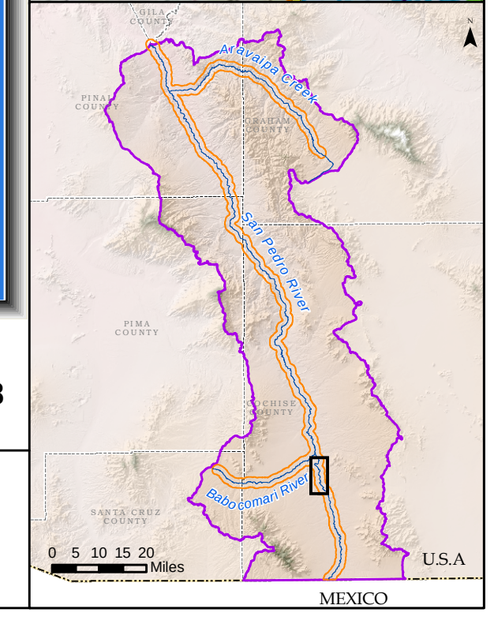
Appendix F
San Pedro River Cross Section at Mile 127
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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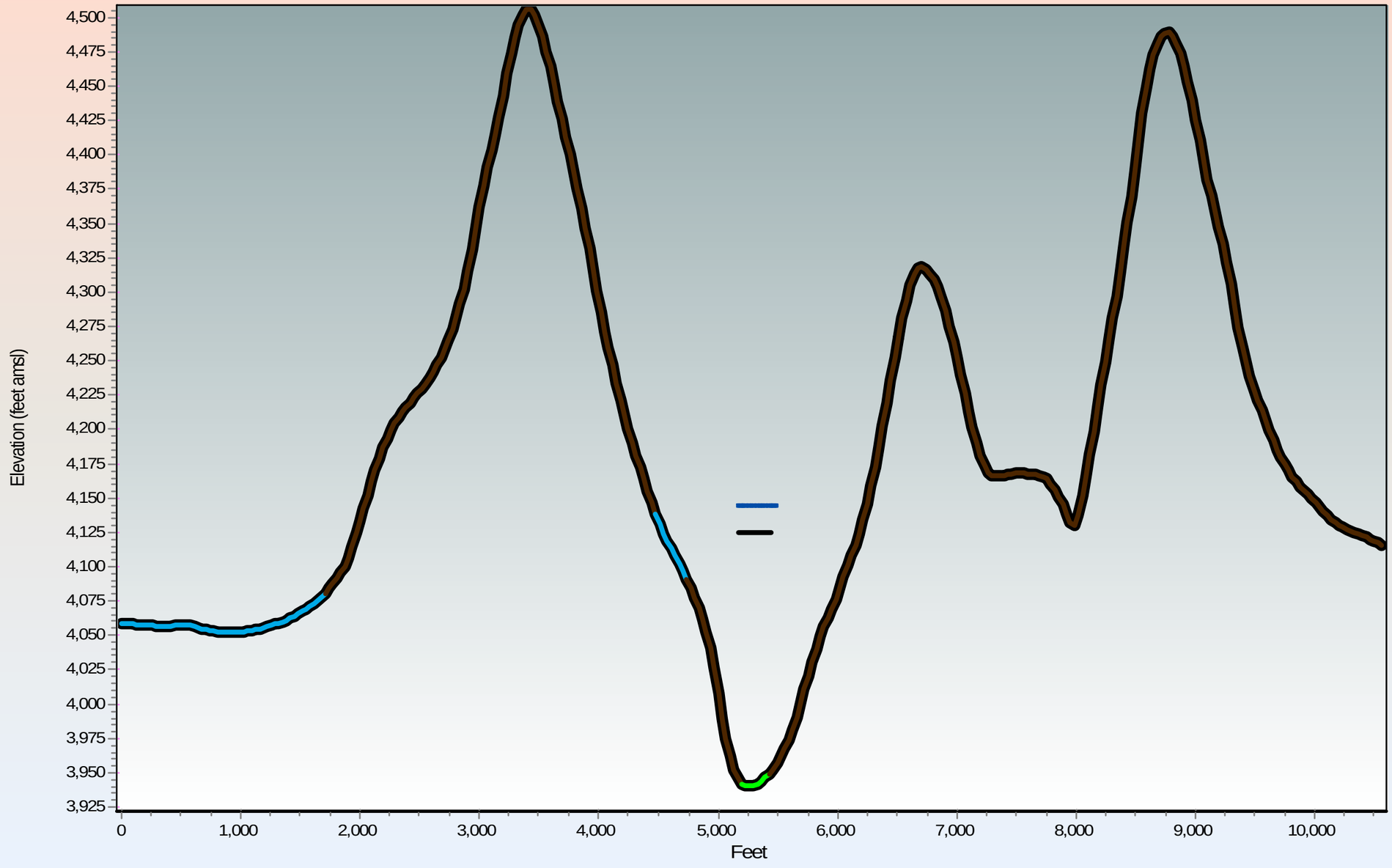
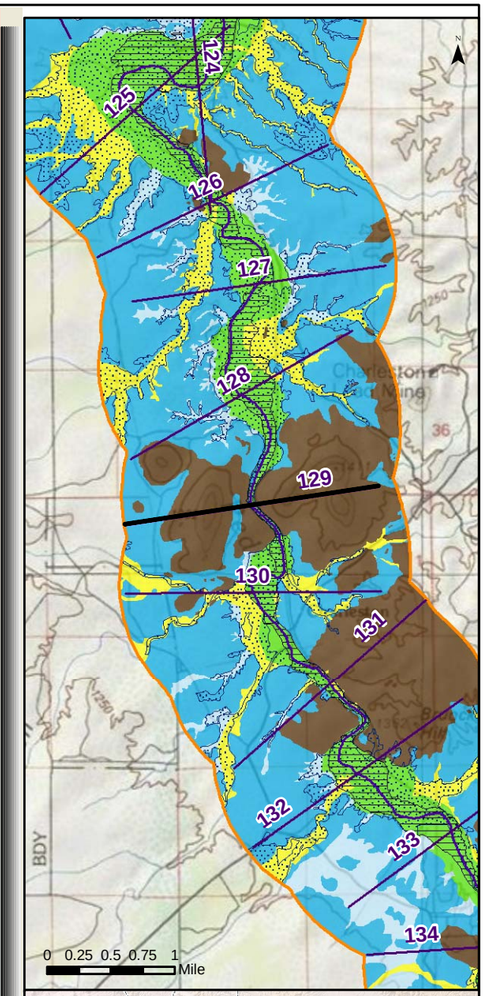
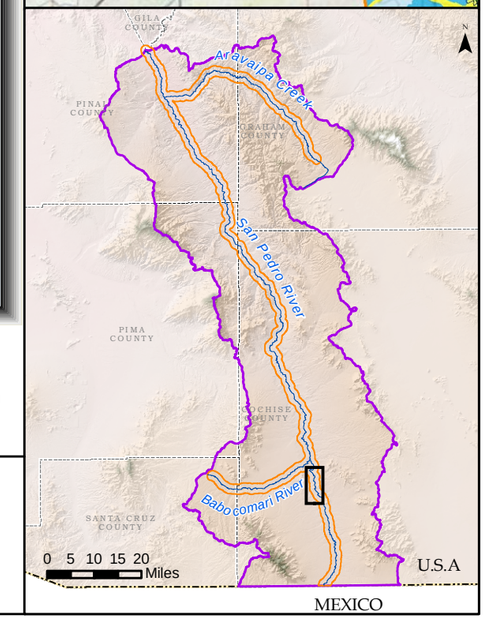
Appendix F
San Pedro River Cross Section at Mile 128
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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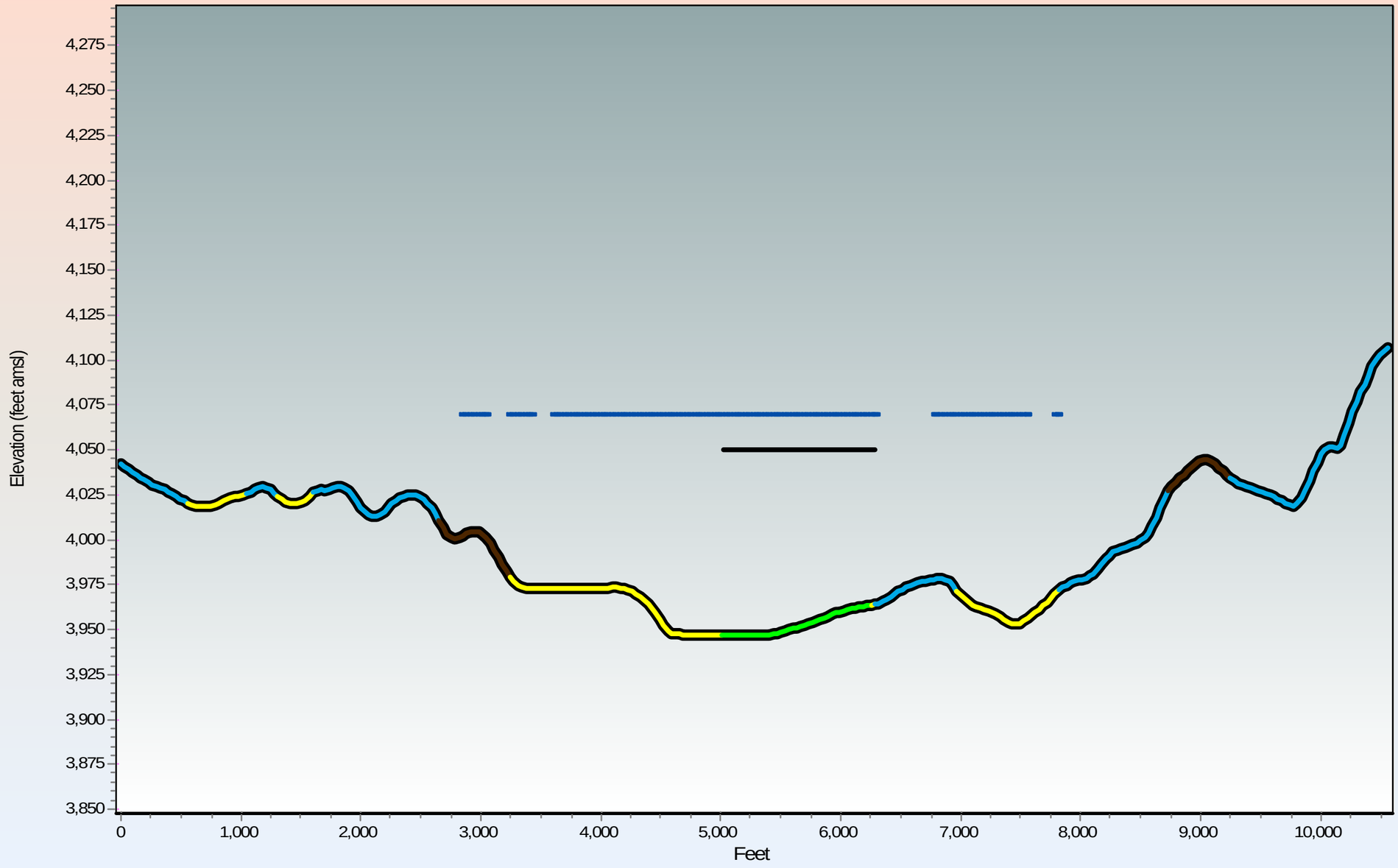
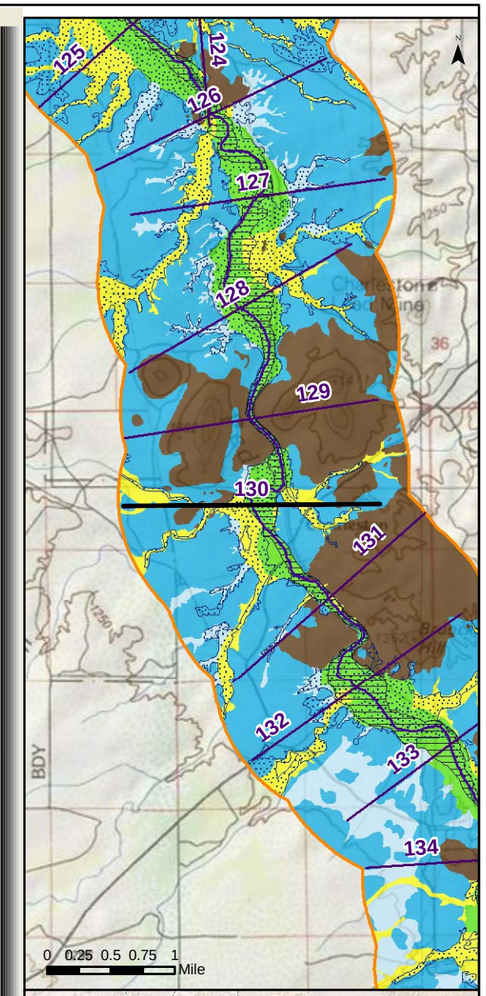
Appendix F

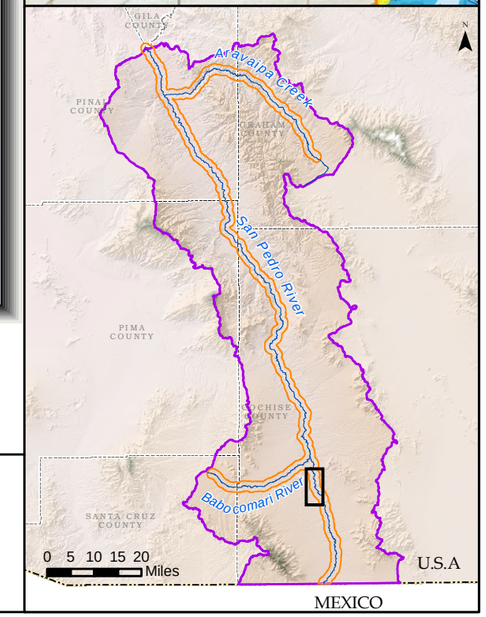
San Pedro River Cross Section at Mile 129

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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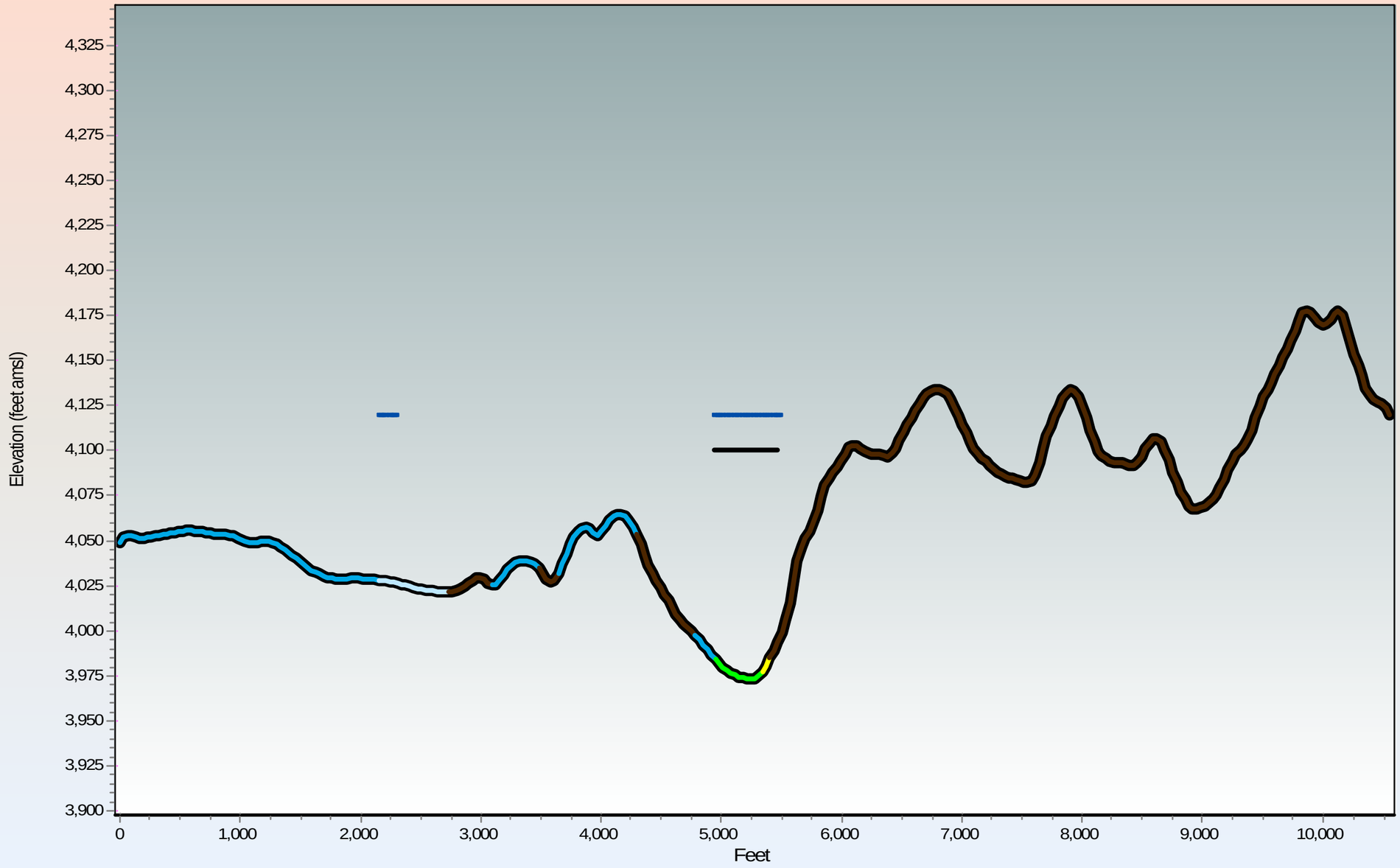
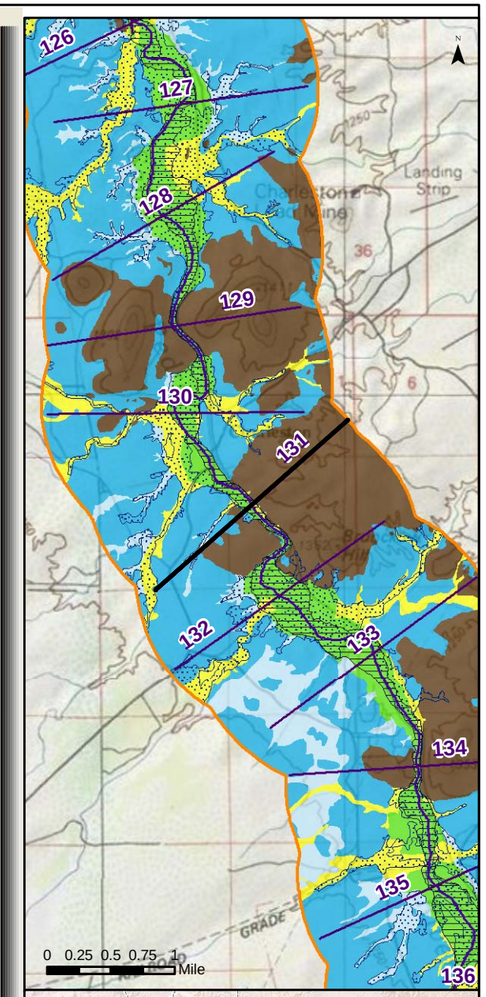
Appendix F

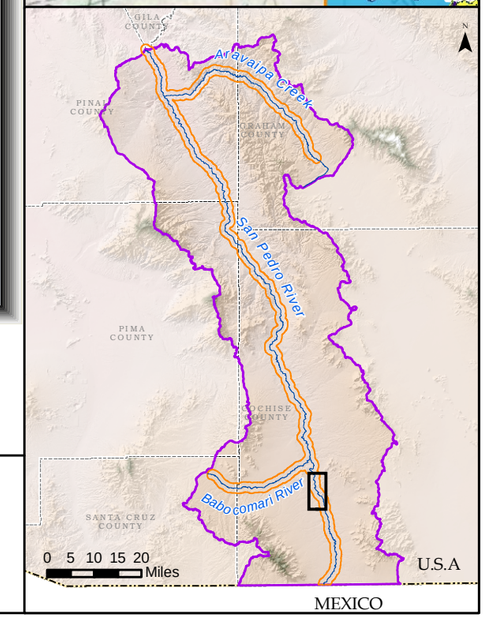
San Pedro River Cross Section at Mile 130

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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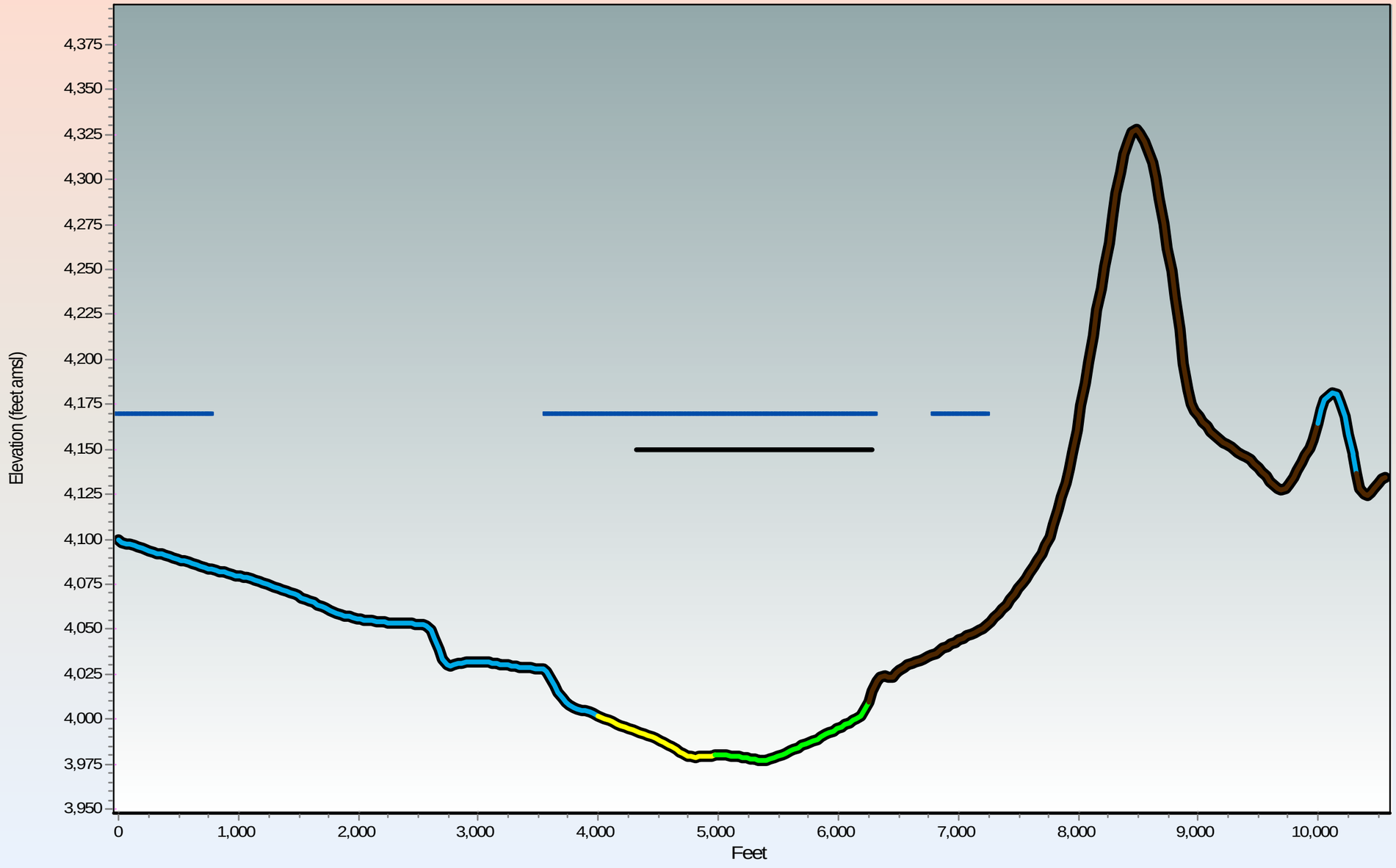
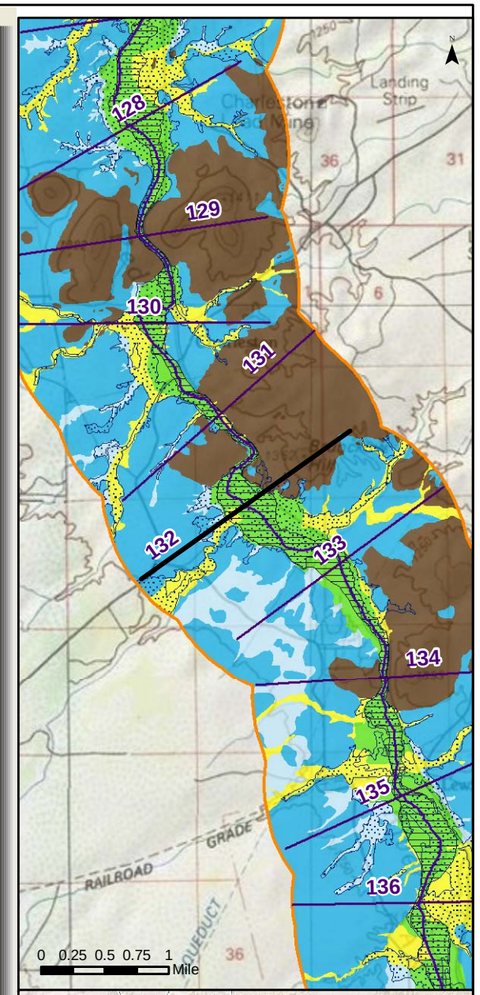
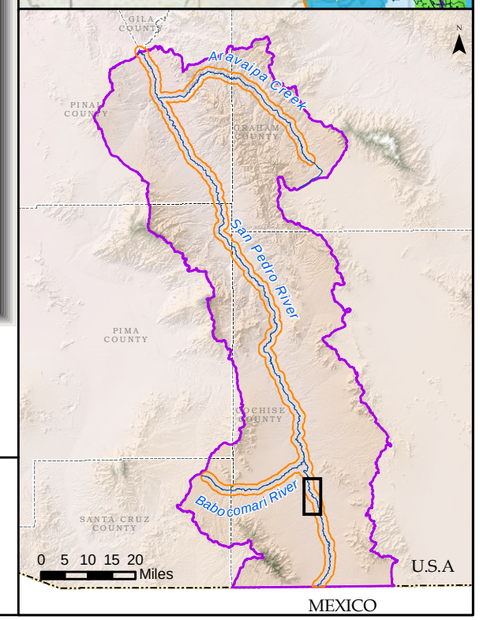
Appendix F
San Pedro River Cross Section at Mile 131
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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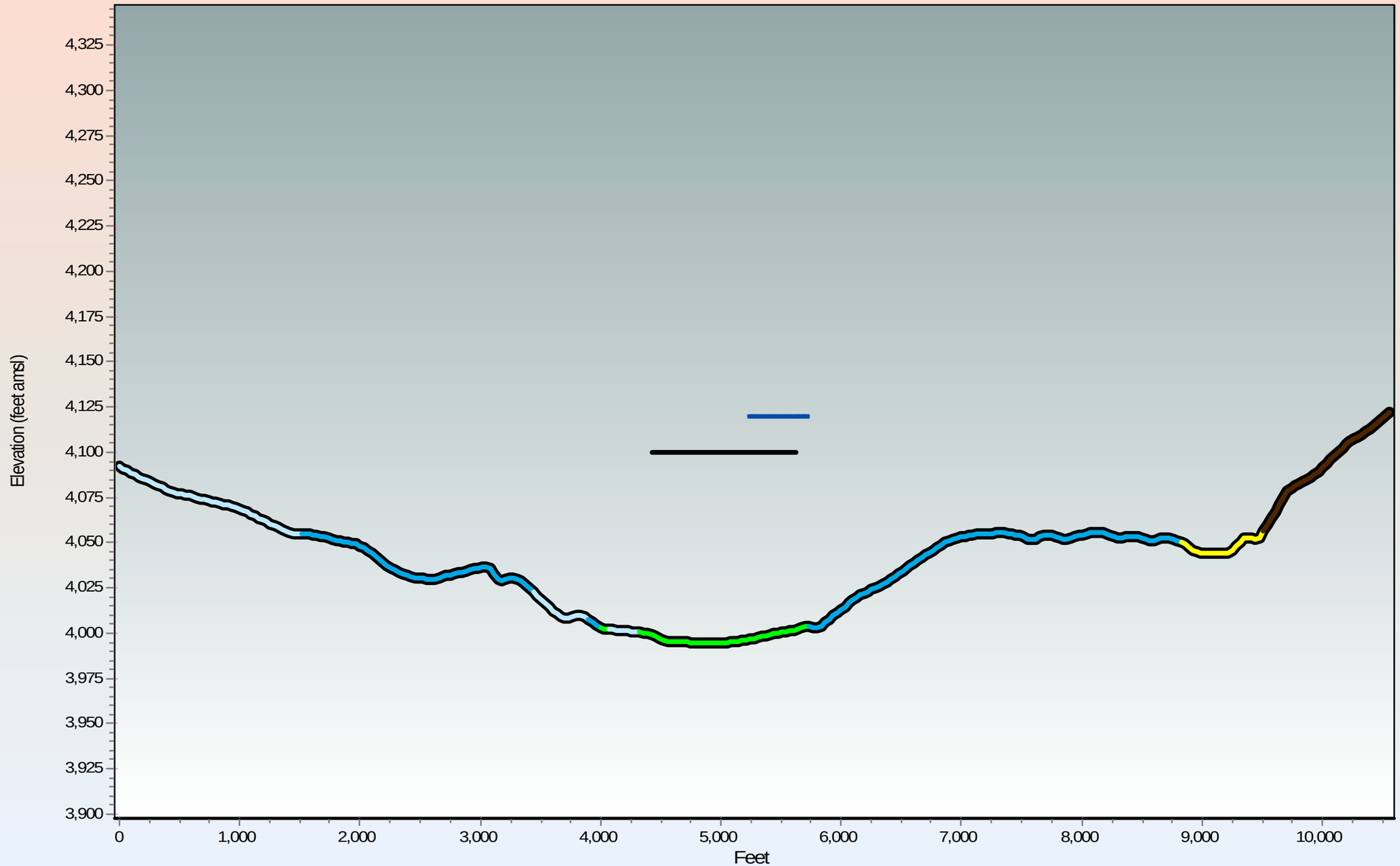
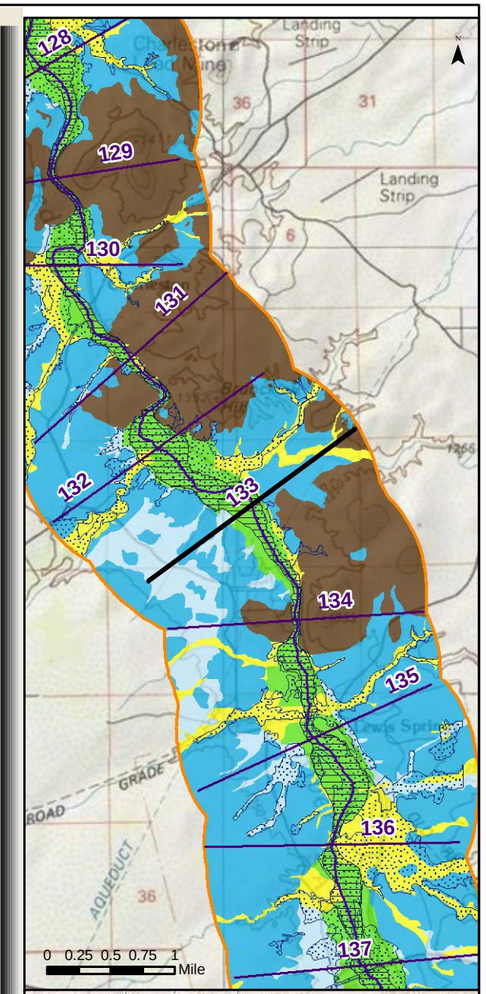
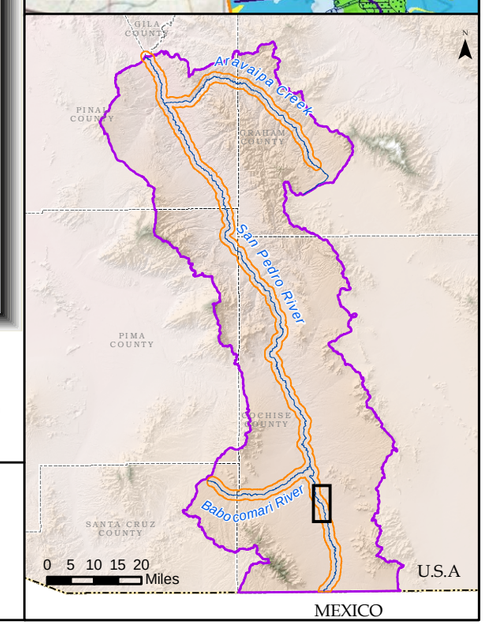
Appendix F
San Pedro River Cross Section at Mile 132
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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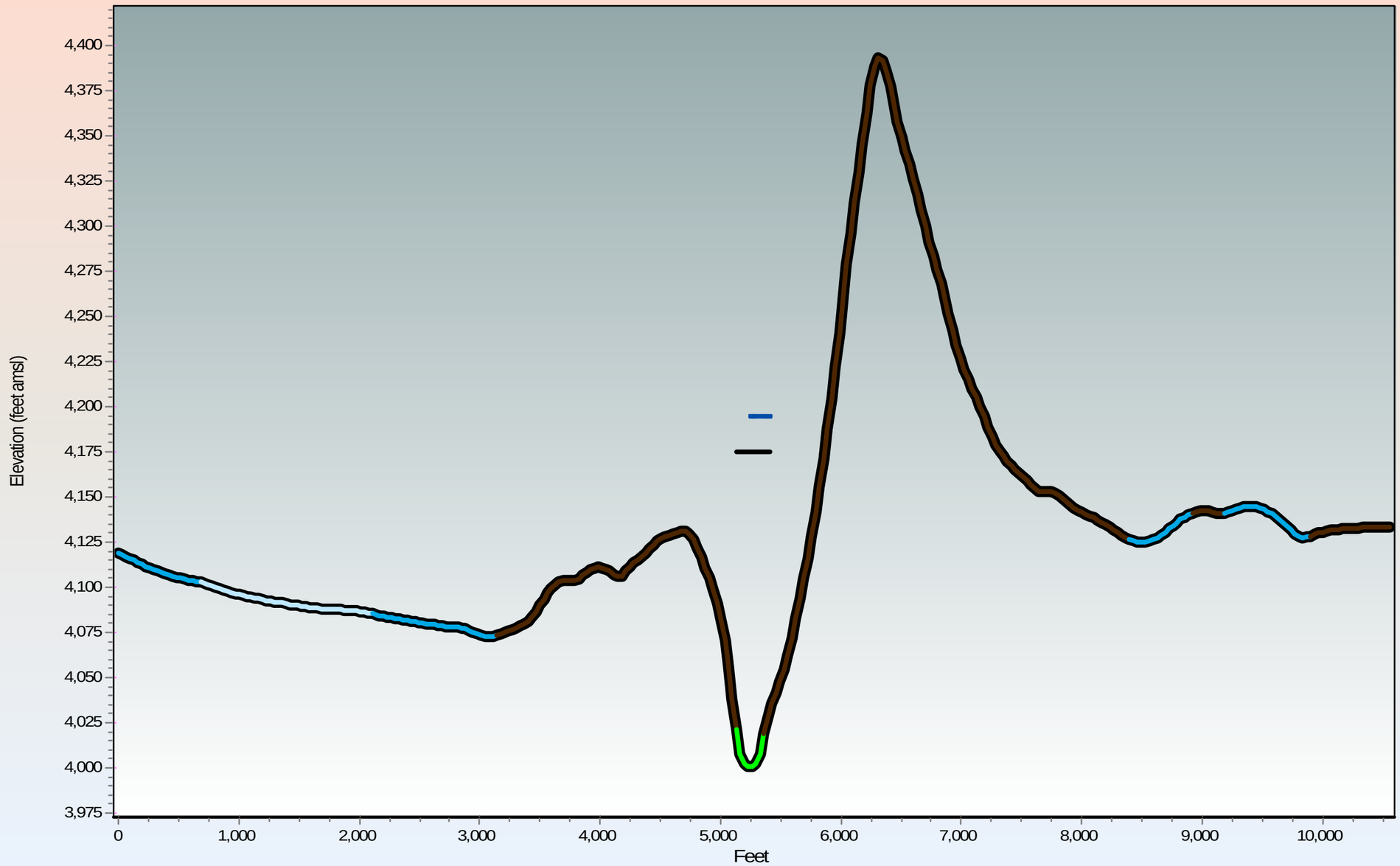
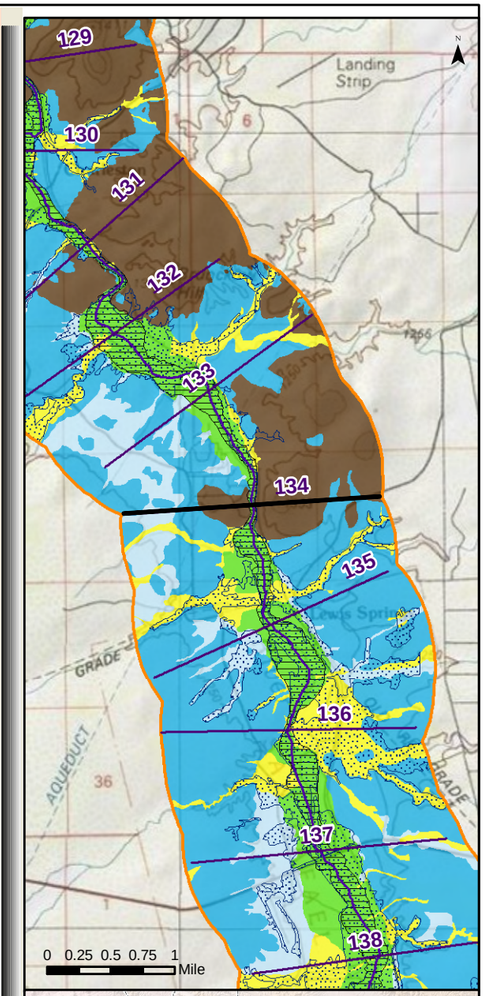
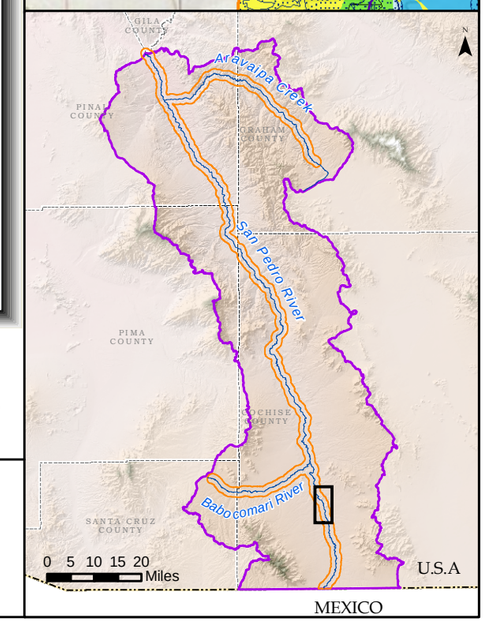
Appendix F
San Pedro River Cross Section at Mile 133
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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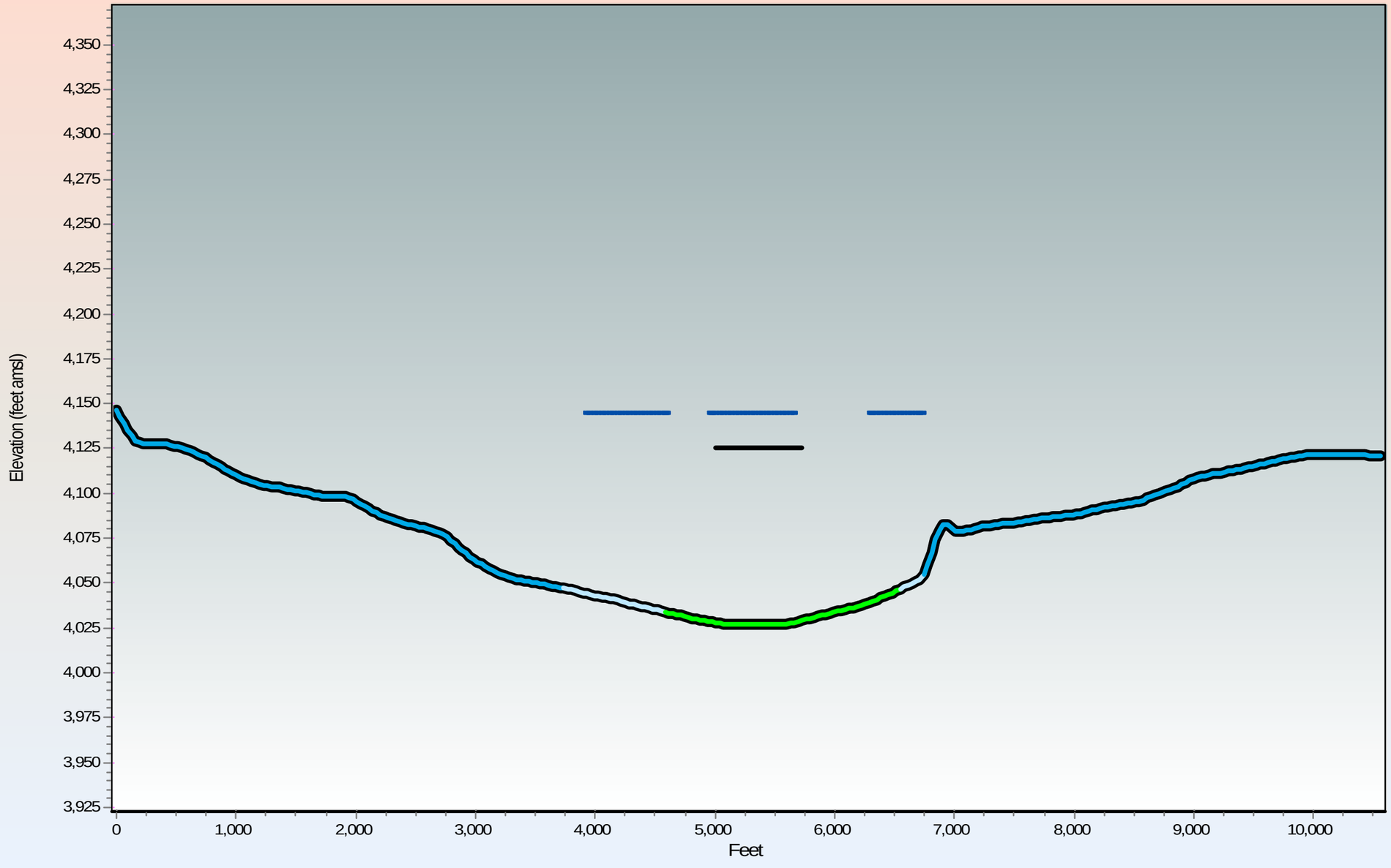
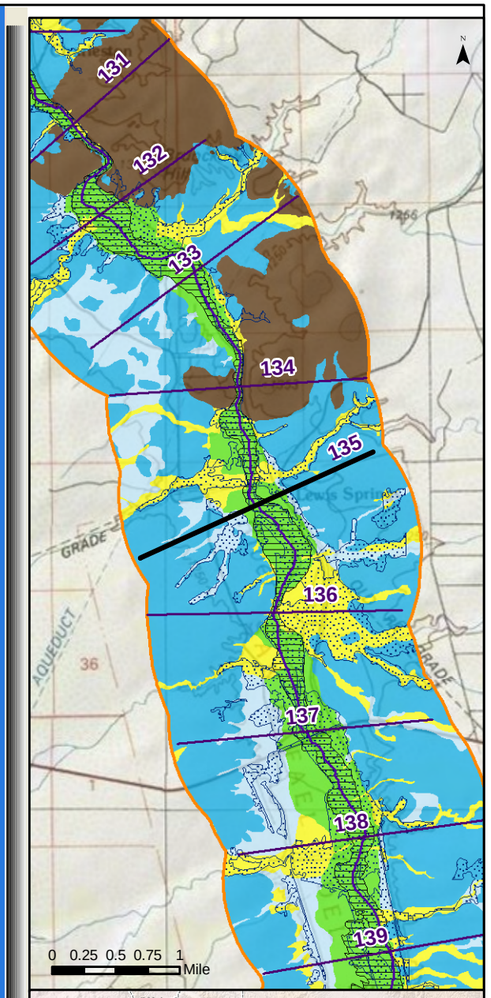
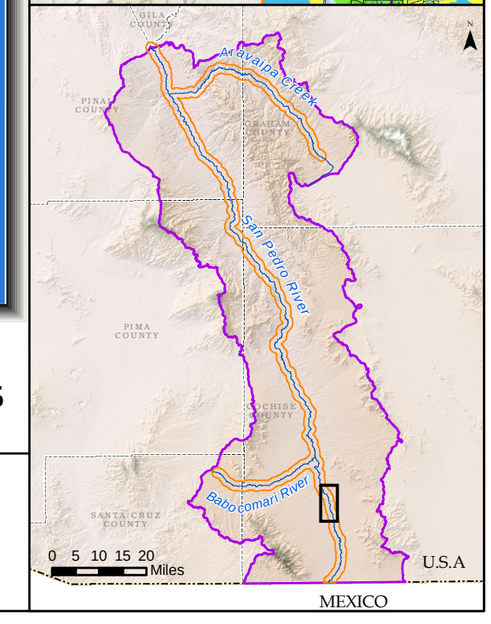
Appendix F
San Pedro River Cross Section at Mile 134
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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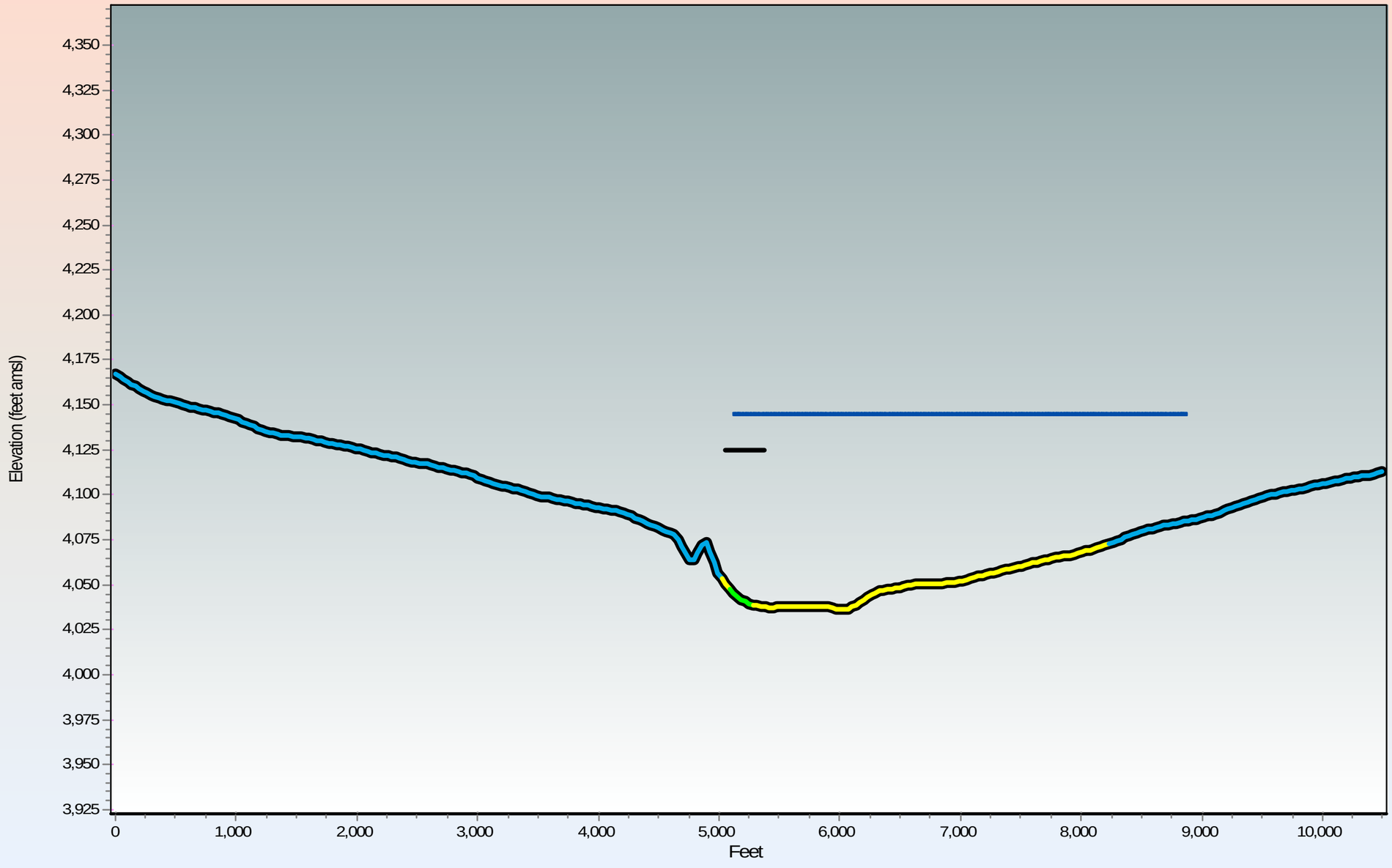
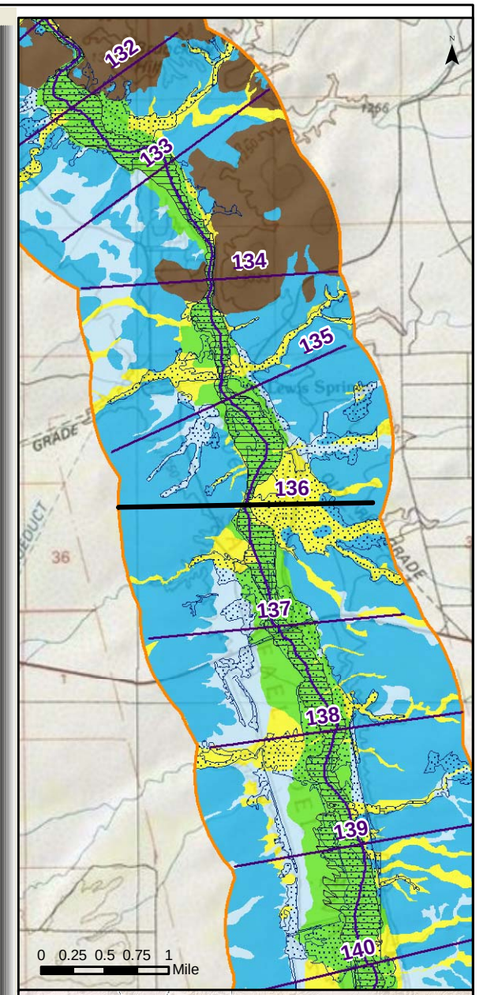
Appendix F

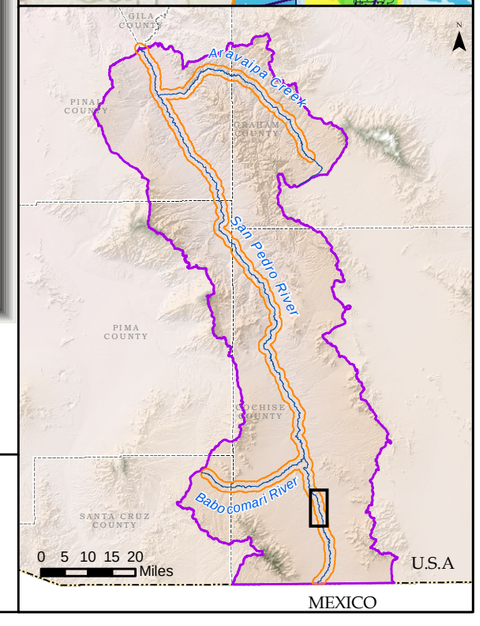
San Pedro River Cross Section at Mile 135

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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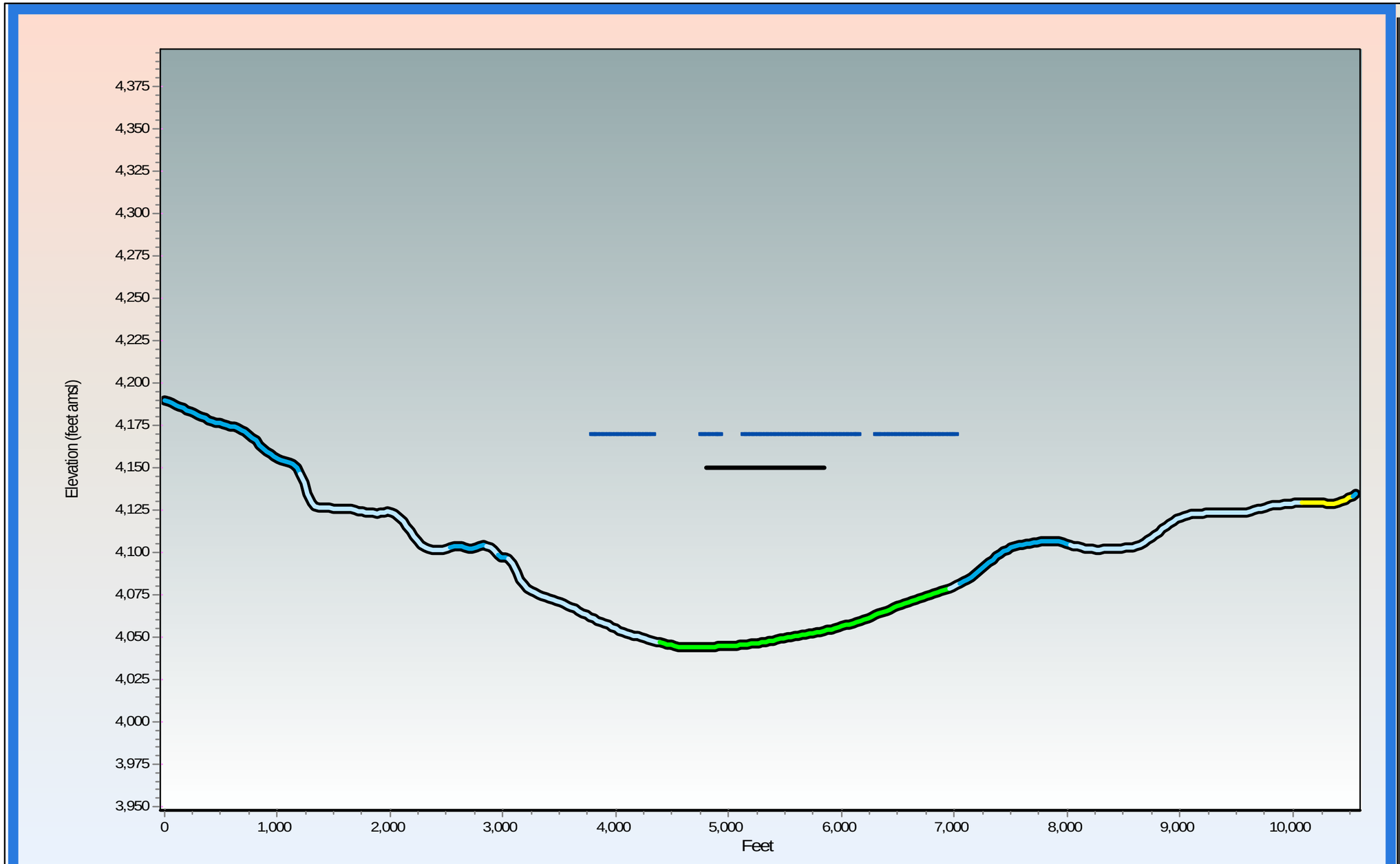
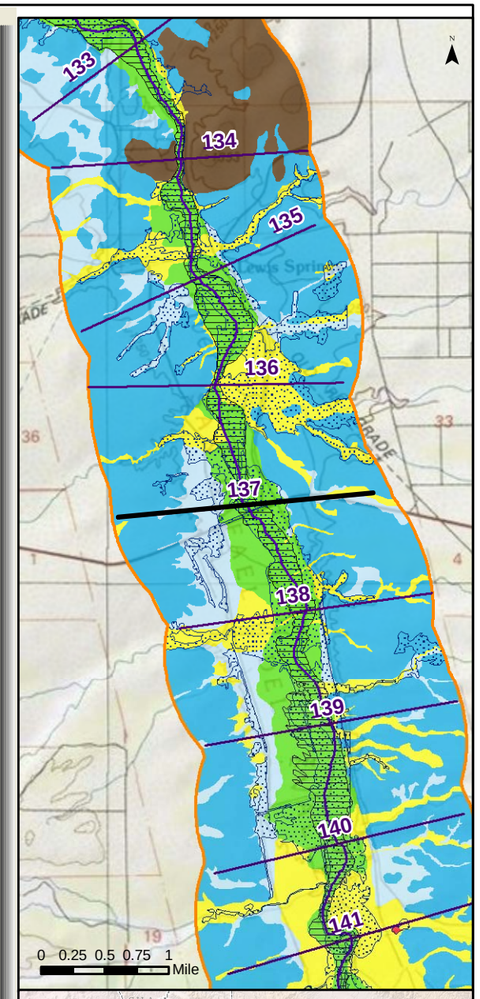
Appendix F

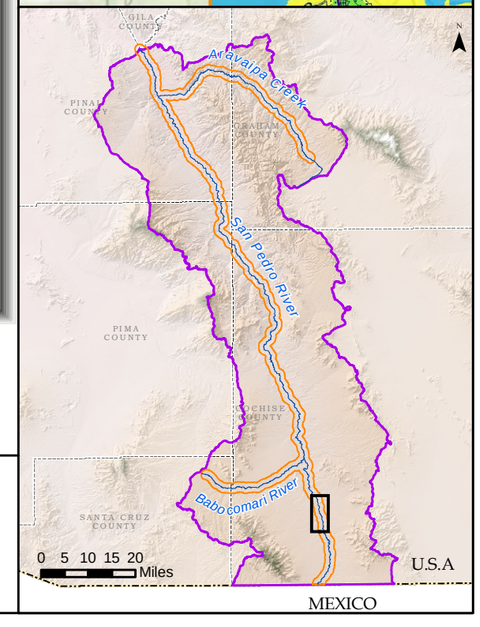
San Pedro River Cross Section at Mile 136

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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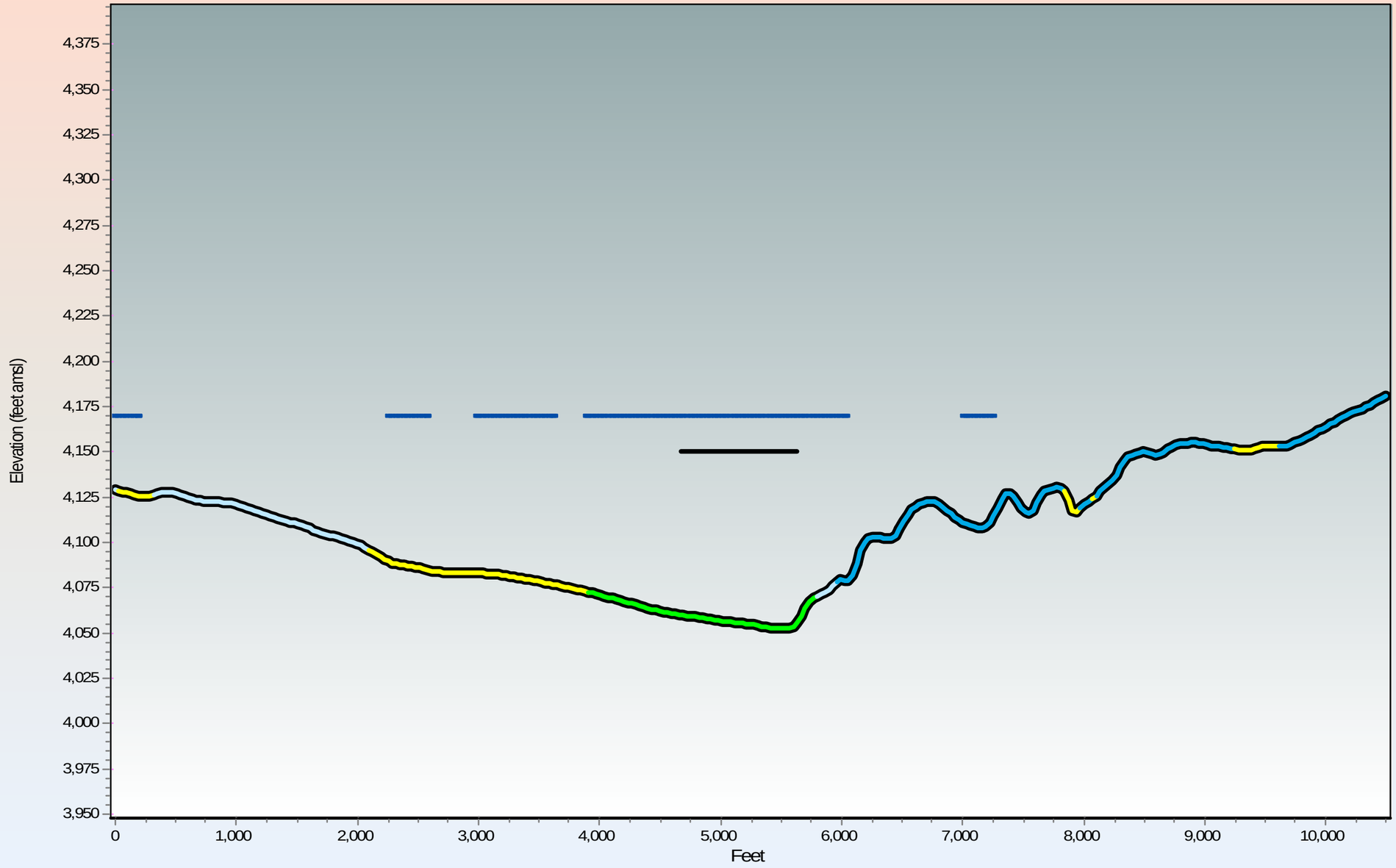
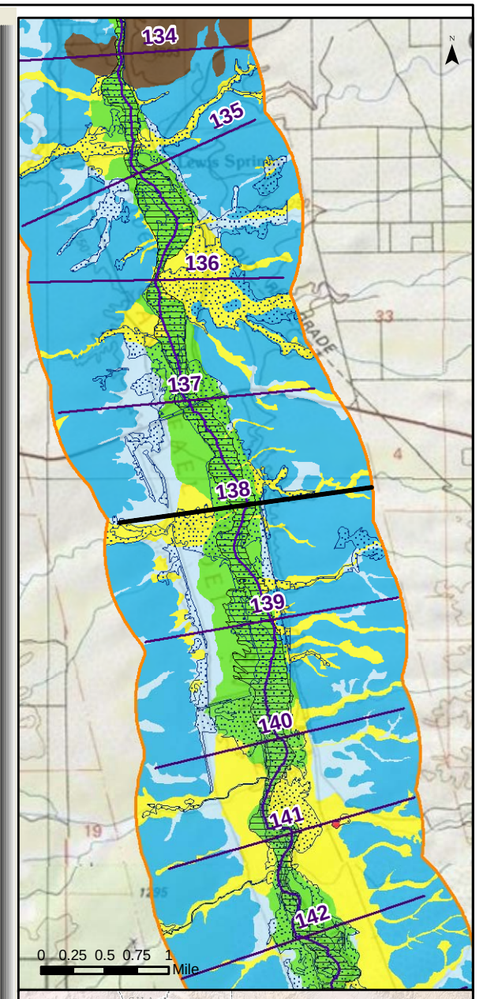
Appendix F

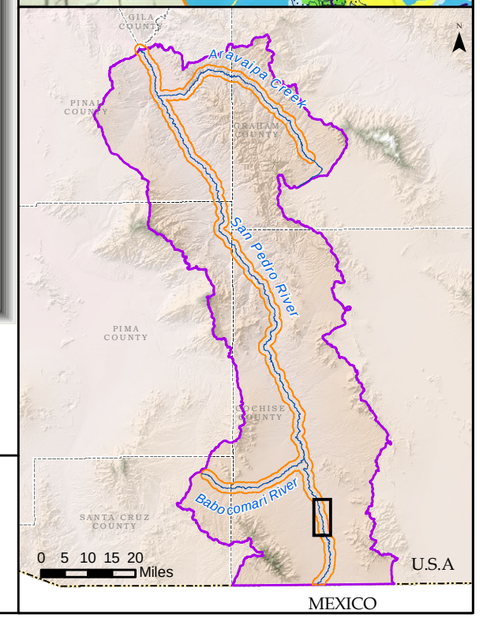
San Pedro River Cross Section at Mile 137

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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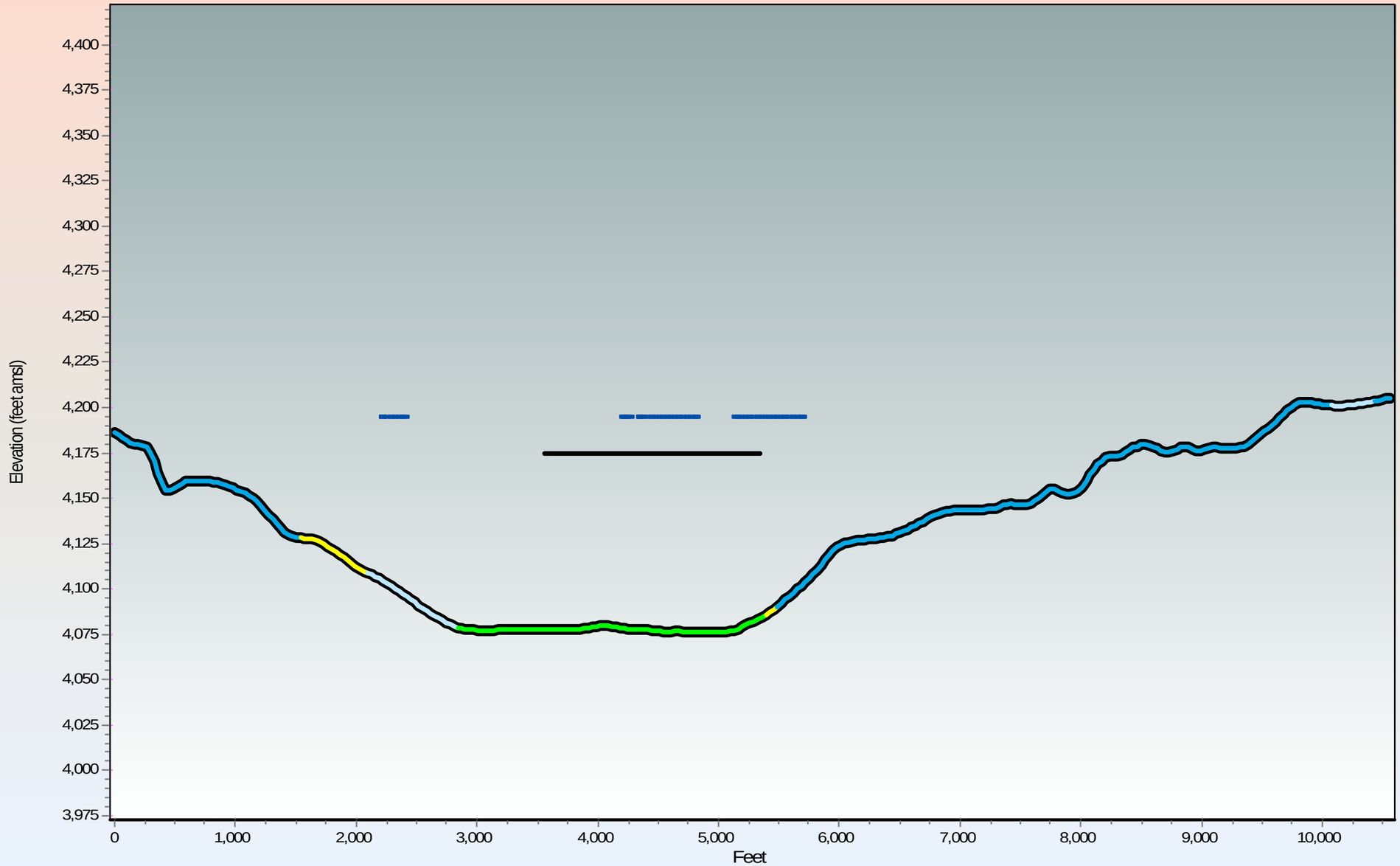
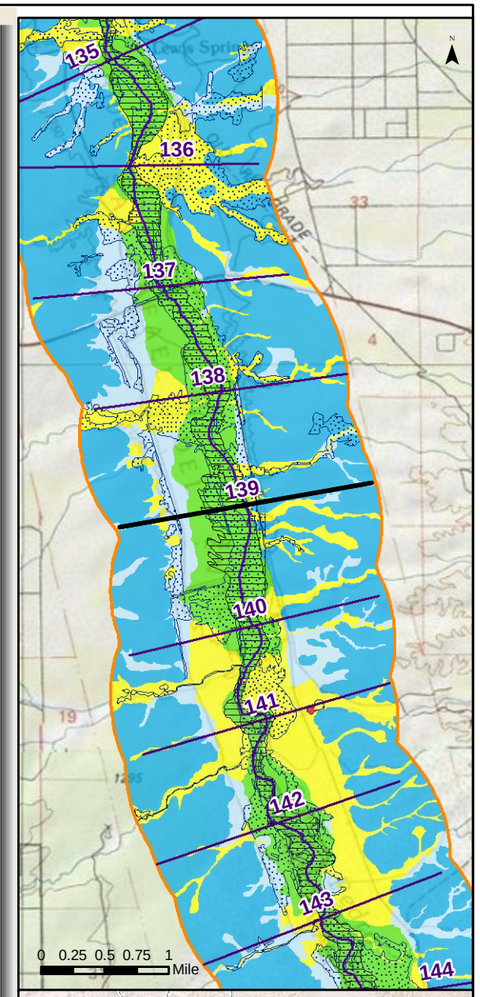
Appendix F

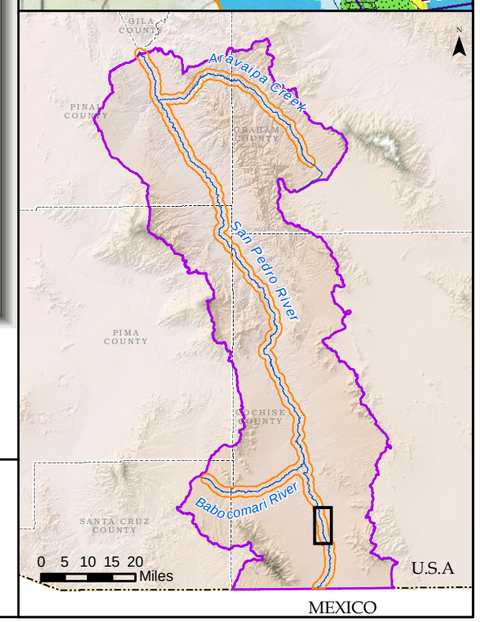
San Pedro River Cross Section at Mile 138

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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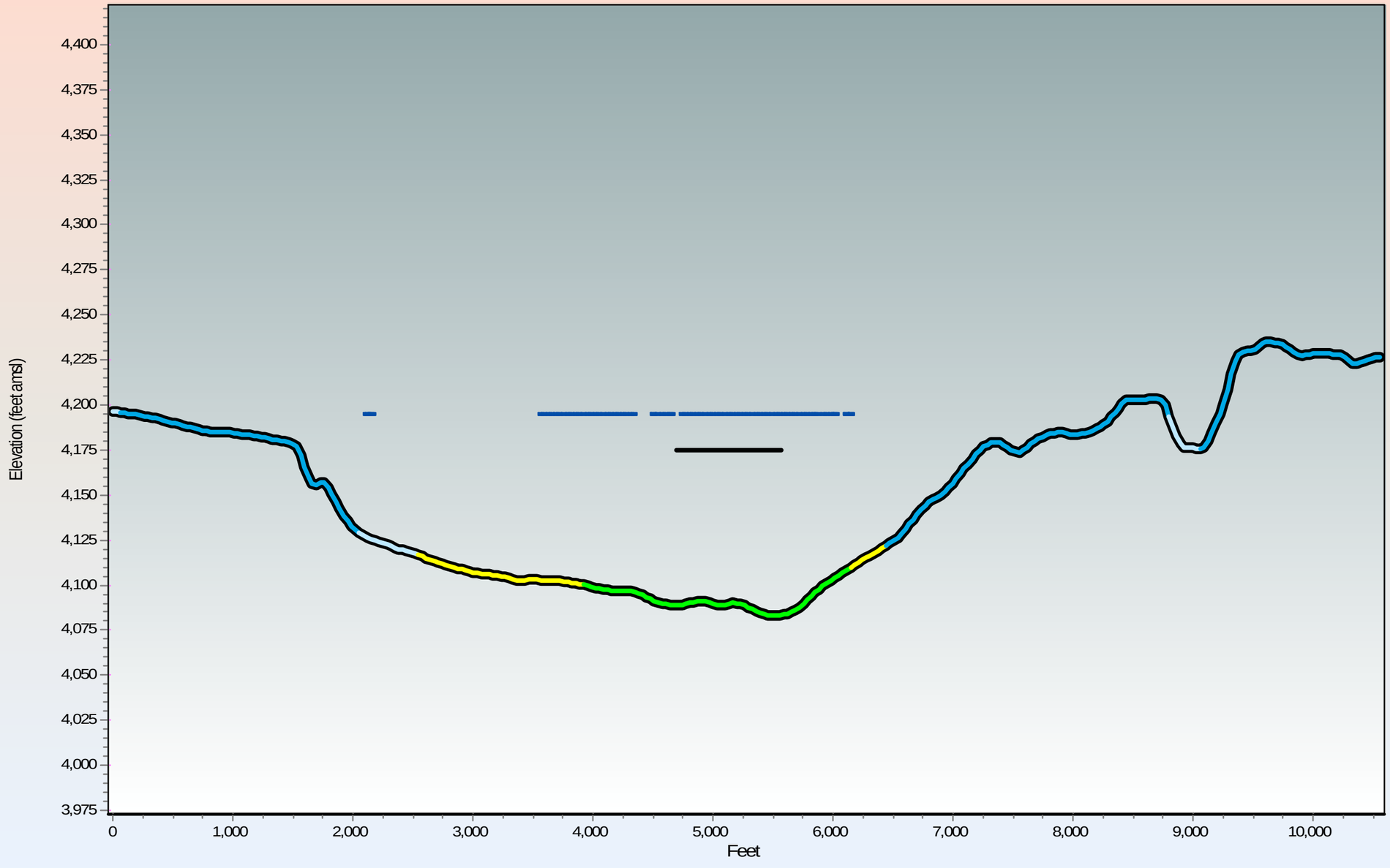
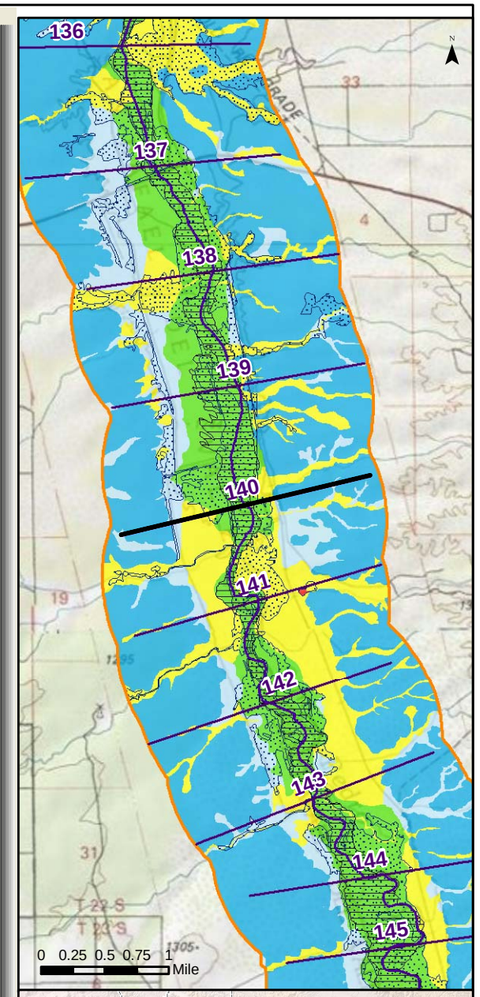
Appendix F

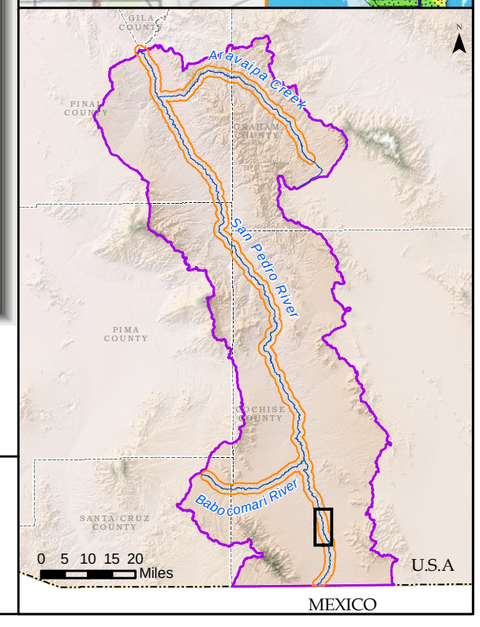
San Pedro River Cross Section at Mile 139

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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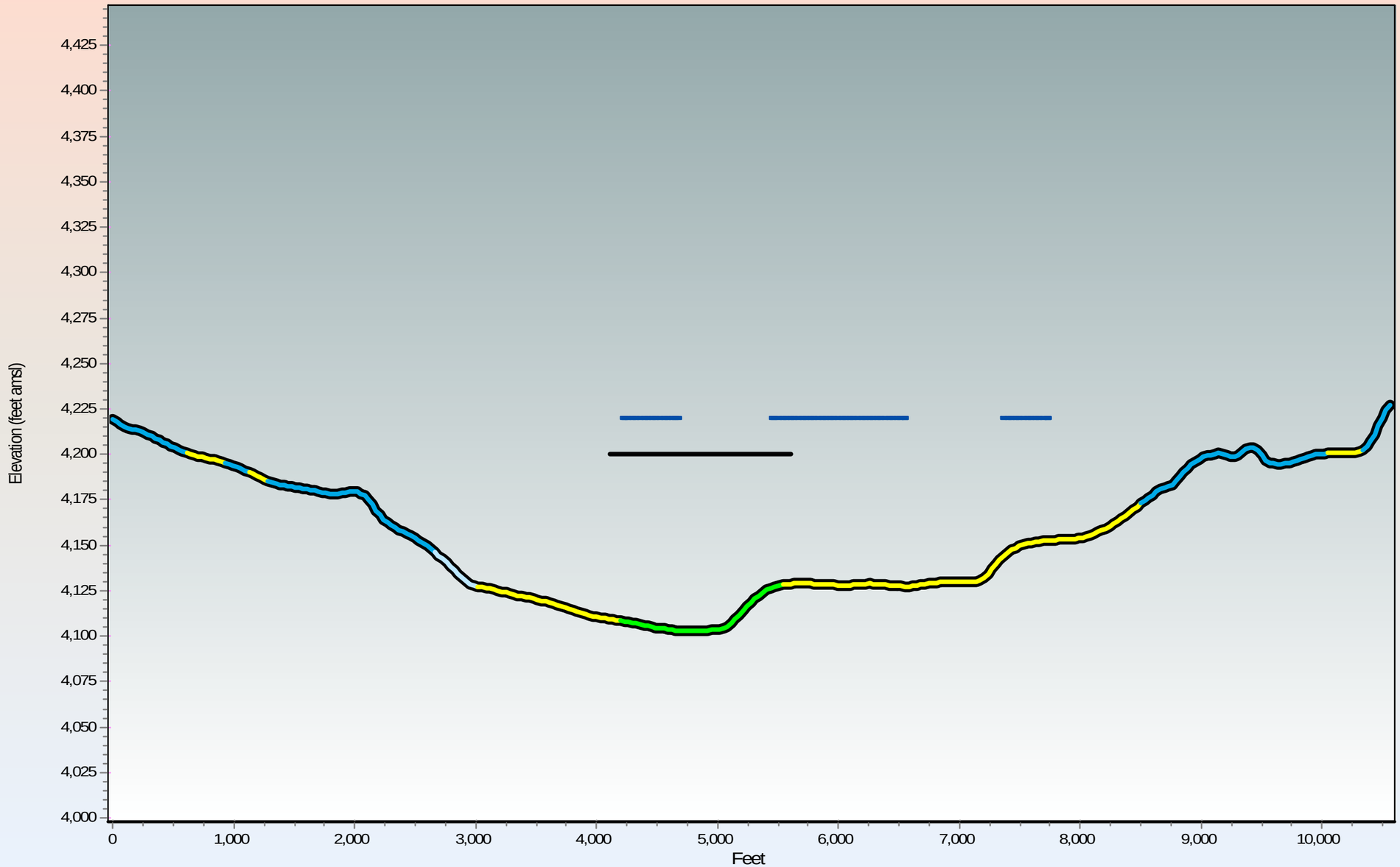
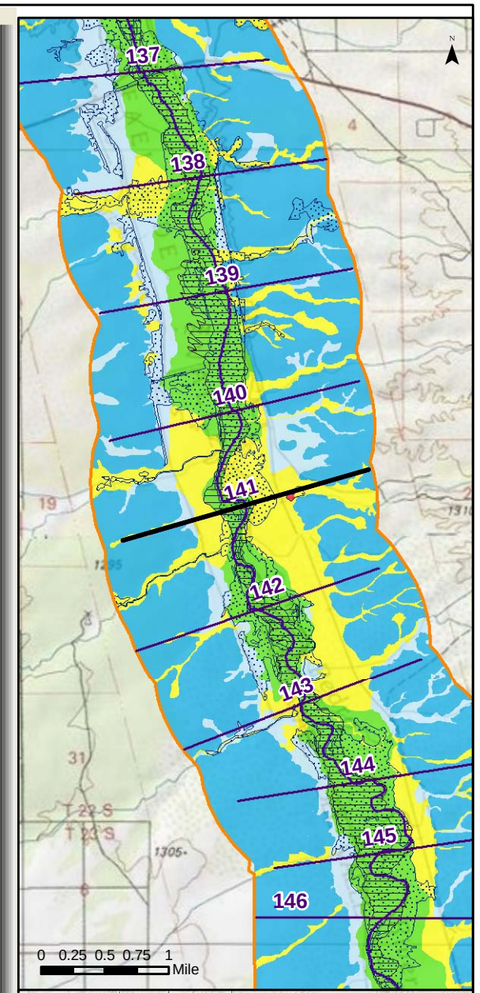
Appendix F

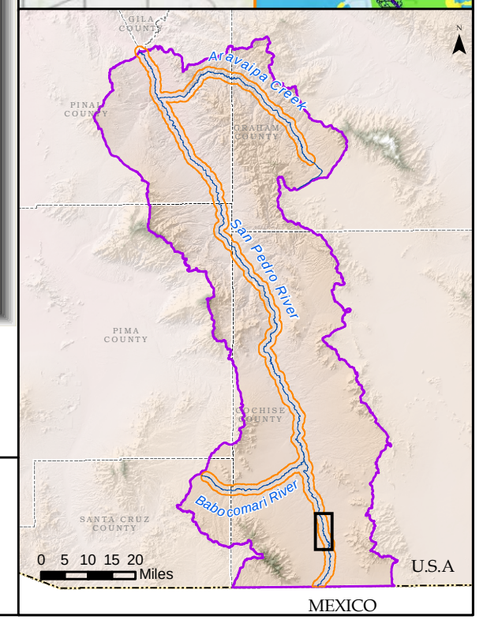
San Pedro River Cross Section at Mile 140

