

## Memo

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To:	Flood Control District of Maricopa County  2801 West Durango Street Phoenix, Arizona	From:	Stantec Consulting Inc. Stephanie Gerlach, PE 8211 South 48 <sup>th</sup> street Phoenix, AZ
File:	Stantec # 181300034	Date:	April 24, 2009

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### **RE: Gila River Bank Stabilization Pre-design Baseline Condition Summary**

#### **Purpose**

The Gila River Bank Stabilization Pre-design project area is located in the Town of Buckeye and City of Goodyear planning areas, unincorporated Maricopa County and within the Buckeye Water Conservation and Drainage District (BWCDD) (see Figure 1). The need for the stabilization project is based on the results of the Lateral Migration Analysis conducted as part of the El Rio Watercourse Master Plan (JE Fuller, 2005) and historic flooding and erosion problems. At locations in the project area, the north bank has been armored with angular and river-run (rounded) rock. The bank stabilization project is proposed to mitigate the public safety hazard due to flooding as a result of potential bank failure and lateral migration. The BWCDD and the Town of Buckeye submitted a Capital Improvement Program (CIP) priority request (Stantec, 2003). A copy of the request is included in Attachment A.

The purpose of this memorandum is to present conclusions that can be drawn from reviewing available documents, in regards to flood and erosion hazard risk to properties along the Gila River North Bank between Perryville Road and Citrus Road. The following was determined / identified for parcels along the north bank:

- potential for flow breakout to occur
- description of historic flood and erosion events
- property, facilities and infrastructure in the lateral migration limits
- property, facilities and infrastructure that are at risk (damage due to flood or erosion) in a flood event
- property, facilities and infrastructure that would benefit from the improvements
- impacts per jurisdictional boundaries
- benefits and constraints

#### **Existing Hydraulic Models and Potential for Flow Breakout to Occur**

Hydraulic models that include the subject reach of the Gila River that were used to delineate 100-year floodplains were developed for the following studies:

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- Salt-Gila River Floodplain Delineation Restudy, prepared by Michael Baker Jr., 1999, for the Flood Control District of Maricopa County (FCDMC), dated May 1999.
- Gila River Floodplain Redelineation Study, Maricopa County, Technical Data Notebook, prepared by Stantec Consulting Inc (Stantec) for the FCDMC, dated March 2008.
- Norte Vista / King Ranch Floodplain Redelineation, Gila River, Goodyear Arizona Letter of Map Revision (Norte Vista / King Ranch) prepared by River Research & Design, Inc. for developers Spencer Management, Inc. and SD Construction, L.L.C., dated June 2007.

The Federal Emergency Management Agency (FEMA) Effective 100-year floodplain (Figure 2) is based on the hydraulic model developed by Michael Baker, Jr. (1999). During the development of the FCDMC's El Rio Watercourse Master Plan it was identified that there was a topographic bust in the vicinity of the Perryville Road alignment crossing of the Gila River. The identification of the topographic bust lead the FCDMC to initiate the Gila River Floodplain Redelineation Study (Stantec, 2008). Comparison of the results of the hydraulic models developed for the two studies indicate that the water surface elevations in the bank stabilization area are lower, as much as four feet. The redelineation removed the floodplain area between Jackrabbit Trail and Citrus and north of Maricopa County Highway 85 (MC85) referred to the El Rio Watercourse Mater Plan as the "Buckeye breakout". Figure 2 depicts the Effective 100-year Floodplain and the 100-year floodplain developed for the Gila River Floodplain Redelineation Study.

The Norte Vista / King Ranch study was submitted to FEMA in 2008. The Norte Vista / King Ranch study is based on the hydraulic model developed for the Gila River Floodplain Redelineation Study.

Figure 2 shows the floodplain and floodway limits (designated as Project Floodplain or Floodway Limits) within the project study limits that were developed for the Gila River Floodplain Redelineation Study. The project floodplain limits lay just south of MC85 and the BWCDD South Extension Canal. Table 1 lists the water surface elevation determined from the hydraulic model used to define the Project Floodplain limits, bank elevation, MC85 elevation, and ground elevation just north of MC85 for each cross section within the project area. The following observations were made:

- The top of bank elevation ranges between five-feet below to six-feet above the 100-year water surface elevation.
- The elevation of MC85 ranges between four-feet to six-feet above the 100-year water surface elevation.
- The ground elevation north of MC 85 ranges between one-foot to four feet above the 100-year water surface elevation.

The potential for flow to breakout of the Gila River due to lateral migration and continue west is low because the ground surface elevation north of MC85 is higher than the 100-year water surface elevation.

**Table 1**

**Comparison of 100-year Water Surface Elevations and Ground Elevations**

Cross Section (miles) (1)	100-year Water Surface Elevation (feet) (2)	Top of Bank Elevation (feet) (3)	MC85 Elevation (feet) (4)	Ground Elevation Just North of MC85 (feet) (5)
190.24	883.58	884	890	886
190.34	884.11	884	890	886
190.43	884.58	884	890	886
190.53	885.10	886	890	888
190.62	885.56	880	890	888
190.72	885.93	884	892	888
190.81	886.27	886	892	888
190.91	886.63	886	892	888
191	887.05	888	892	890
191.1	887.44	888	892	890
191.19	887.79	892	894	892
191.29	888.20	894	894	892
191.38	888.62	888	894	892
191.48	889.10	886	894	890

(1), (3), (4) and (5) – Elevation data was obtained from the topographic mapping prepared as part of the Redelineation project (Stantec, 2008). The elevations were rounded to the nearest contour.

(2) – Water surface elevation was obtained from the redelineation HEC-RAS model (Stantec, 2008).

**Lateral Migration Limits**

As part of the El Rio Watercourse Master Plan, a Lateral Migration Analysis was conducted (JE Fuller, 2005). An Erosion Hazard Zone (EHZ) was developed as part of the study and is shown on Figure 2. The EHZ defines an area that the river potentially could erode away. The EHZ is based on geology/soil data, historical analysis, field data and hydraulic analysis. The project lies entirely within the EHZ. Should the river erode to the EHZ limits the ground elevations adjacent to the EHZ are higher than the project 100-year water surface elevation, this indicates that flow should not break out.

## **Historic Flood and Erosion Events**

Historically the project reach has been subject to numerous flooding events in which erosion and lateral migration has taken place. In this section of the memorandum, data and graphics developed as part of the El Rio Watercourse Master Plan are used to chronologically order flooding events and associated erosion/lateral migrations.

### Hydrologic Time Line

A time line representing the recorded flood history for the study area is shown on Figure 3. The data shown on that figure consists of mean daily and instantaneous discharge records for the gaging station at the Gila River below Gillespie Dam (09519500). This station is used to represent the flood history for the study reach because it is the closest station to the study area with the longest period of record. In general, stream flow in the study area occurs only after long duration rainfall events of large aerial extent. The three most significant recorded events occurred in December 1978, February 1980 and January 1993. The flooding of 1978 resulted from a tropical storm that moved across the state dumping large quantities of rainfall over a period of several days. The major reservoirs in the watershed were already near capacity from the unusually wet 1977 – 78 season and large releases were necessary. The maximum discharge recorded at Gillespie Dam (09519500) for this storm was 125,000 cfs. The flooding of 1980 was a result of a series of tropical storms that moved across the state dumping as much as 13 inches of rainfall in the upper portion of the watershed over a ten-day period. The maximum recorded discharge at Gillespie Dam for this storm was 178,000 cfs, which is the largest recorded discharge for the period of record. The flooding of 1993 was a result of a series of winter storms beginning in December 1992 that resulted in record breaking snowpack throughout the state. In January 1993, 15 days of rainfall combined with the rapidly melting snow to fill the major reservoirs that were already near capacity. The maximum estimated discharge at Gillespie Dam for this storm was 130,000 cfs. Based on a flood frequency analysis the return period was estimated to be 33 years, that is, floods with peak discharges in excess of the 1993 flood would be expected only once every 33 years on the average (SFC Engineering Company, 1997).

### Lateral Migration

Figures and aerial photographs from the Lateral Migration Analysis Report (JE Fuller, 2005) developed for the El Rio Watercourse Master Plan are used to depict evidence of lateral migration that has occurred over time. Aerial photographs from the Lateral Migration Analysis report are included in Attachment B. The reach studied for the El Rio Watercourse Master Plan was subdivided into multiple reaches for the purpose of presenting information. The reaches that coincide with the project reach for this study are Reaches 6 and 7. The aerial photographs span the period from 1937 to 2004. To aid the reader in finding key points of interest in relation to information being presented, the project boundary for this study (red line work, location of main channel/channels (red dot) and the location of canals (blue dots) have been added to the figures.

Aerial photographs for Reach 7 depict the greatest physical change to the river due to lateral migration. The following are observations and conclusions made from the review of the aerials:

Review of 1937 (Fairchild) aerial photography:

- Red dot shows the location of the main channel network. The channel is characterized by multiple braids.
- Blue dots indicate the location of a canal. The canal is a lateral to the BWCDD Main Canal. The canal appears to have a southwestern sinuous alignment.
- Clearing of vegetation has occurred south of the lateral.

Observations made from the review of February 20, 1949 (USDA) aerial photography that are different than the review of the 1937 (Fairchild) aerial photography:

- The area of vegetation clearing south of the lateral is greater.

Observations made from the review of January 3, 1958 (USDA) aerial photography that are different than review of the February 20, 1949 (USDA) aerial photography:

- It appears that canal laterals from the lateral to the Main Canal have been constructed.
- The area of vegetation clearing south of the lateral is greater.

Observations made from the review of January 21, 1964 (USDA) and June 1971 USGS aerial photography that are different than the review of earlier aerial photography are:

- Density of vegetation within the channel appears to be significantly less than observed in earlier photographs. Review of the Hydrologic Time Line presented in Figure 3 indicates that one of the driest periods of recorded occurred in the time frame between the photograph dates.
- The area of vegetation clearing south of the lateral is greater

Observations made from the review of December 5, 1977 (Cooper Aerial), June 12 1978 (USBLM) and the May 13, 1979 (USDA) aerial photography that are different than the review of earlier aerial photography are:

- Channels appear to have laterally migrated to the north. The greatest evidence of lateral migration is depicted in the May 13, 1979 aerial photograph. The main channel has migrated from the center of the watercourse to the north bank.
- There is a significant loss of agricultural lands.
- A significant amount of vegetation has been removed from the channel.

Review of the Hydrologic Time Line presented in Figure 3 indicates that one of the wettest periods of recorded occurred in the time frame between the photograph dates. Significant lateral migration has occurred in response to runoff events.

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Observations made from the review of October 14, 1983 (USGS), March 22 1985 (Aerial Mapping Co.) aerial photography that are different than the review of earlier aerial photography are:

- Main channels appear to be predominately along the north bank and within the northern half of the watercourse.

Review of the Hydrologic Time Line presented in Figure 3 indicates that significant runoff events occurred in the time frame between the photograph dates. The maximum recorded runoff event occurred February 8<sup>th</sup> 1980.

The FCDMC initiated the design of the existing bank protection in 1982 and construction occurred in 1983.

Observations made from the review of April 18 and September 6, 1992 (USGS DOQQ), June 26, July 1, 1993 (USGS) and April 30, 1997 (USGS NAPP) that are different than the review of earlier aerial photography are:

- There appears to be up to three defined channels (see red dot on aerial photograph)
- The channels appear to be clean of vegetation in the 1993 and 1997 aerial photography. The lack of vegetation is due to the 1993 runoff event.

During the 1993 runoff event additional bank protection material was placed on the bank protection constructed in 1983.

In summary the review of the aerial photographs and Figure 3 the following is offered:

- Farm fields located just west of the Citrus Road alignment extend south of the BWCCD South Extension Canal in photographs dated 1958, 1964, 1971, 1977 and 1978.
- Laterals to the Main Canal were constructed presumably to service the added farm fields.
- Extensive erosion and lateral migration resulting in the loss of farm fields and canals took place prior to the 1979 aerial.
- The main channel migrated from the central portion of the river corridor to the north bank.
- The main channel of the river remained up against the north bank of the river in photographs dated 1983, 1985, 1992, 1993 and 1997.

JE Fuller (2005) reports lateral migration movement for the El Rio Watercourse Master Plan study reach of the Gila River. A figure (Compound Channel – Right Bank Lateral Migration Summary) from their report presenting the movement of channel banks for various years is also included in Attachment B. The location of this project on the figure would be between stations 51,000 and 58,000.

The following observations can be made from these figures:

- Between 1971 and 1977 the compound channel moved southward approximately 1,000 feet.
- Between 1978 and 1979 the compound channel moved northward approximately 2,500 feet in the project area.

*Flood Damage to Infrastructure*

During the 1980 flooding event portions of the South Extension Canal were lost (personal phone conversation with Ed Gerak, BWCDD General Manager, 5 February 2009). The canal was rebuilt further to the north (see Figure 4). During 1983 the FCDMC constructed the Perryville Bank Stabilization project at a cost of \$270,010 (Camp Dresser & McKee, Inc. 1983). The as-builts of the bank stabilization are included in Attachment A. The purpose of the project was to prevent further erosion of the riverbank and the resultant loss of land and improvements. The limits of the project are shown on Figure 1. The plans indicate that rock was in place before the bank protection was added. The slope of the rock was listed as 1 horizontal to 1 vertical. According to the plans gabions were added to the toe of the rock. Riprap was added upstream and downstream of the existing rock at a slope of 2.5 horizontal to 1 vertical. Originally, the riprap was to extend 10-feet below ground surface. According to FCDMC records the toe-down trench could not be excavated because the groundwater was higher than expected and there was fine-grained soil. The toe-down was replaced with gabions.

During the 1993 flooding event the Perryville Bank Stabilization was damaged. An aerial photograph from the 1993 flooding event is shown on Figure 5. The records indicated that 1,600 cubic yards (cy) of riprap and 1,100 cy of fill was placed, but did not indicate where the damage occurred.

***Existing Bank Protection***

During February 2009, four test pits were excavated in the existing bank stabilization area (AMEC, 2009). The report indicated the bank stabilization material consisted of cobble approximately 1.5-feet thick underlain by a woven geotextile. The toe of bank stabilization consists of gabion baskets that are 6- to 8-inches thick. Based on a preliminary bank slope stability analysis, AMEC concluded the bank protection has an adequate factor of safety in regards to slope stability. As part of the El Rio project the total scour was estimated to be approximately 9-feet deep at the thalweg of the channel (Stantec, 2005). Based on this information the existing bank protection may not be deep enough. The Design Report for this project will include scour analysis and riprap sizing. The Design Report will further discuss the adequacy and/or deficiency of the existing bank protection.

**Property, Facilities and Infrastructure in the Lateral Migration Limits**

Table 2 includes a list of properties that are located within the EHZ and notes if the properties include primary residential structures. The properties are also shown on Figure 6. Residential structures were identified through a field reconnaissance of the project area. The table also lists whether the damage to the property would be due to flooding or erosion. The last column in the tables identifies whether the proposed bank stabilization will benefit the property.

Other facilities that are located within the EHZ or floodplain include Perryville Road (187<sup>th</sup> Avenue) and MC85. Emergency vehicles and the public use MC85 as major route to access portions of the Town of Buckeye and City of Goodyear. Traffic counts for MC85 from Maricopa County Department of Transportation (MCDOT) are included on Table 3 (MCDOT, 2009). According to the CIP Memorandum the estimated roadway replacement cost is between \$600,000 and \$800,000 per mile (Stantec, 2003). The future alignment of the SR 303L may also extend into the project area. There are several utilities that parallel MC85 and they include wells, overhead electric, high-pressure gas, telephone, BWCDD irrigation facilities and private irrigation facilities. BWCDD has several facilities in the EHZ including the South Extension Canal, check structures, turnout structures and laterals. According to the CIP Memorandum the estimated replacement cost of the South Extension Canal is approximately \$400,000 per mile. Table 4 lists the utilities and identifies whether the proposed bank stabilization will benefit the utility.

Table 2

Properties Located within the Erosion Hazard Zone

Parcel Number	Parcel Owner	Includes a primary residential structure	Damage Due to Flood or Erosion	Would property benefit from proposed improvement?
502-57-010C	State of Arizona	Yes	Erosion	Yes <sup>1</sup>
502-57-003	DRM Farms LLC	No	Erosion	Yes <sup>1</sup>
502-57-014C, 502-57-014S, 502-57-019, 502-59-002H, 502-57-014F, 502-57-012F, 502-57-010E, 502-57-014R, 502-59-005F, 502-57-020, 502-59-008C, 502-57-014H, 502-57-014E, 502-57-014D, 502-57-018, 502-57-016, 502-57-014K, 502-57-012D, 502-57-014N, 502-59-002F, 502-57-014Y, 502-59-003B, 502-57-012E, 502-59-004B, 502-57-017, 502-57-014G	Dos Rios Materials LLC	No	Flood and Erosion	No
502-57-009	Brown, John Charles	Yes	Flood and Erosion	Yes <sup>1</sup>
502-57-014Z	Wolfe Carl Leroy/ Jennifer F	Yes	Flood and Erosion	Yes <sup>1</sup>
502-57-014B, 502-57-014P	Mendoza Robert P & Esther G	Yes	Flood and Erosion	Yes <sup>1</sup>
502-57-007, 502-57-008C	Buckeye Group LLC	Yes	Erosion	Yes <sup>1</sup>
502-57-012G	Flood Control District of Maricopa County	No	Flood and Erosion	No
502-57-011B	Triangle 85 Partnership	No	Erosion	Yes <sup>1</sup>
502-57-001B	BWCCD	No	Flood and Erosion	No

1) Potential erosion hazard is mitigated.

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**Table 3**

**MC85 Traffic Counts**

Date (1)	Direction (2)	Ref Road (3)	Travel (4)	ADT 2007 (5)	2007 AM Hour (6)	2007 AM Volume (7)	2007 PM Hour (8)	2007 PM Volume (9)
10/22/2007	E	Rainbow Rd	B	10177	730	791	1545	887
10/10/2007	E	Miller Rd	B	12649	1100	824	1530	1025
10/22/2007	W	Southern Ave	B	10083	600	838	1530	840

Source: MCDOT, 2009

(5) ADT – Average Daily Traffic Count. Traffic counts represent a 24 hour ADT.

(4) Indicates traffic flow for count. B = Both directions

(6) and (8) the AM/PM indicate time during morning and evening where traffic was heaviest.

(7) and (9) indicate the volume during the morning and evening where traffic was heaviest.