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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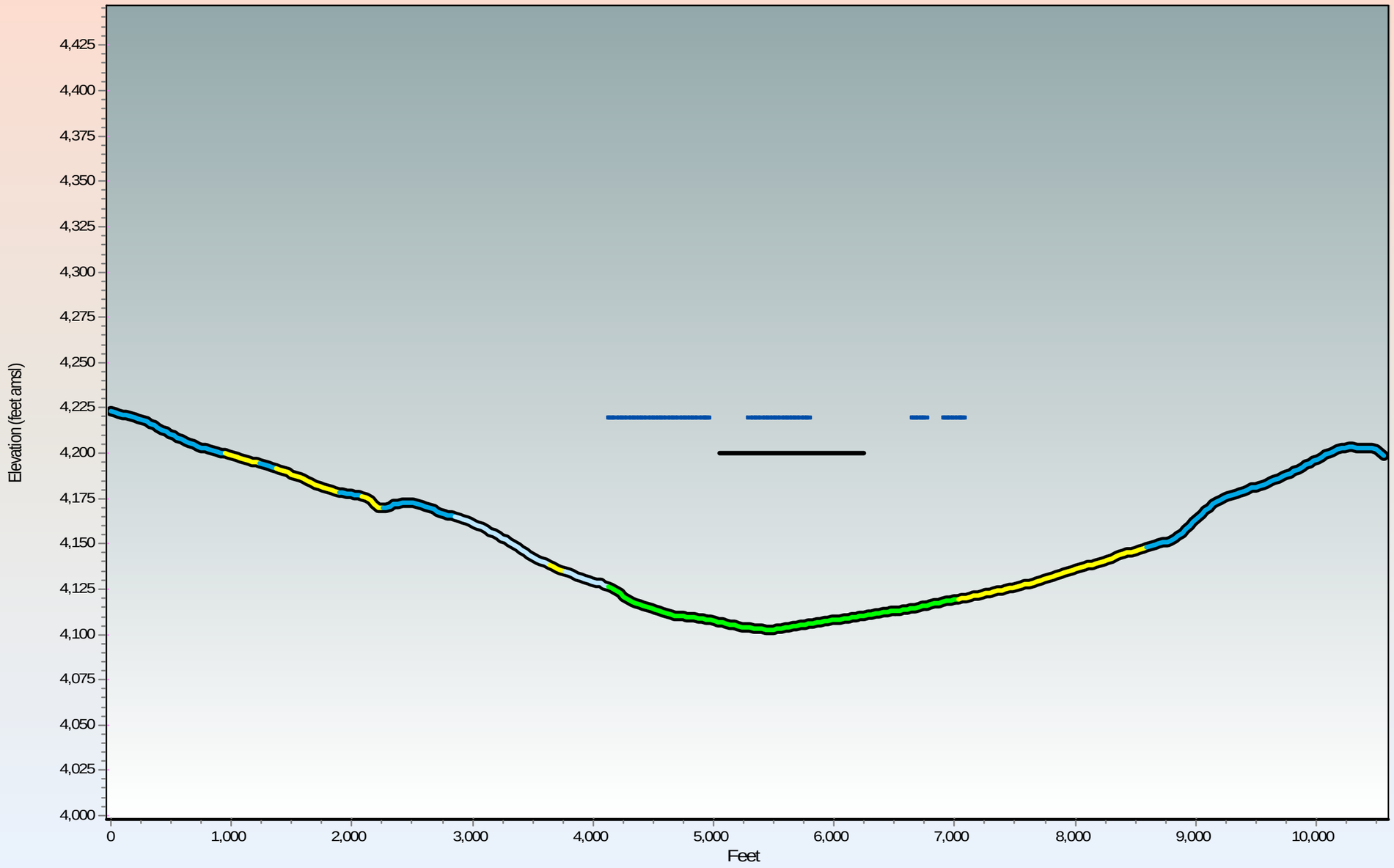
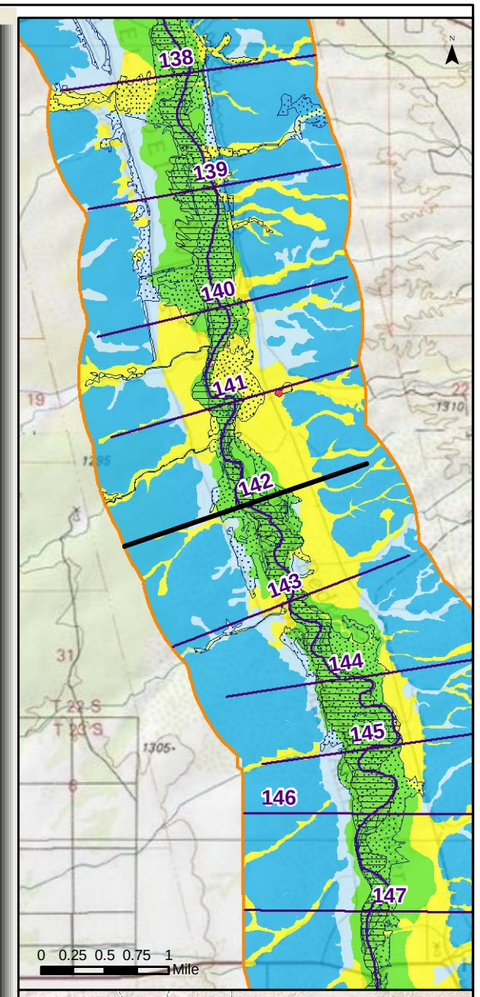
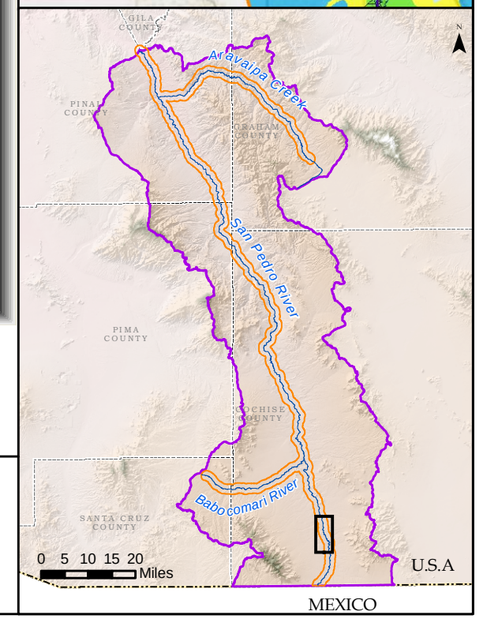
Appendix F
San Pedro River Cross Section at Mile 141
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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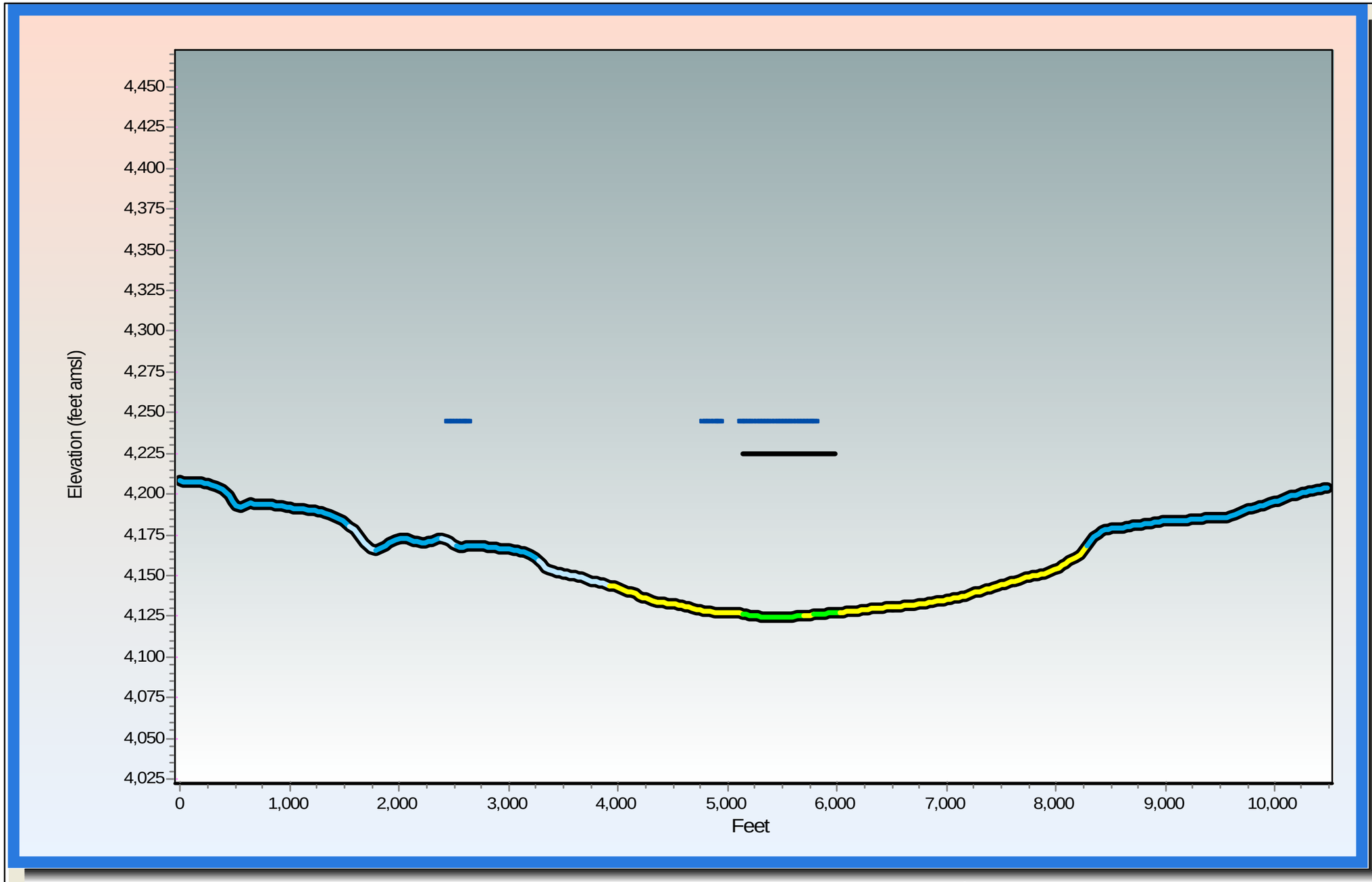
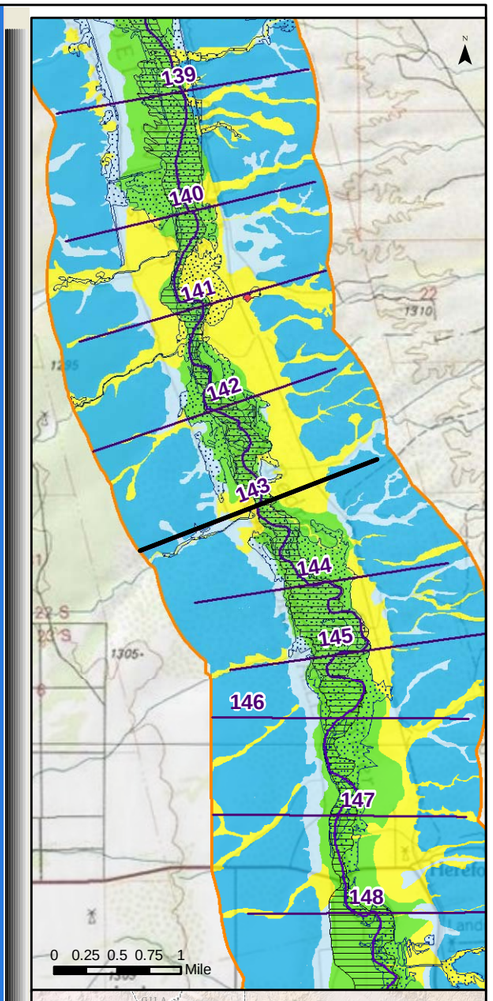
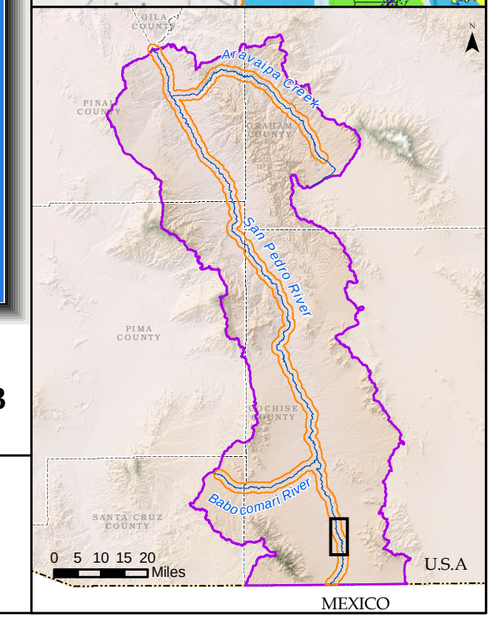
Appendix F
San Pedro River Cross Section at Mile 142
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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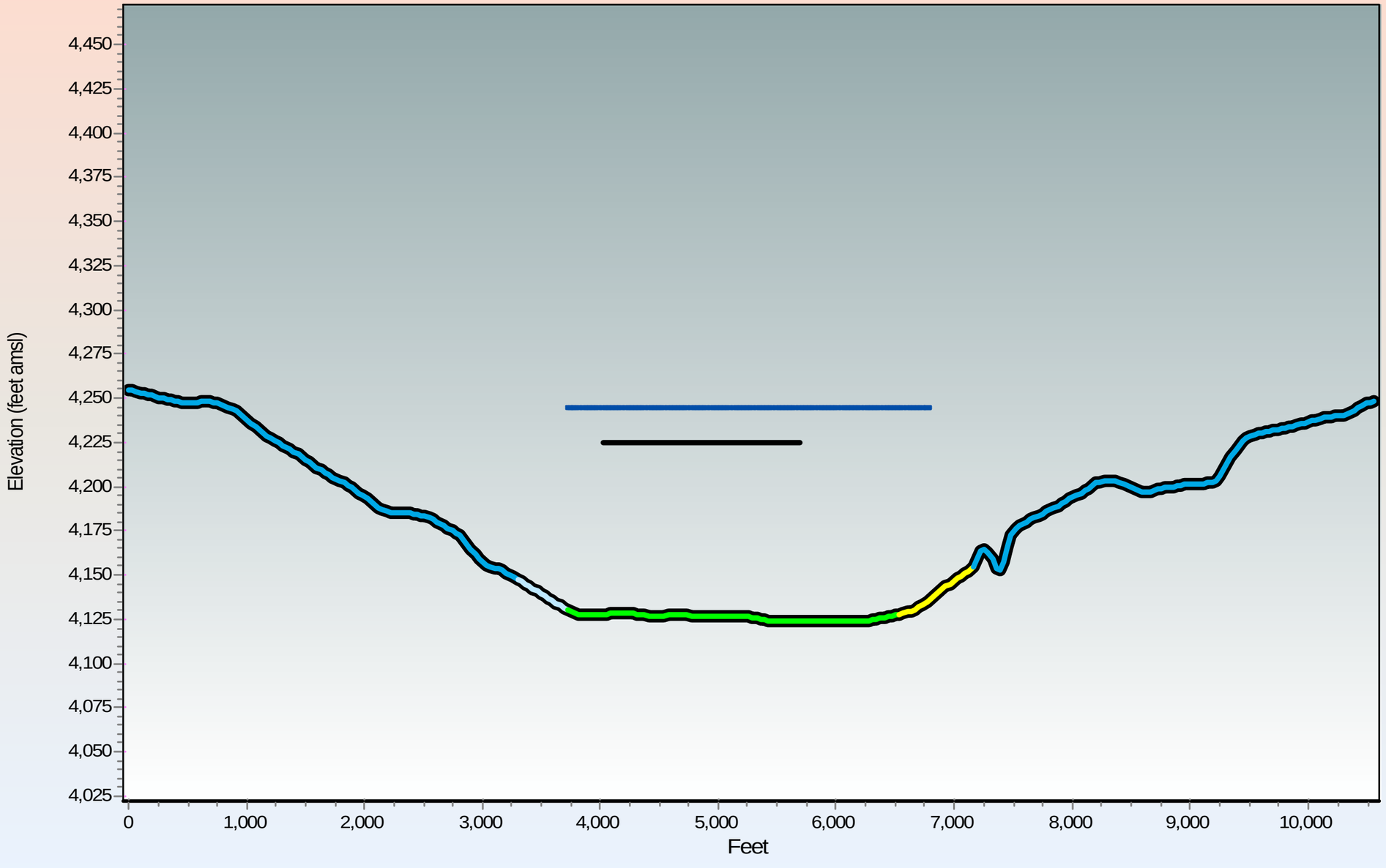
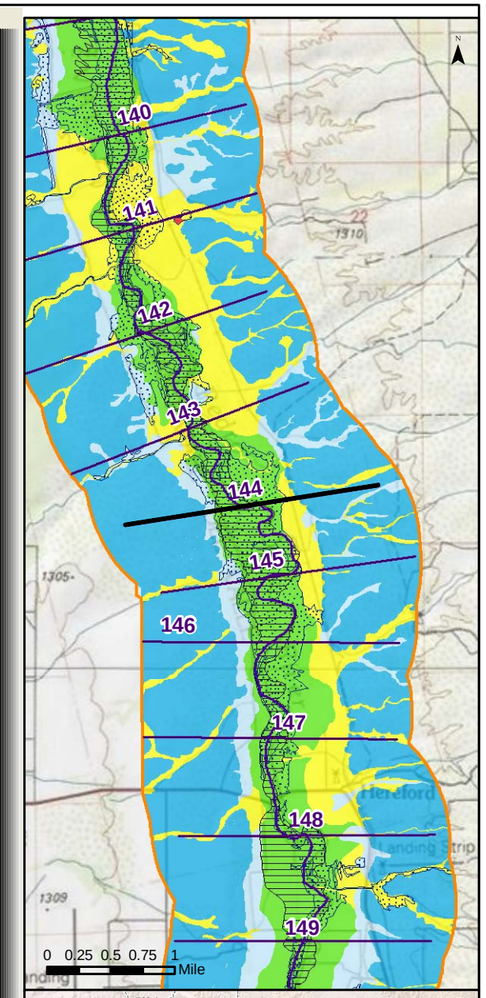
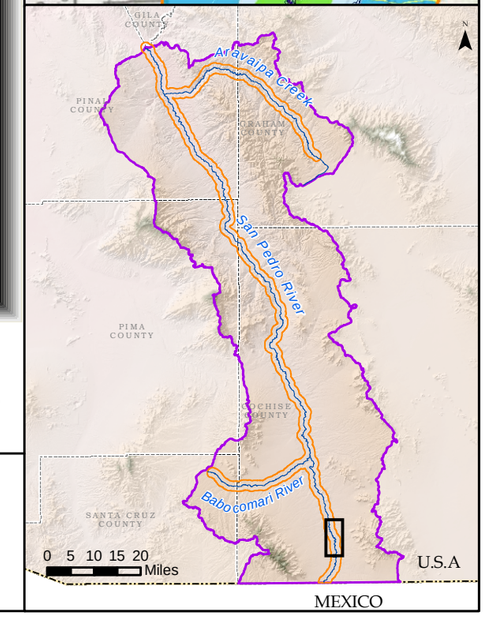
Appendix F
San Pedro River Cross Section at Mile 143
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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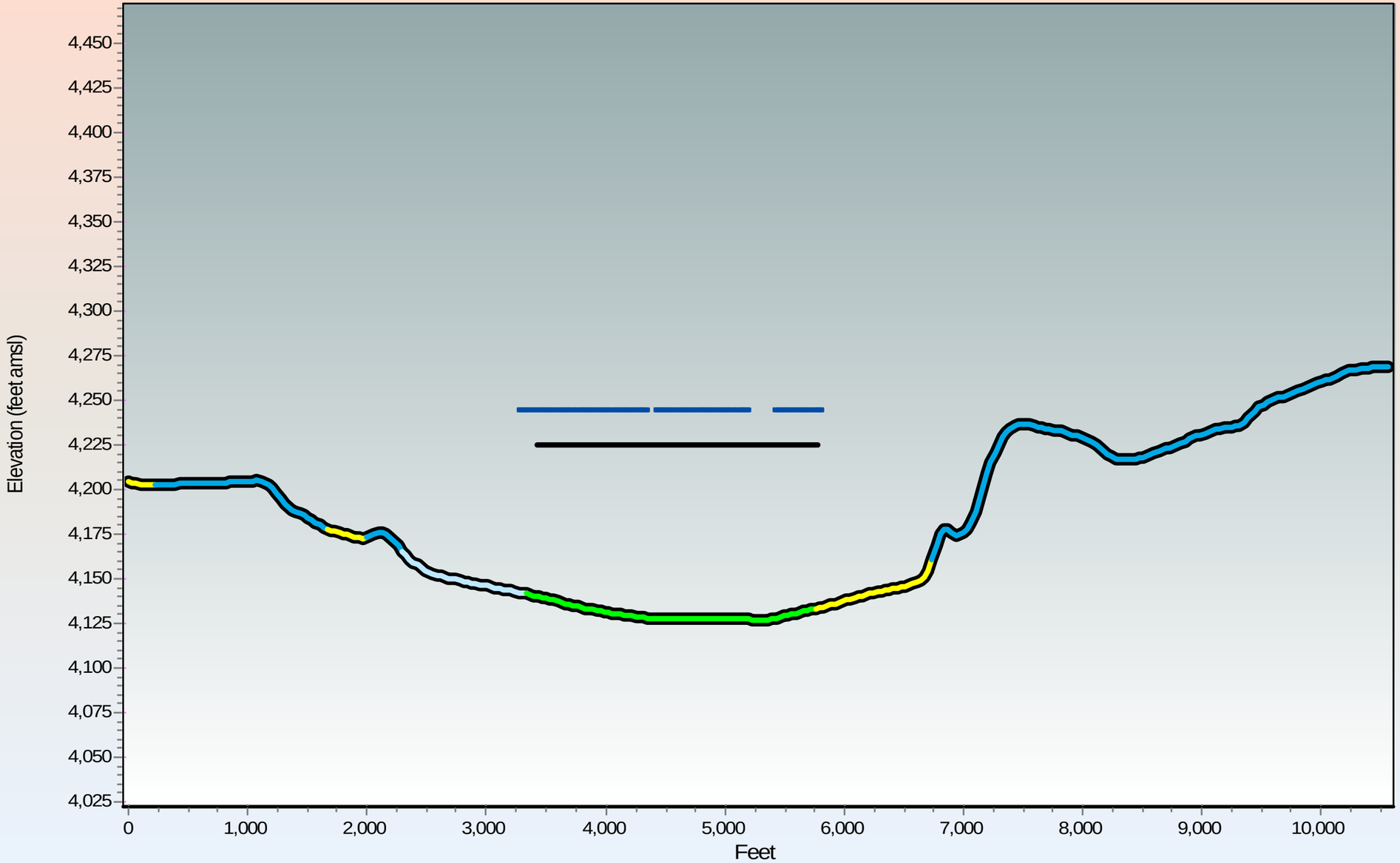
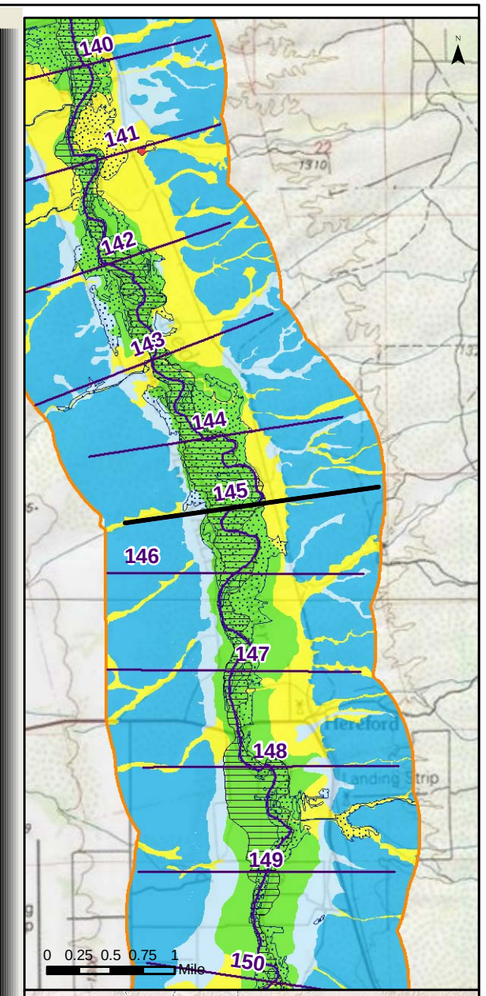
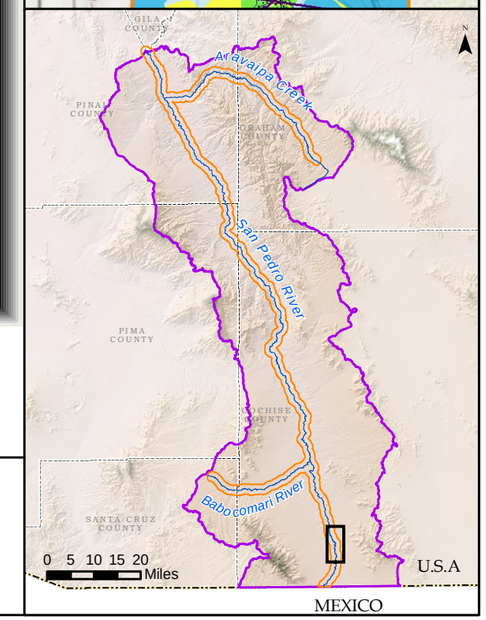
Appendix F
San Pedro River Cross Section at Mile 144
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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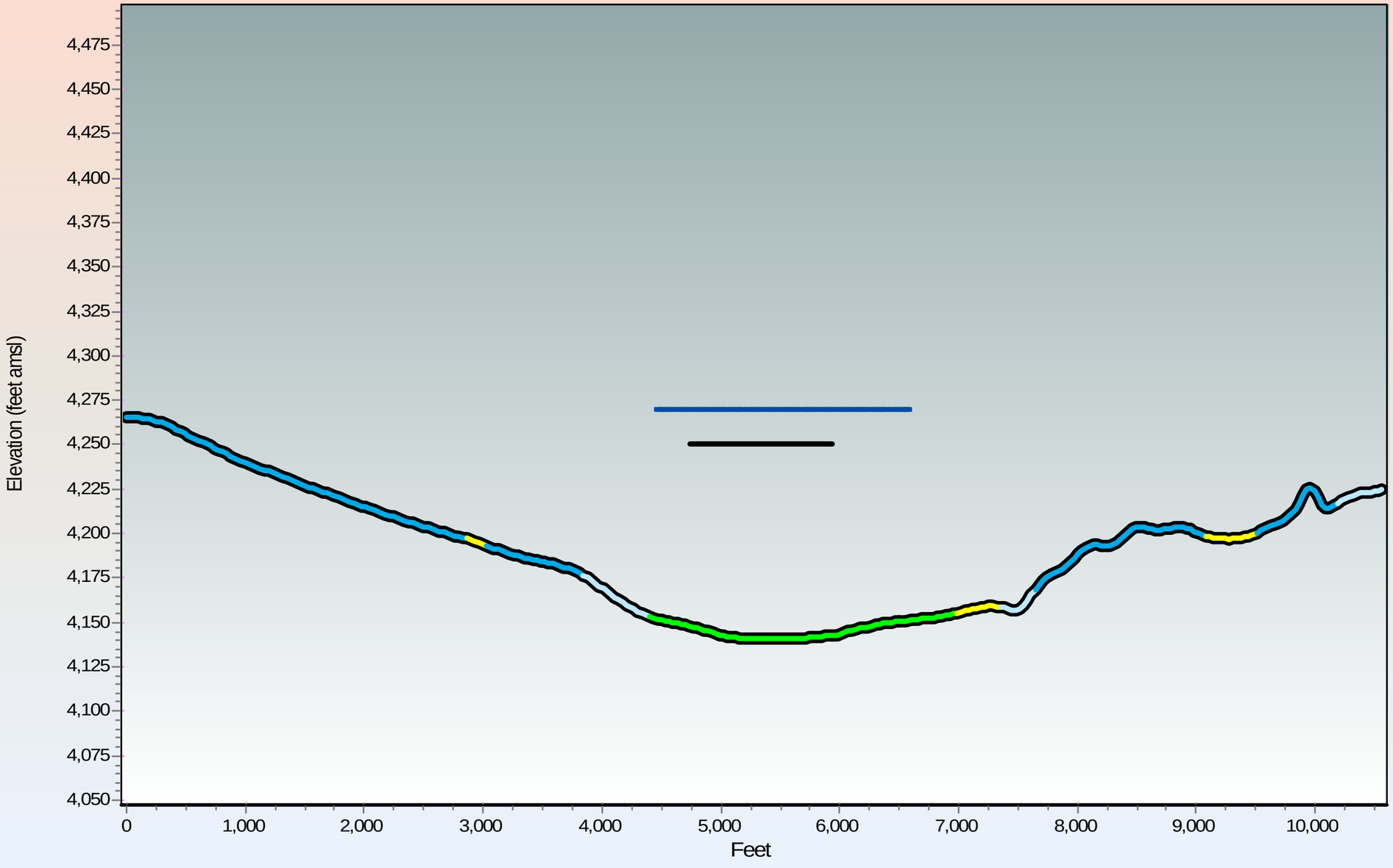
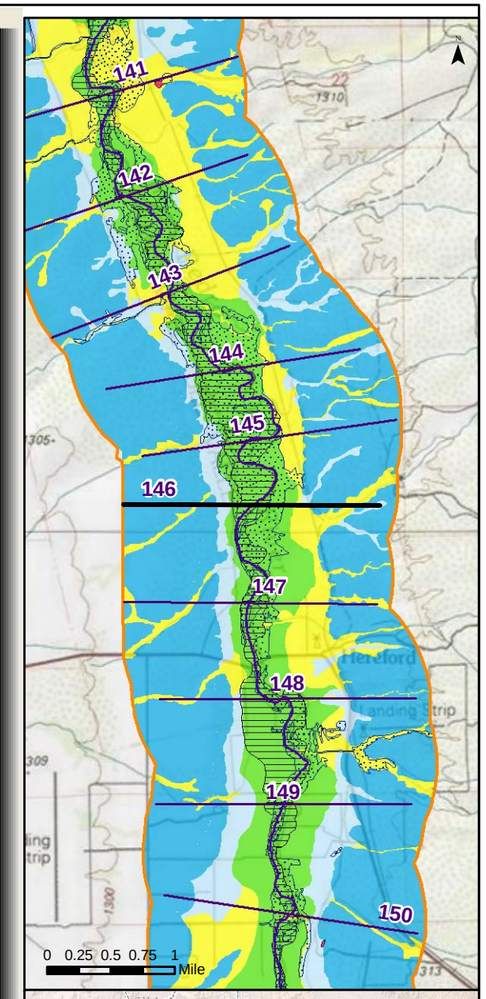
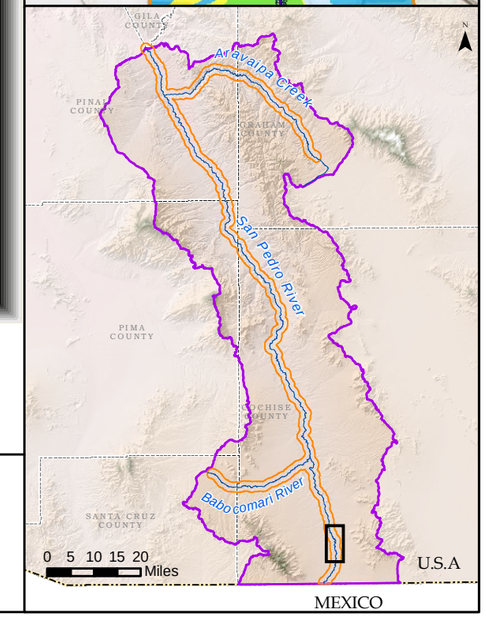
Appendix F
San Pedro River Cross Section at Mile 145
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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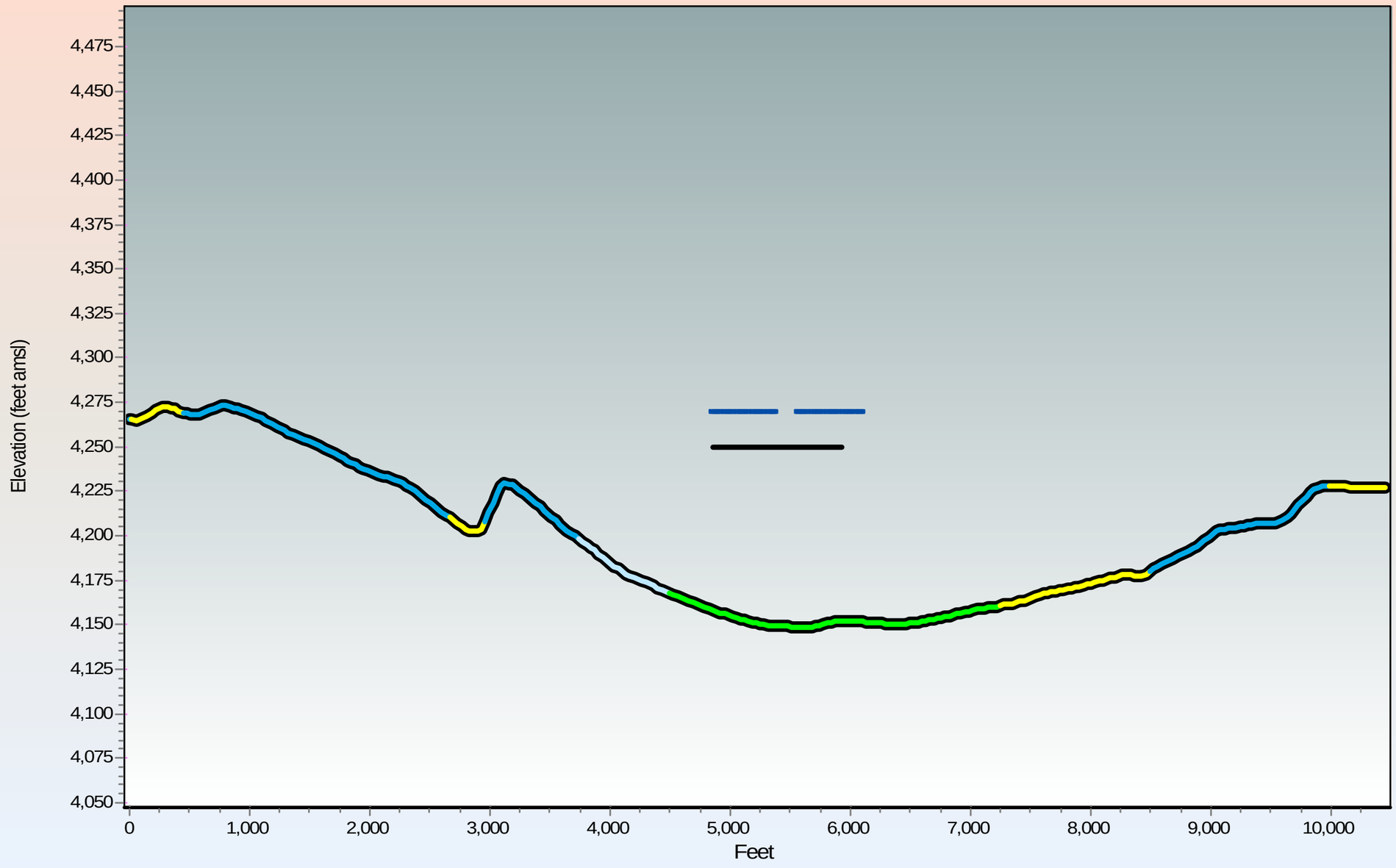
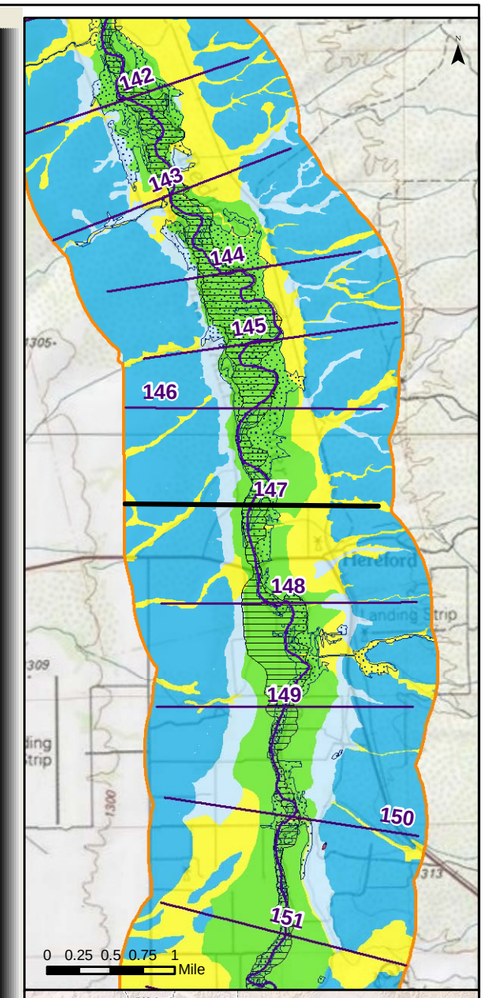
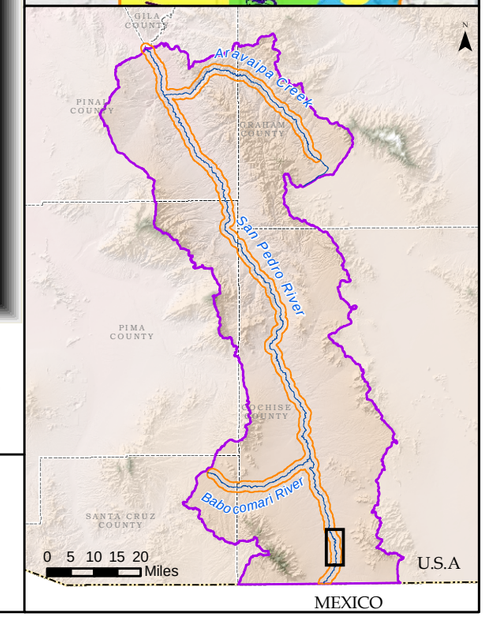
Appendix F
San Pedro River Cross Section at Mile 146
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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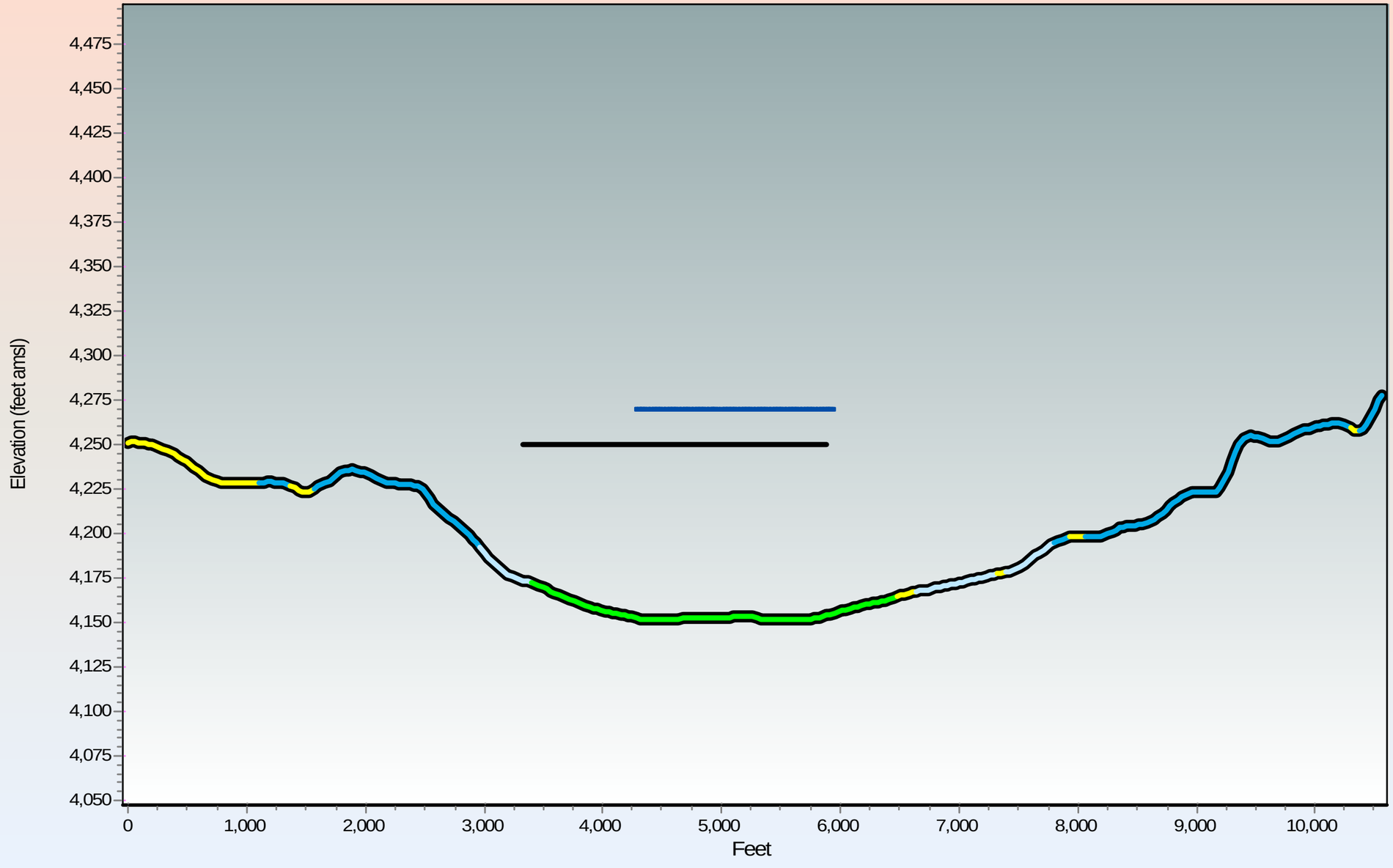
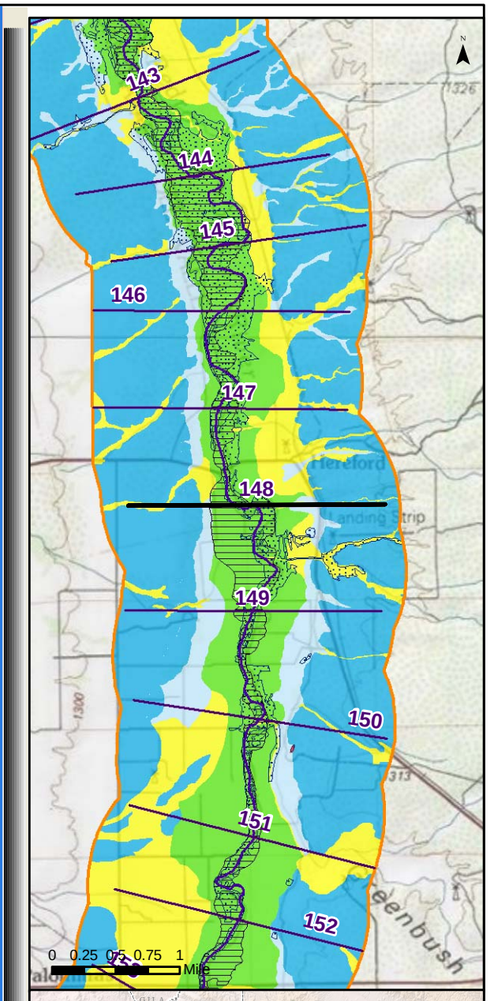
Appendix F

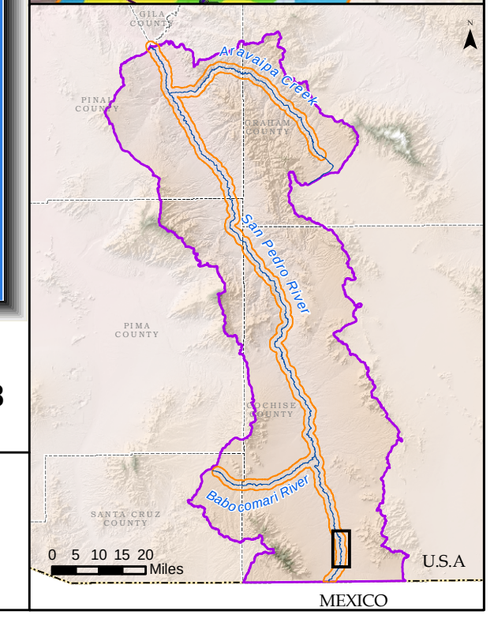
San Pedro River Cross Section at Mile 147

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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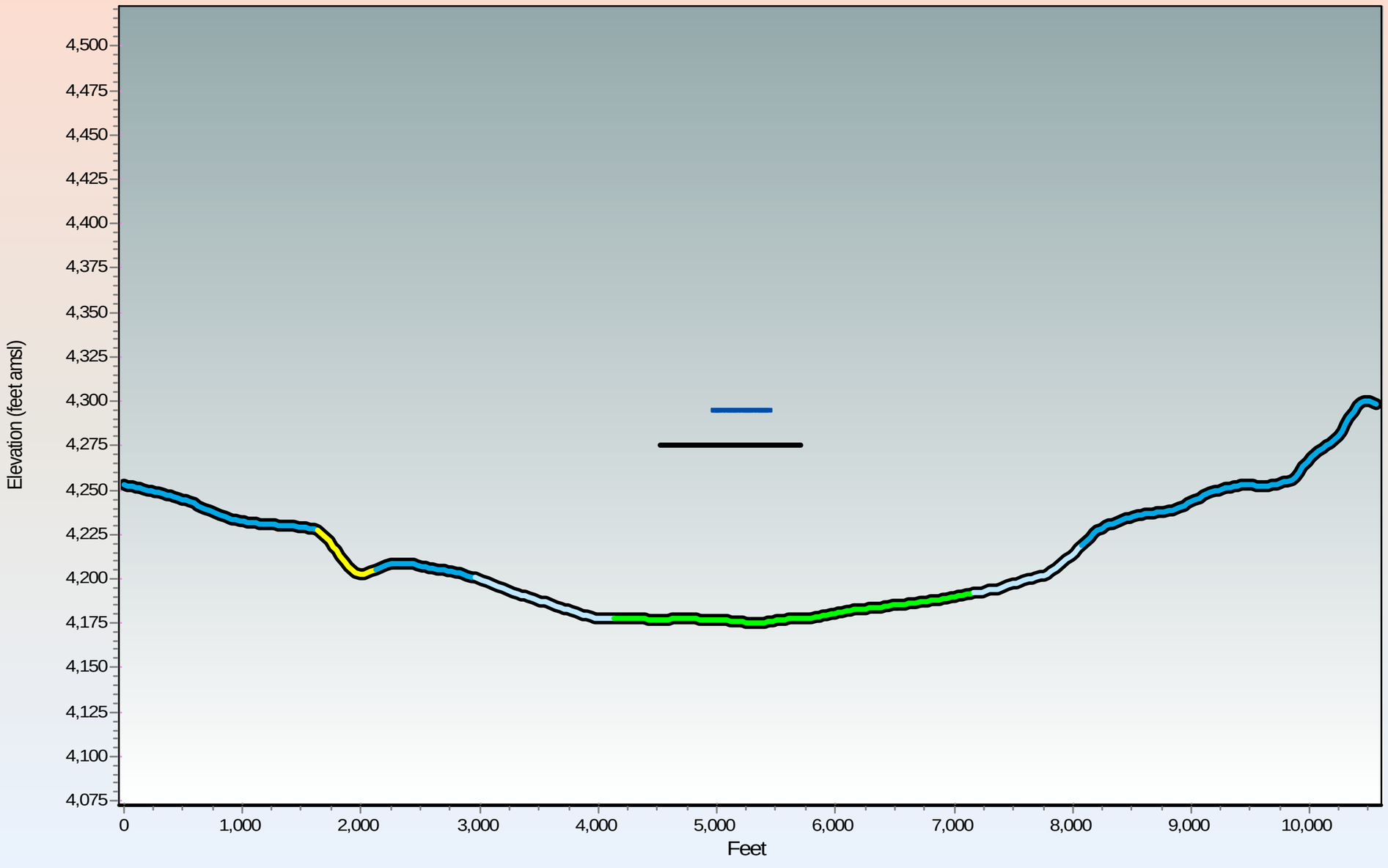
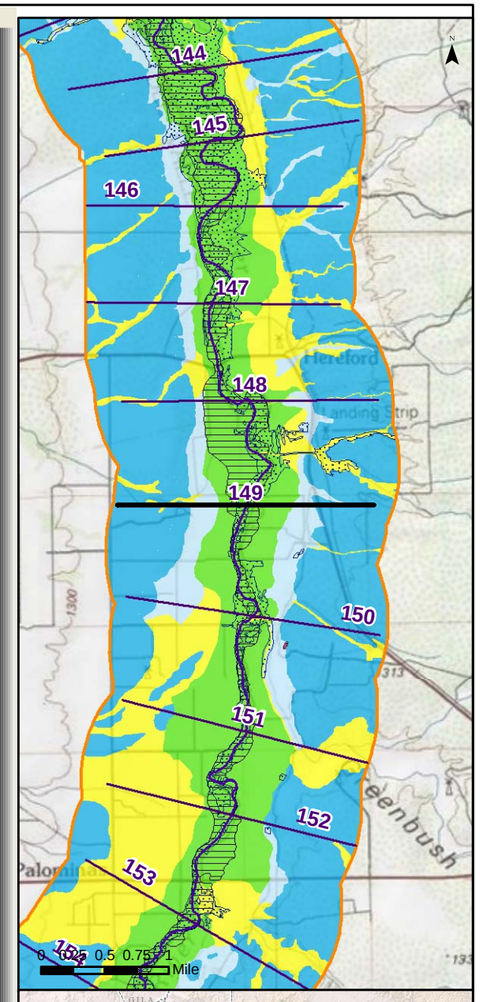
Appendix F

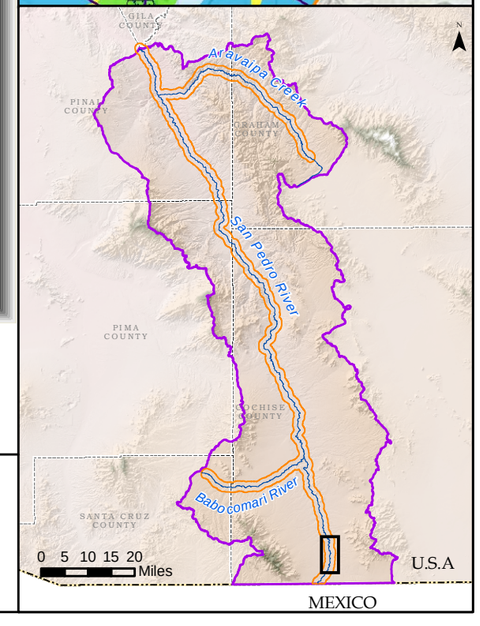
San Pedro River Cross Section at Mile 148

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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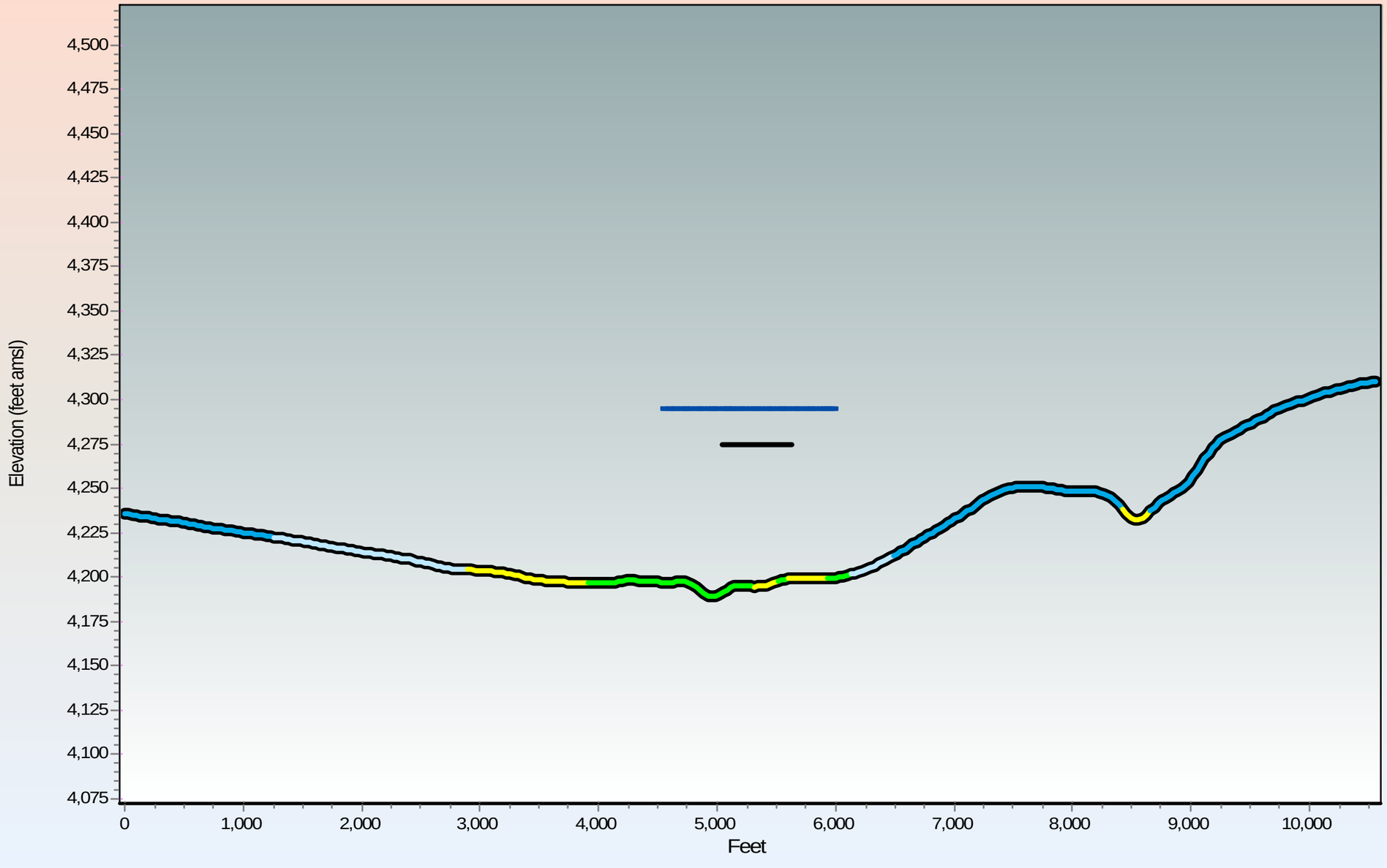
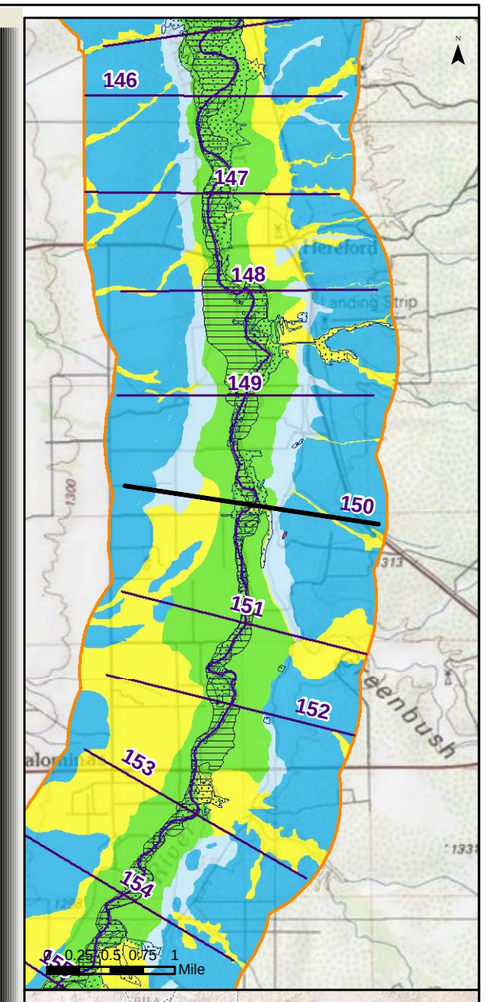
Appendix F

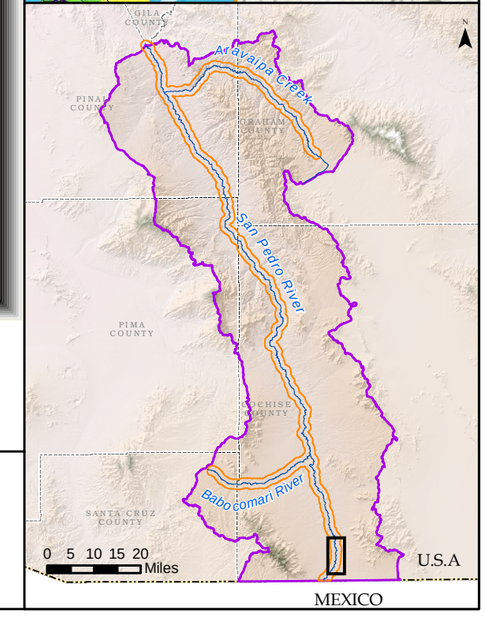
San Pedro River Cross Section at Mile 149

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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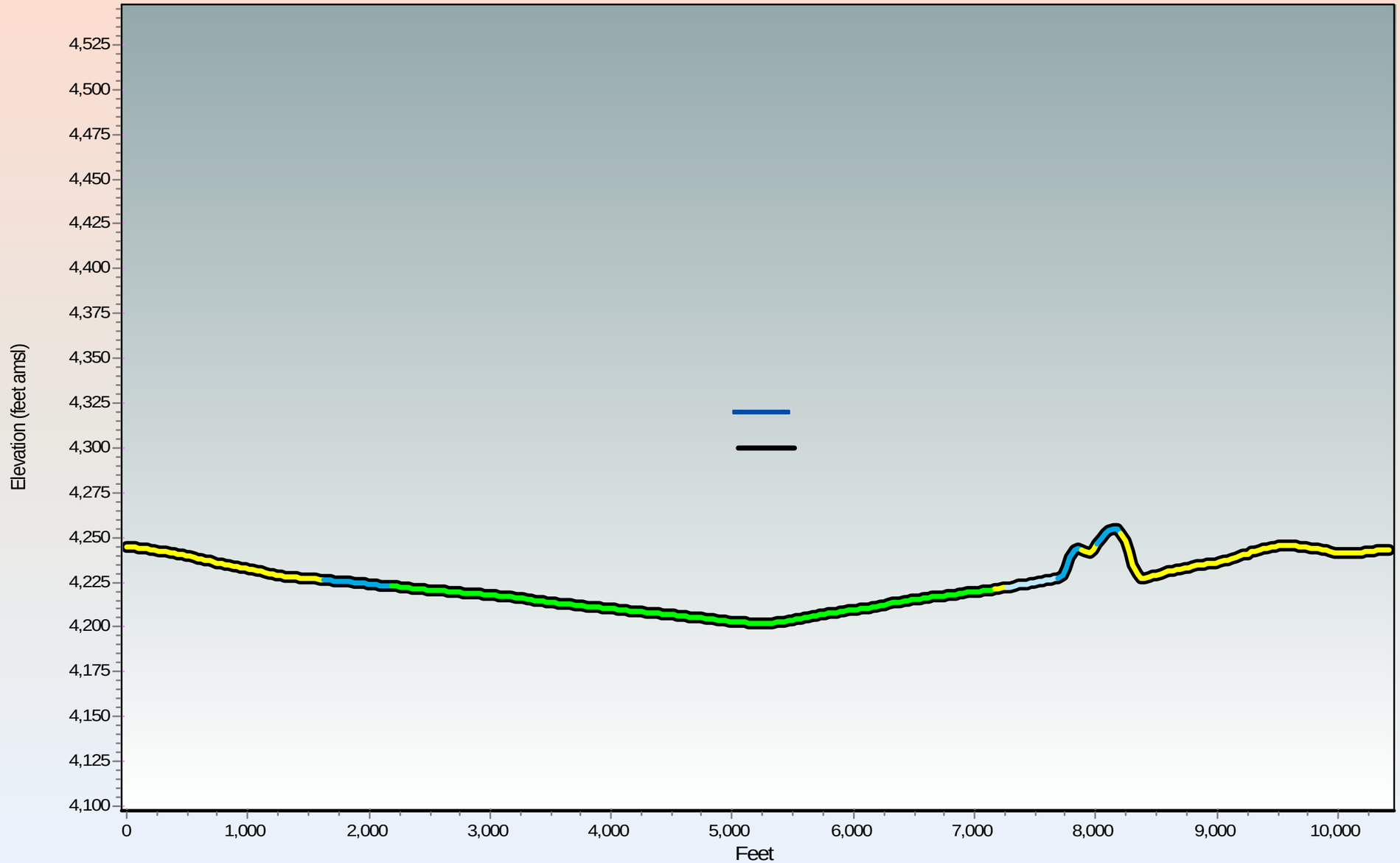
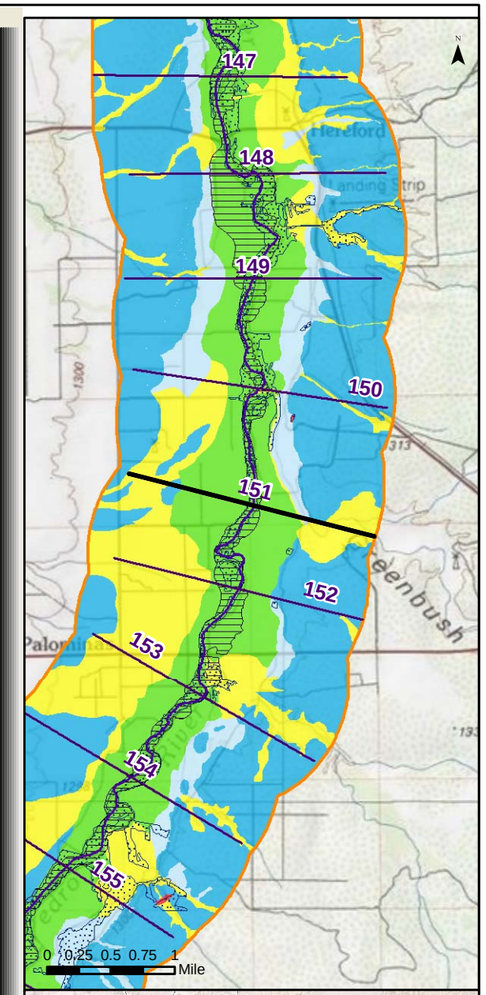
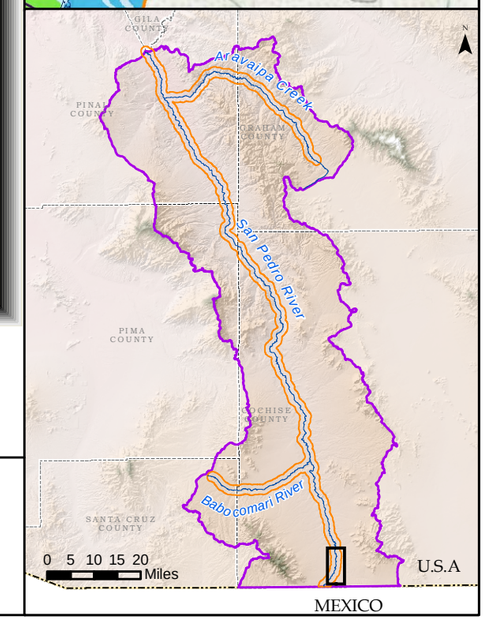
Appendix F
San Pedro River Cross Section at Mile 150
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

1/3/2011, \\adwrsas1-phx01.azwater.gov\gis-vns, u:\workspaces\statewideplanning\adjudications\projects\sanpedro\maps\resoncetoobjections_jan2011\appendixf_crosssections\appendixf_crosssections.mxd







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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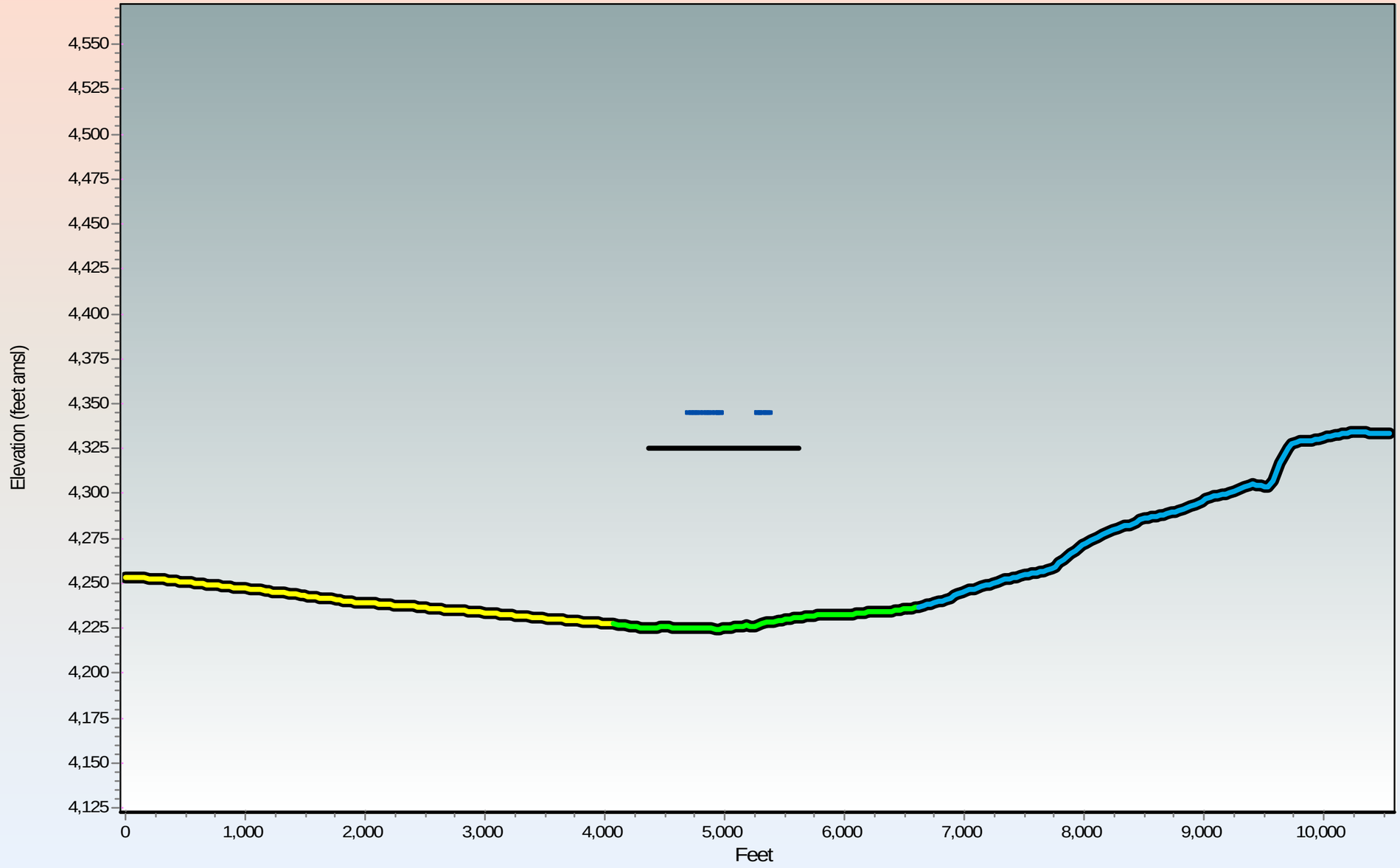
Appendix F

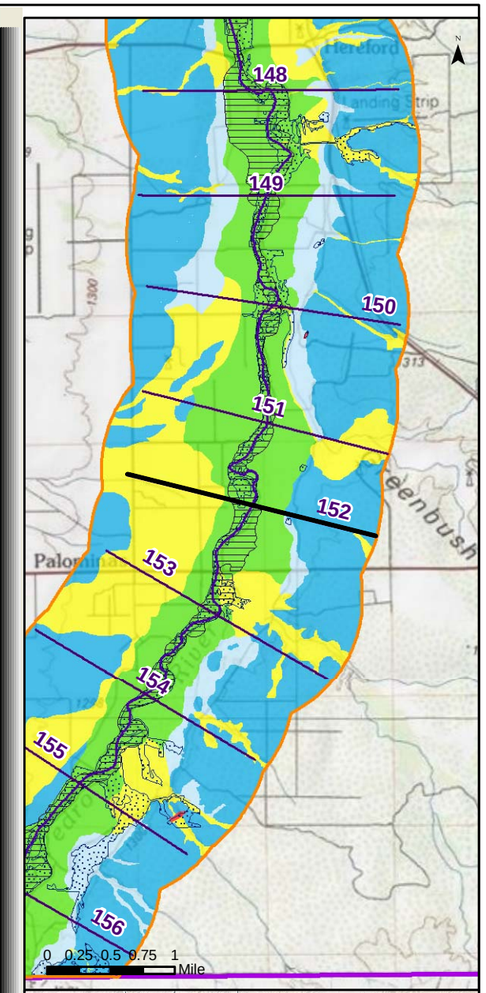
San Pedro River Cross Section at Mile 151

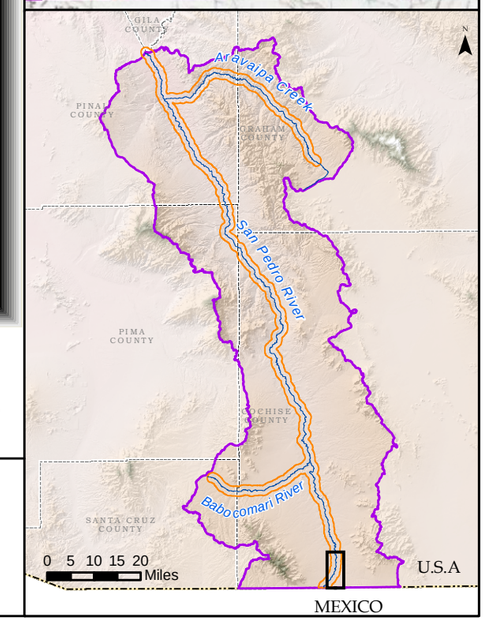
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

1/3/2011, \\adwrsas1-phx01.azwater.gov\gis-vns, u:\workspaces\statewideplanning\adjudications\projects\sanpedro\maps\resoncetoobjections_jan2011\appendixf_crosssections\appendixf_crosssections.mxd







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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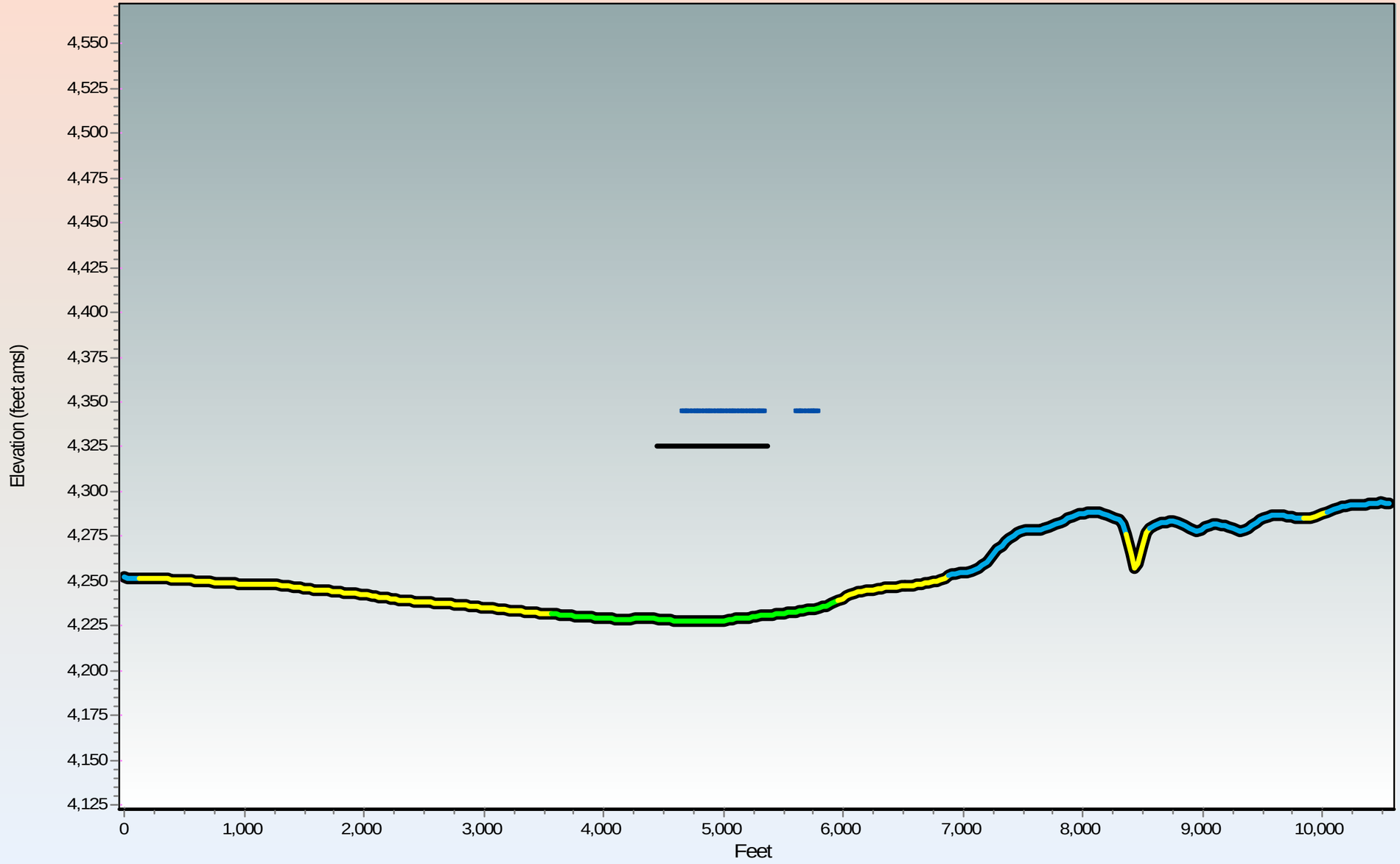
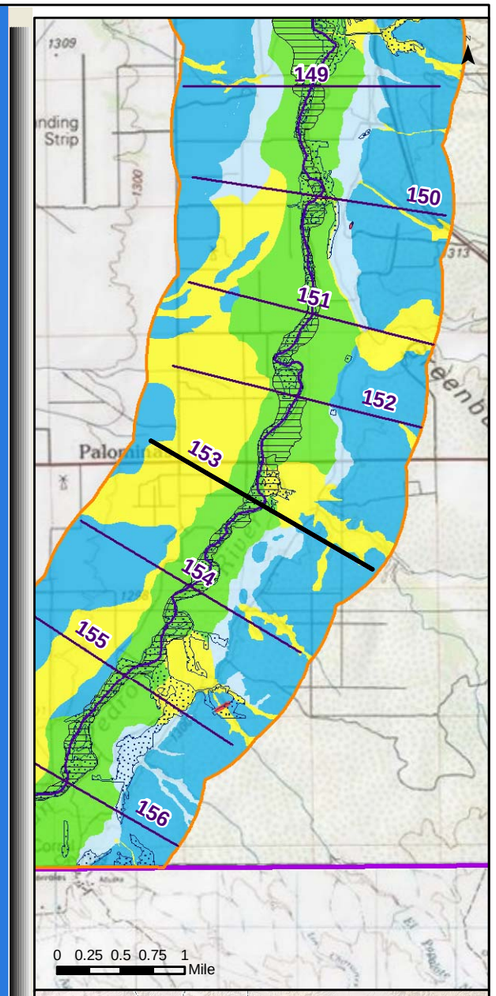
Appendix F

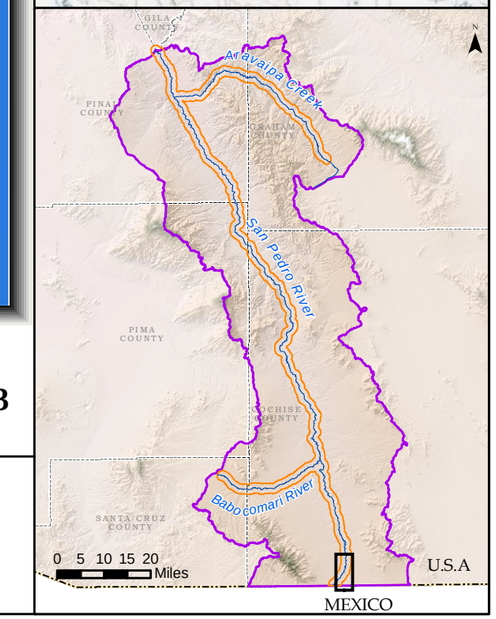
San Pedro River Cross Section at Mile 152

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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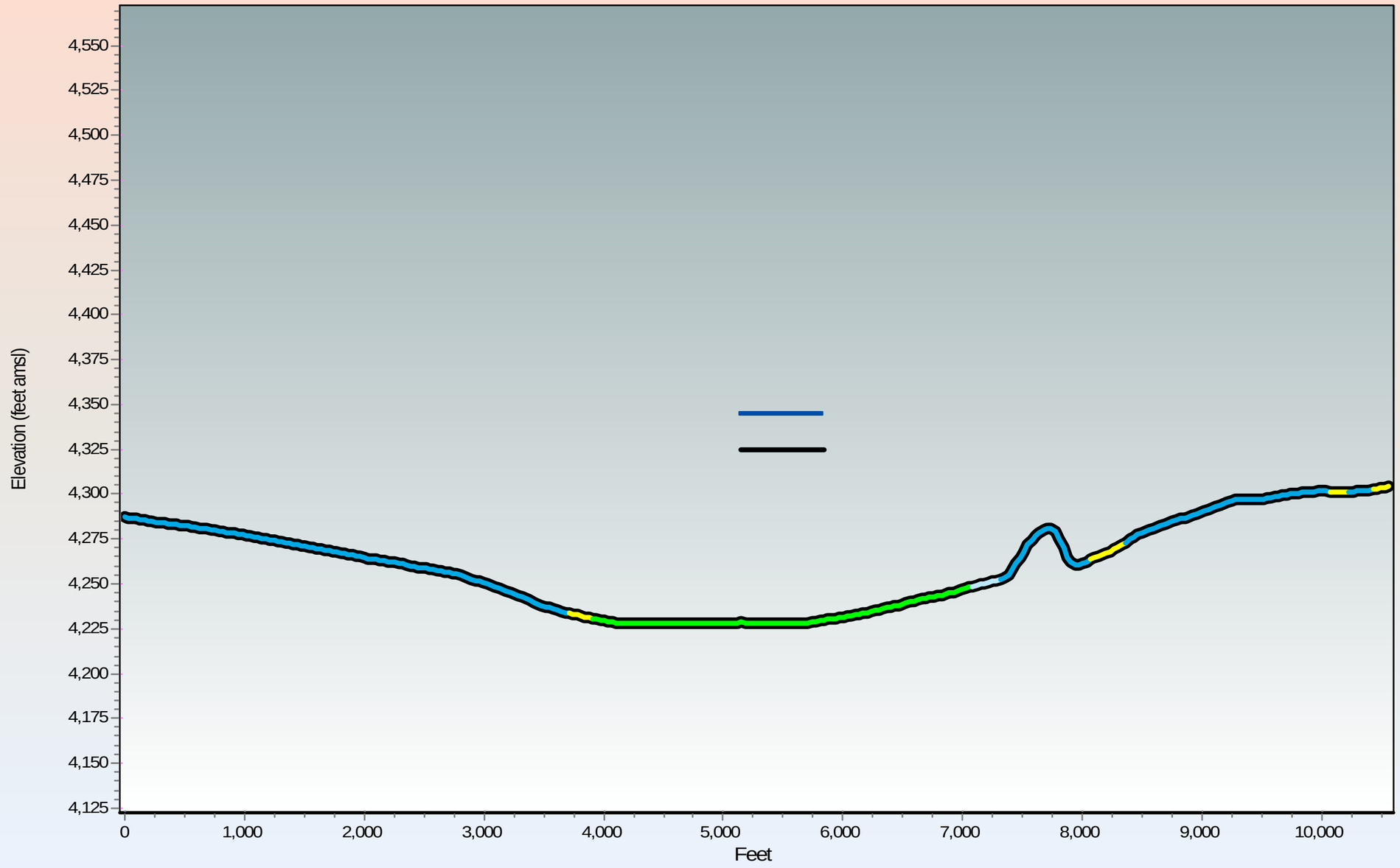
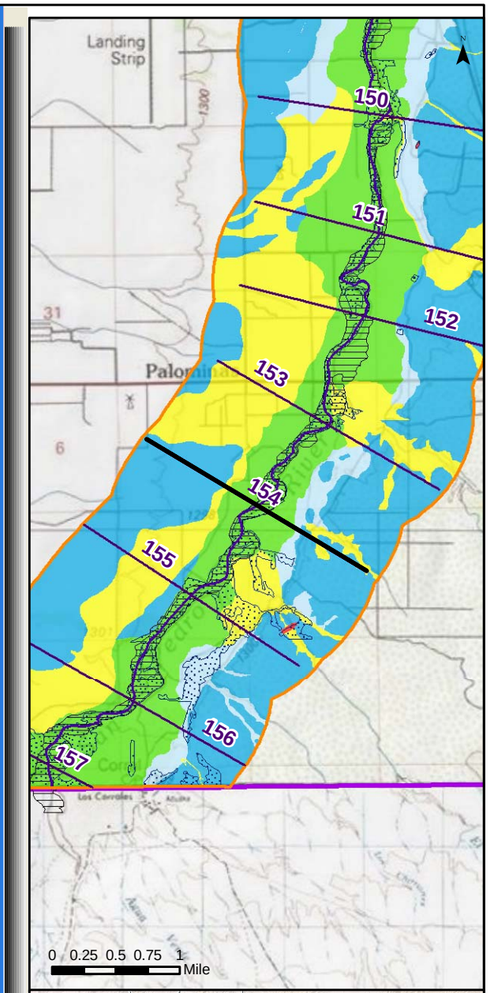
Appendix F

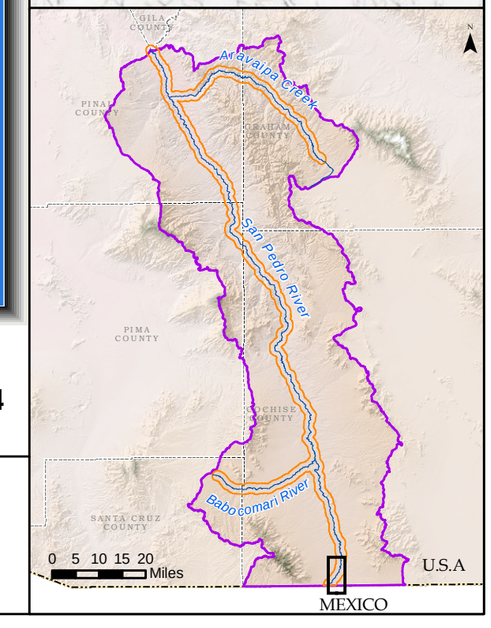
San Pedro River Cross Section at Mile 153

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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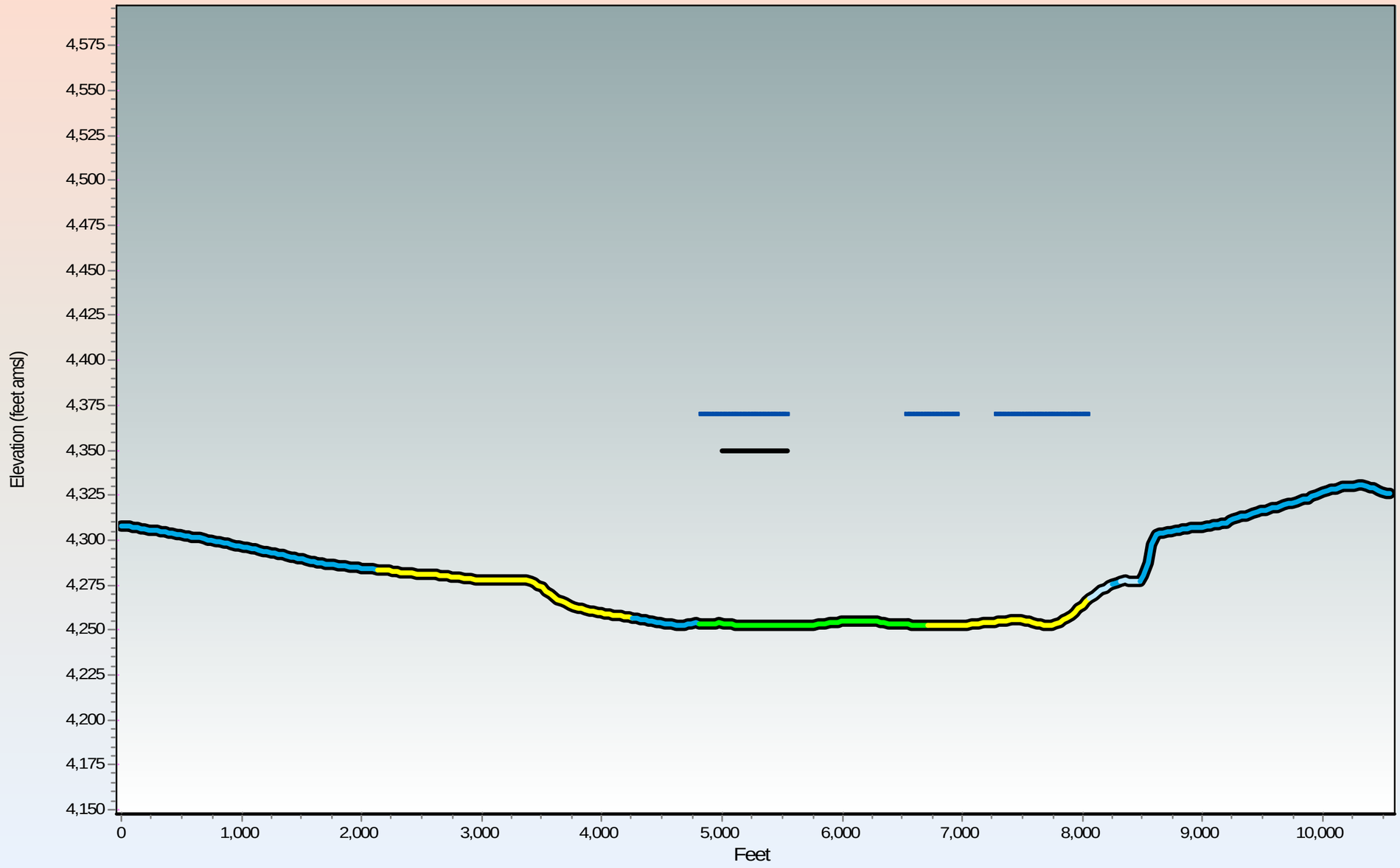
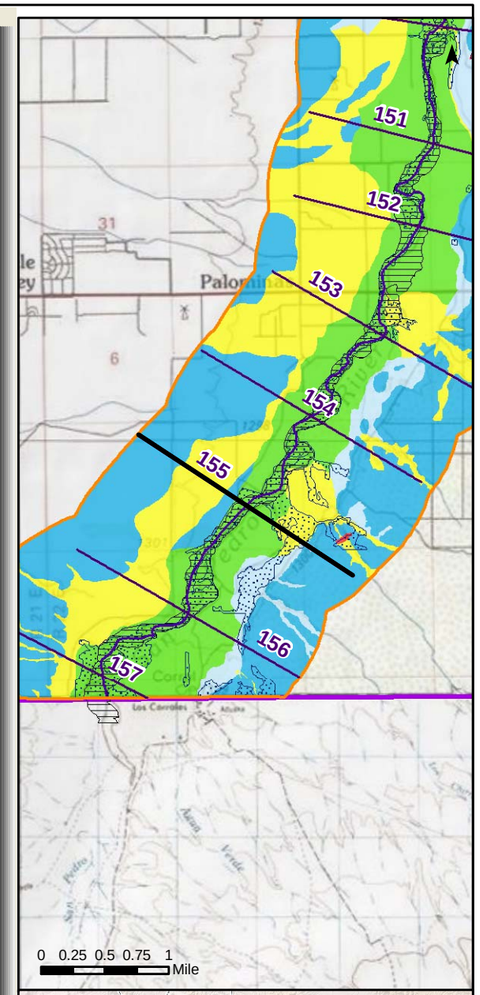
Appendix F

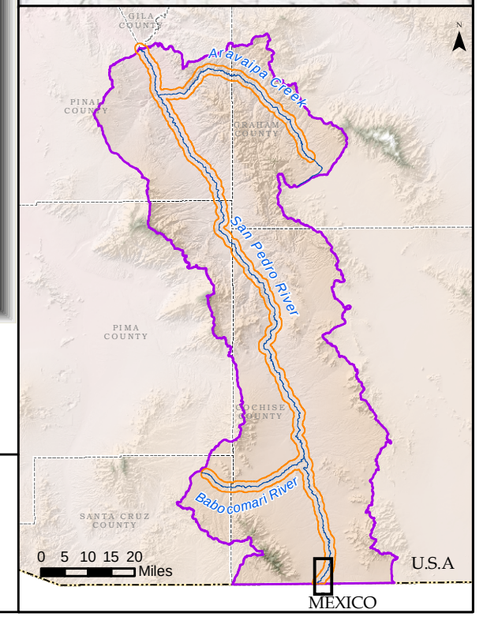
San Pedro River Cross Section at Mile 154

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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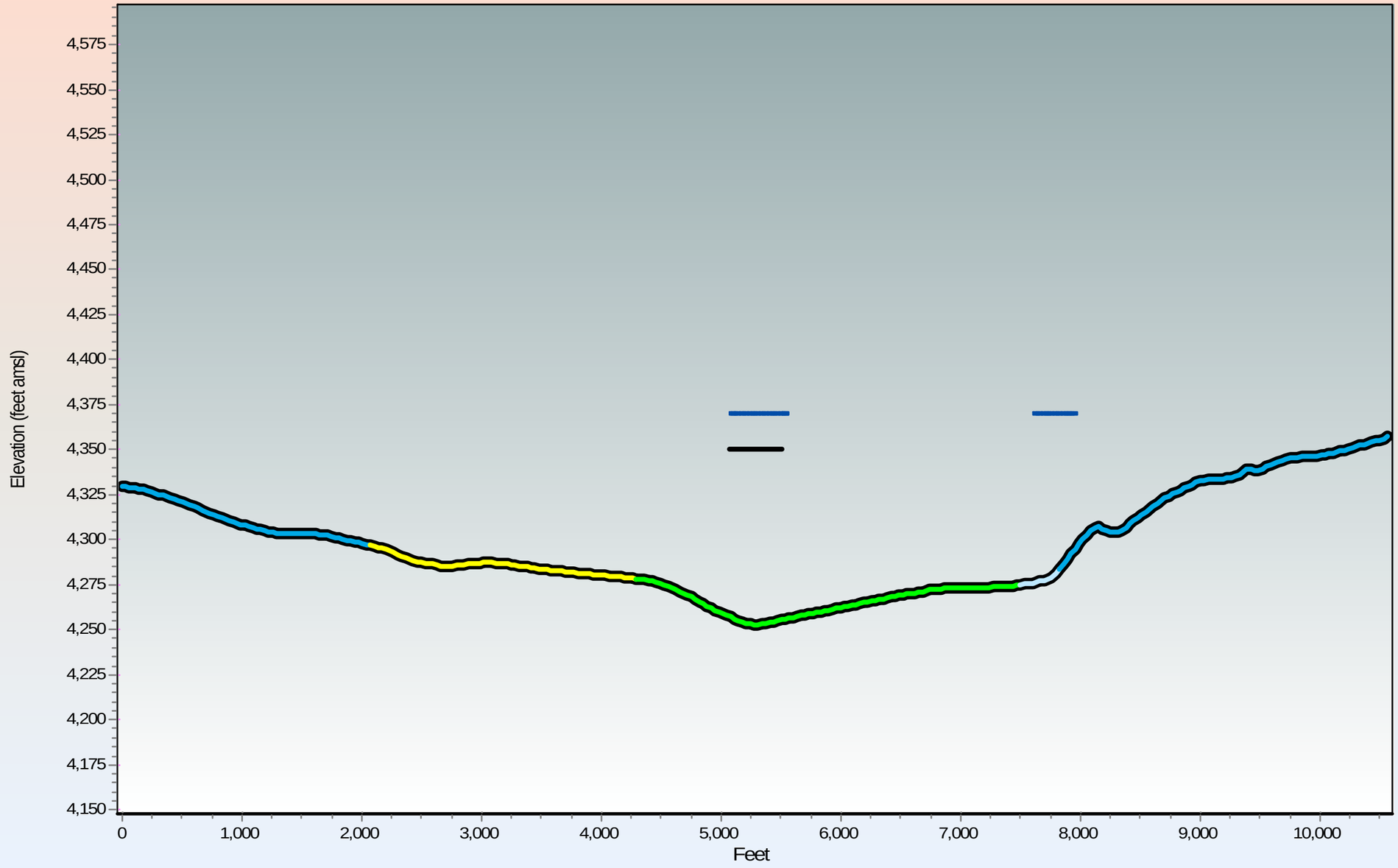
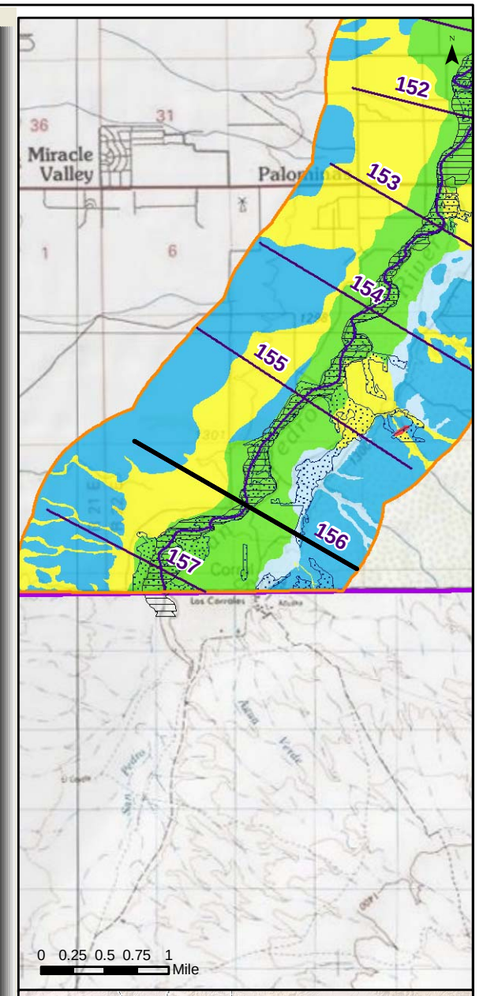
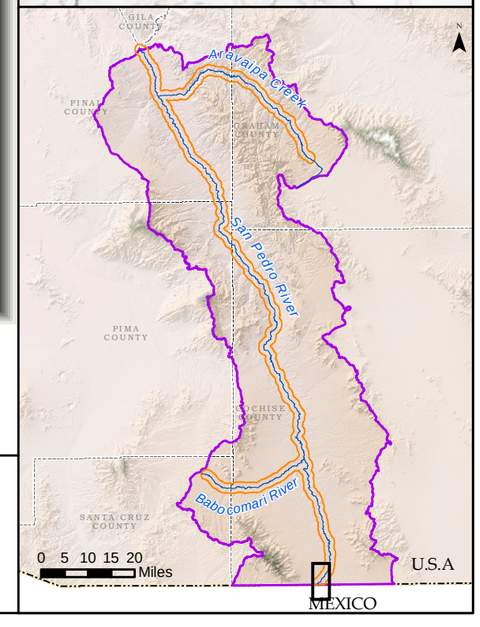
Appendix F
San Pedro River Cross Section at Mile 155
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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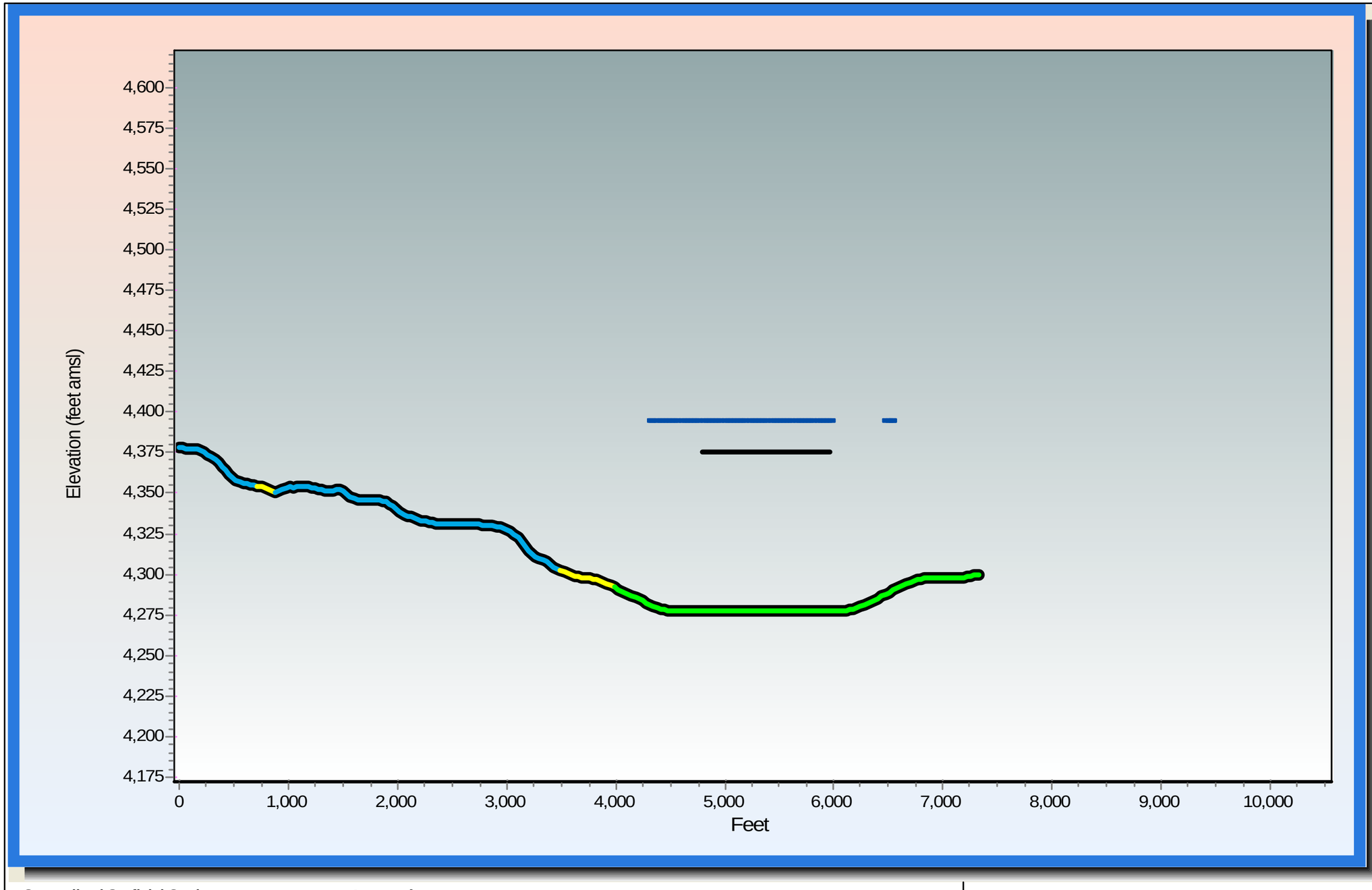
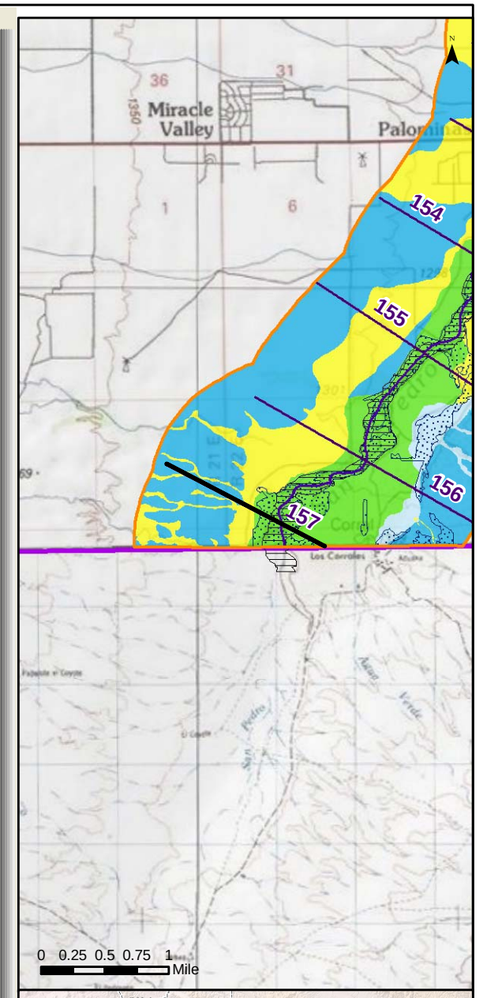
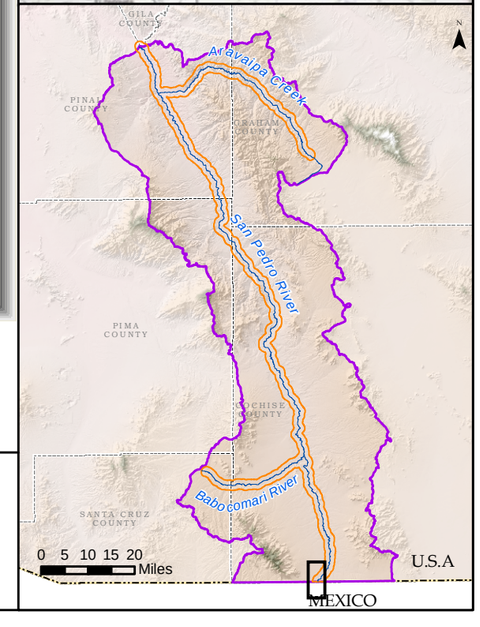
Appendix F
San Pedro River Cross Section at Mile 156
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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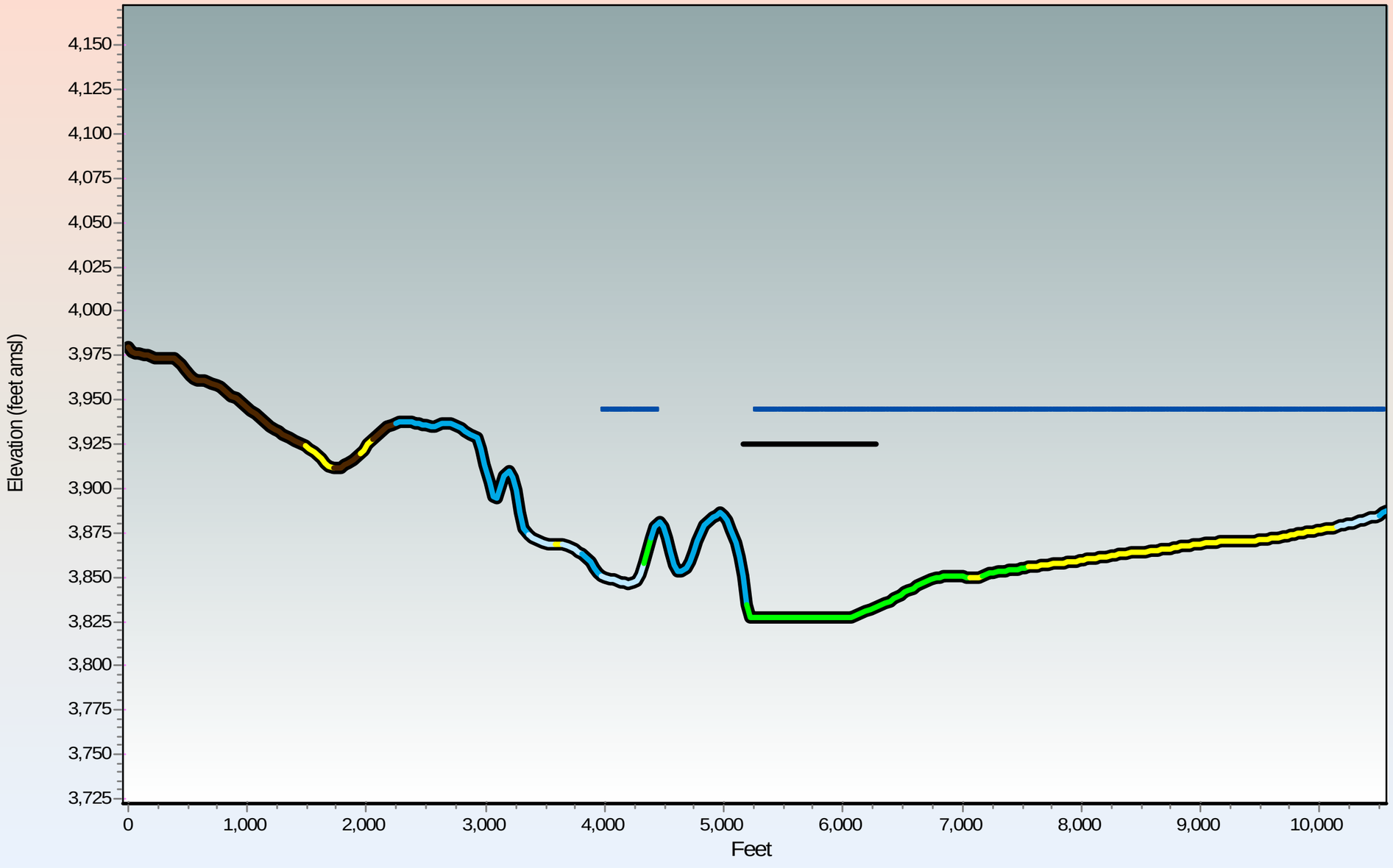
Appendix F

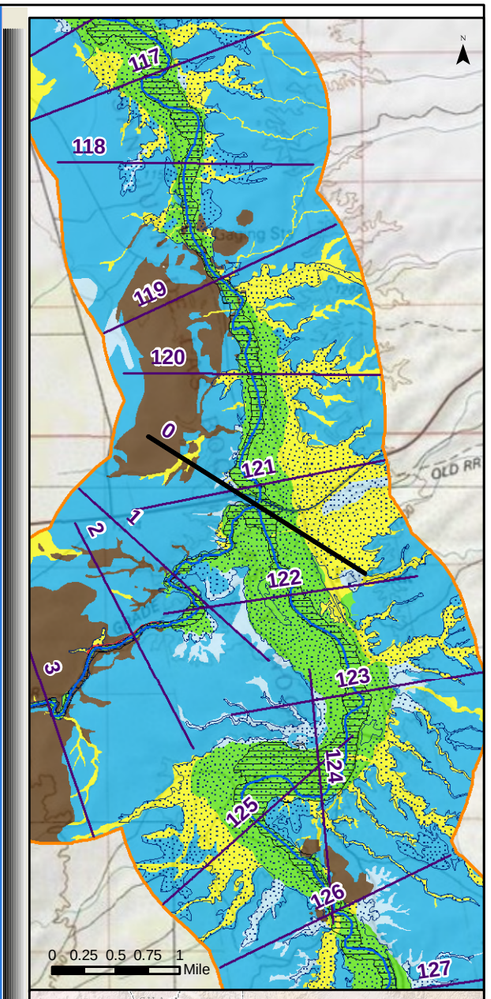
San Pedro River Cross Section at Mile 157

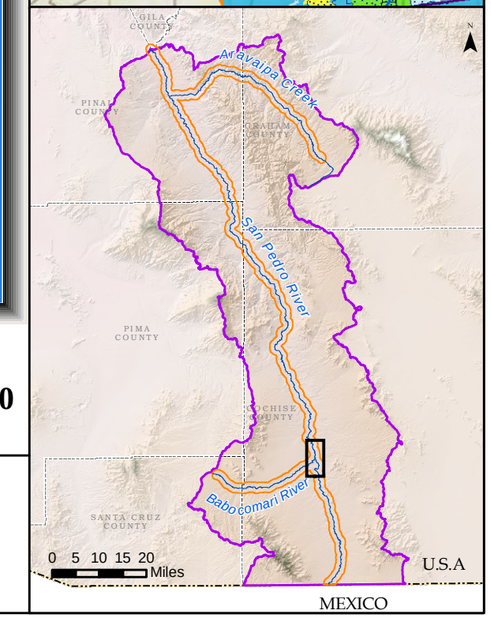
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

Babocomari River Cross Sections







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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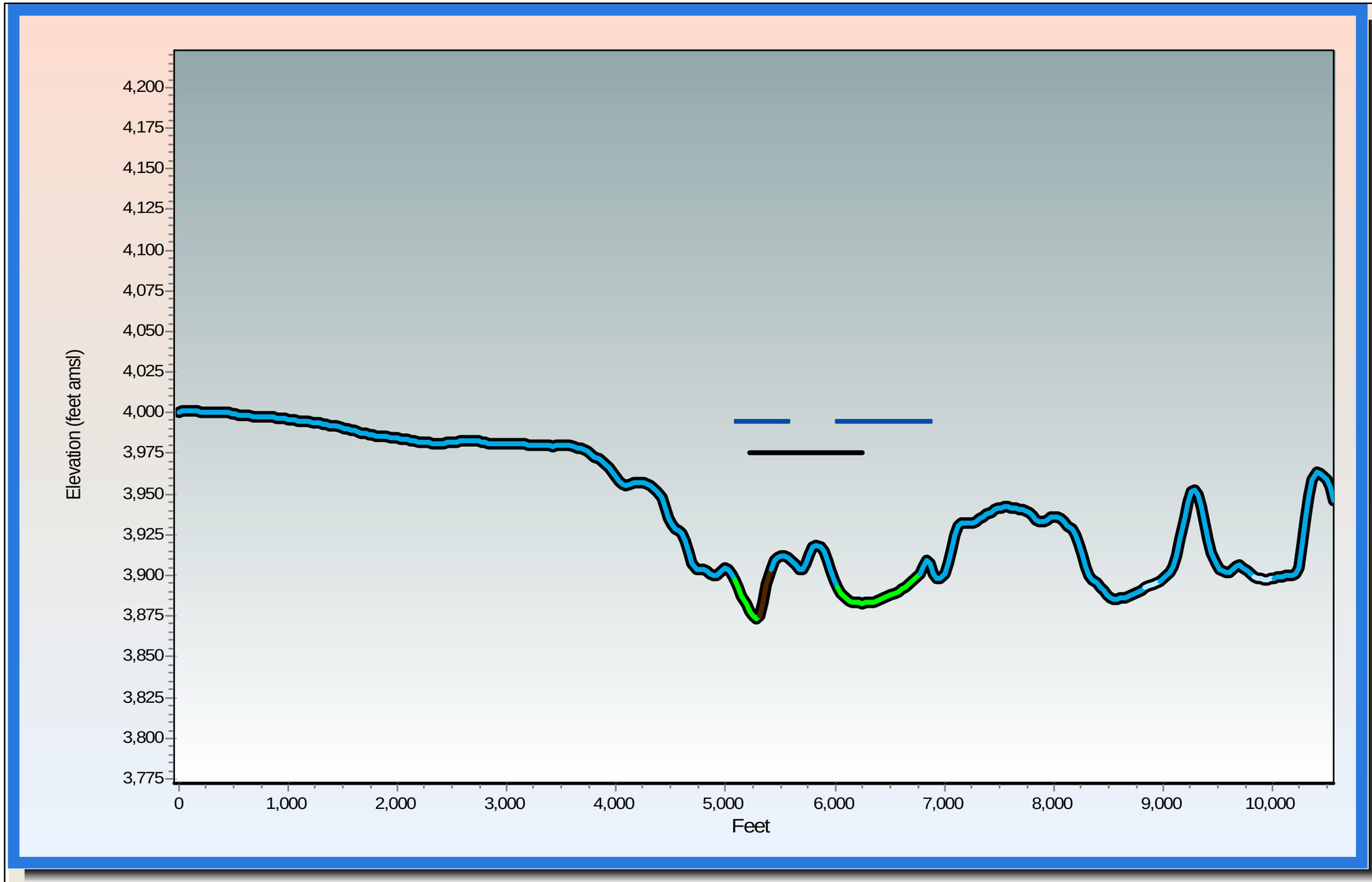
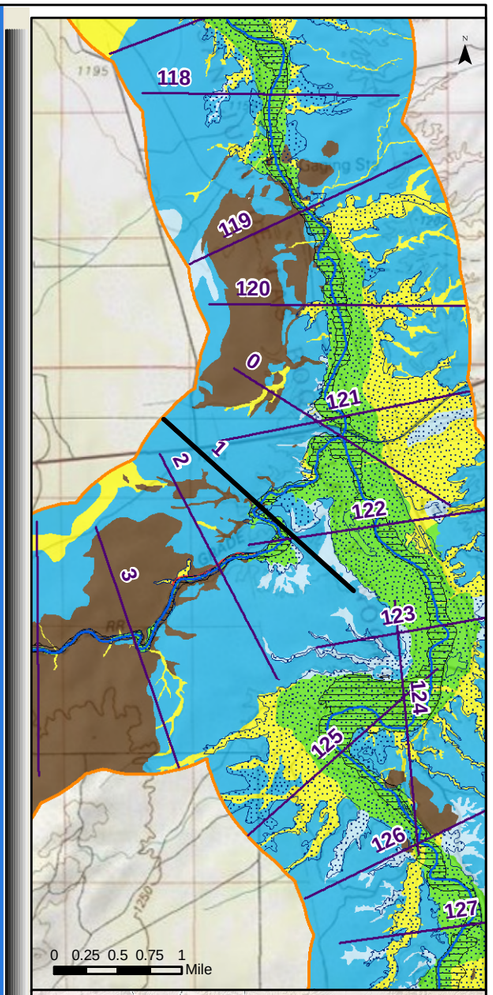
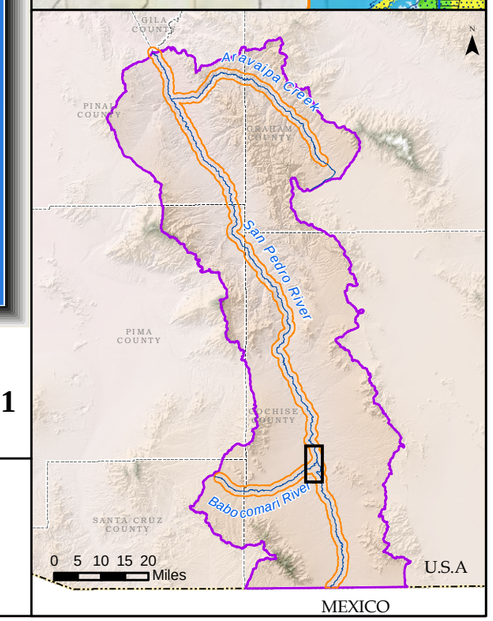
Appendix F
Babocomari River Cross Section at Mile 00
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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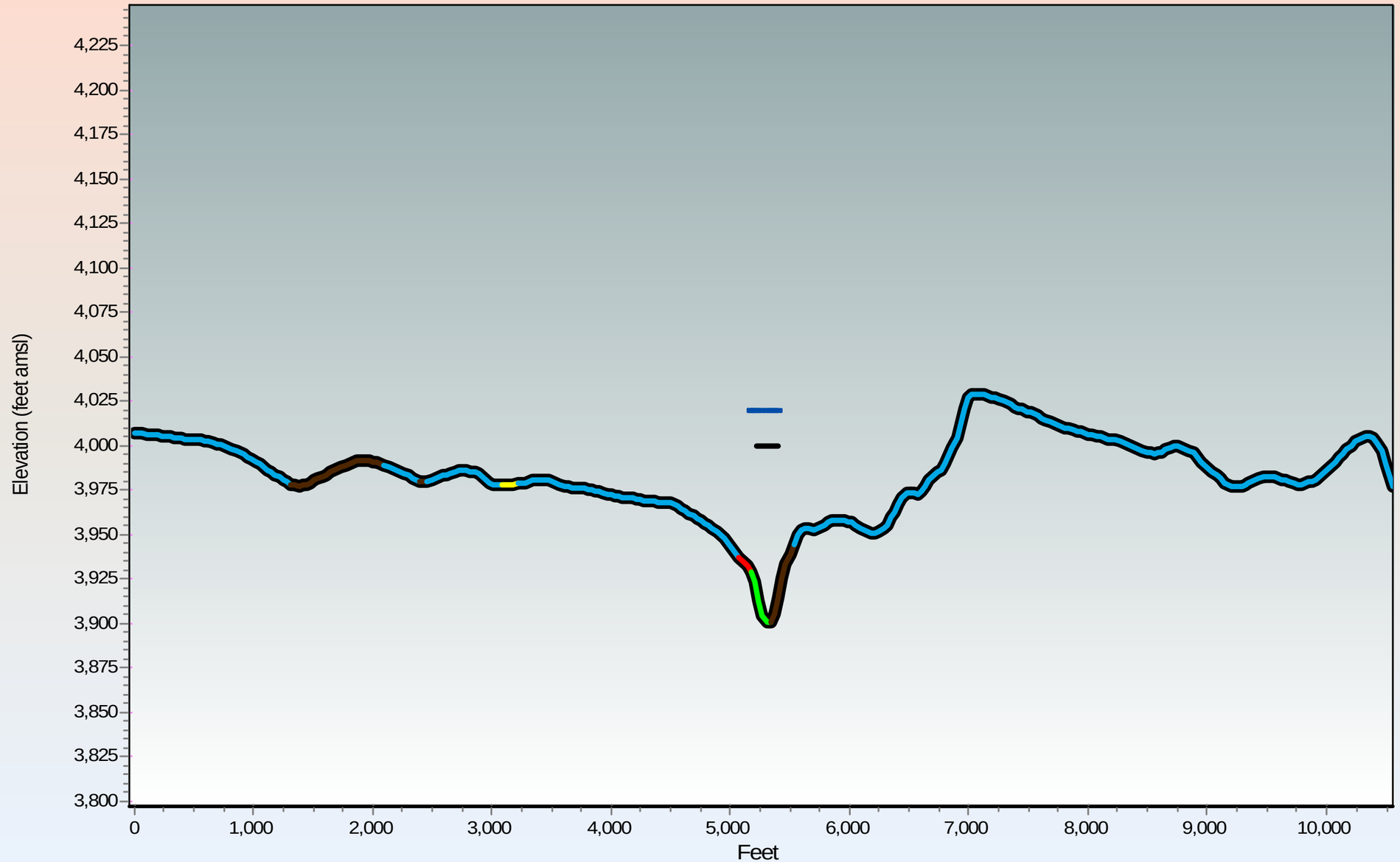
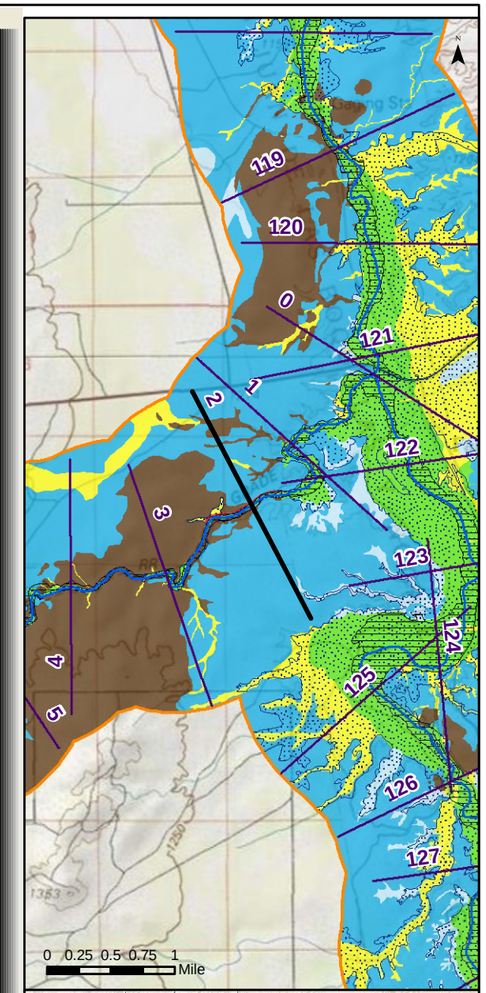
Appendix F

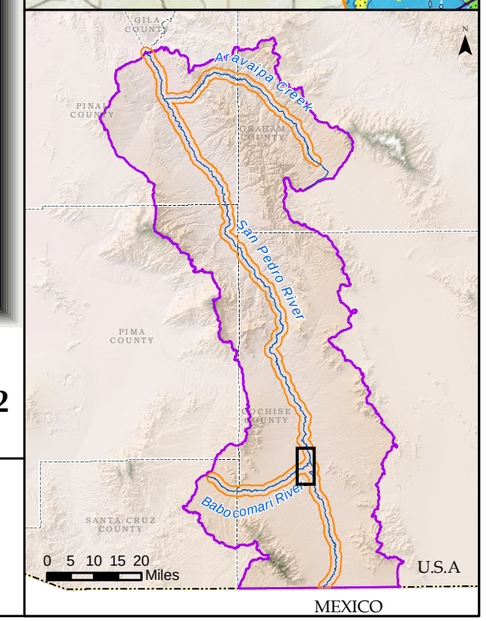
Babocomari River Cross Section at Mile 01

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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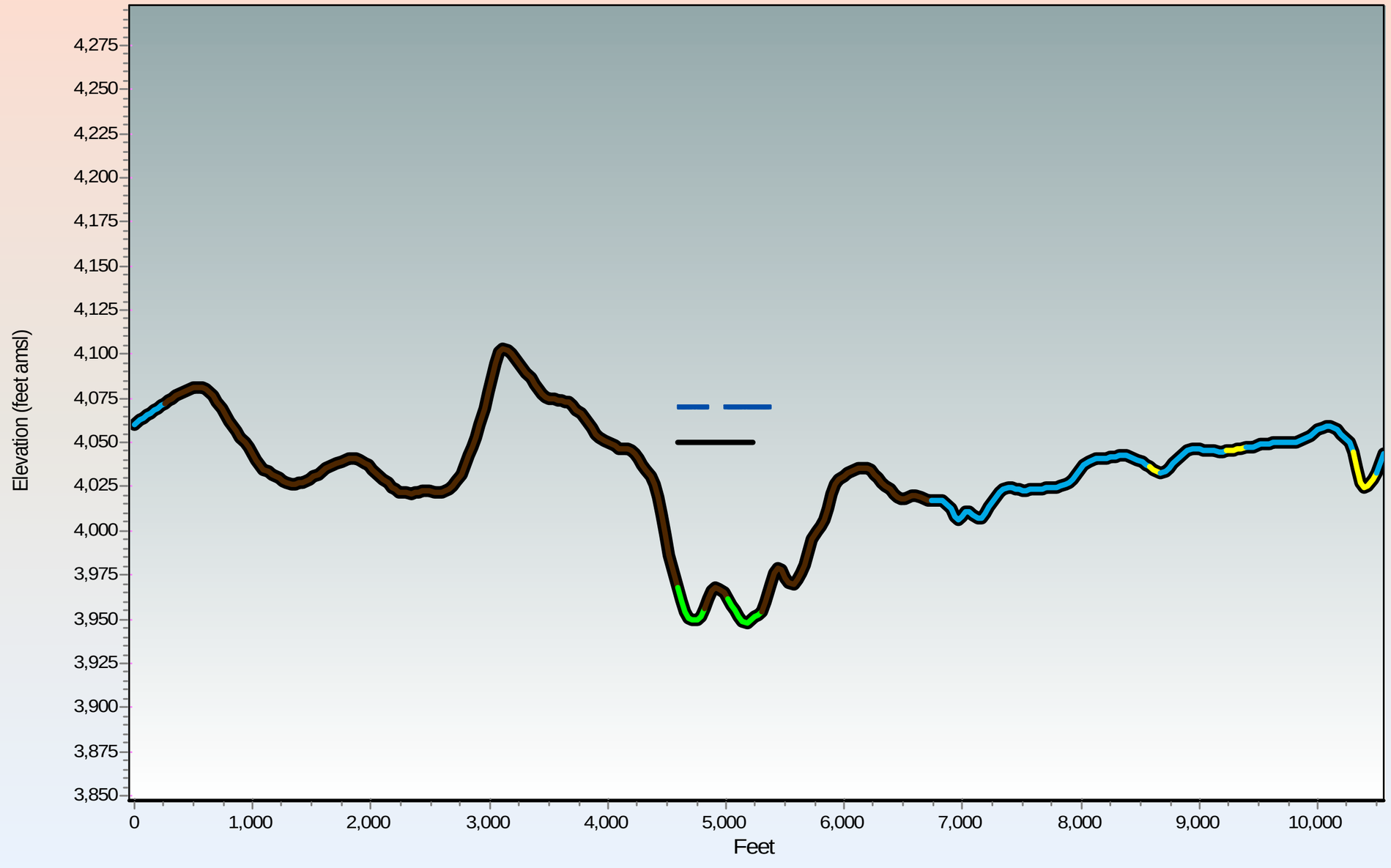
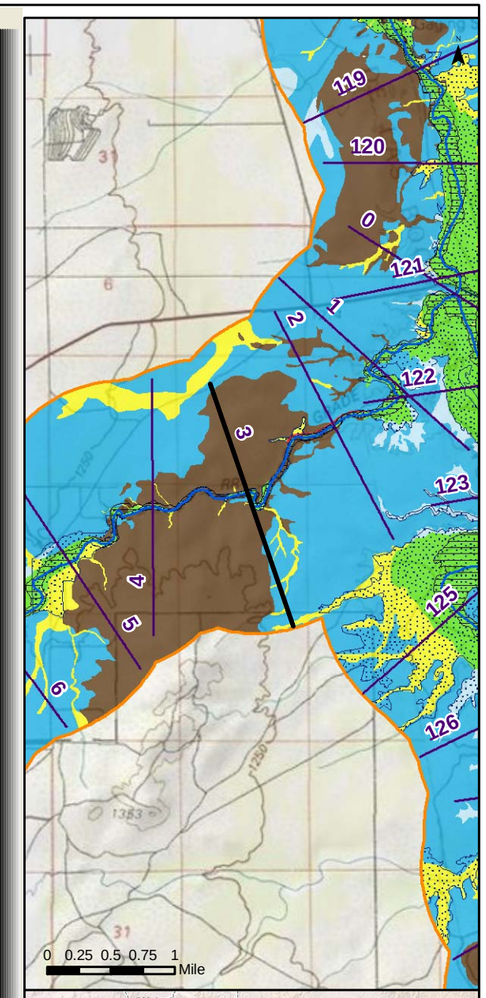
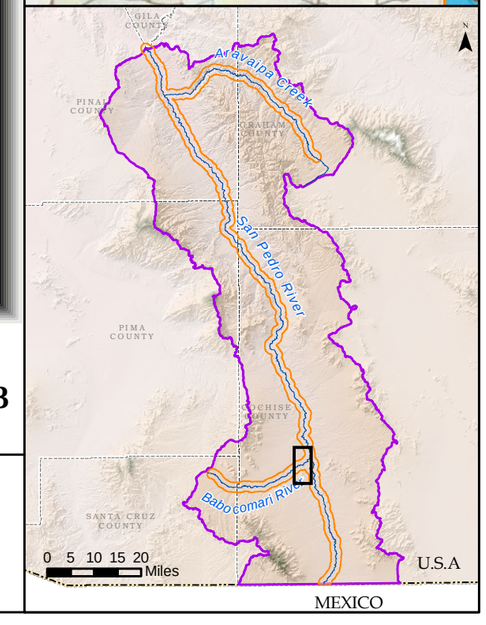
Appendix F
Babocomari River Cross Section at Mile 02
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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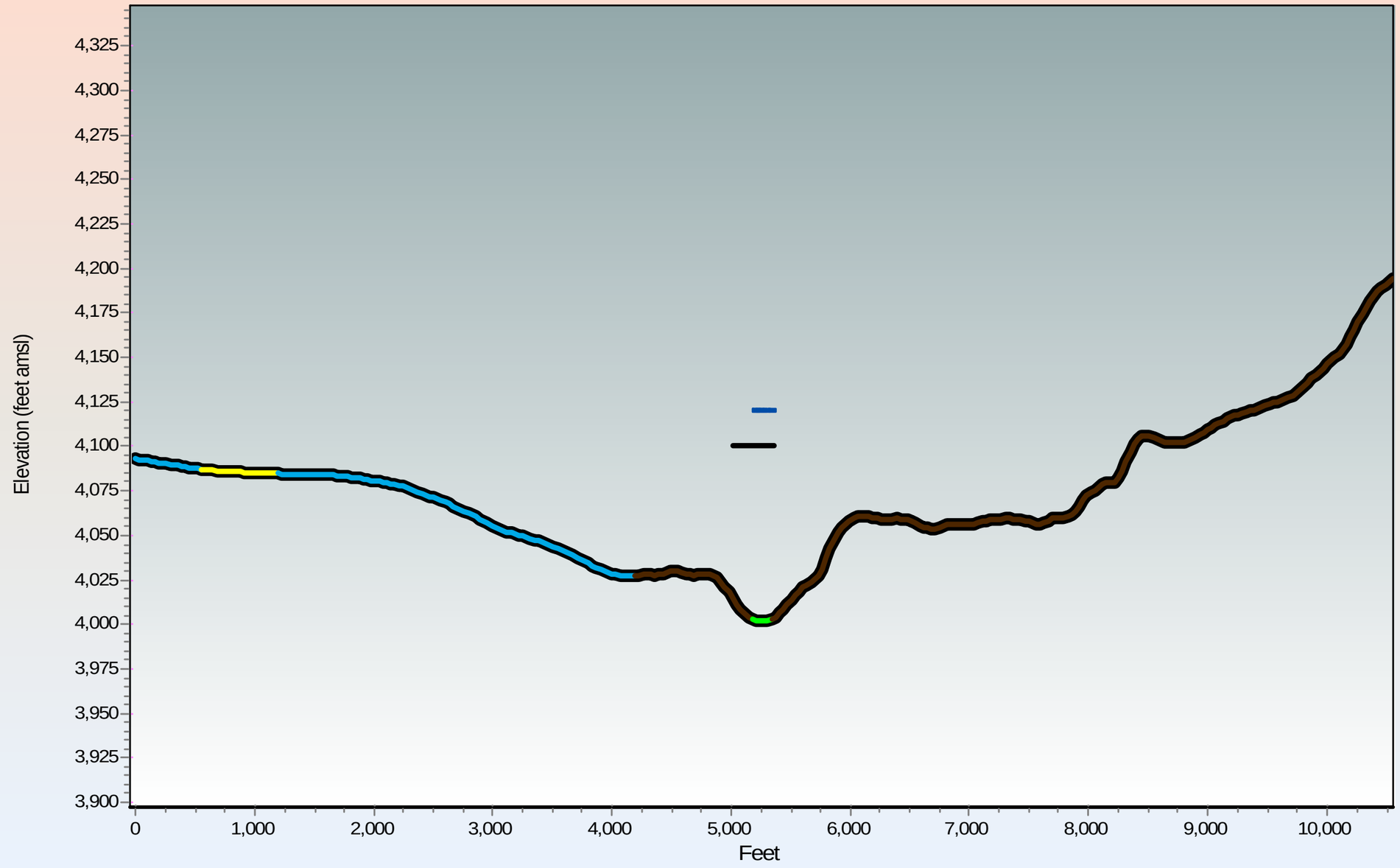
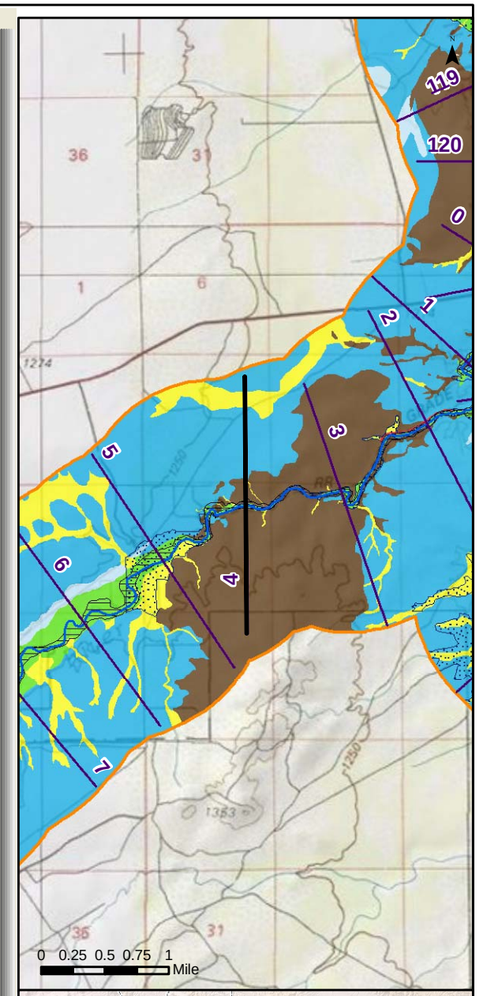
Appendix F

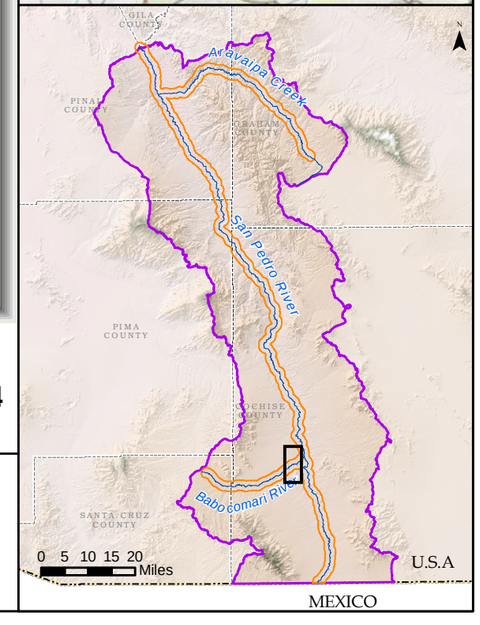
Babocomari River Cross Section at Mile 03

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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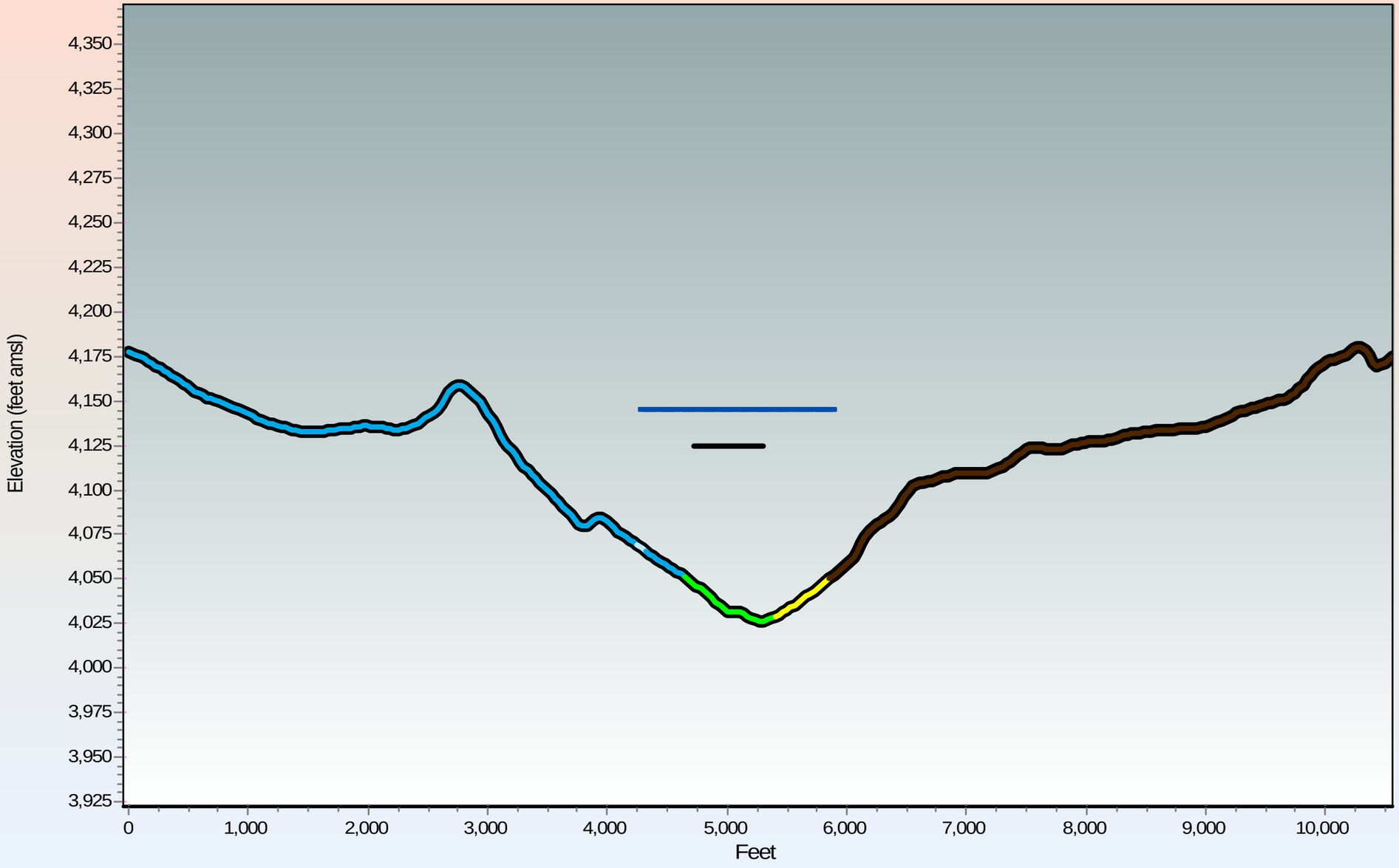
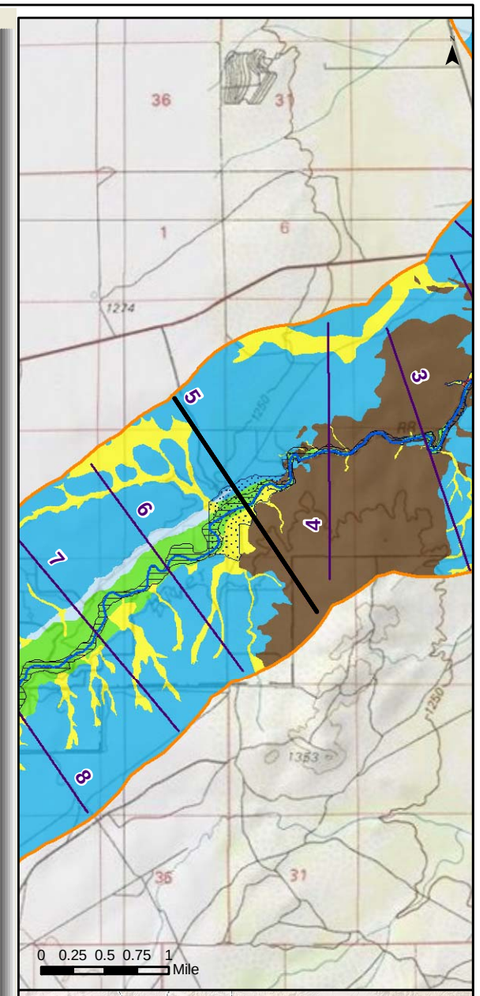
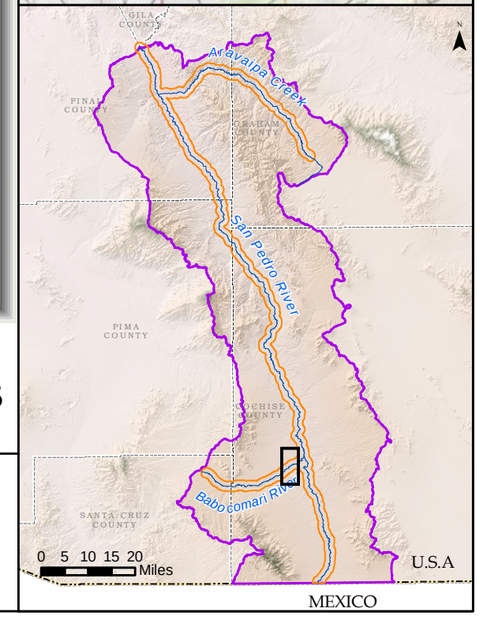
Appendix F
Babocomari River Cross Section at Mile 04
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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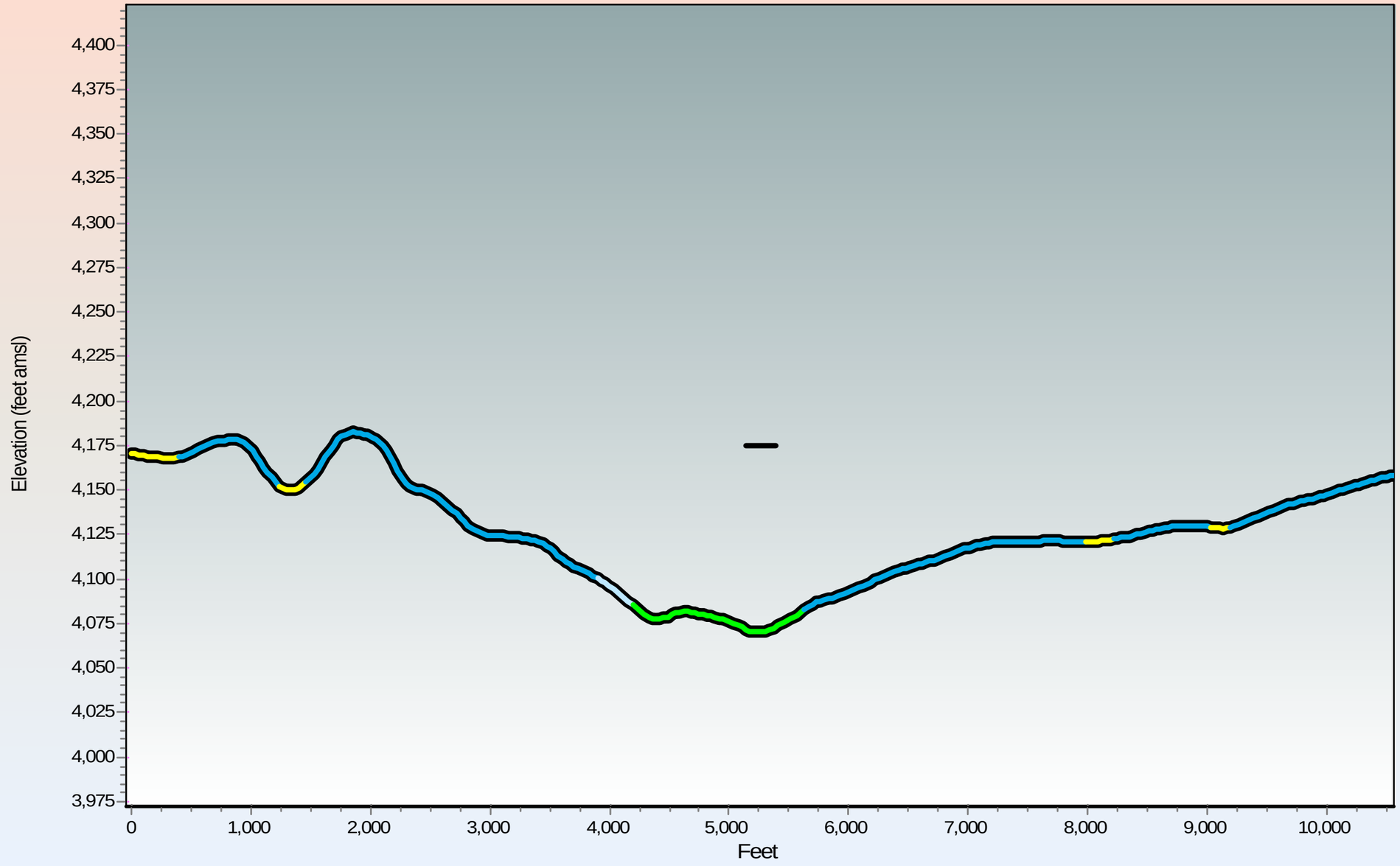
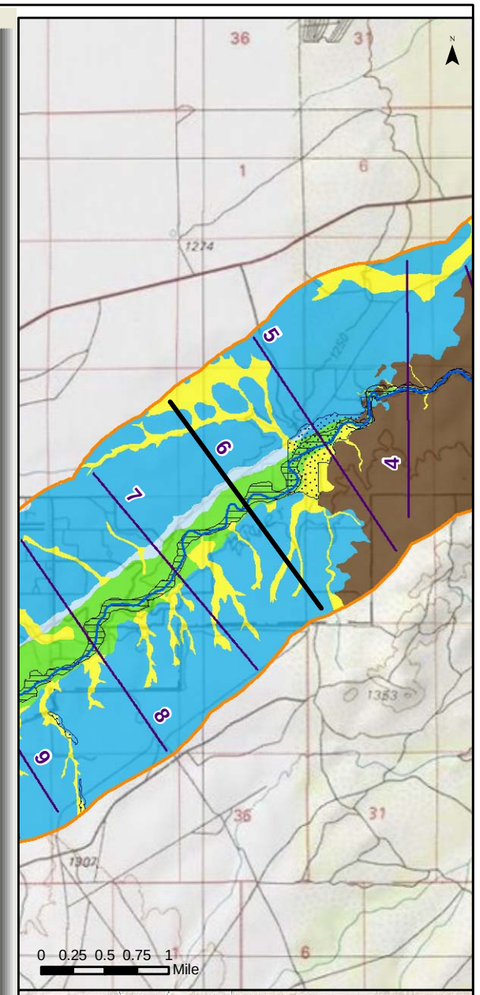
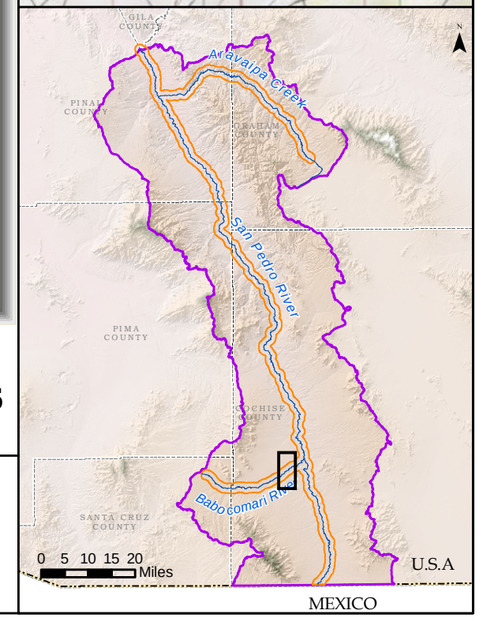
Appendix F
Babocomari River Cross Section at Mile 05
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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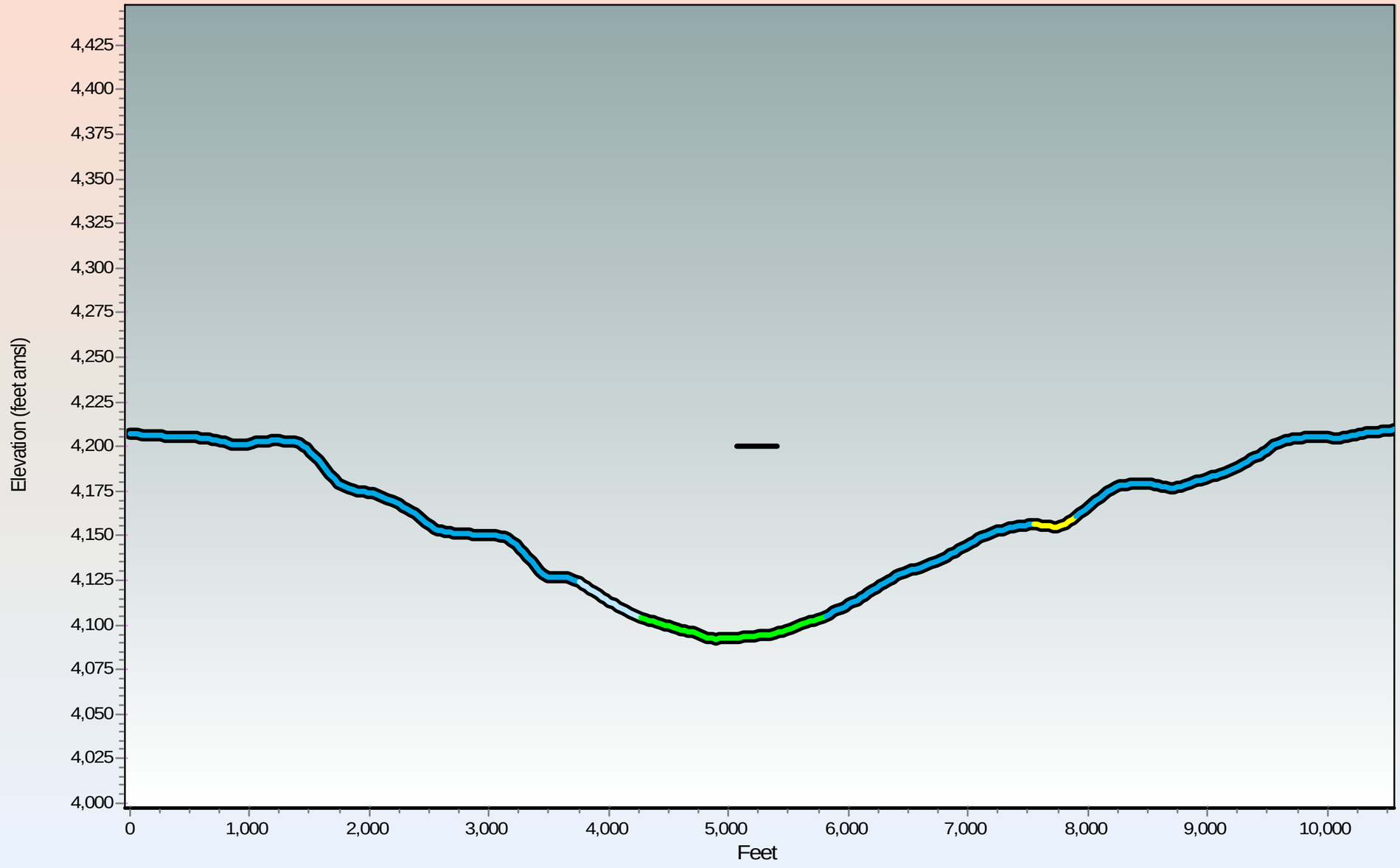
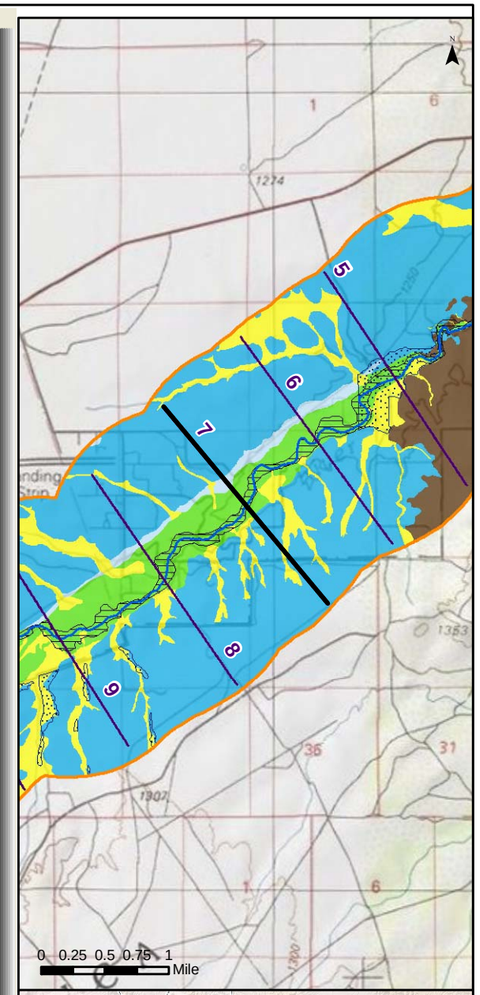
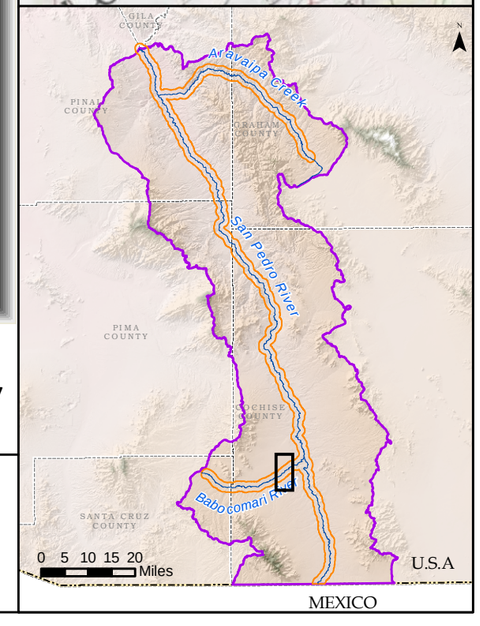
Appendix F
Babocomari River Cross Section at Mile 06
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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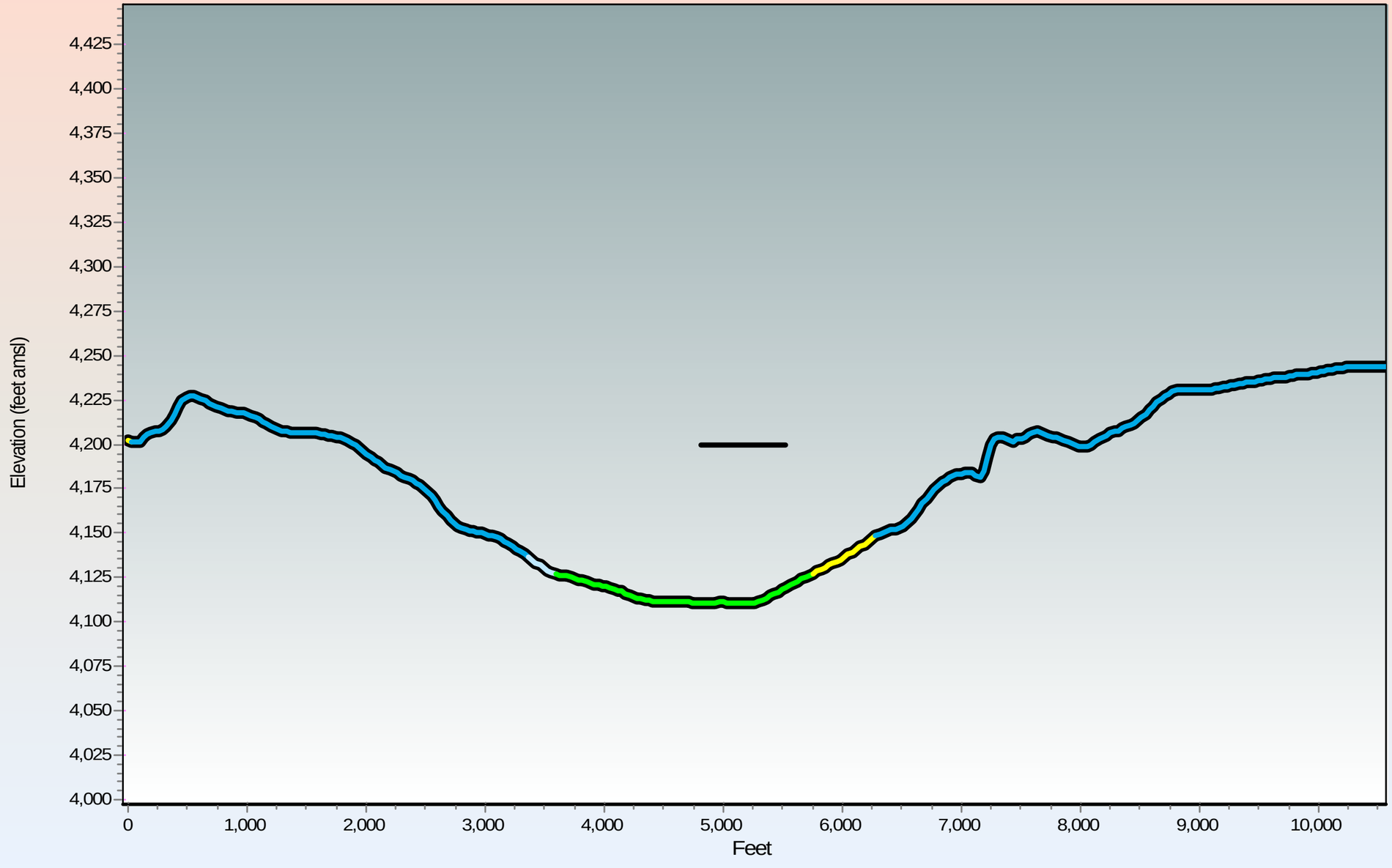
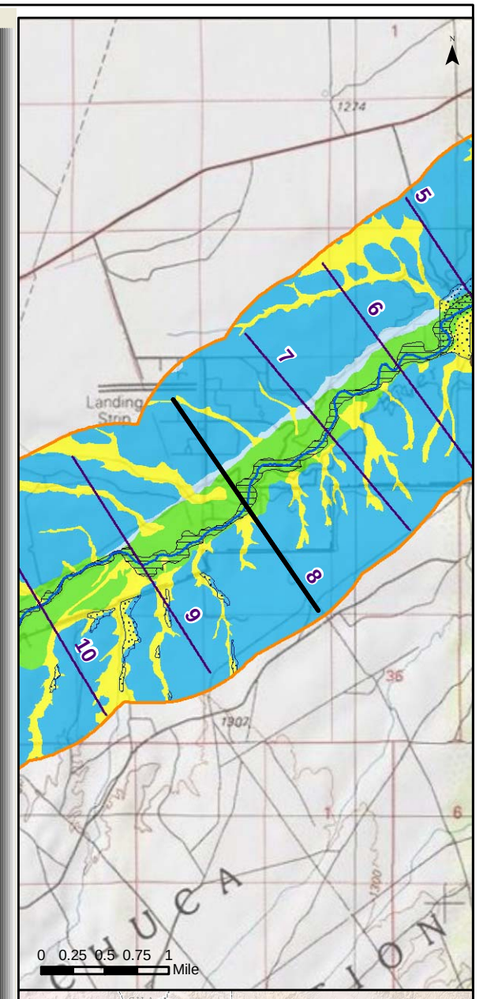
Appendix F

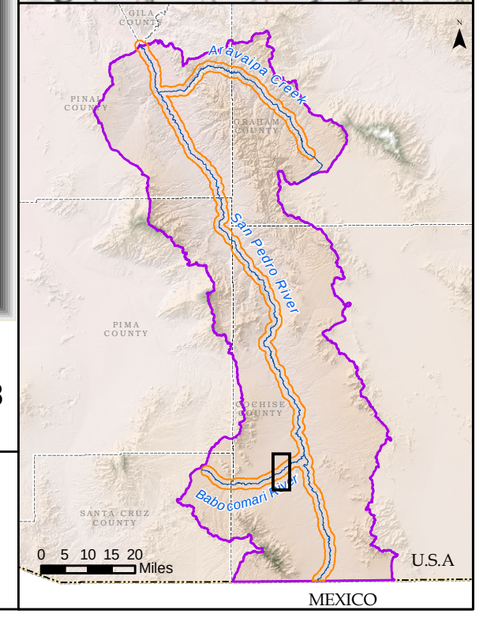
Babocomari River Cross Section at Mile 07

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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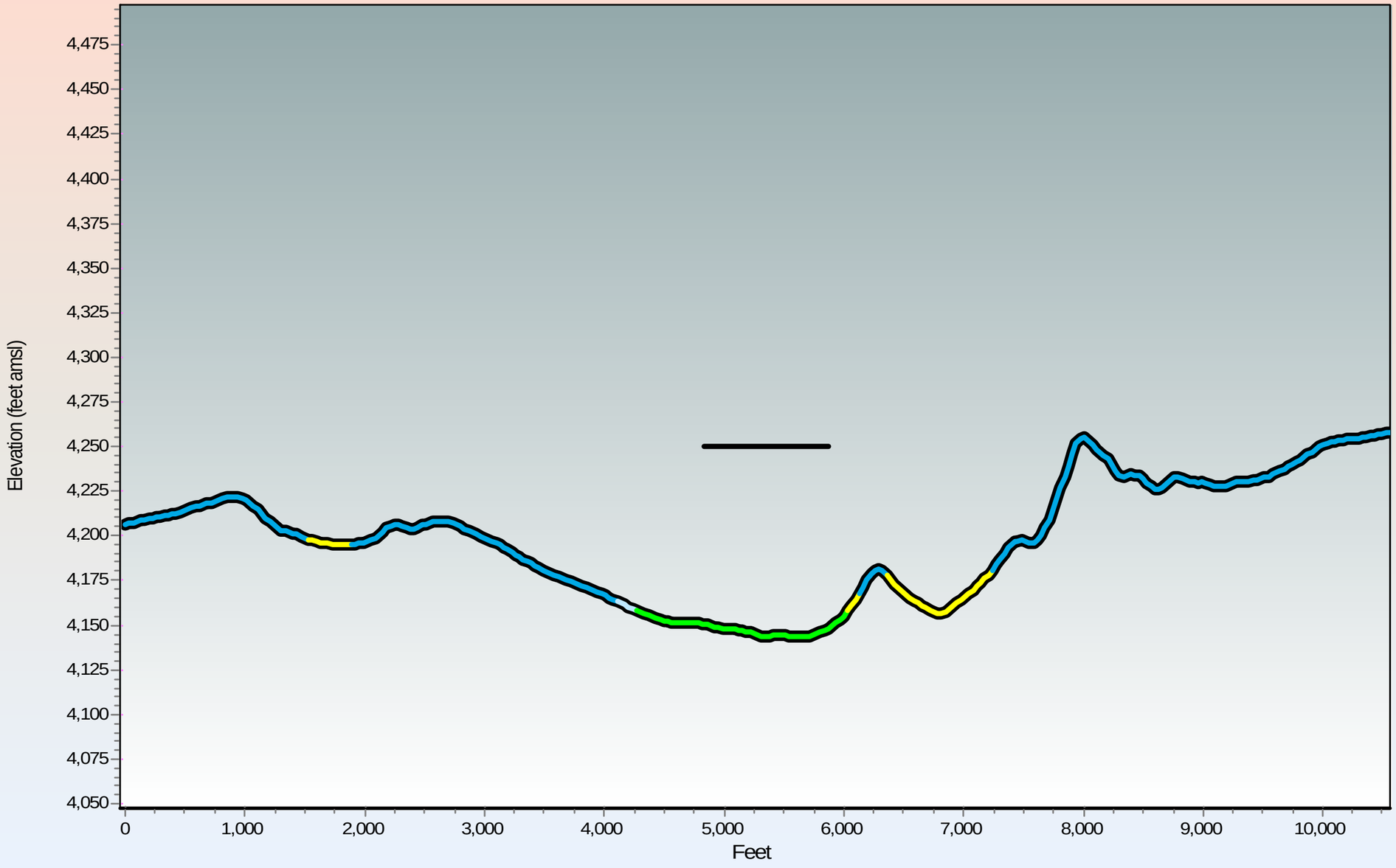
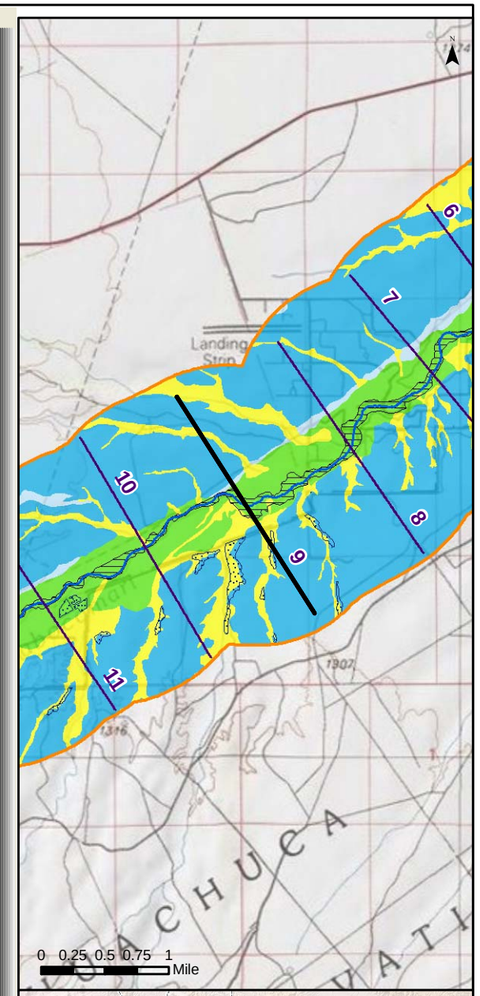
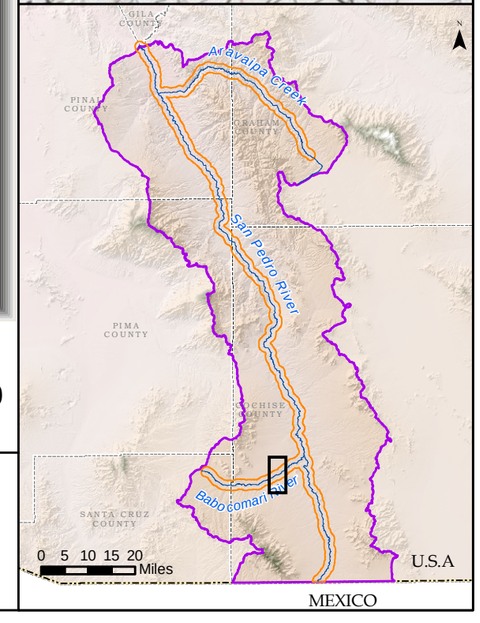
Appendix F
Babocomari River Cross Section at Mile 08
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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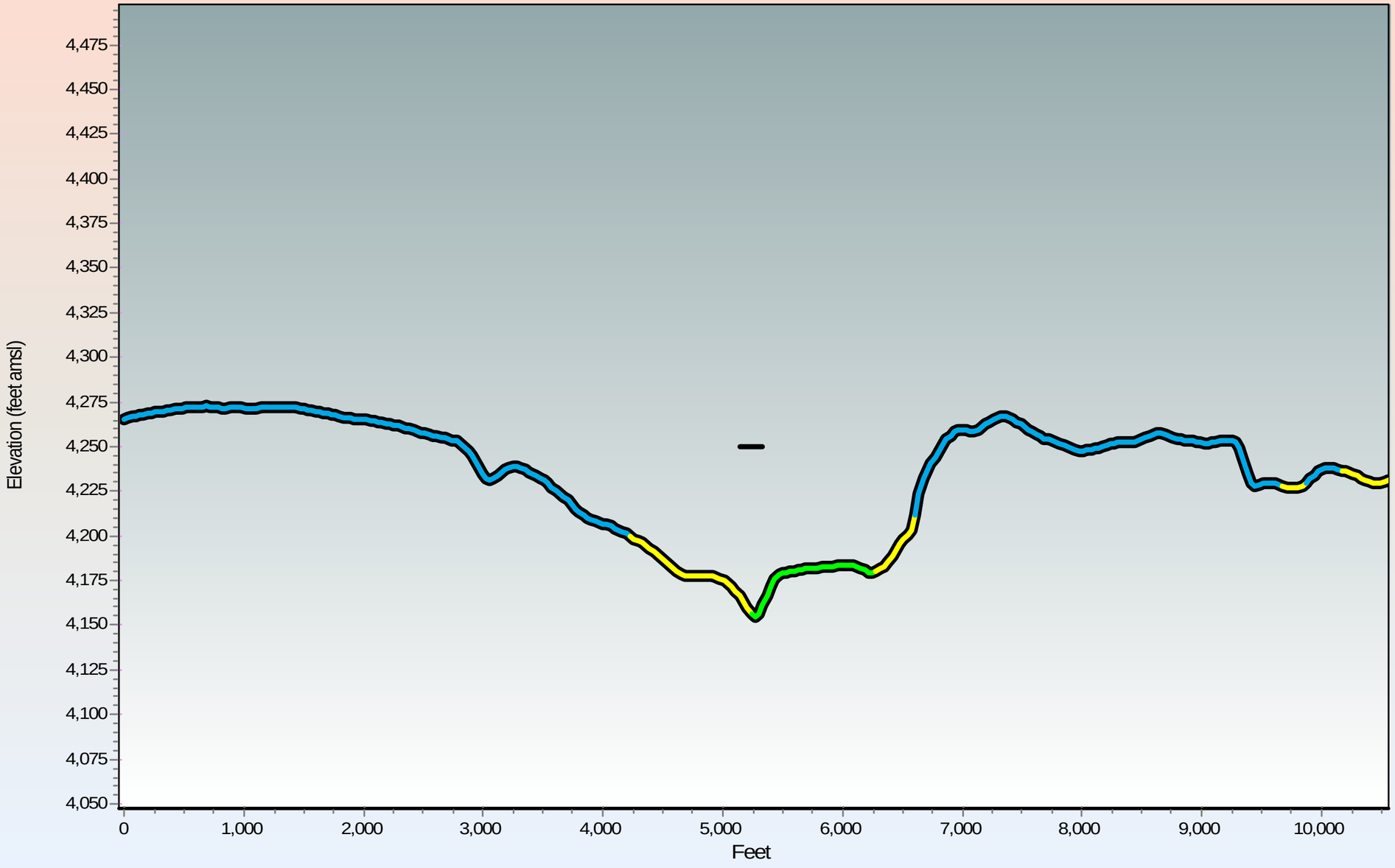
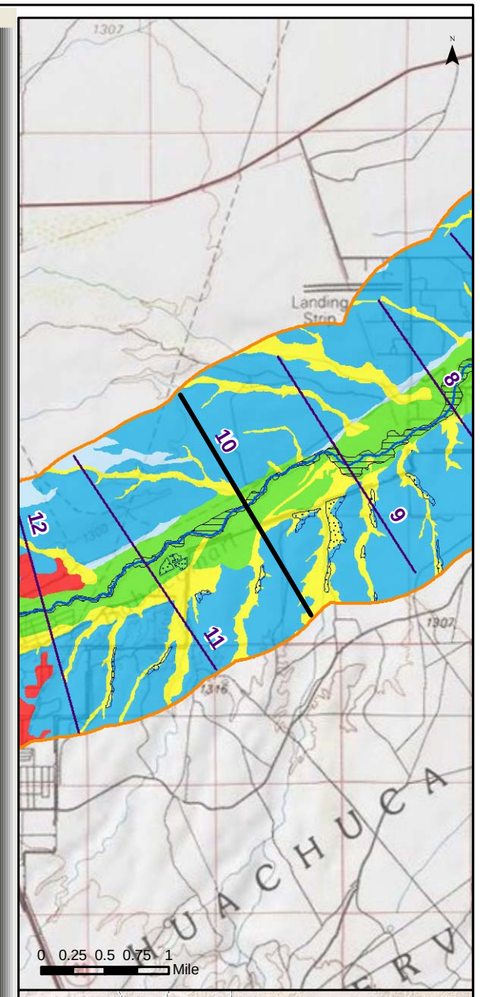
Appendix F

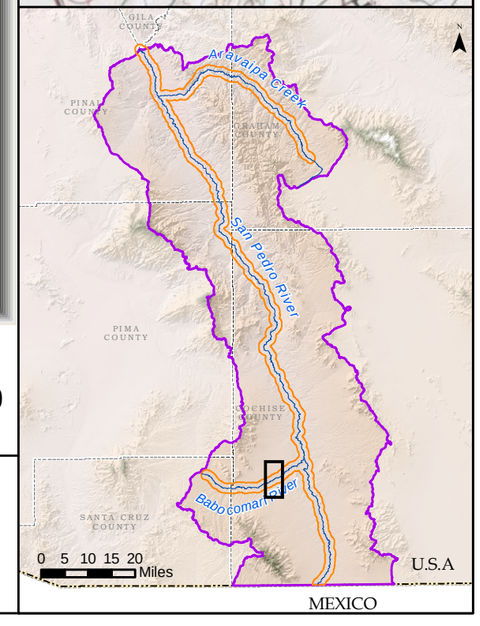
Babocomari River Cross Section at Mile 09

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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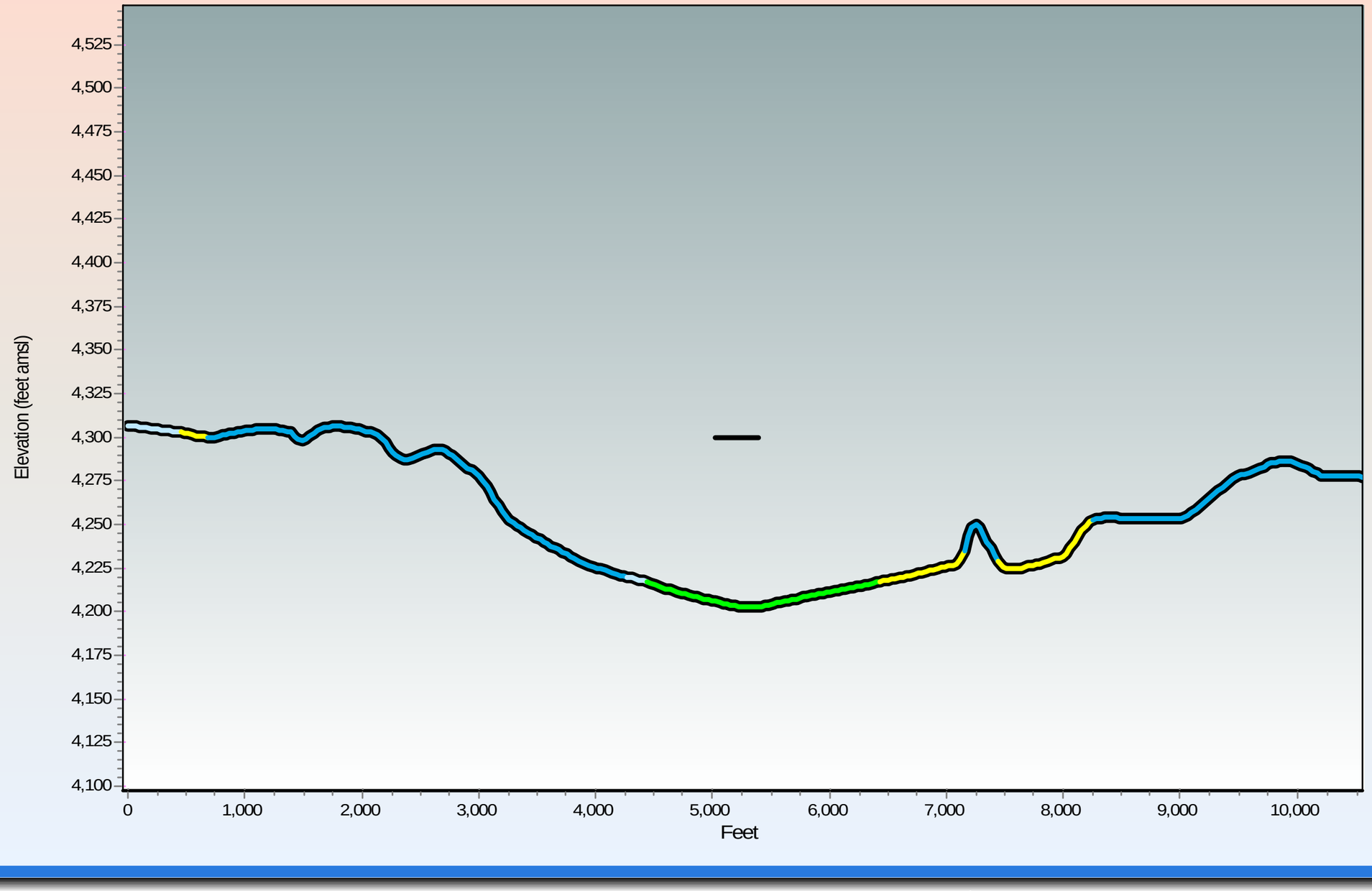
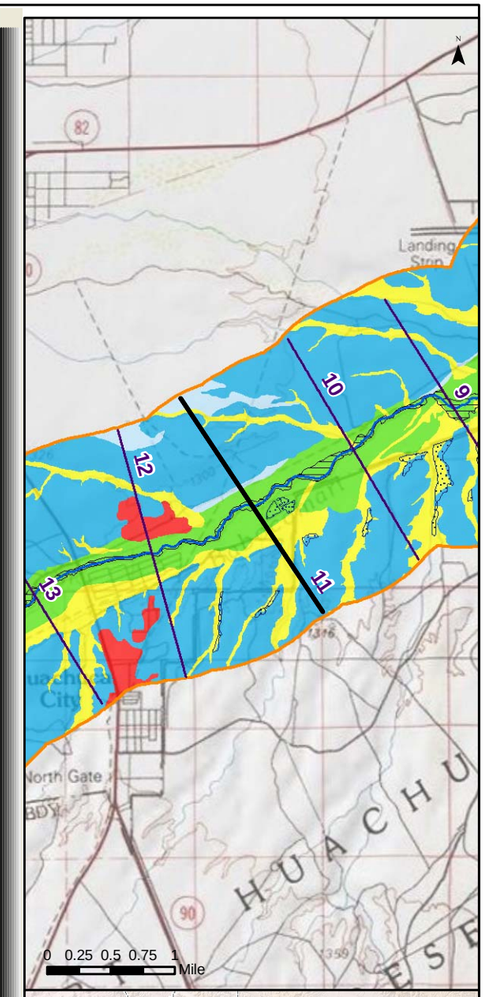
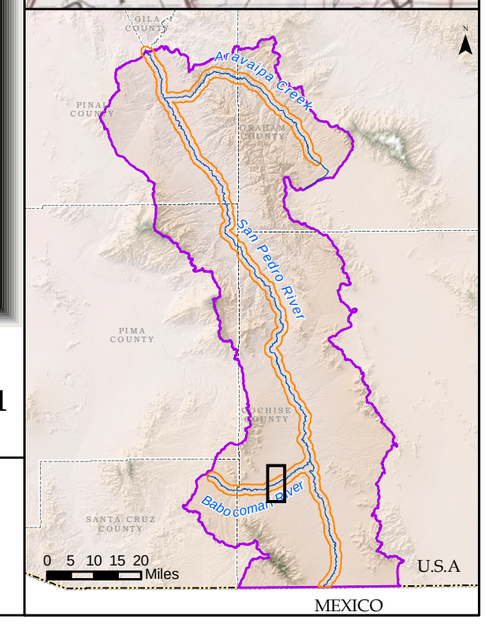
Appendix F
Babocomari River Cross Section at Mile 10
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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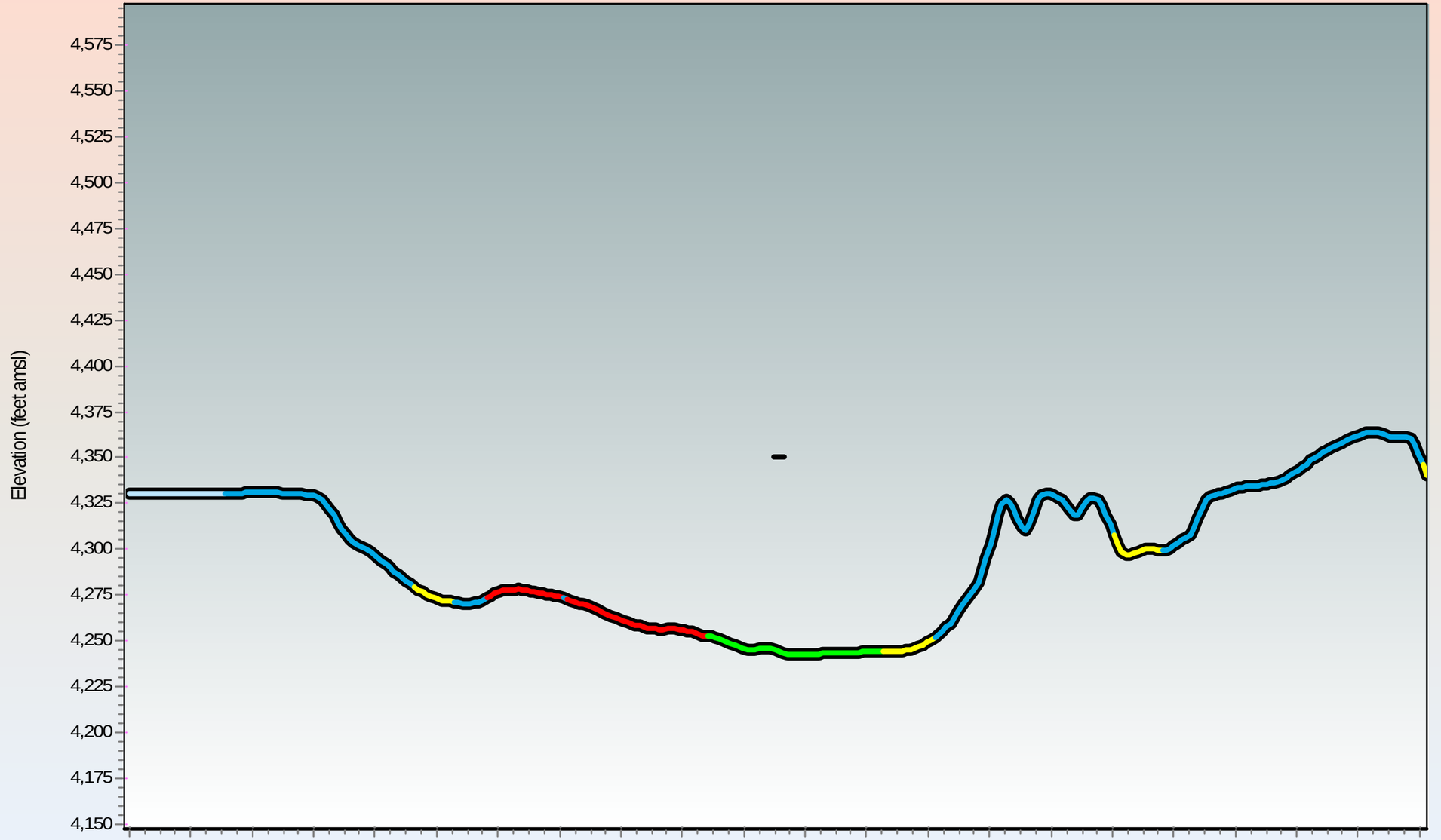
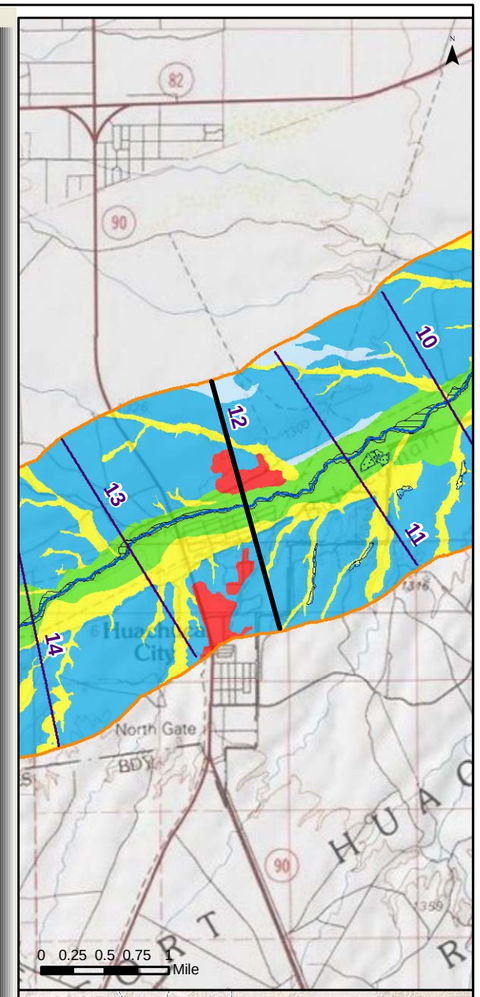
Appendix F

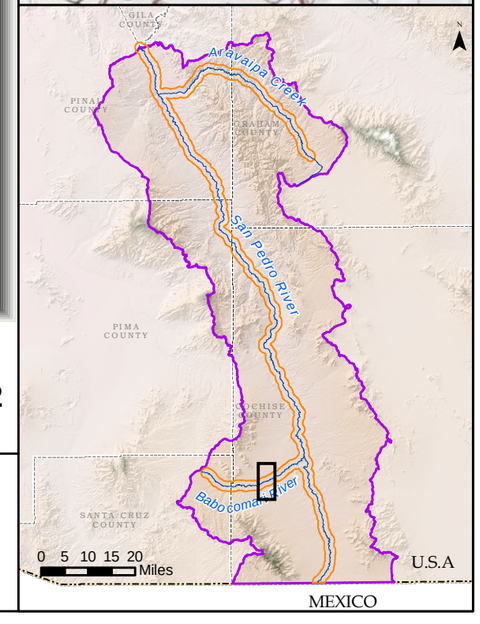
Babocomari River Cross Section at Mile 11