**Table 4**

**Utilities**

Utility Company (1)	Utility (2)	Damage due to flood or erosion (3)	Would utility benefit from proposed improvement? (4)
APS	Electric	Erosion	Yes
Southwest Gas	Natural Gas	Erosion	Yes
Qwest	Telephone	Erosion	Yes
BWCDD	Irrigation	Flood and Erosion	Yes
Private Irrigation Wells	Irrigation	Flood and Erosion	Yes
	Privately owned	Flood and Erosion	Yes

**Impacts per Jurisdictional Boundaries**

The study area is located within unincorporated Maricopa County except for Citrus Road alignment (see Figure 7). Citrus Road alignment is owned by the City of Goodyear (COG). See Table 5 for the number of acres impacted from flooding and erosion. The project area is also included in two general plans, Town of Buckeye (TOB) and City of Goodyear (TOB and COG, 2007). The land uses are shown on Figure 7 and Attachment C includes copies of the general plans. According to the plans the study area was assigned the classifications of rural residential, open space, business park and very low density. The alignment of the bank stabilization lies between the land uses rural residential and open space. These land uses should not affect the

alignment. See Table 6 for the number of acres impacted from flooding and erosion to the City of Goodyear land use areas.

**Table 5**

**Jurisdictional Impacts**

<b>Jurisdiction</b> (1)	<b>Flooding</b> <b>(acres)</b> (2)	<b>Erosion</b> <b>(acres)</b> (3)	<b>Would benefit from</b> <b>proposed improvement?</b> (4)
Unincorporated Maricopa County	16.3	93.3	Yes
City of Goodyear	0.3	1.1	No

**Table 6**

**City of Goodyear Land Use Impacts**

<b>Land Use</b> (1)	<b>Flooding</b> <b>(acres)</b> (2)	<b>Erosion</b> <b>(acres)</b> (3)	<b>Would benefit from</b> <b>proposed improvement?</b> (4)
Rural Residential	0	90.1	Yes
Open Space	16.3	0	No
Community Commercial	0	3.1	Yes

**Cultural Resource Sites**

As part of the El Rio Watercourse Master Plan project, James Rodgers prepared a cultural resources report (Rodgers, 2002). The report includes an archival map of the major Hohokam canals and adjacent villages of the eastern Buckeye Valley. The report documents three sites near the project, AZ T:11:22 ASM, Midvale 4 and ASM 87-222, 98-4. These sites are shown on Figure 8. An additional site was discovered during the project, AZ T:11:189 ASM, and is located near the start of the proposed alignment. Two sites, AZ T:11:22 ASM and AZ T:11:189 will be impacted by the alignment. The other cultural sites are located outside the preliminary alignment of the bank protection.

A figure presented in Rodgers (2002) report indicates that bank erosion took place within the subject reach in 1917. A copy of the figure is included in Attachment D.

**Proposed Alignment of Bank Stabilization**

The proposed alignment of the bank stabilization is shown on Figure 6 and it lies just south of MC85 and BWCDD South Extension Canal. The bank stabilization will provide the following benefits:

- Based on the results of the recent studies the elevation of the ground surface north of MC85 is higher than the 100-year water surface elevation. The potential for breakout to the west is low.

- Protect seven properties from damage caused by flooding/erosion or erosion as identified in Table 2. Of the seven properties, five have a primary residential structure.
- Protect existing farm fields from lateral migration of the Gila River.
- Provide protection of utilities within the erosion hazard boundary including overhead power, high-pressure gas and telephone.
- The bank stabilization will provide protection of MC85 during flood events. MC85 is the main route of emergency services for the area. The roadway also provides public access to the City of Goodyear and Town of Buckeye. The loss of MC85 would cause economic hardship to the public. The CIP memorandum estimated the roadway replacement to be between \$600,000 and \$800,000 per mile.
- Protection of future SR 303L.
- Provide protection of BWCDD facilities including South Extension Canal, check structures and turnout structures. The CIP memorandum estimated the replacement cost would be approximately \$400,000 per mile.
- Provide protection of 16.3 acres from flooding and 93.3 acres from erosion in unincorporated Maricopa County.
- Provide protection of 90.1 acres from erosion in the City of Goodyear land use rural residential and 3.1 acres from erosion in the land use community commercial.
- Once the bank stabilization is constructed the FCDMC will have better all-weather operation and maintenance access.

Constraints to the bank stabilization include the following:

- Some of the river bank fill on the west end of the project consists of non-engineered material and trash. Additional mitigation may be necessary in these areas. See the Initial Preliminary Geotechnical Investigation Report by AMEC and the Phase I Environmental Assessment report for more information.
- Construction of the bank stabilization will require acquisition of the right-of-way from landowners for the entire alignment of the bank stabilization.
- Two cultural sites are located in the proposed alignment of the bank stabilization. The design report will consider options for protecting the sites.
- Based on the information from the bank protection design drawings and total scour depth from the El Rio study the toe-down of the existing bank protection is

not adequate. Further evaluation of the riprap size and total scour depth will be completed as part of the Design Report.

- Partnerships with the Maricopa County Department of Transportation (McDOT), Town of Buckeye, City of Goodyear and BWCCD will be beneficial to fully fund the project.

### **References**

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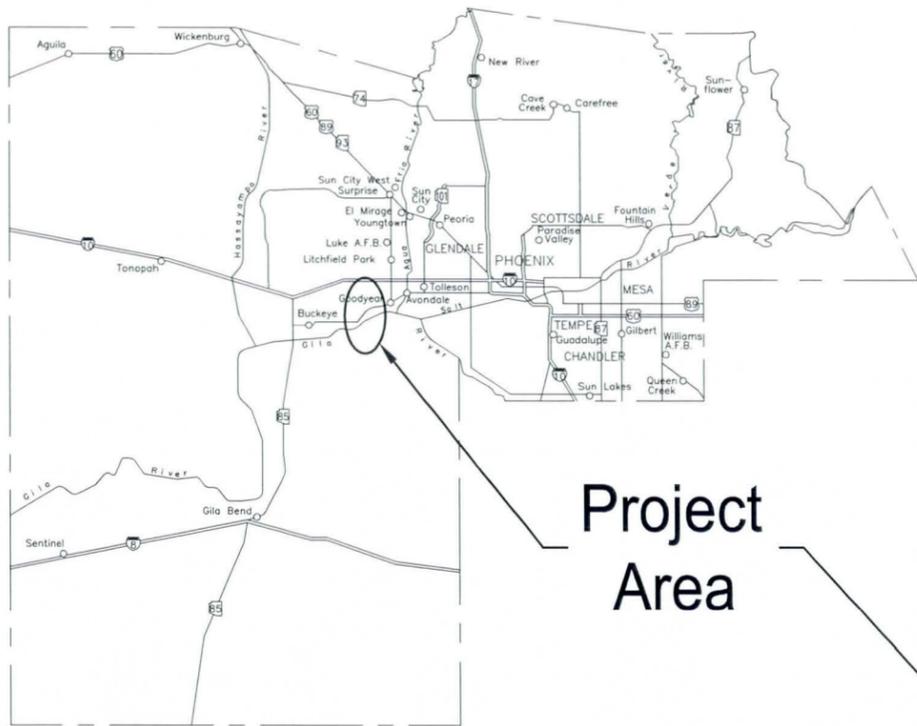
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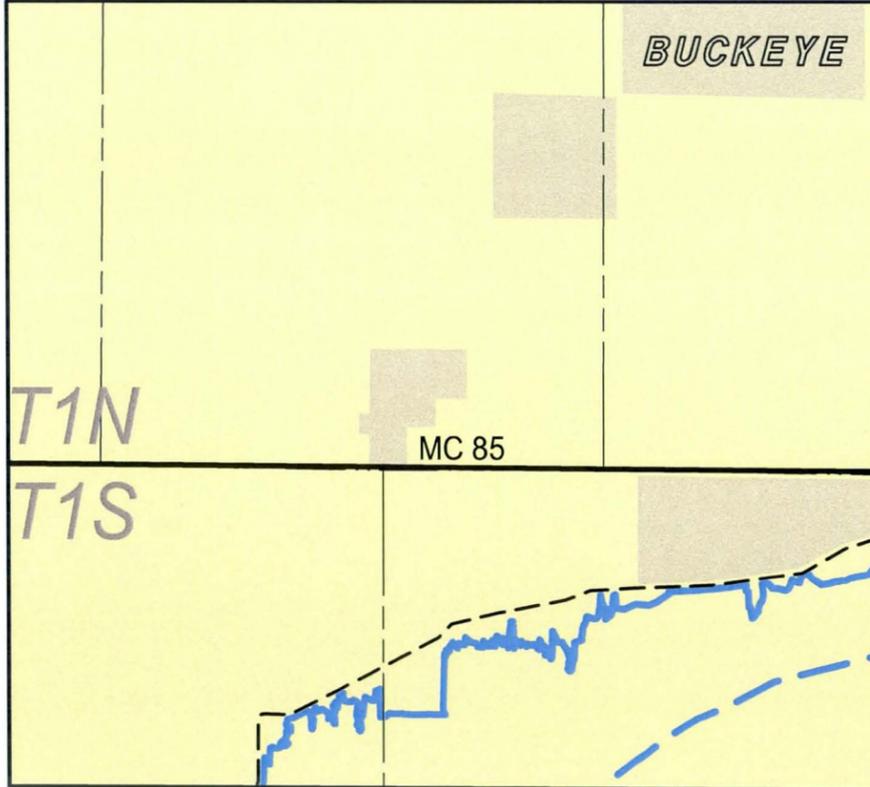
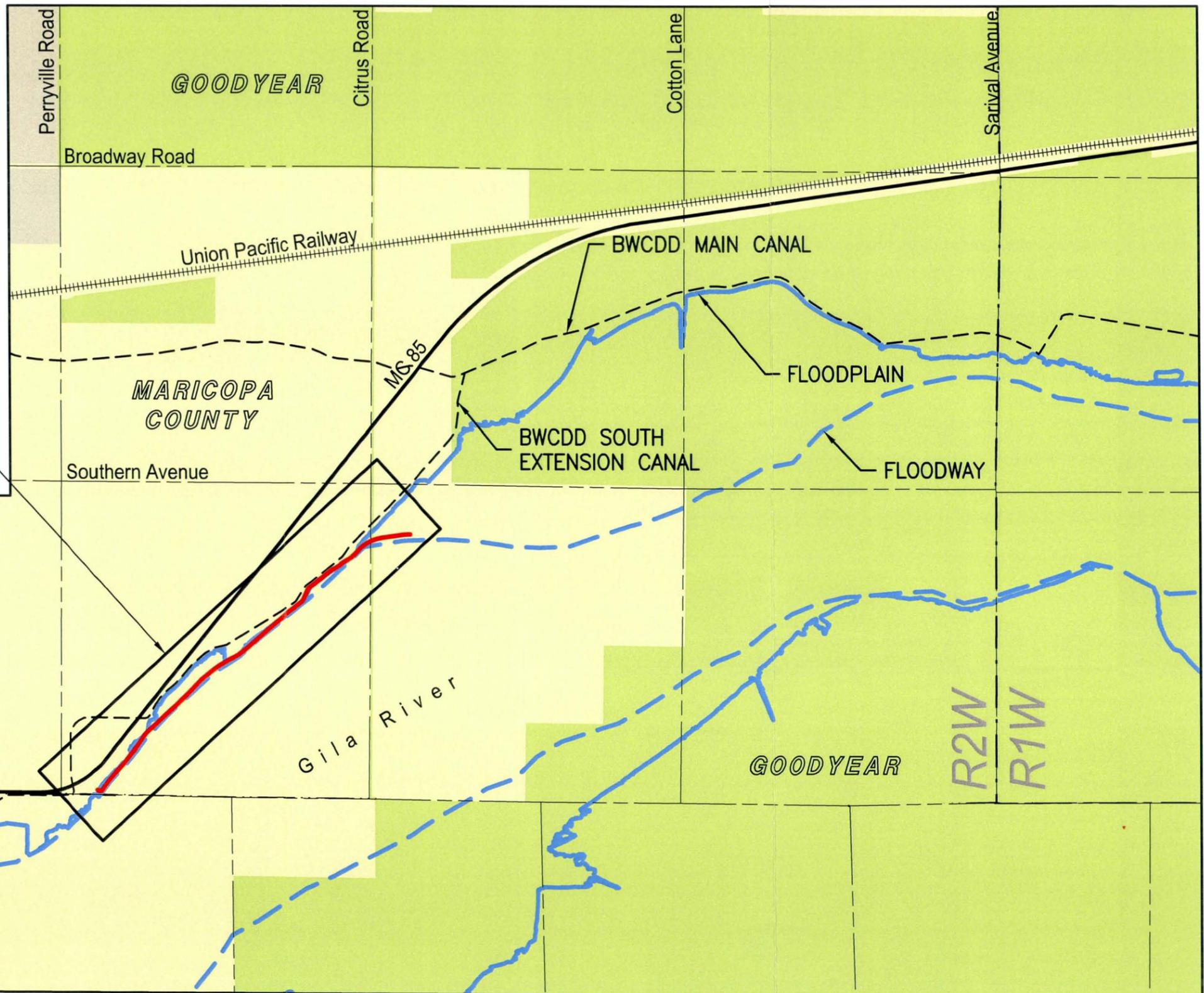
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Town of Buckeye, 2007, Town of Buckeye 2007 General Plan Update, Adopted January 18, 2008 and Ratified May 20, 2008.

**Figures**



**Project Area**



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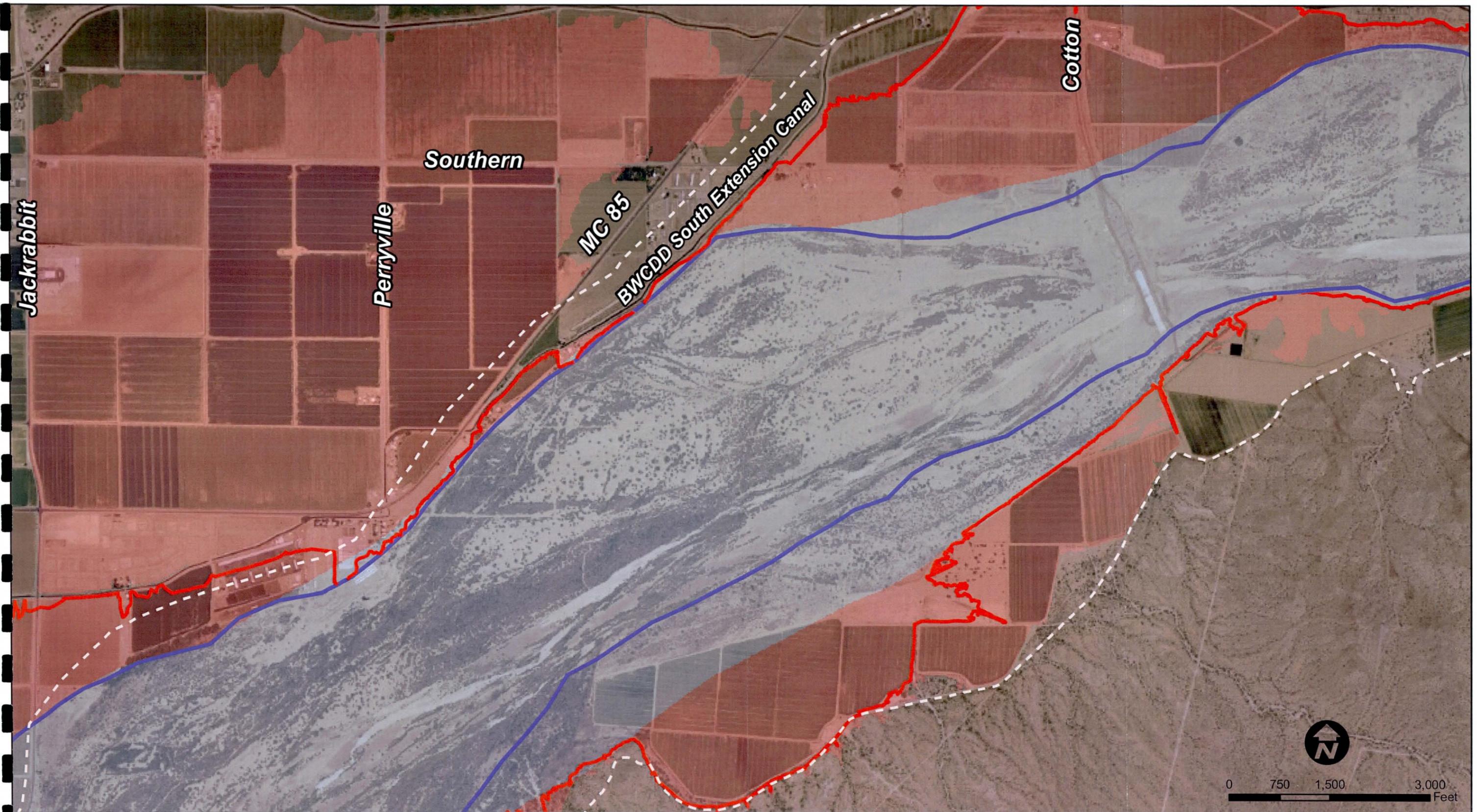
- Maricopa County
- Goodyear
- Buckeye

Client/Project  
Flood Control District of Maricopa County  
Gila River Bank Protection Pre-Design Project  
Perryville Road to Citrus Road - FCD No. 2007-C017