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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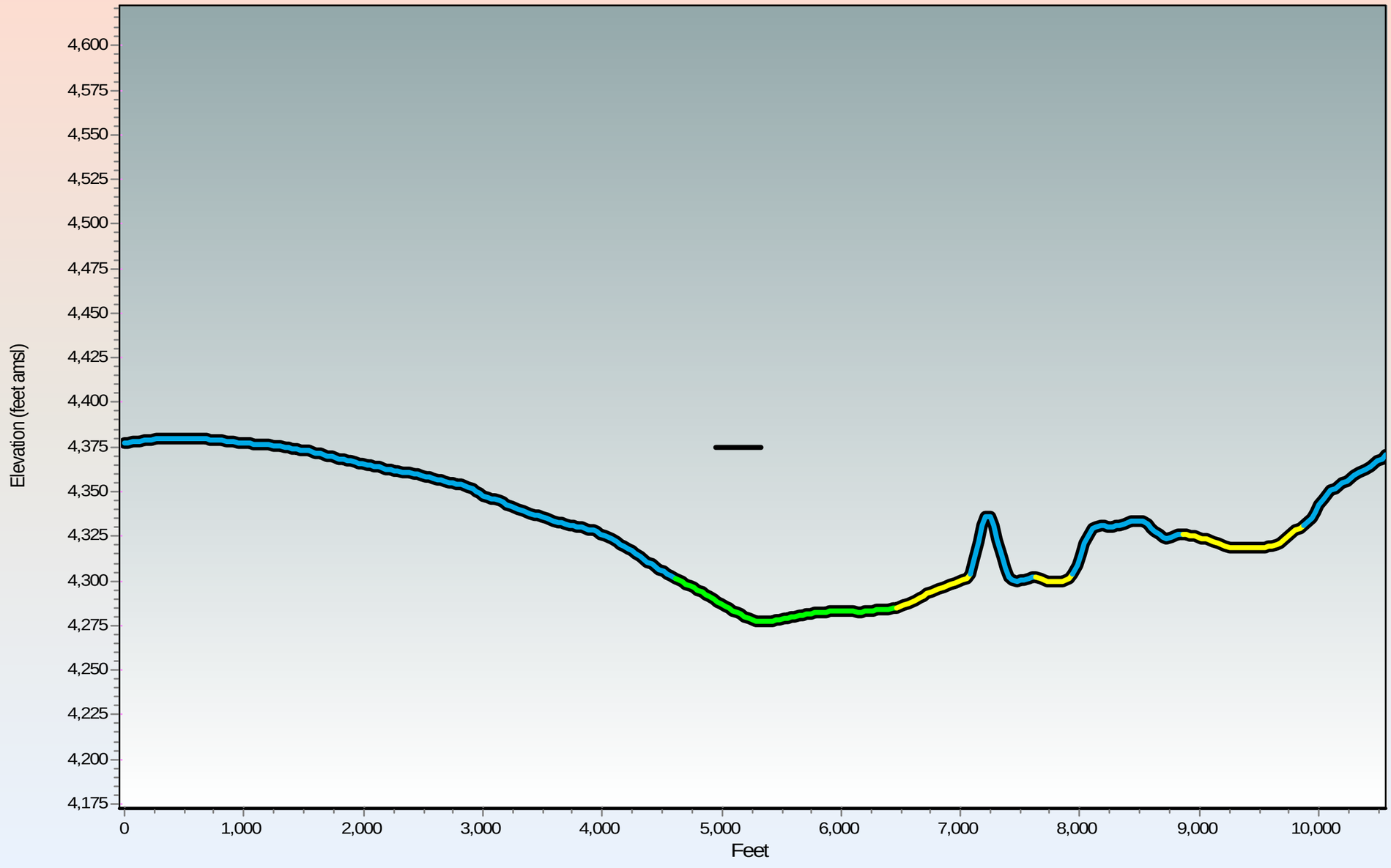
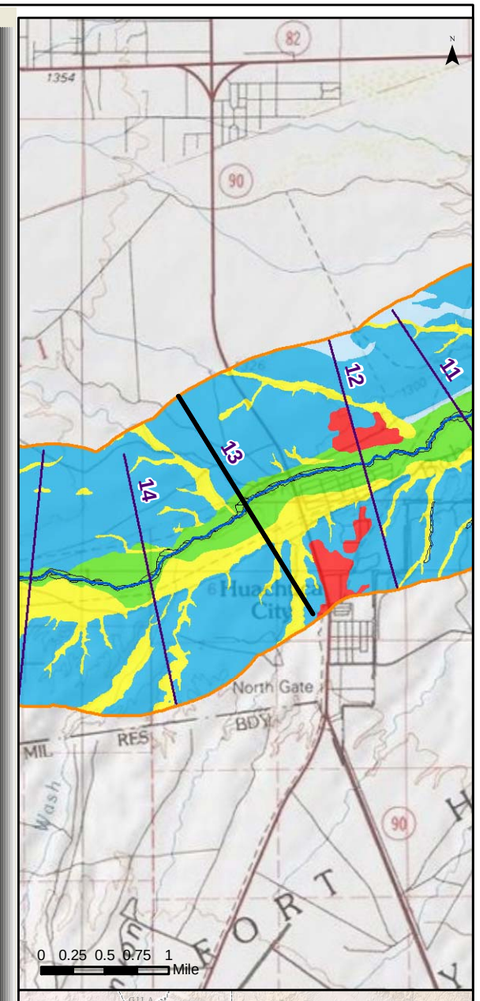
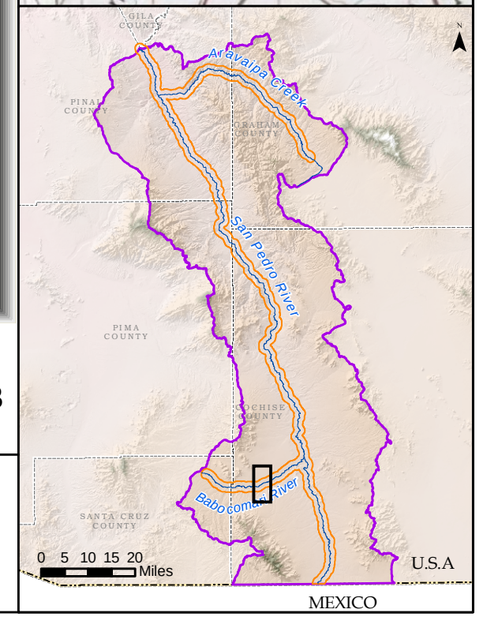
Appendix F
Babocomari River Cross Section at Mile 12
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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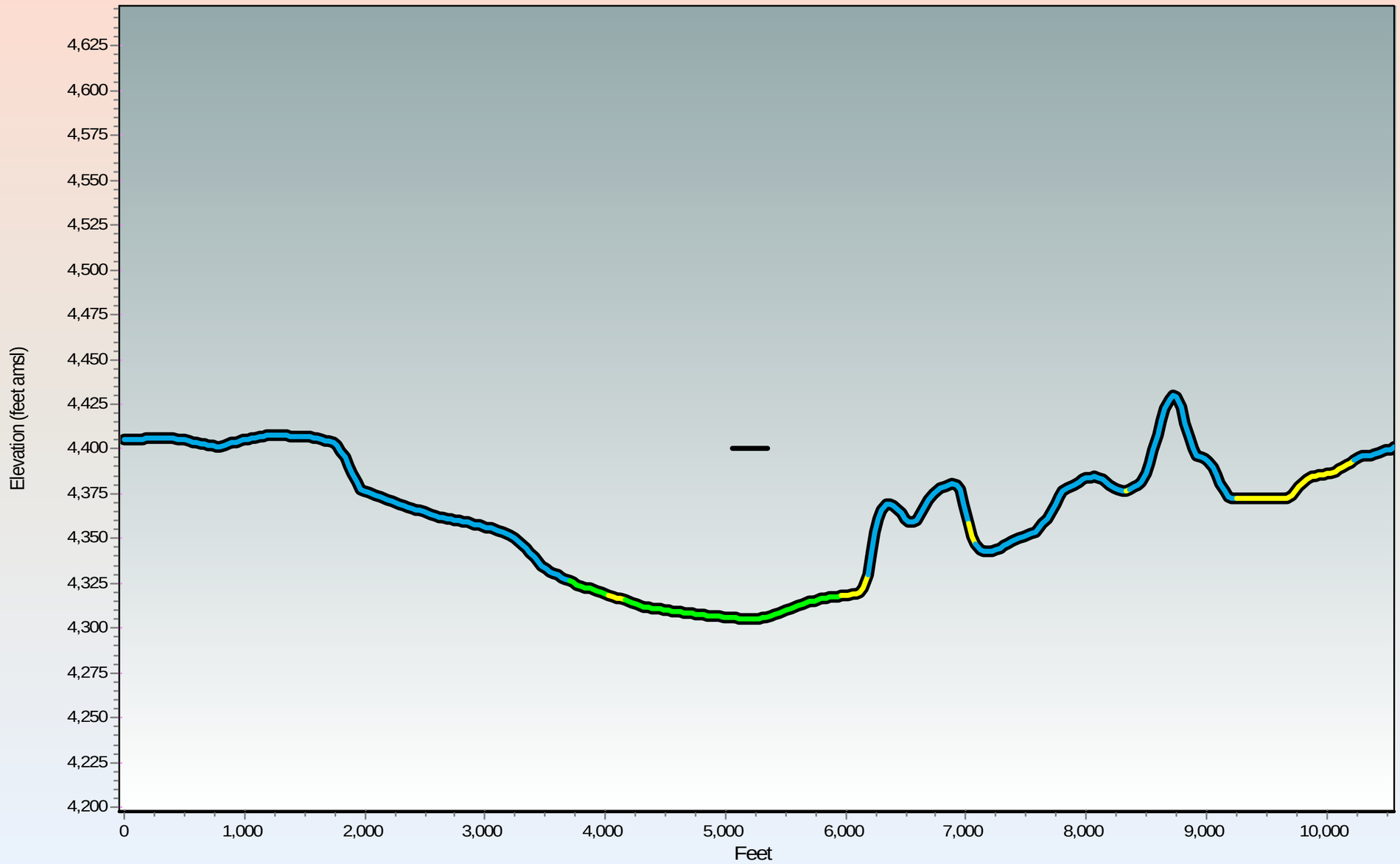
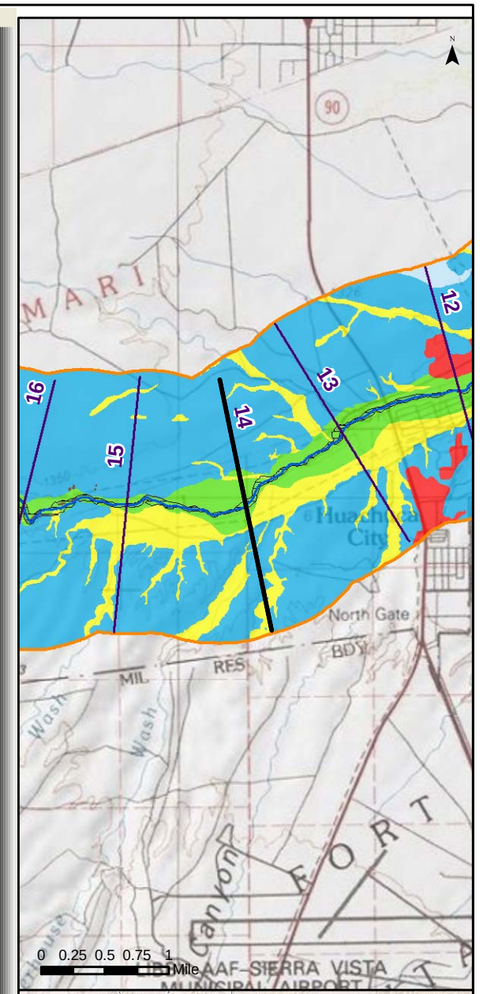
Appendix F

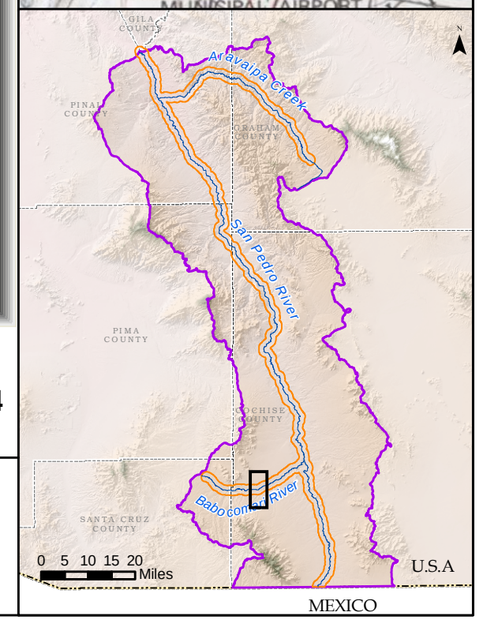
Babocomari River Cross Section at Mile 13

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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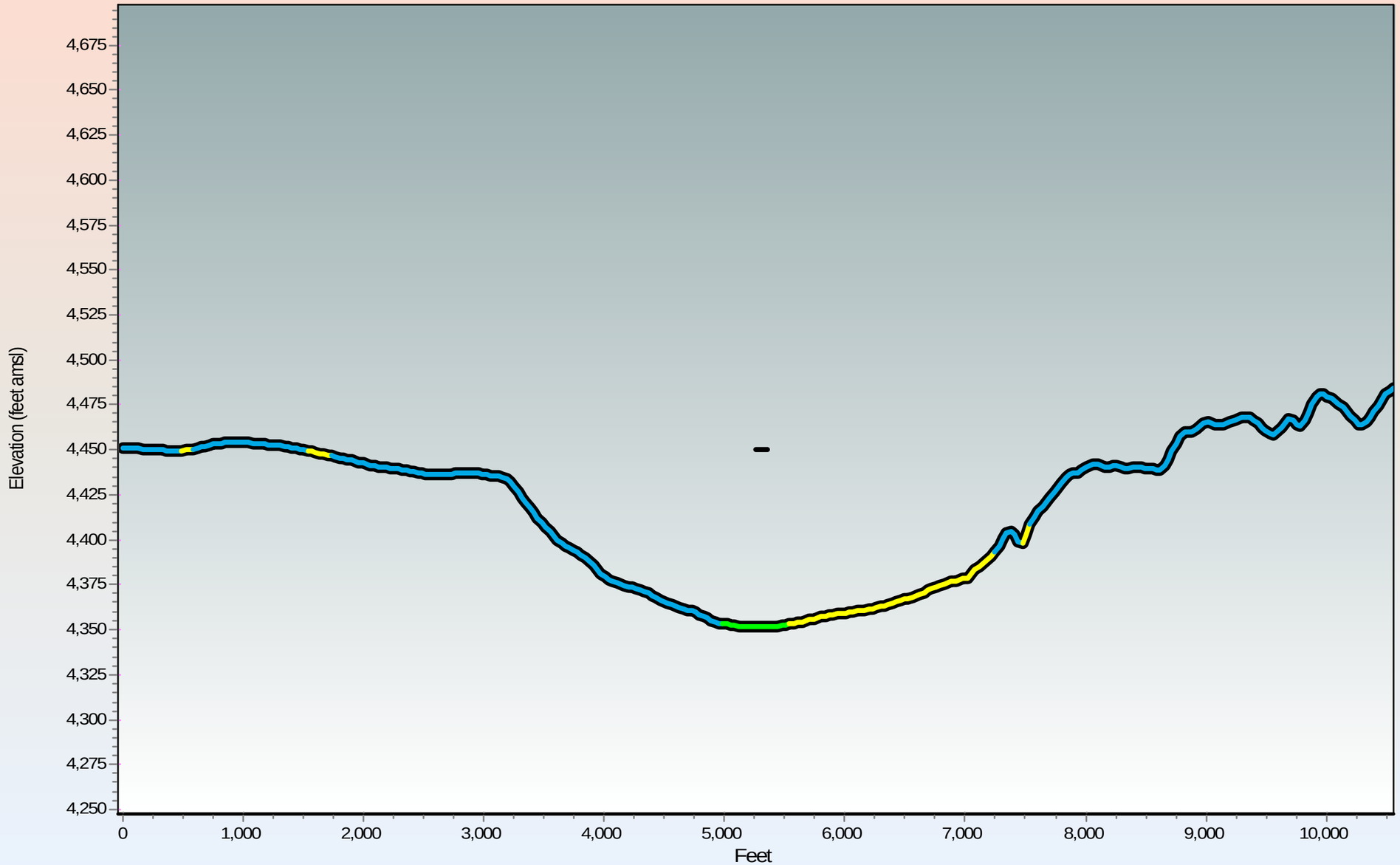
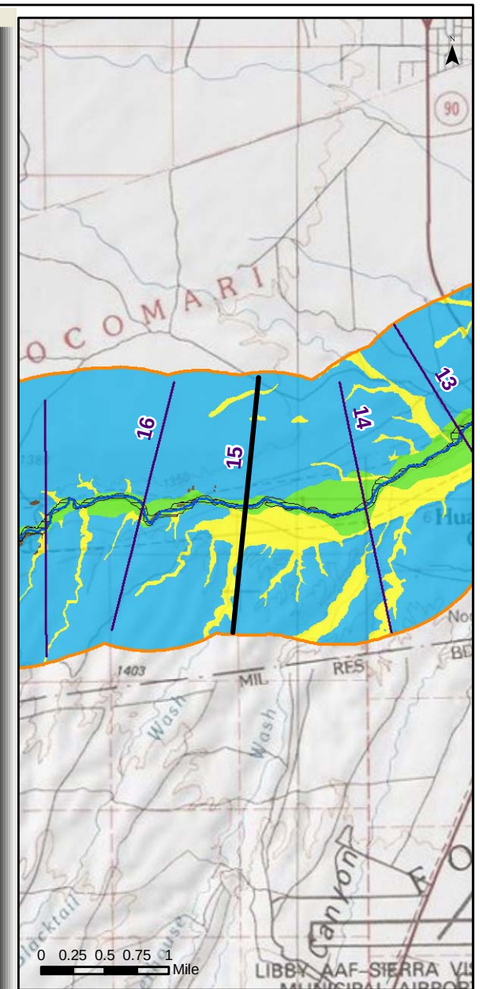
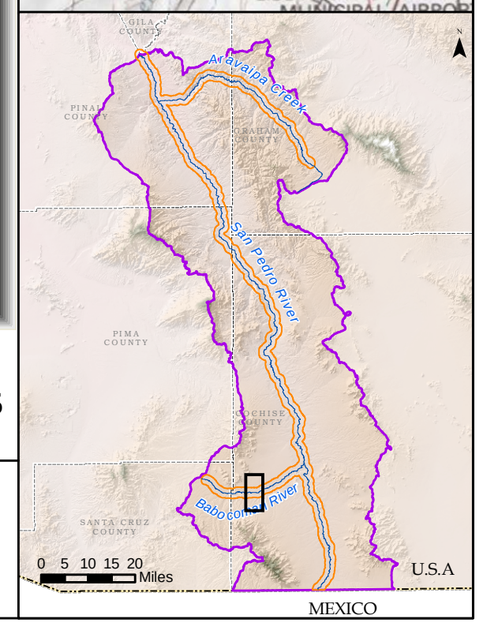
Appendix F
Babocomari River Cross Section at Mile 14
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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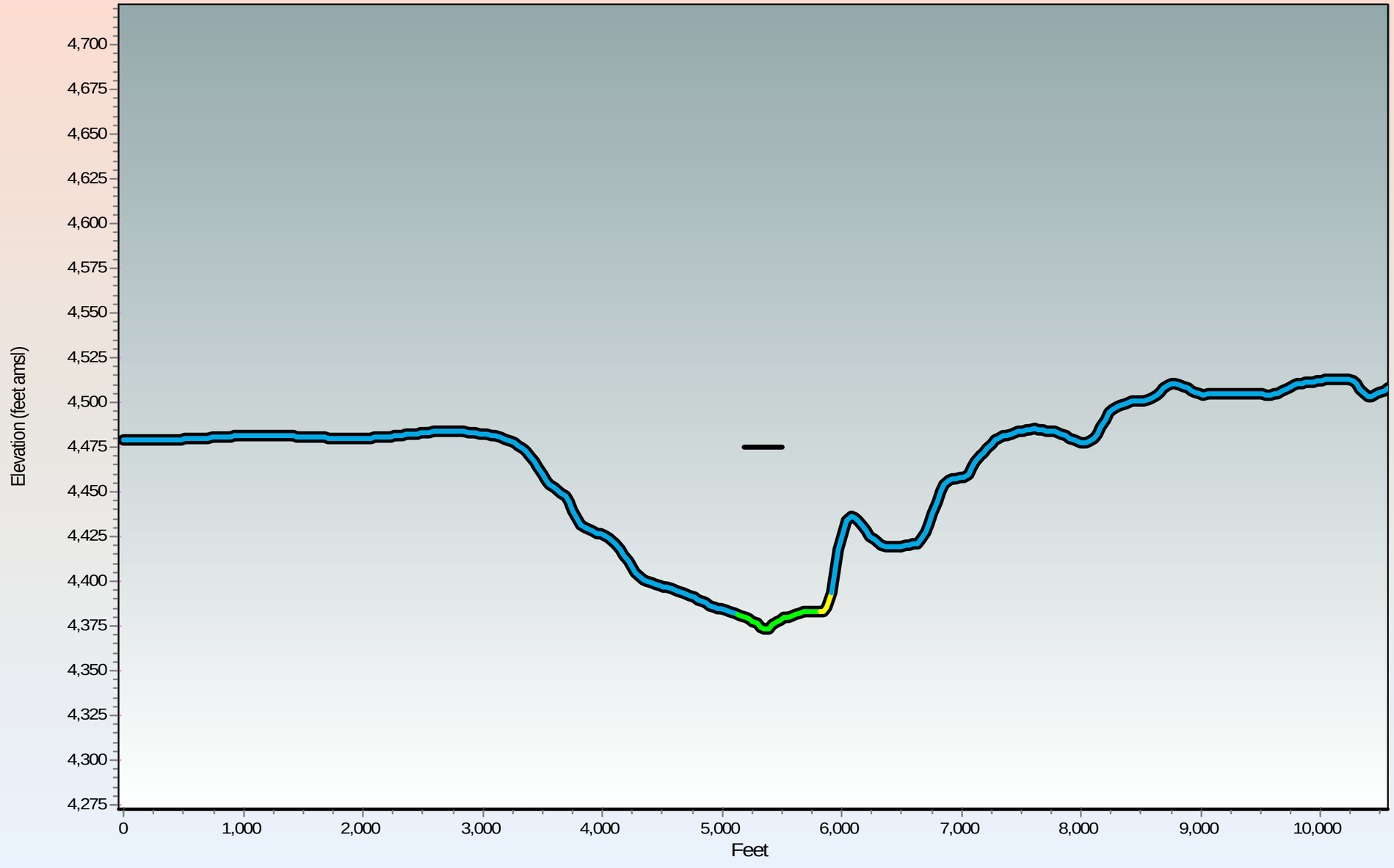
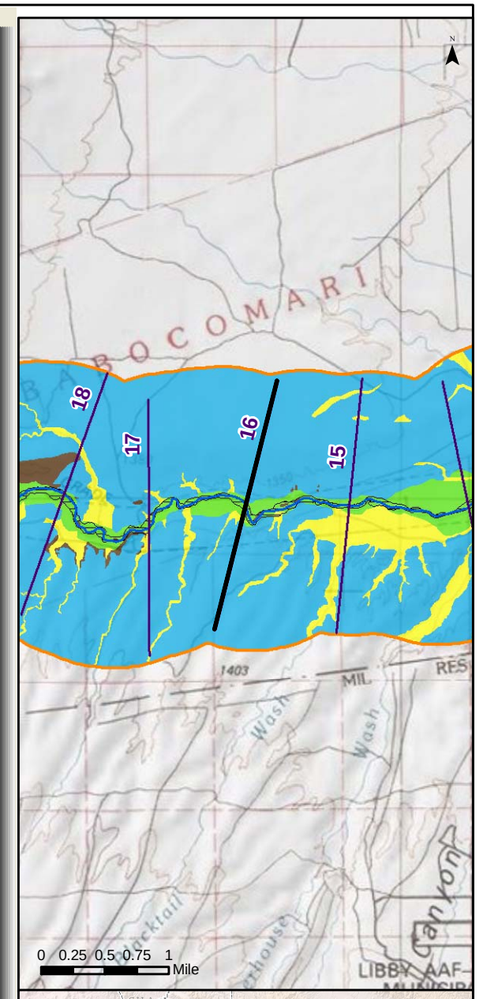
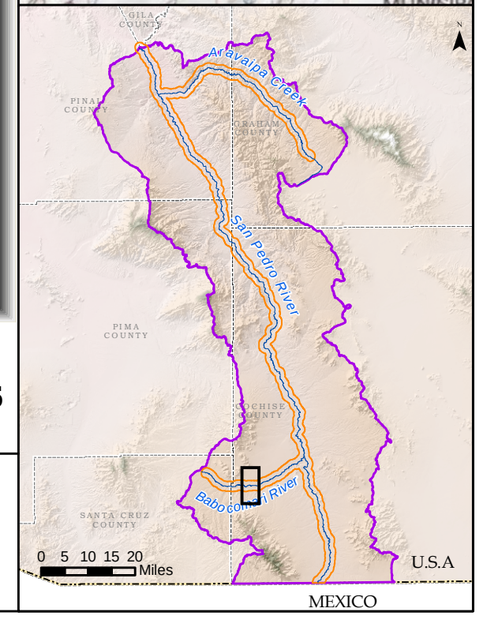
Appendix F
Babocomari River Cross Section at Mile 15
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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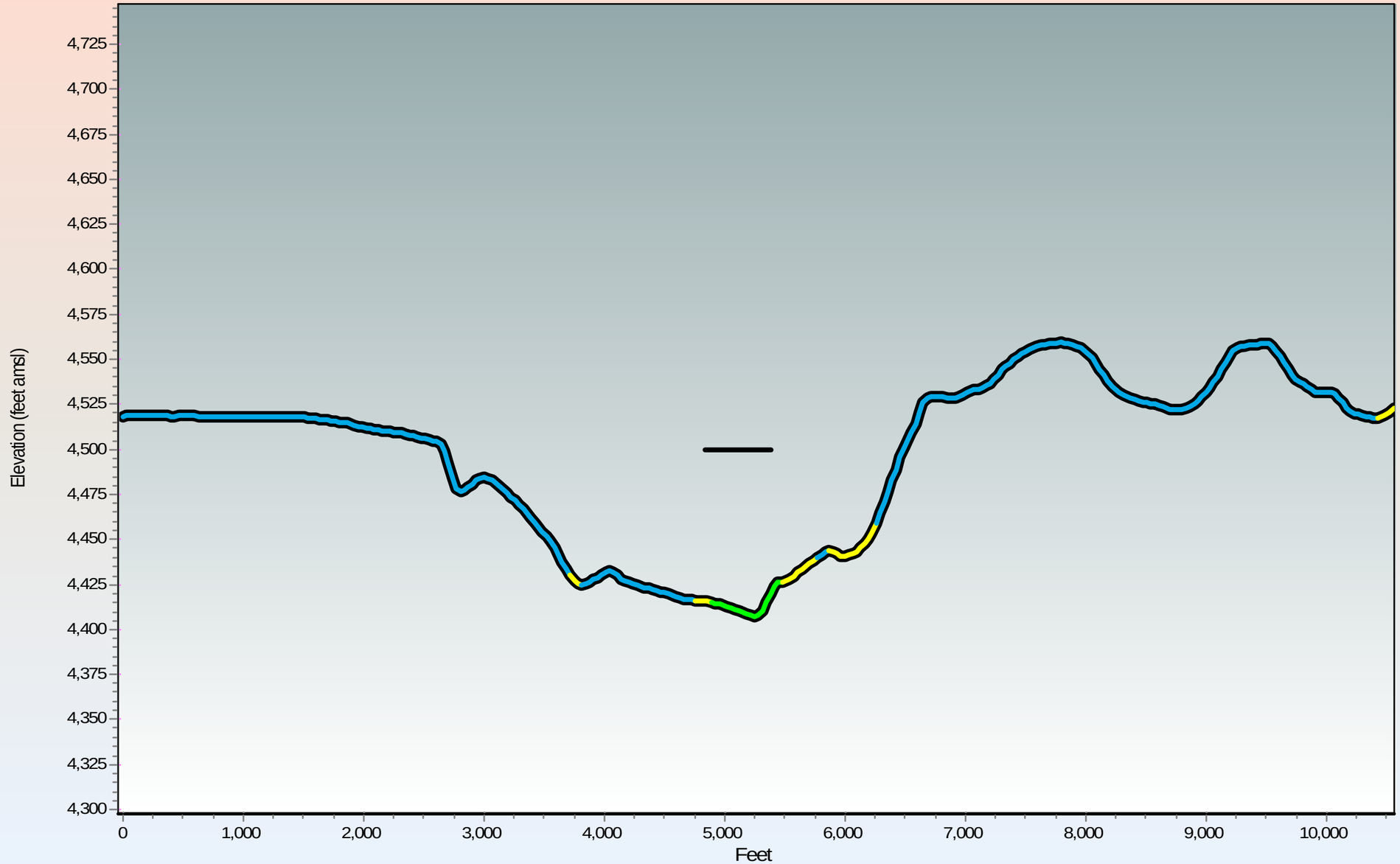
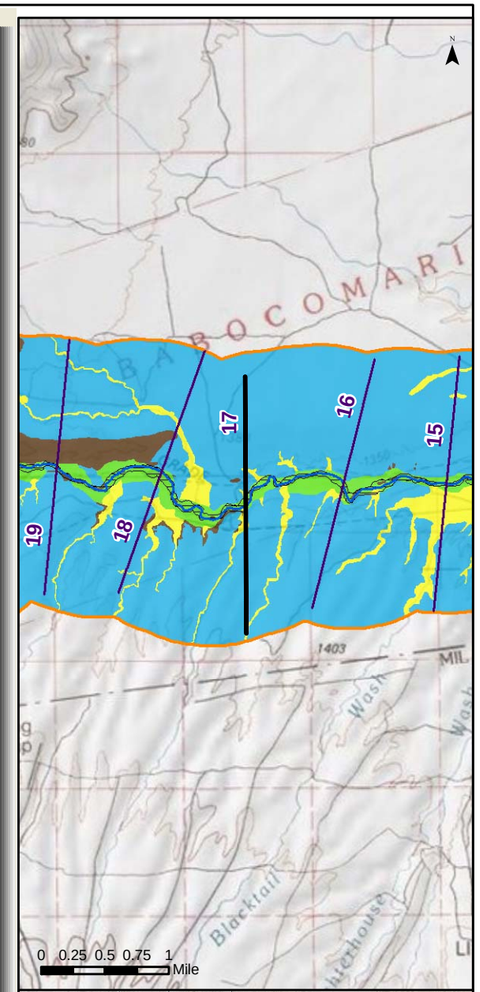
Appendix F

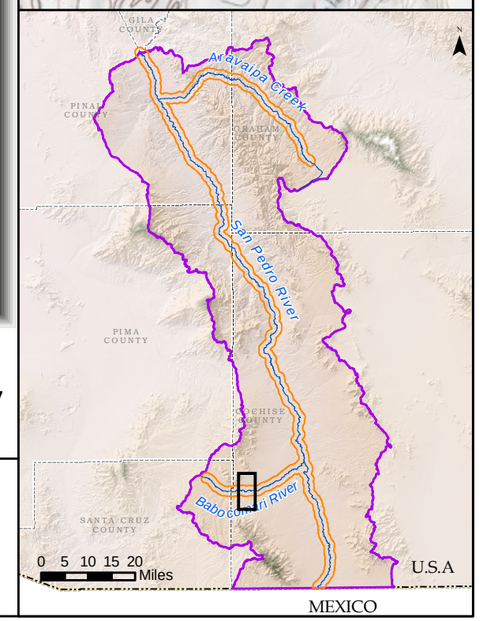
Babocomari River Cross Section at Mile 16

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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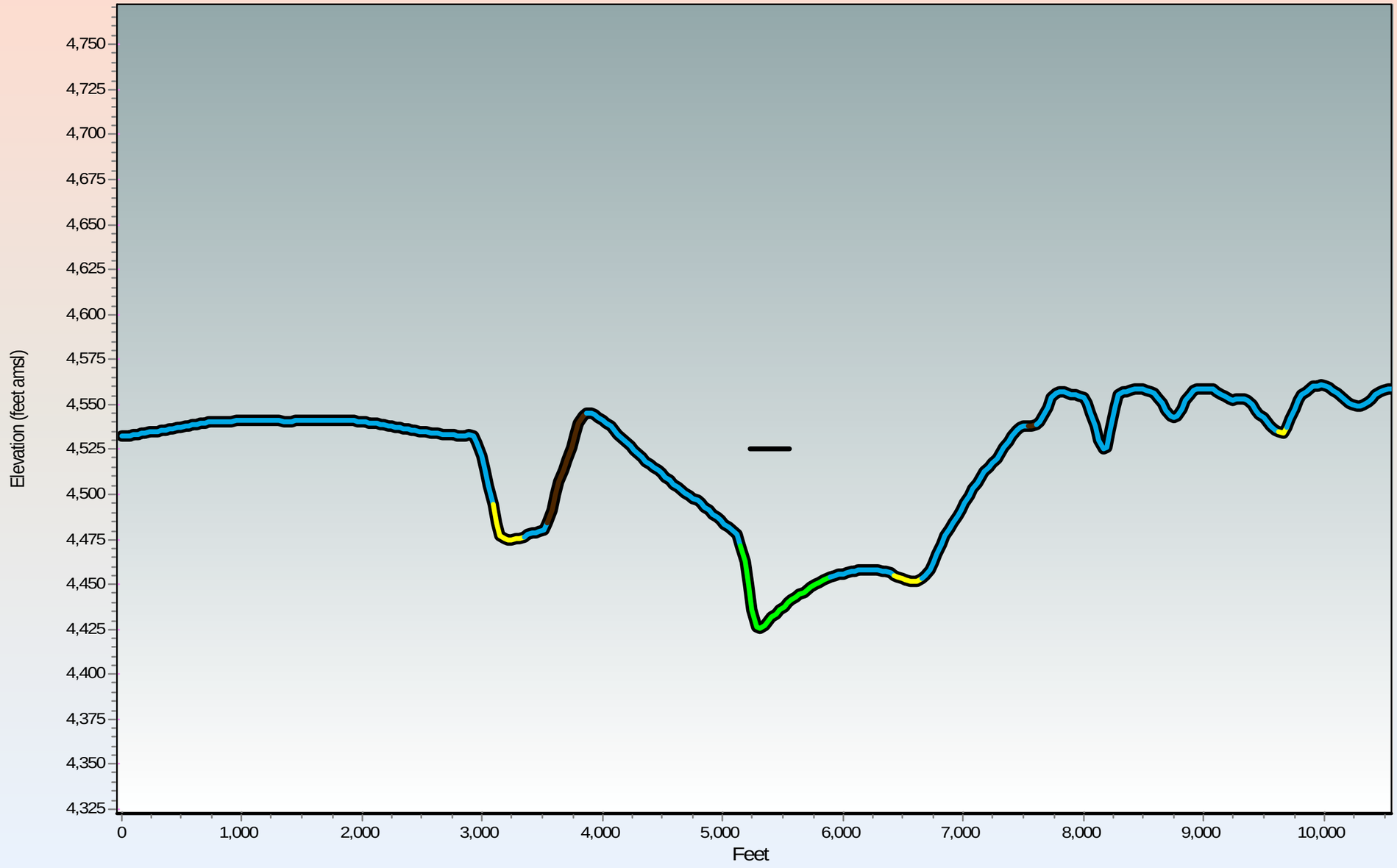
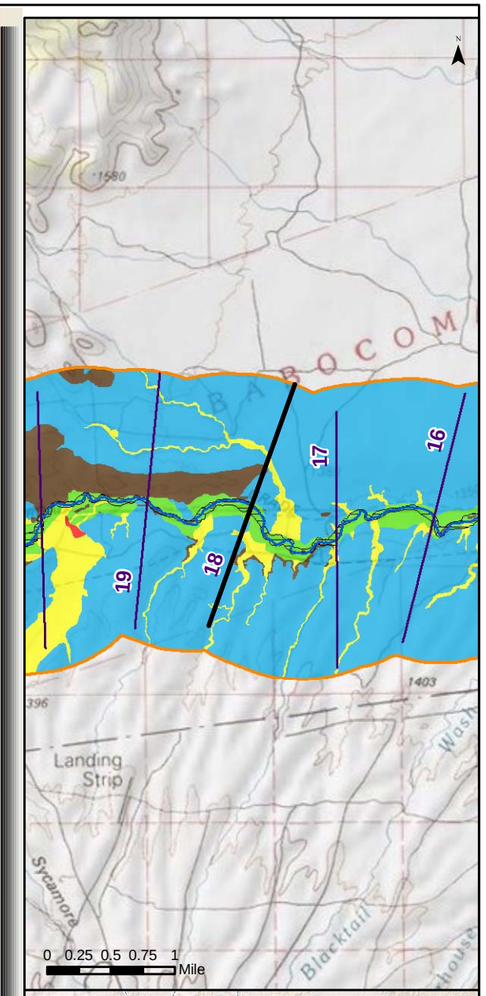
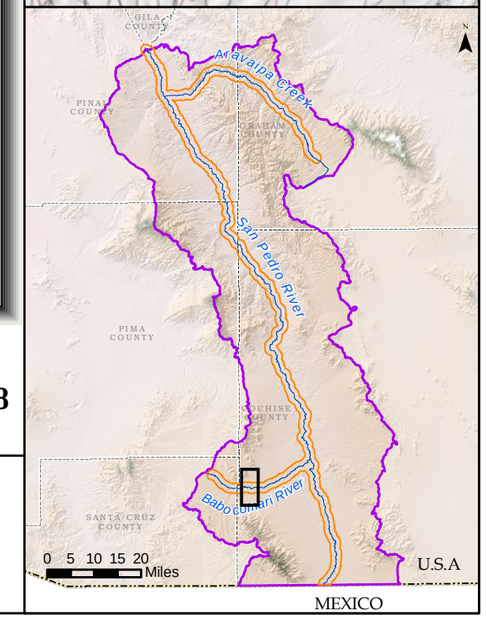
Appendix F
Babocomari River Cross Section at Mile 17
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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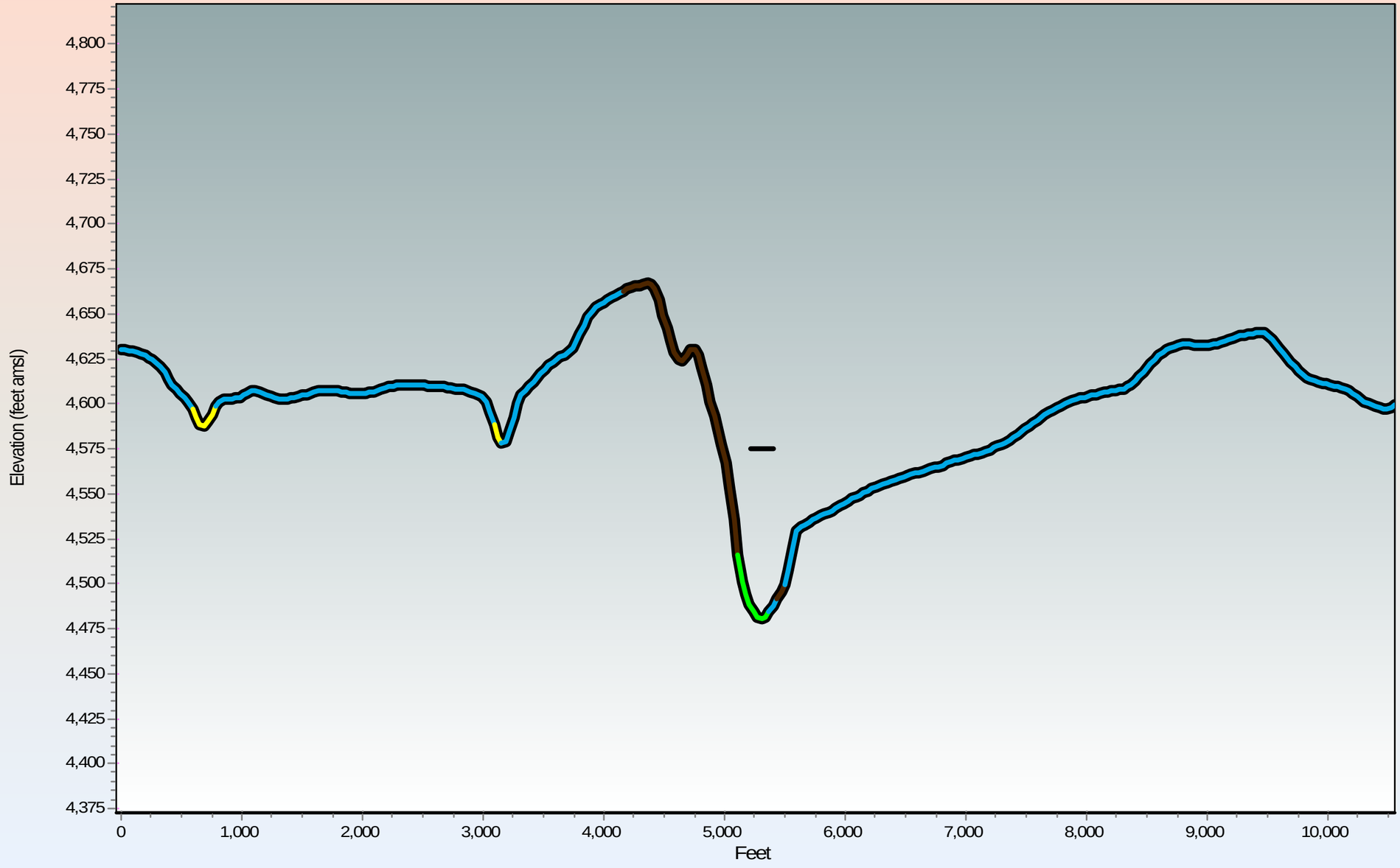
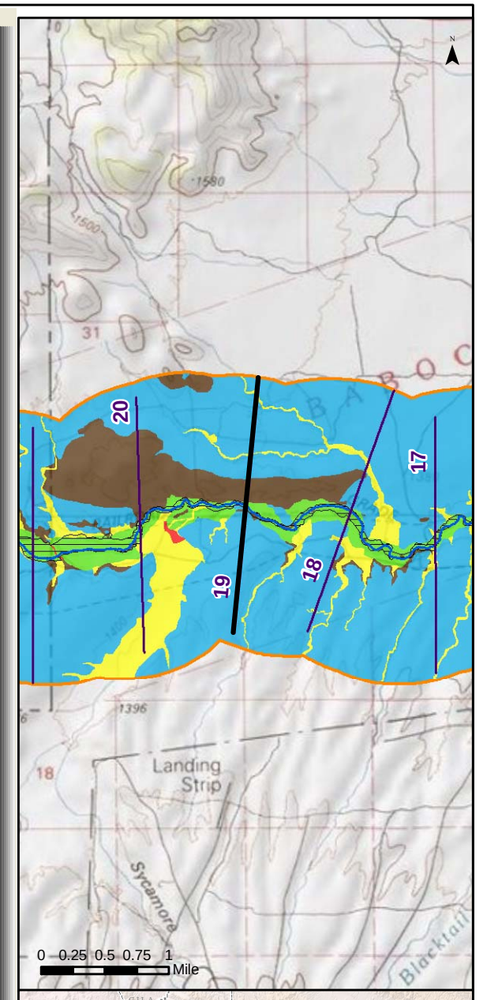
Appendix F

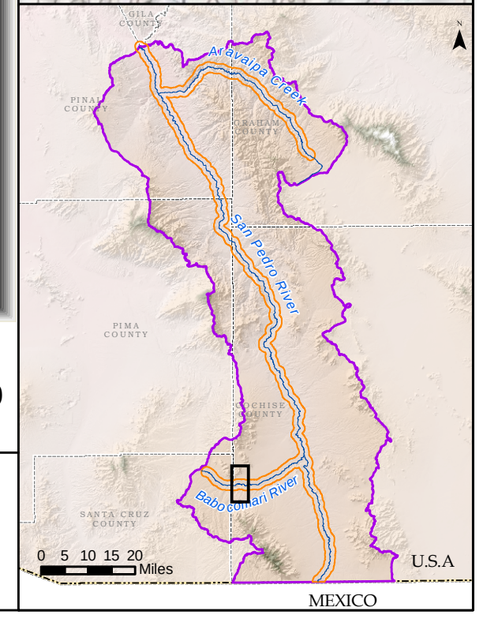
Babocomari River Cross Section at Mile 18

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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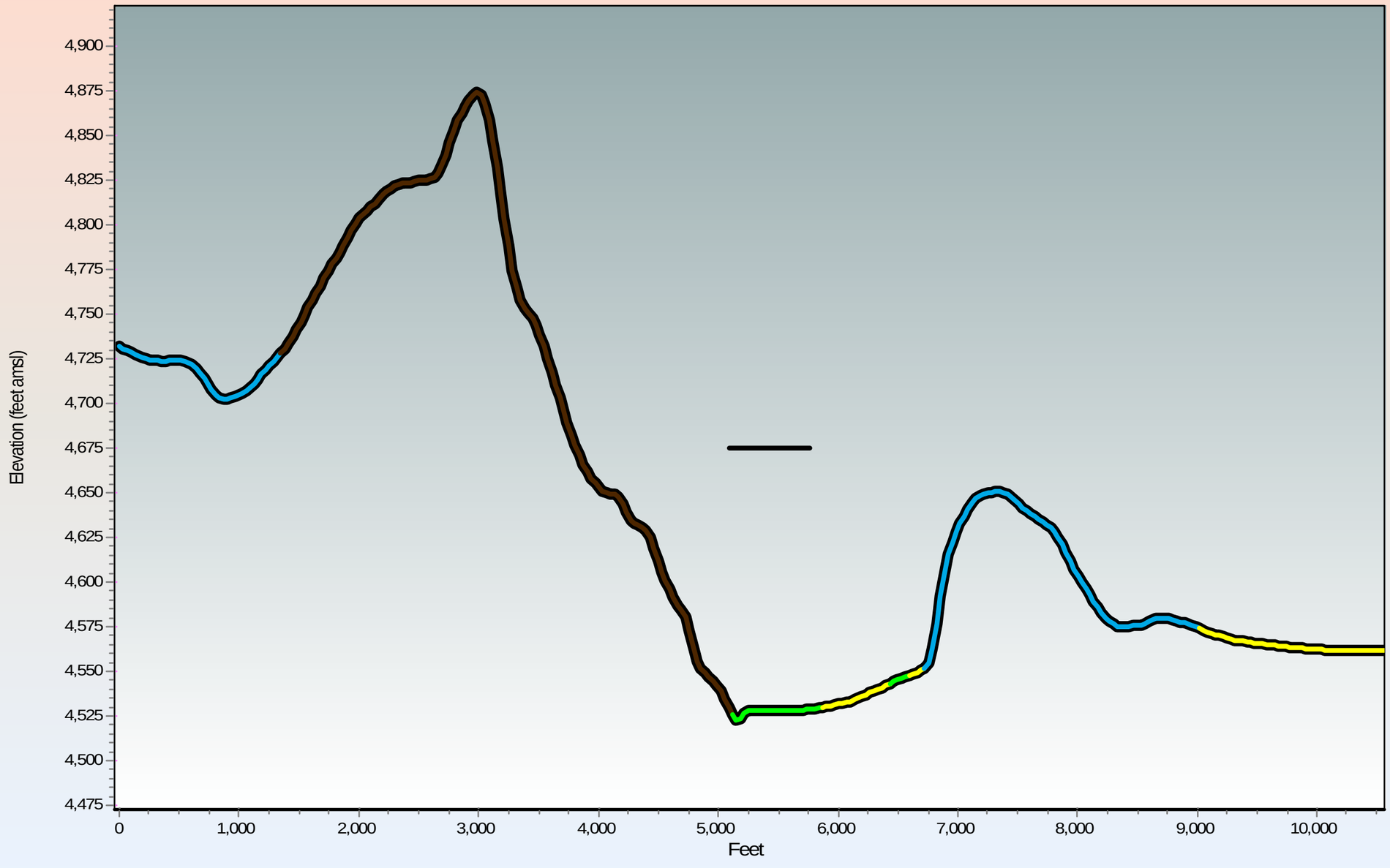
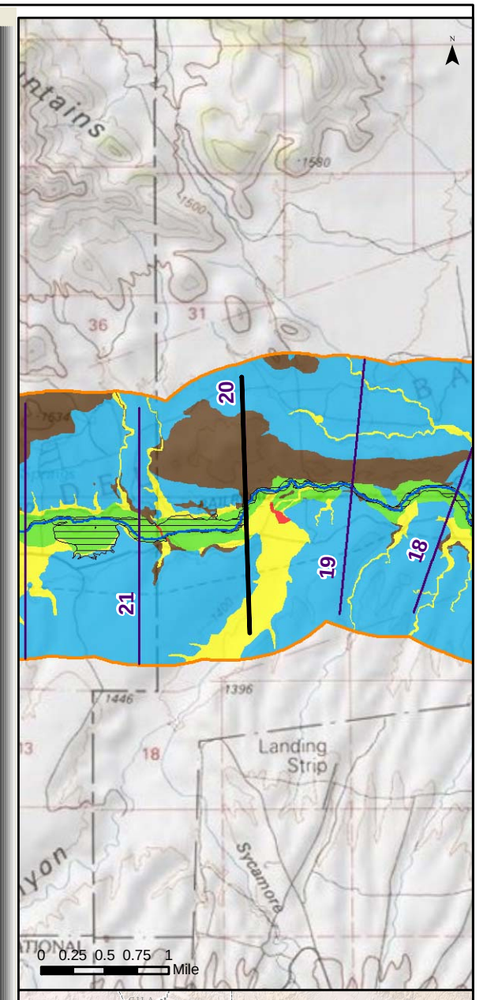
Appendix F

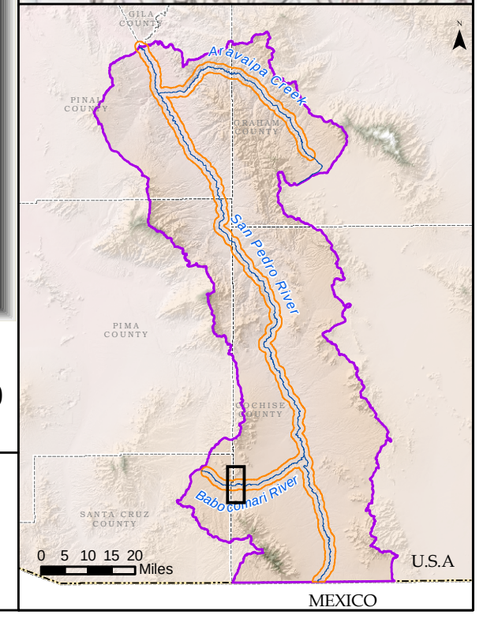
Babocomari River Cross Section at Mile 19

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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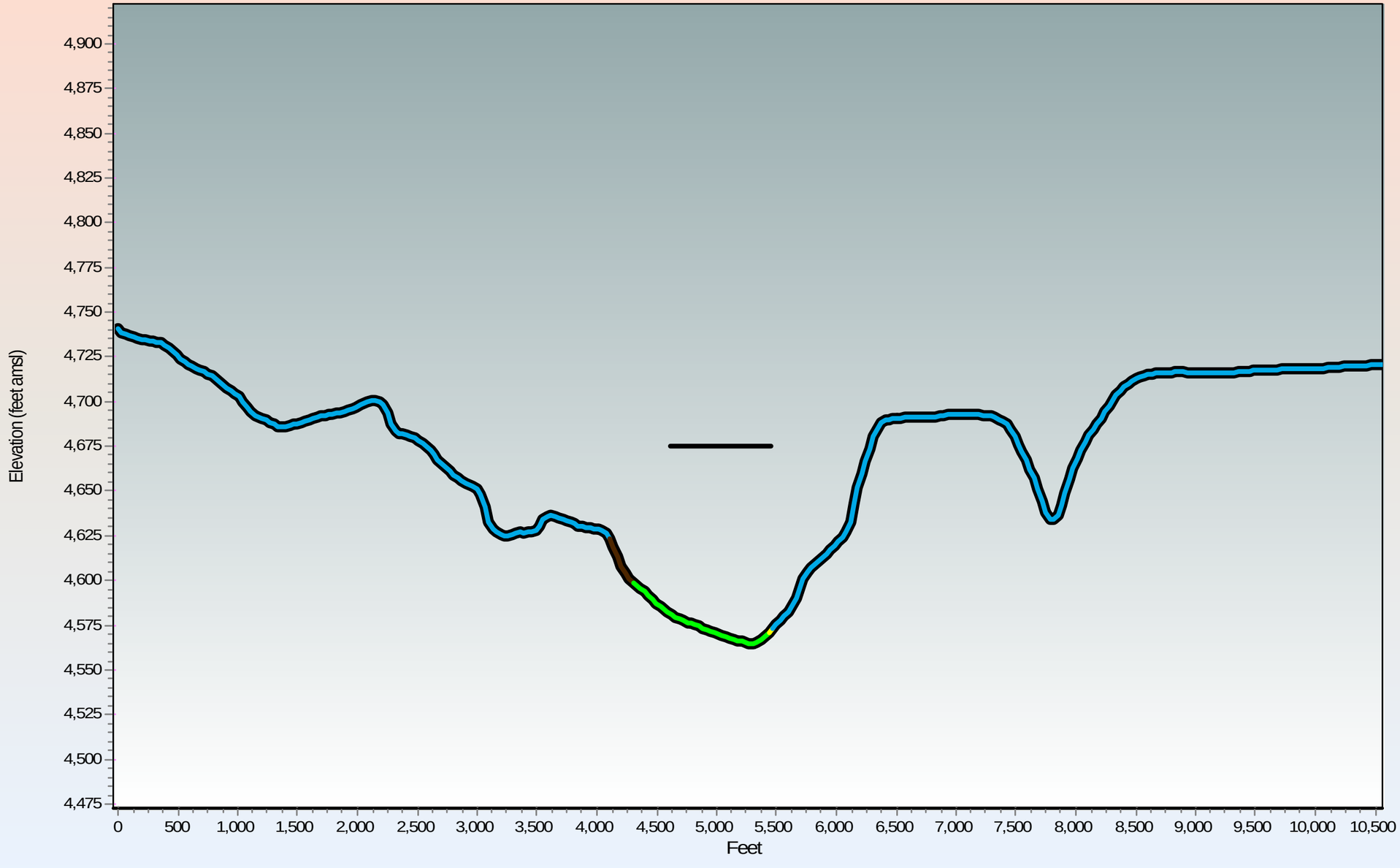
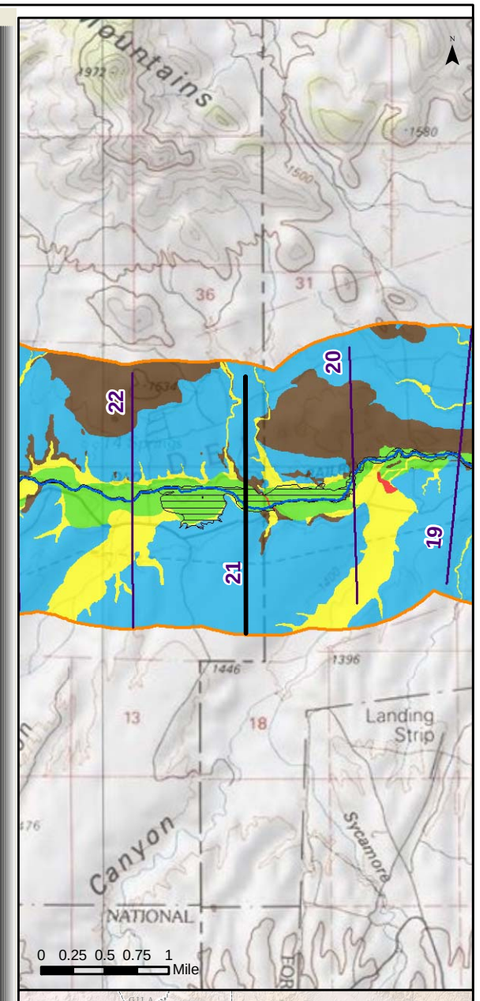
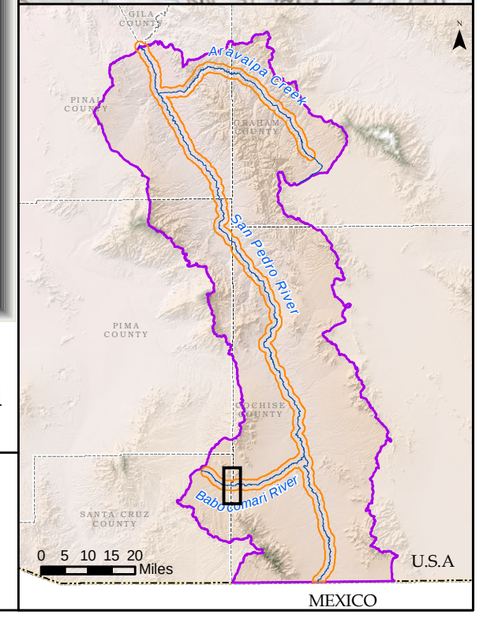
Appendix F
Babocomari River Cross Section at Mile 20
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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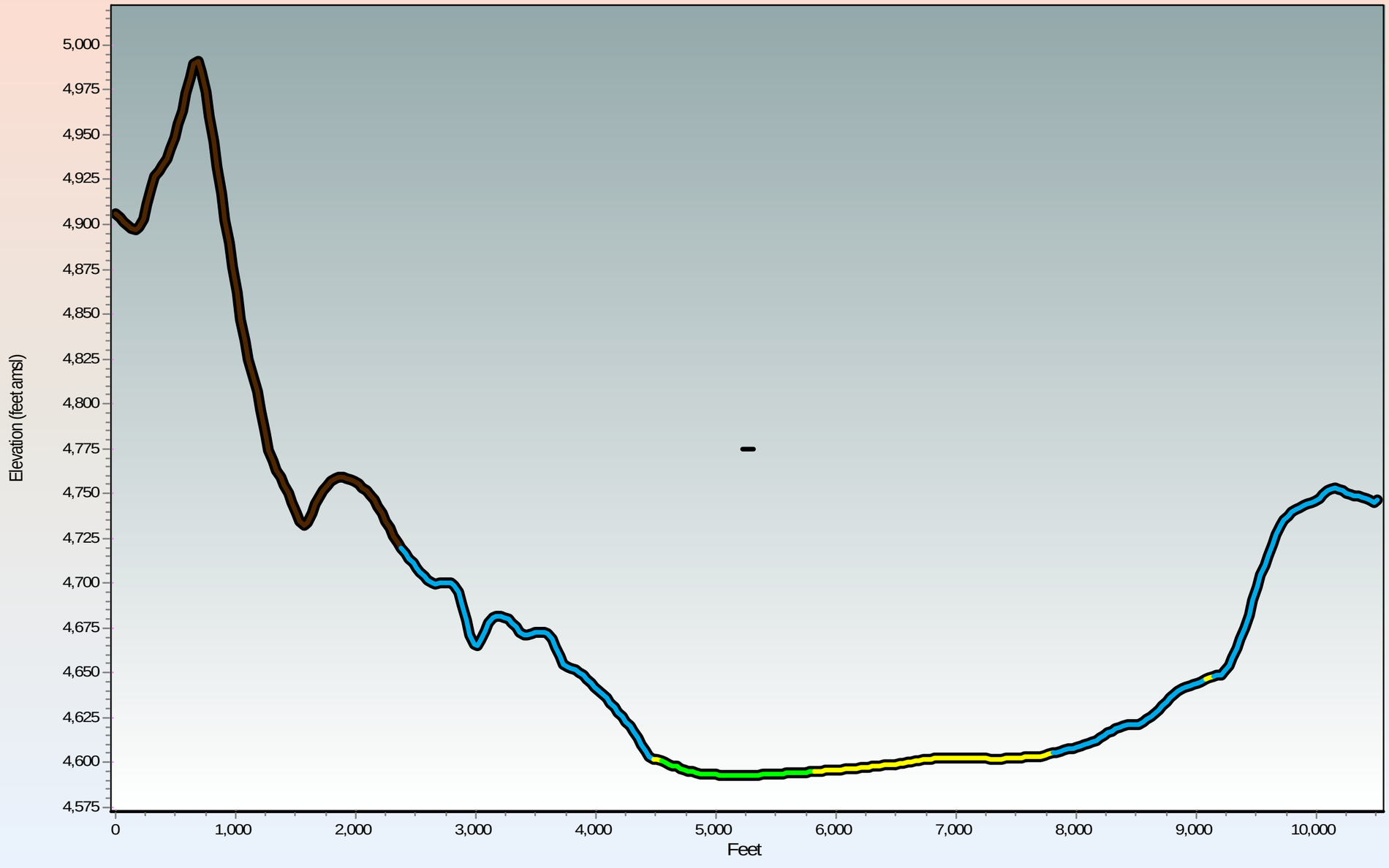
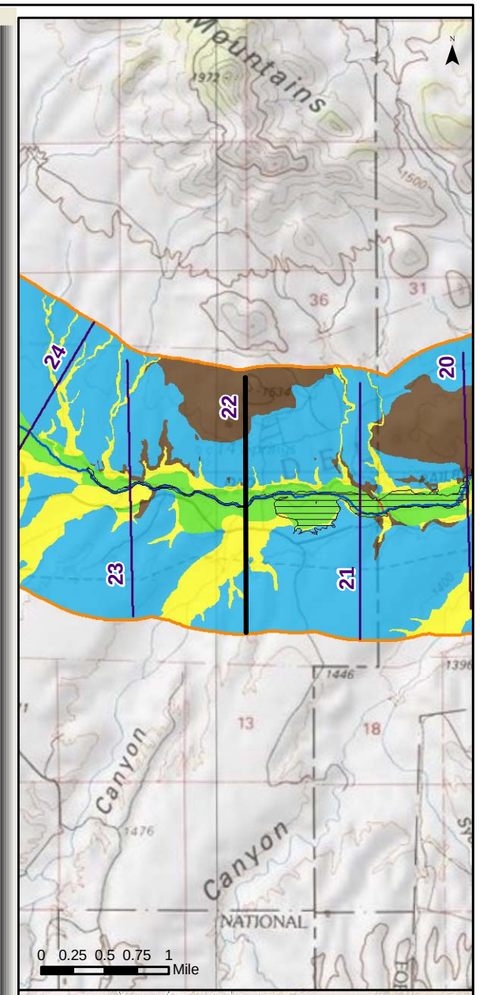
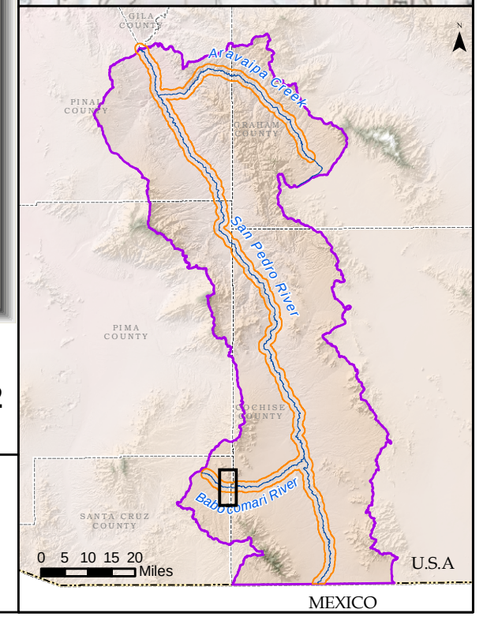
Appendix F
Babocomari River Cross Section at Mile 21
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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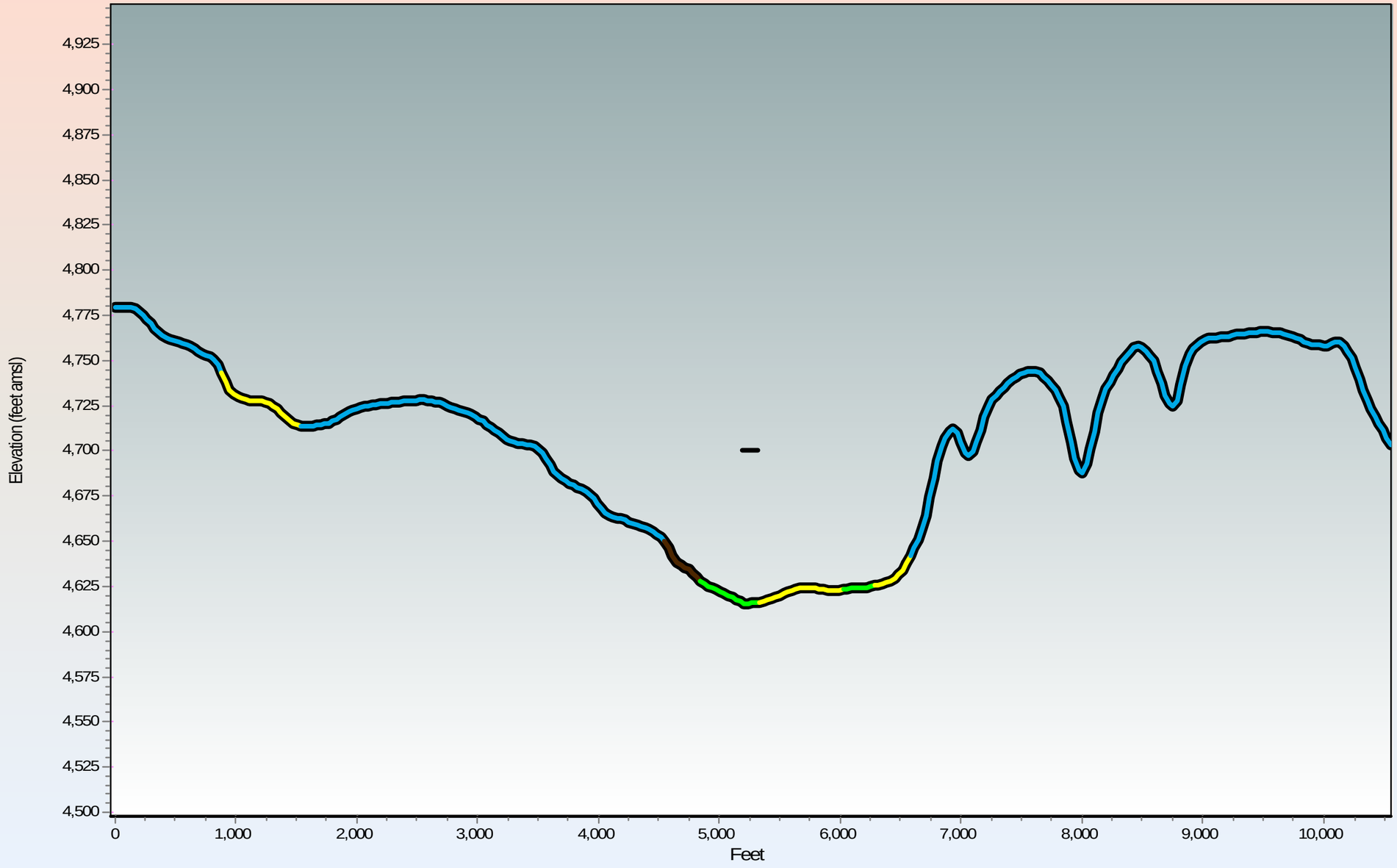
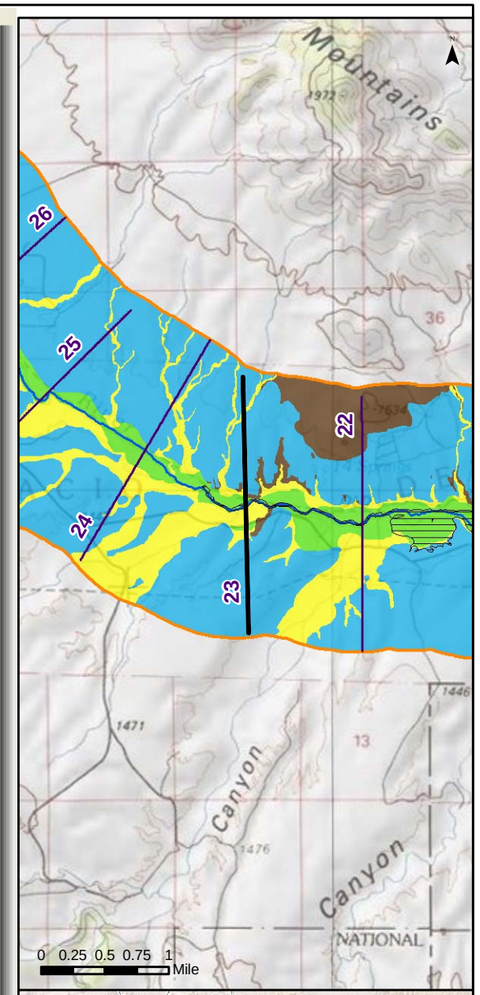
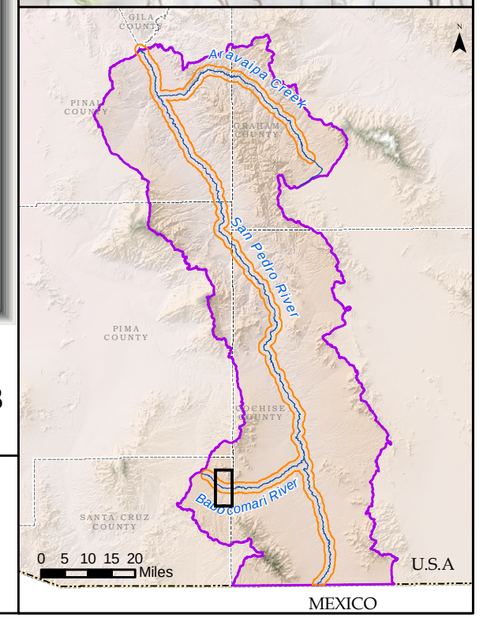
Appendix F
Babocomari River Cross Section at Mile 22
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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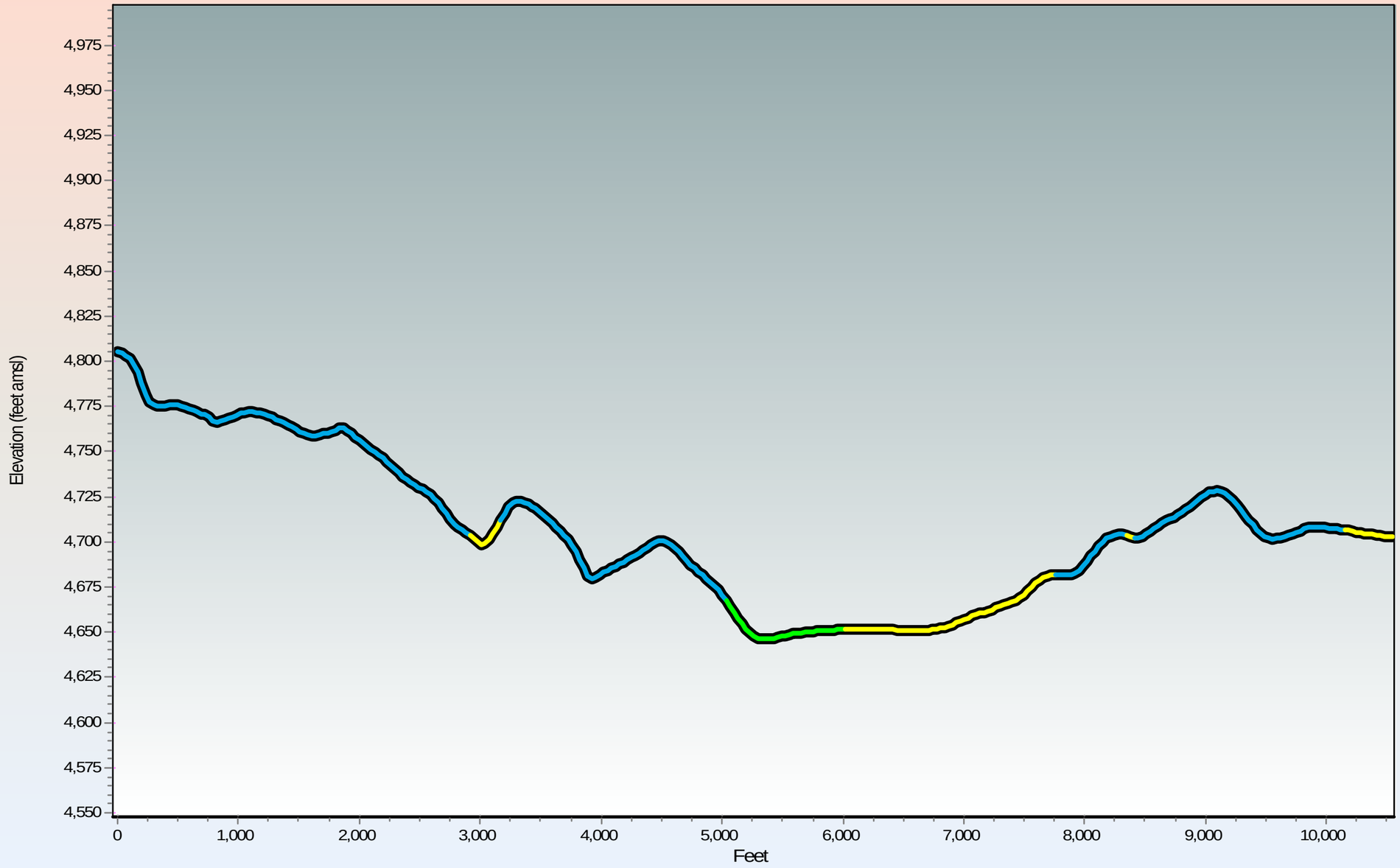
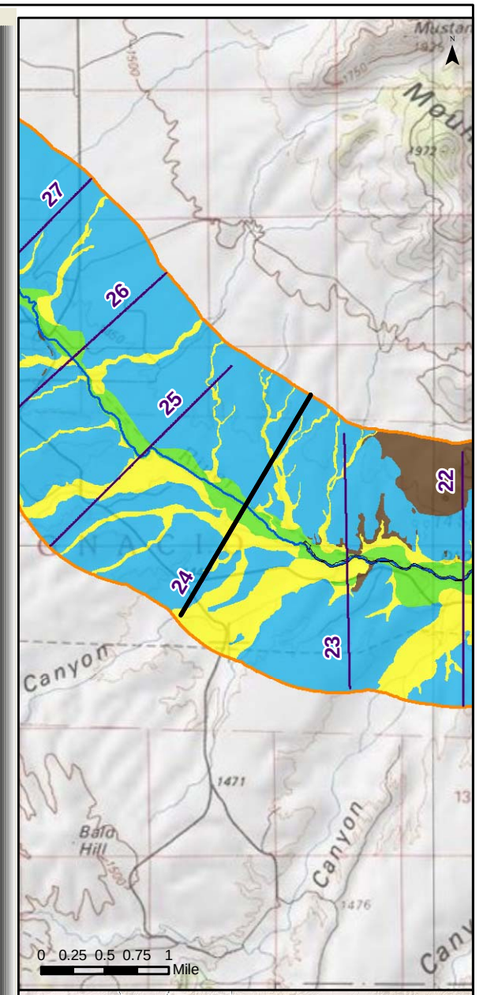
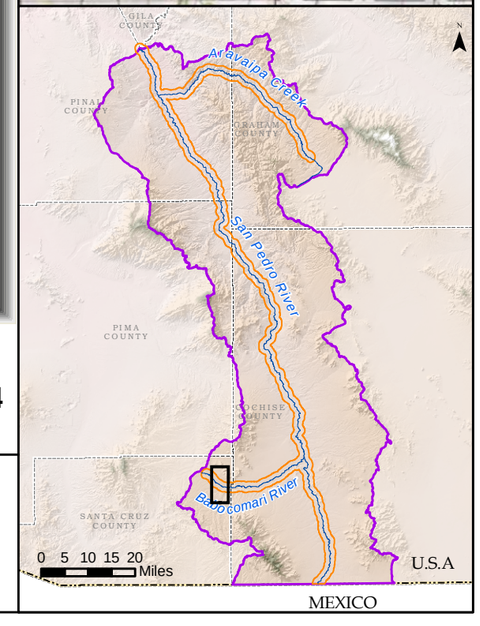
Appendix F
Babocomari River Cross Section at Mile 23
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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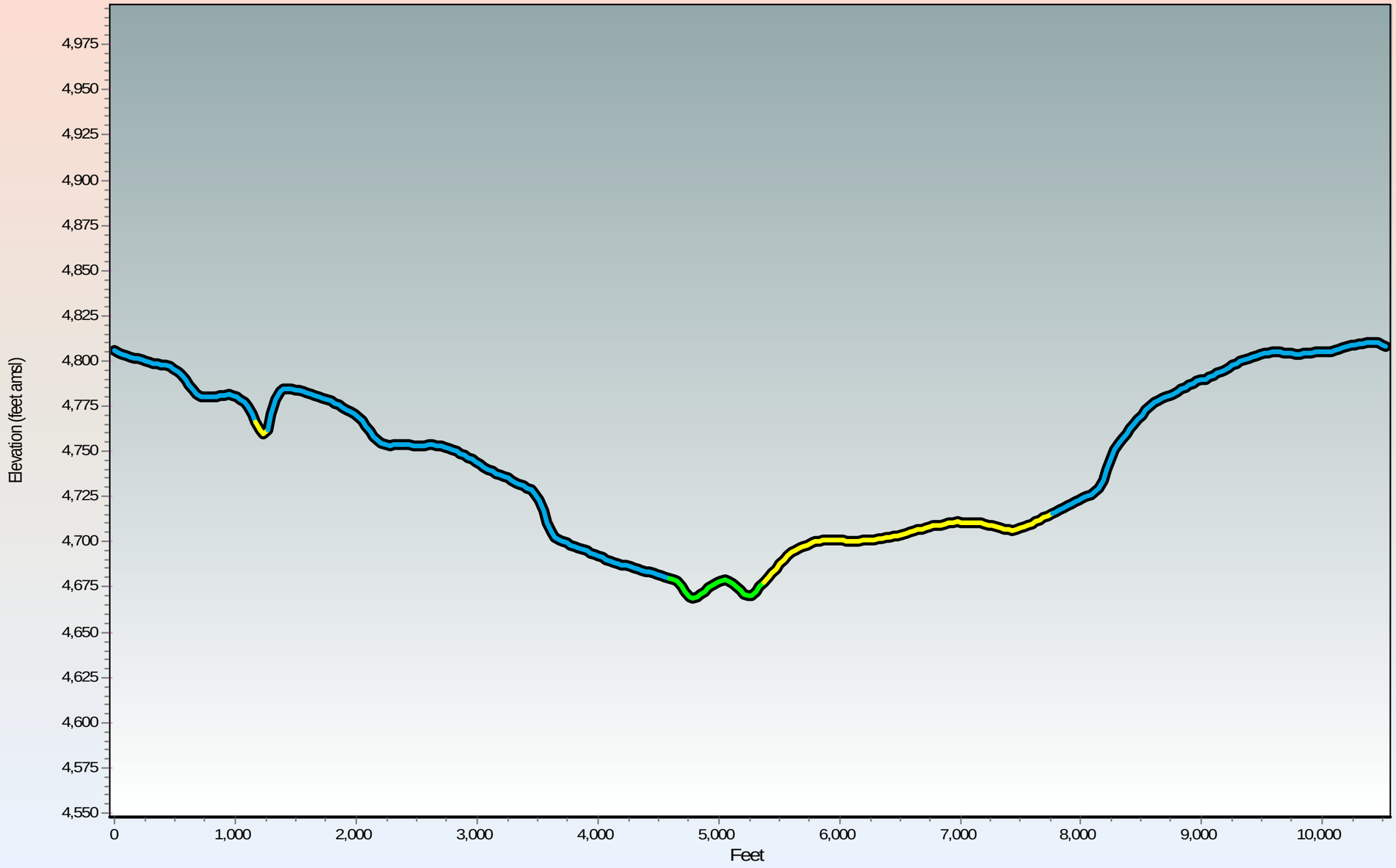
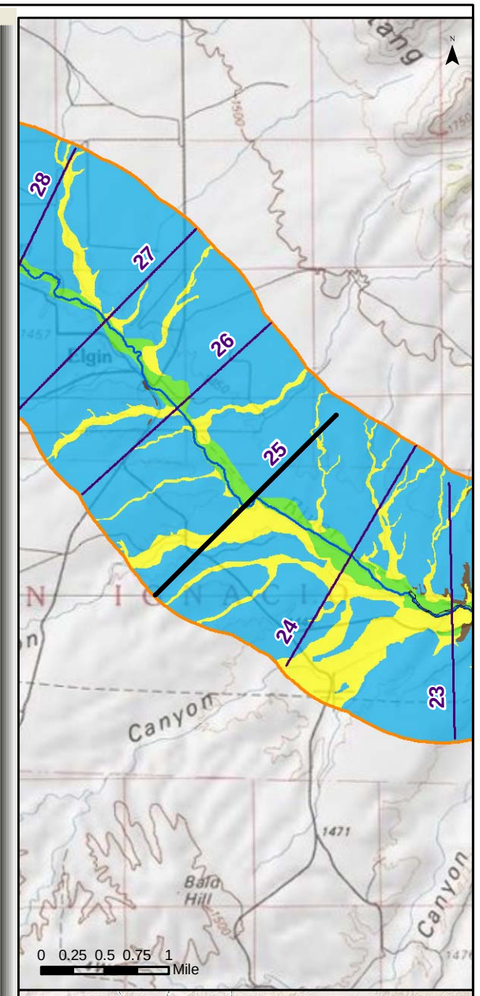
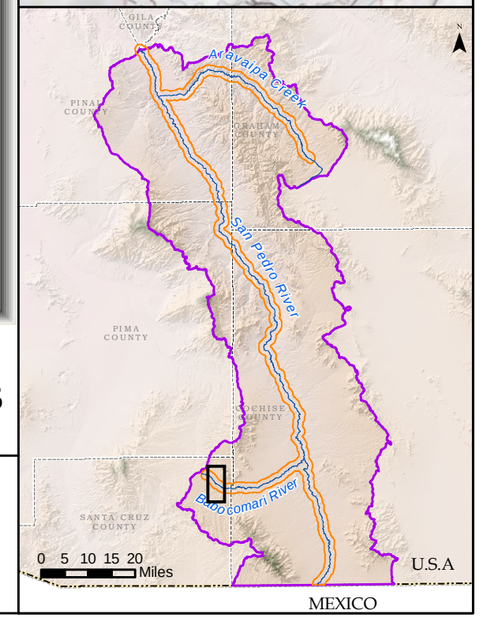
Appendix F
Babocomari River Cross Section at Mile 24
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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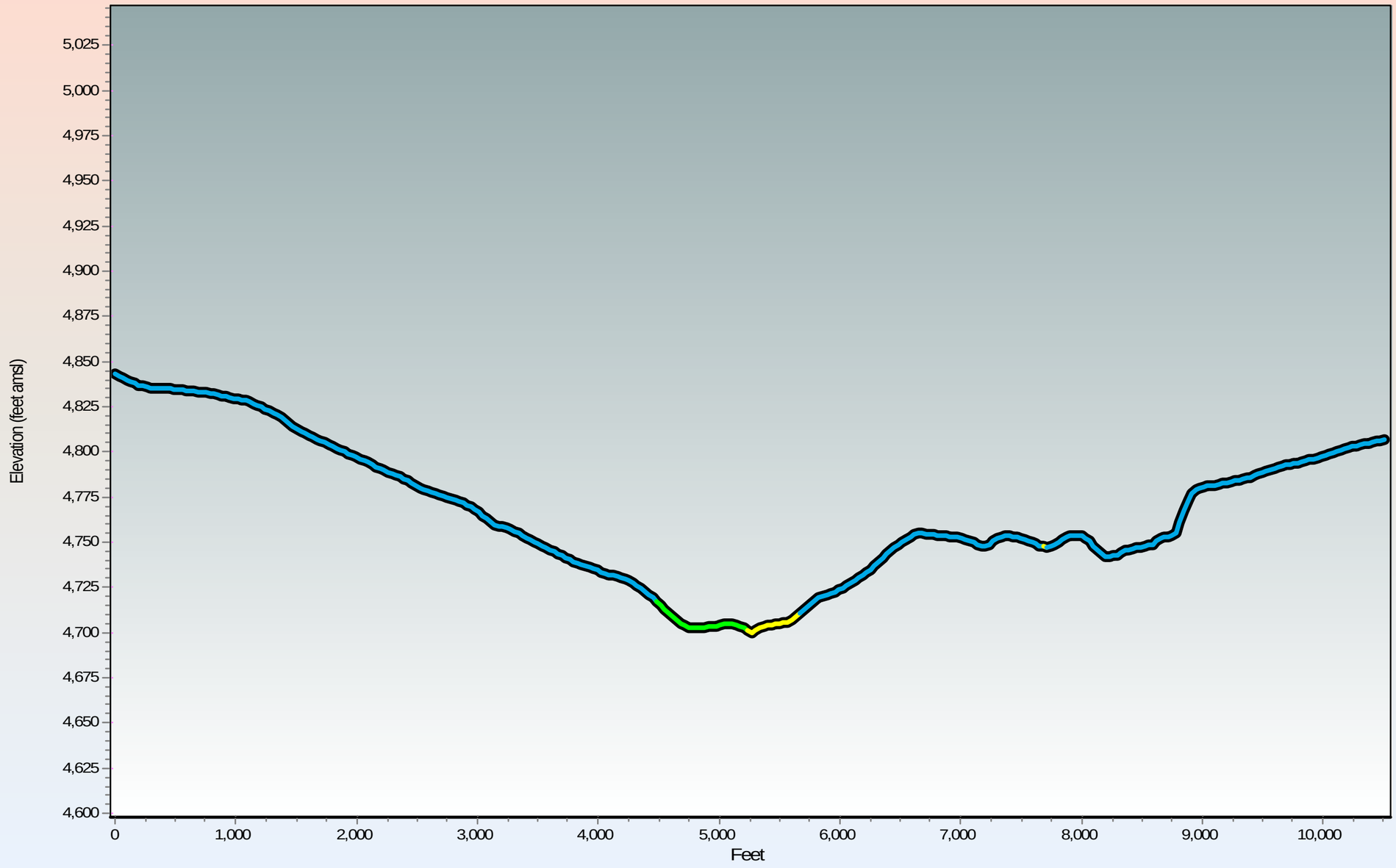
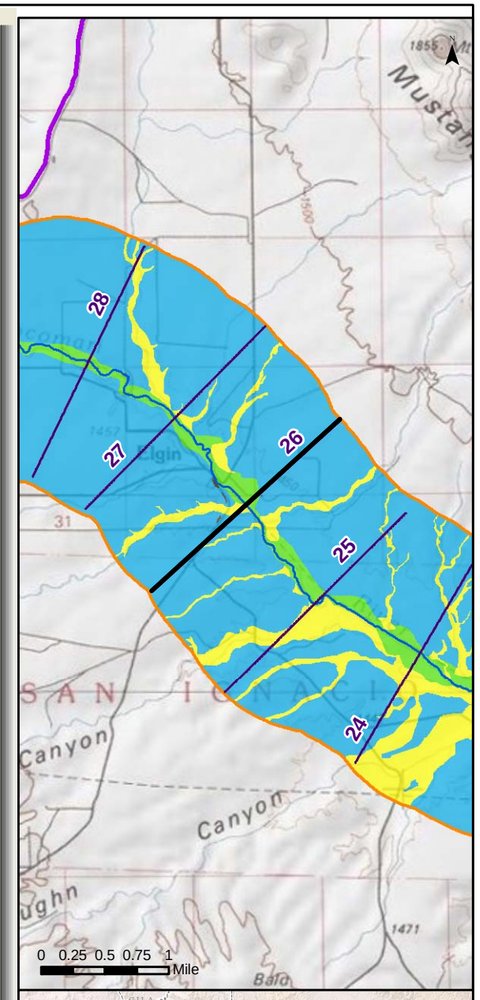
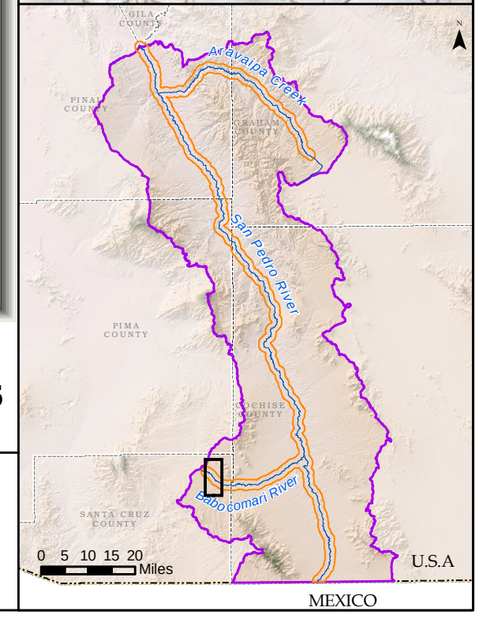
Appendix F
Babocomari River Cross Section at Mile 25
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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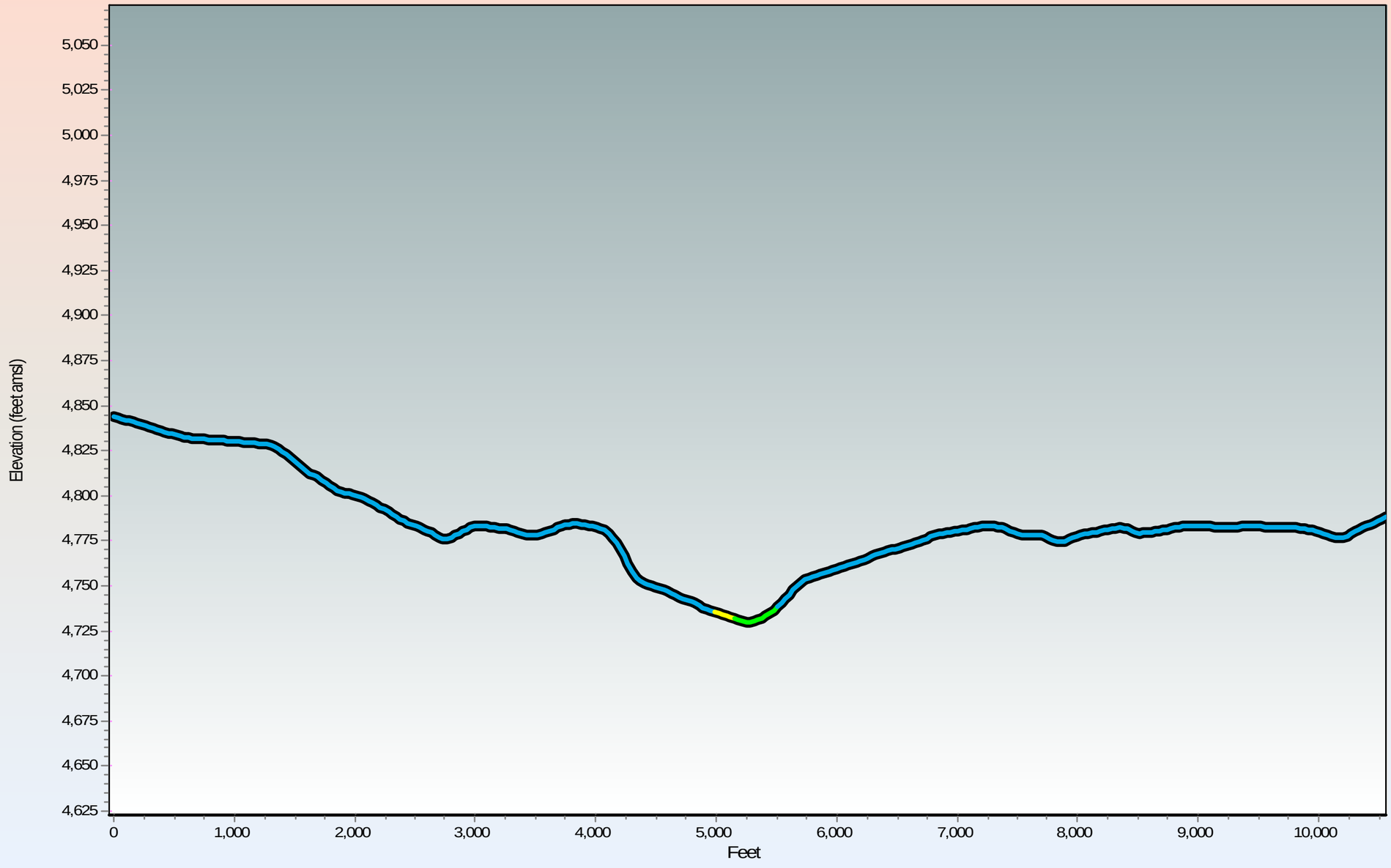
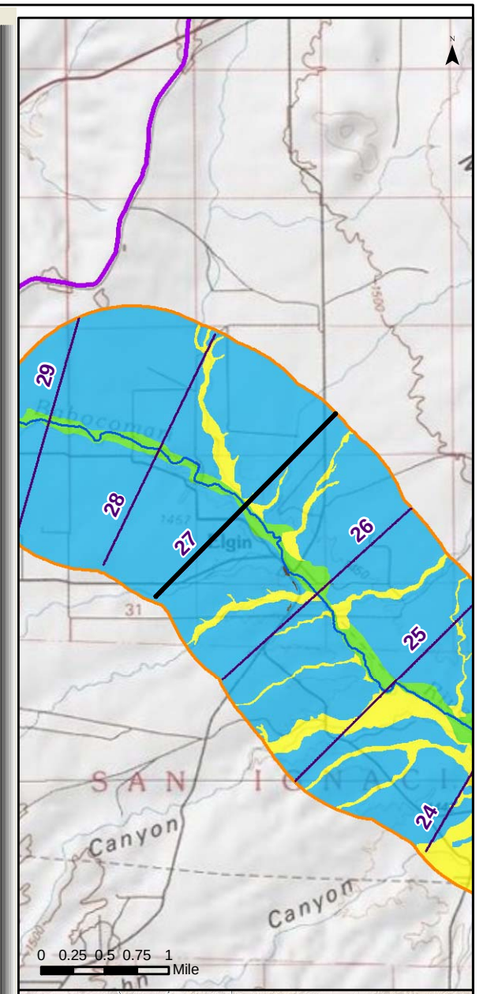
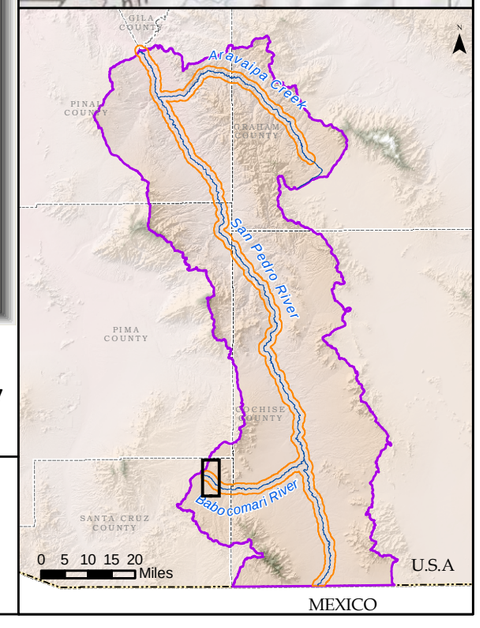
Appendix F
Babocomari River Cross Section at Mile 26
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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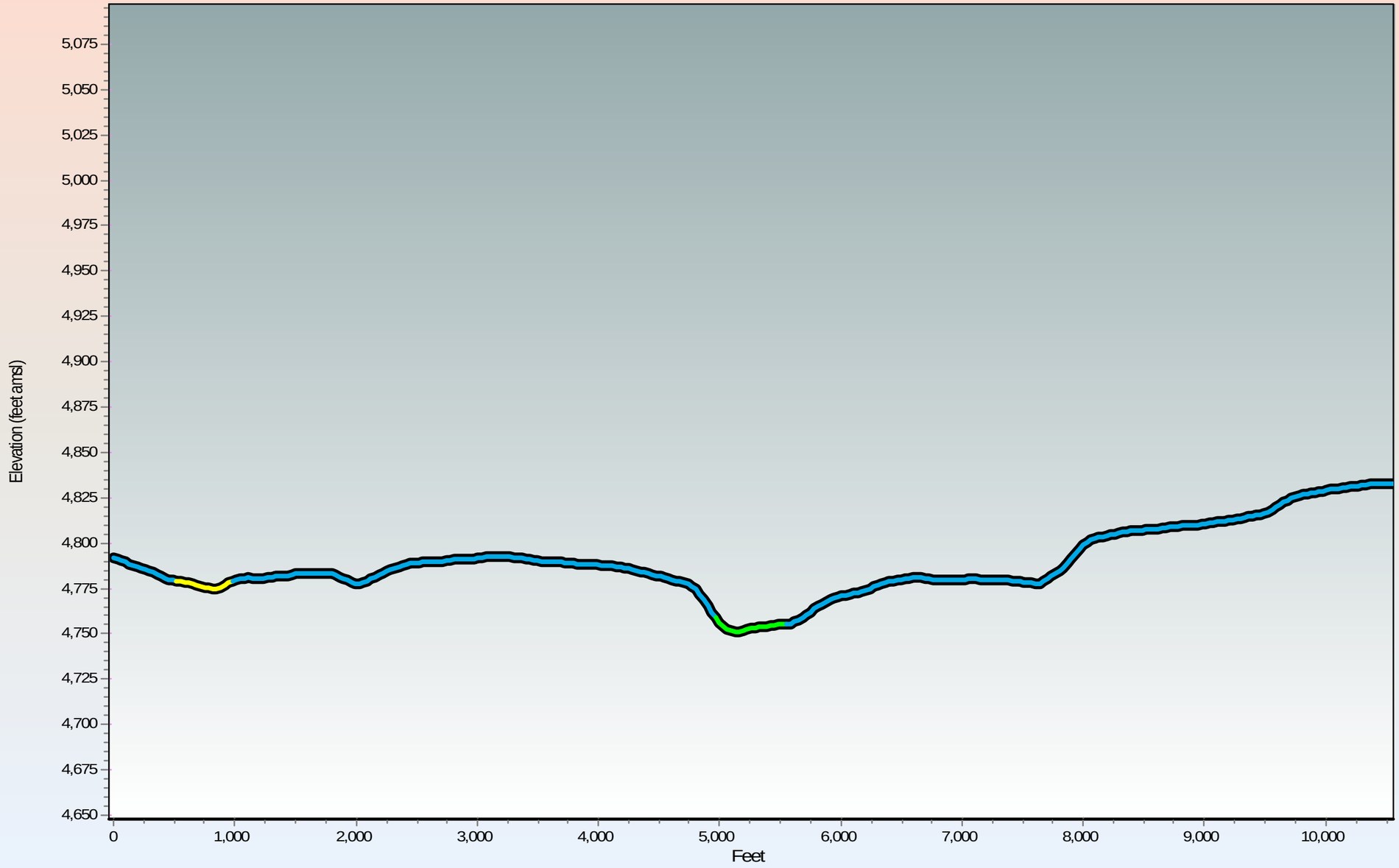
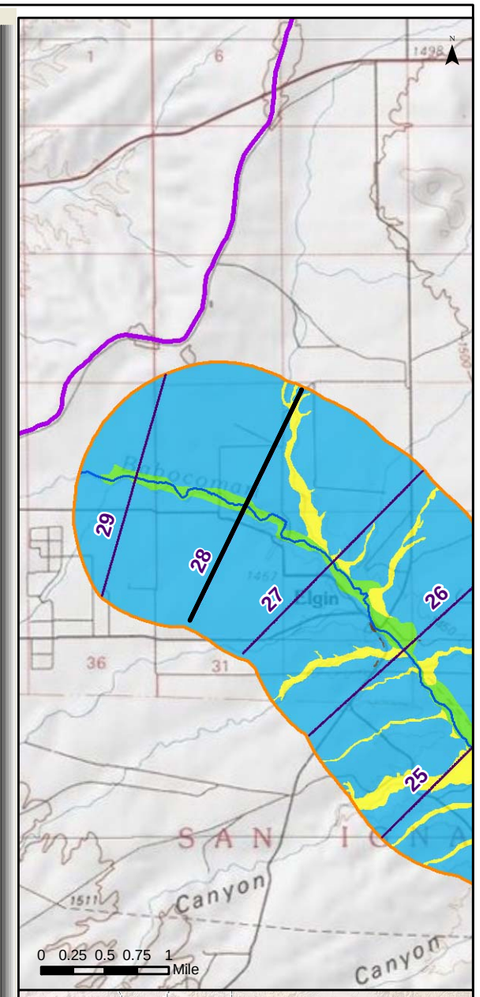
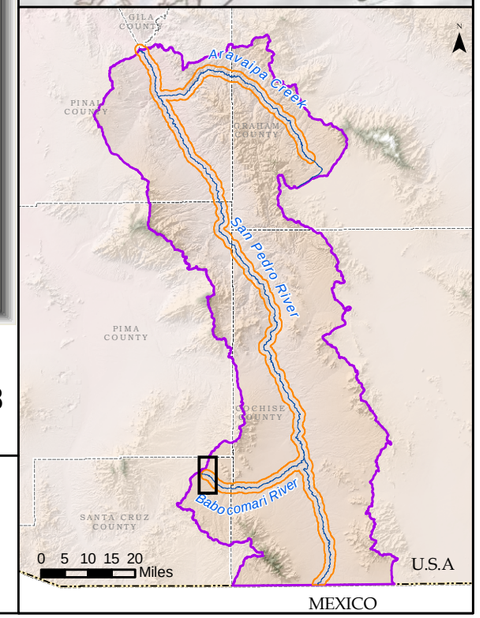
Appendix F
Babocomari River Cross Section at Mile 27
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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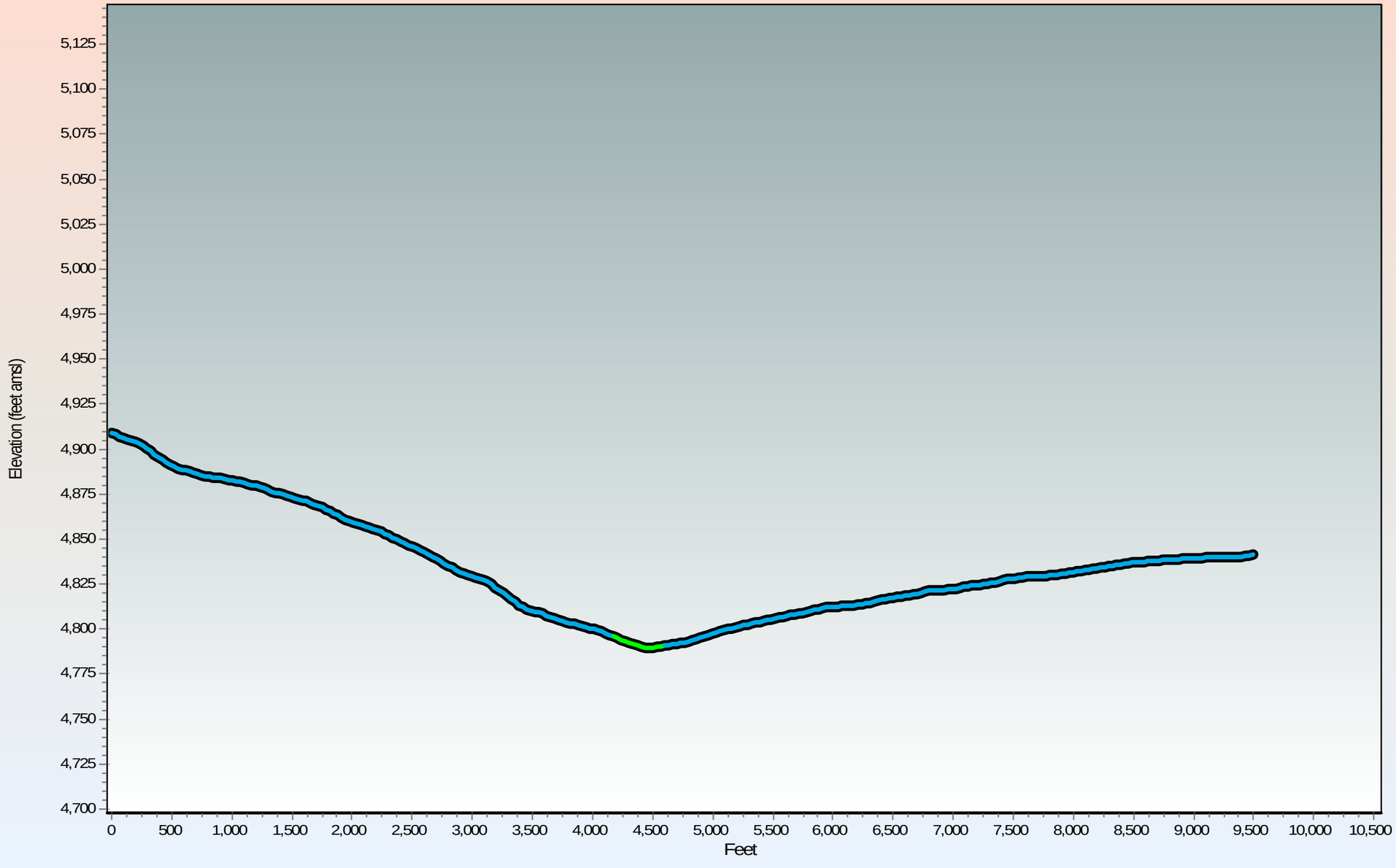
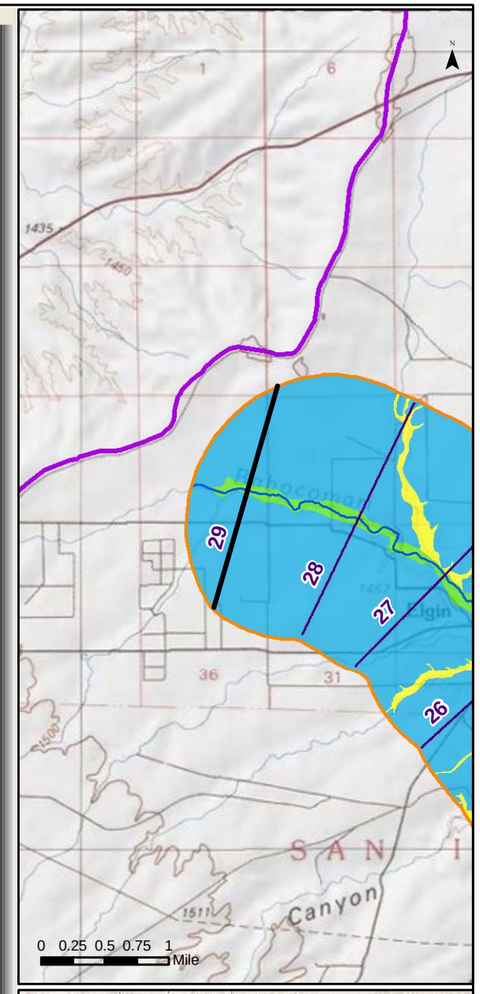
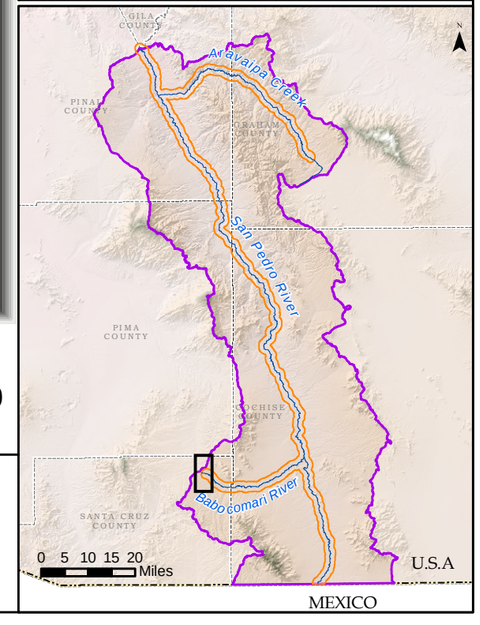
Appendix F
Babocomari River Cross Section at Mile 28
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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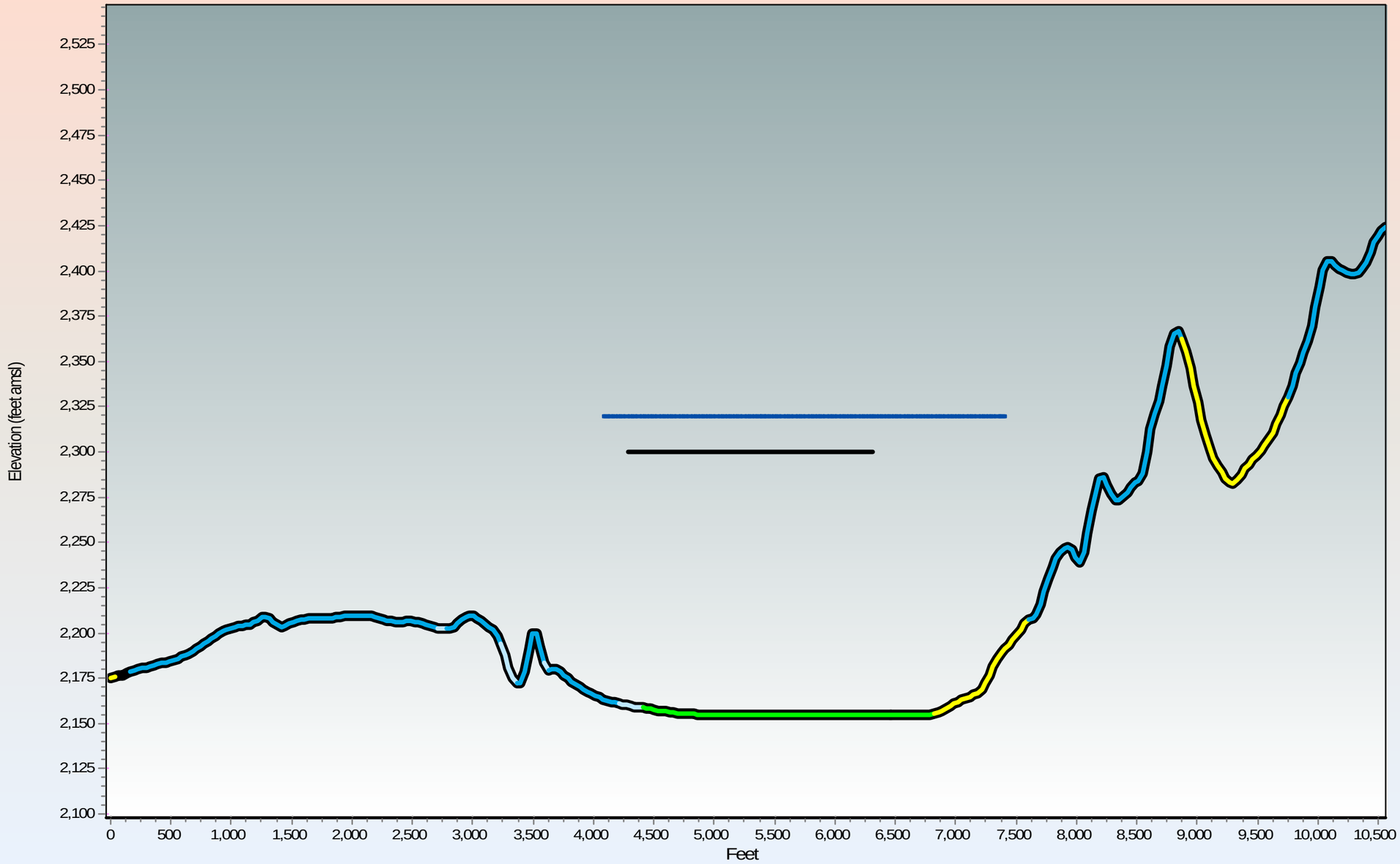
Appendix F