Figure No.  
1

Title

Vicinity Map



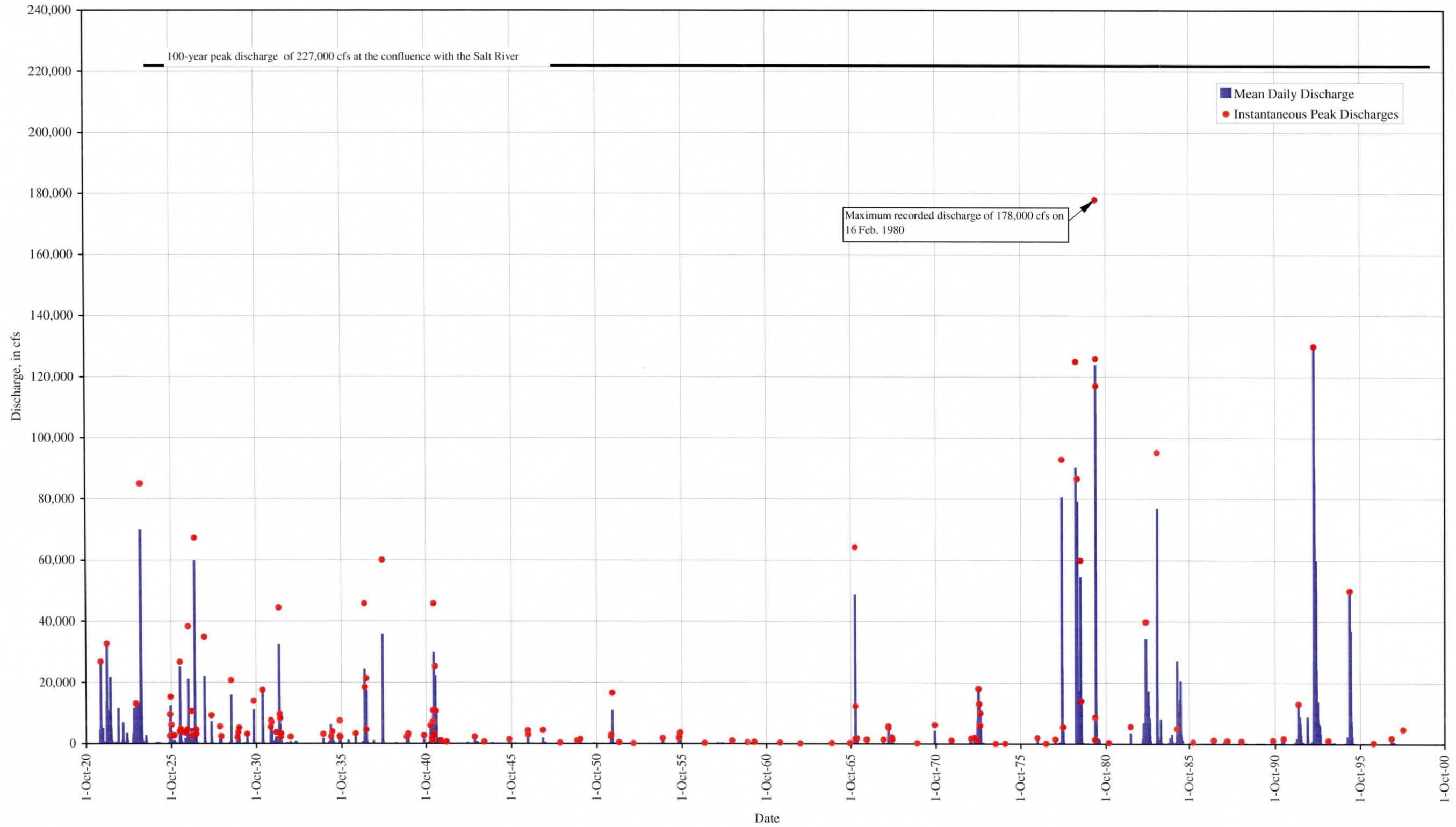
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- Project 100-year Floodway
  - Project 100-year Floodplain
  - Effective Floodway
  - Effective Floodplain
  - Erosion Hazard Zone

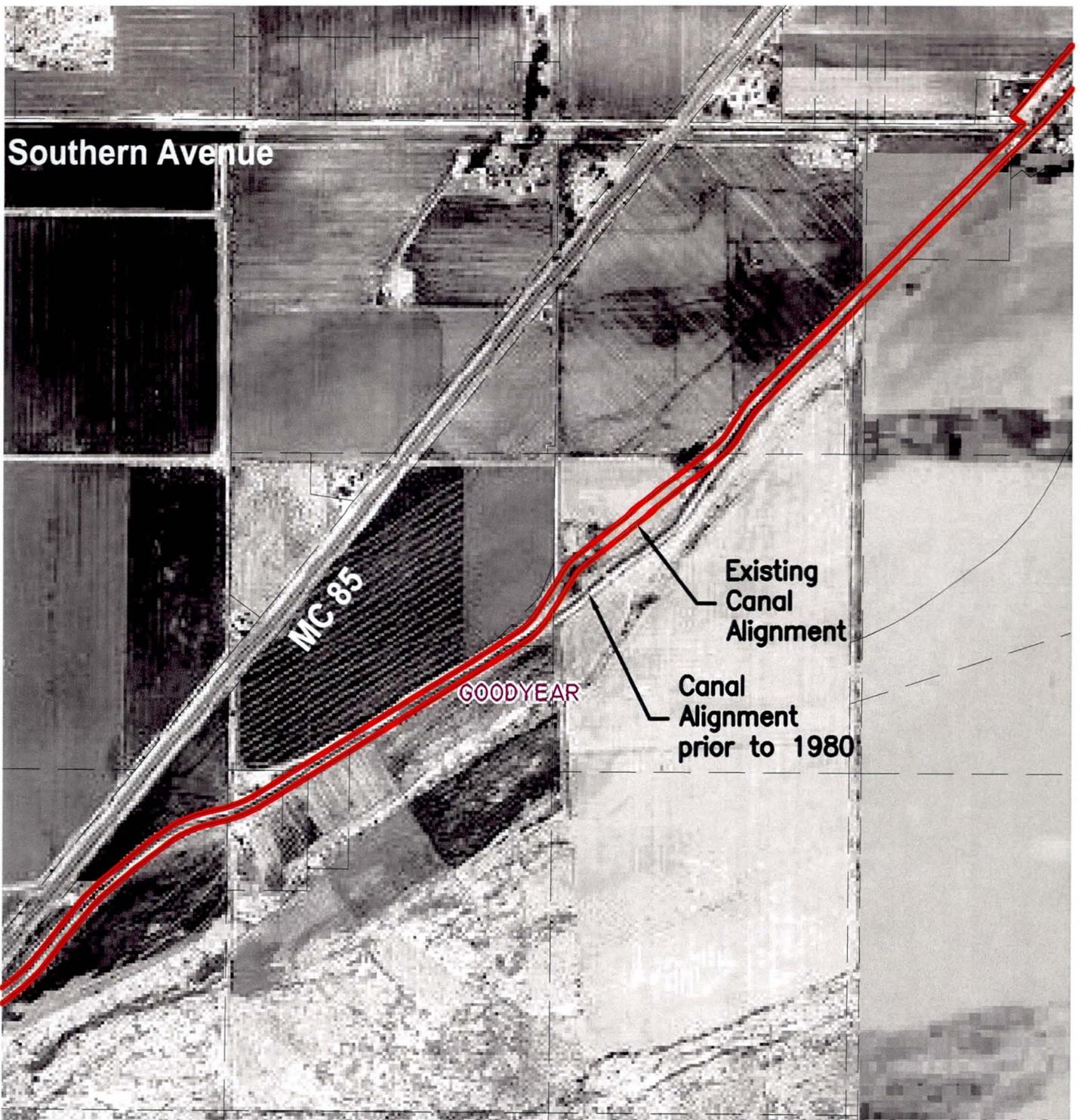
Client/Project  
**Flood Control District of Maricopa County**  
 Gila River Bank Protection Pre-Design Project  
 Perryville Road to Citrus Road - FCD No. 2007-C017

Figure No.  
**Figure 2**

Title  
**Floodplain and Floodway Comparison**

Figure 3  
Hydrologic Time Line





SOURCE: FCDMC Aerial Dated 1959



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Client/Project

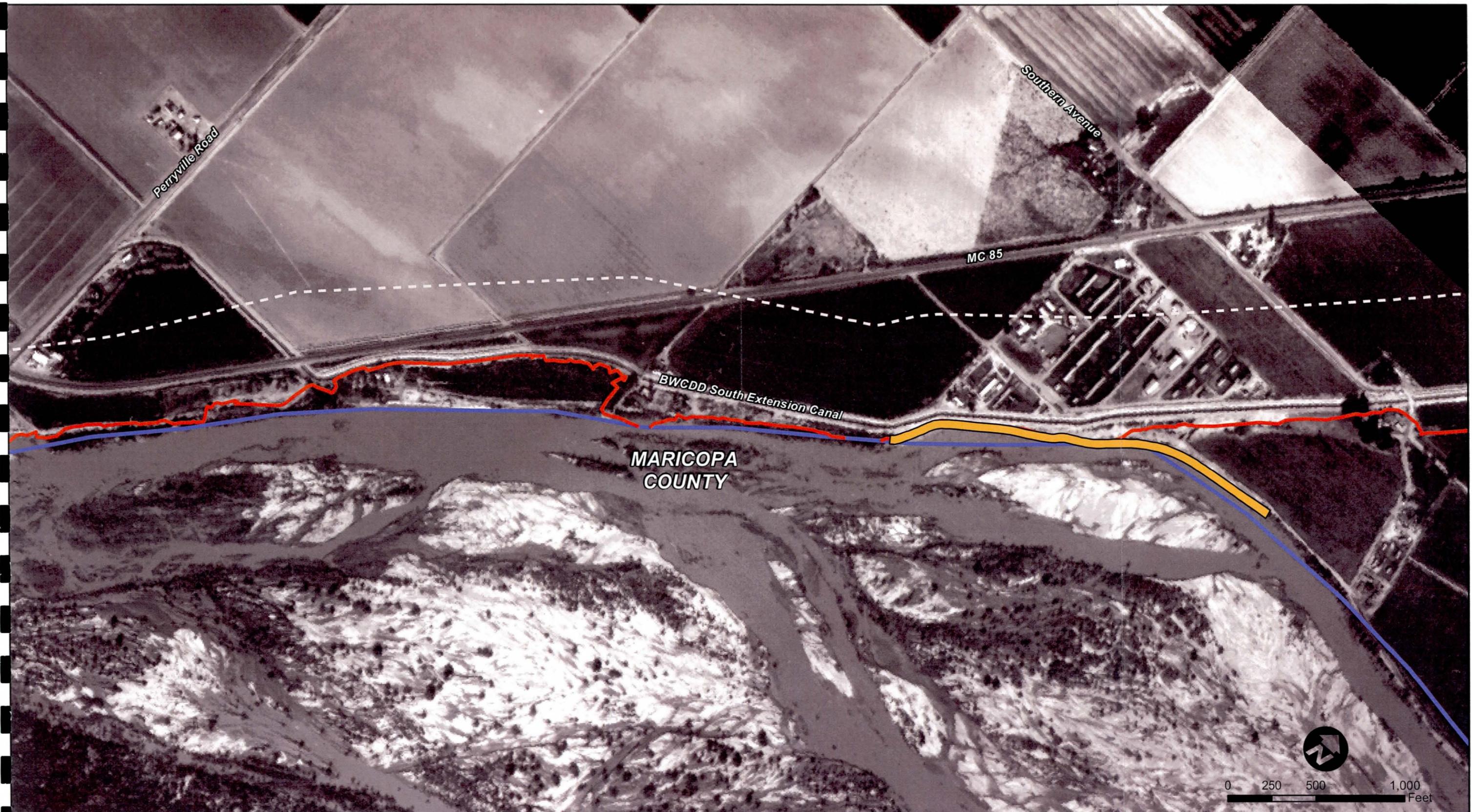
Flood Control District of Maricopa County  
Gila River Bank Protection Pre-Design Project  
Perryville Road to Citrus Road - FCD No. 2007-C017

Figure No.

4

Title

BWCDD South Extension  
Canal Alignment



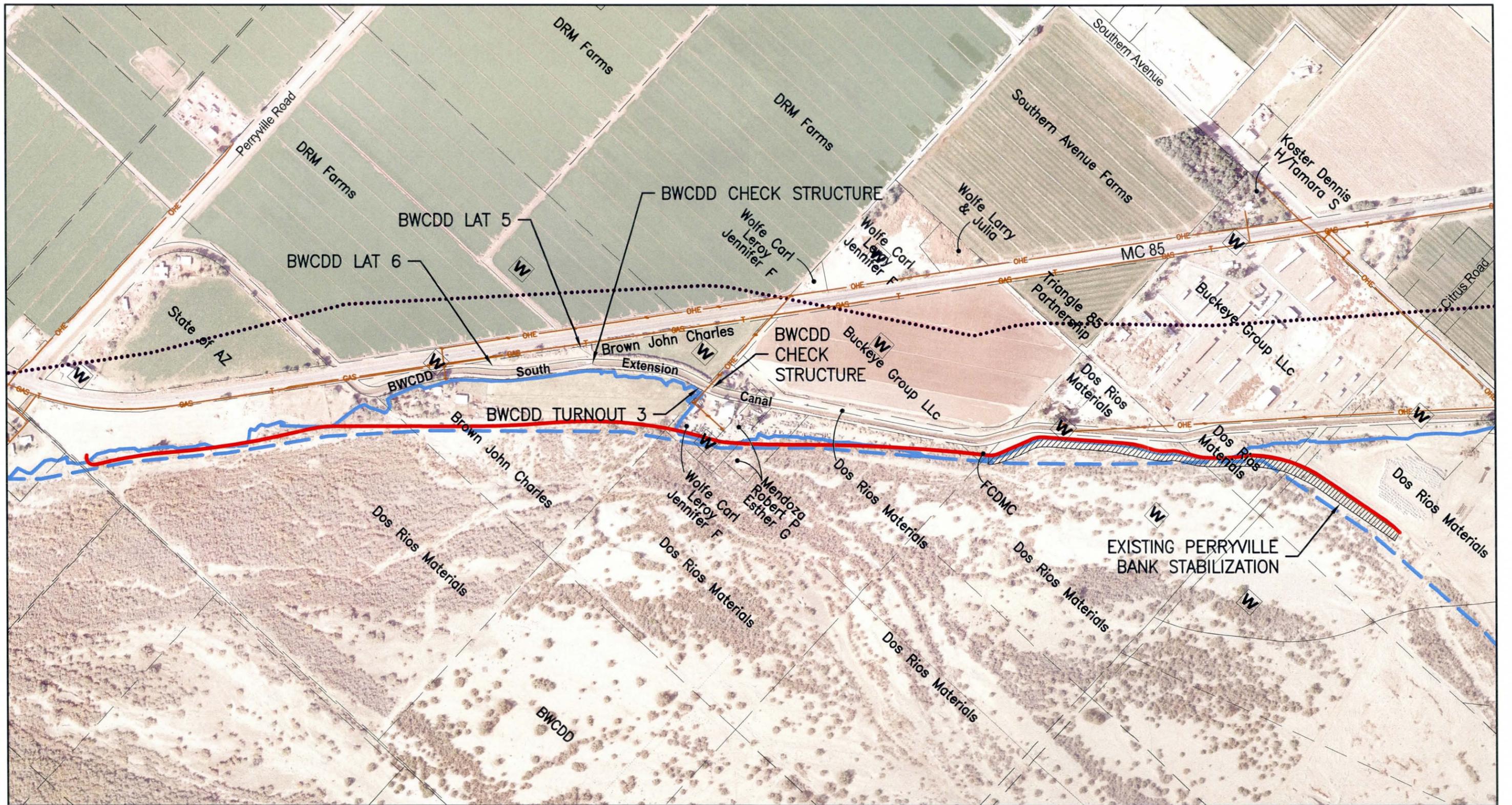
- Legend
- Project 100-year Floodway
  - Project 100-year Floodplain
  - Existing Bank Protection
  - Erosion Hazard Zone

Aerial Photos taken 2 February 1993 by FCDMC

Client/Project  
**Flood Control District of Maricopa County**  
**Gila River Bank Protection Pre-Design Project**  
**Perryville Road to Citrus Road - FCD No. 2007-C017**

Figure No.  
**Figure 5**

Title  
**Limits of 1993 Flood Event**



01.2009  
181300034



- Legend**
- Preliminary Bank Protection Alignment
  - Project 100-year Floodplain
  - - - Project 100-year Floodway
  - ⋯ Erosion Hazard Zone
  - OHE Overhead Electric
  - GAS High Pressure Gas
  - T Telephone

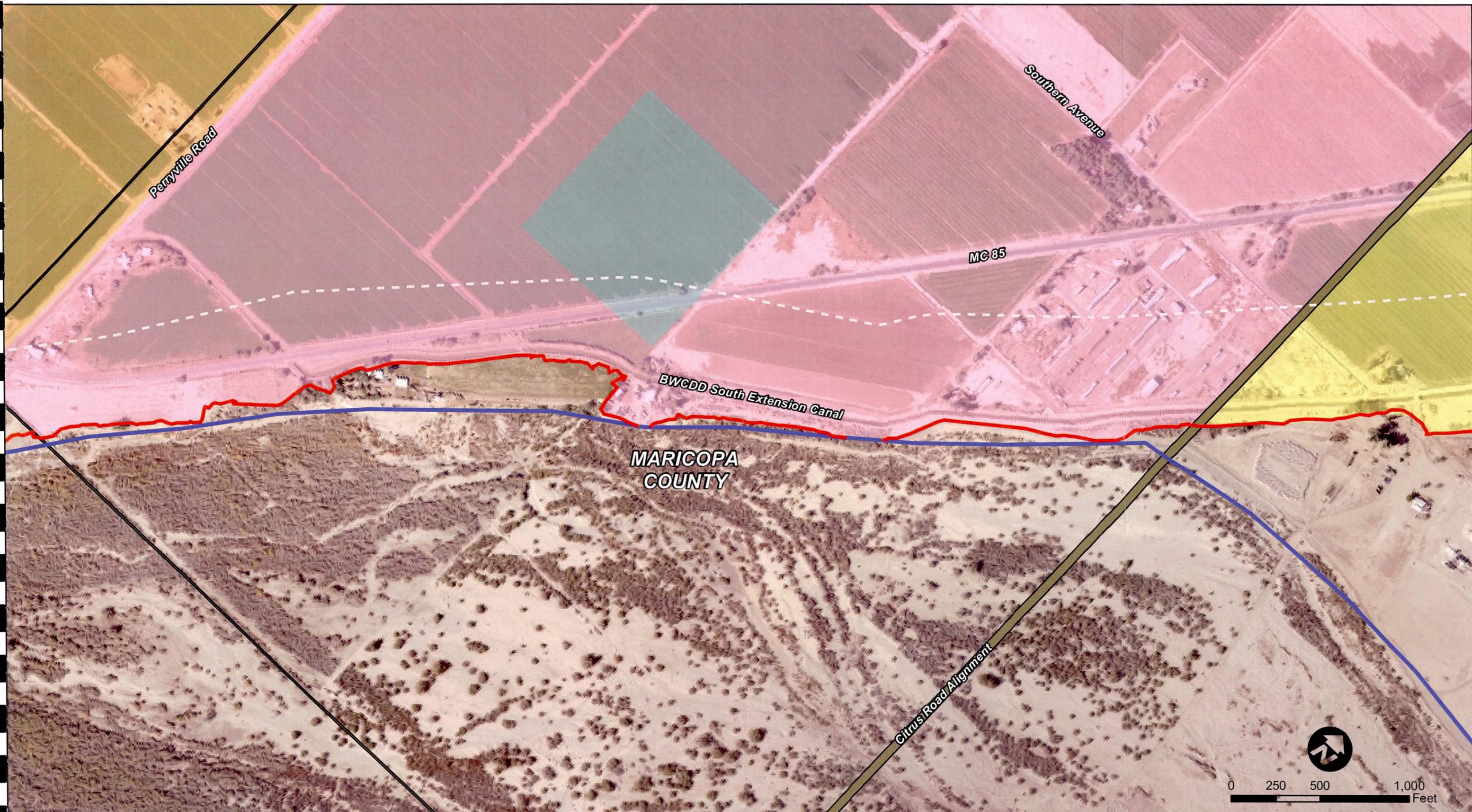
**W** ADWR Well Location



Client/Project  
Flood Control District of Maricopa County  
Gila River Bank Protection Pre-Design Project  
Perryville Road to Citrus Road - FCD No. 2007-C017

Figure No.  
6

Title  
Property, Facilities and Infrastructure Impacts



- Legend**
- Project 100-year Floodway
  - Project 100-year Floodplain
  - Erosion Hazard Zone

- Land Use Legend**
- Buckeye - Business Park
  - Goodyear - Community Commercial
  - Goodyear - Low Density Residential
  - Goodyear - Rural Residential
  - Buckeye - Very Low Density
  - Goodyear - Open Space

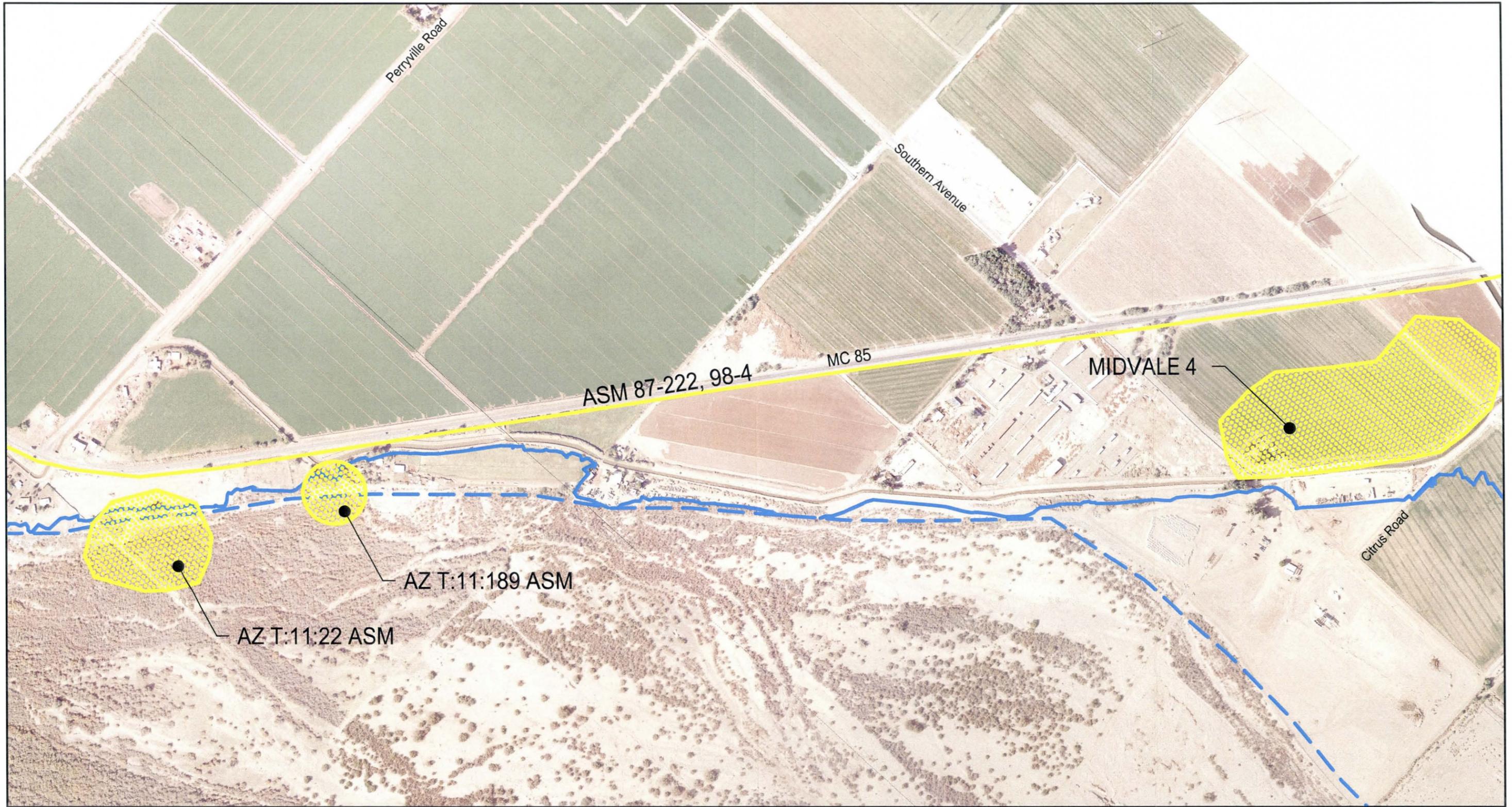
- Jurisdictional Boundaries**
- Goodyear
  - Maricopa County

Client/Project  
**Flood Control District of Maricopa County**  
 Gila River Bank Protection Pre-Design Project  
 Perryville Road to Citrus Road - FCD No. 2007-C017

Figure No.  
**Figure 7**

Title  
**Jurisdictional Boundaries and Land Use**





03.2009  
1813000034



- Legend**
-  Project 100-year Floodplain
  -  Project 100-year Floodway
  -  Cultural Resource Sites



NTS

Client/Project  
Flood Control District of Maricopa County  
Gila River Bank Protection Pre-Design Project  
Perryville Road to Citrus Road - FCD No. 2007-C017

Figure No.  
**Figure 8**

Title  
Cultural Resource Sites

**Attachment A**

CD

CIP Project Priority Request for North Bank of the Gila River Bank Stabilization/Levee  
Project, 175<sup>th</sup> Avenue to Jackrabbit Trail

Perryville Bank Protection As-builts

## **Attachment B**

### Excerpts from the Lateral Migration Analysis Report

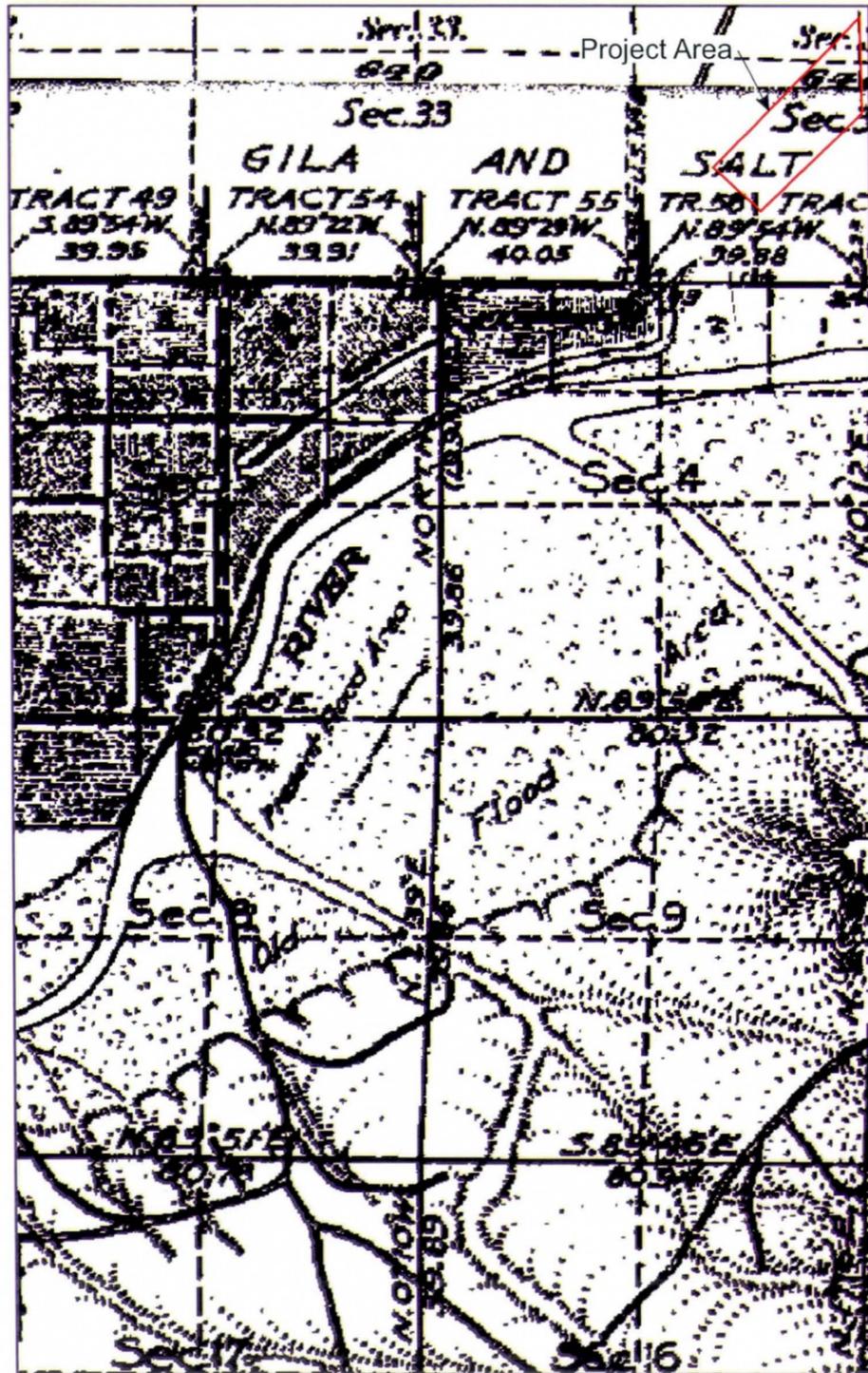
Source:

JE Fuller, 2005, El Rio Watercourse Master Plan Lateral Migration Analysis Report, prepared for the Flood Control District of Maricopa County, dated December 2005.

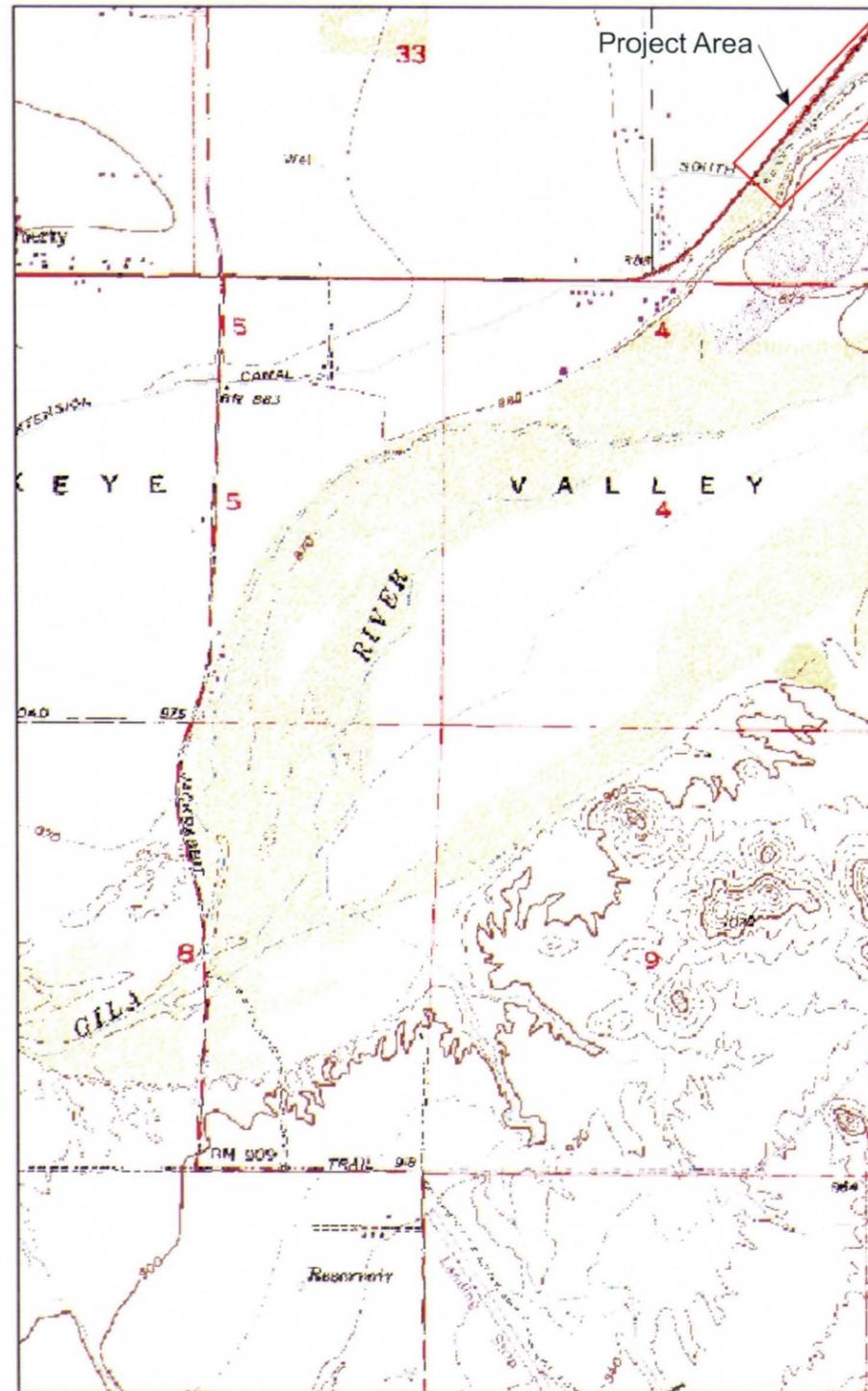


# El Rio Watercourse Master Plan Historic Map Comparison

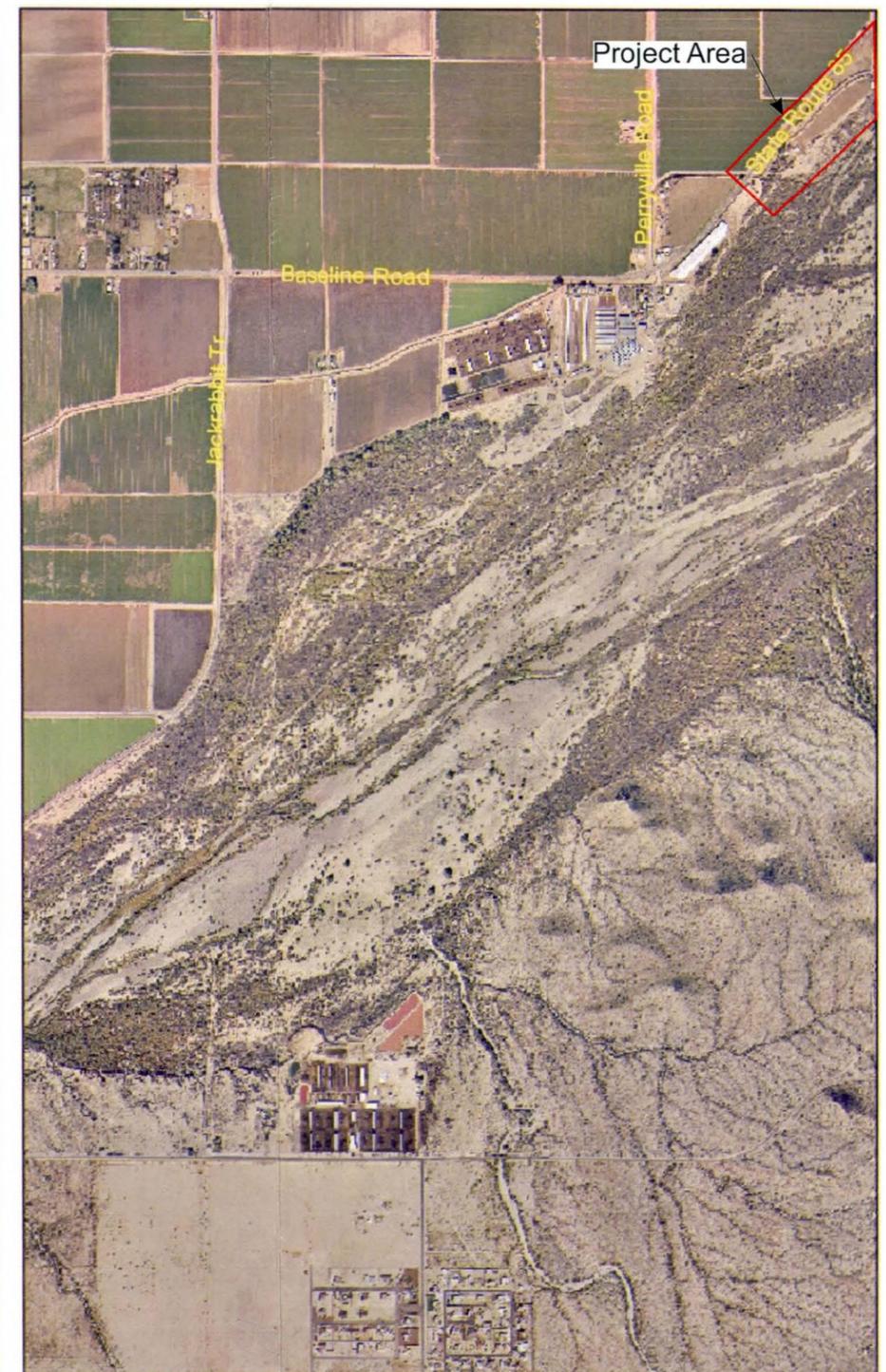
## Reach 6



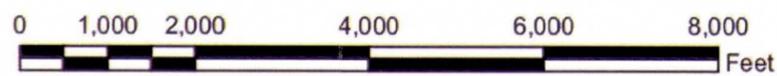
1882 GLO Plat



USGS DRG Quadrangles (1971 and 1982 photorevised)