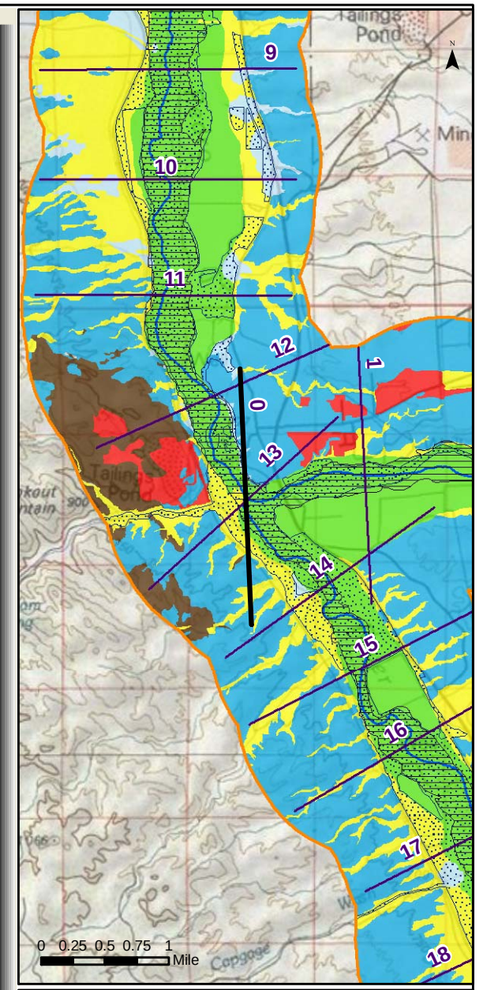
Babocomari River Cross Section at Mile 29

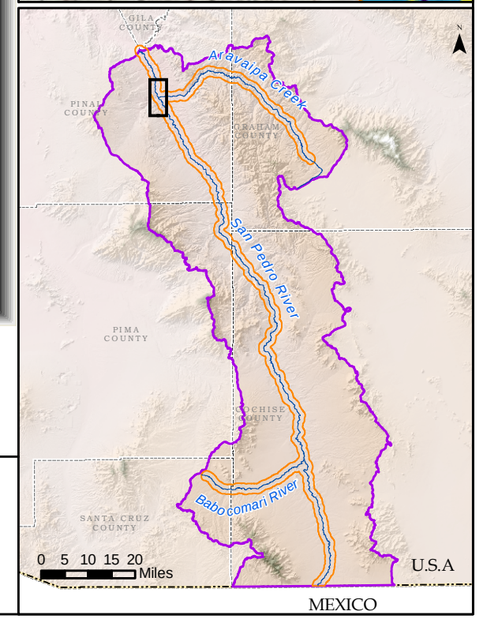
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

Aravaipa Creek Cross Sections







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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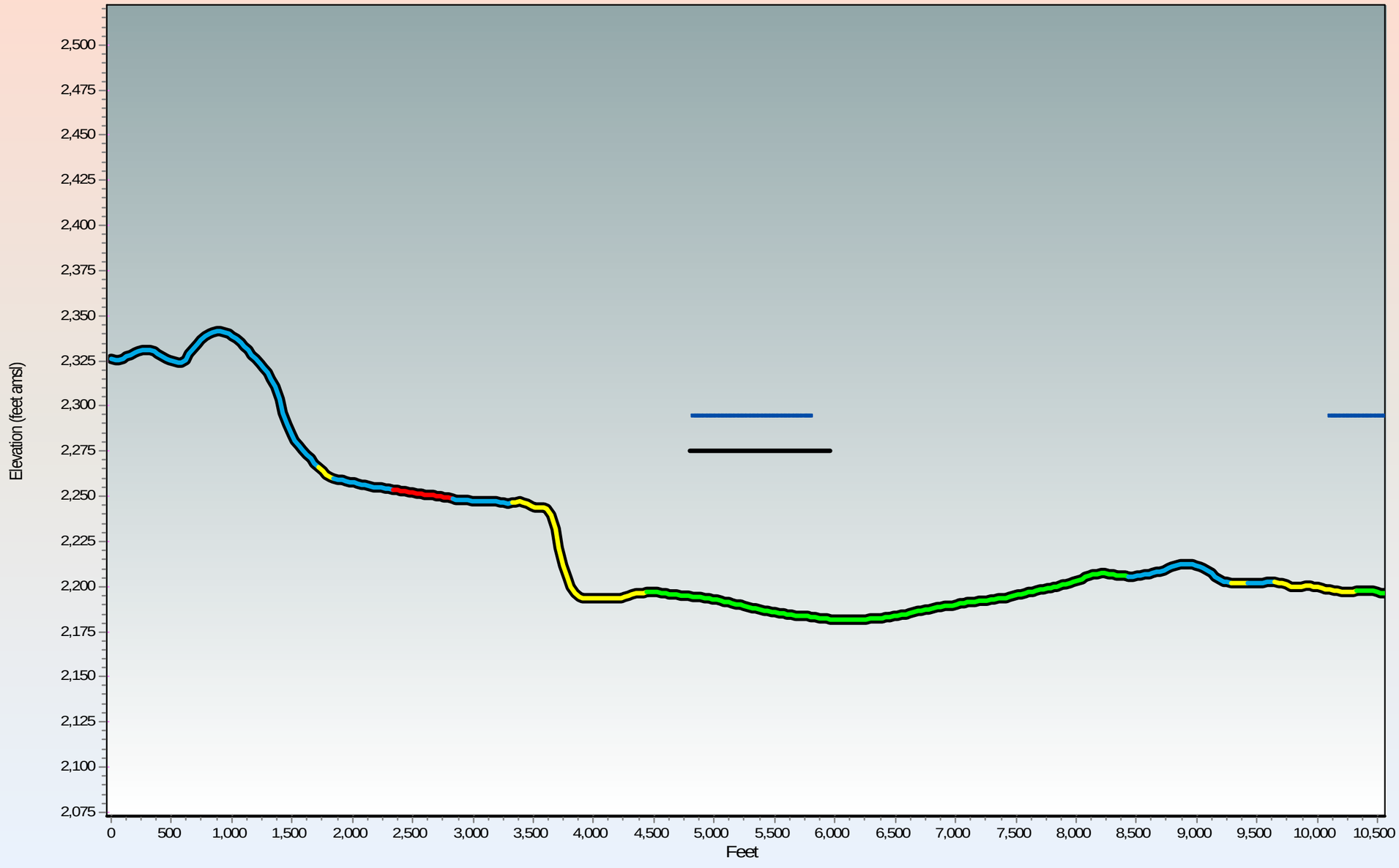
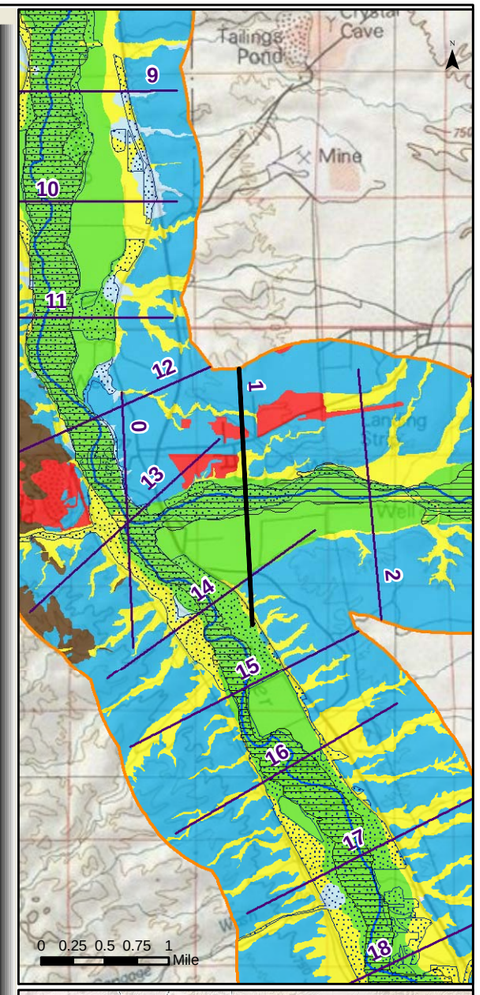
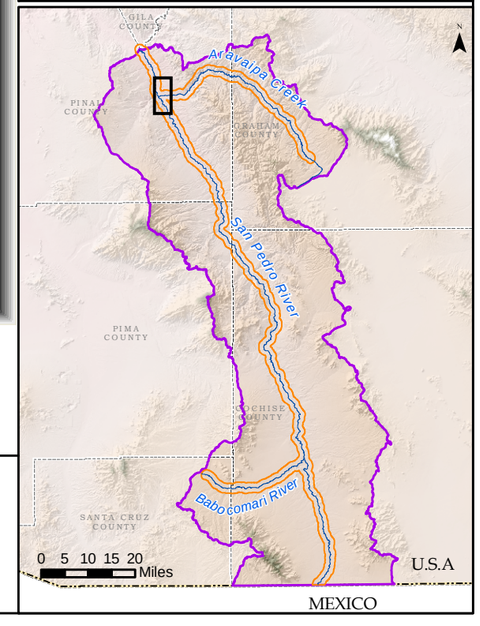
Appendix F
Aravaipa Creek Cross Section at Mile 00
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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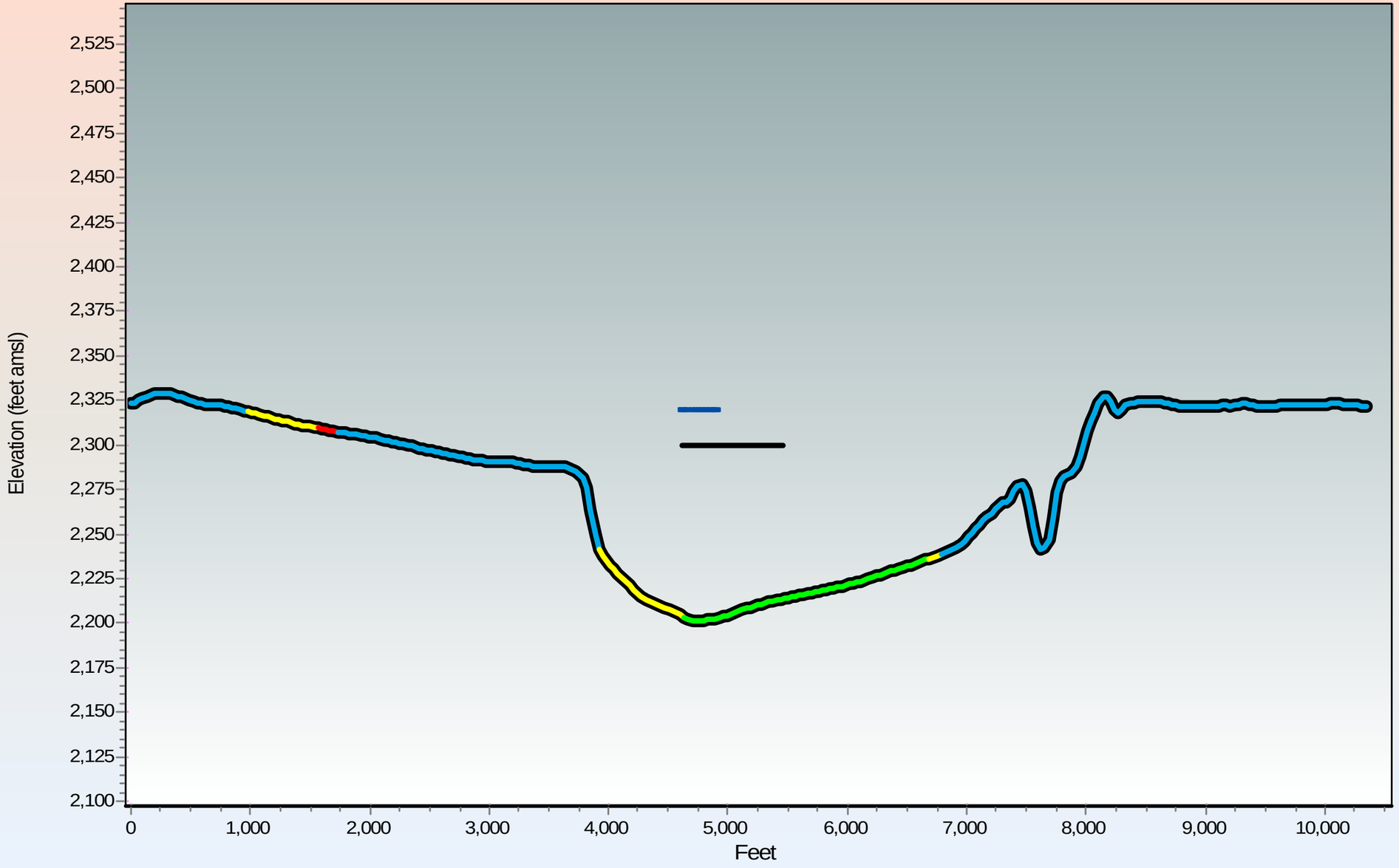
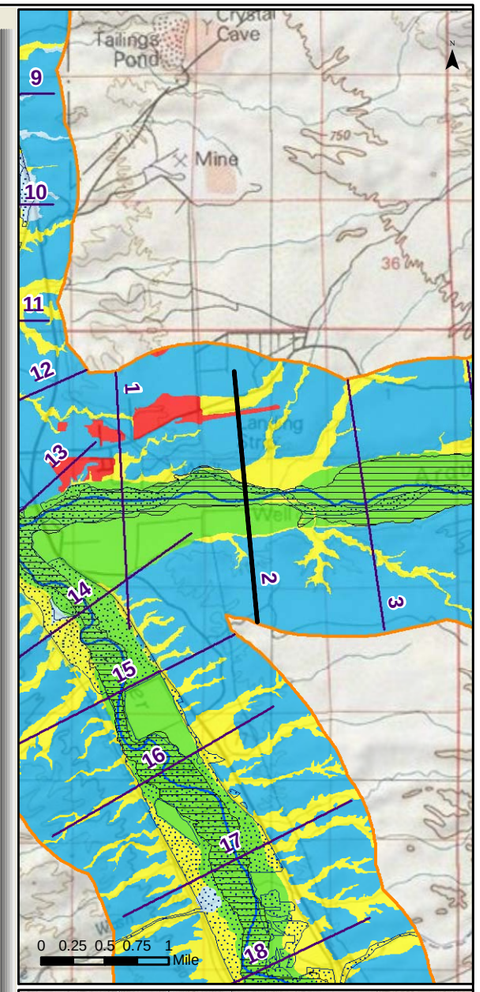
Appendix F

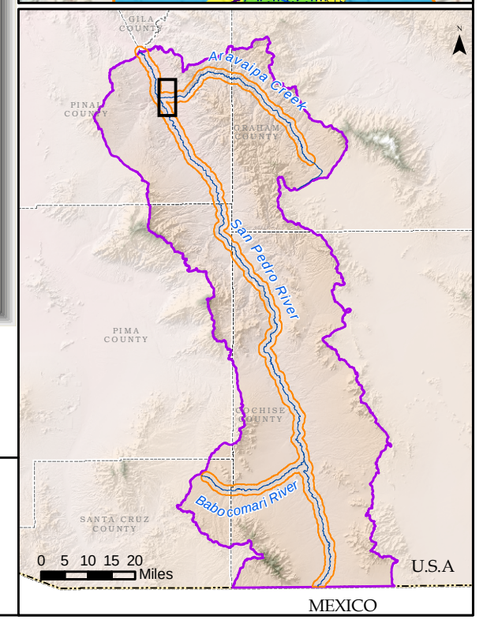
Aravaipa Creek Cross Section at Mile 01

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

Legend

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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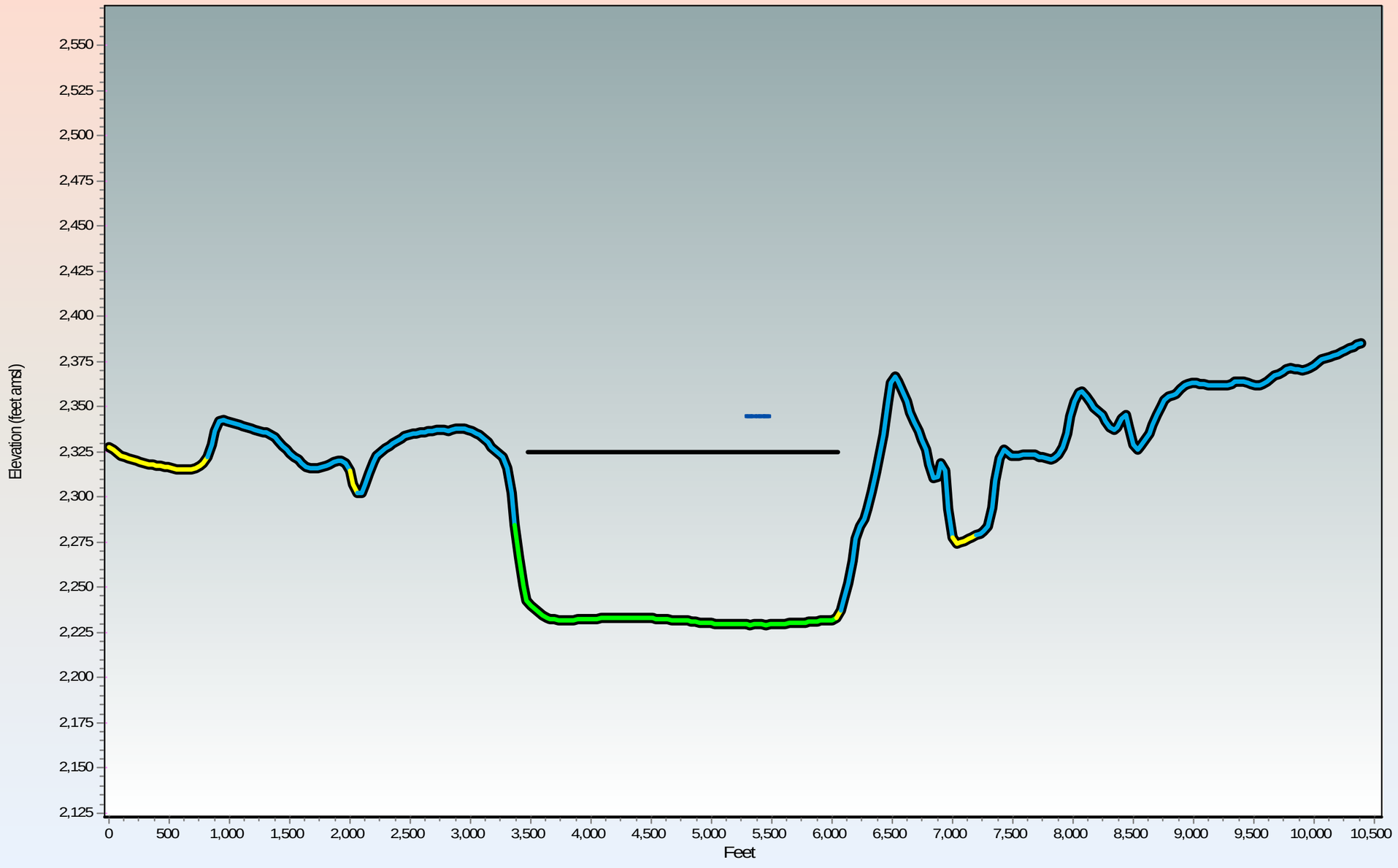
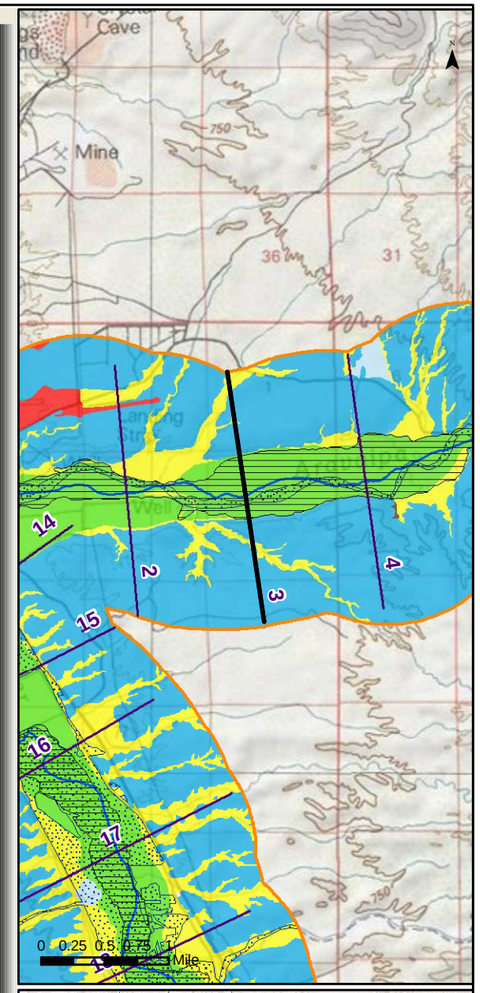
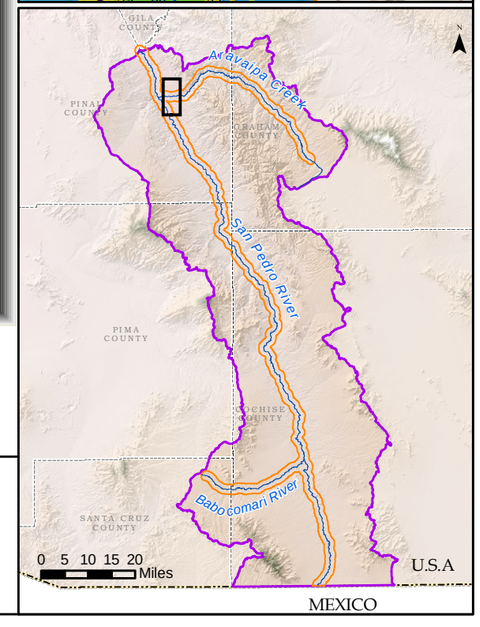
Appendix F
Aravaipa Creek Cross Section at Mile 02
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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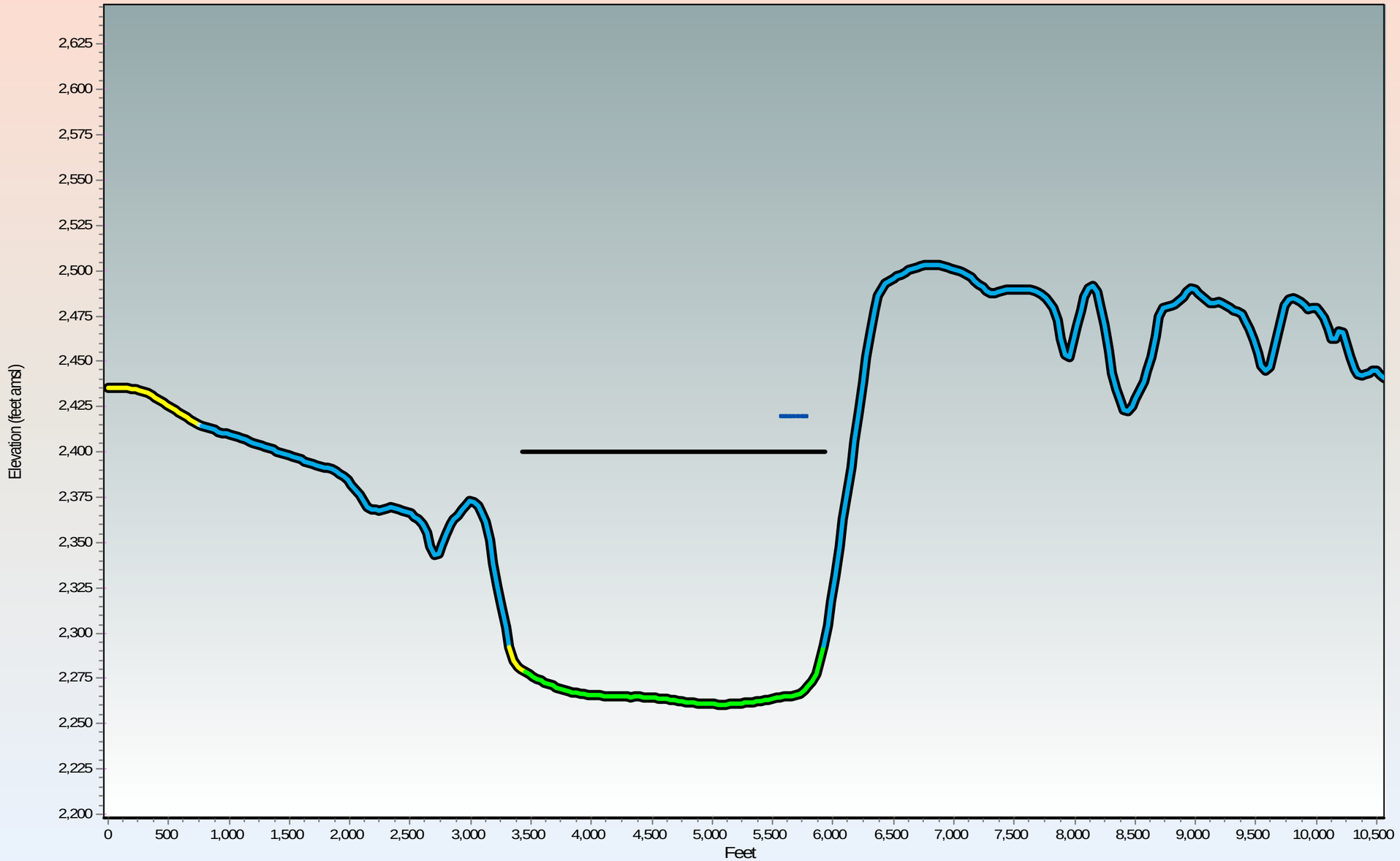
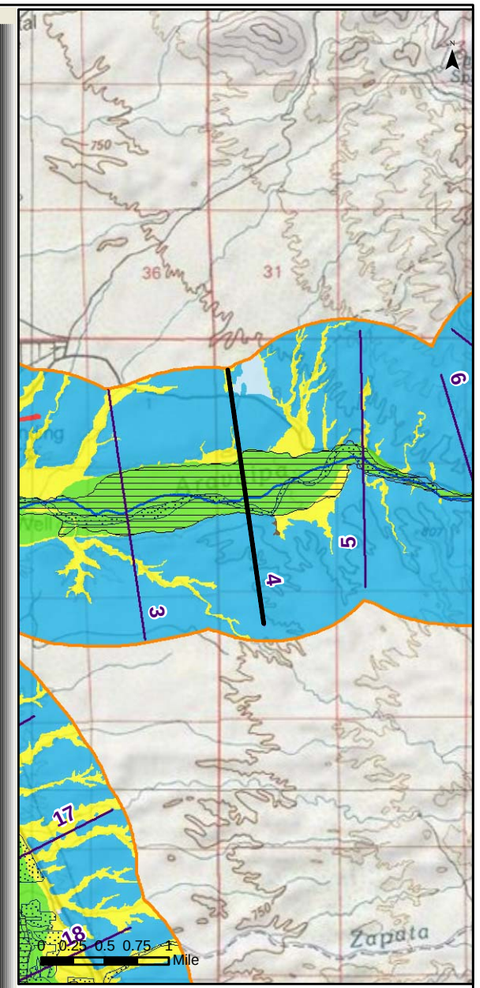
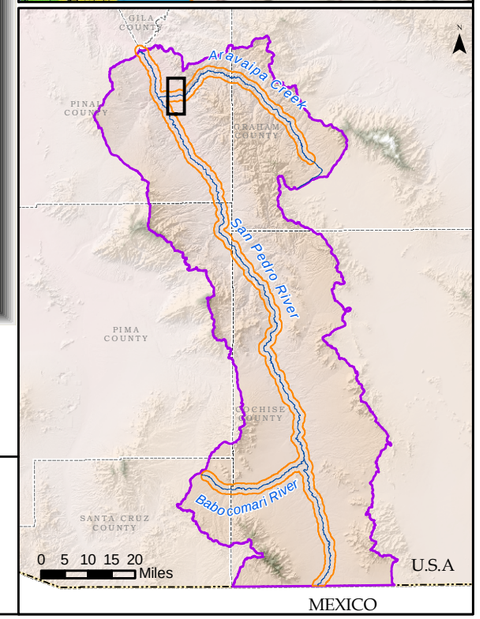
Appendix F
Aravaipa Creek Cross Section at Mile 03
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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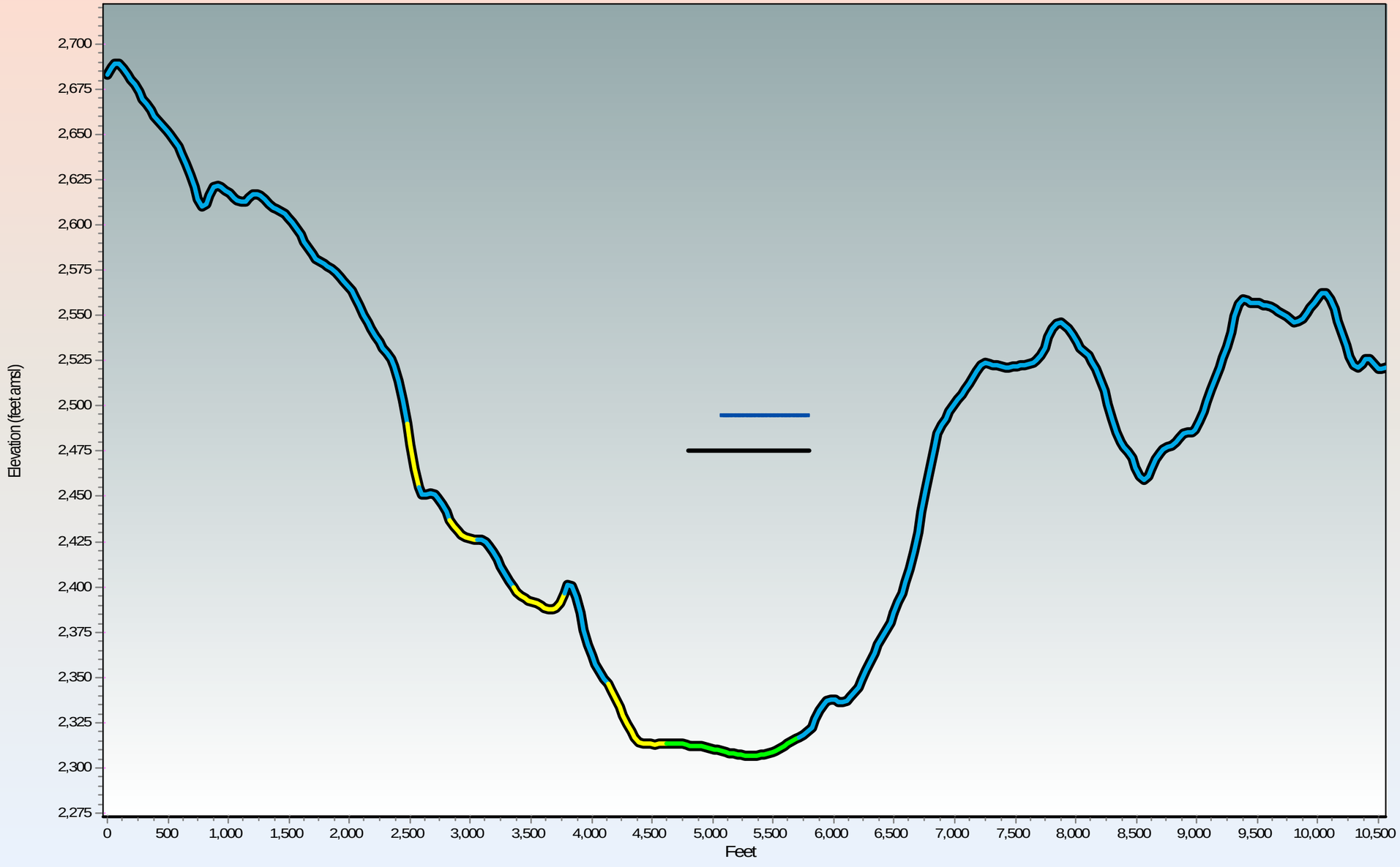
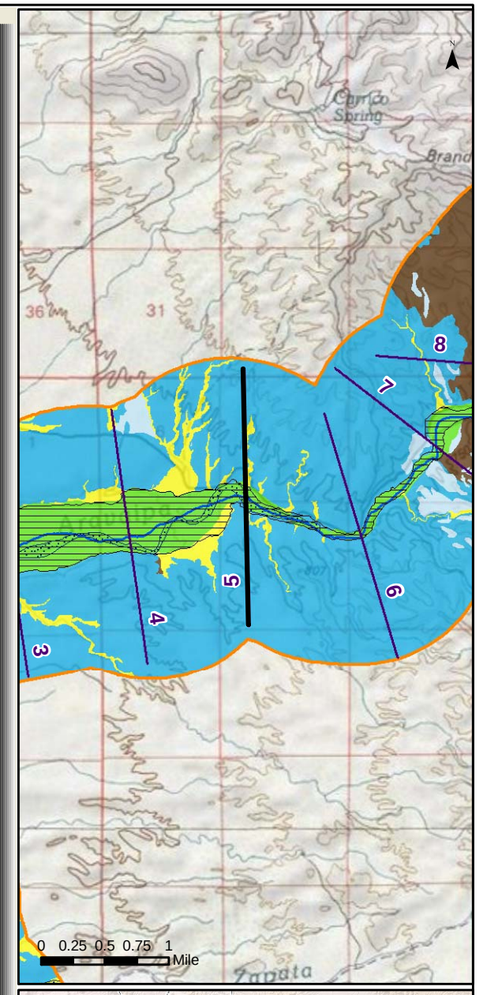
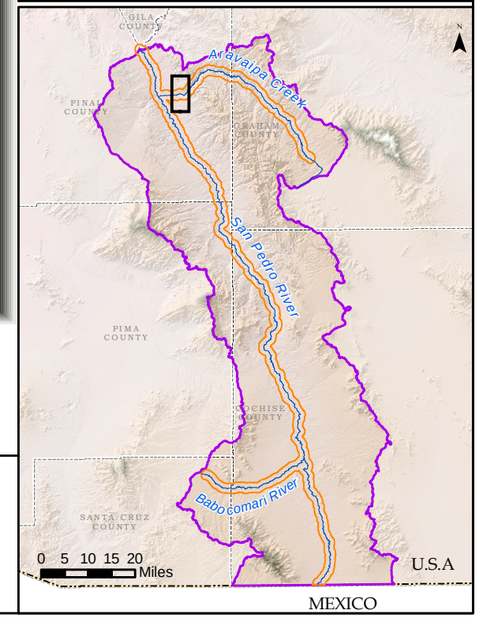
Appendix F
Aravaipa Creek Cross Section at Mile 04
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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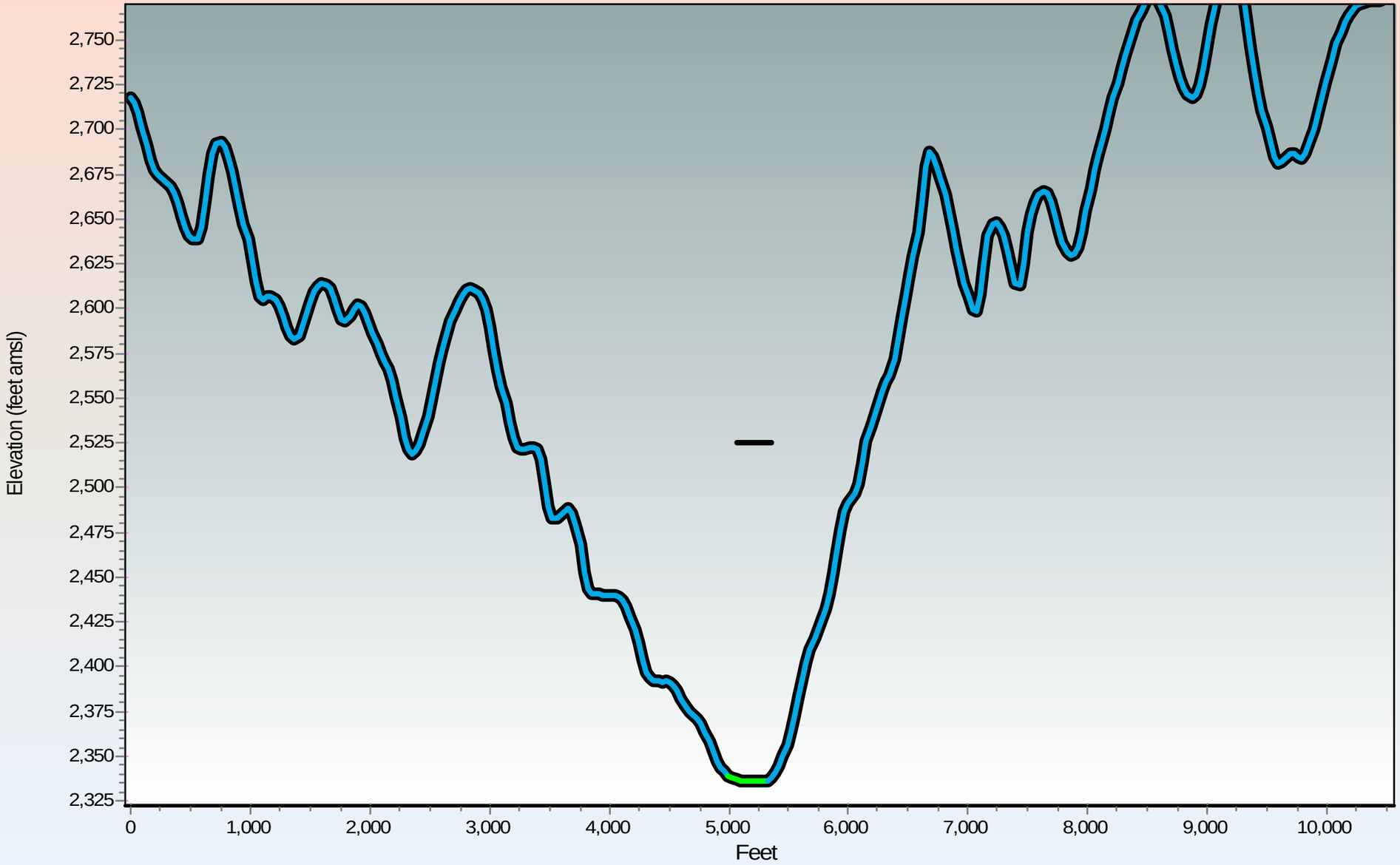
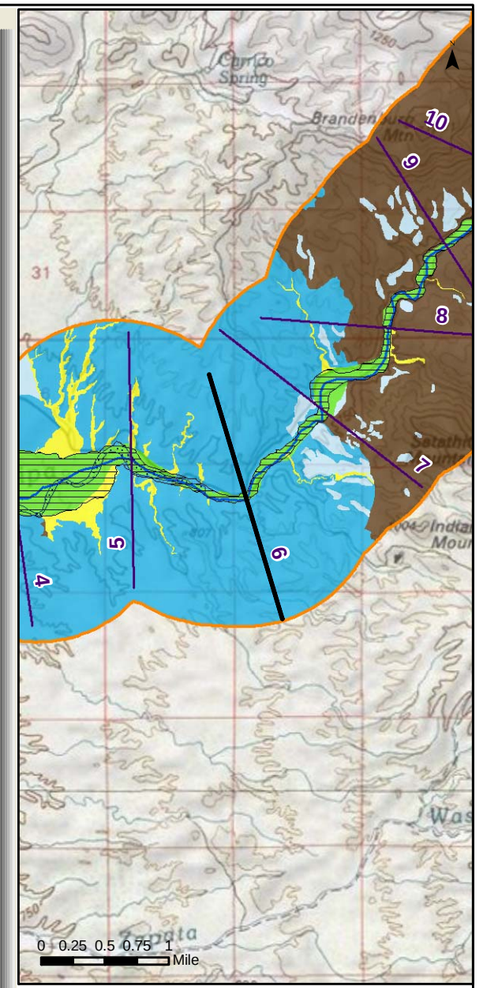
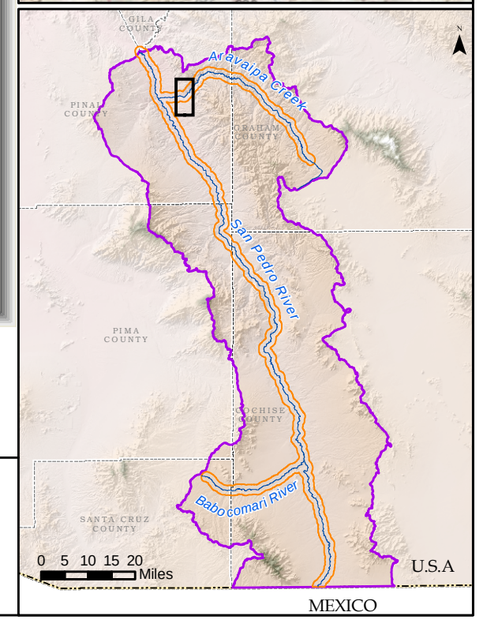
Appendix F
Aravaipa Creek Cross Section at Mile 05
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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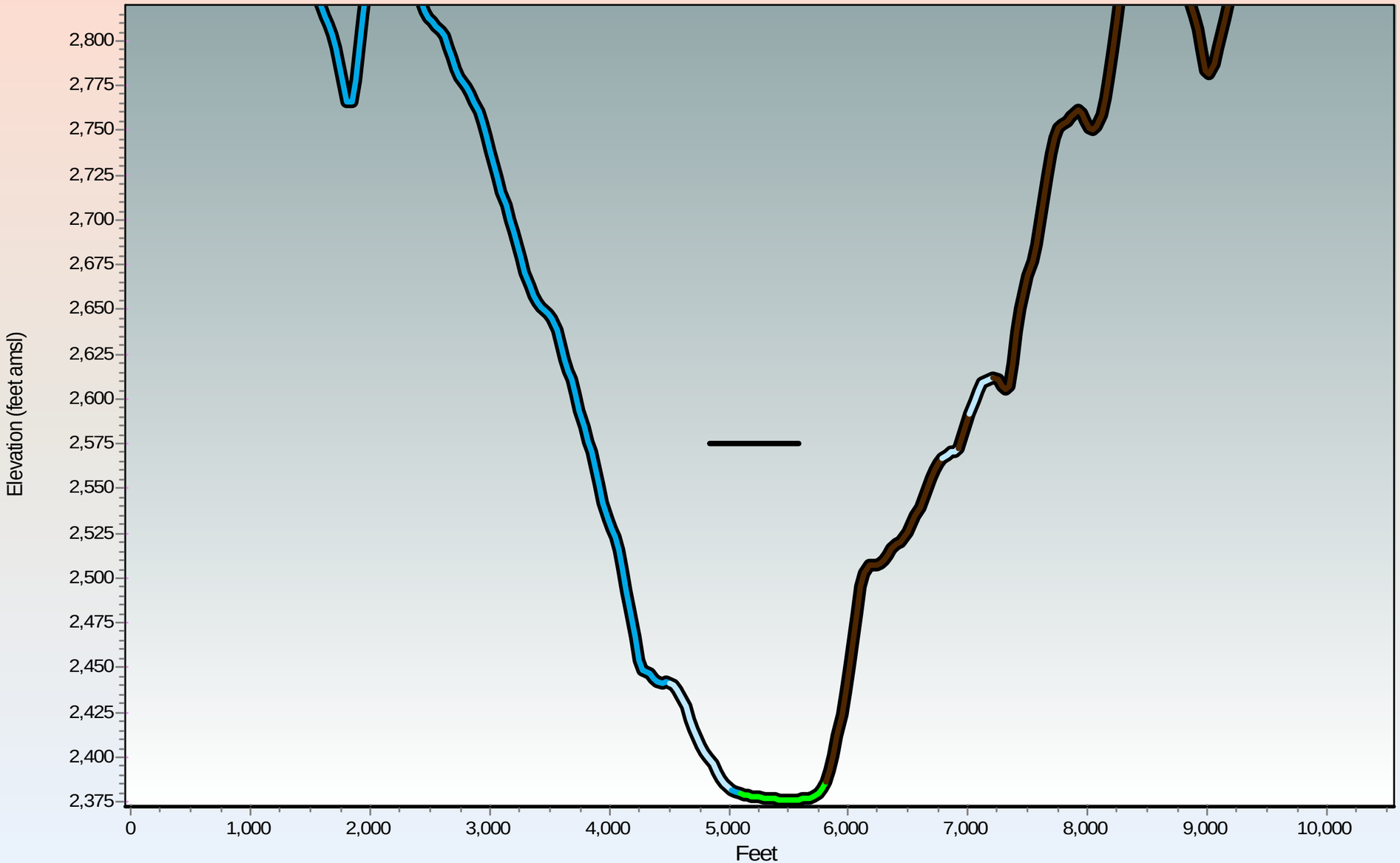
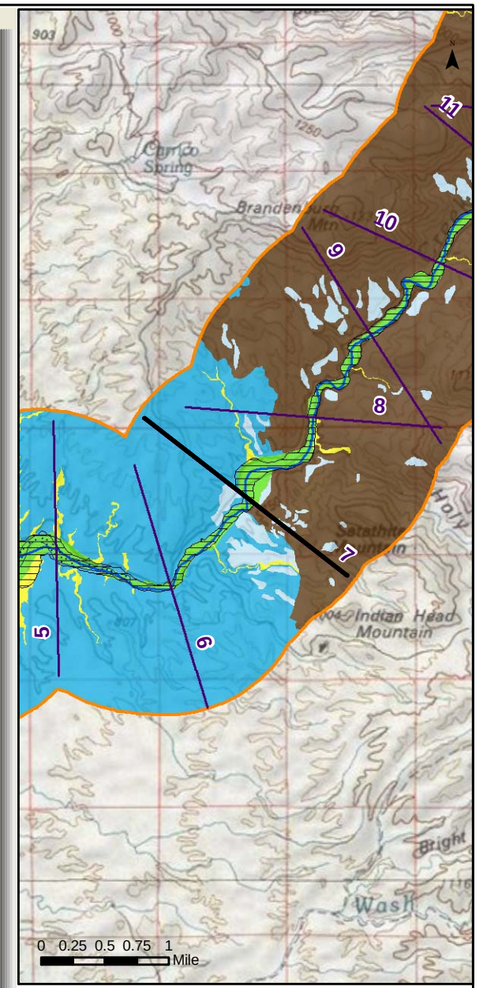
Appendix F

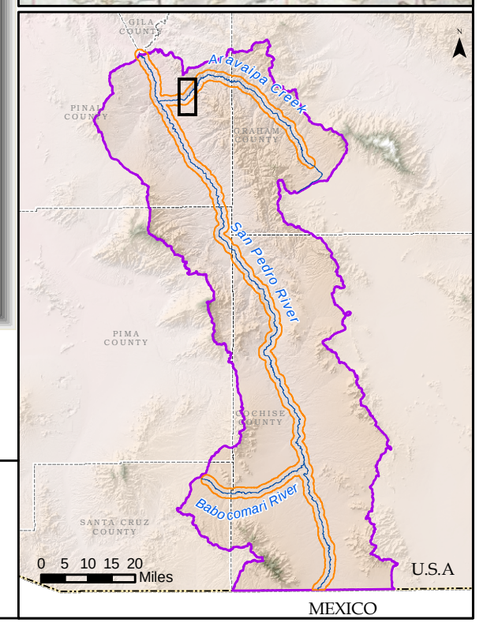
Aravaipa Creek Cross Section at Mile 06

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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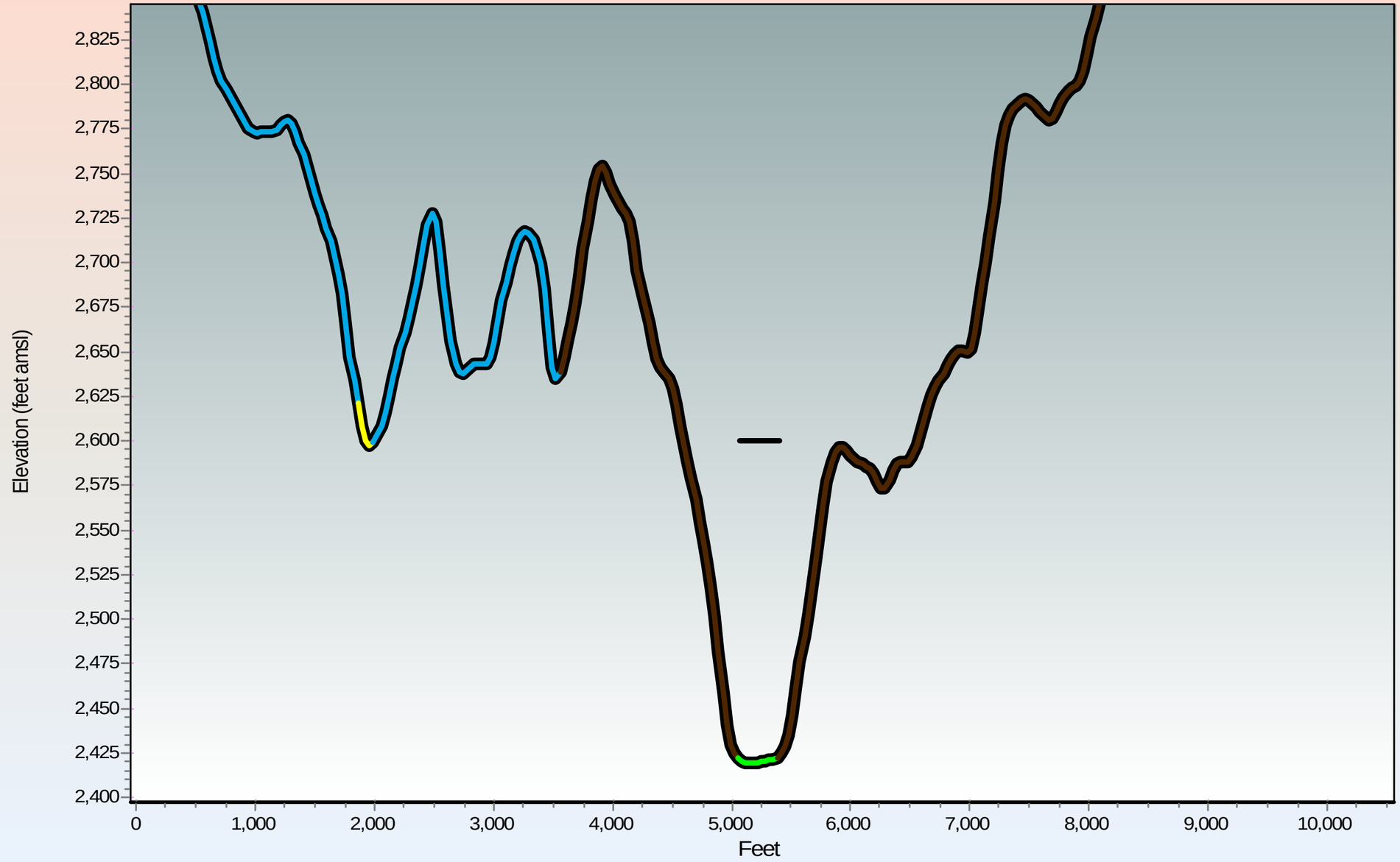
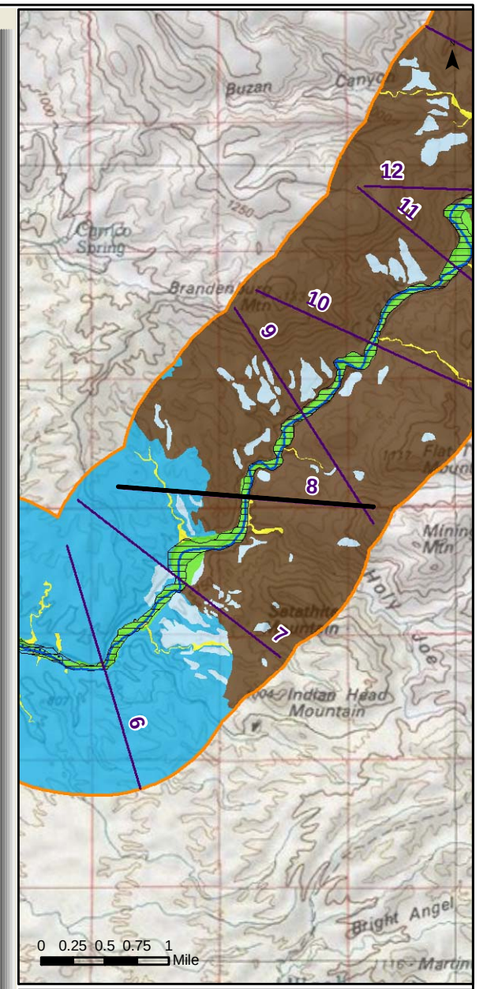
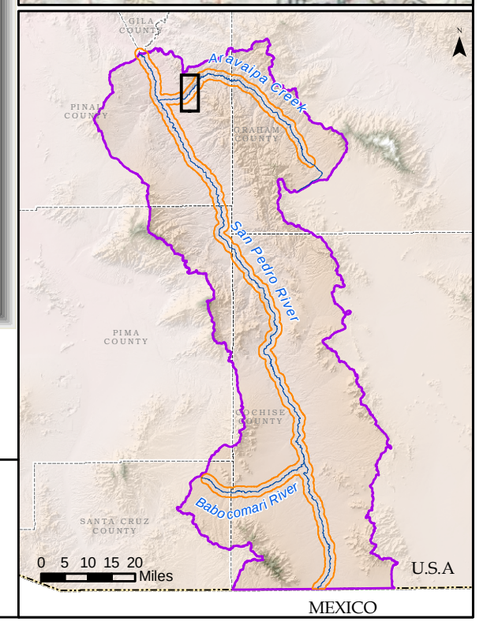
Appendix F
Aravaipa Creek Cross Section at Mile 07
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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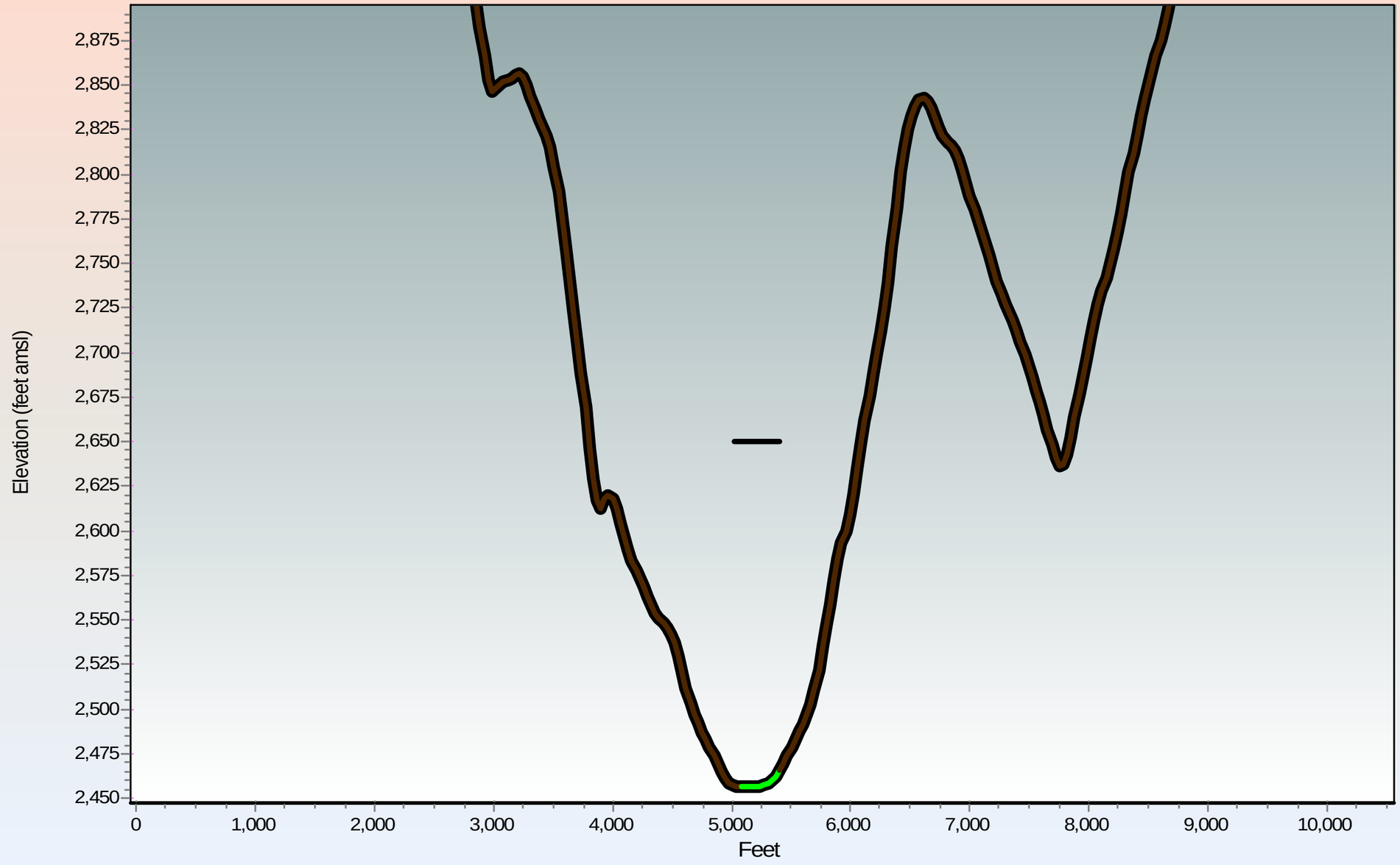
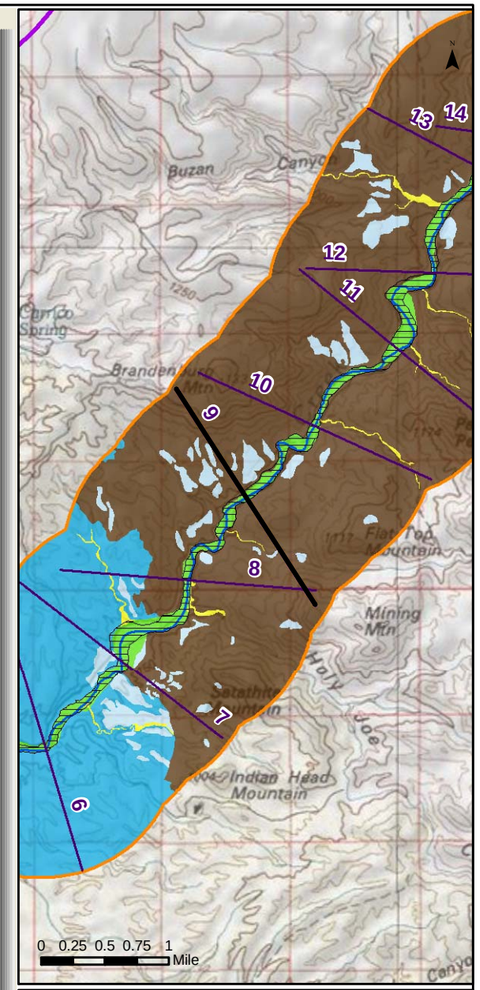
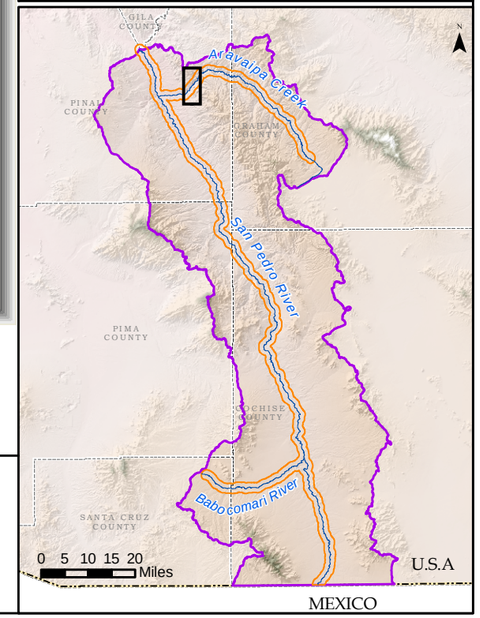
Appendix F
Aravaipa Creek Cross Section at Mile 08
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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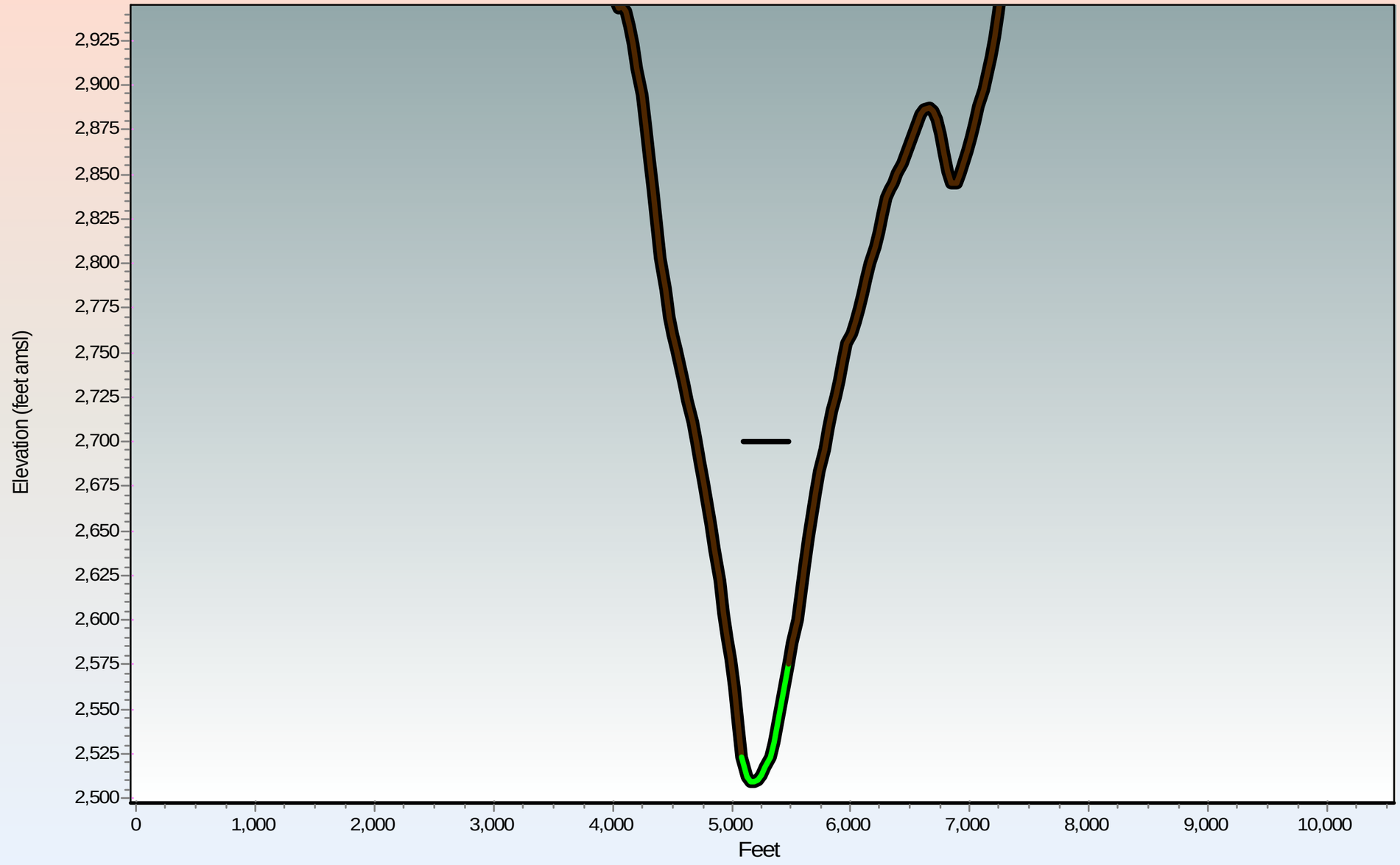
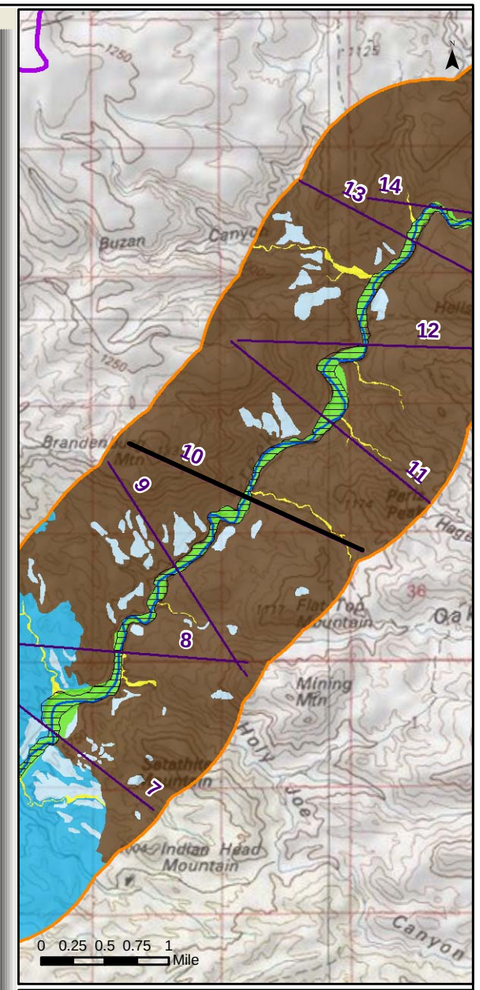
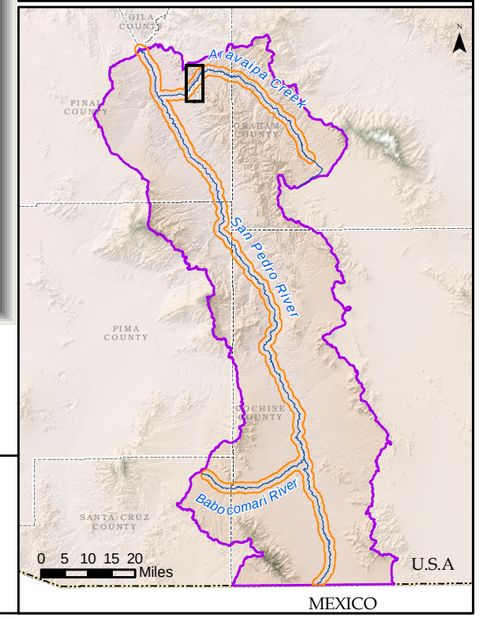
Appendix F
Aravaipa Creek Cross Section at Mile 09
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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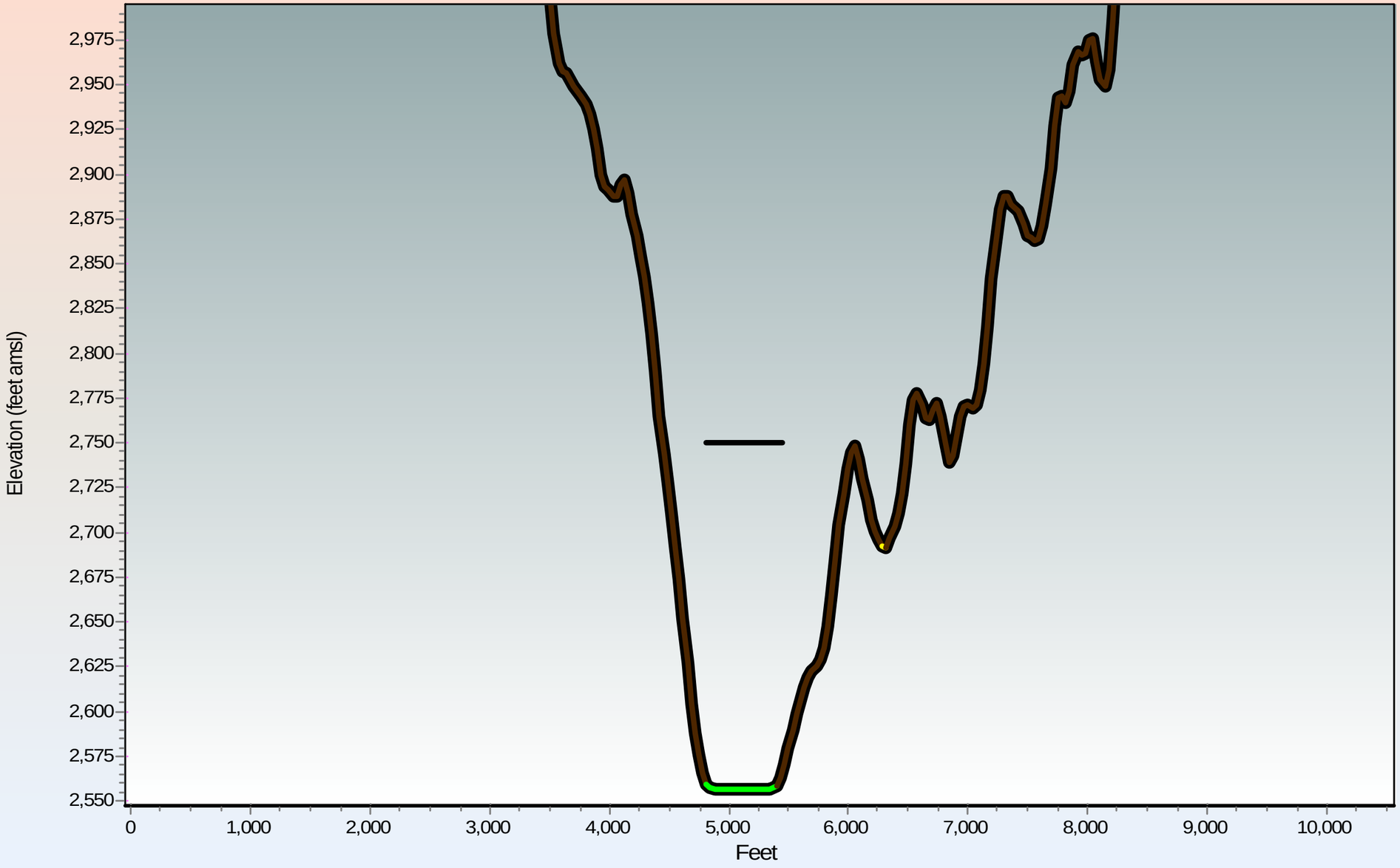
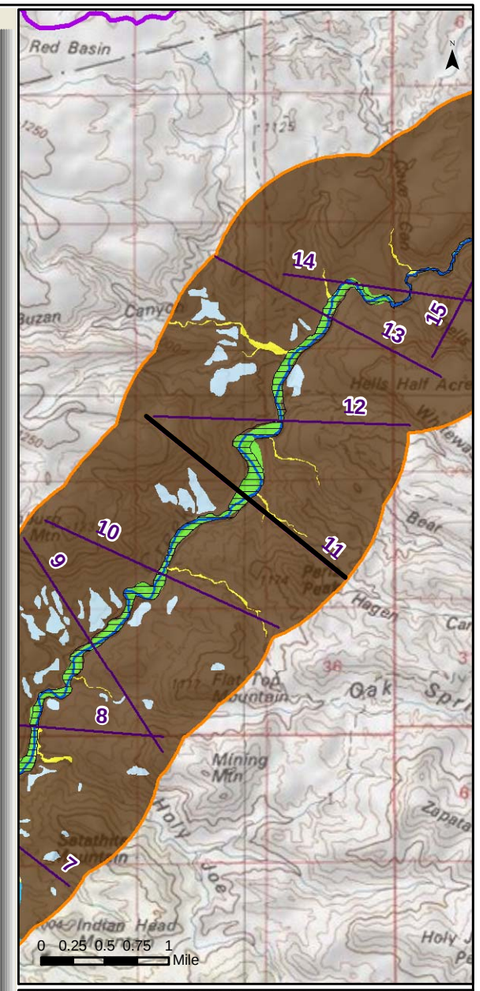
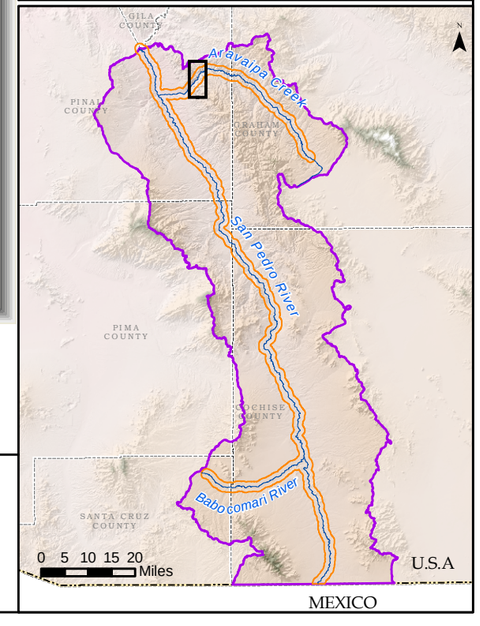
Appendix F
Aravaipa Creek Cross Section at Mile 10
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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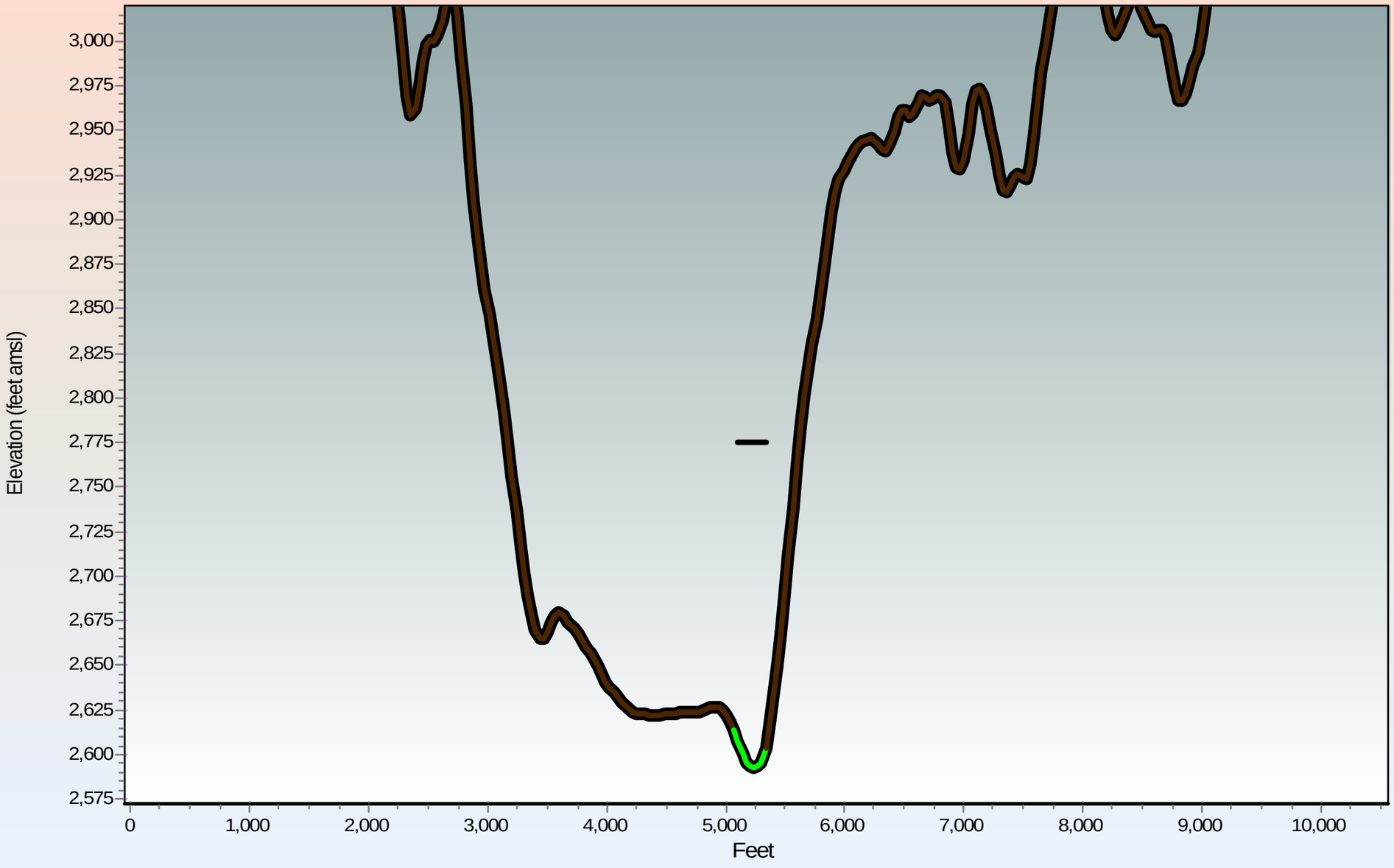
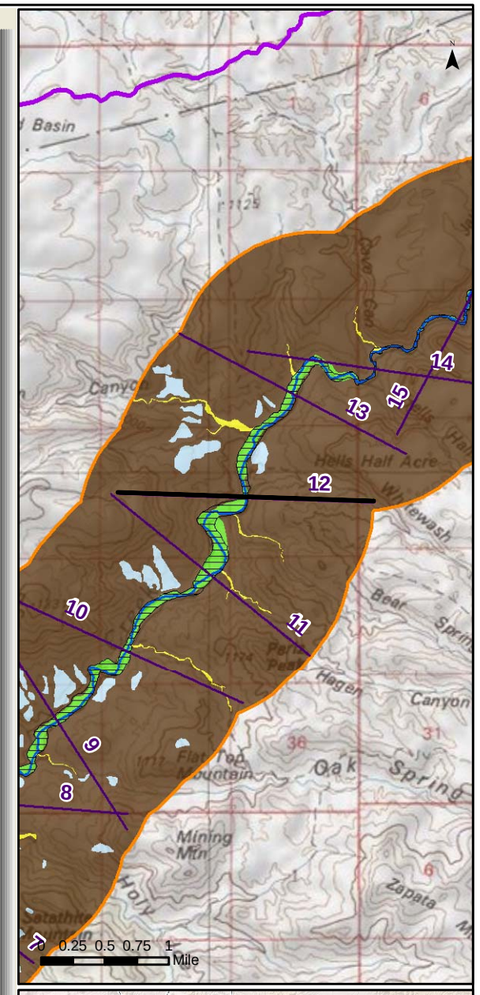
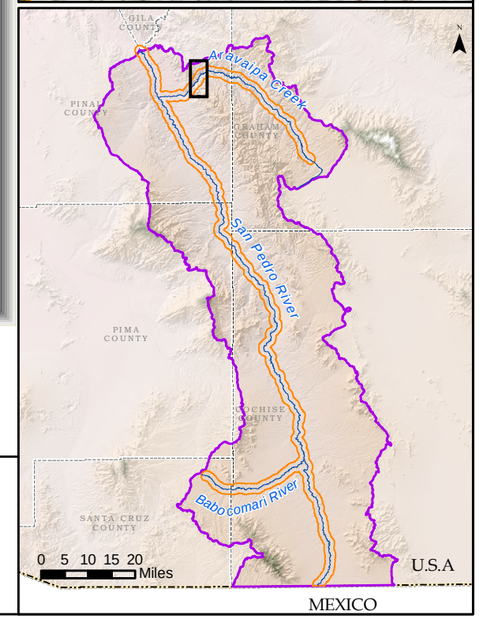
Appendix F
Aravaipa Creek Cross Section at Mile 11
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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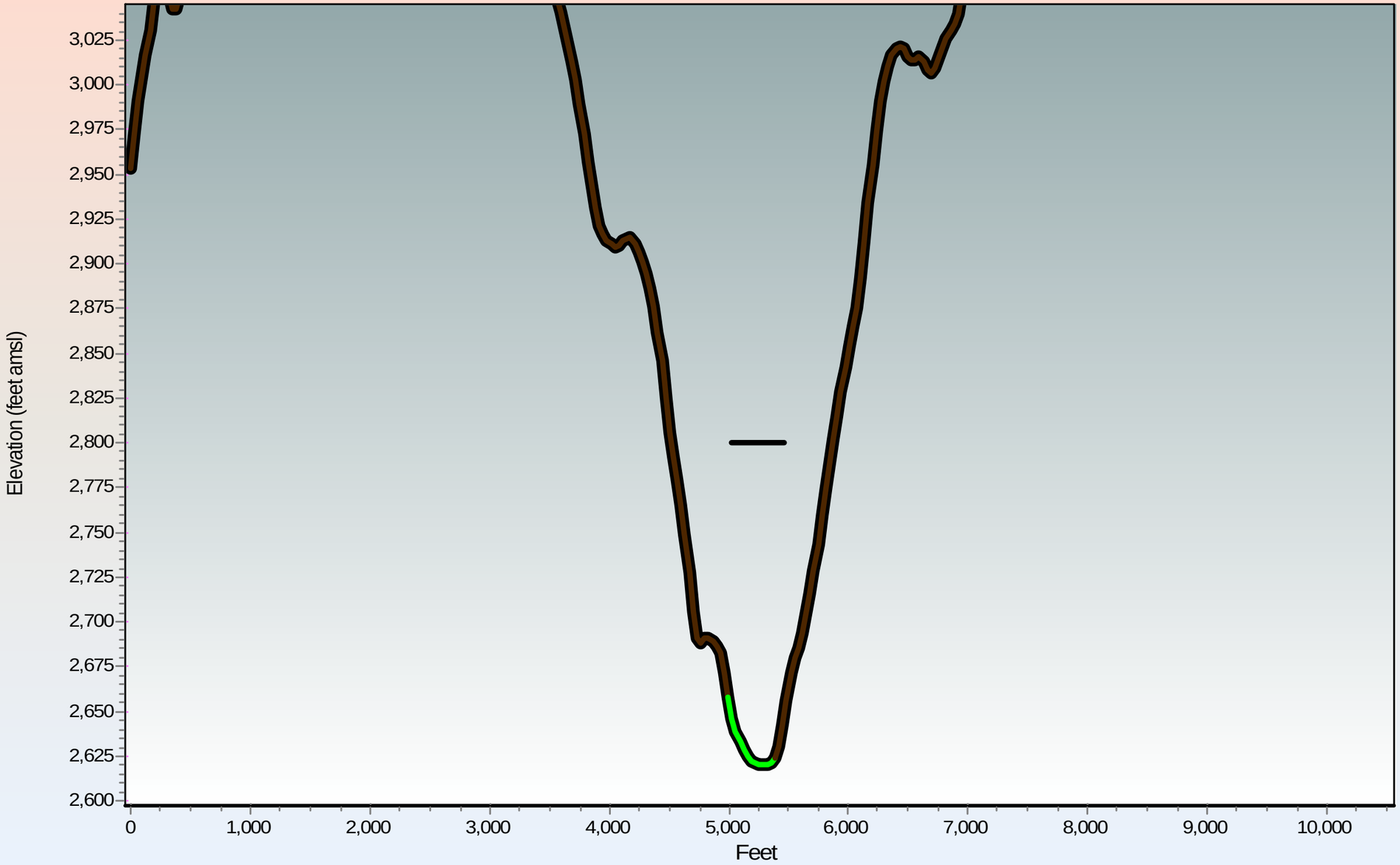
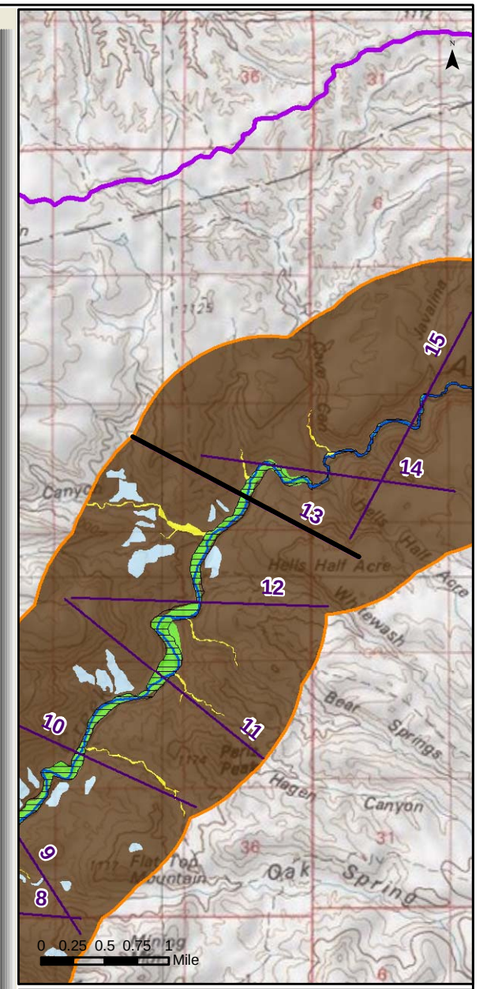
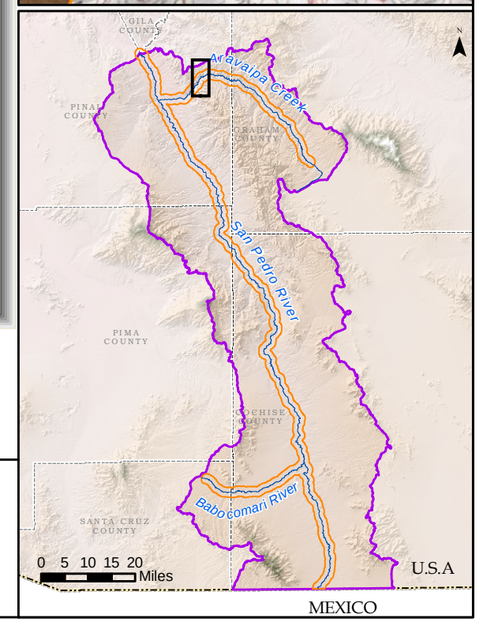
Appendix F
Aravaipa Creek Cross Section at Mile 12
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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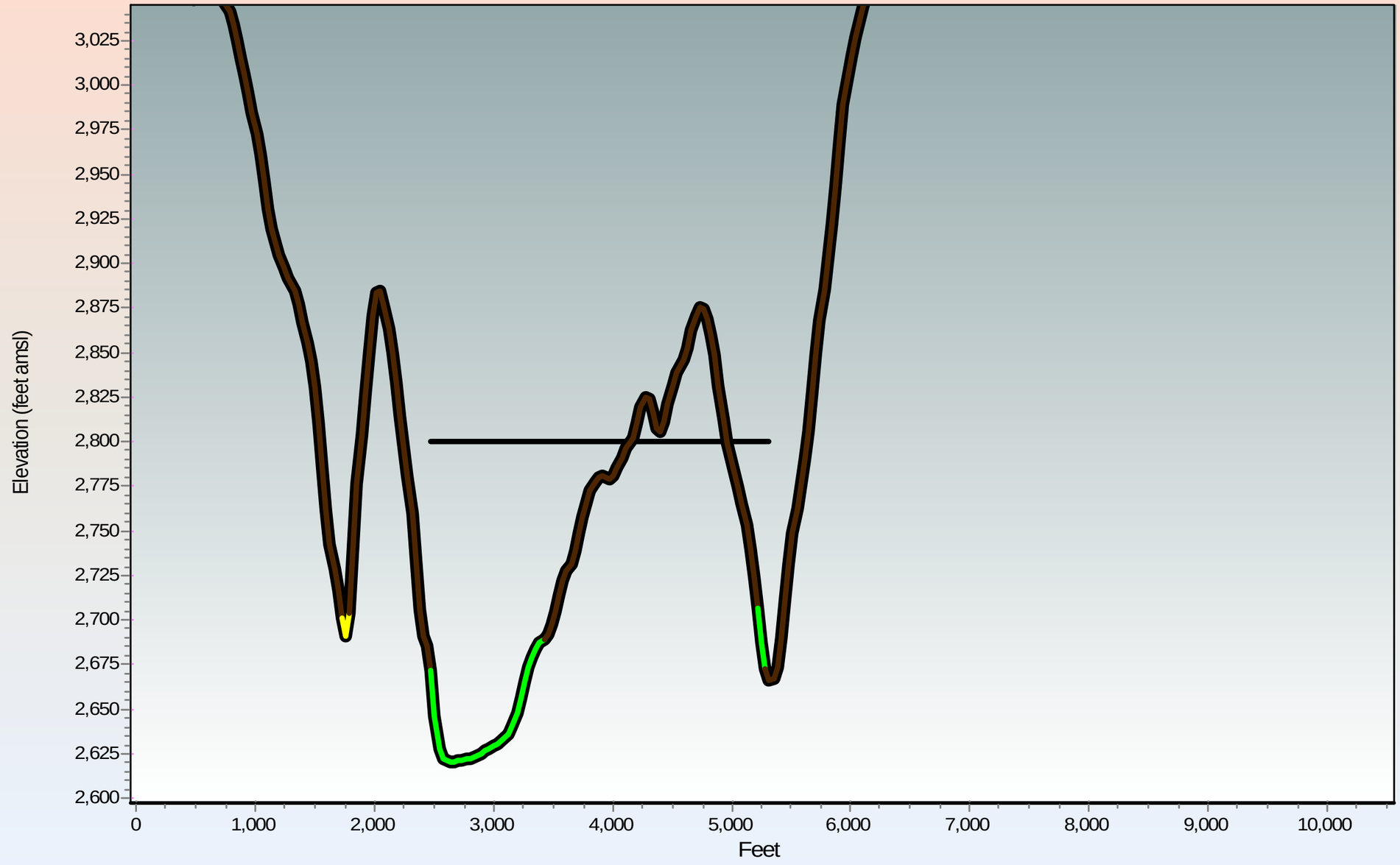
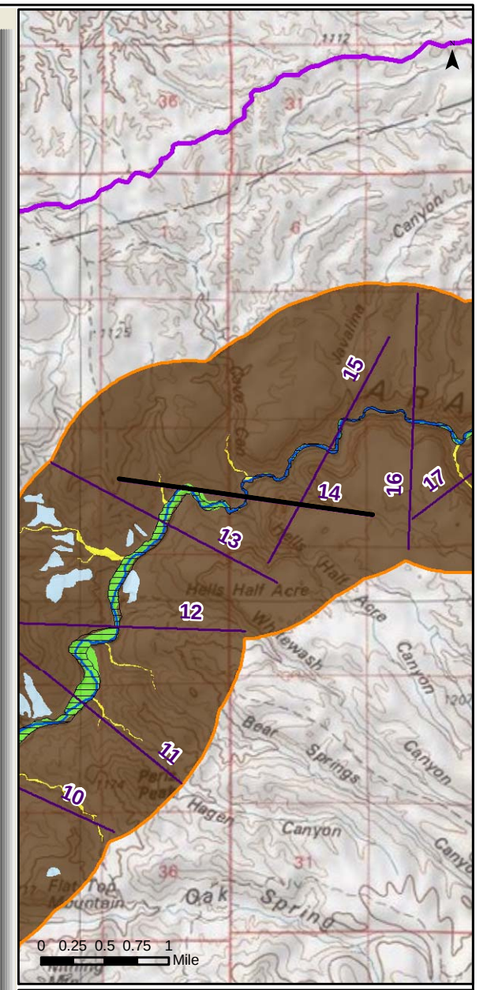
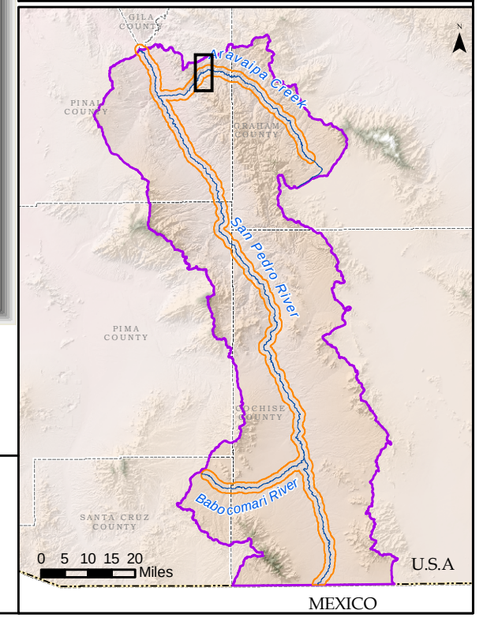
Appendix F
Aravaipa Creek Cross Section at Mile 13
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed

1/4/2011, \\adwrsas1-phx01.azwater.gov\gis-vns, u:\workspaces\statewideplanning\adjudications\projects\sanpedro\maps\resoncetoobjections_jan2011\appendixf_crosssections\appendixf_crosssections.mxd







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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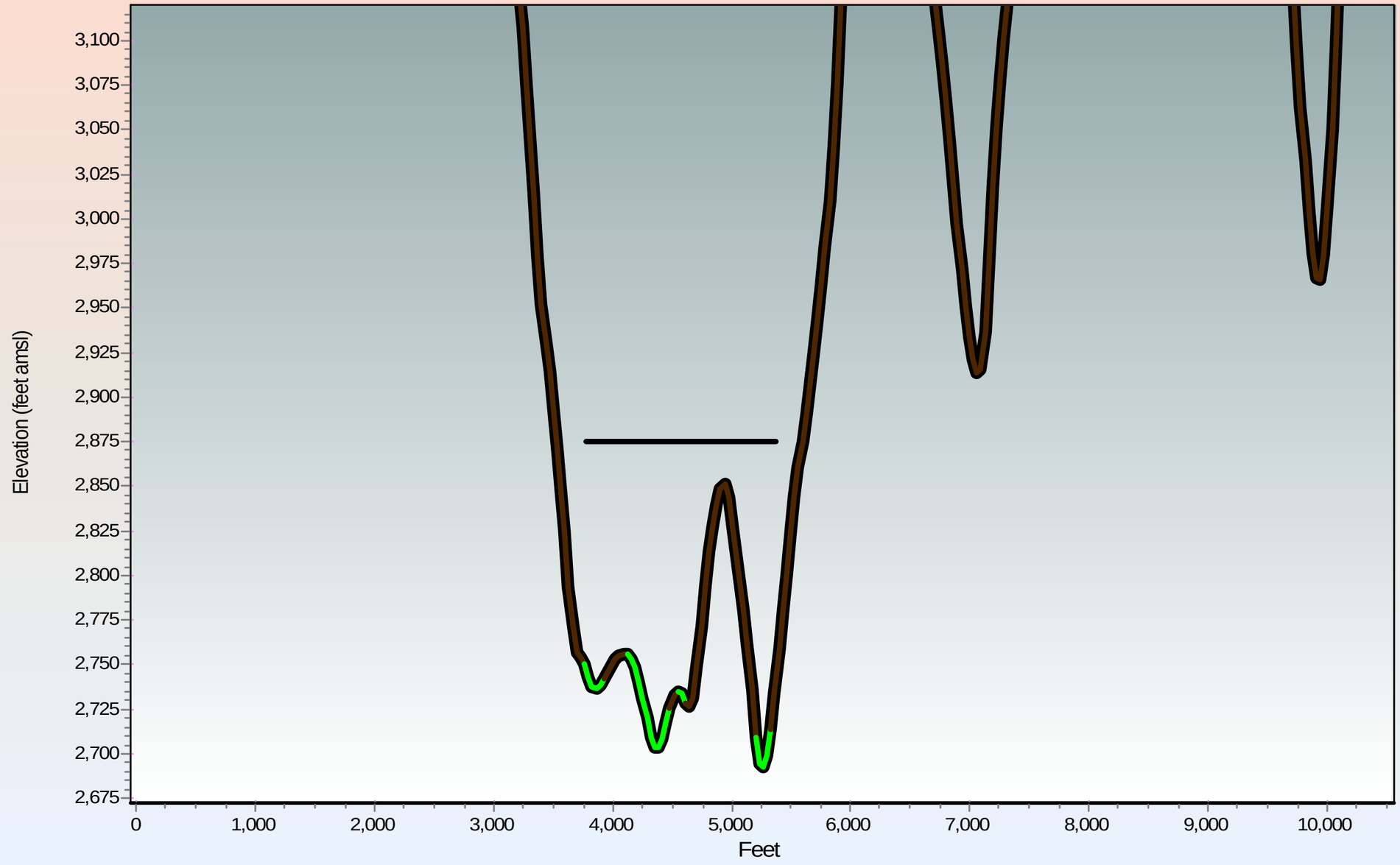
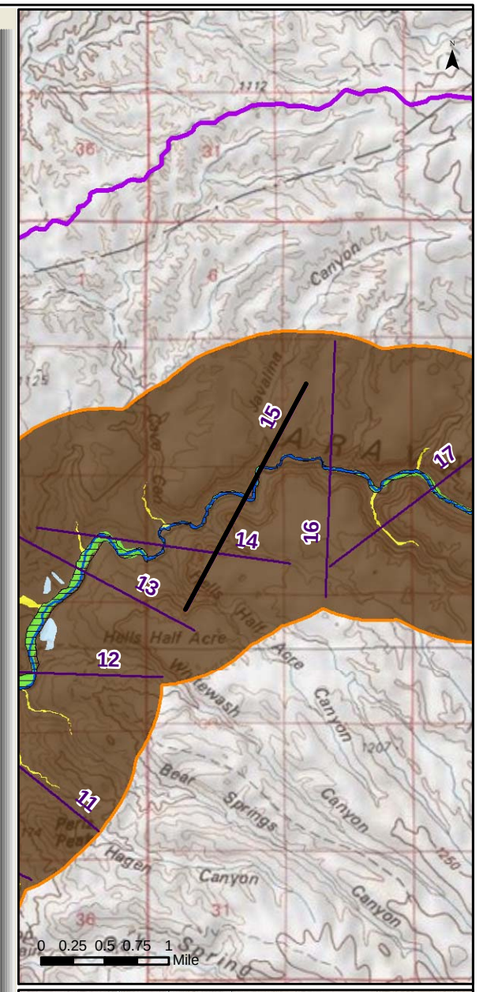
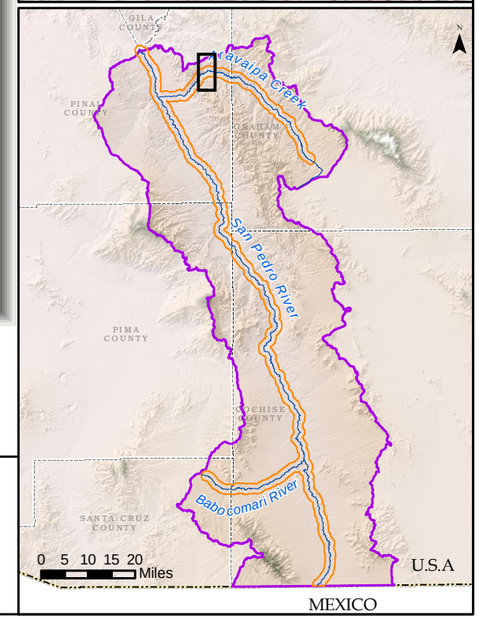
Appendix F
Aravaipa Creek Cross Section at Mile 14
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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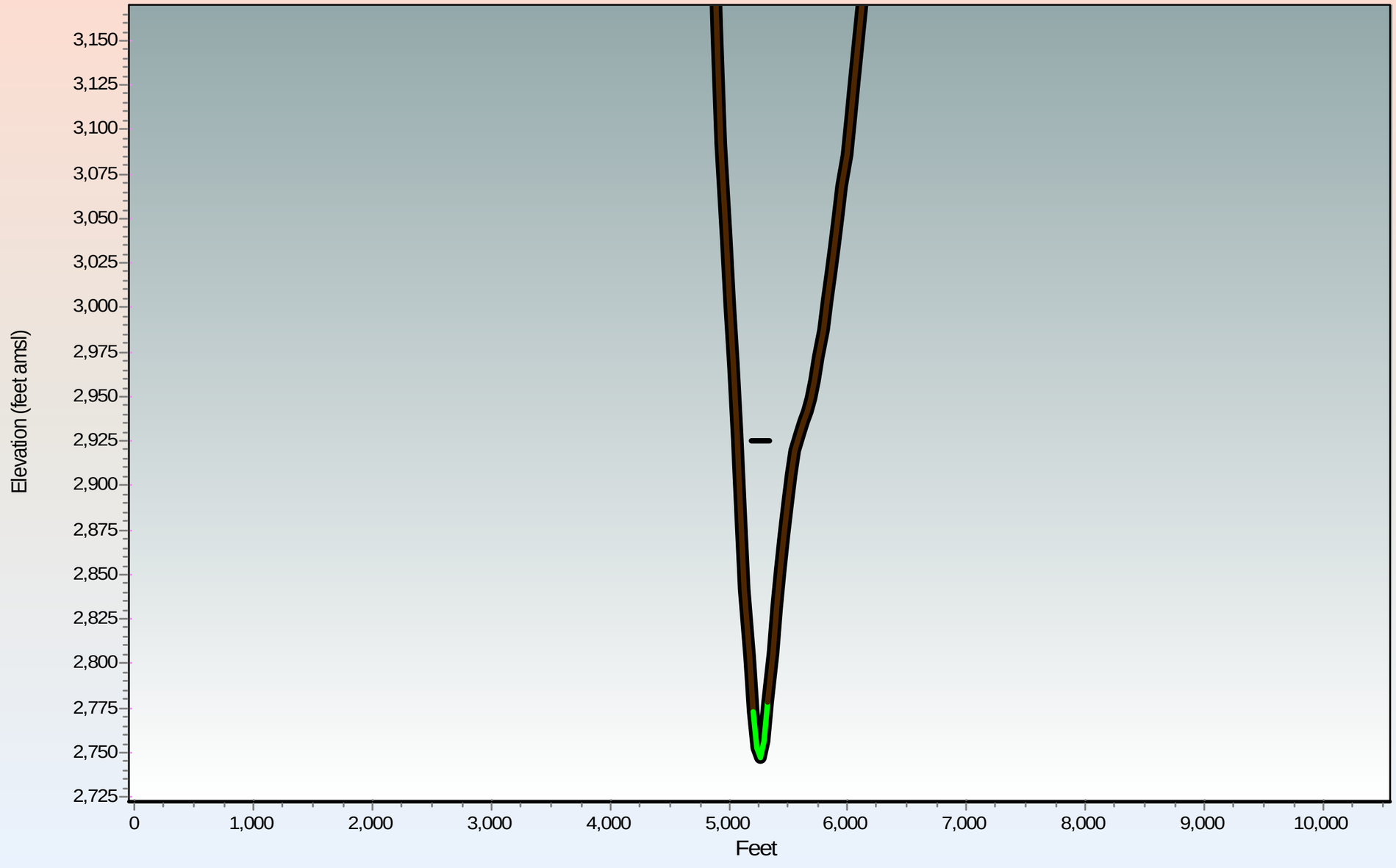
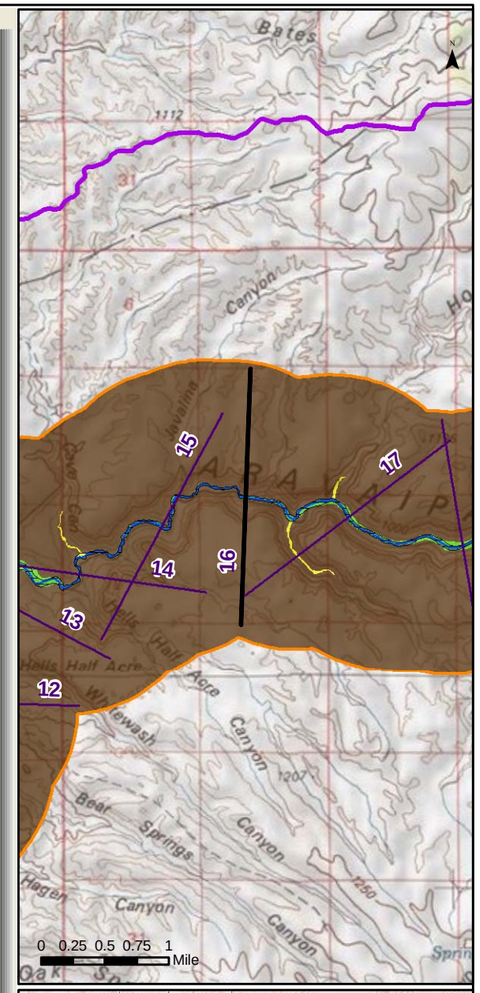
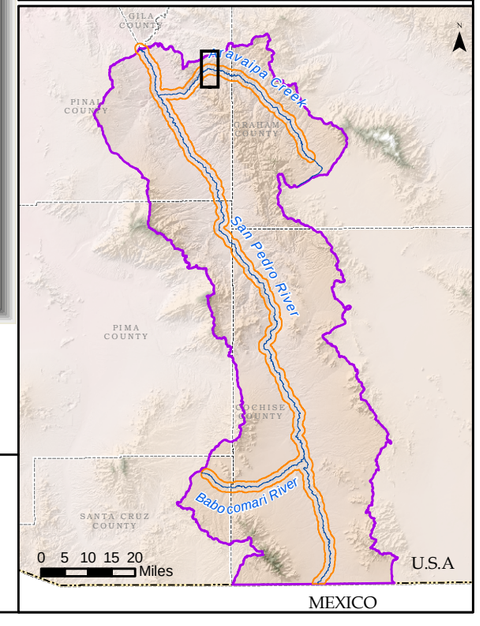
Appendix F
Aravaipa Creek Cross Section at Mile 15
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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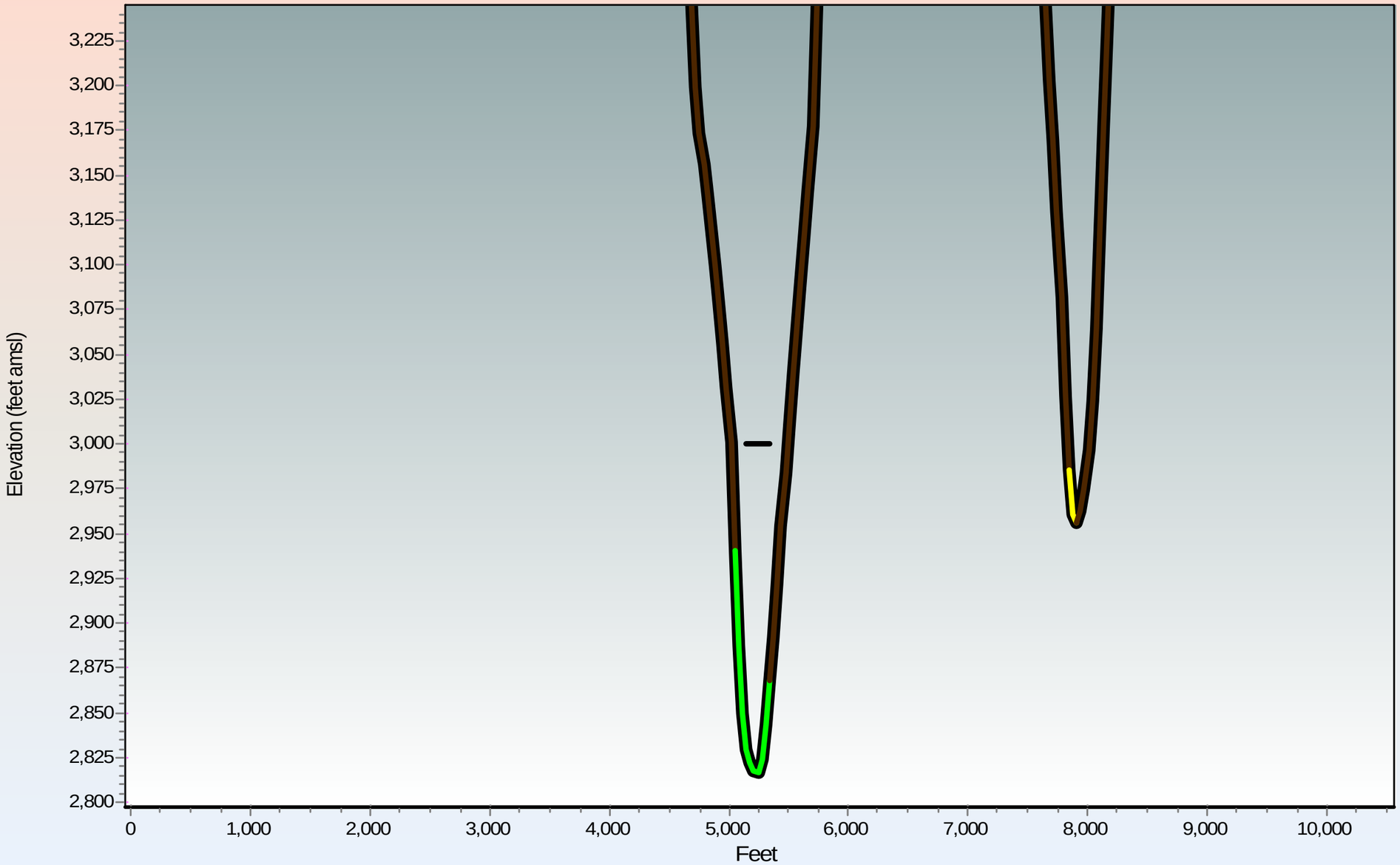
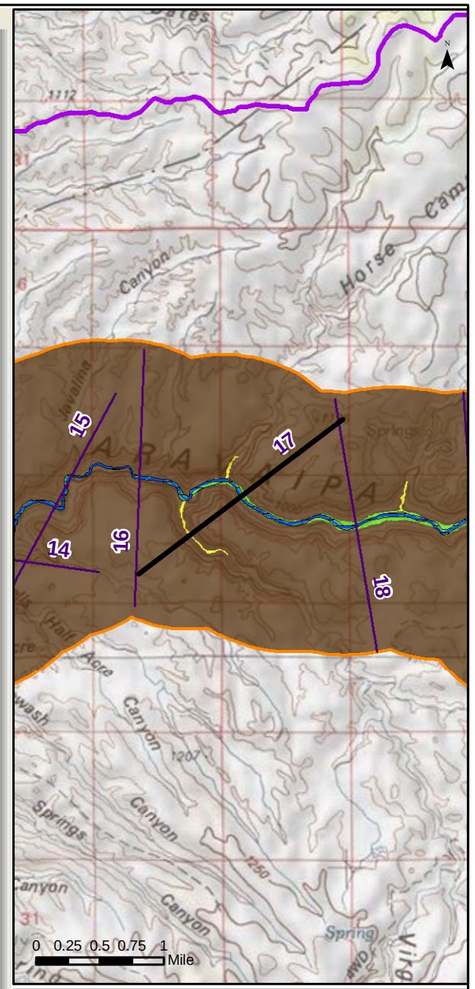
Appendix F

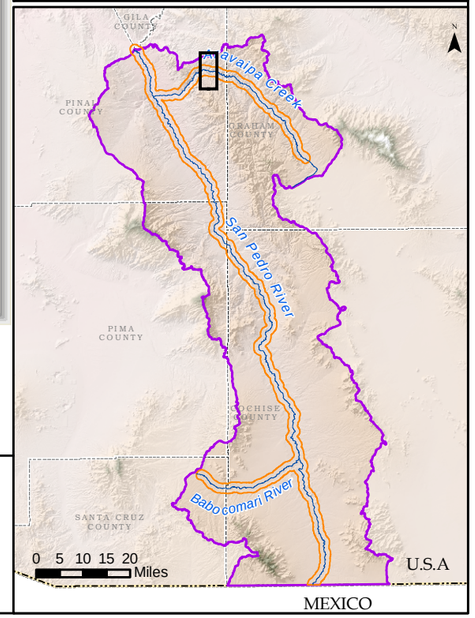
Aravaipa Creek Cross Section at Mile 16

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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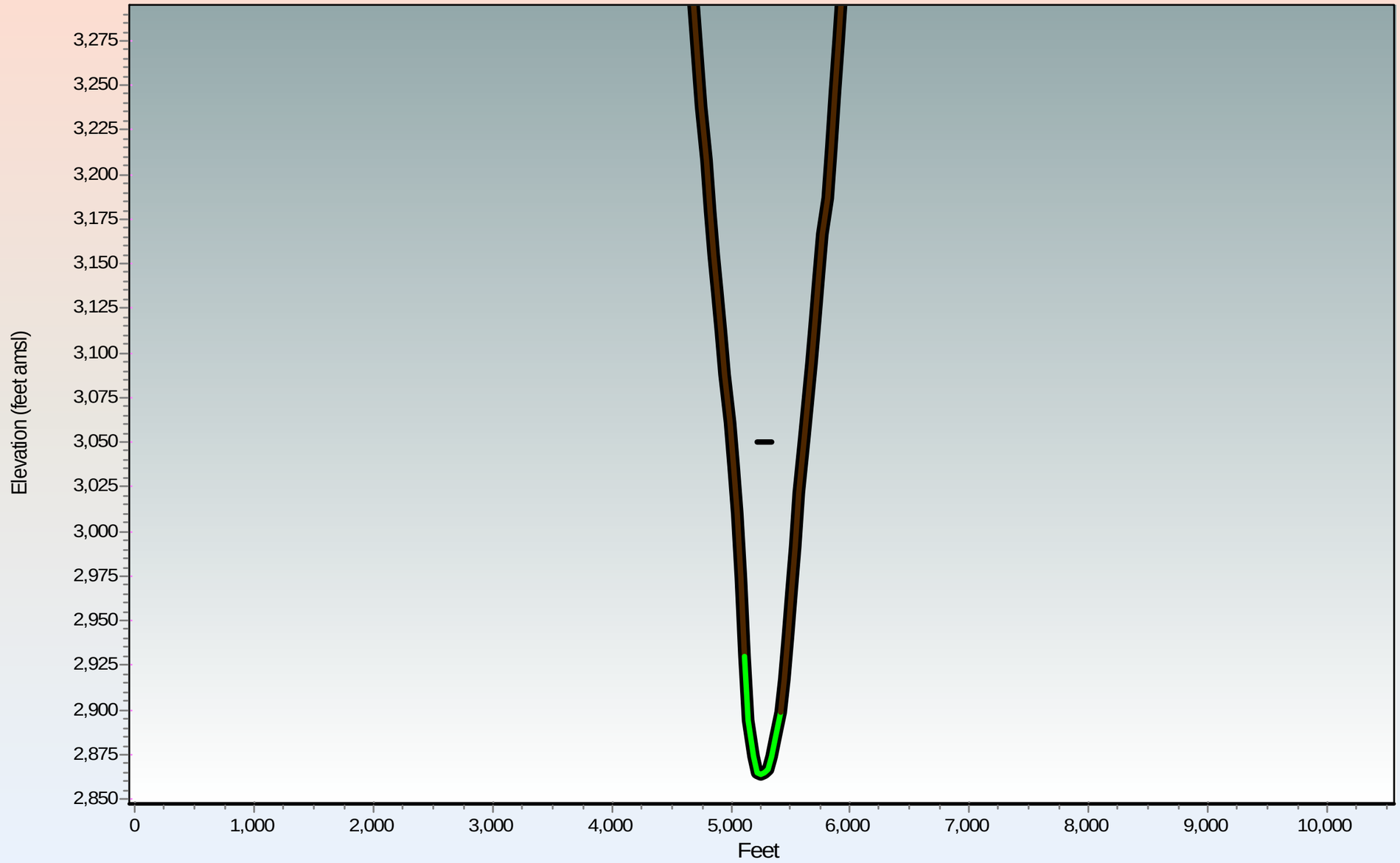
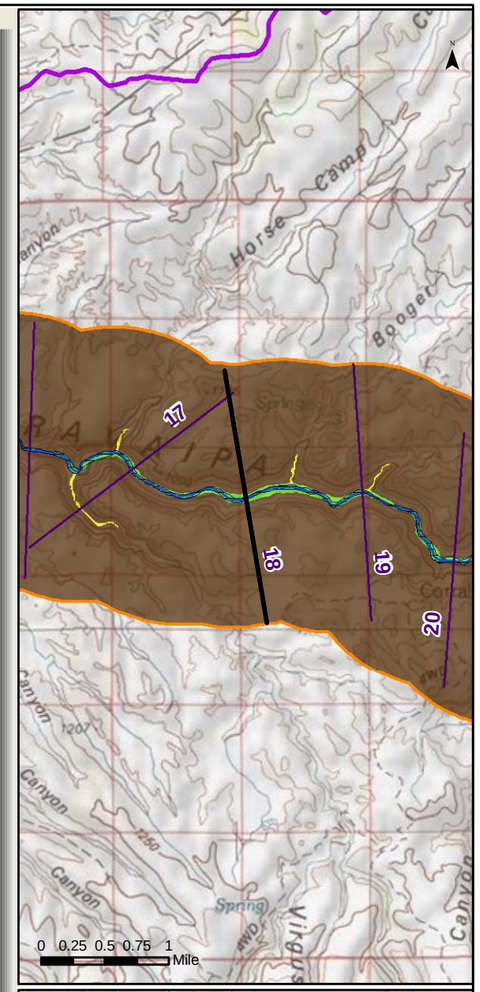
Appendix F