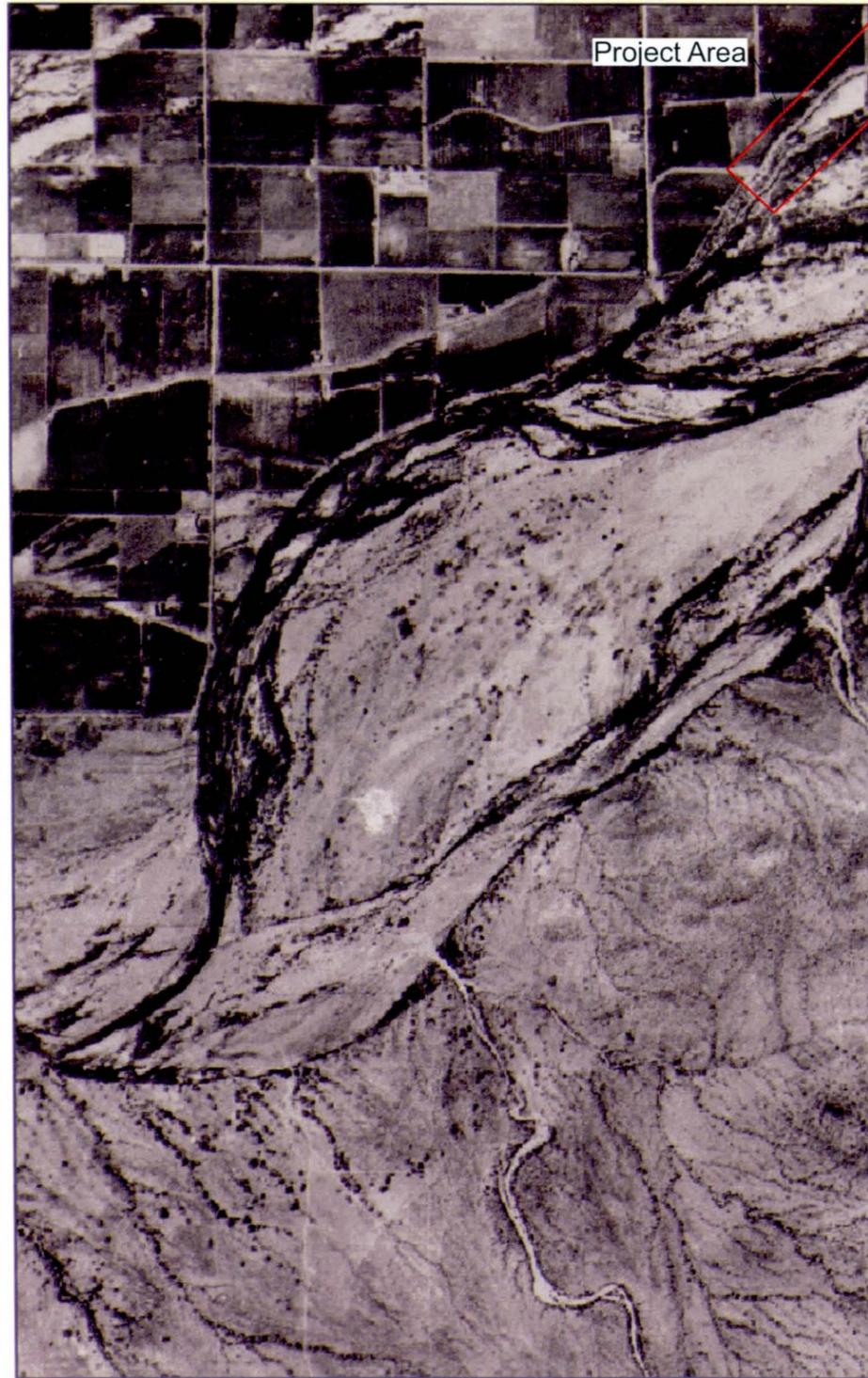
December 2004 (FCDMC)





# El Rio Watercourse Master Plan Historic Photo Comparison

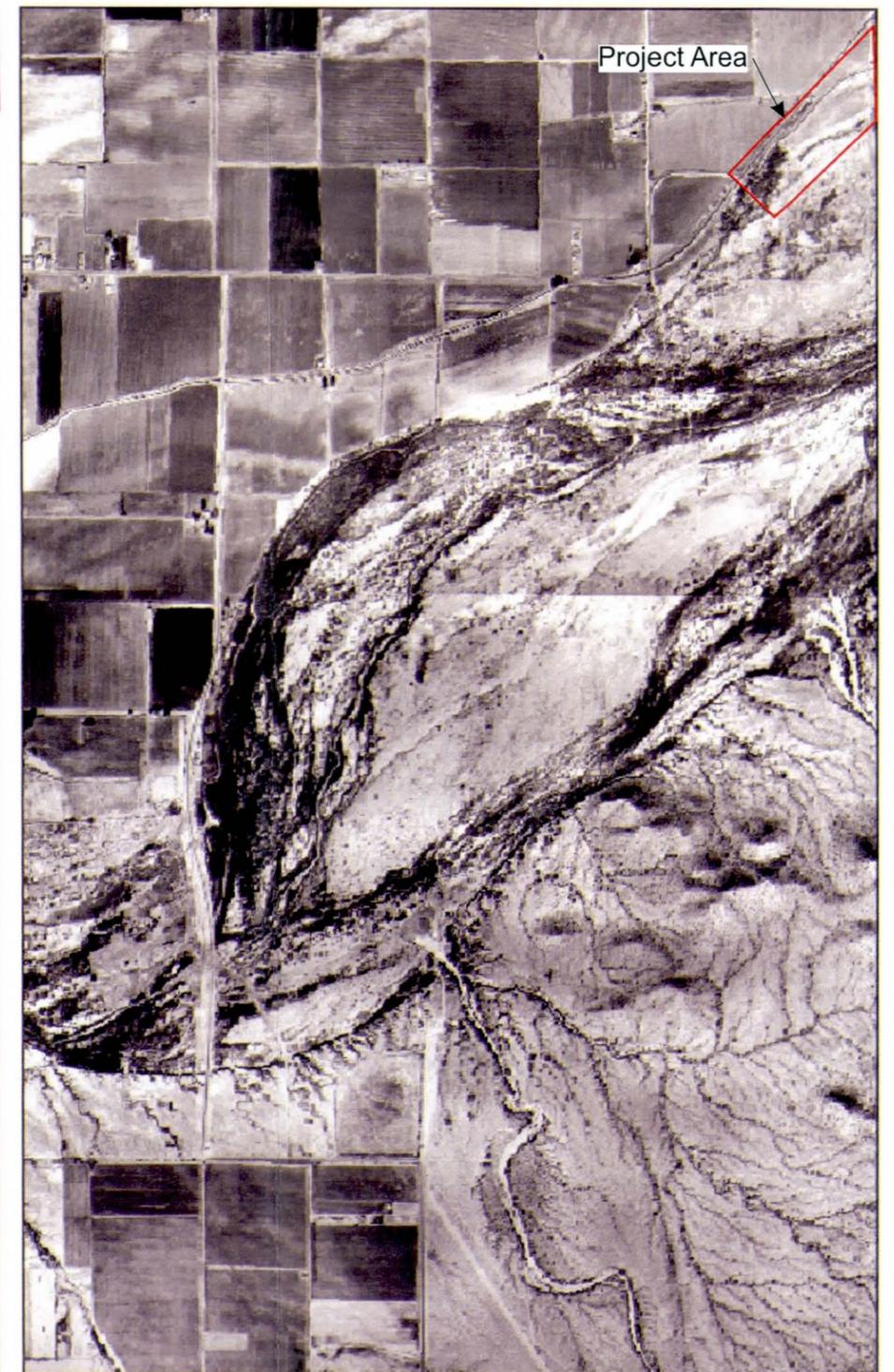
Reach 6



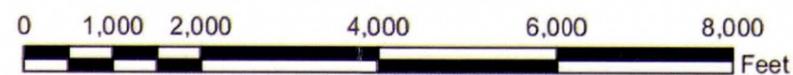
1937 (Fairchild)



February 20, 1949 (USDA)



January 3, 1958 (USDA)





# El Rio Watercourse Master Plan Historic Photo Comparison

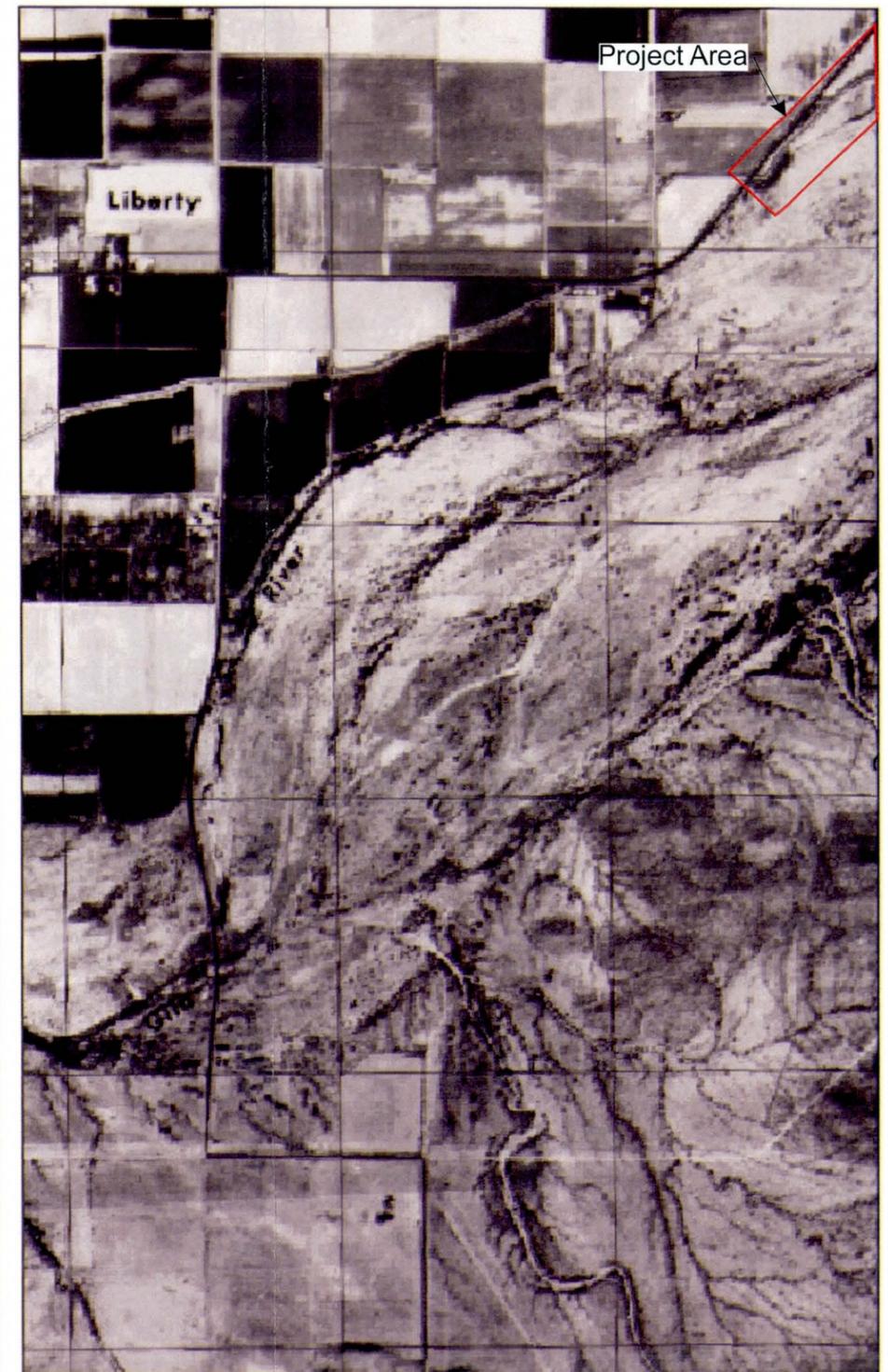
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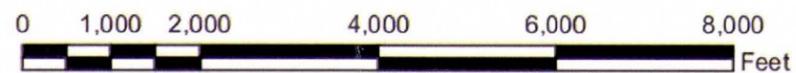
January 3, 1958 (USDA)  
(photo set is repeated)



January 21, 1964 (USDA)



June 1971 (USGS)





# El Rio Watercourse Master Plan

## Historic Photo Comparison

### Reach 6



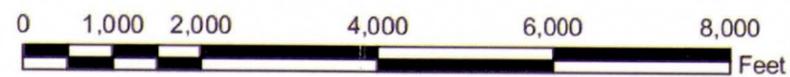
December 5, 1977 (Cooper Aerial)



June 12, 1978 (USBLM)



May 13, 1979 (USDA)





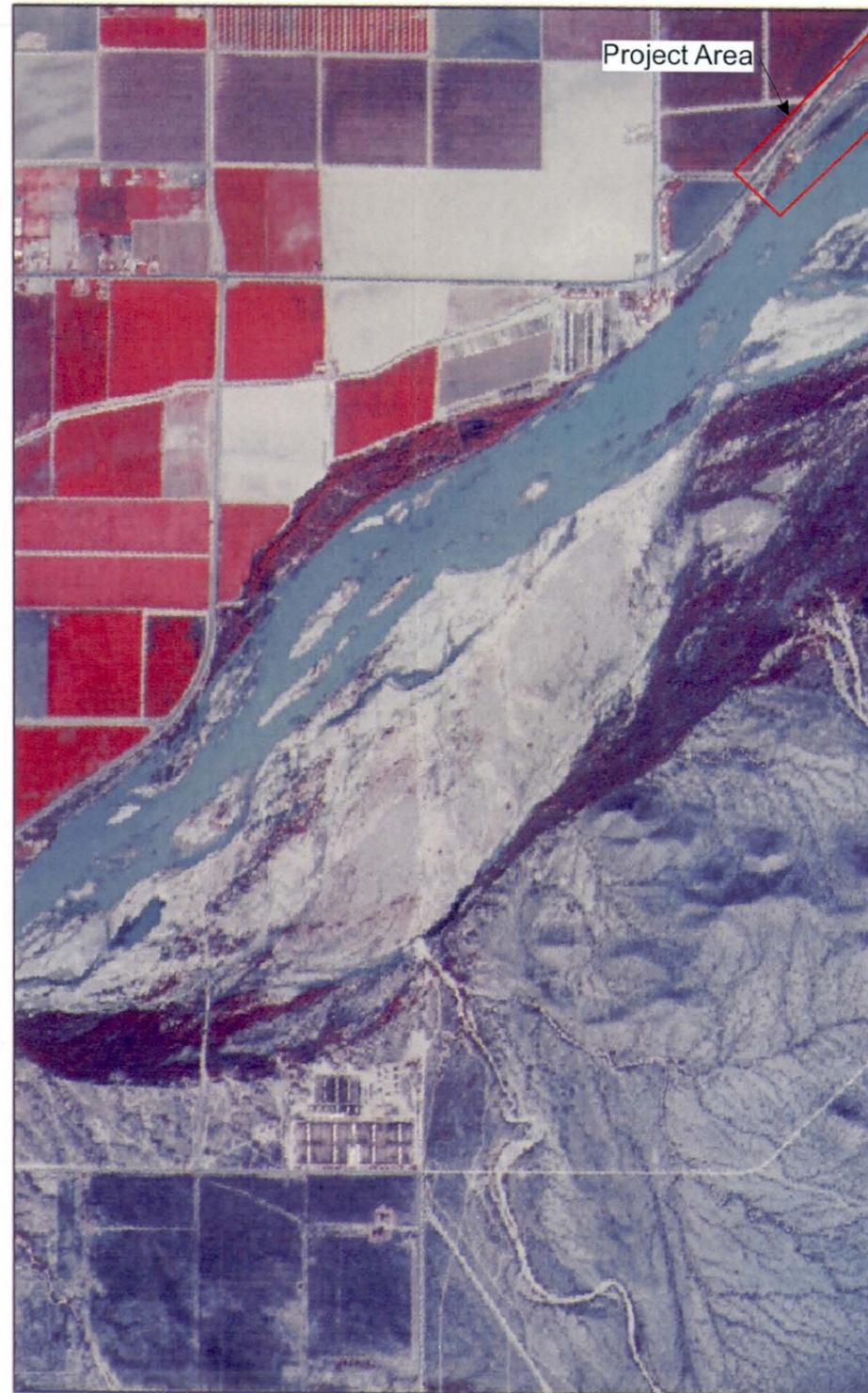
# El Rio Watercourse Master Plan

## Historic Photo Comparison

Reach 6



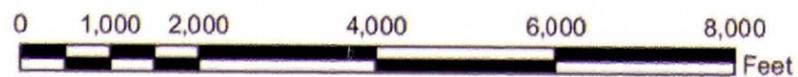
May 13, 1979 (USDA)  
(photo set is repeated)



October 14, 1983 (USGS)



November 20, 1986 (Aerial Mapping Co.)