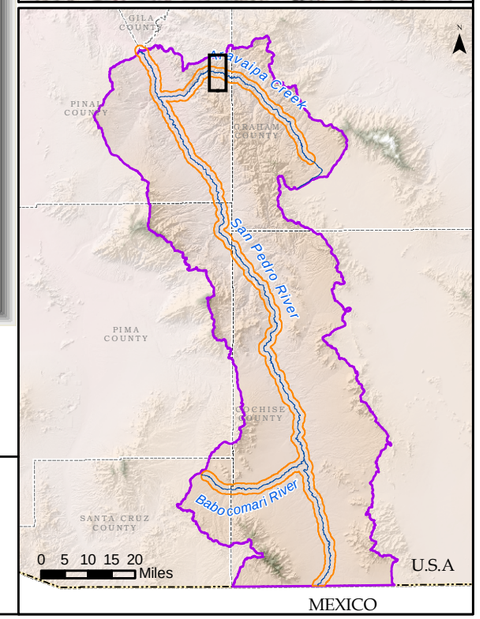
Aravaipa Creek Cross Section at Mile 17

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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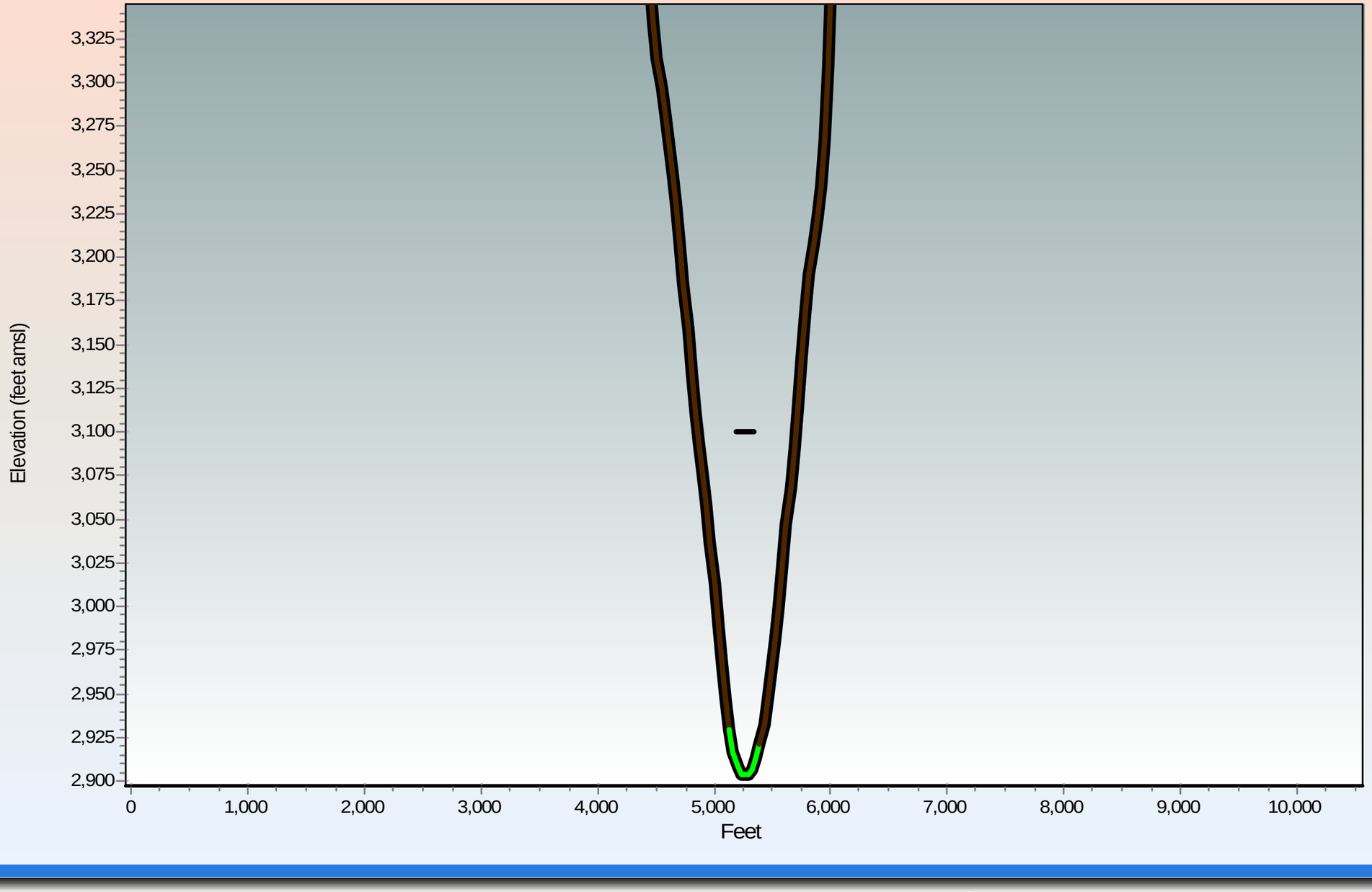
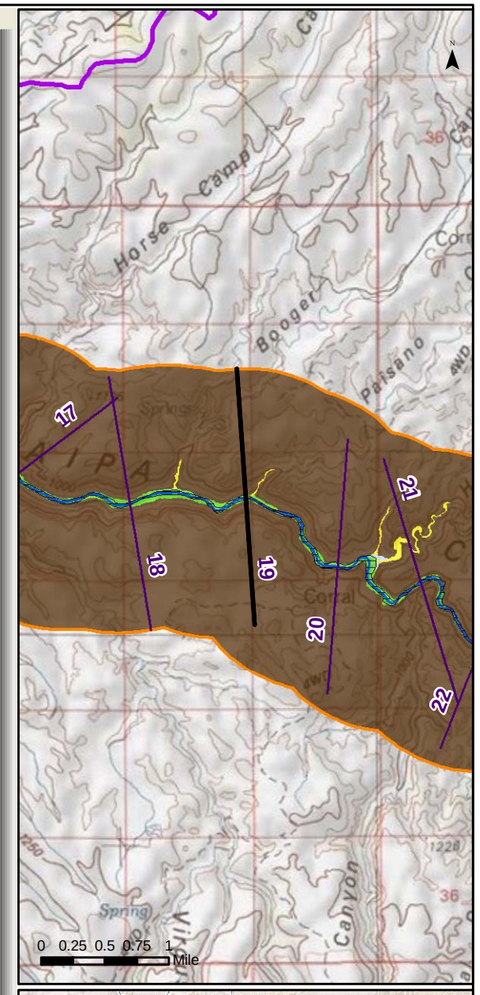
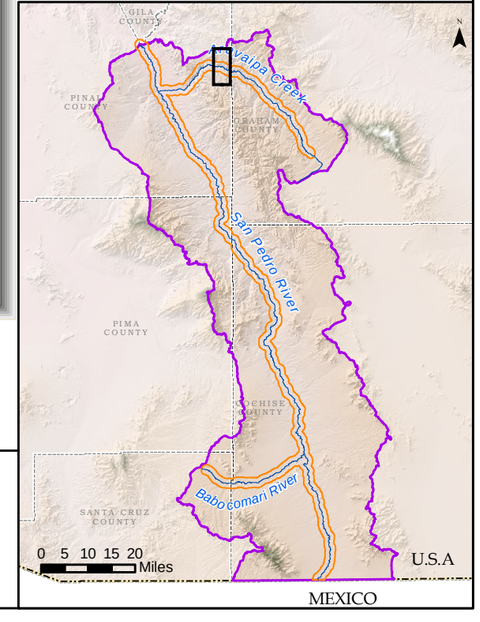
Appendix F
Aravaipa Creek Cross Section at Mile 18
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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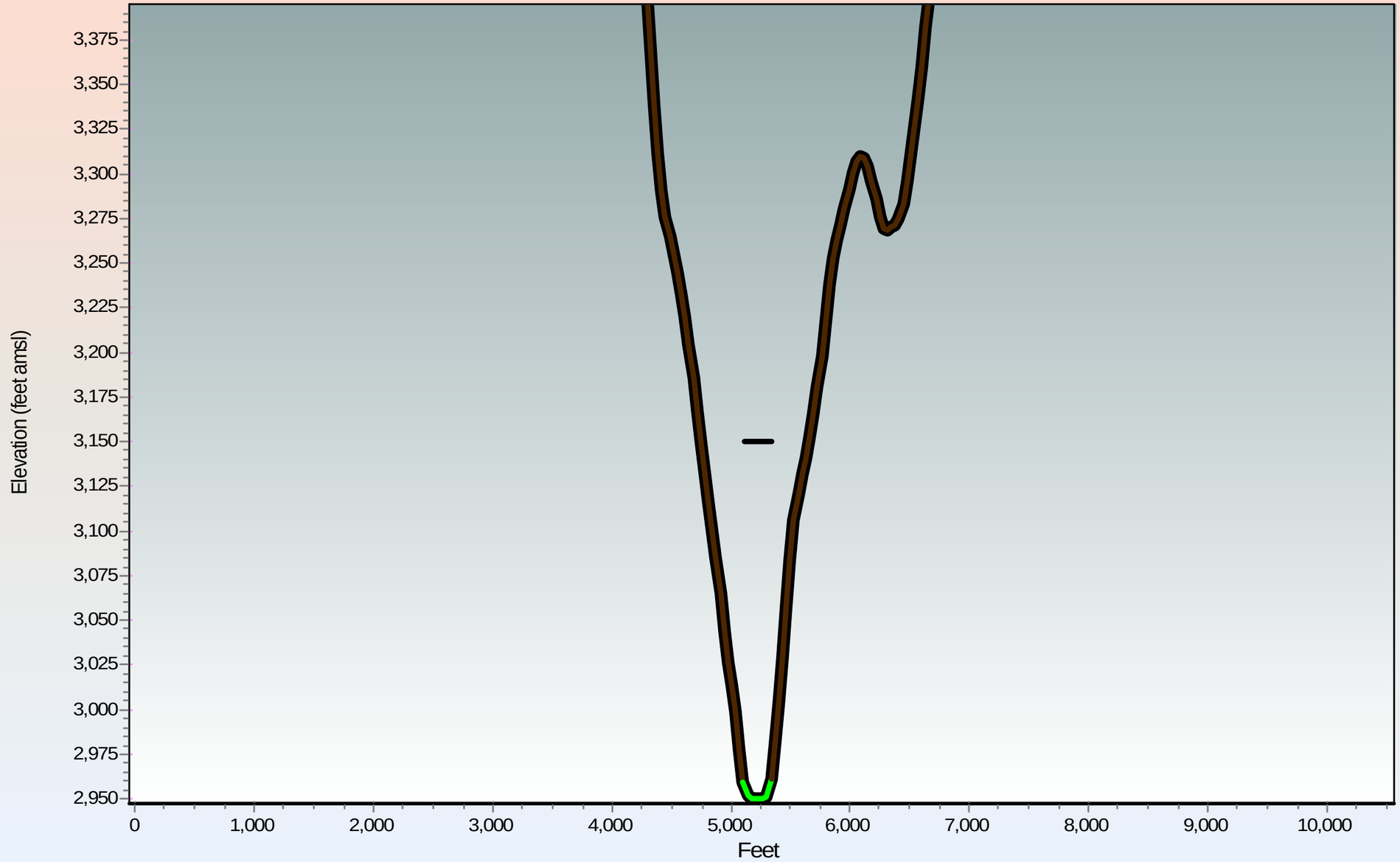
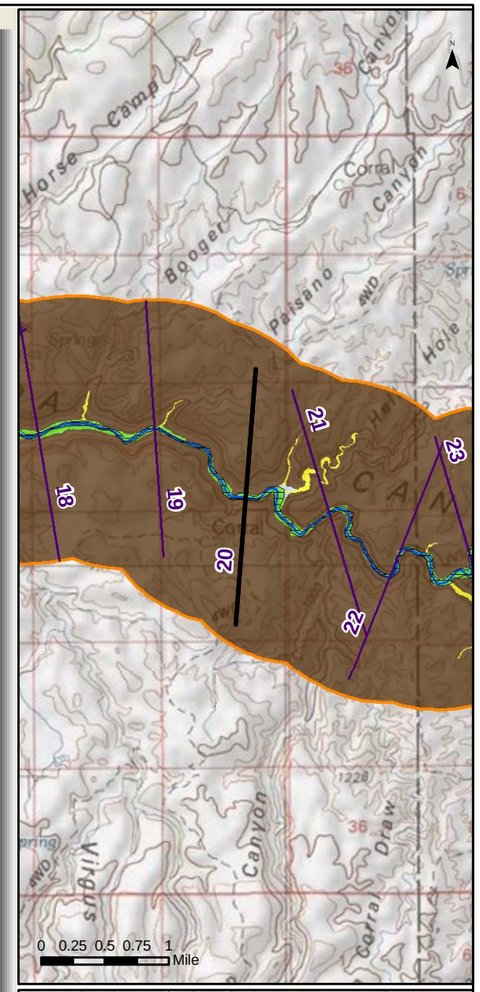
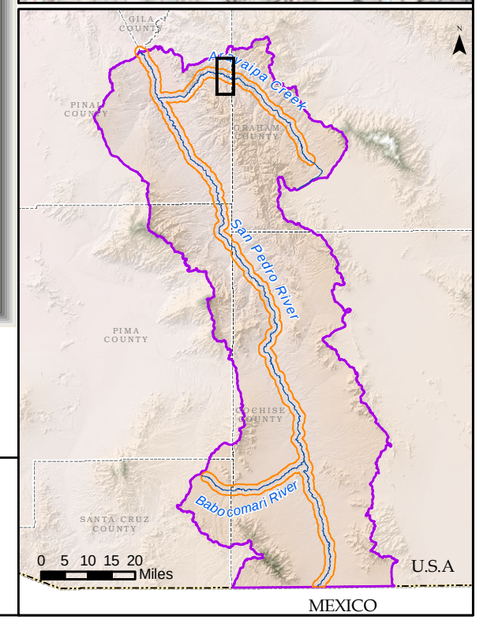
Appendix F
Aravaipa Creek Cross Section at Mile 19
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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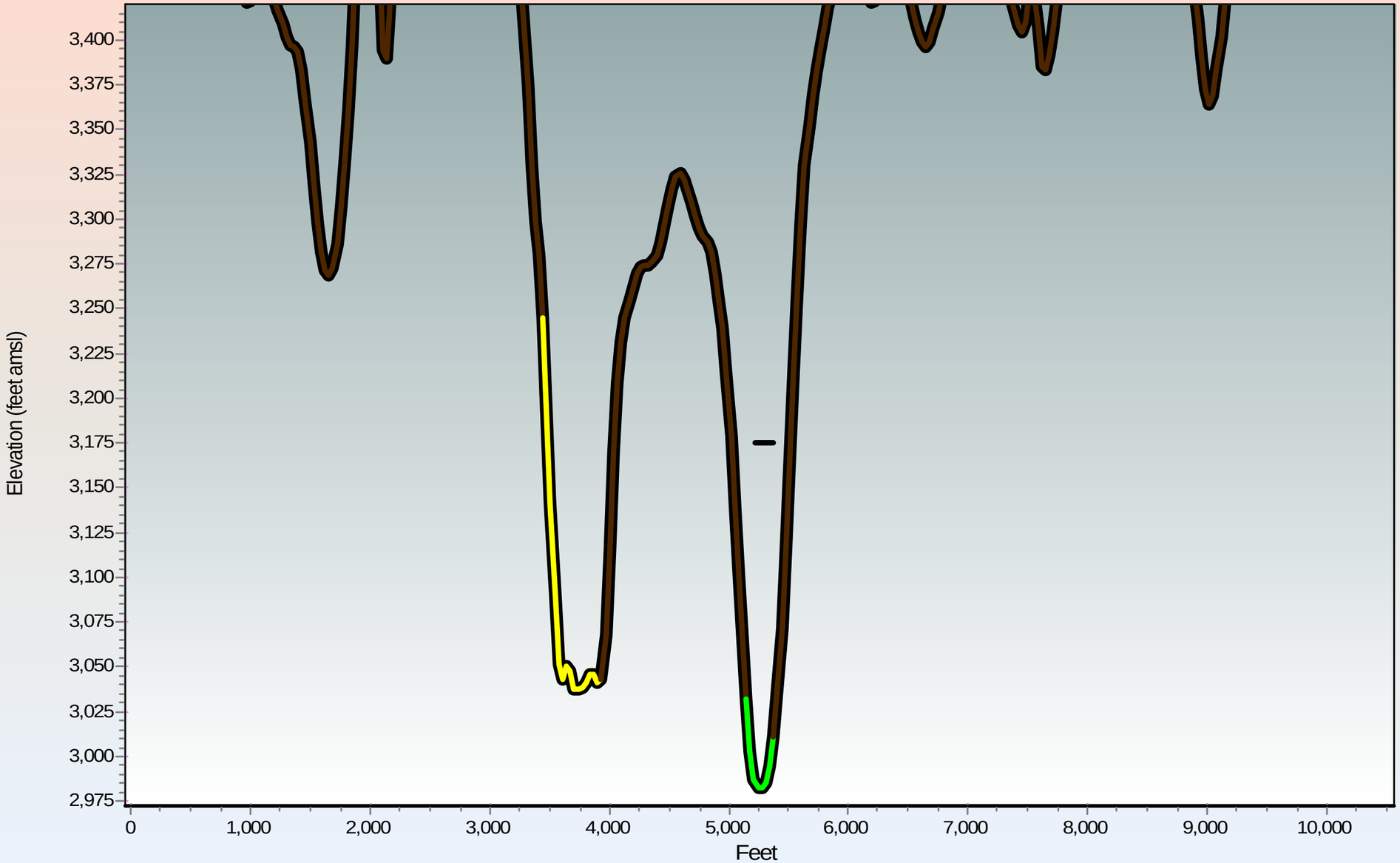
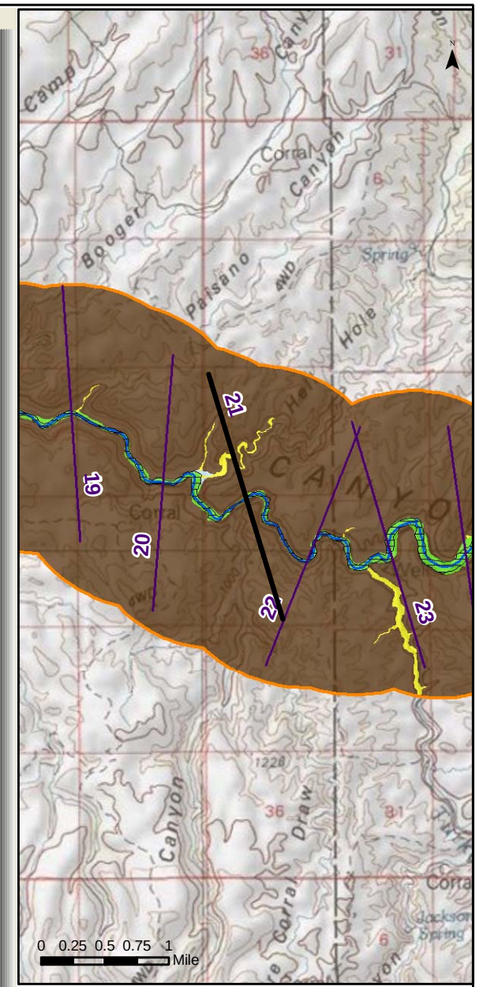
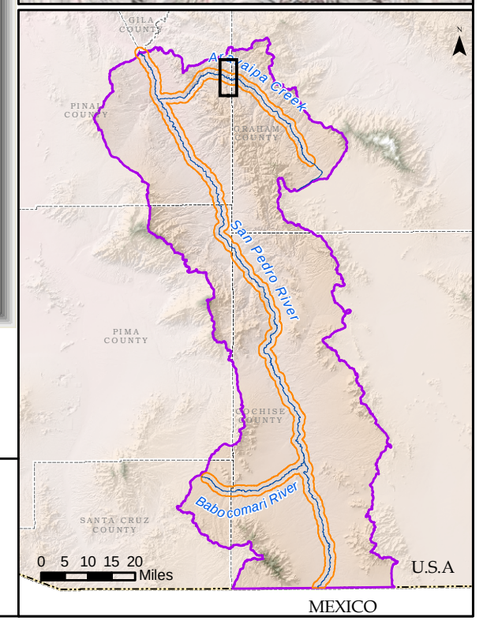
Appendix F
Aravaipa Creek Cross Section at Mile 20
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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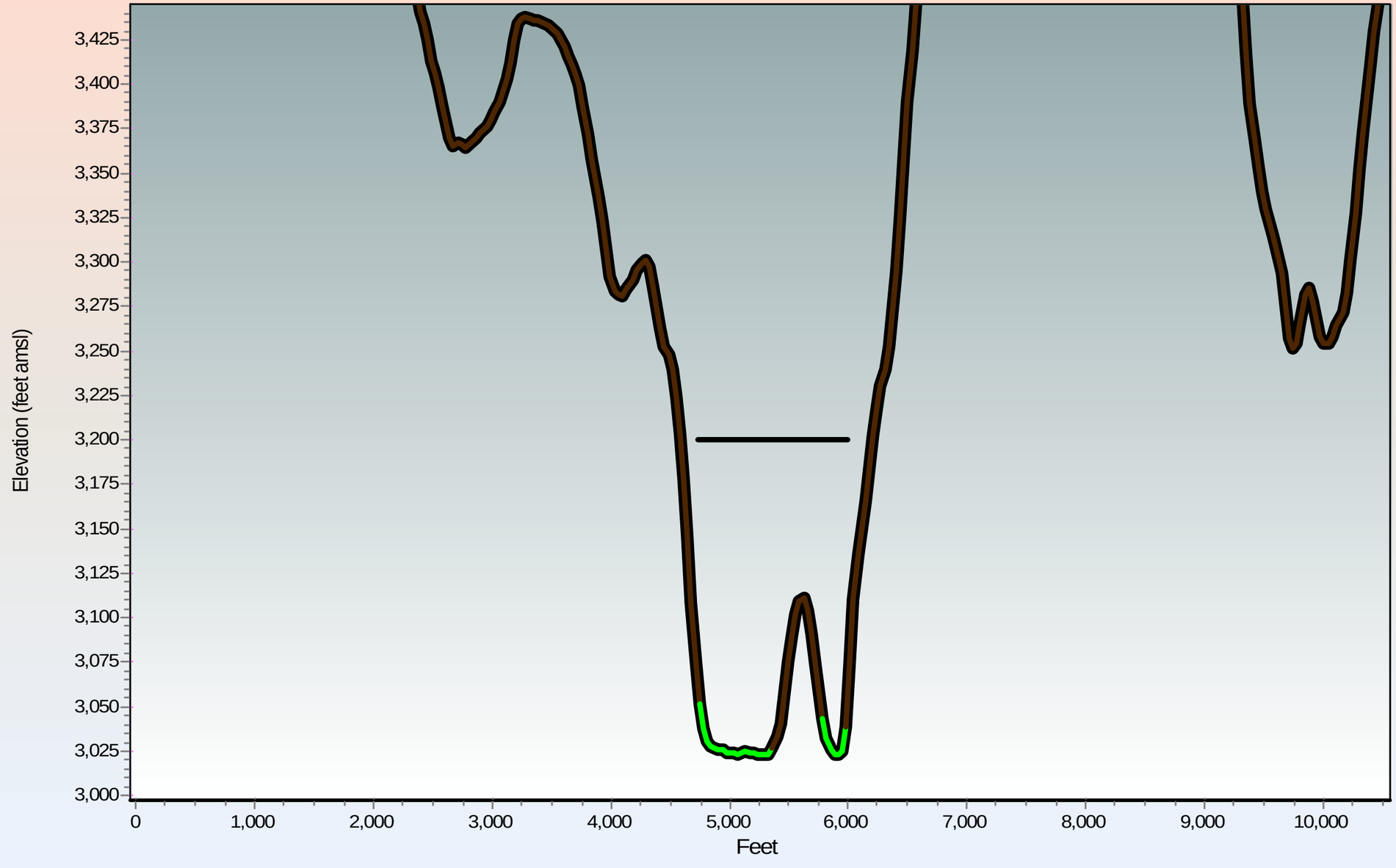
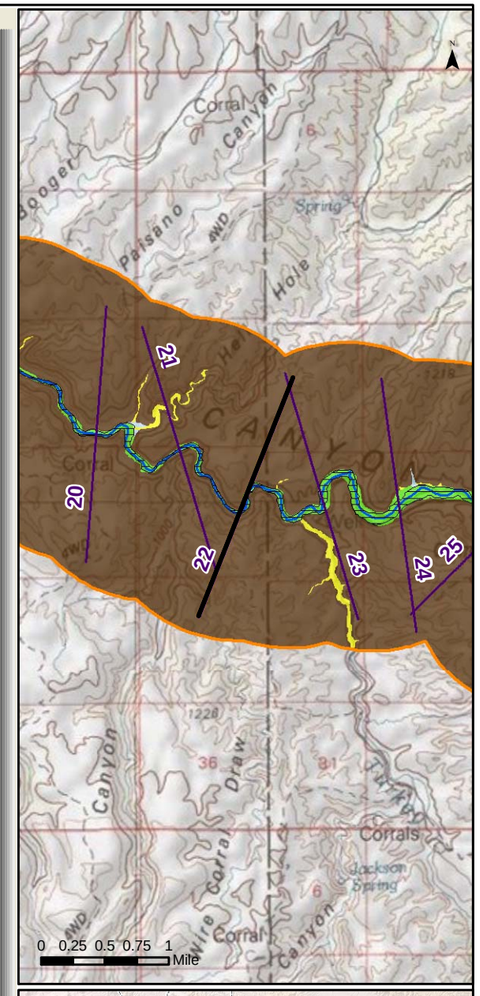
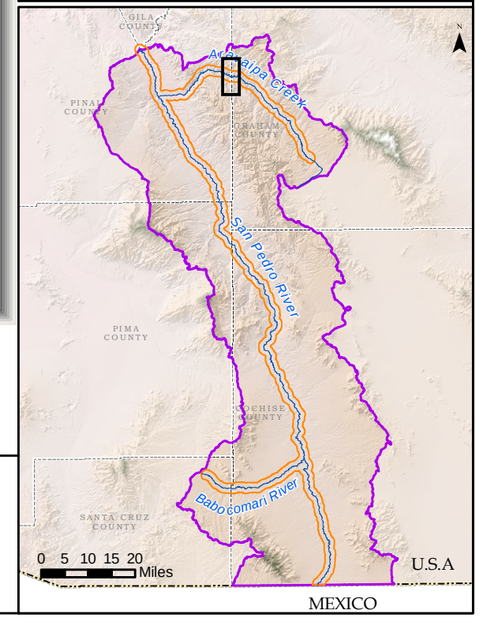
Appendix F
Aravaipa Creek Cross Section at Mile 21
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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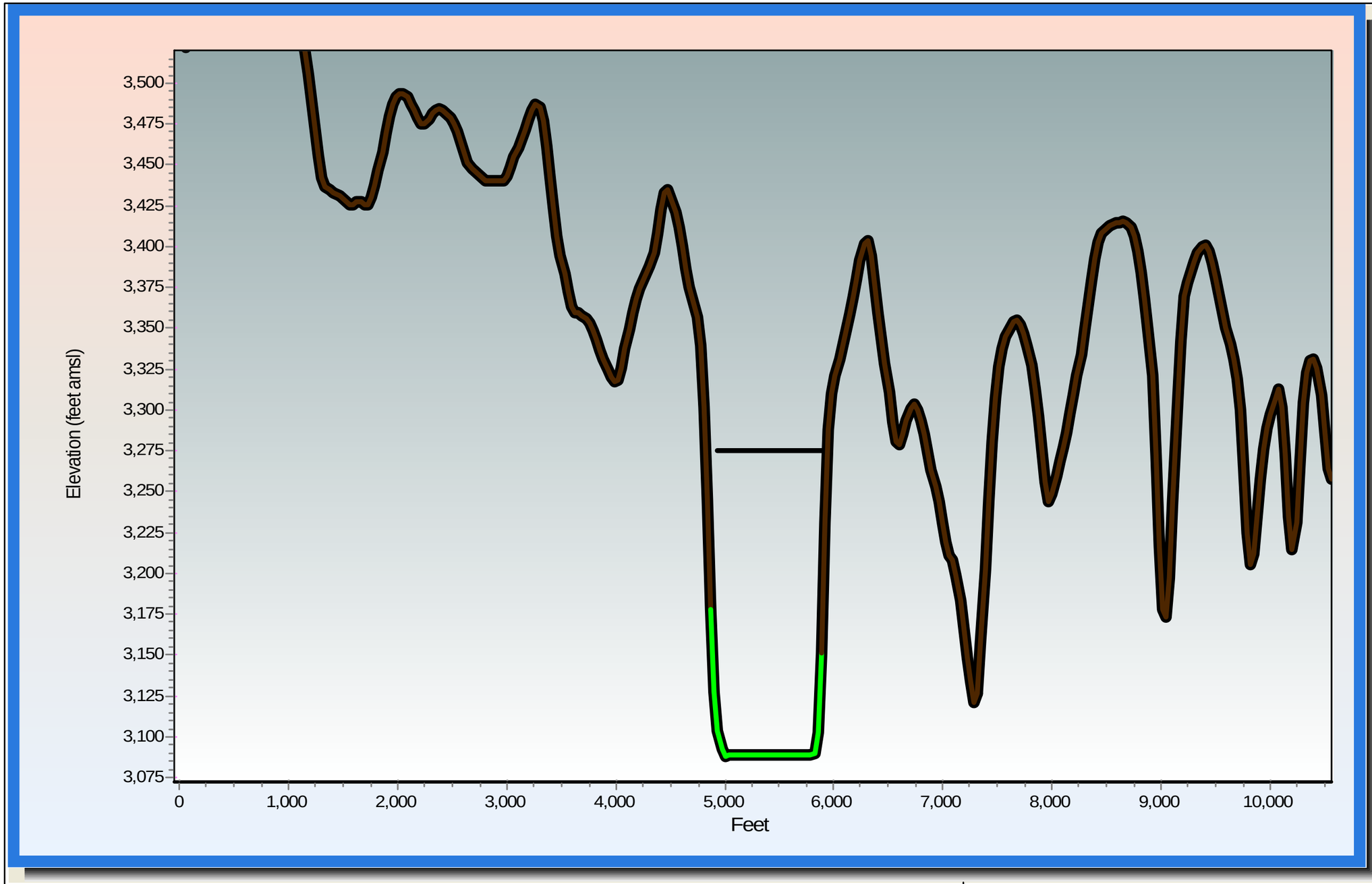
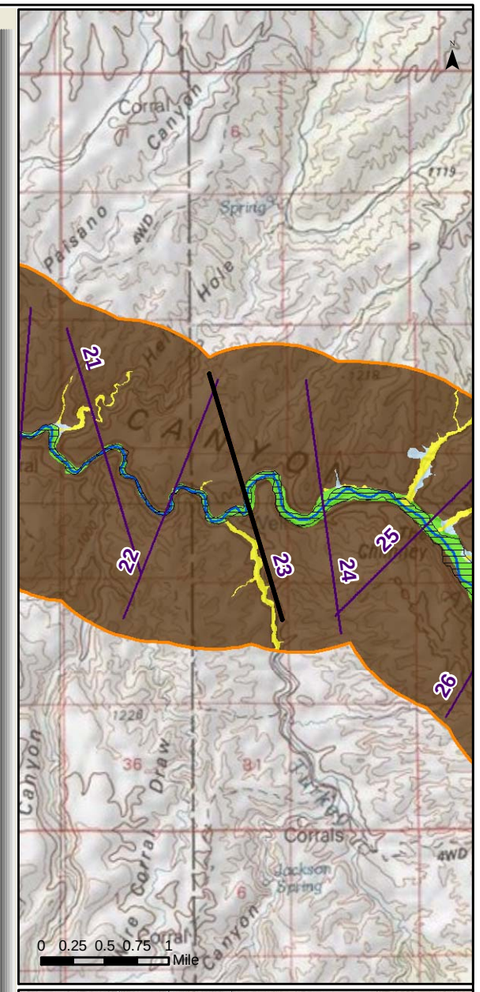
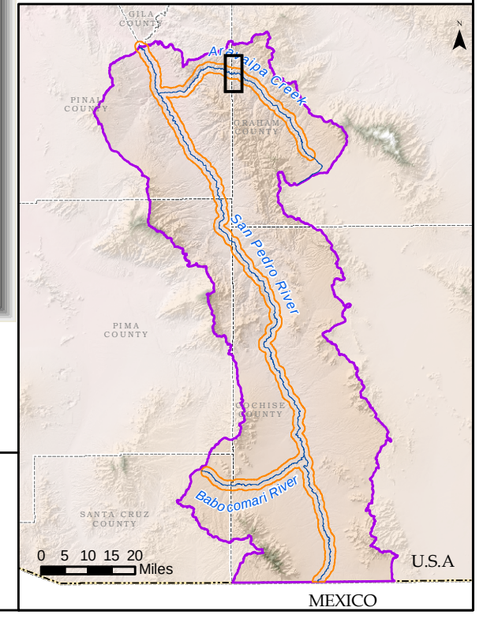
Appendix F
Aravaipa Creek Cross Section at Mile 22
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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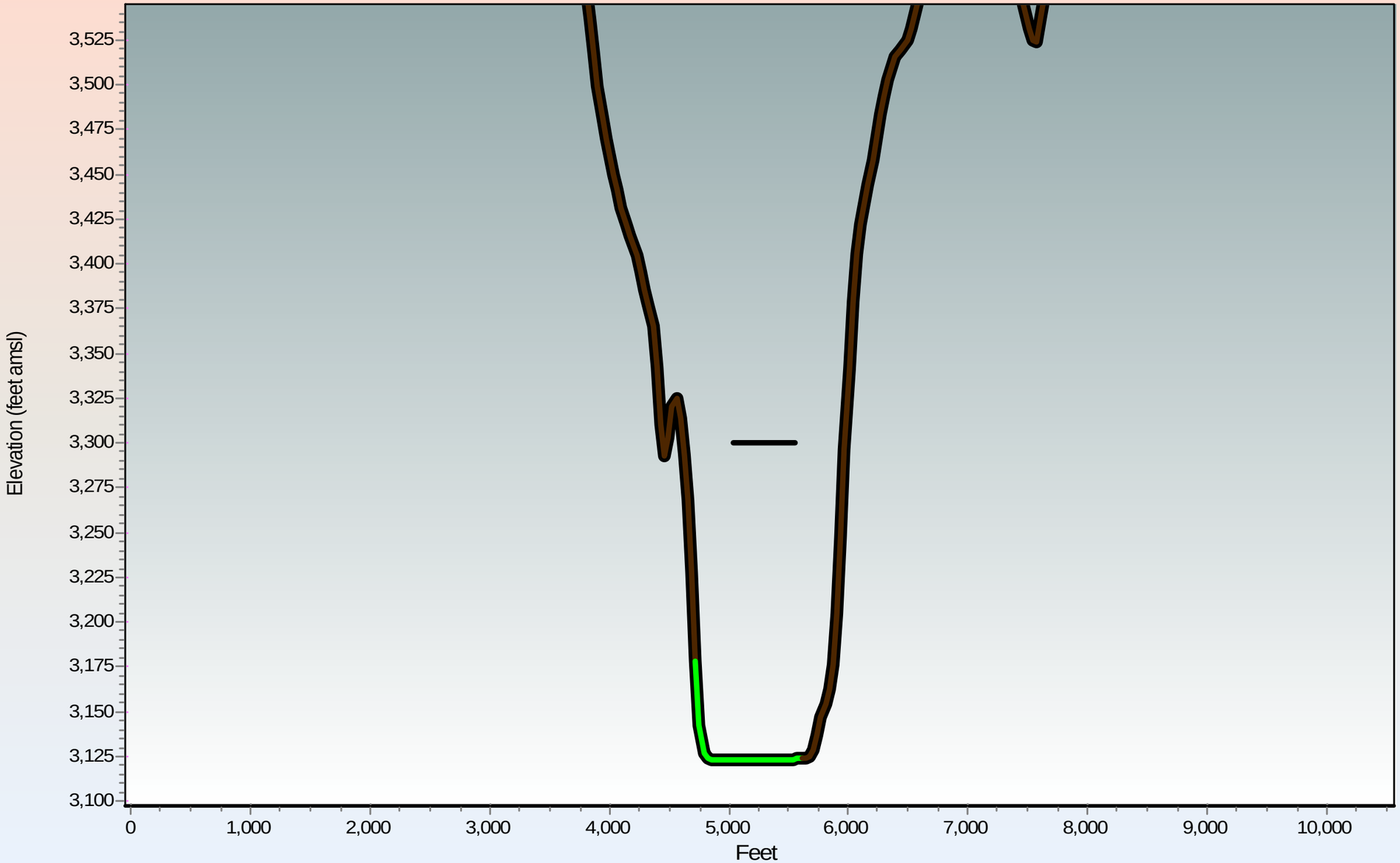
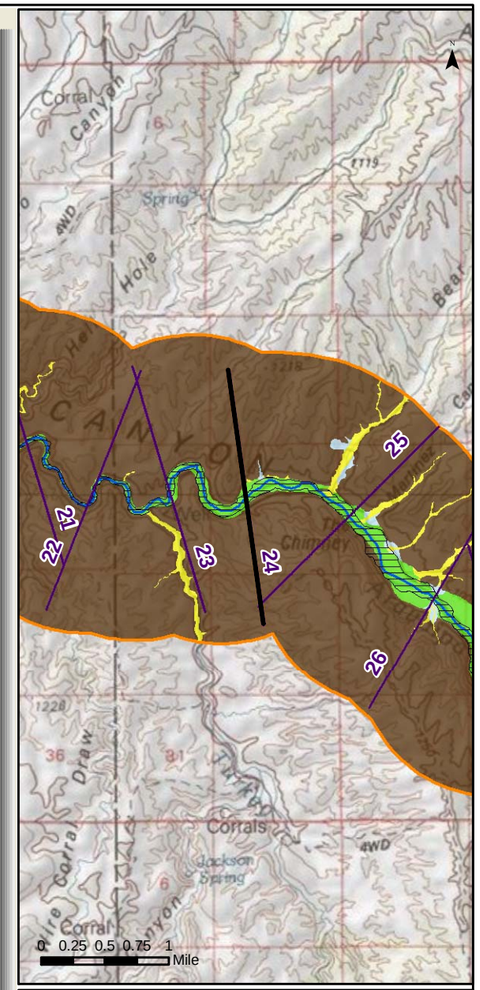
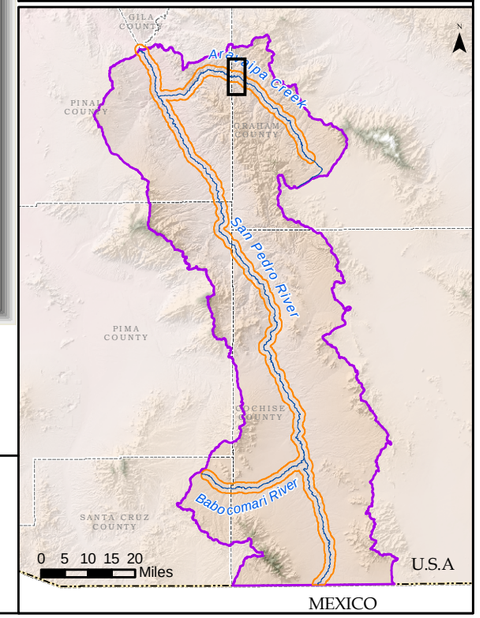
Appendix F
Aravaipa Creek Cross Section at Mile 23
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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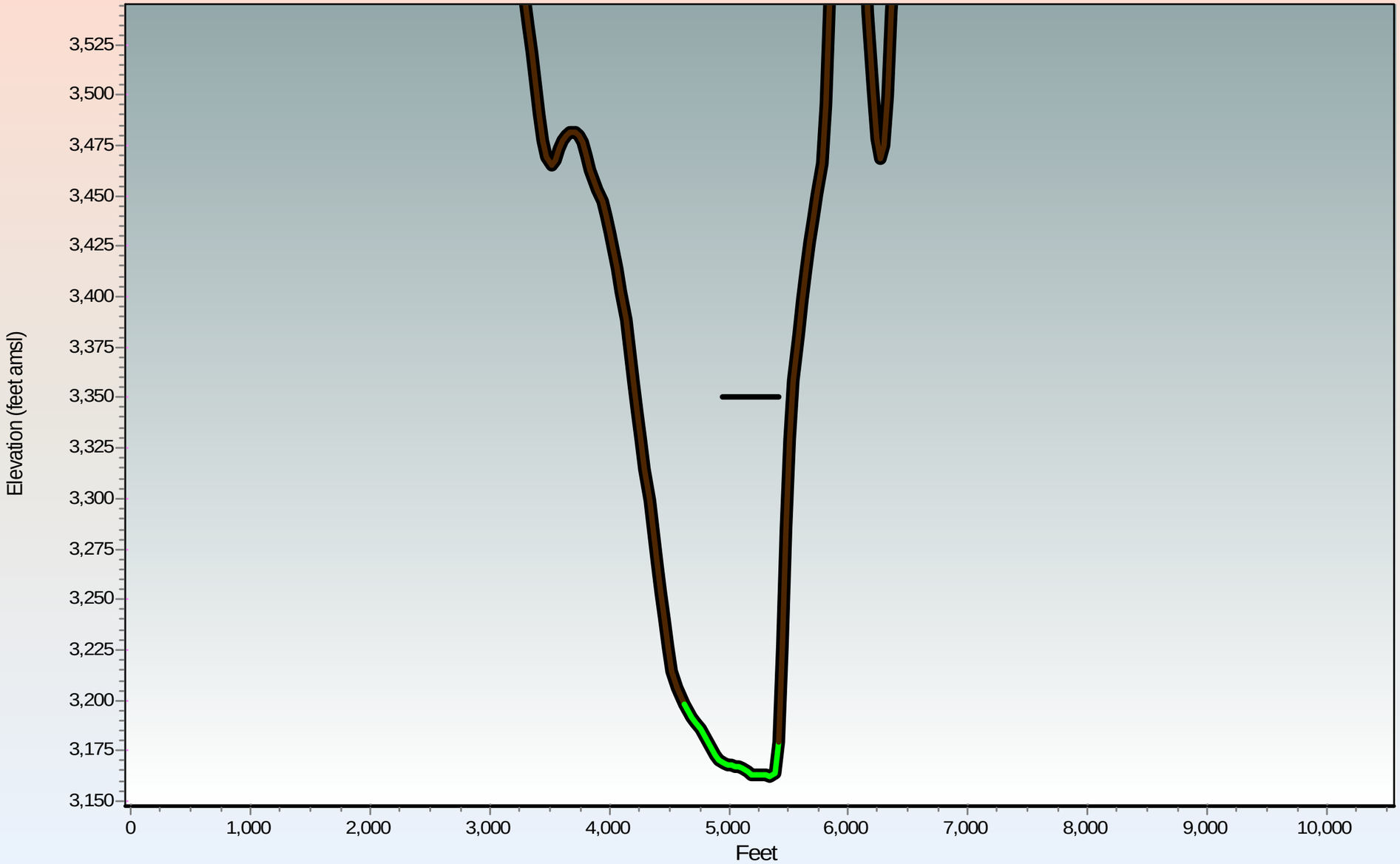
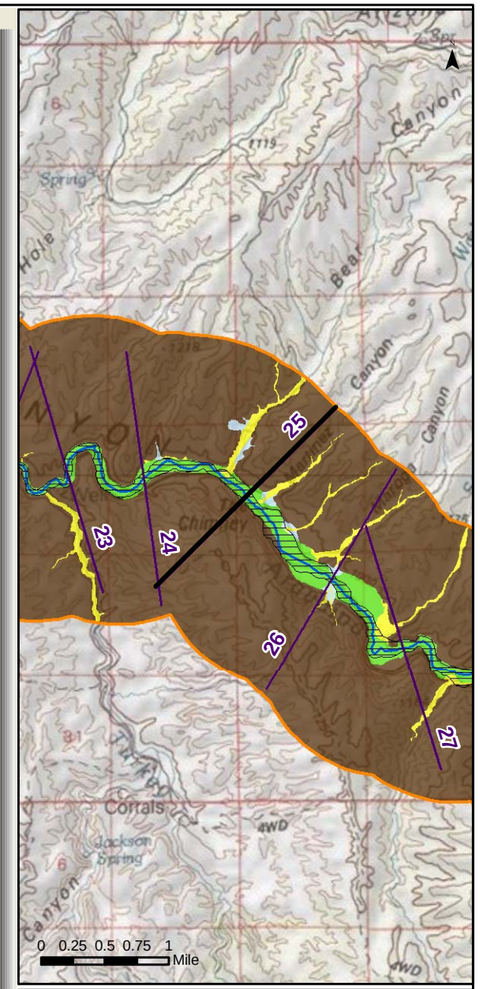
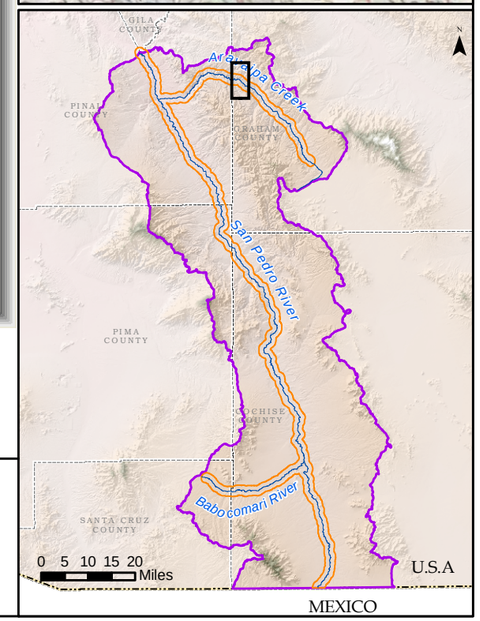
Appendix F
Aravaipa Creek Cross Section at Mile 24
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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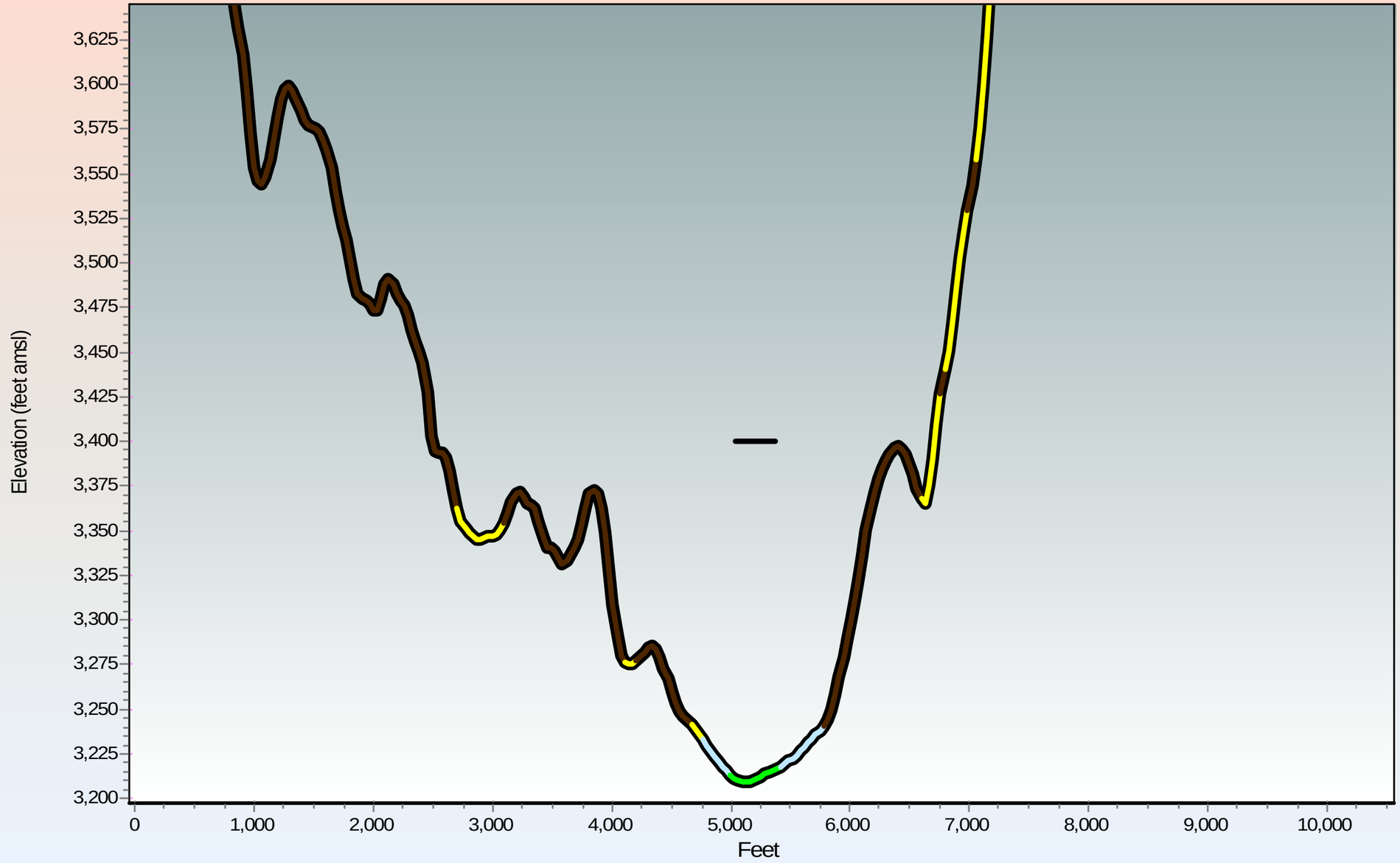
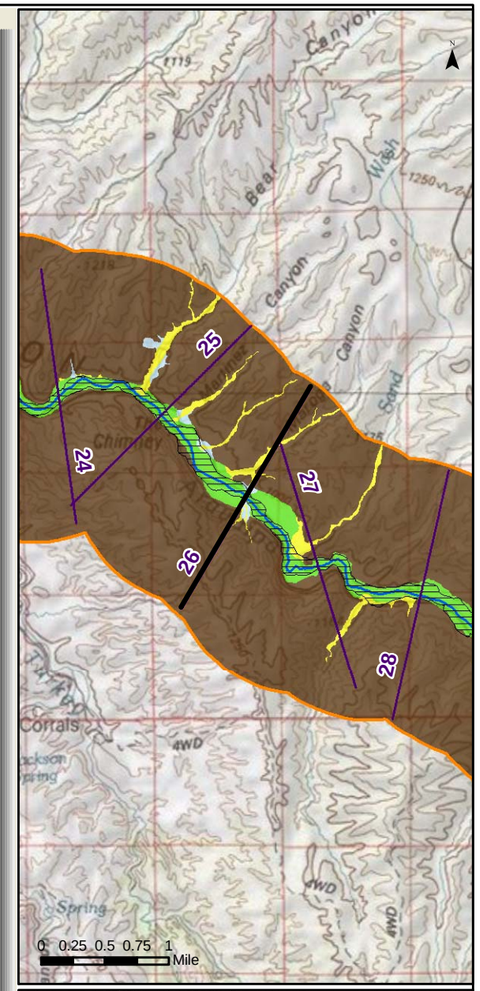
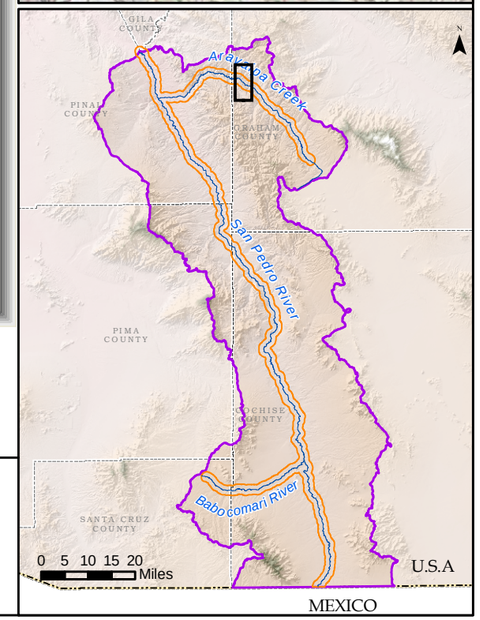
Appendix F
Aravaipa Creek Cross Section at Mile 25
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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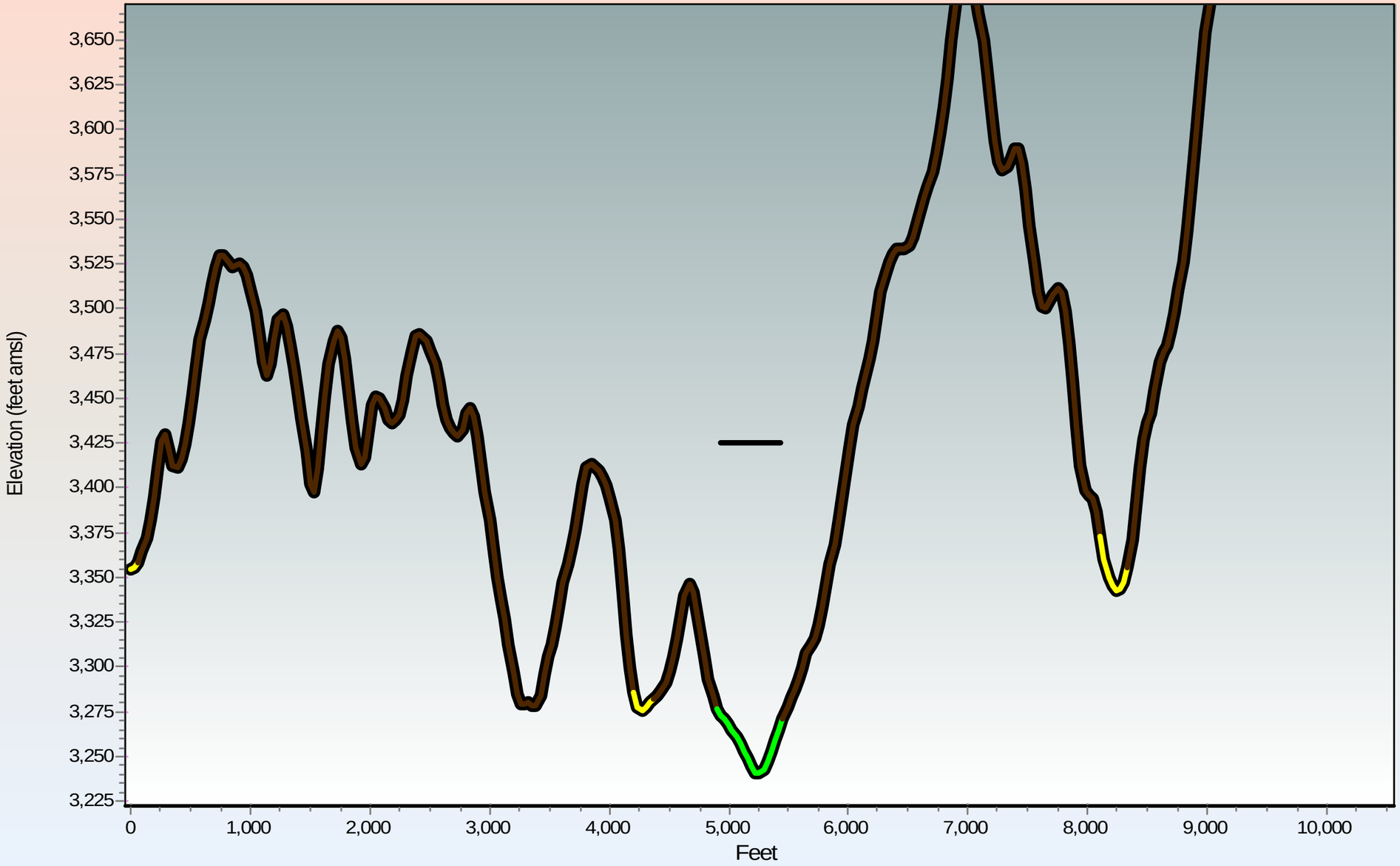
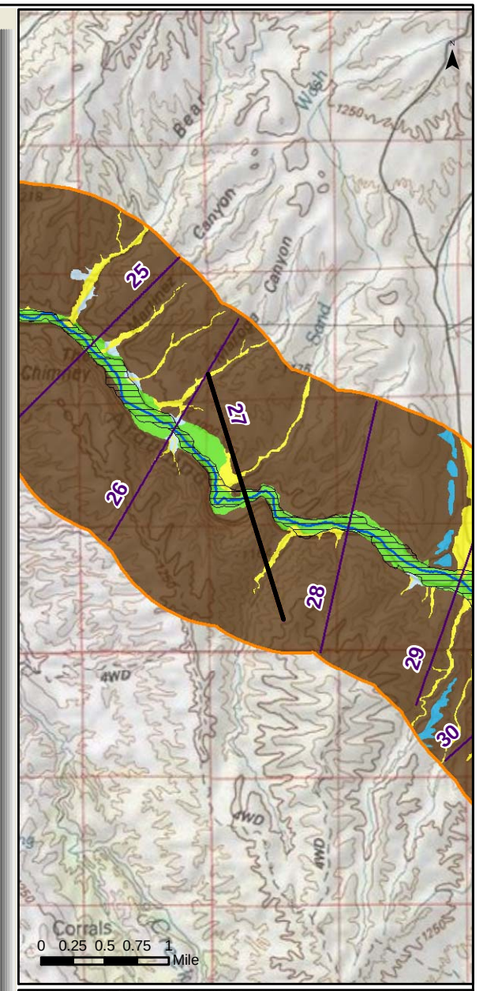
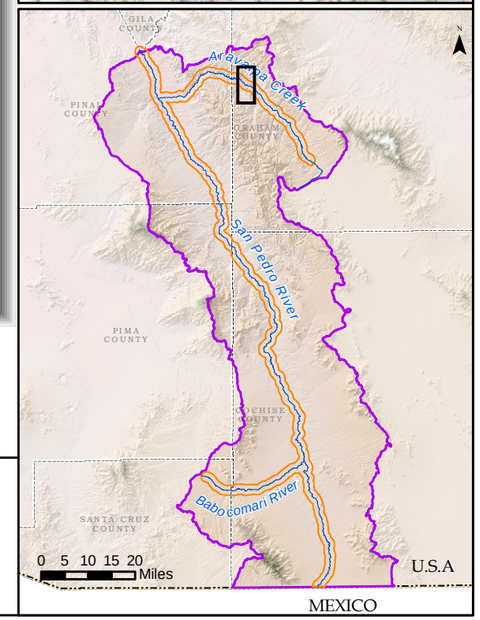
Appendix F
Aravaipa Creek Cross Section at Mile 26
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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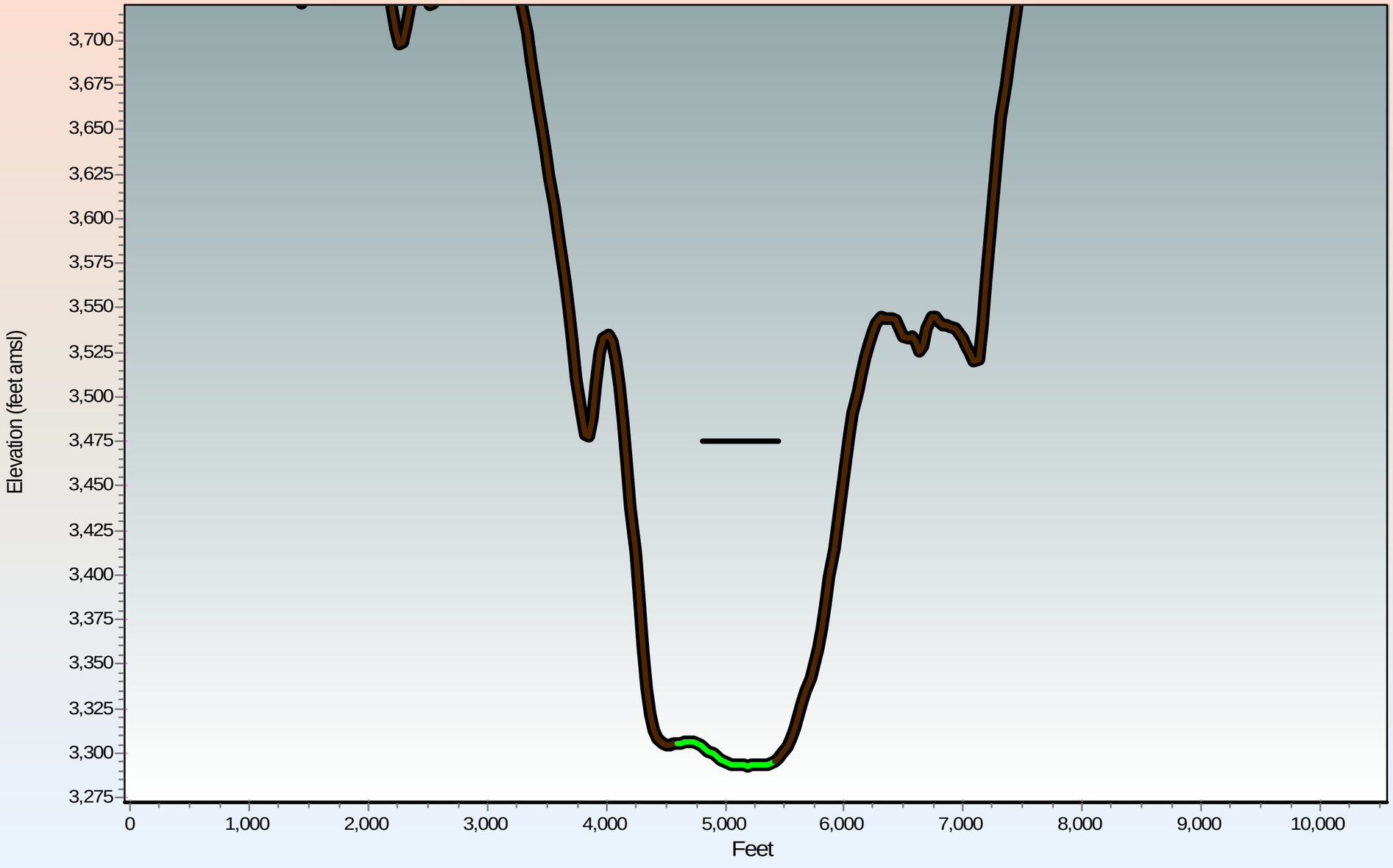
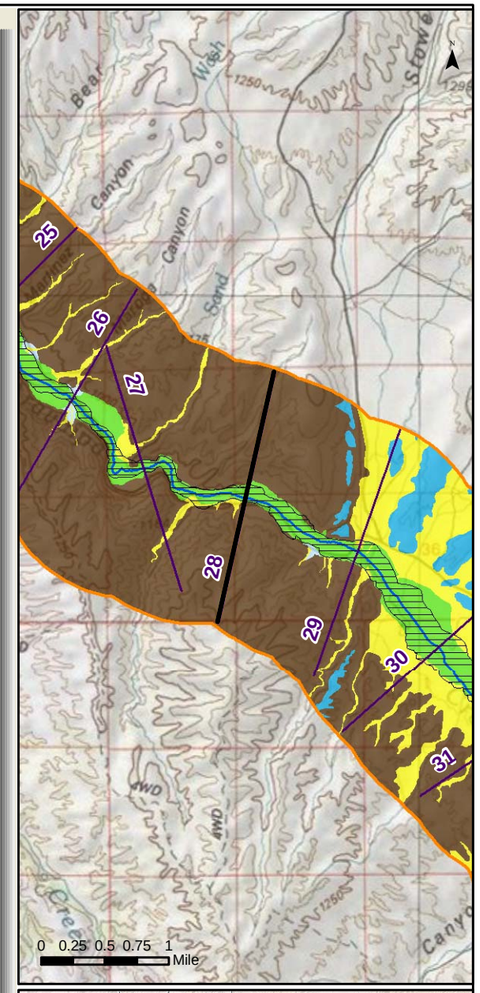
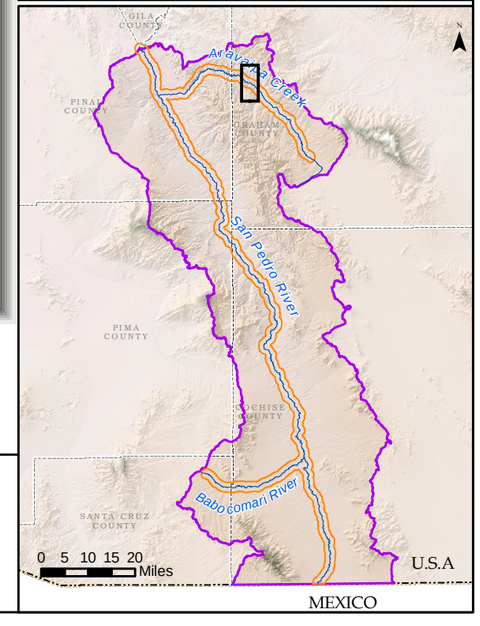
Appendix F
Aravaipa Creek Cross Section at Mile 27
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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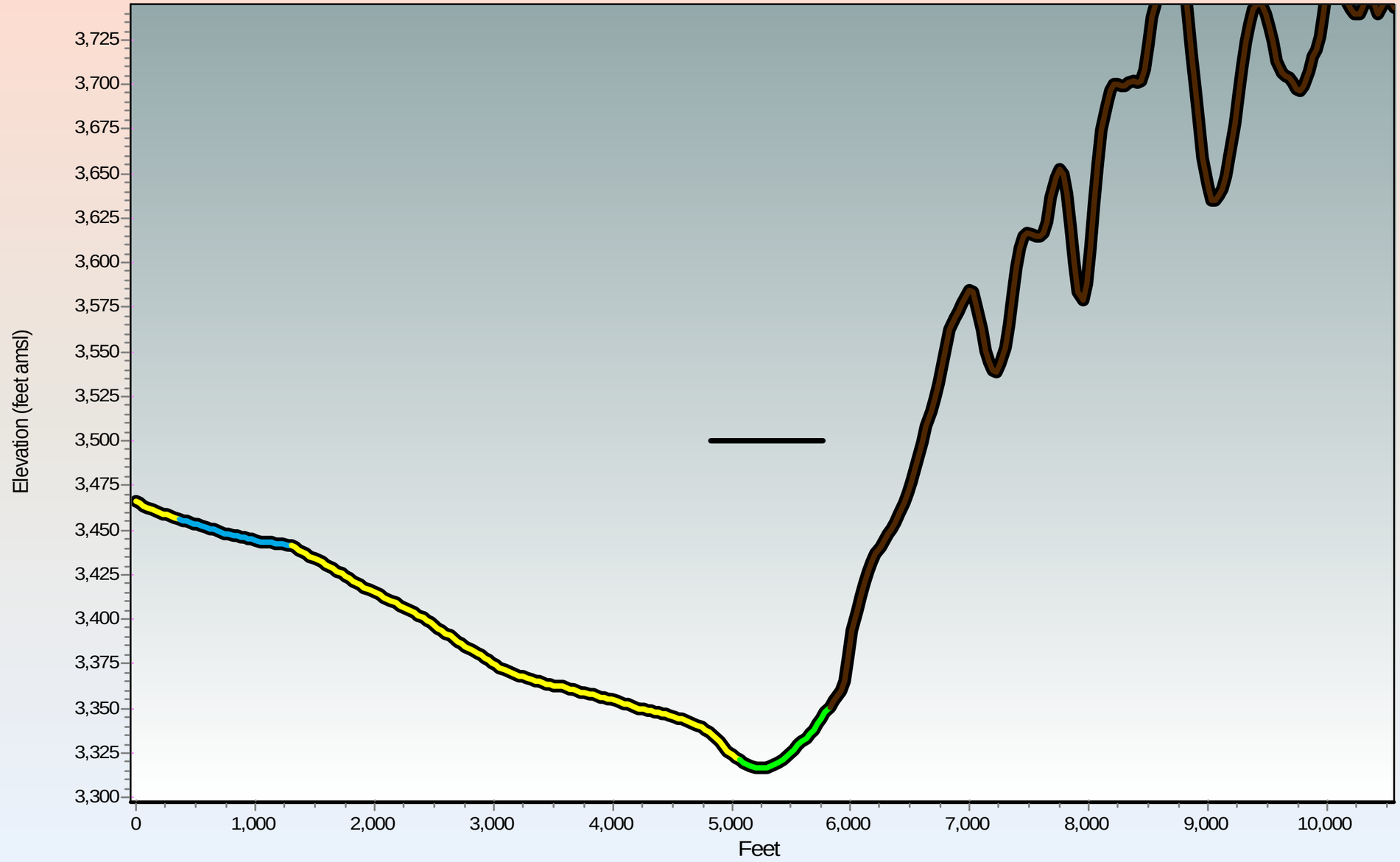
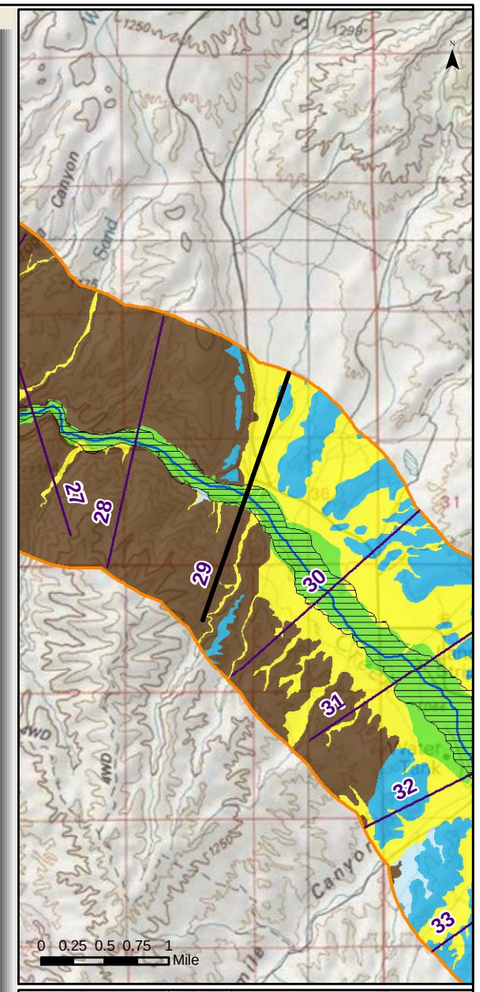
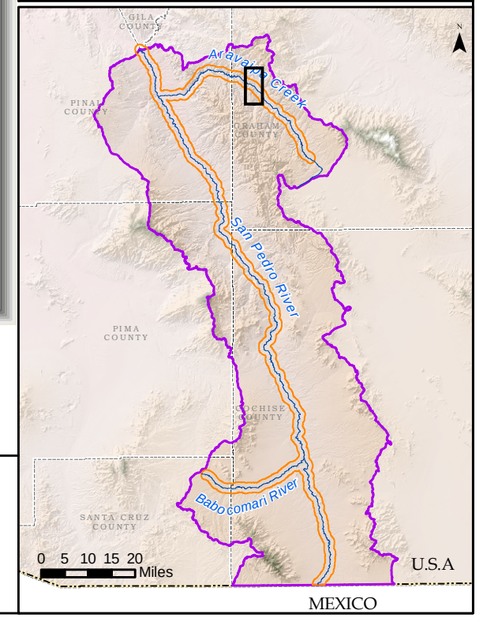
Appendix F
Aravaipa Creek Cross Section at Mile 28
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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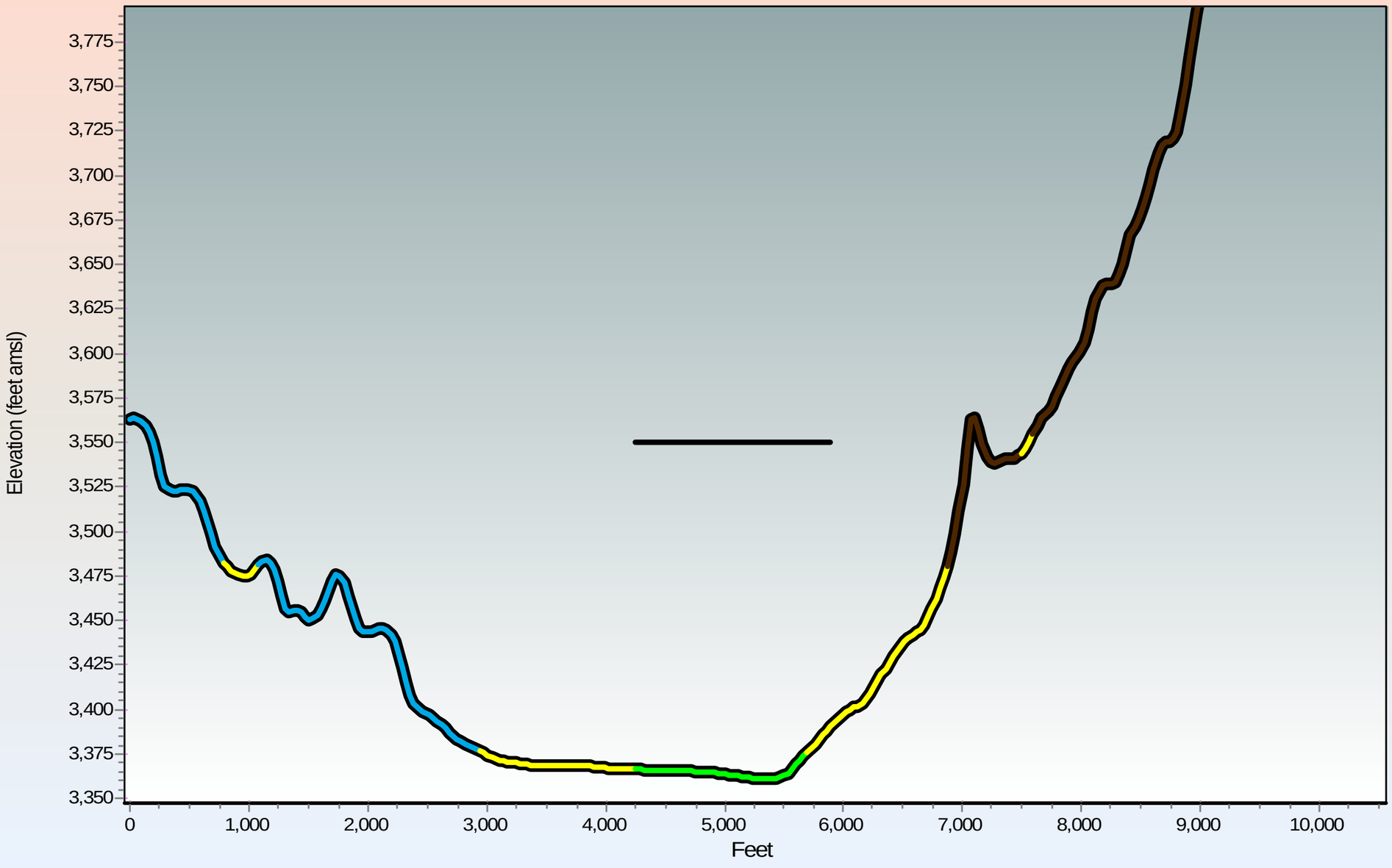
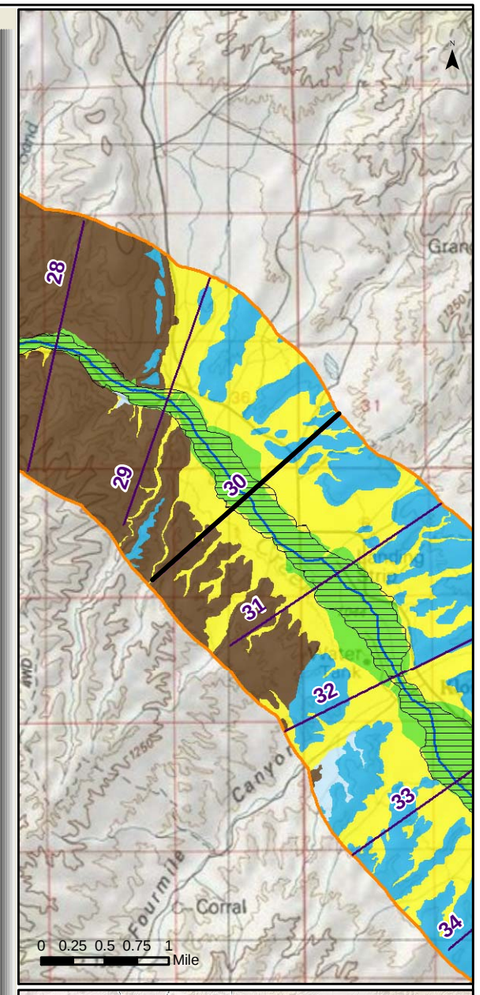
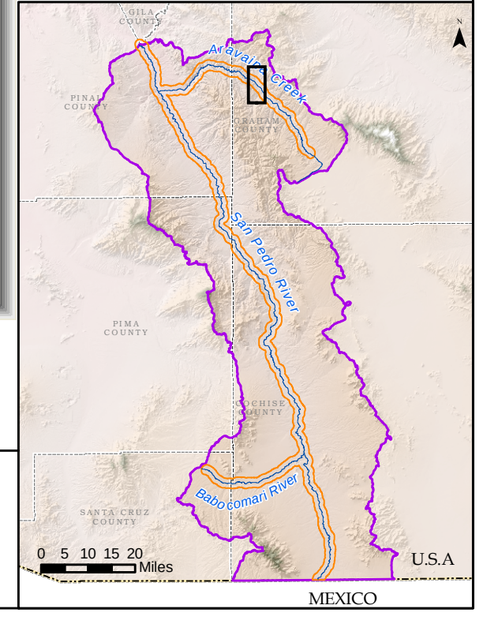
Appendix F
Aravaipa Creek Cross Section at Mile 29
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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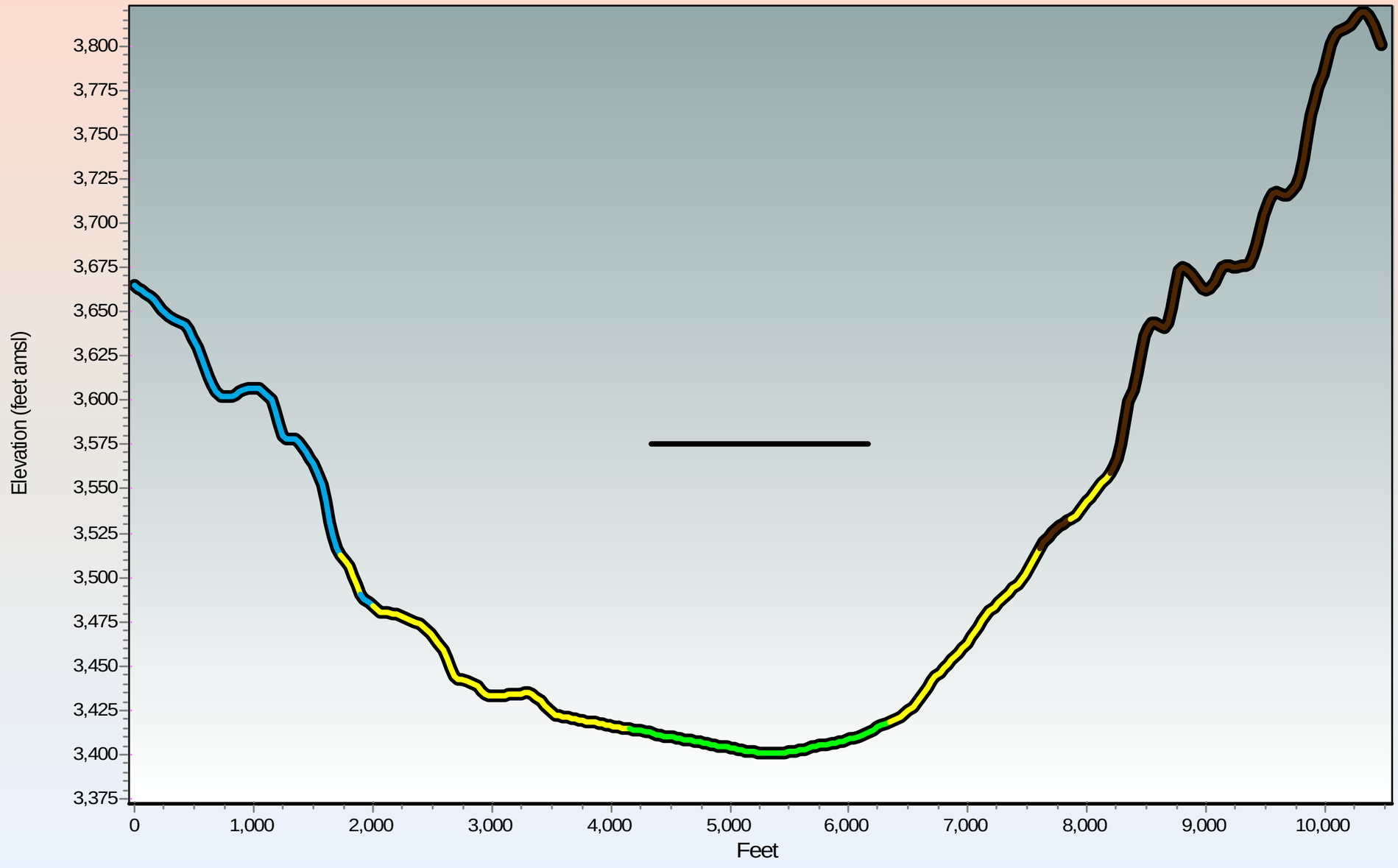
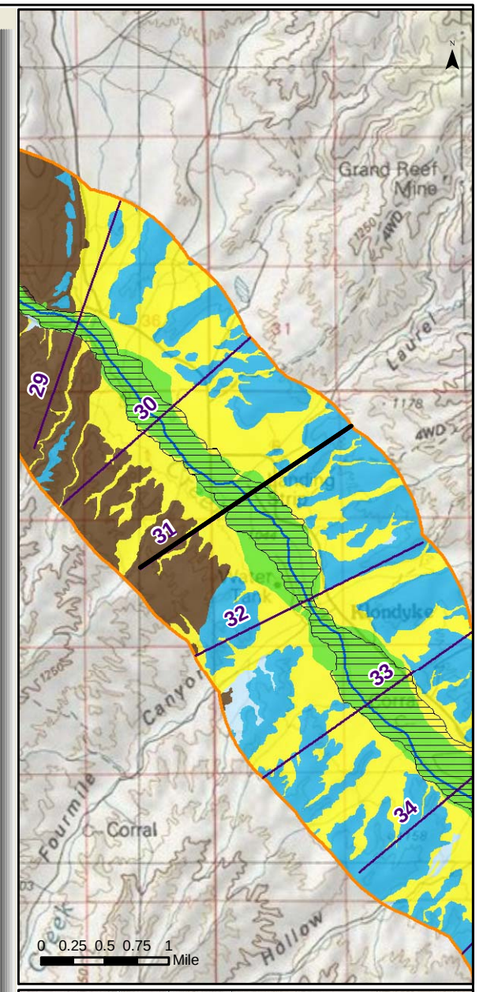
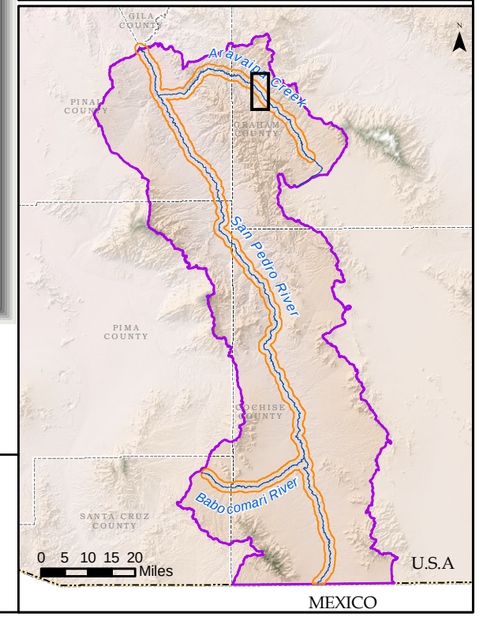
Appendix F
Aravaipa Creek Cross Section at Mile 30
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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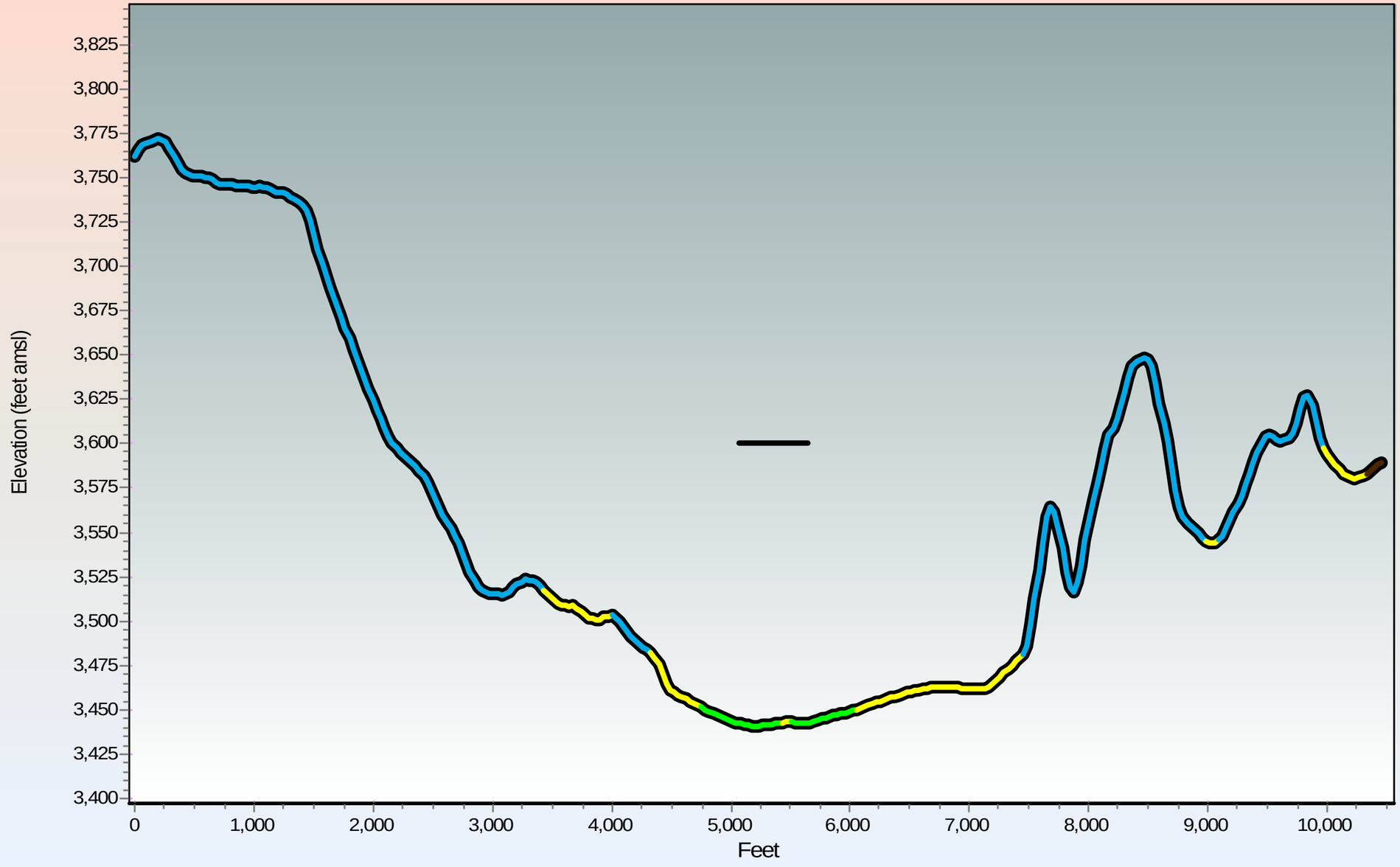
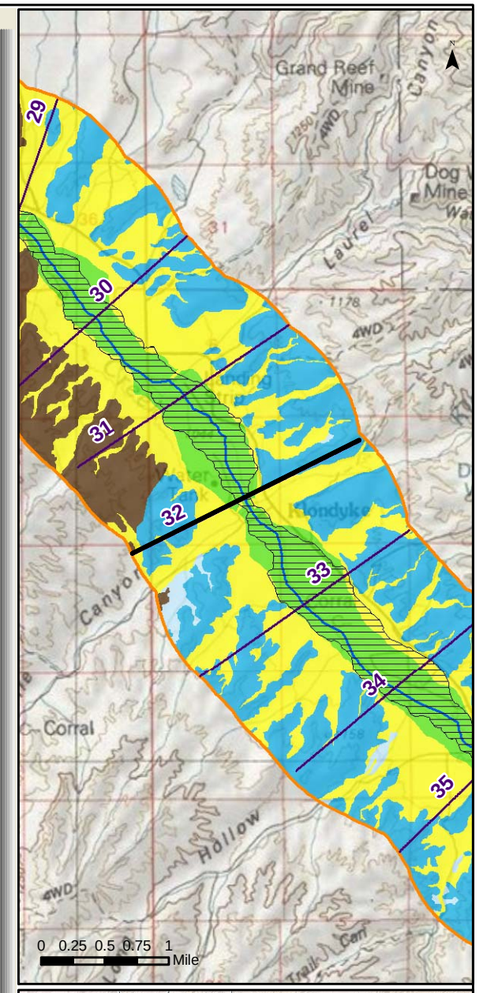
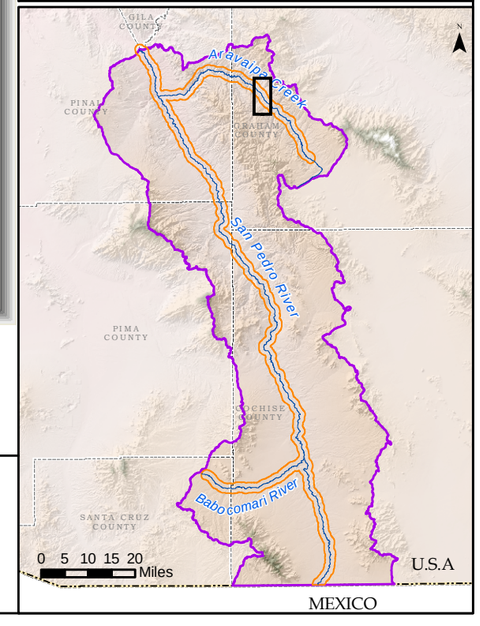
Appendix F
Aravaipa Creek Cross Section at Mile 31
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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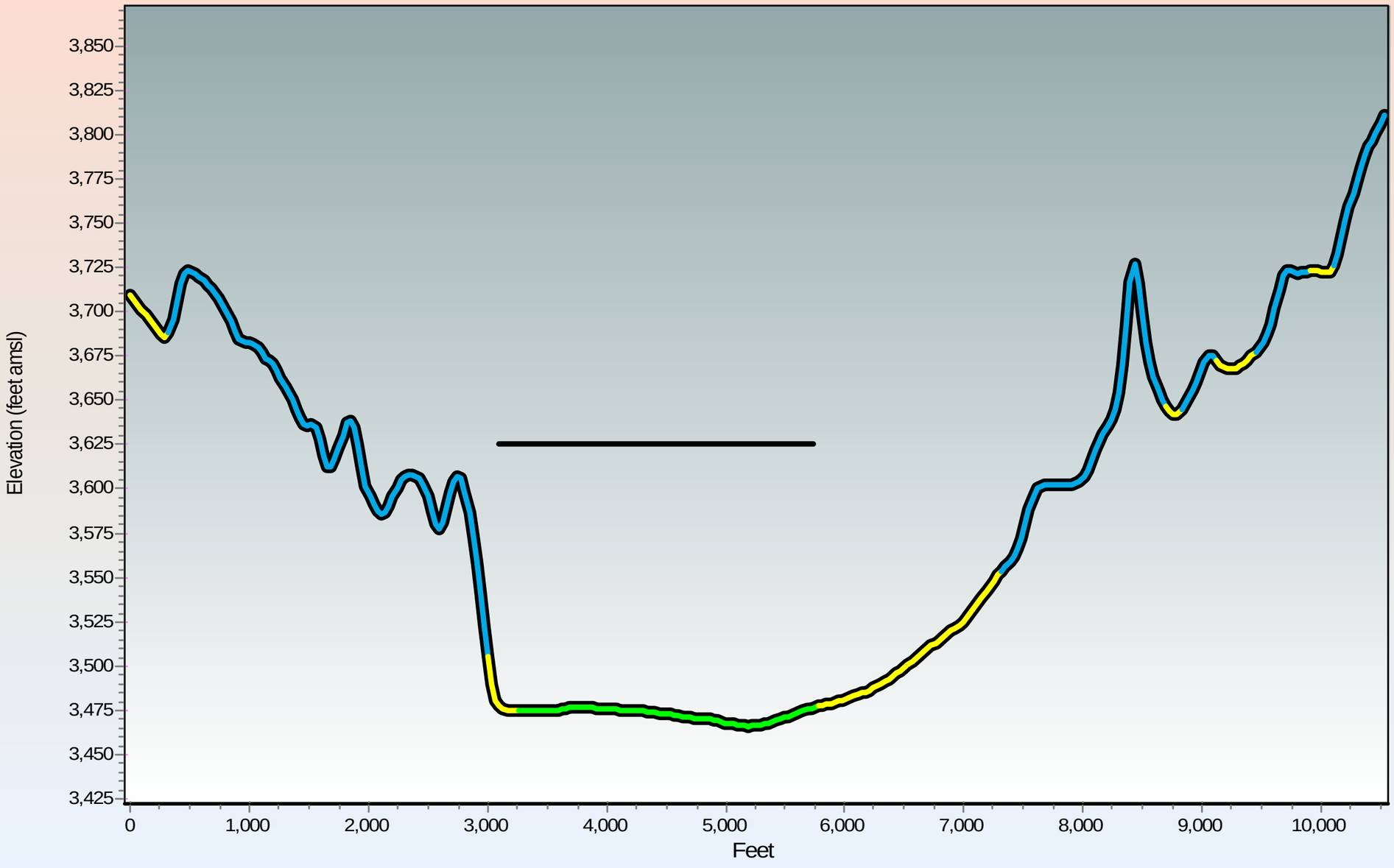
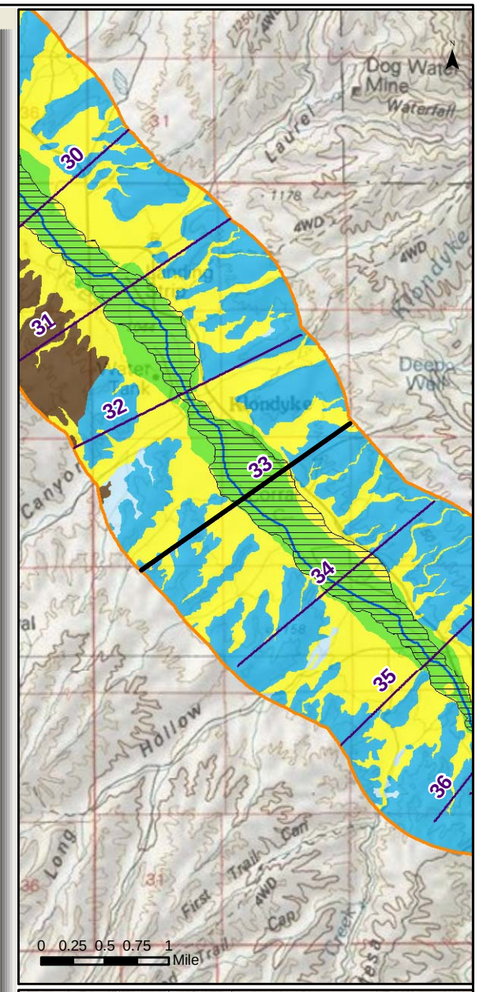
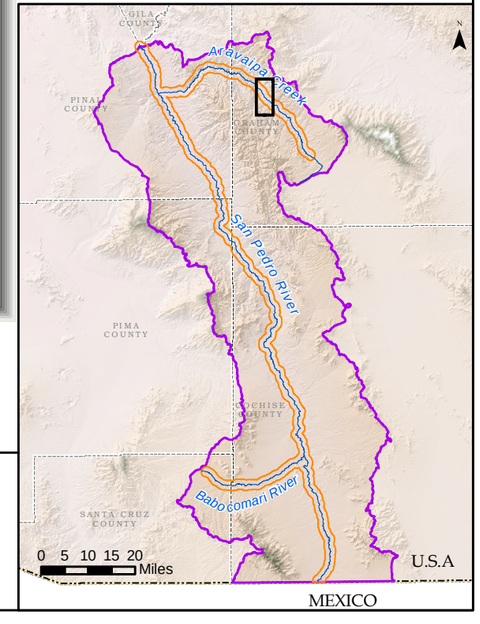
Appendix F
Aravaipa Creek Cross Section at Mile 32
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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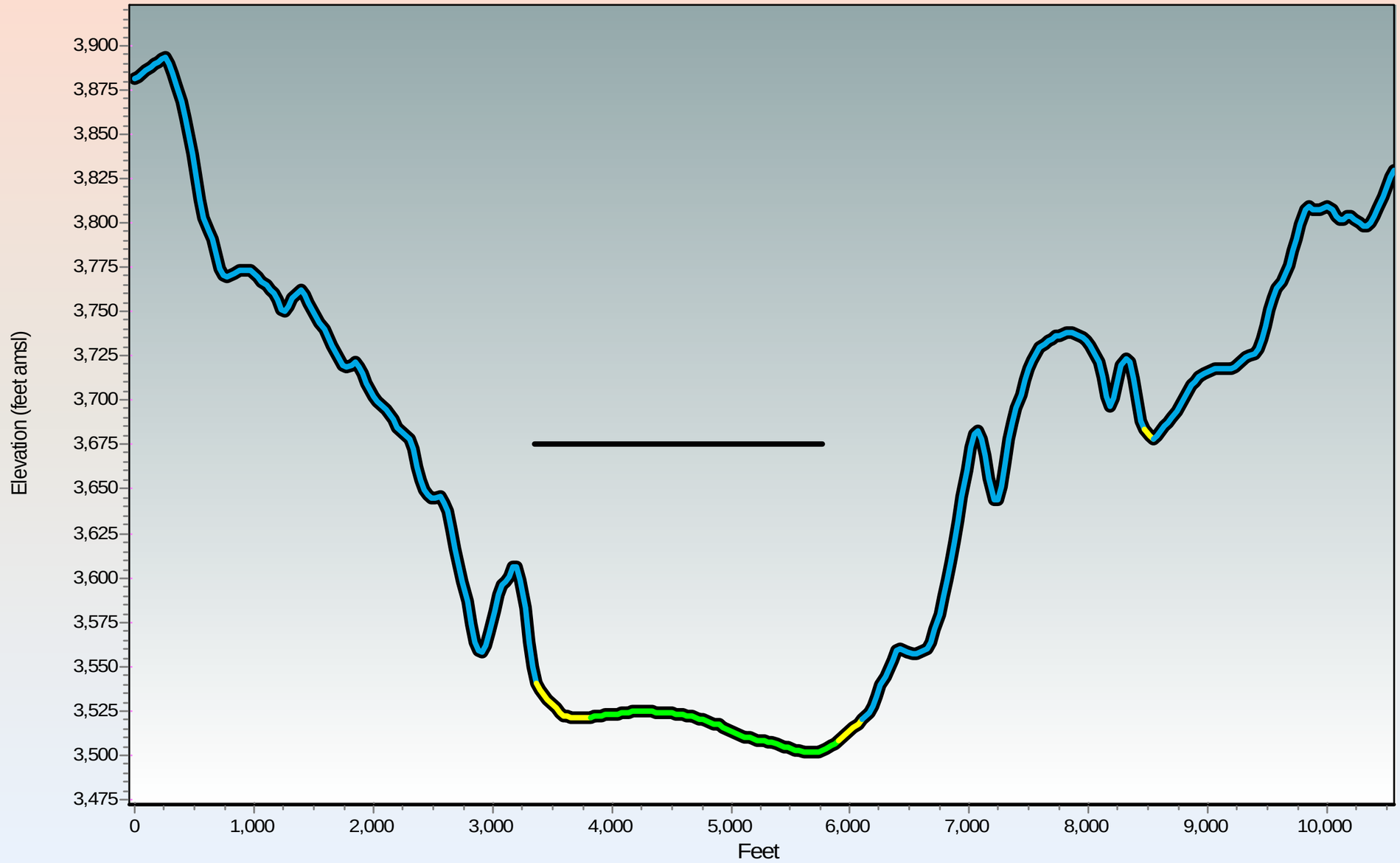
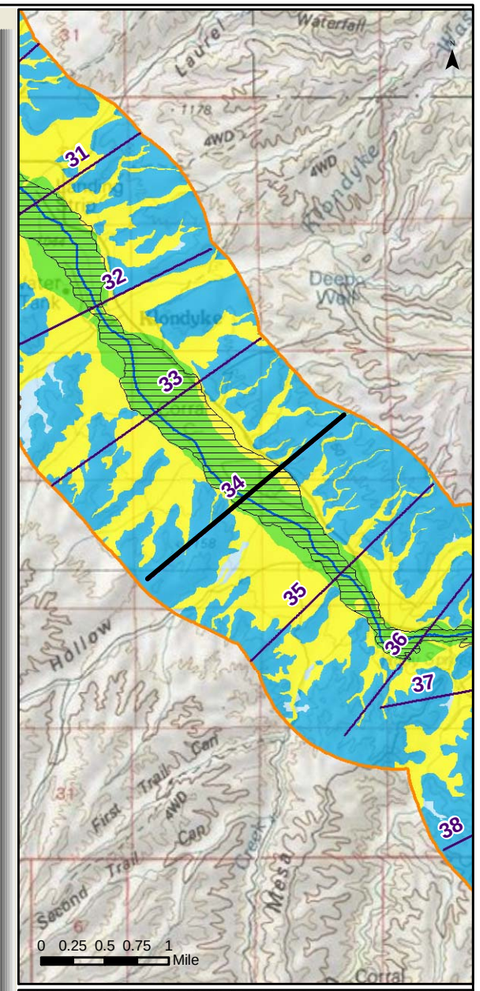
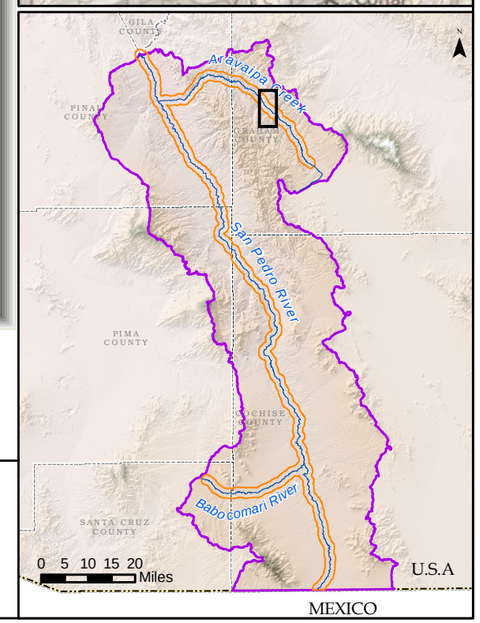
Appendix F
Aravaipa Creek Cross Section at Mile 33
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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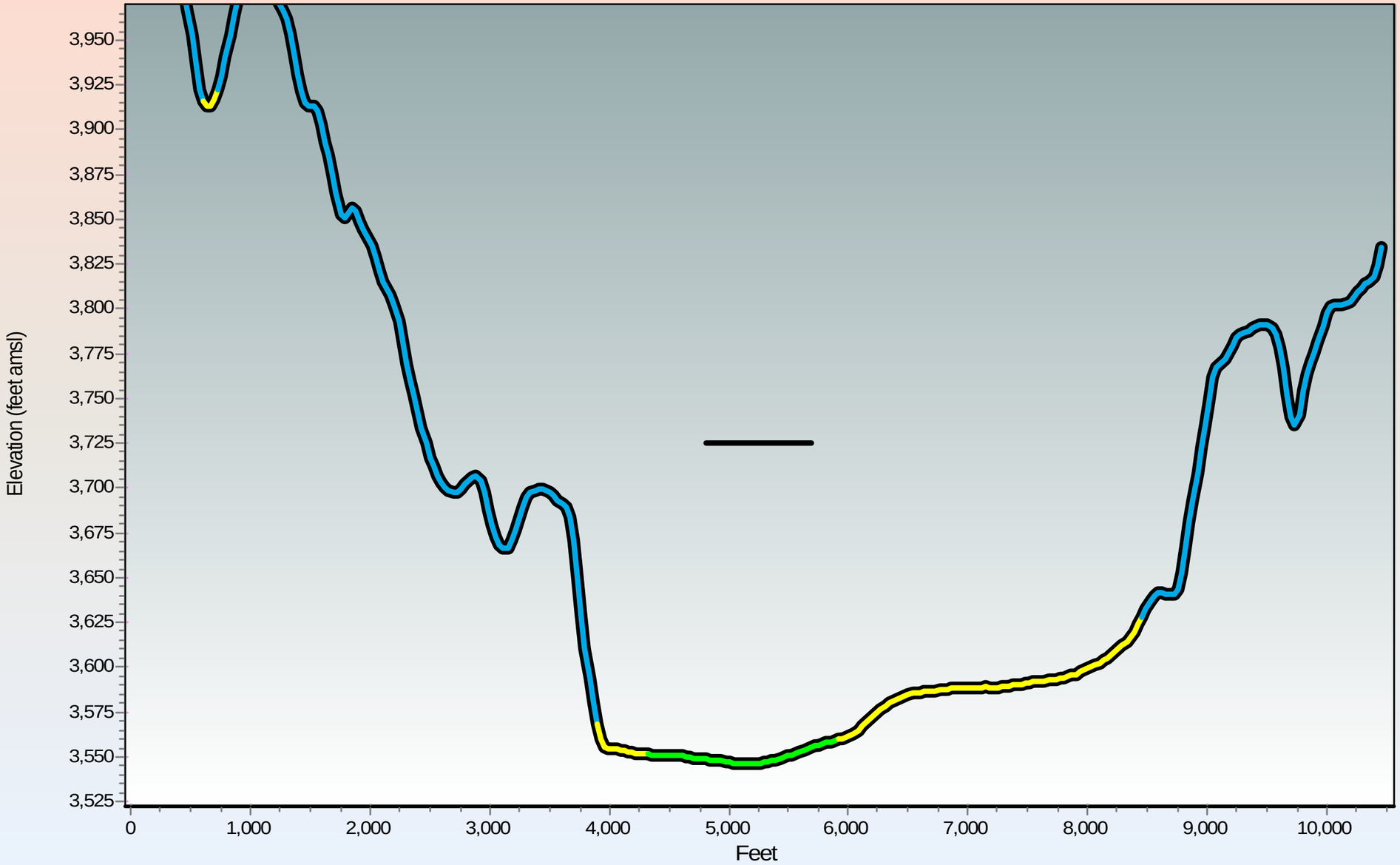
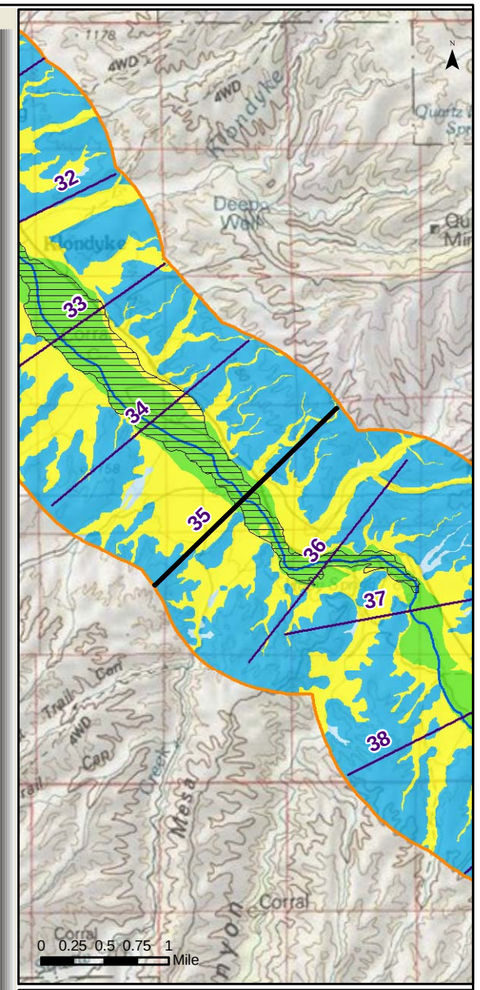
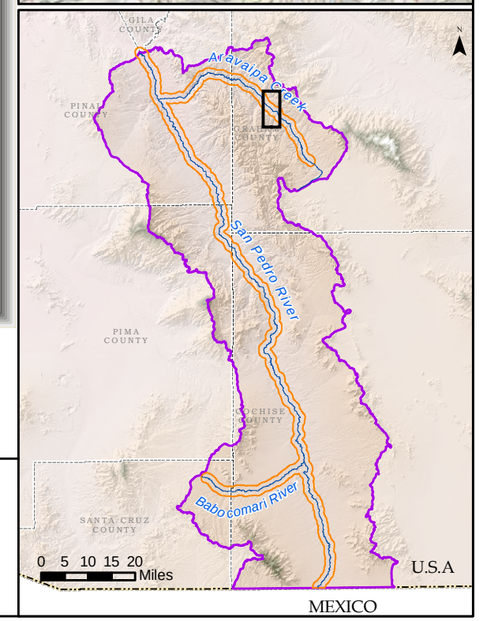
Appendix F
Aravaipa Creek Cross Section at Mile 34
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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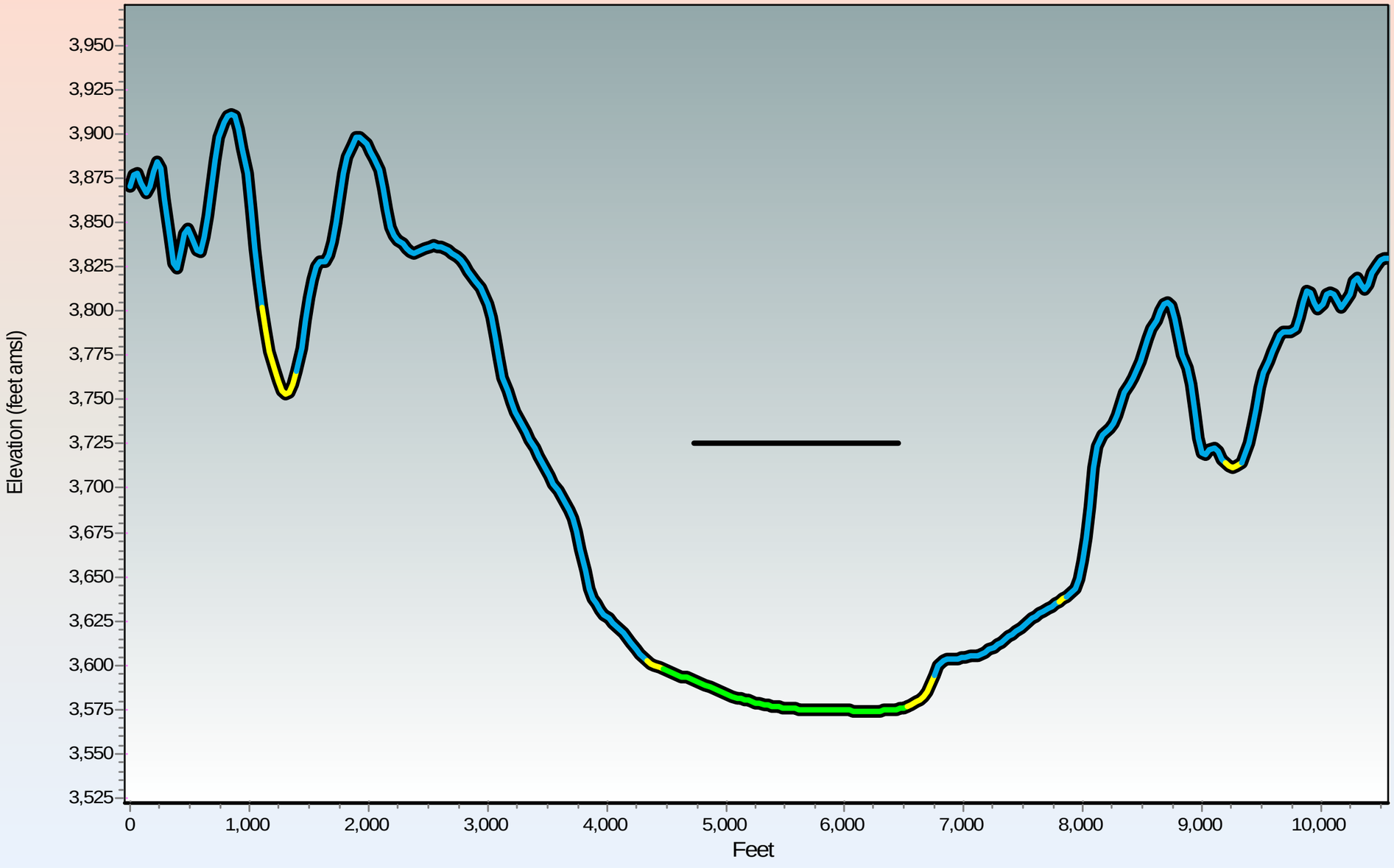
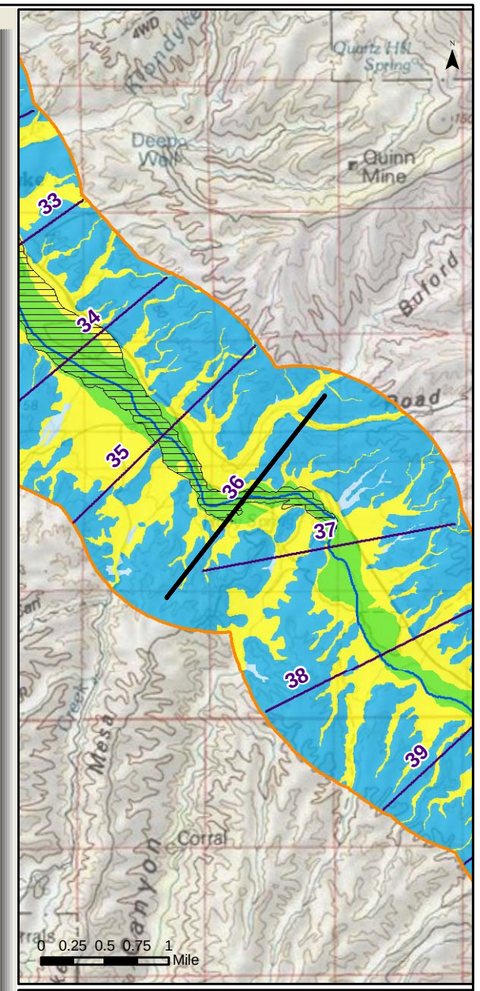
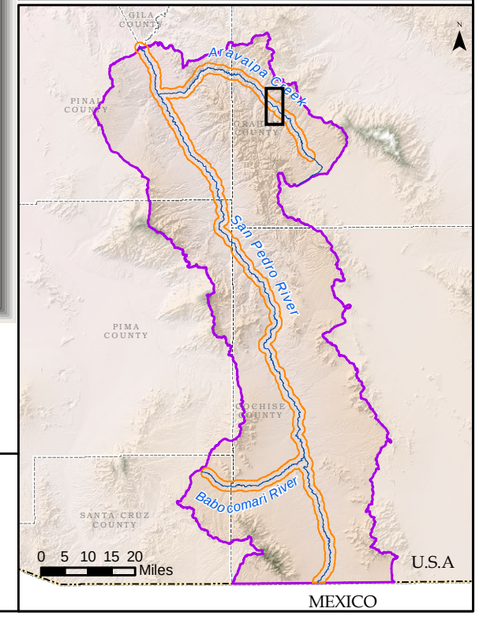
Appendix F
Aravaipa Creek Cross Section at Mile 35
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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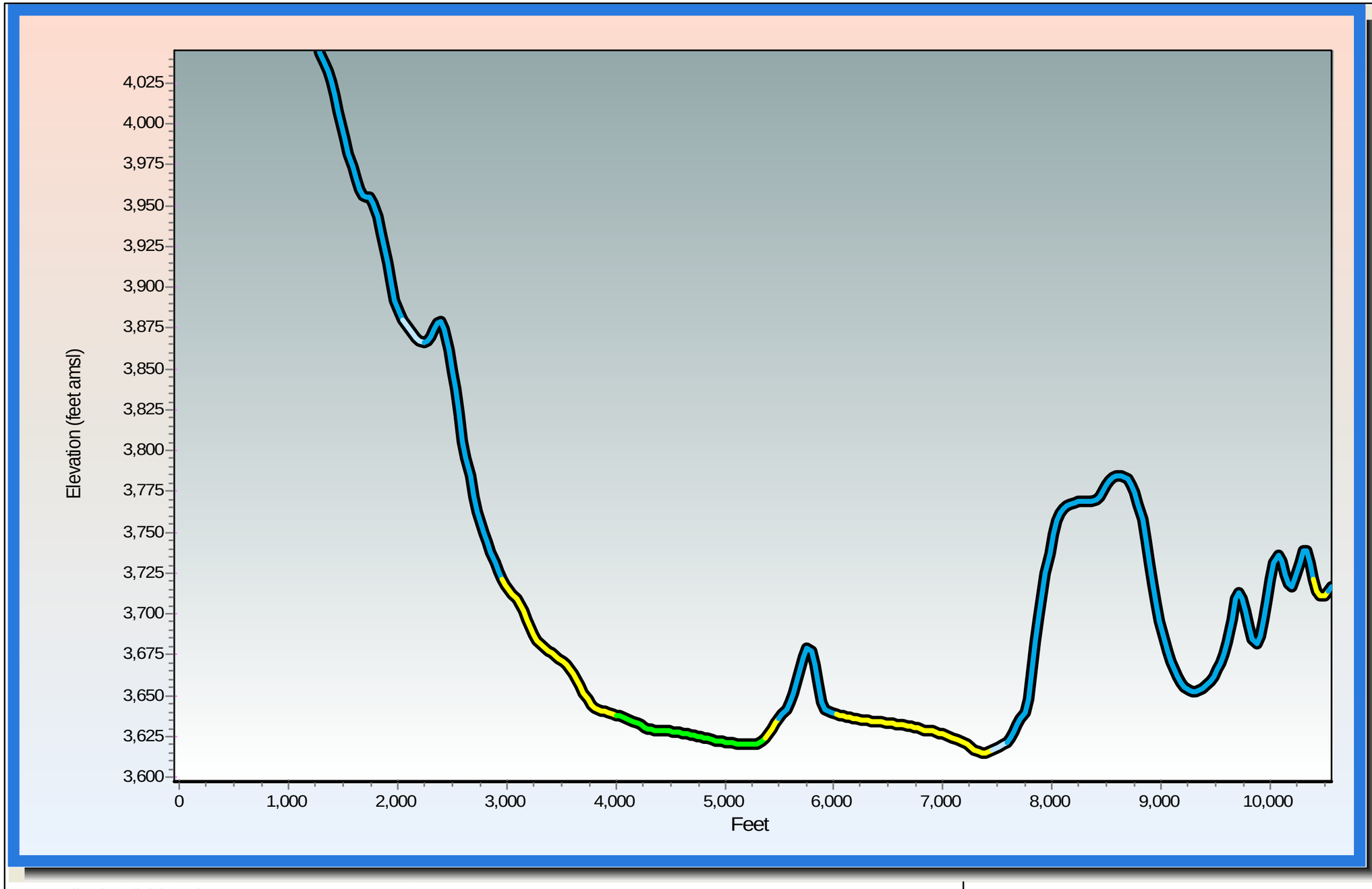
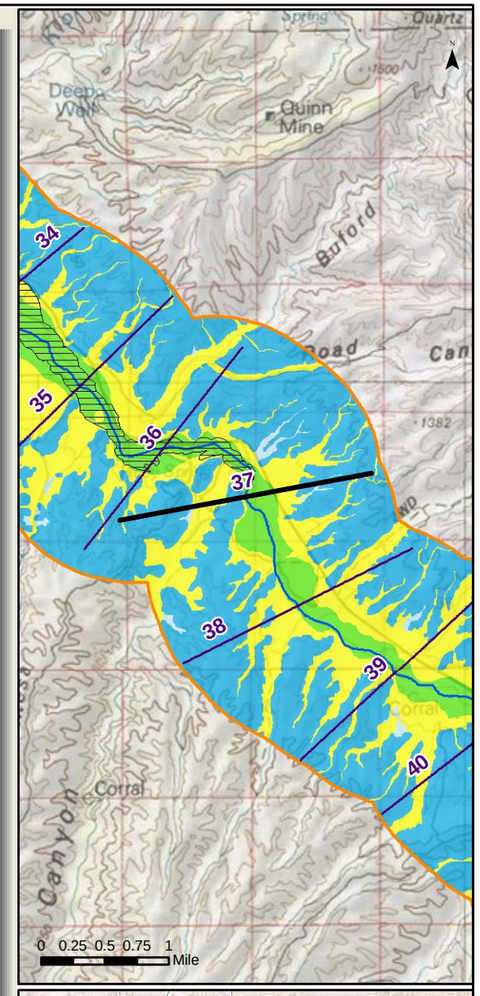
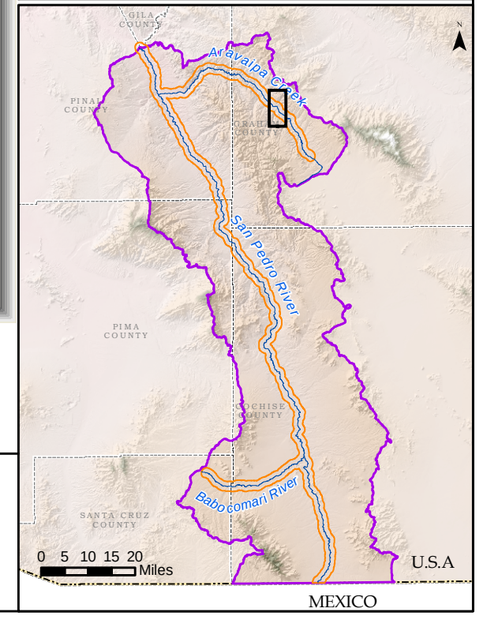
Appendix F
Aravaipa Creek Cross Section at Mile 36
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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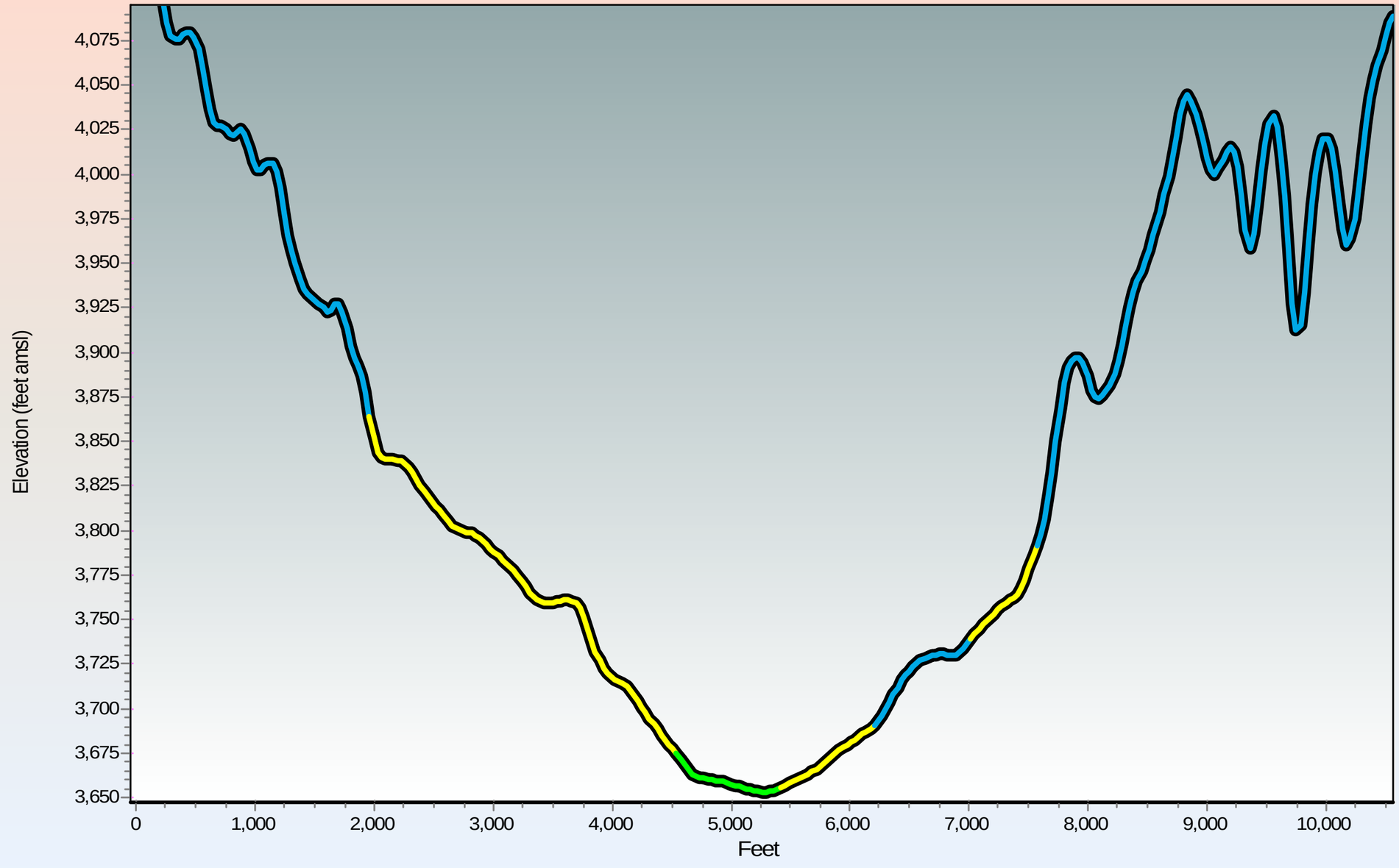
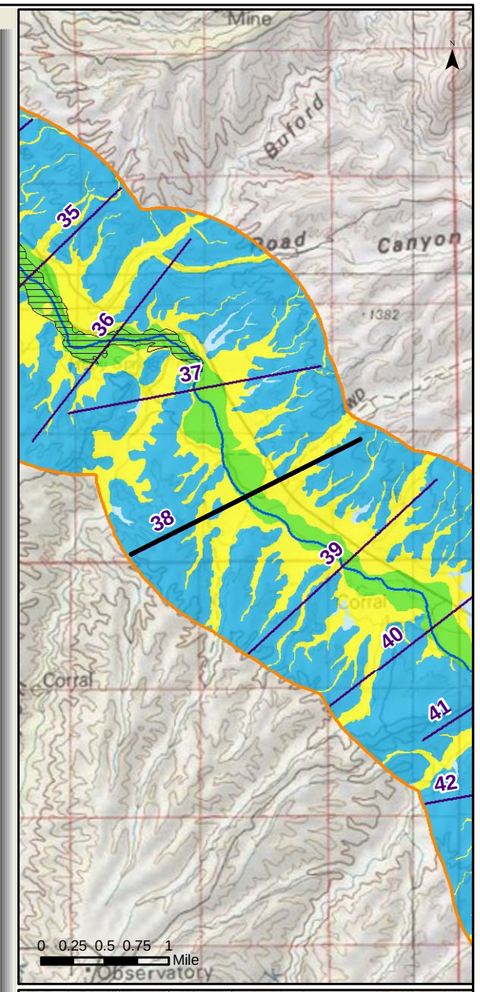
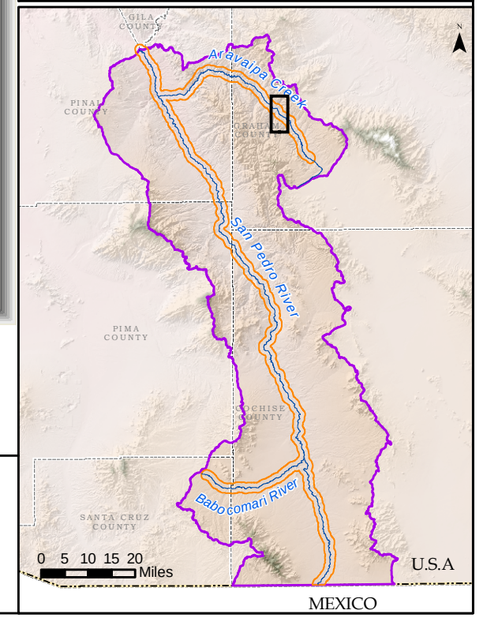
Appendix F
Aravaipa Creek Cross Section at Mile 37
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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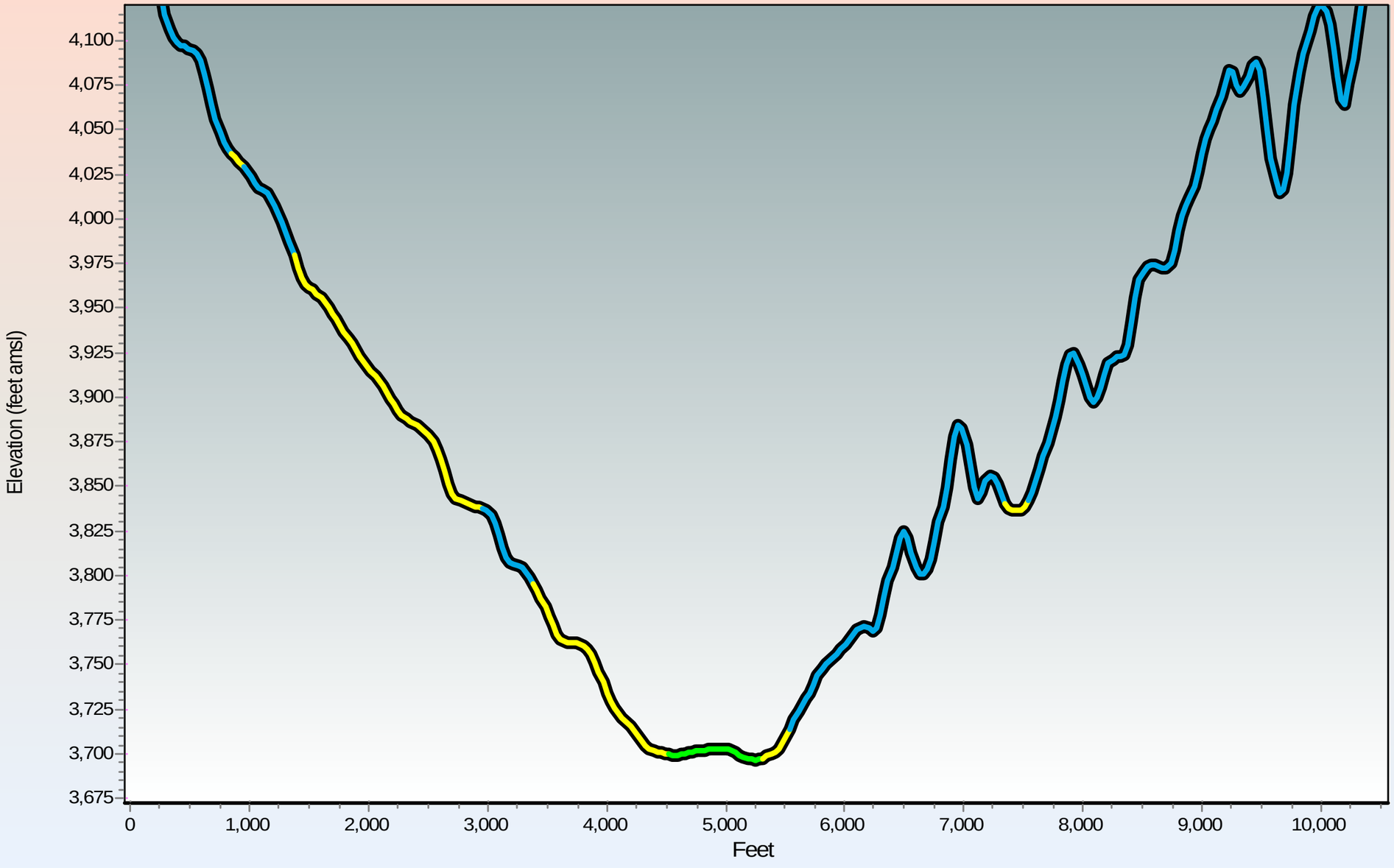
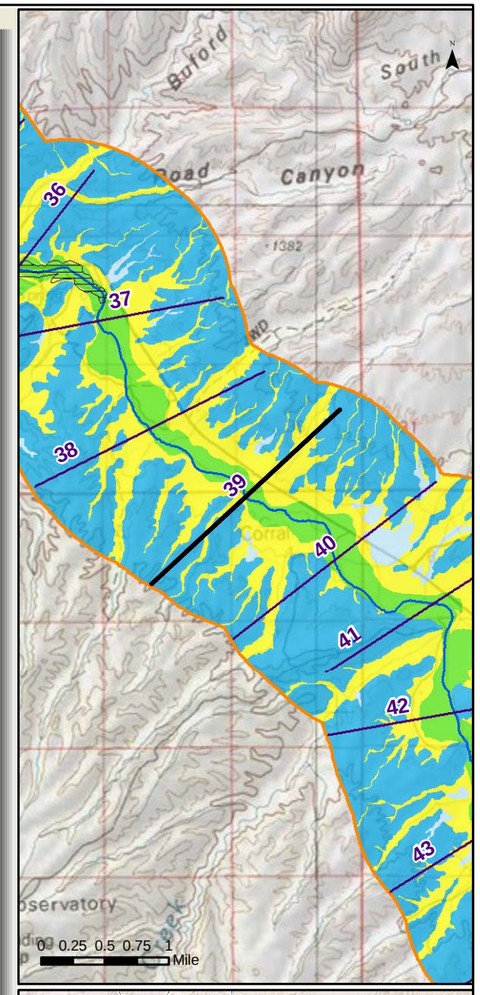
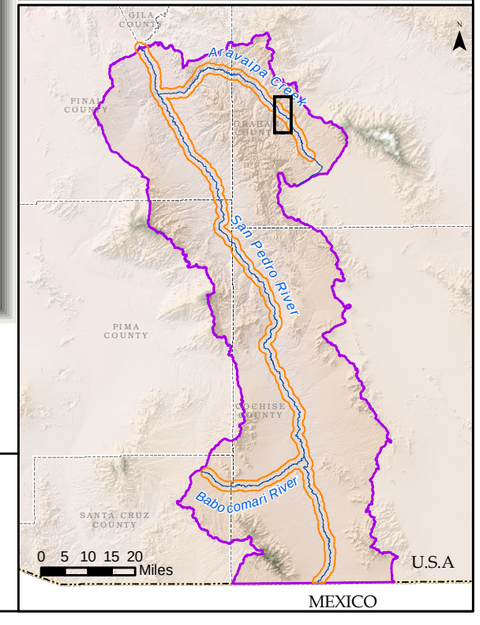
Appendix F
Aravaipa Creek Cross Section at Mile 38
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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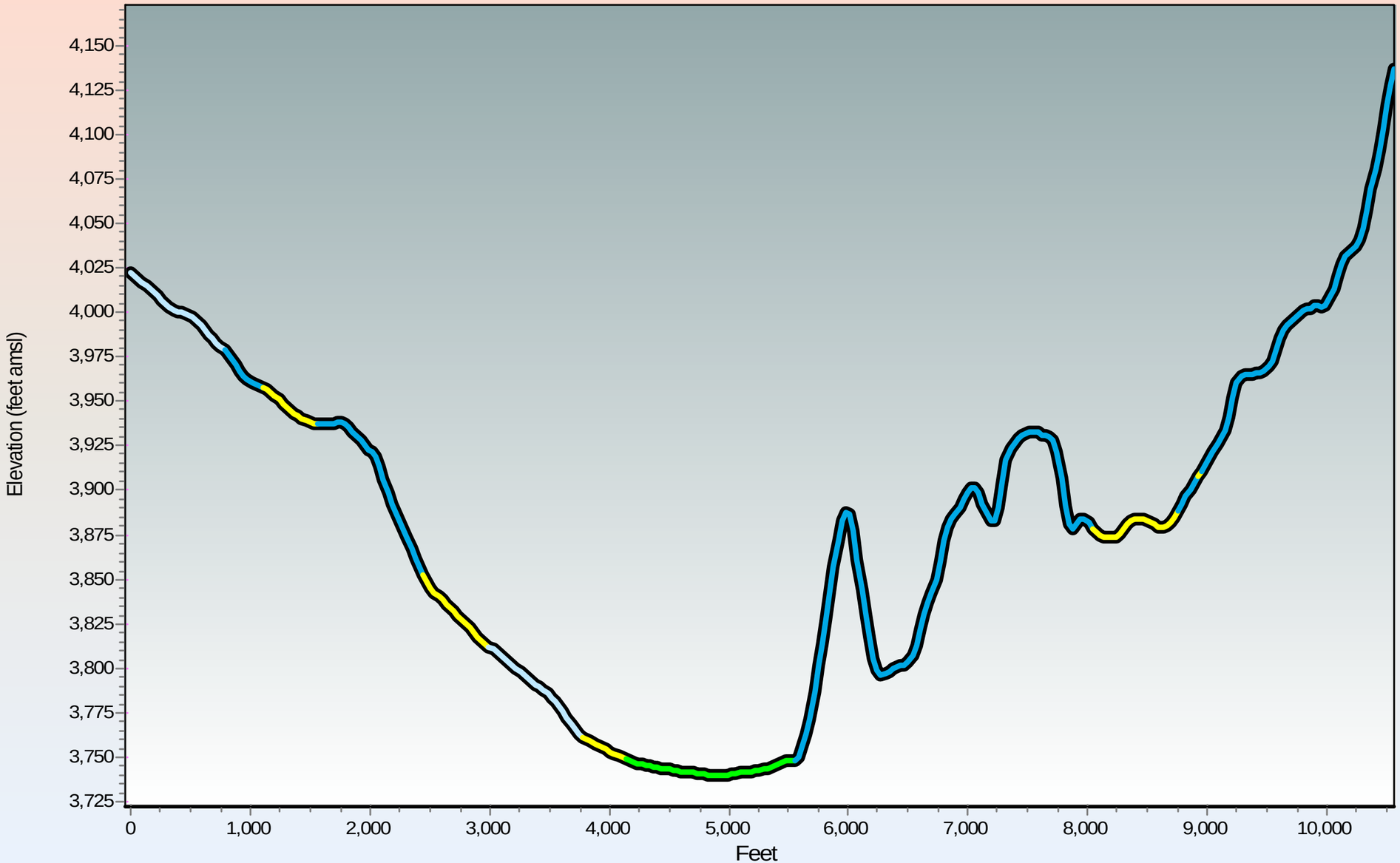
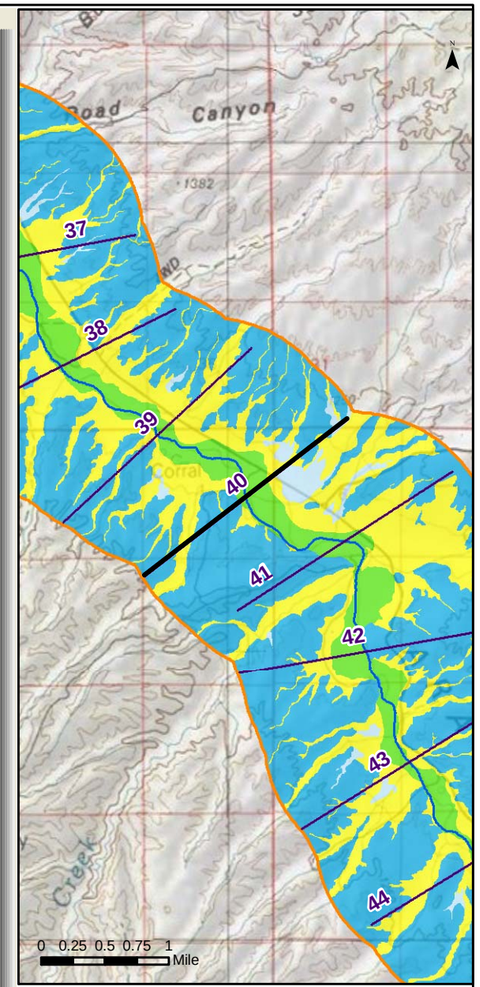
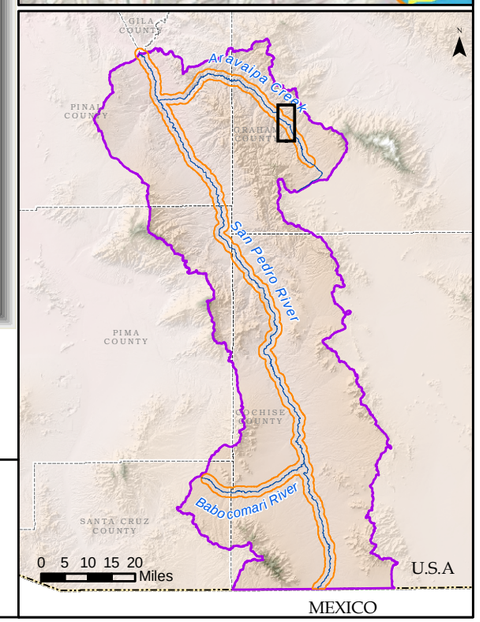
Appendix F
Aravaipa Creek Cross Section at Mile 39
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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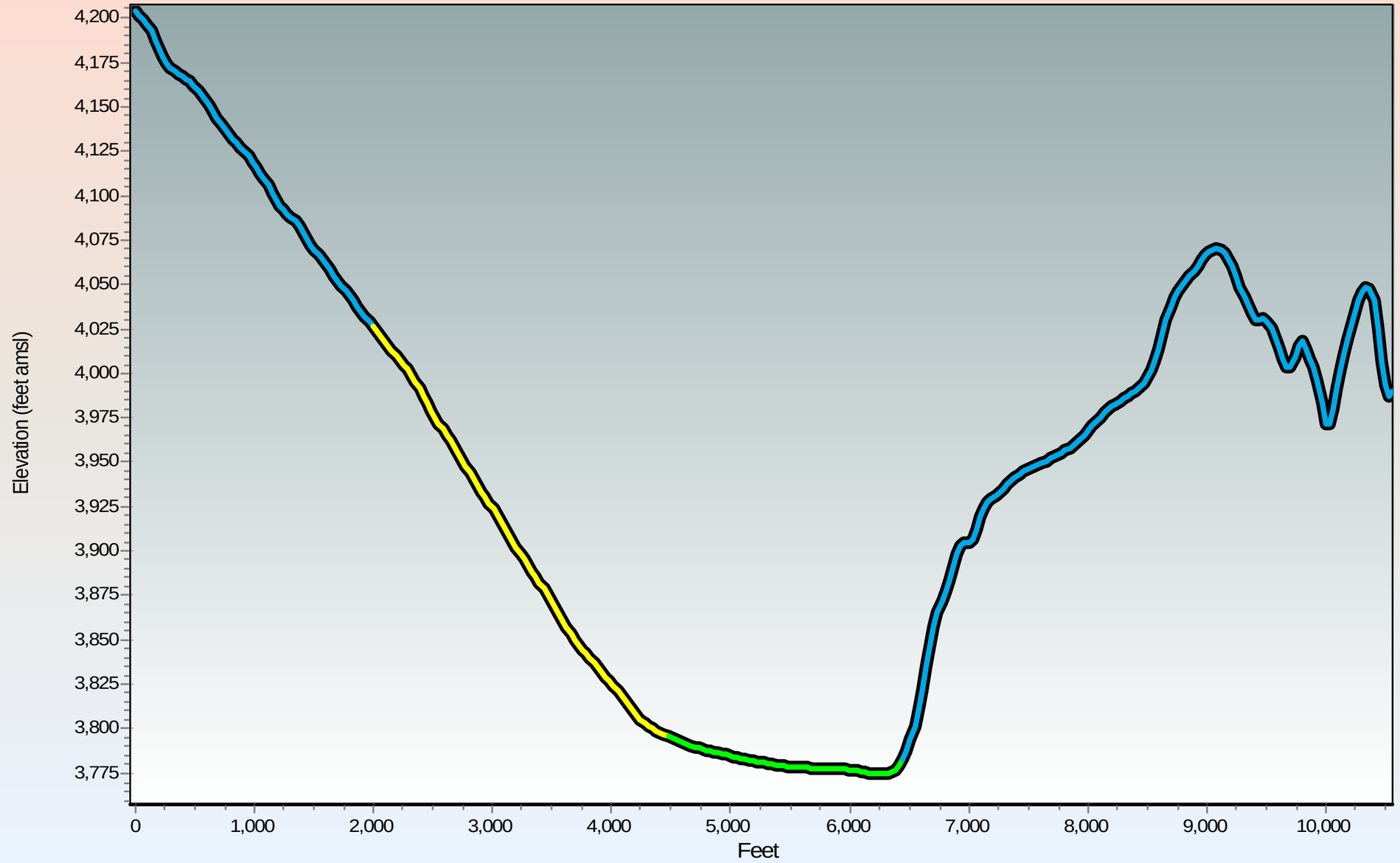
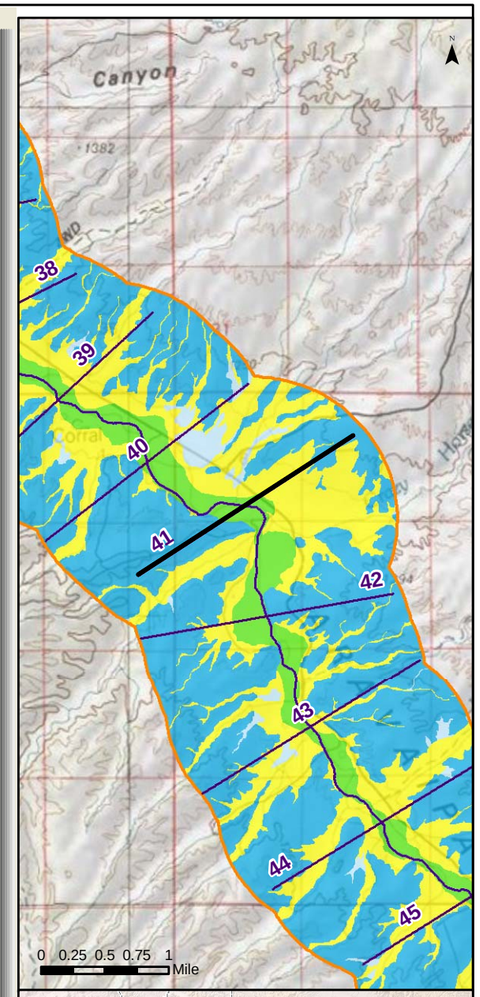
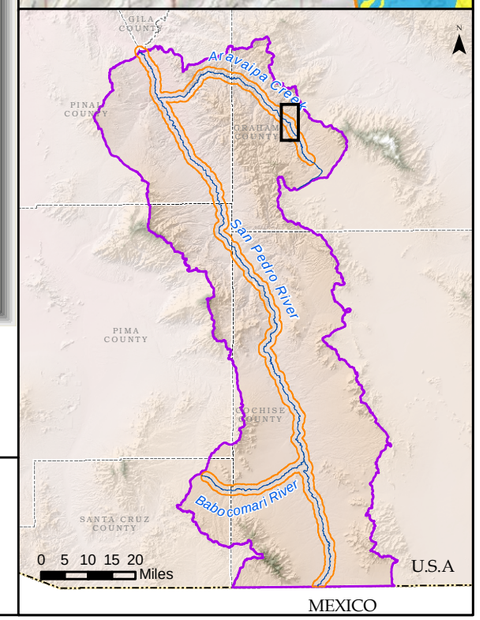
Appendix F
Aravaipa Creek Cross Section at Mile 40
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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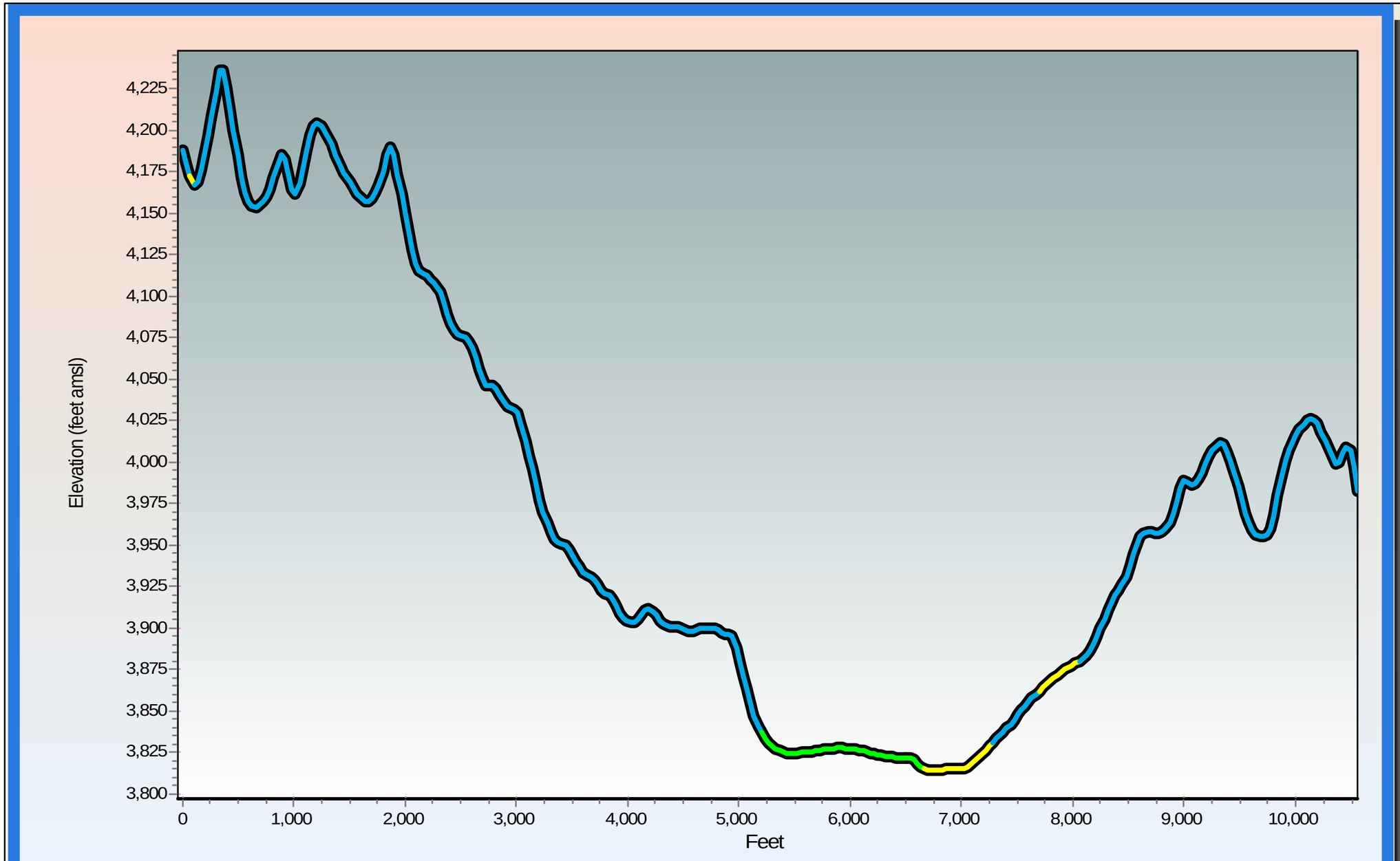
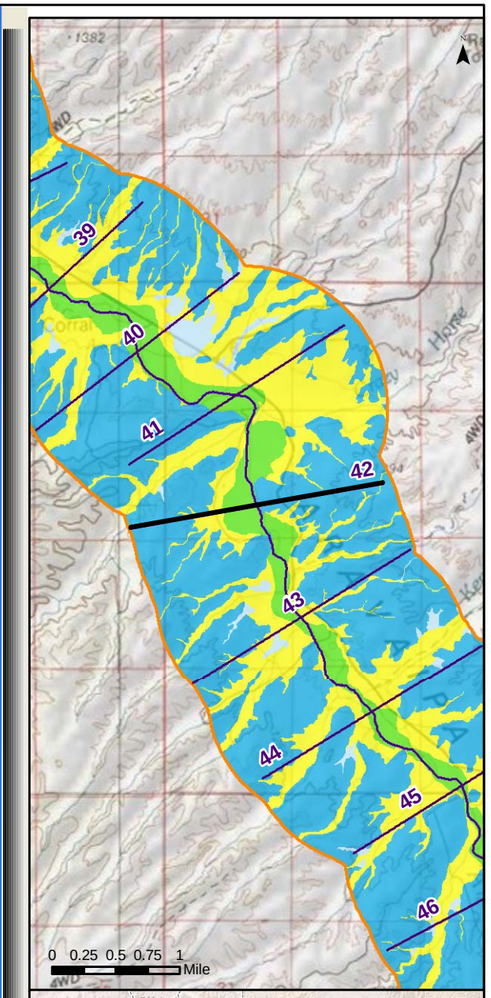
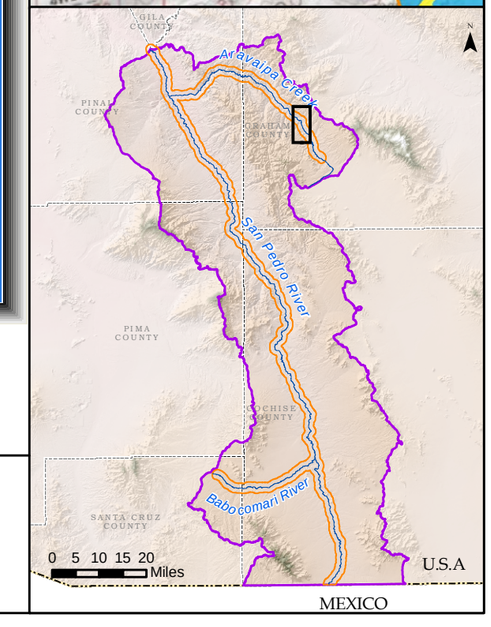
Appendix F
Aravaipa Creek Cross Section at Mile 41
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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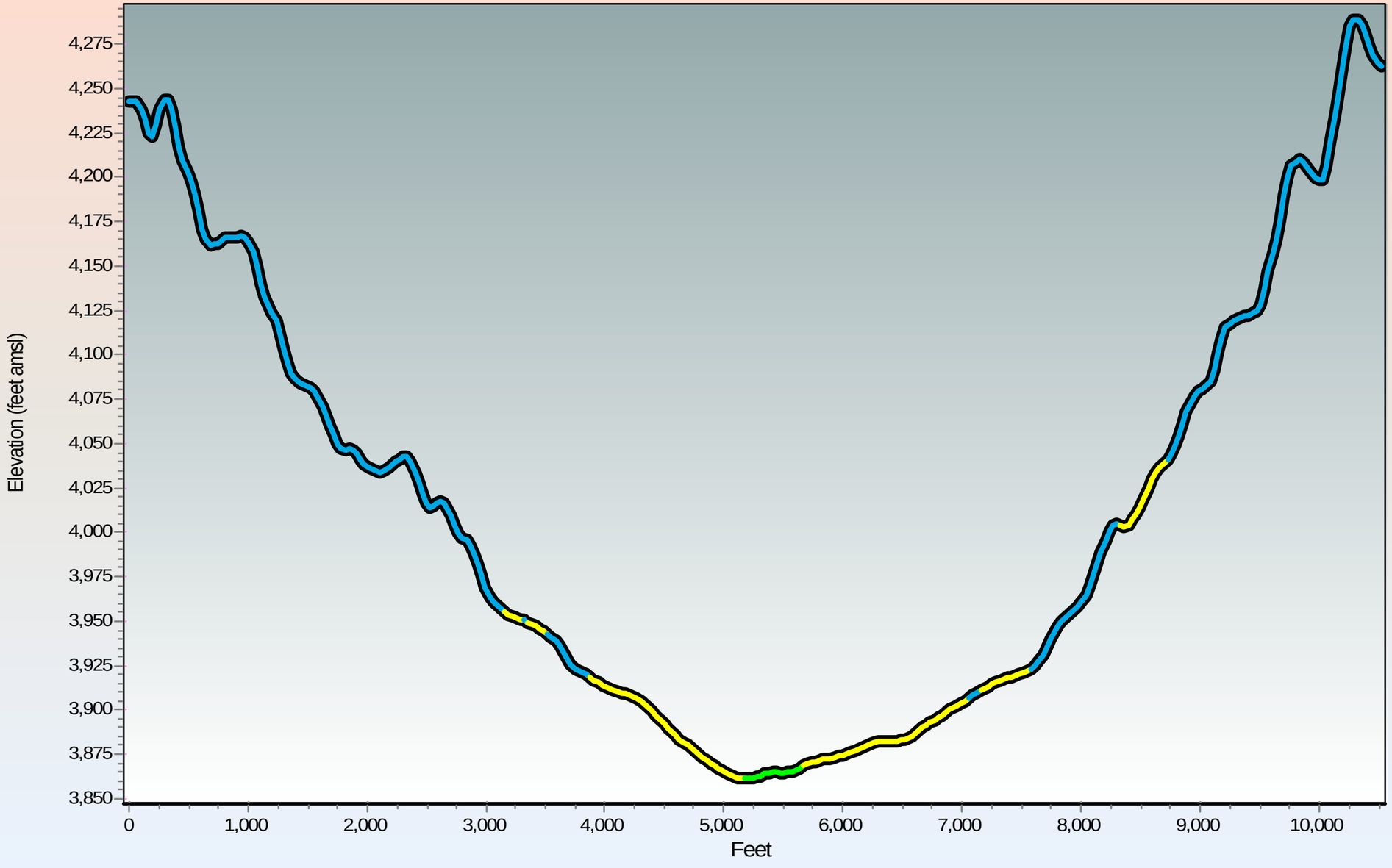
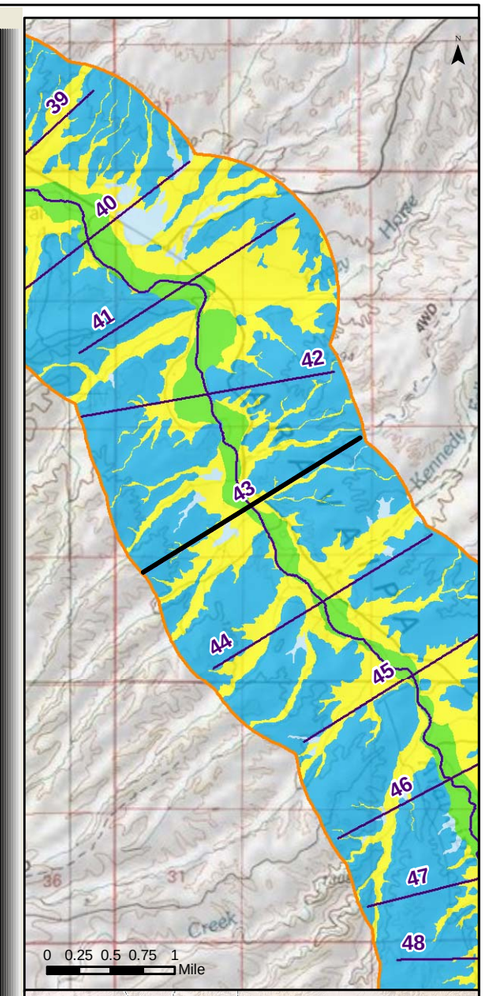
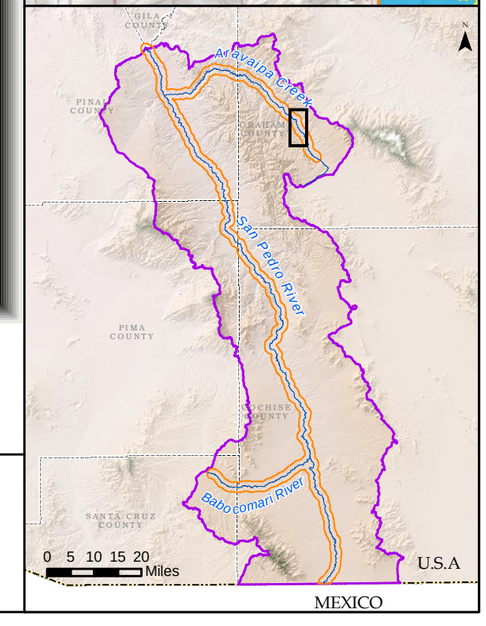
Appendix F
Aravaipa Creek Cross Section at Mile 42
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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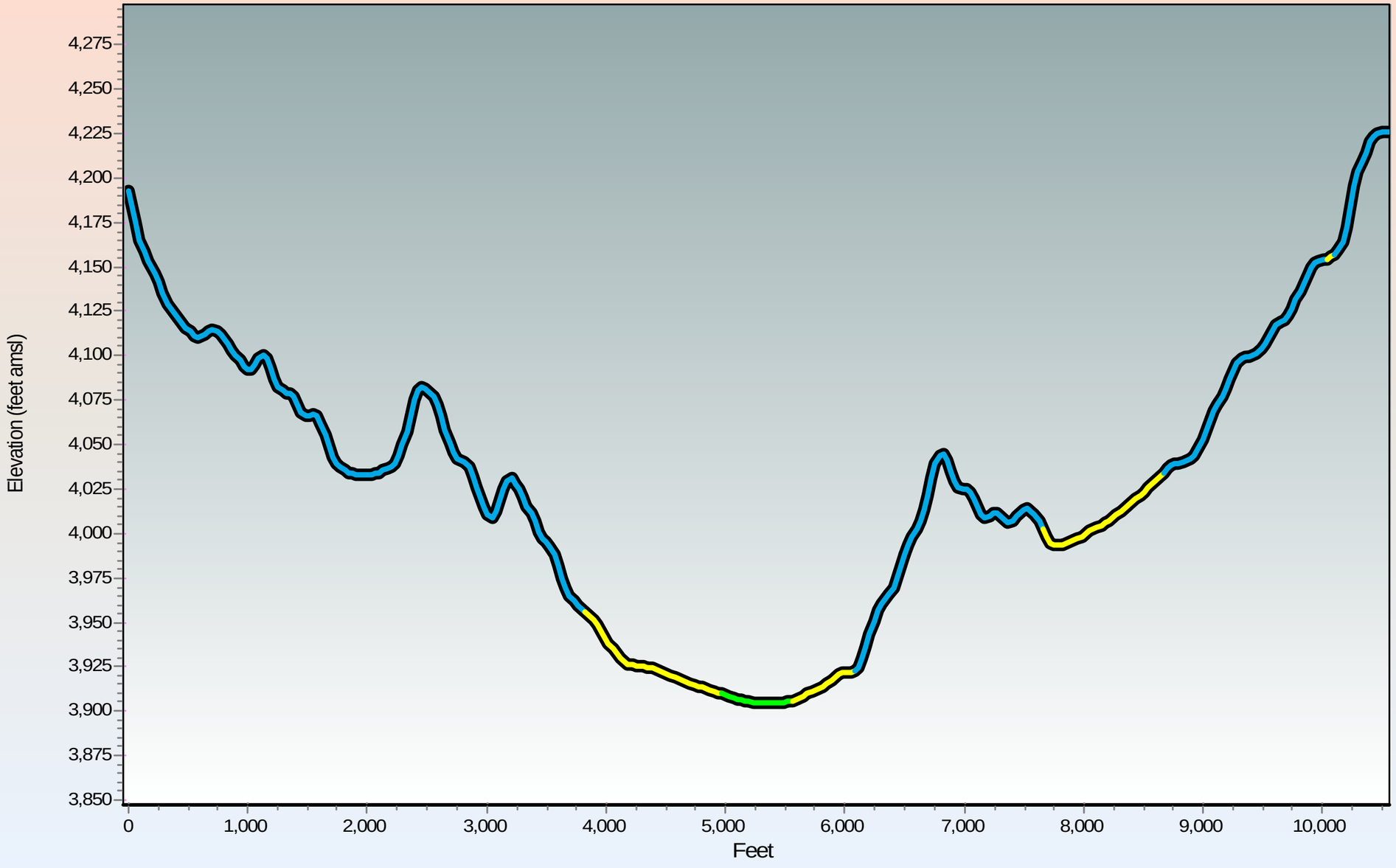
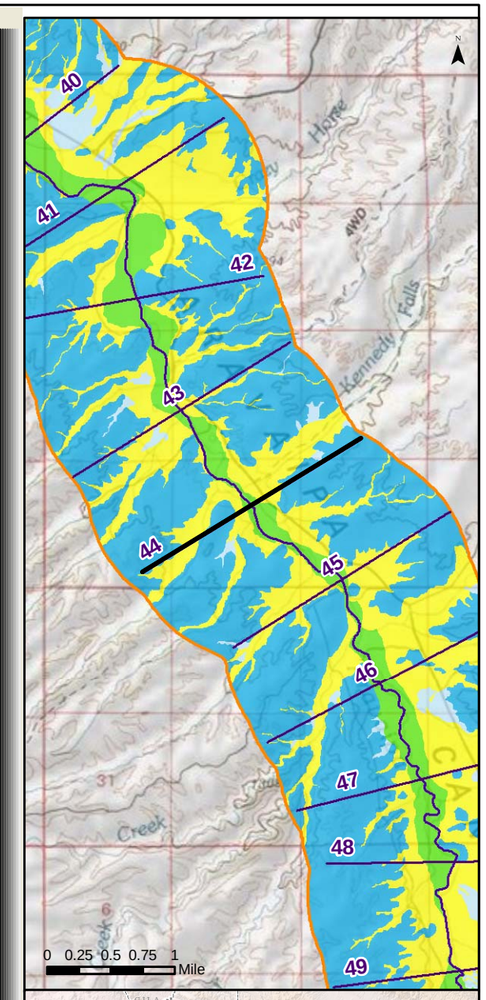
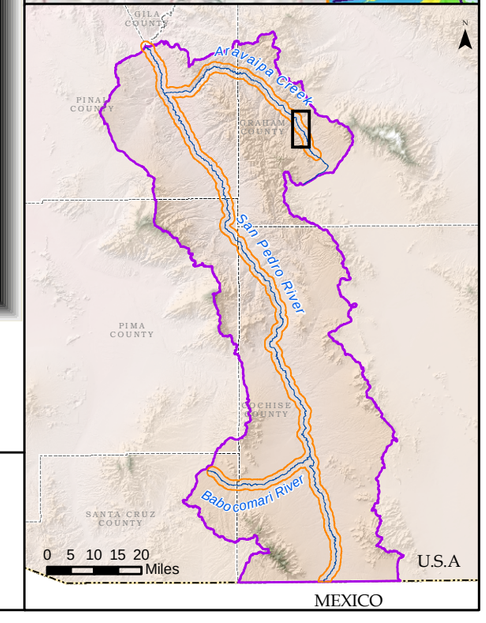
Appendix F
Aravaipa Creek Cross Section at Mile 43
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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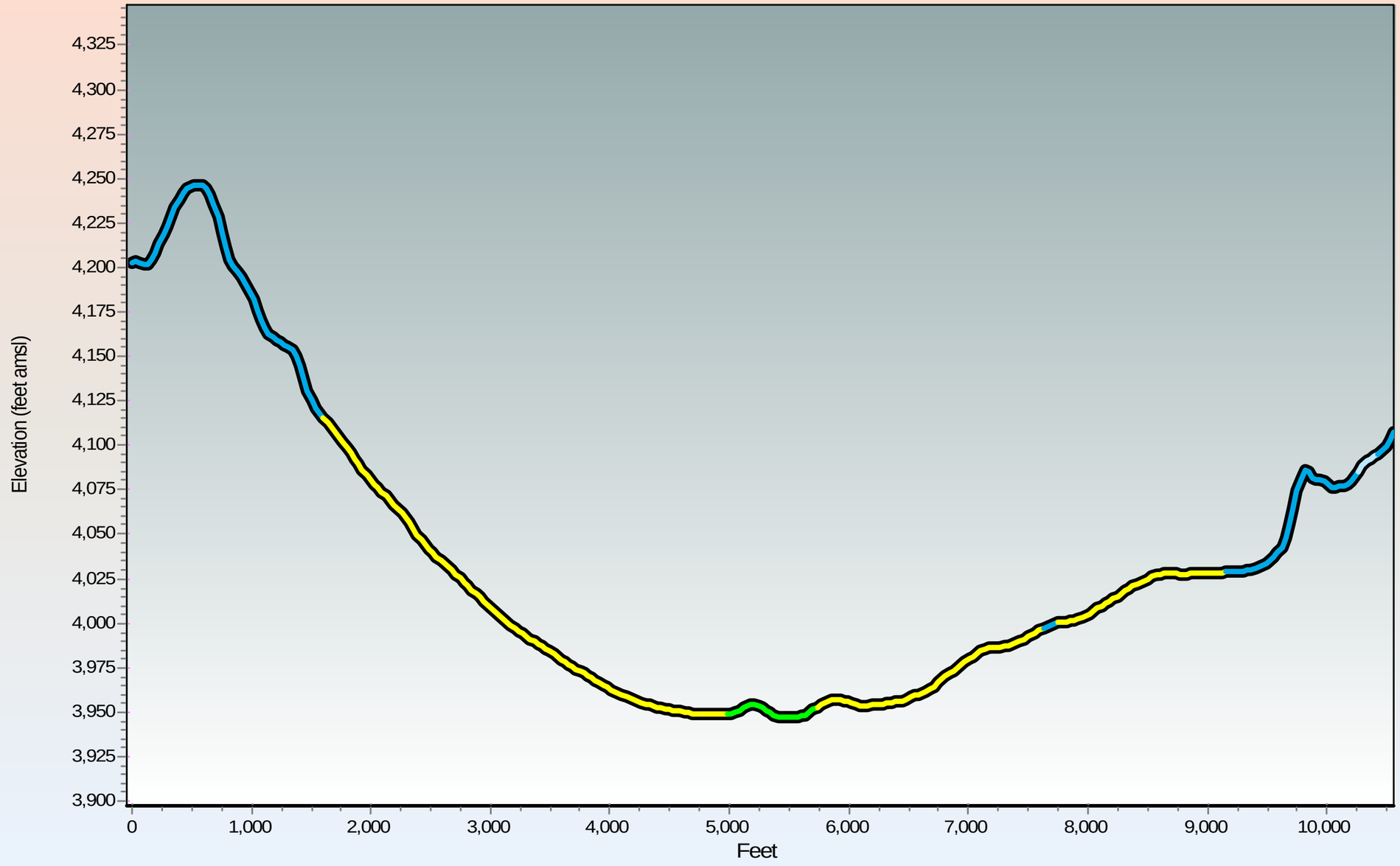
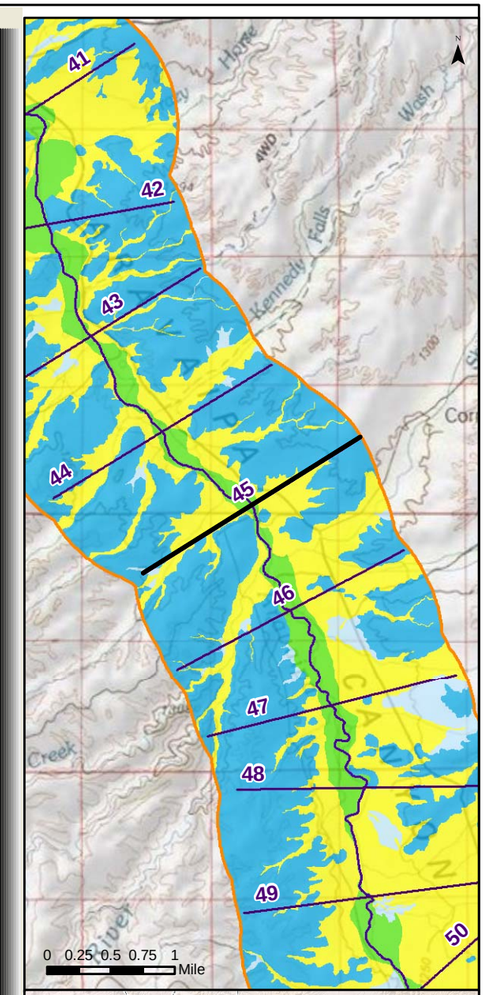
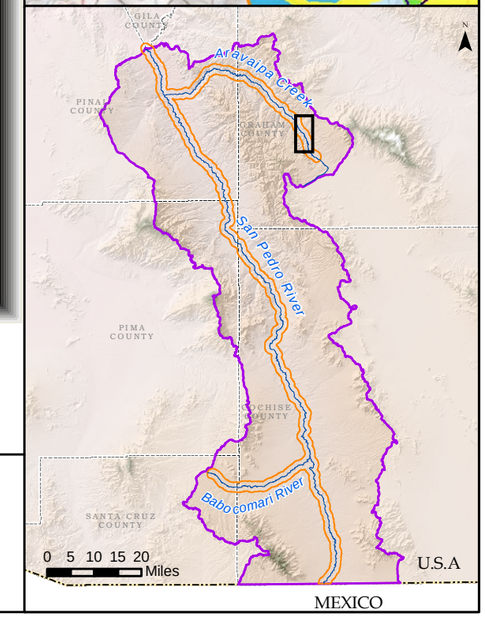
Appendix F
Aravaipa Creek Cross Section at Mile 44
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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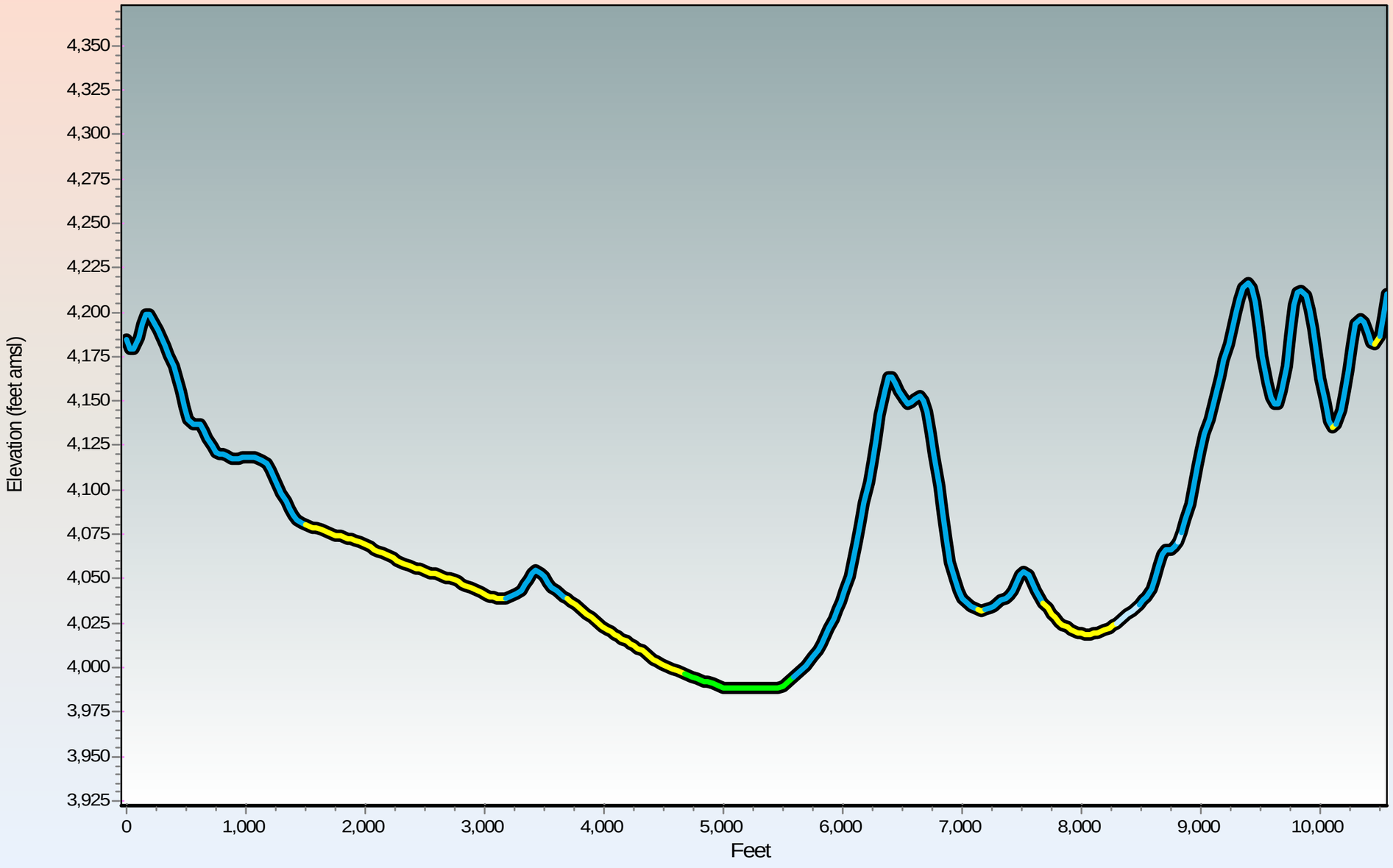
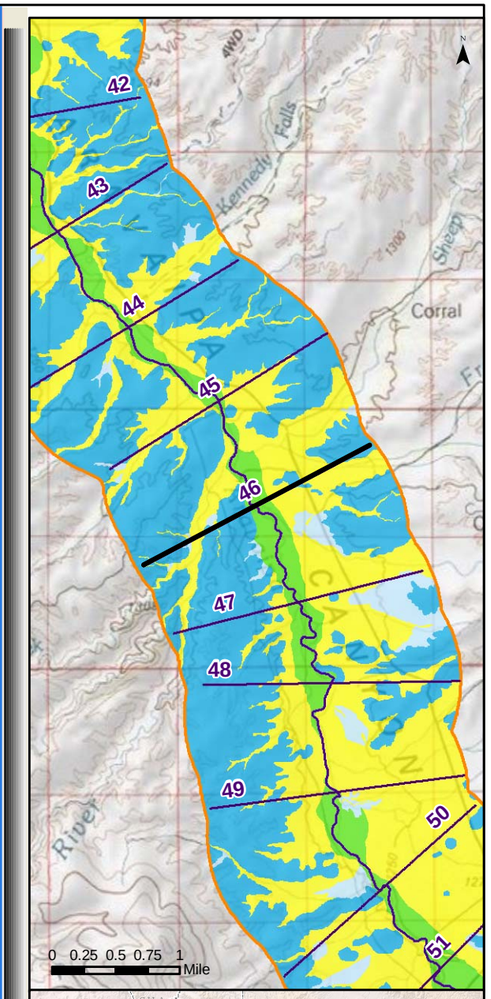
Appendix F