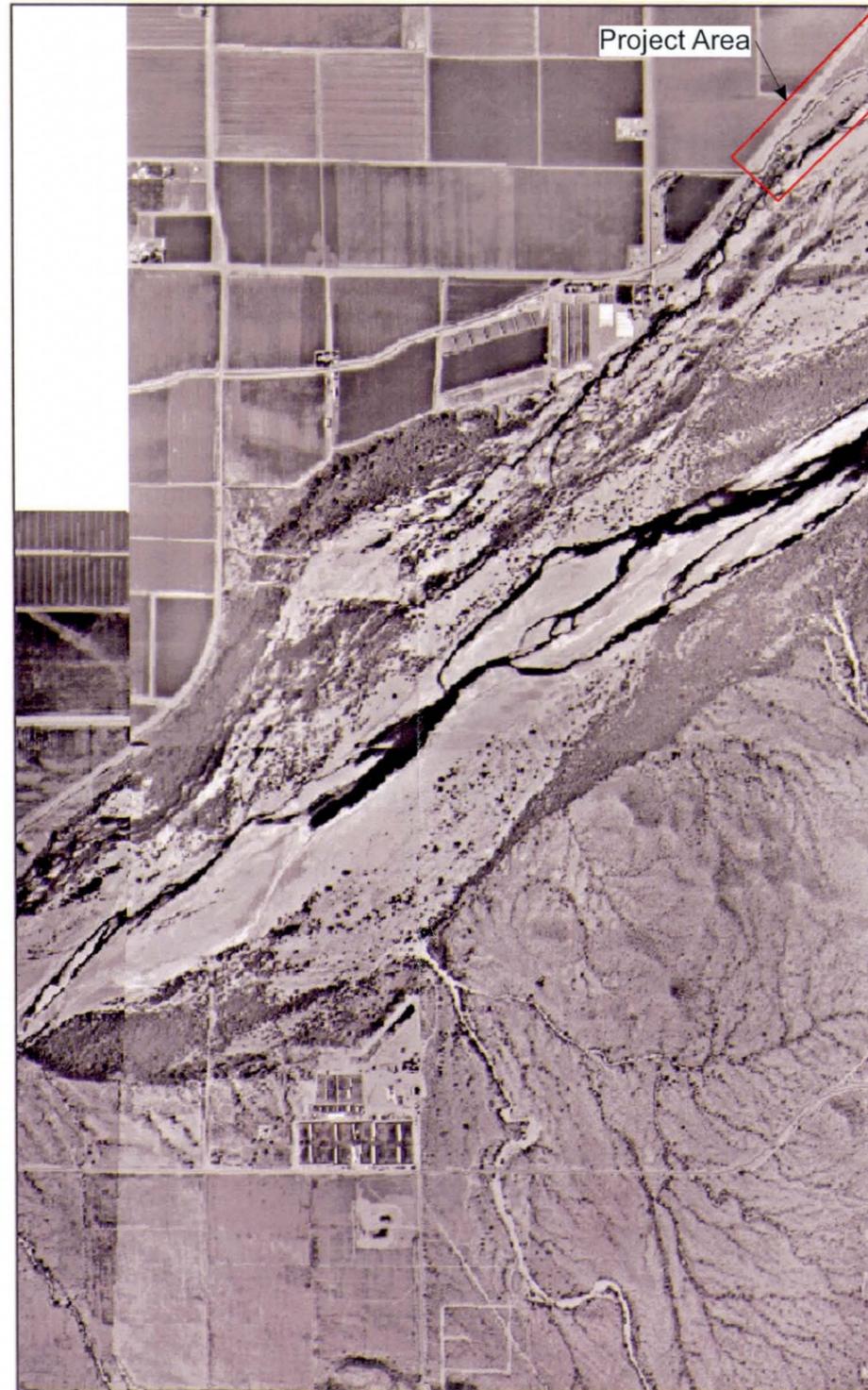


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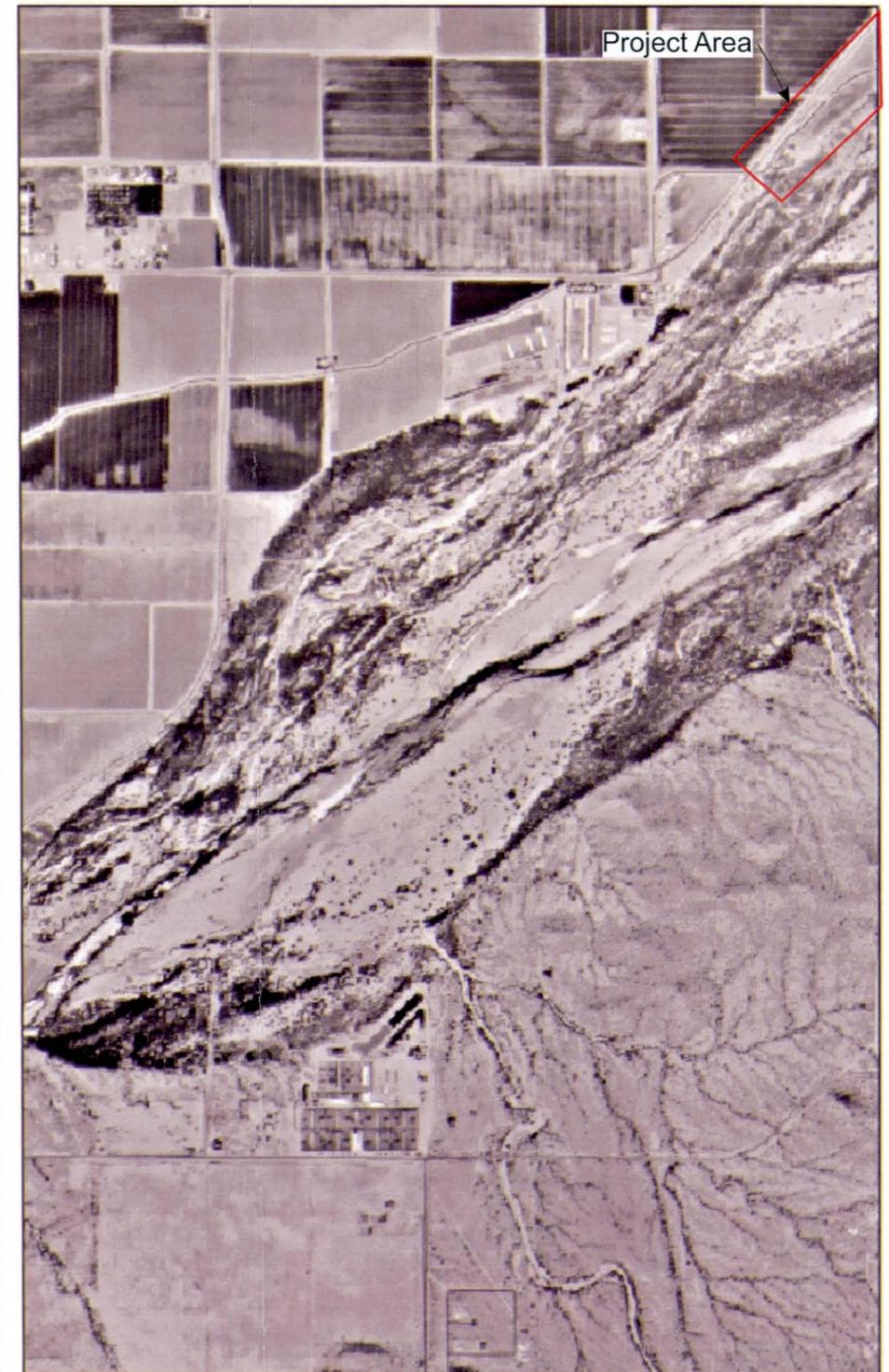
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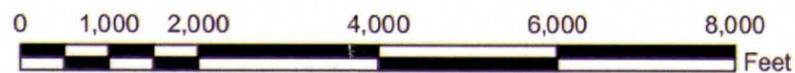
April 18, 1992 (USGS DOQQ)



June 26, July 1, 1993 (USGS)



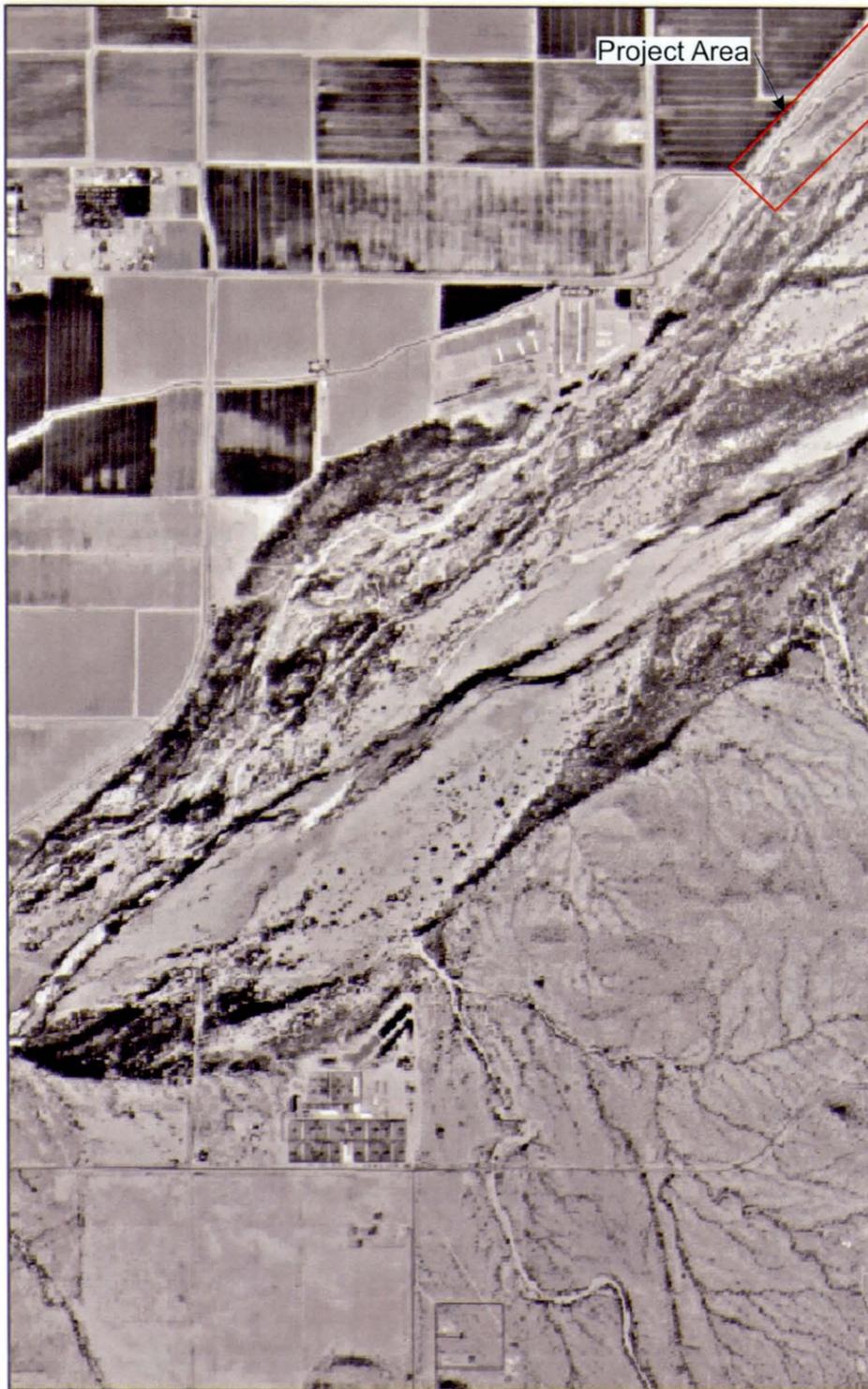
April 30, 1997 (USGS NAPP)





# El Rio Watercourse Master Plan Historic Photo Comparison

## Reach 6



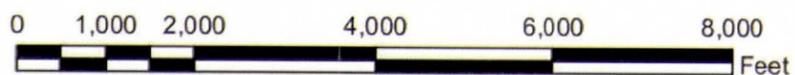
April 30, 1997 (USGS NAPP)  
(photo set is repeated)



February 2002 (FCDMC)



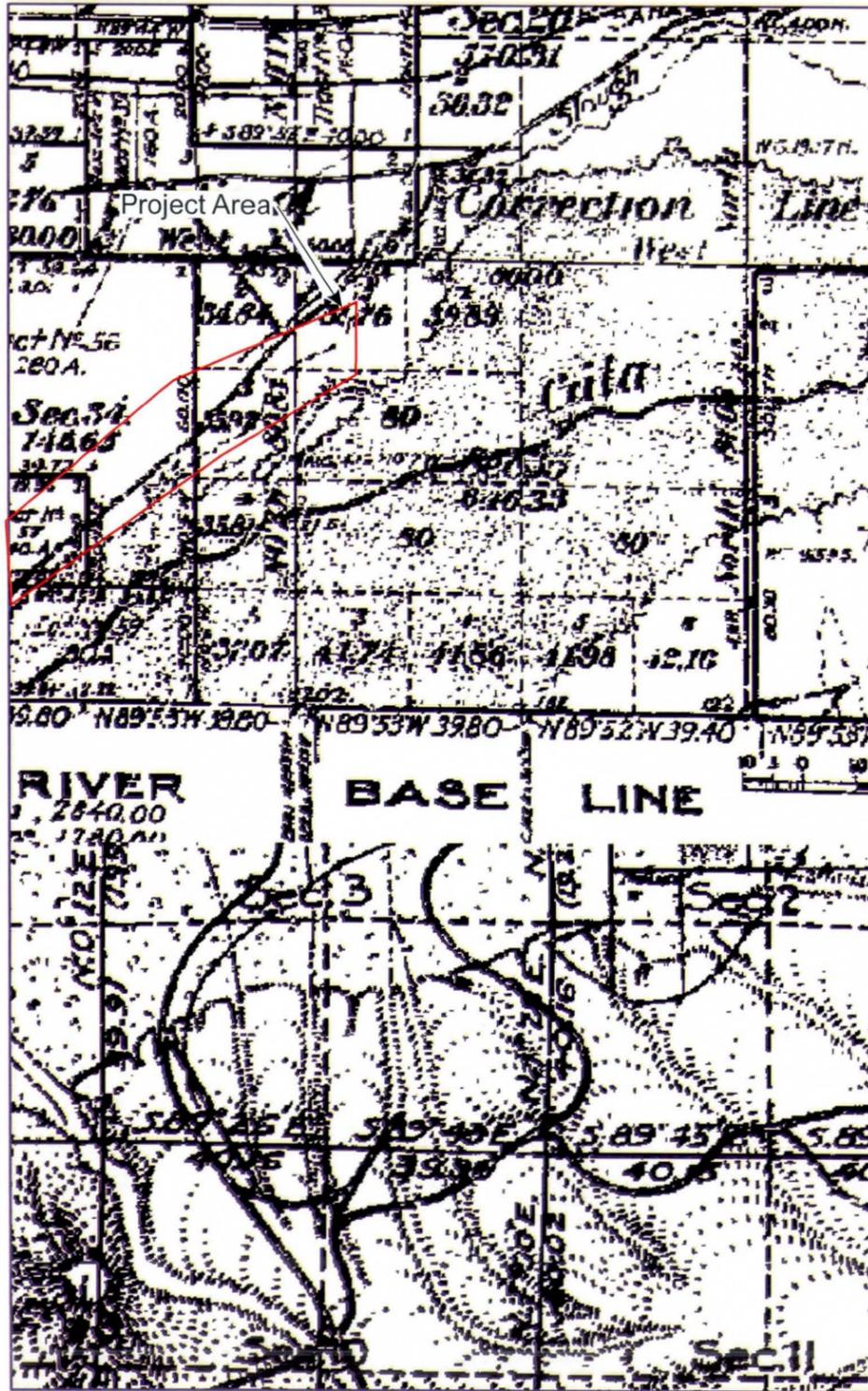
December 2004 (FCDMC)



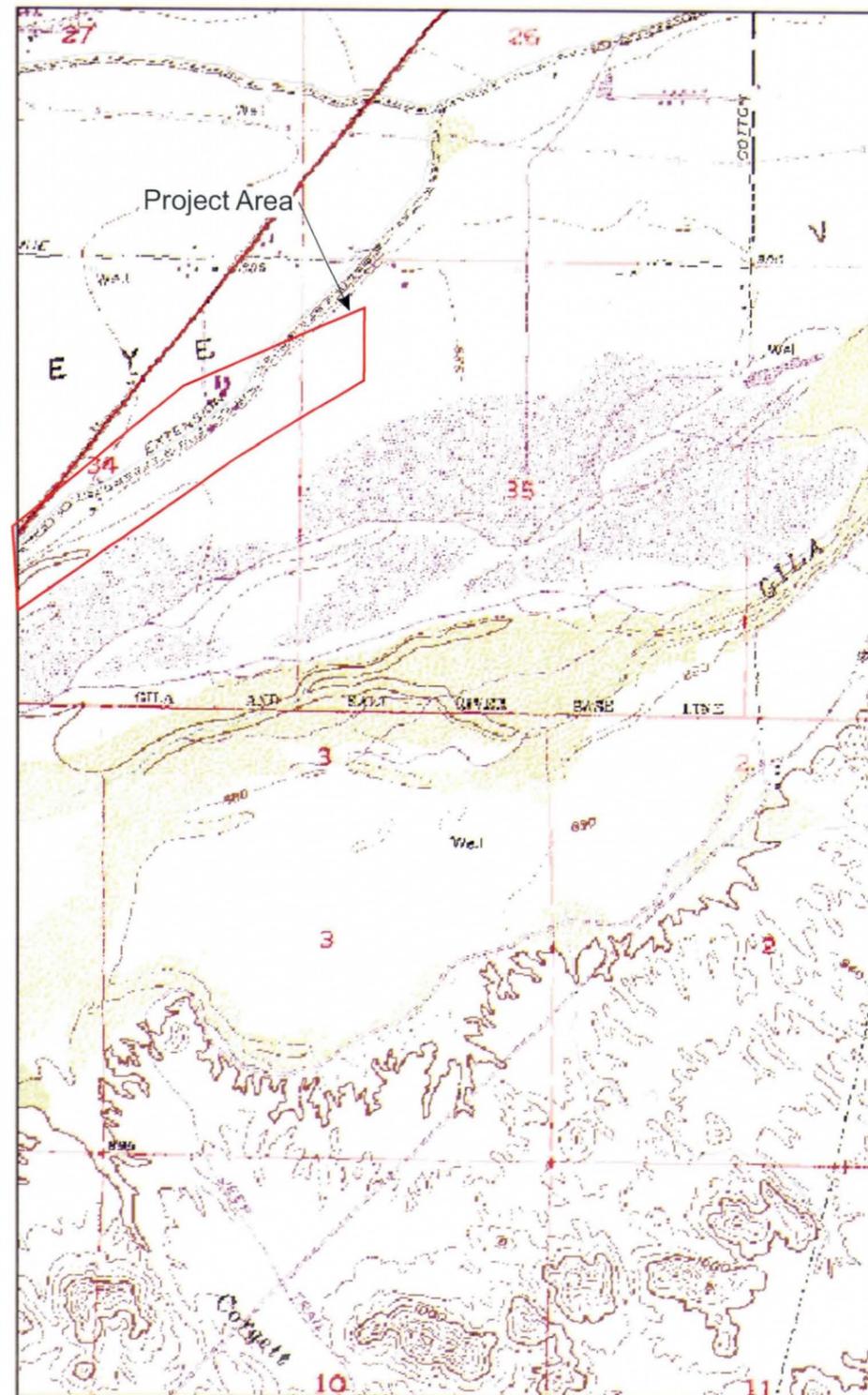


# El Rio Watercourse Master Plan Historic Map Comparison

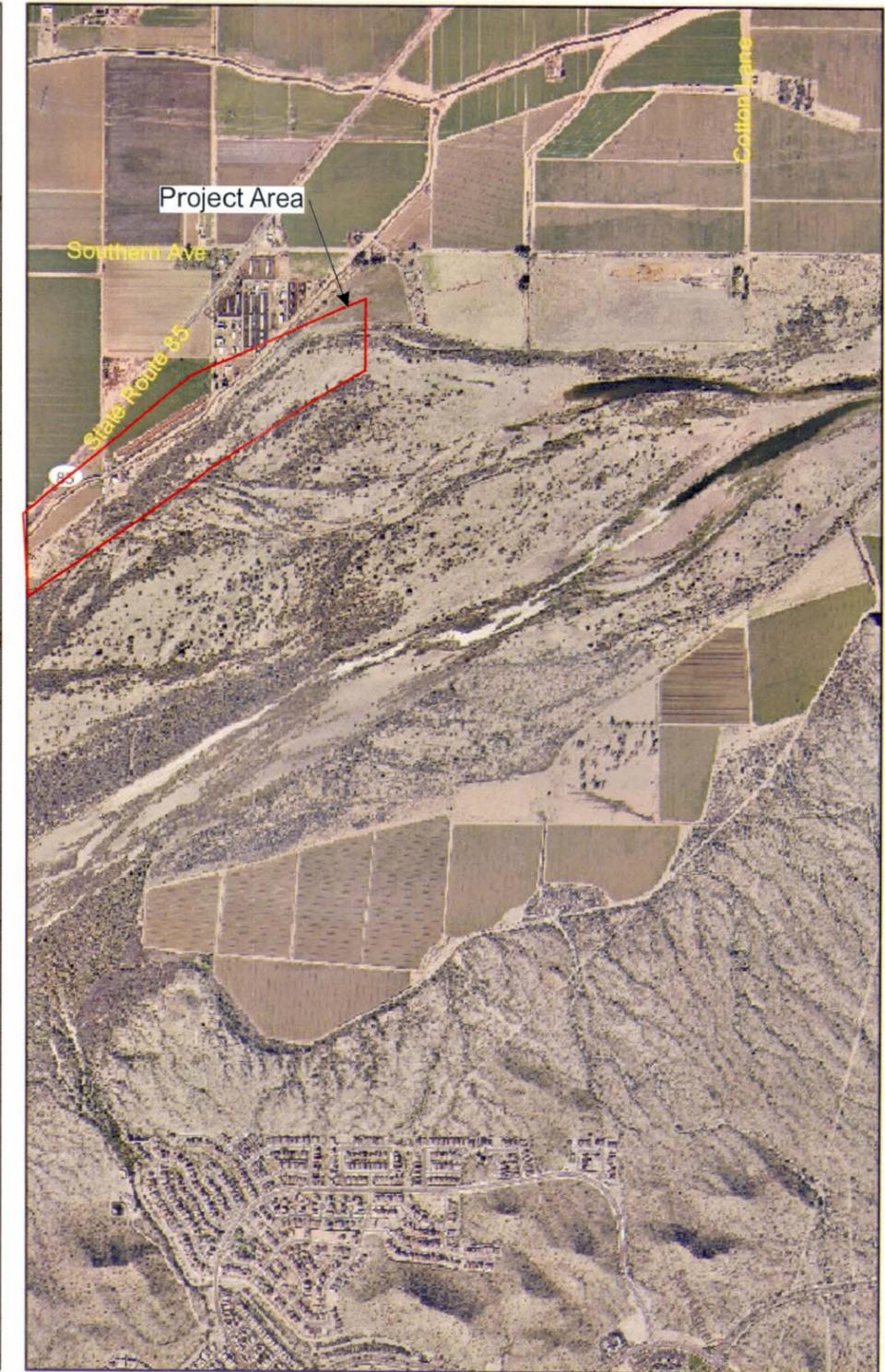
Reach 7



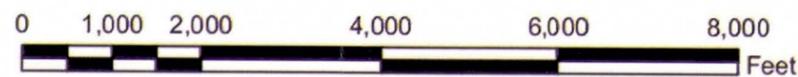
1907 GLO Plat



USGS DRG Quadrangles (1982 photorevised)



December 2004 (FCDMC)

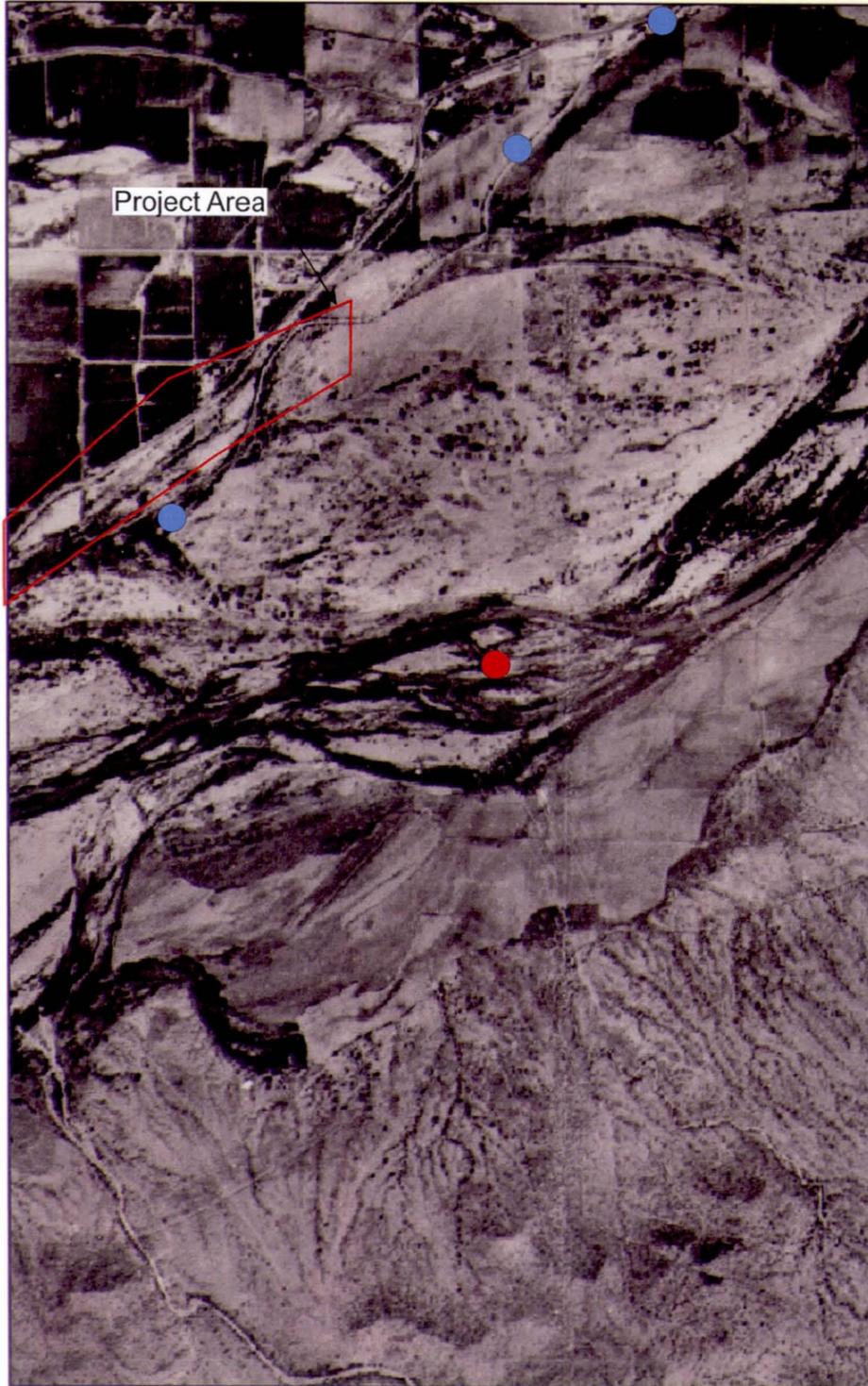




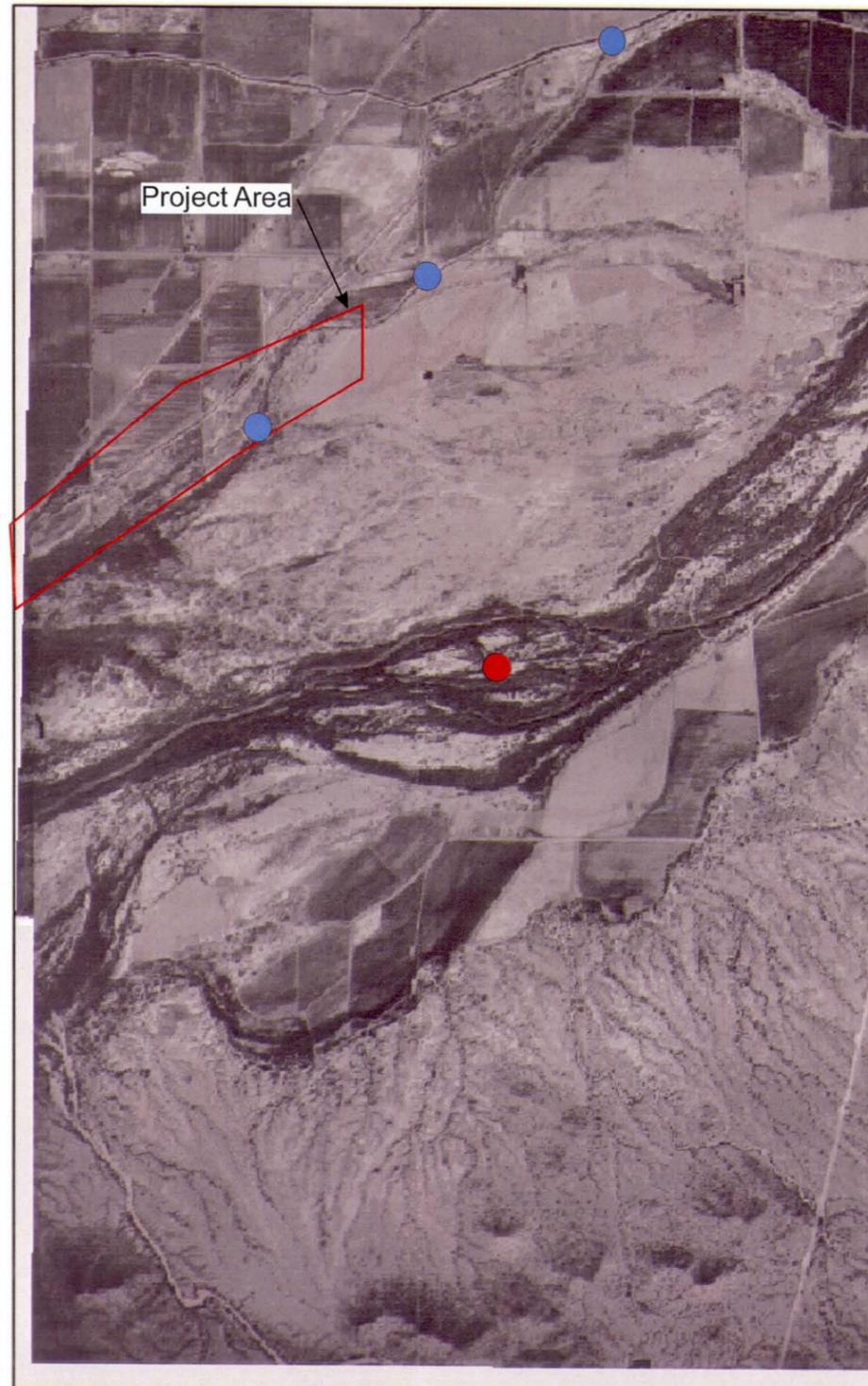
# El Rio Watercourse Master Plan Historic Photo Comparison

- Location of Canals
- Location of Channels

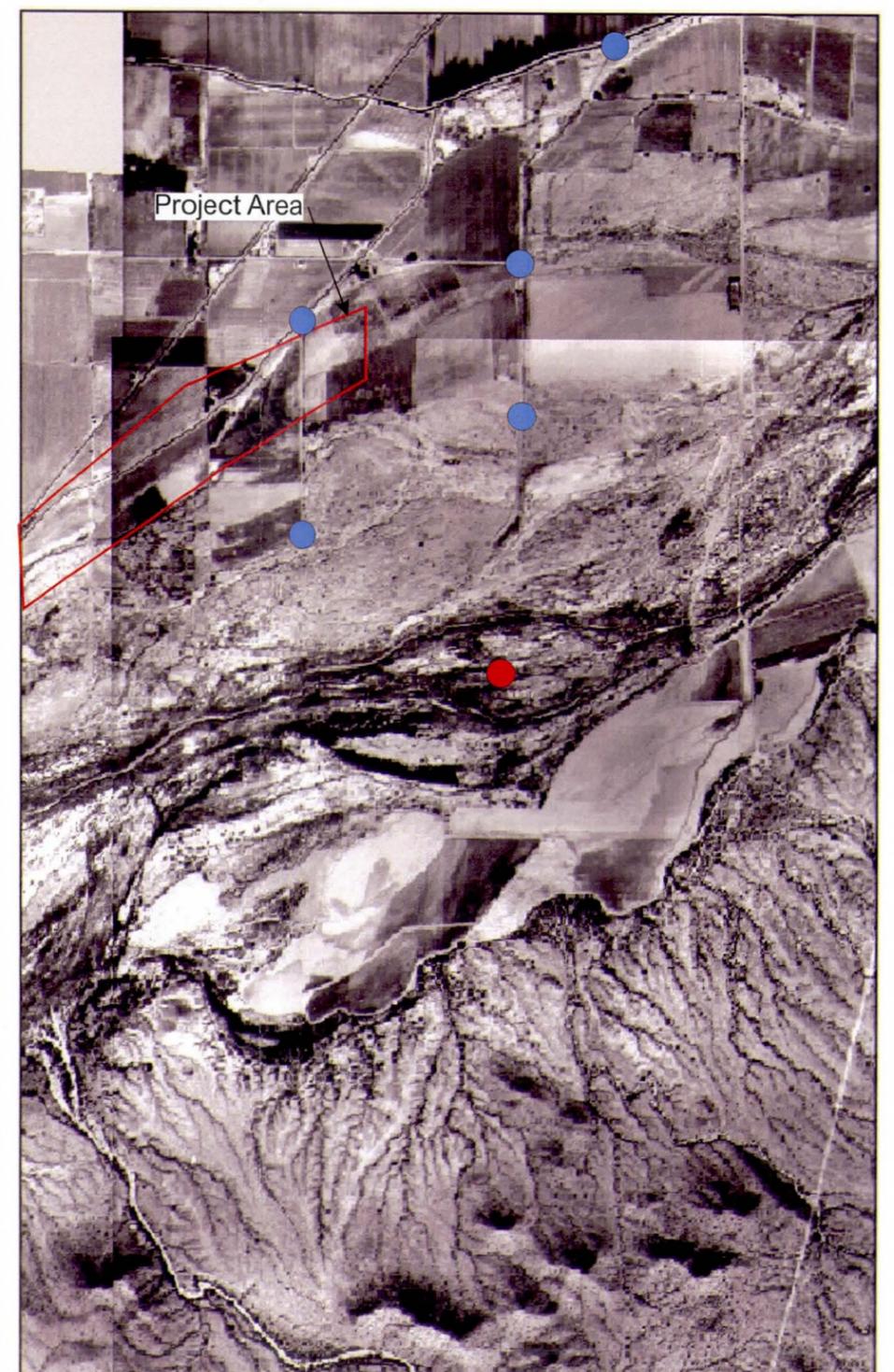
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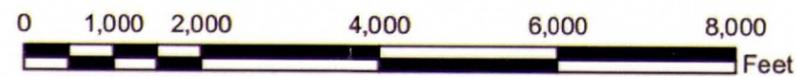
1937 (Fairchild)



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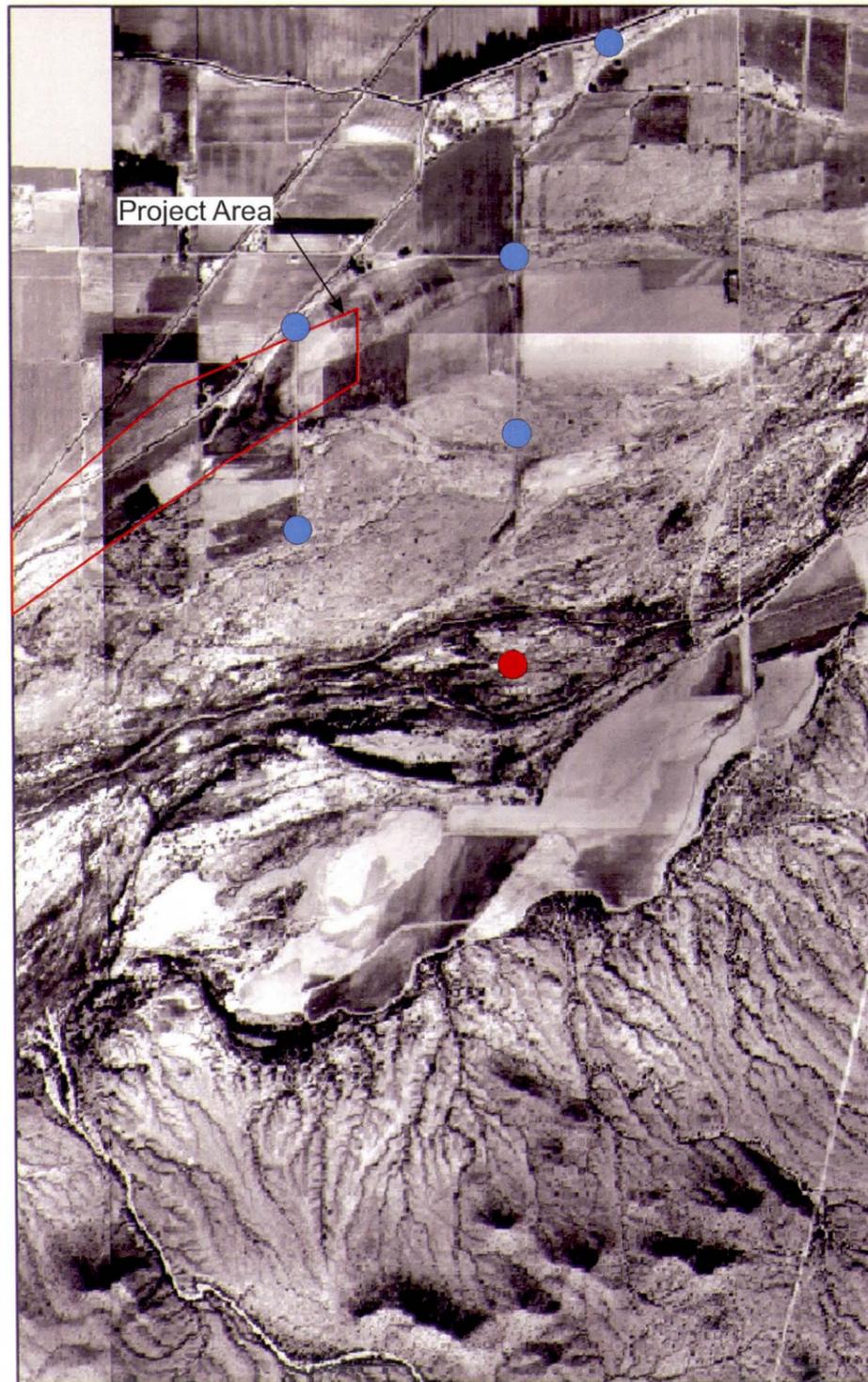


# El Rio Watercourse Master Plan

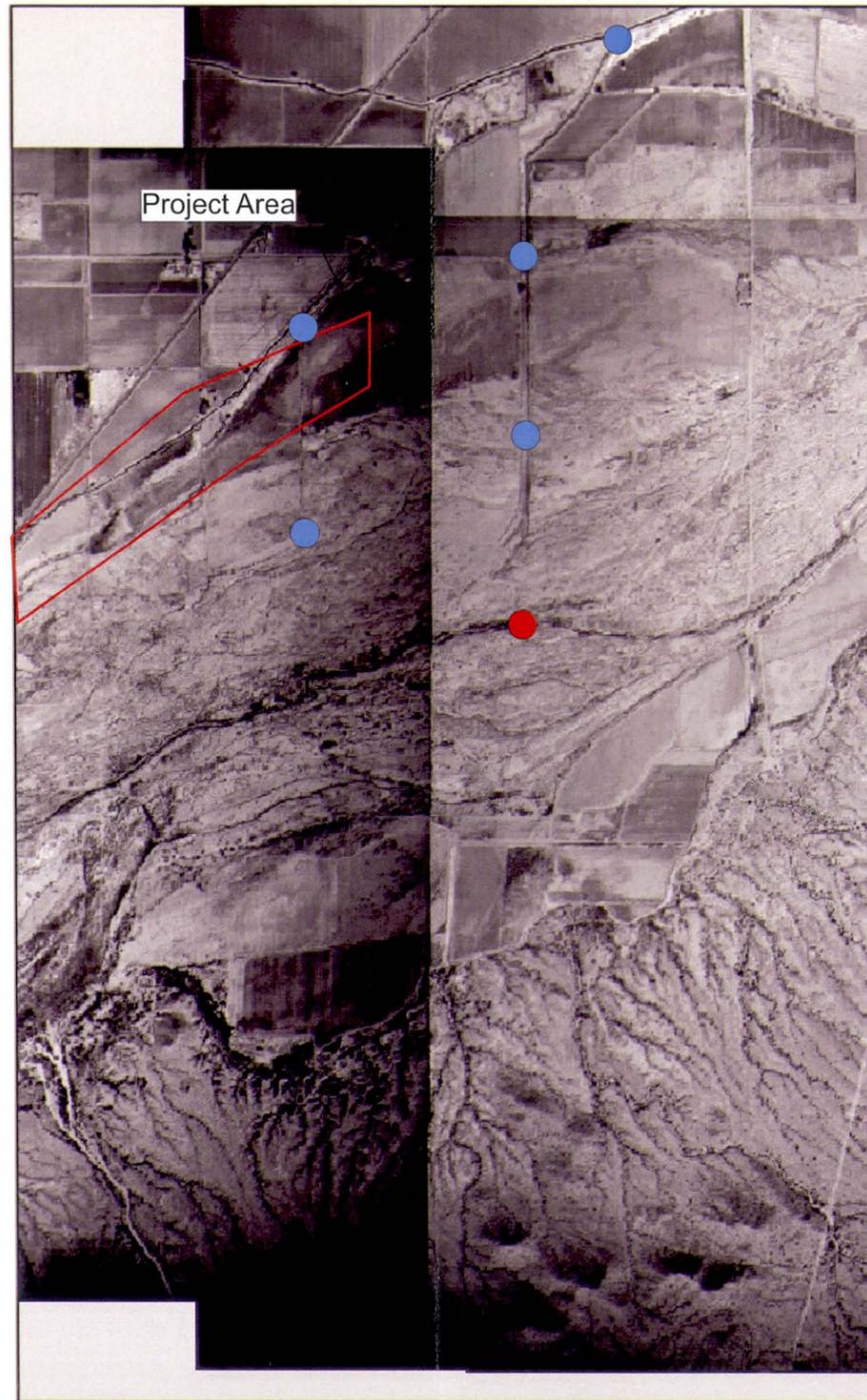
## Historic Photo Comparison

- Location of Canals
- Location of Channels

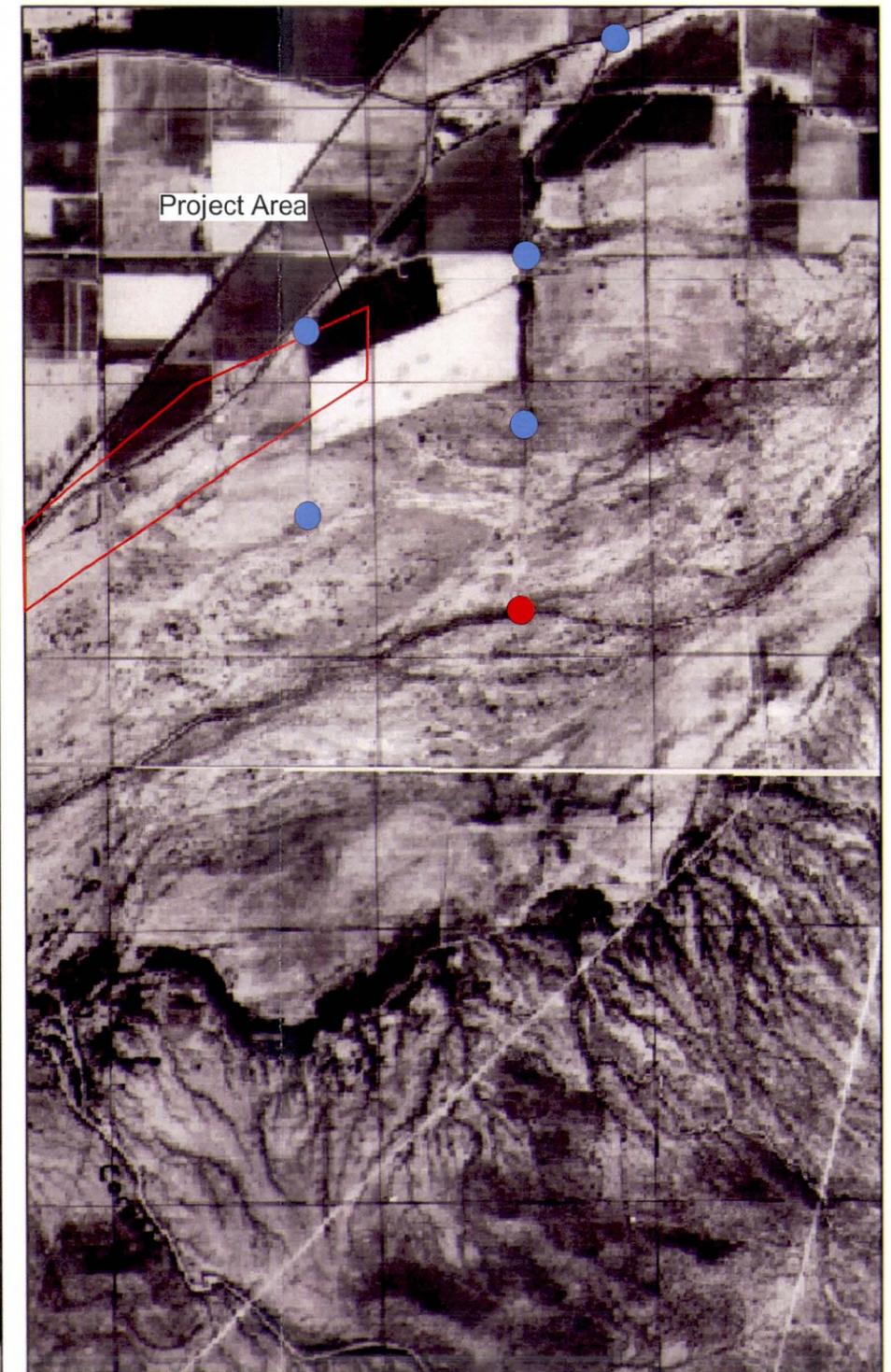
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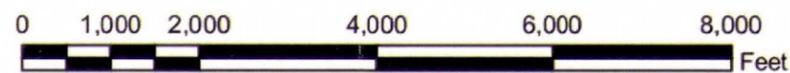
January 3, 1958 (USDA)  
(photo set is repeated)



January 21, 1964 (USDA)



June 1971 (USGS)

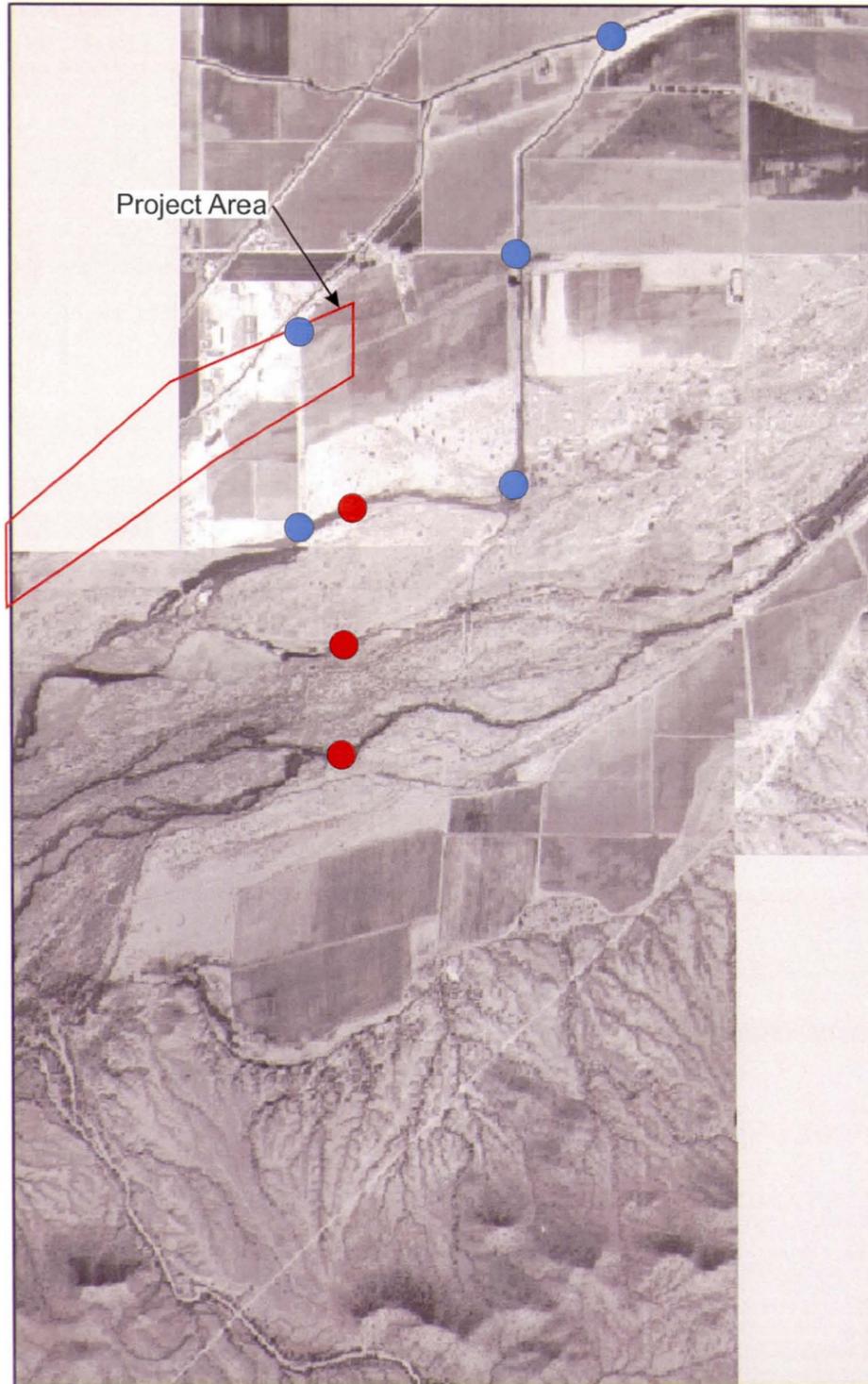




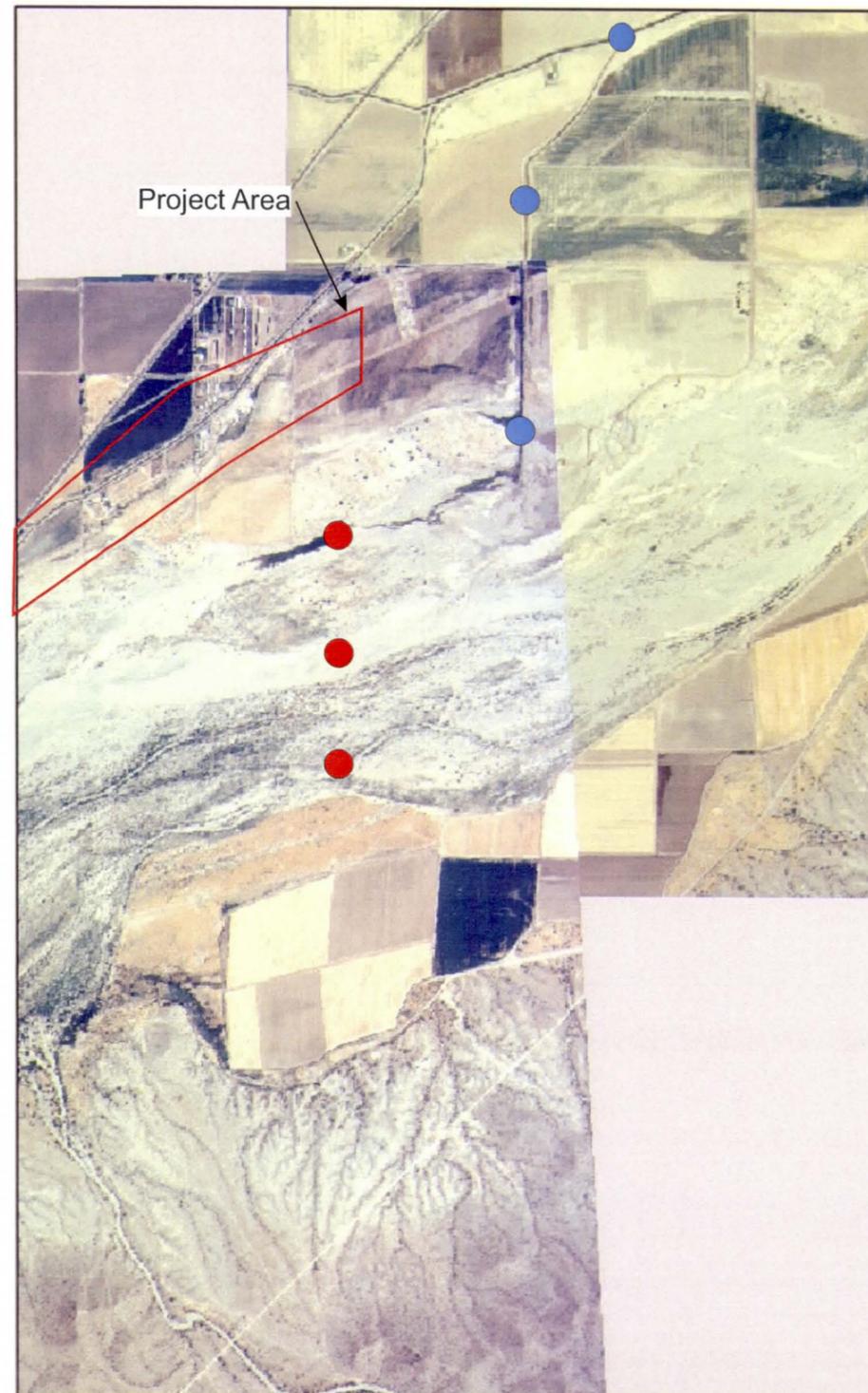
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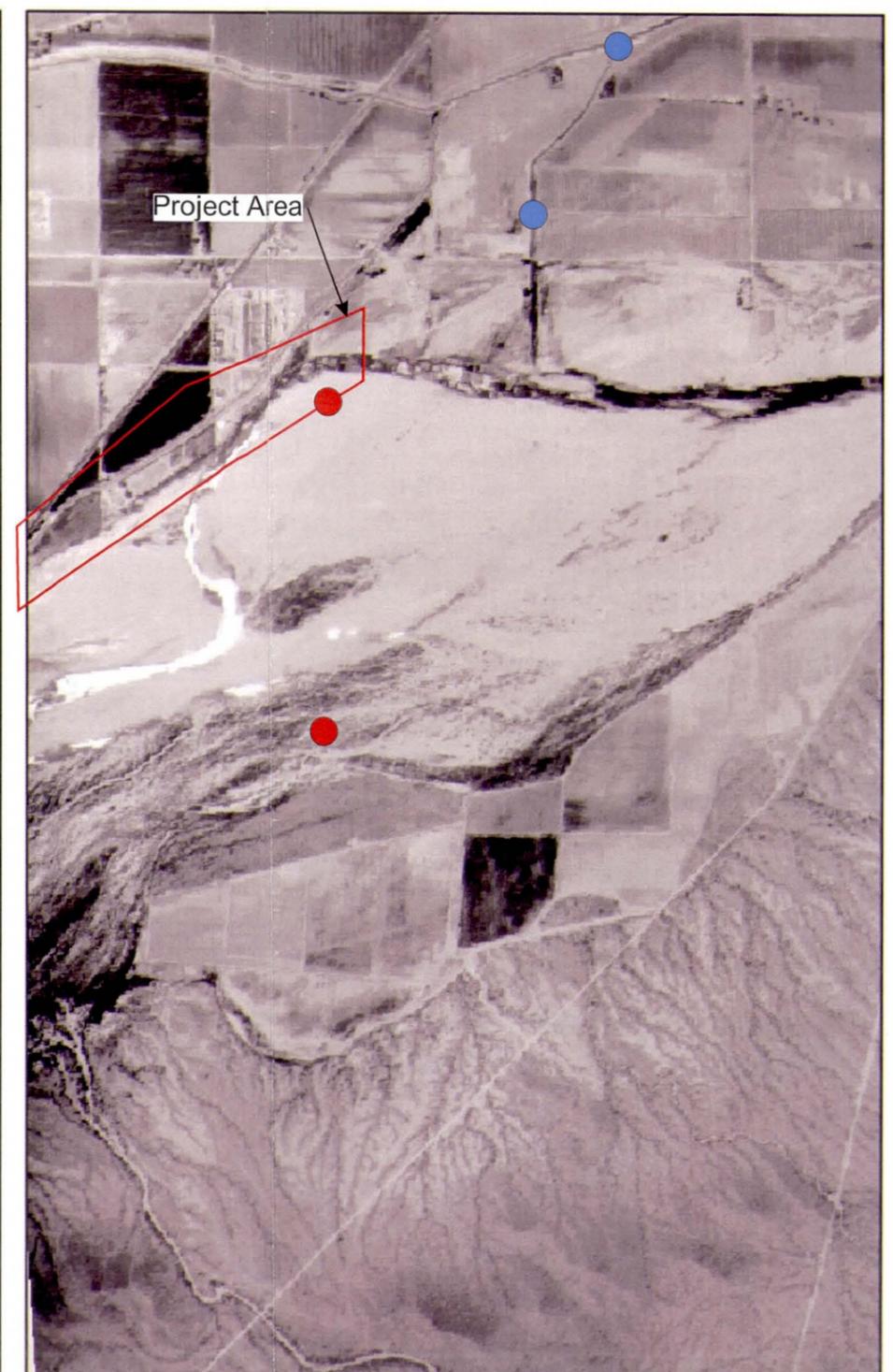
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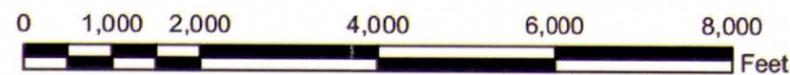
December 5, 1977 (Cooper Aerial)



June 12, 1978 (USBLM)



May 13, 1979 (USDA)