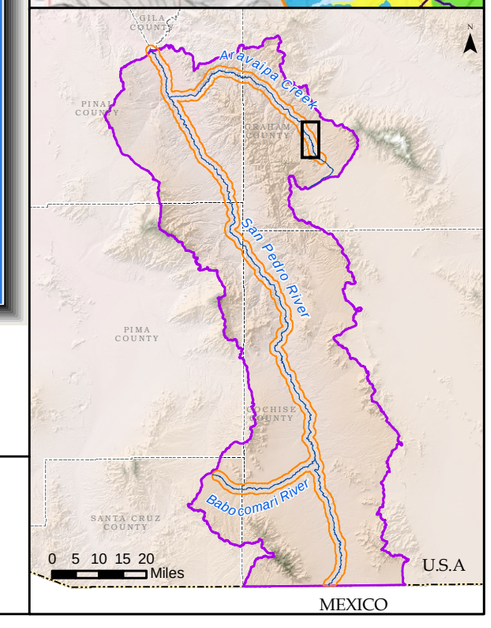
Aravaipa Creek Cross Section at Mile 45

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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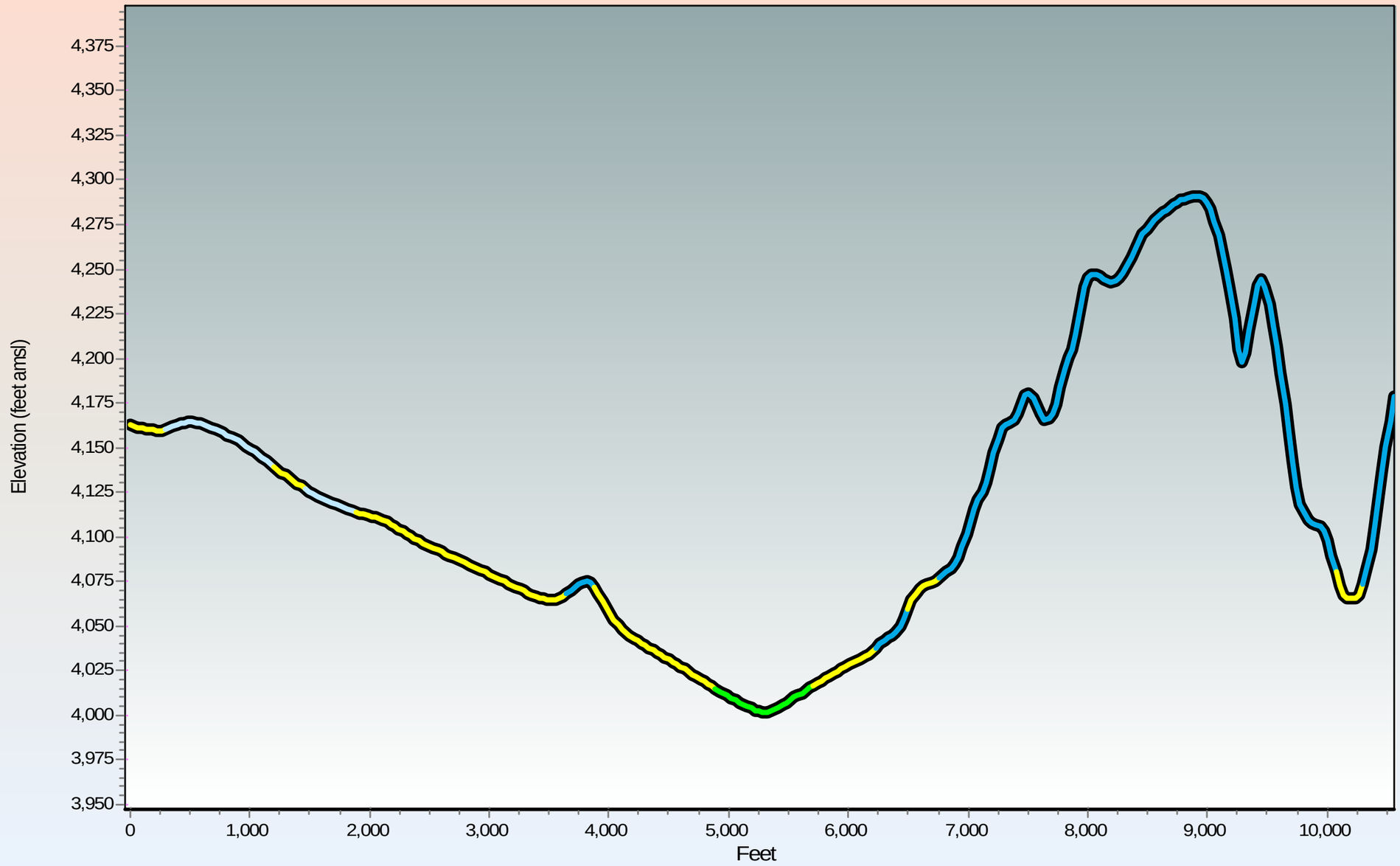
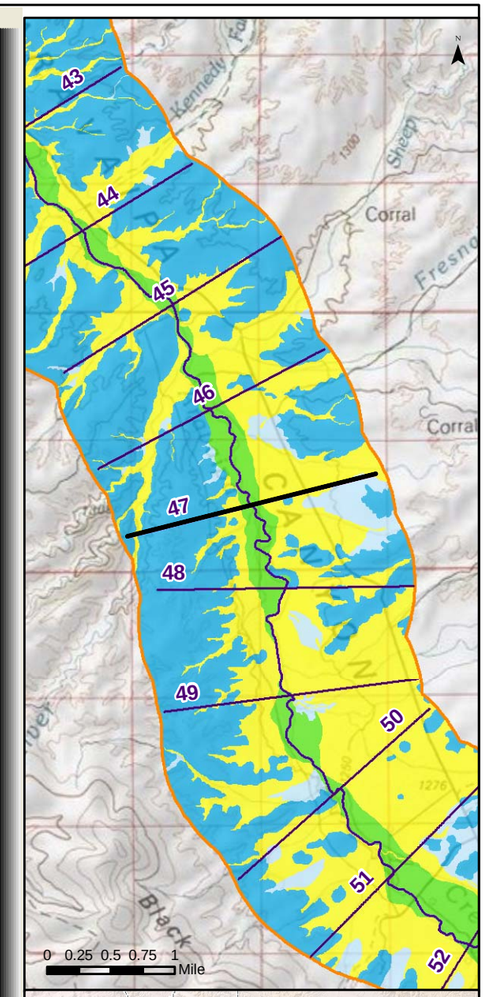
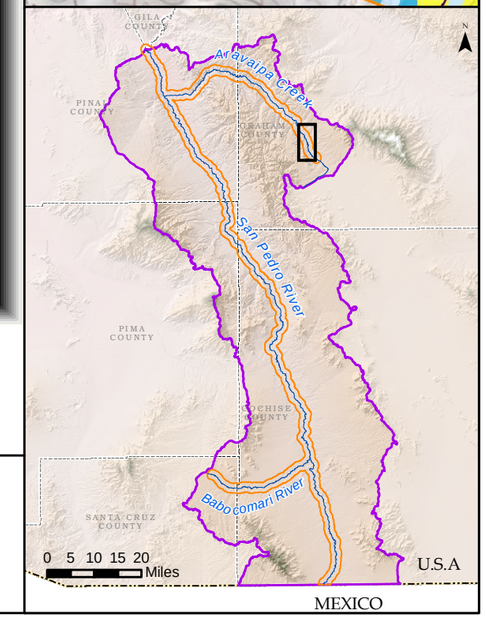
Appendix F
Aravaipa Creek Cross Section at Mile 46
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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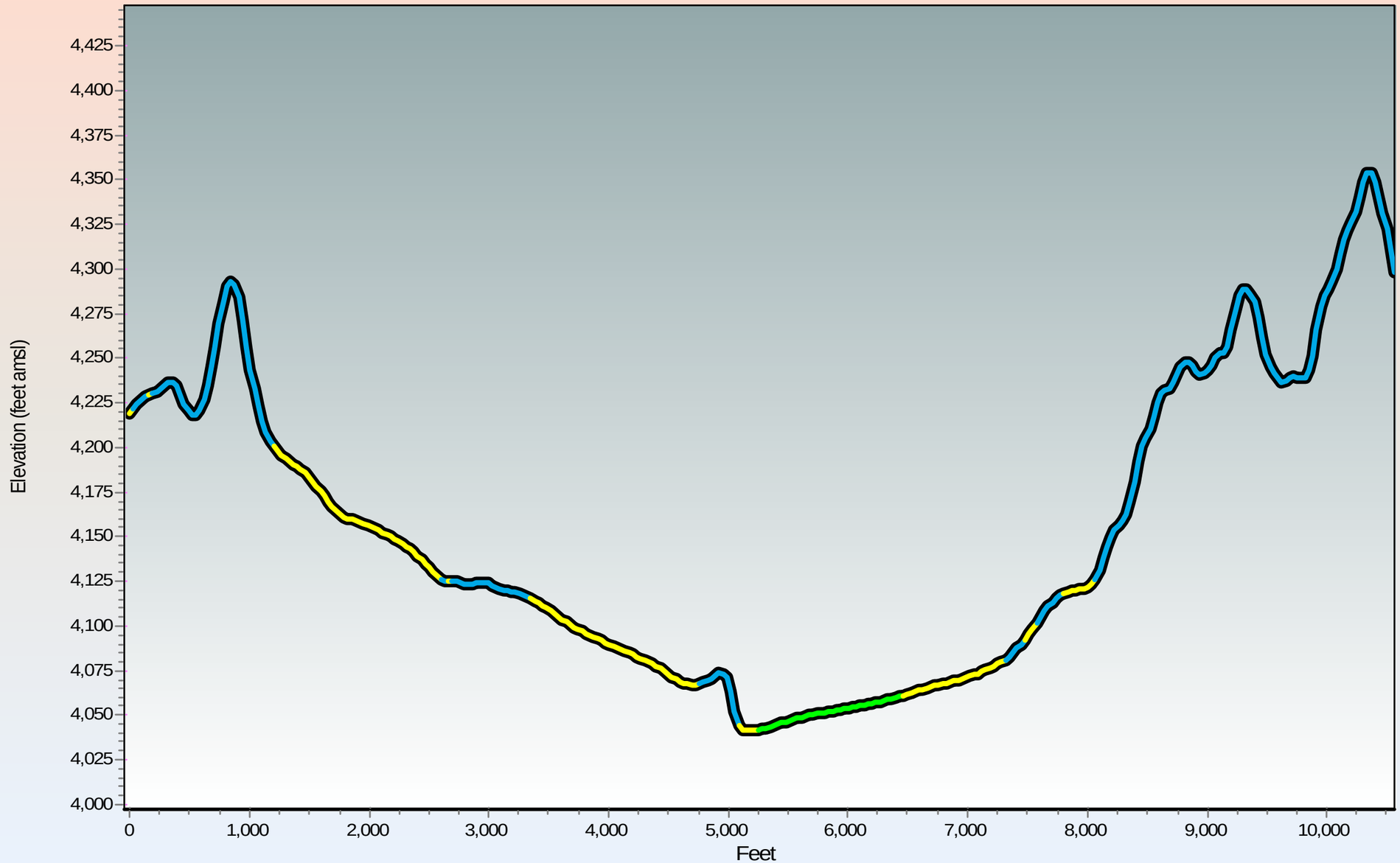
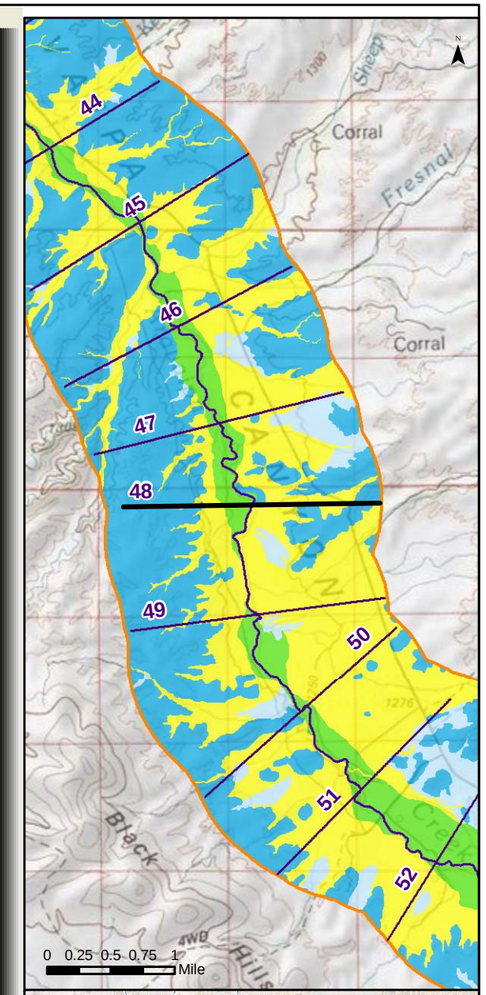
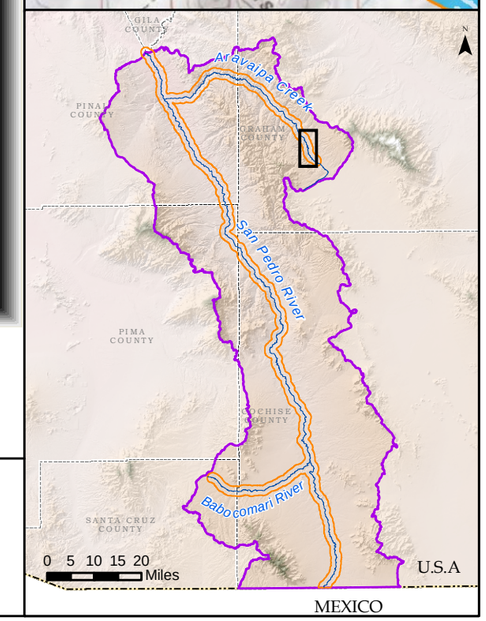
Appendix F
Aravaipa Creek Cross Section at Mile 47
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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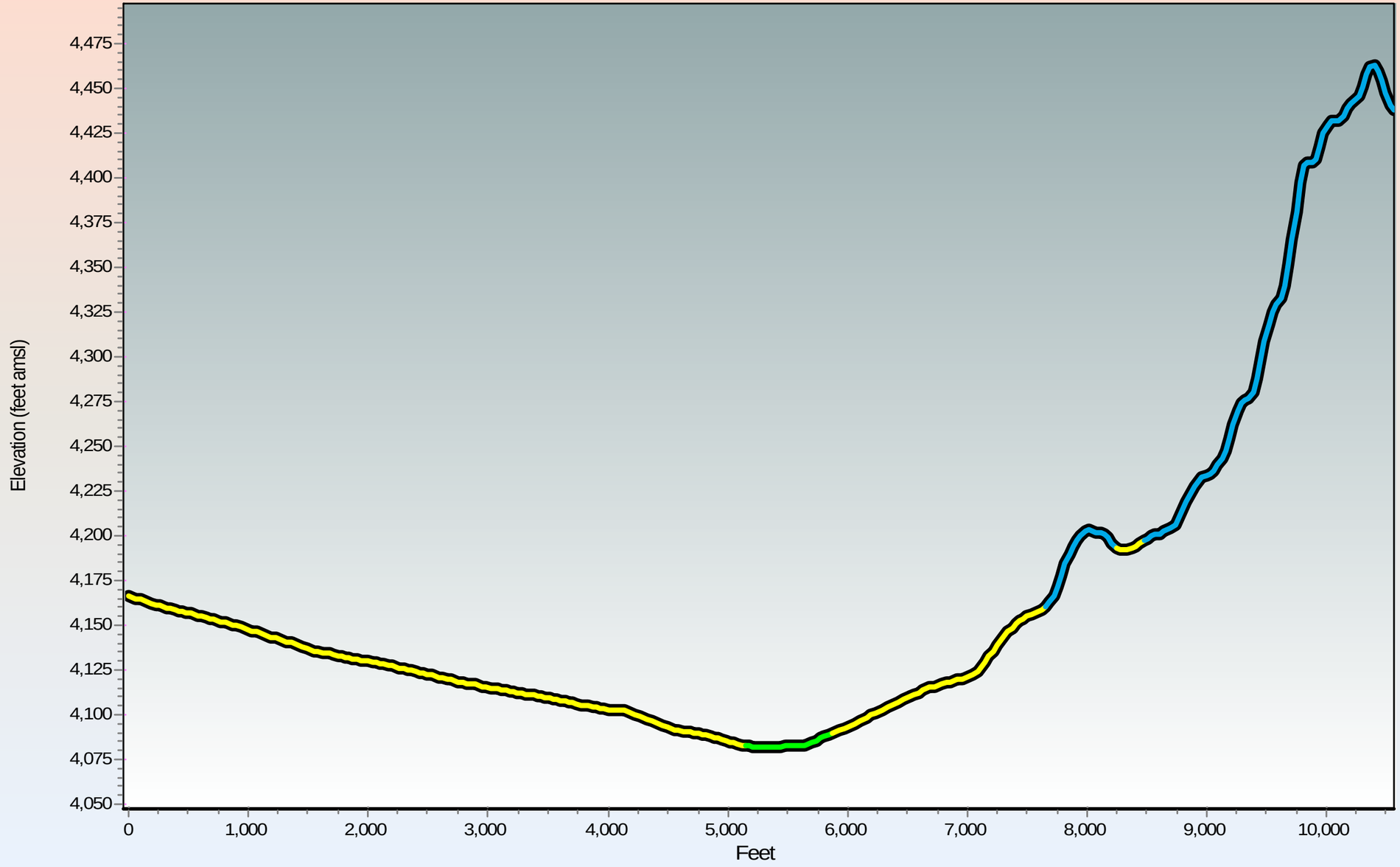
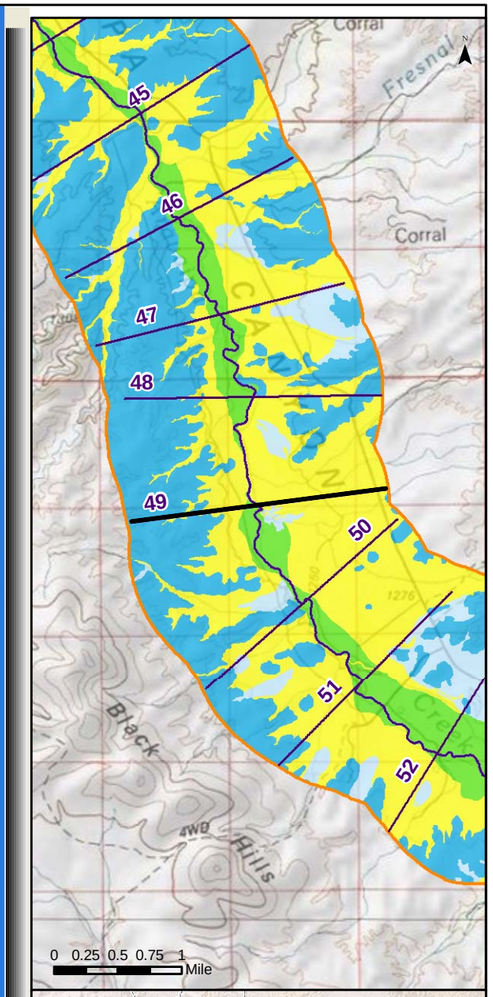
Appendix F

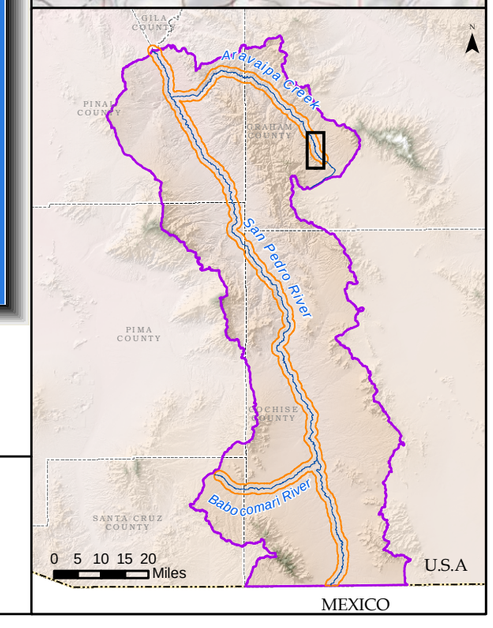
Aravaipa Creek Cross Section at Mile 48

(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)

- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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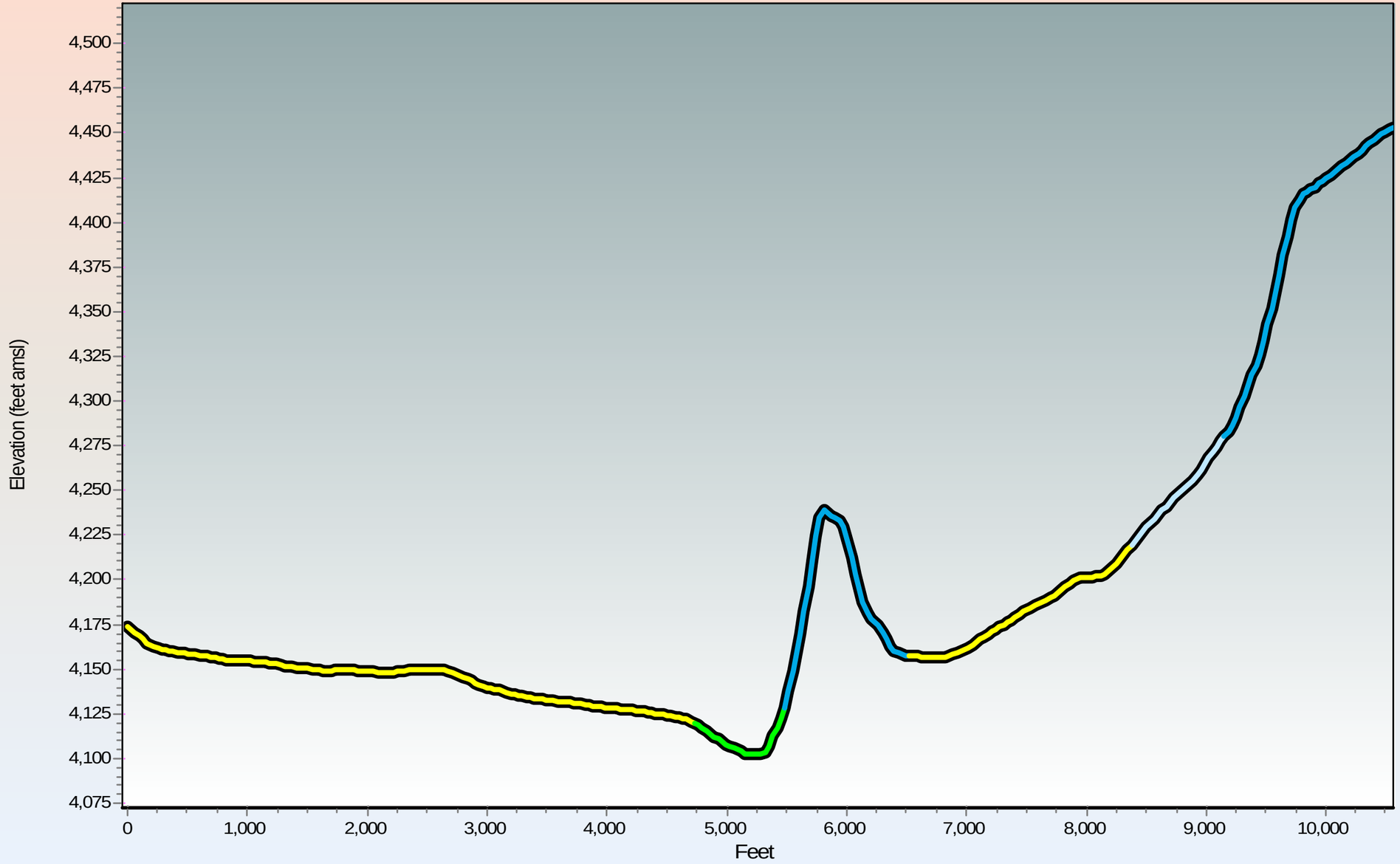
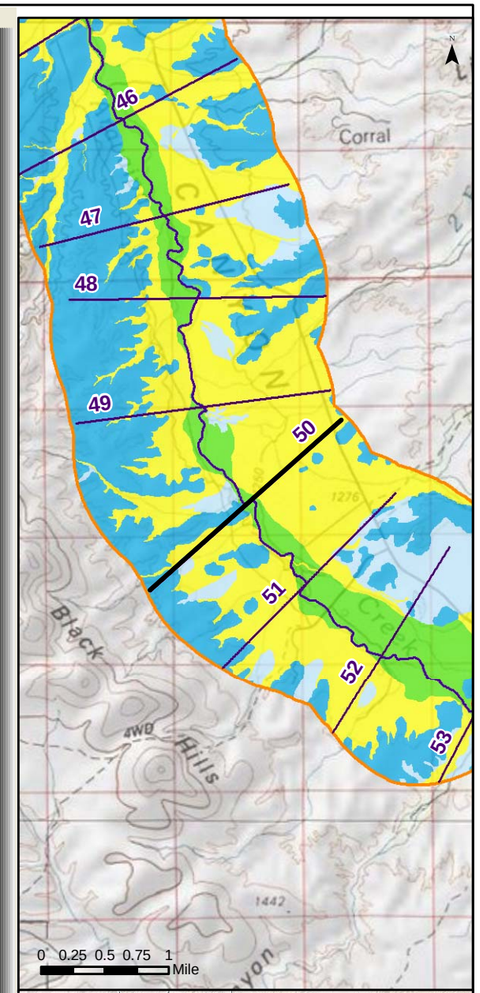
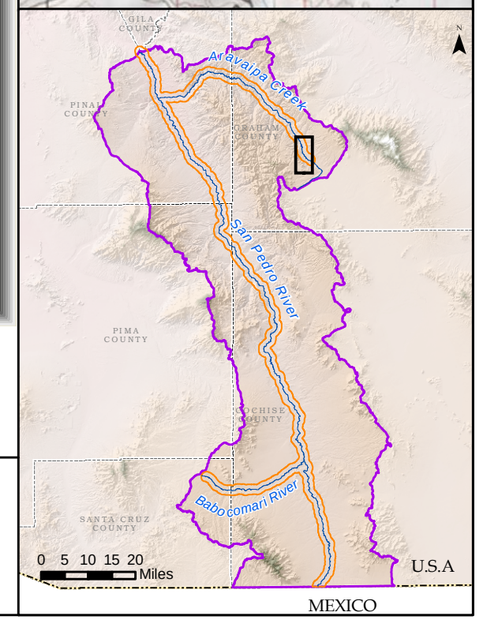
Appendix F
Aravaipa Creek Cross Section at Mile 49
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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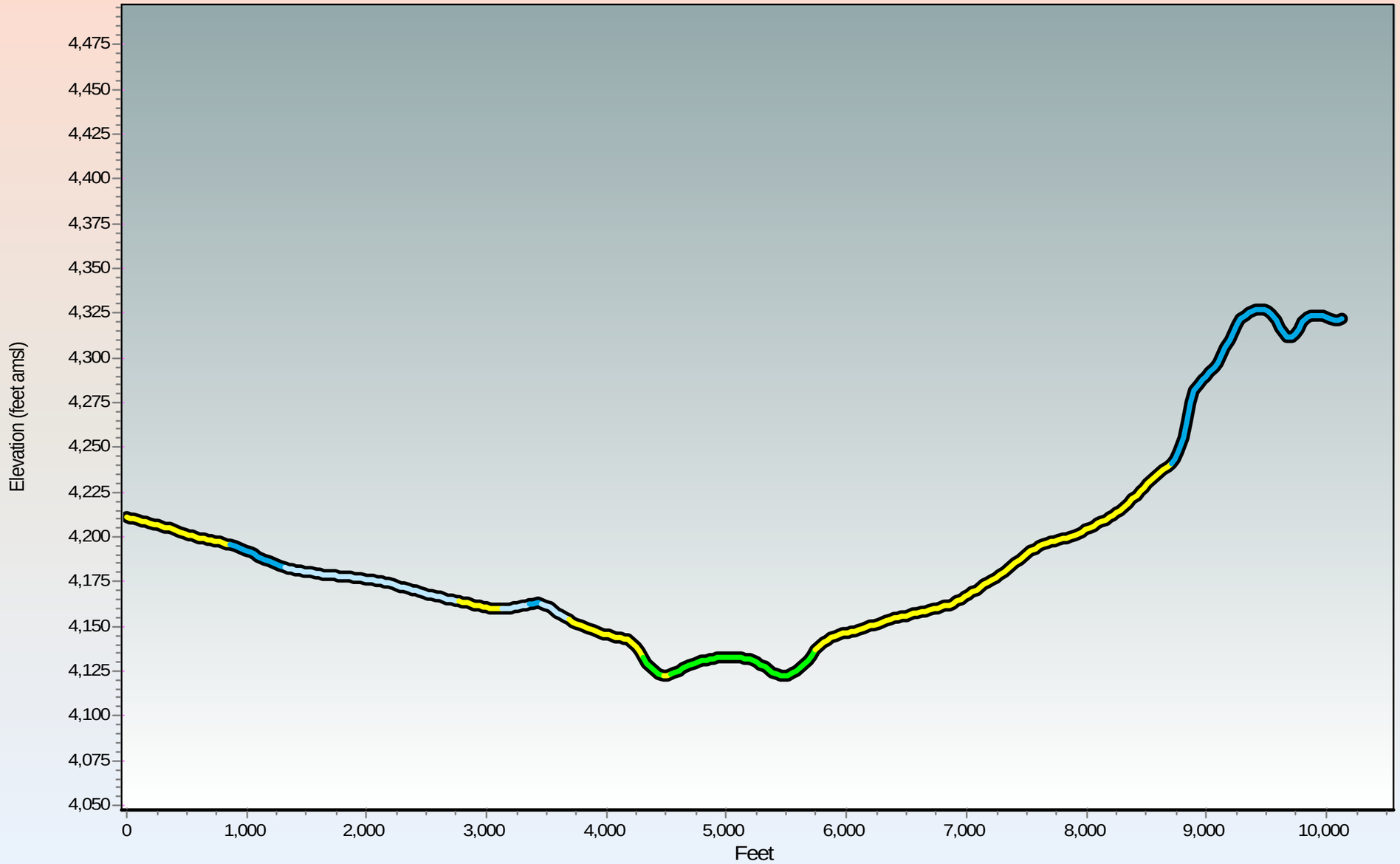
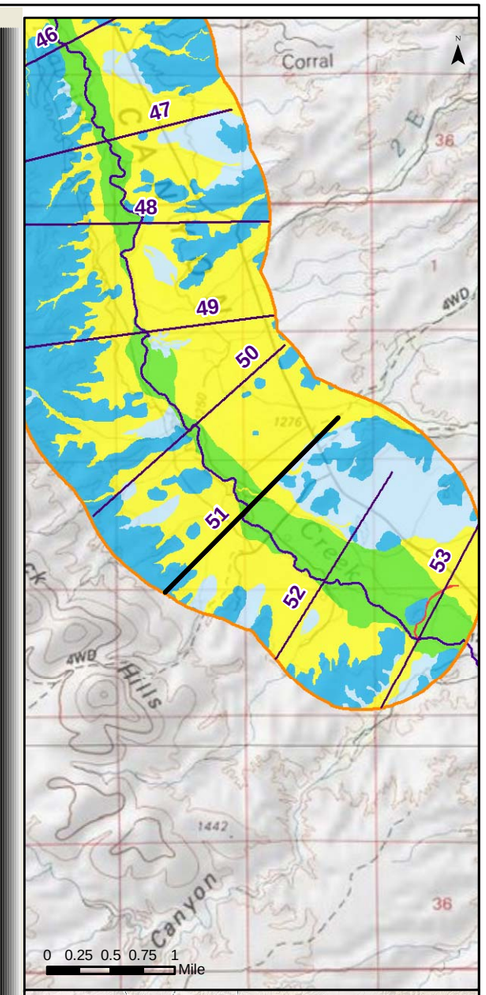
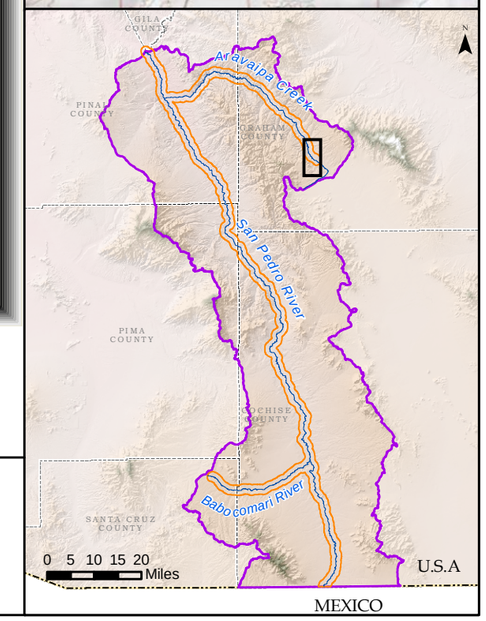
Appendix F
Aravaipa Creek Cross Section at Mile 50
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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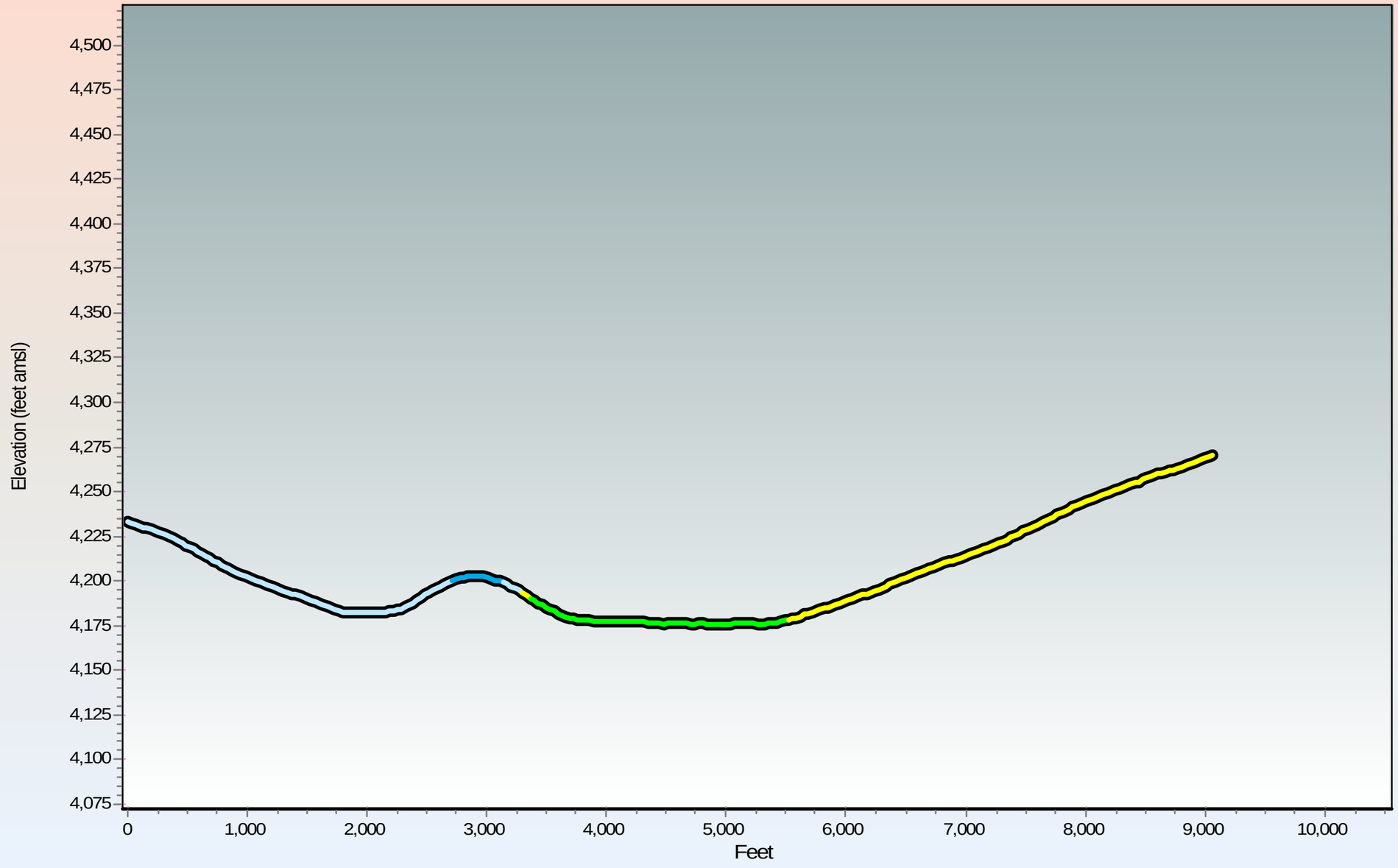
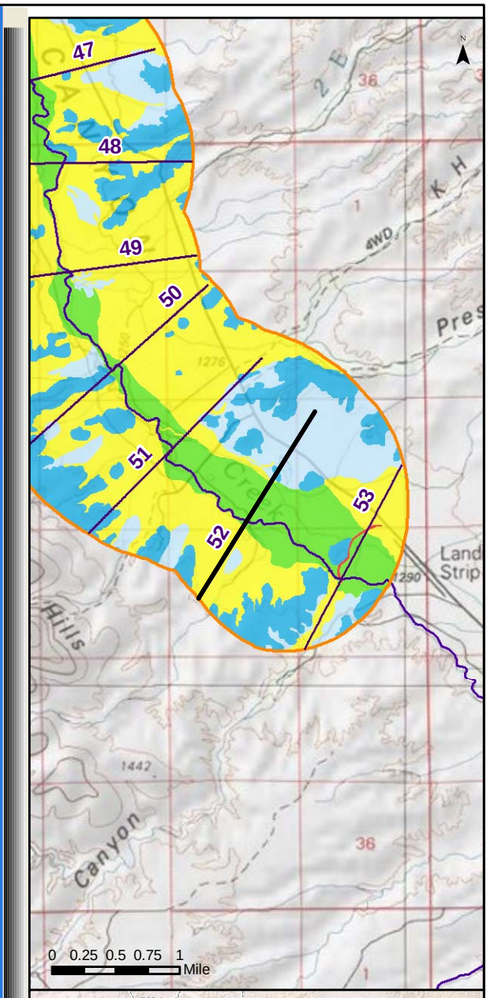
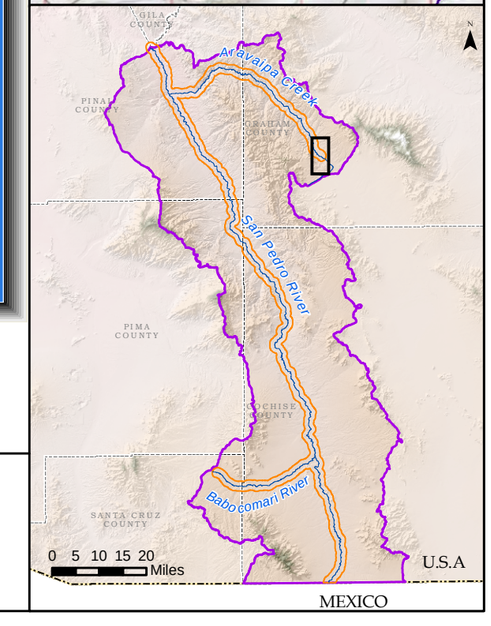
Appendix F
Aravaipa Creek Cross Section at Mile 51
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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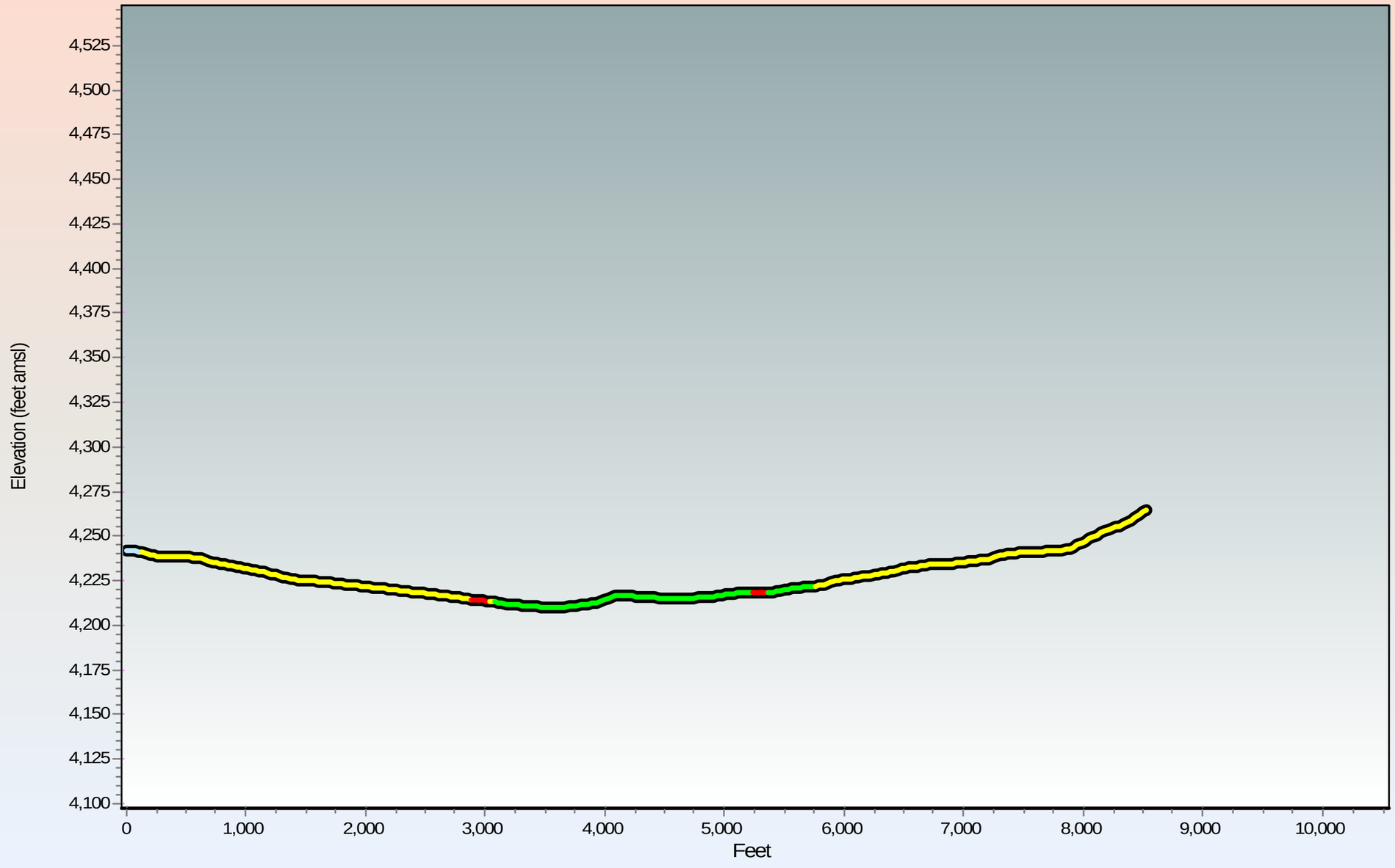
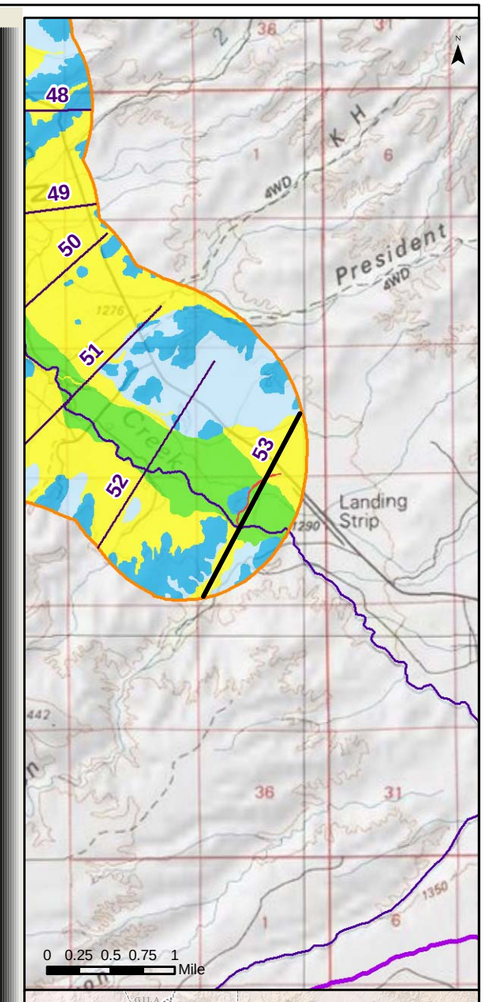
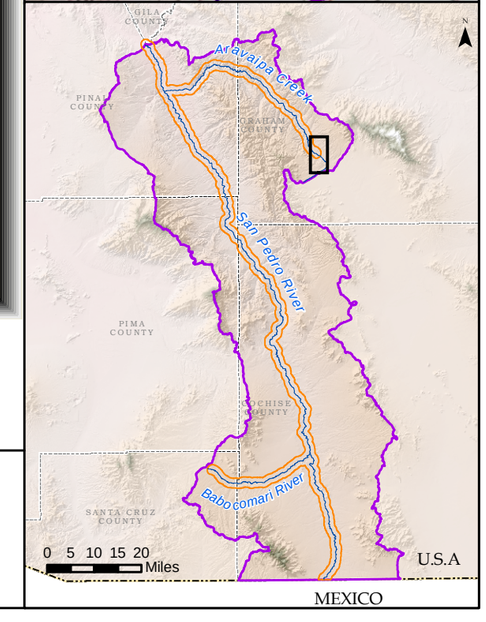
Appendix F
Aravaipa Creek Cross Section at Mile 52
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed







Generalized Surficial Geology

- Floodplain Holocene Alluvium (FHA)
- Tributary Holocene Alluvium
- Holocene Basin Fill
- Older Basin Fill
- Bedrock
- Disturbed (unit not determined)
- Lateral extent of USFWS Riparian Area/Wetland
- Lateral extent of ADWR Composite (1930s to 2007) Active Floodplain Boundary

Legend

- Cross Section
- Surficial Geology Mapped by AZGS (2009)
- USFWS Riparian Area/Wetland
- ADWR Composite (1930s to 2007) Active Floodplain Boundary
- Major Stream
- San Pedro River Watershed

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Appendix F
Aravaipa Creek Cross Section at Mile 53
(15 X Vertical Exaggeration)

Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed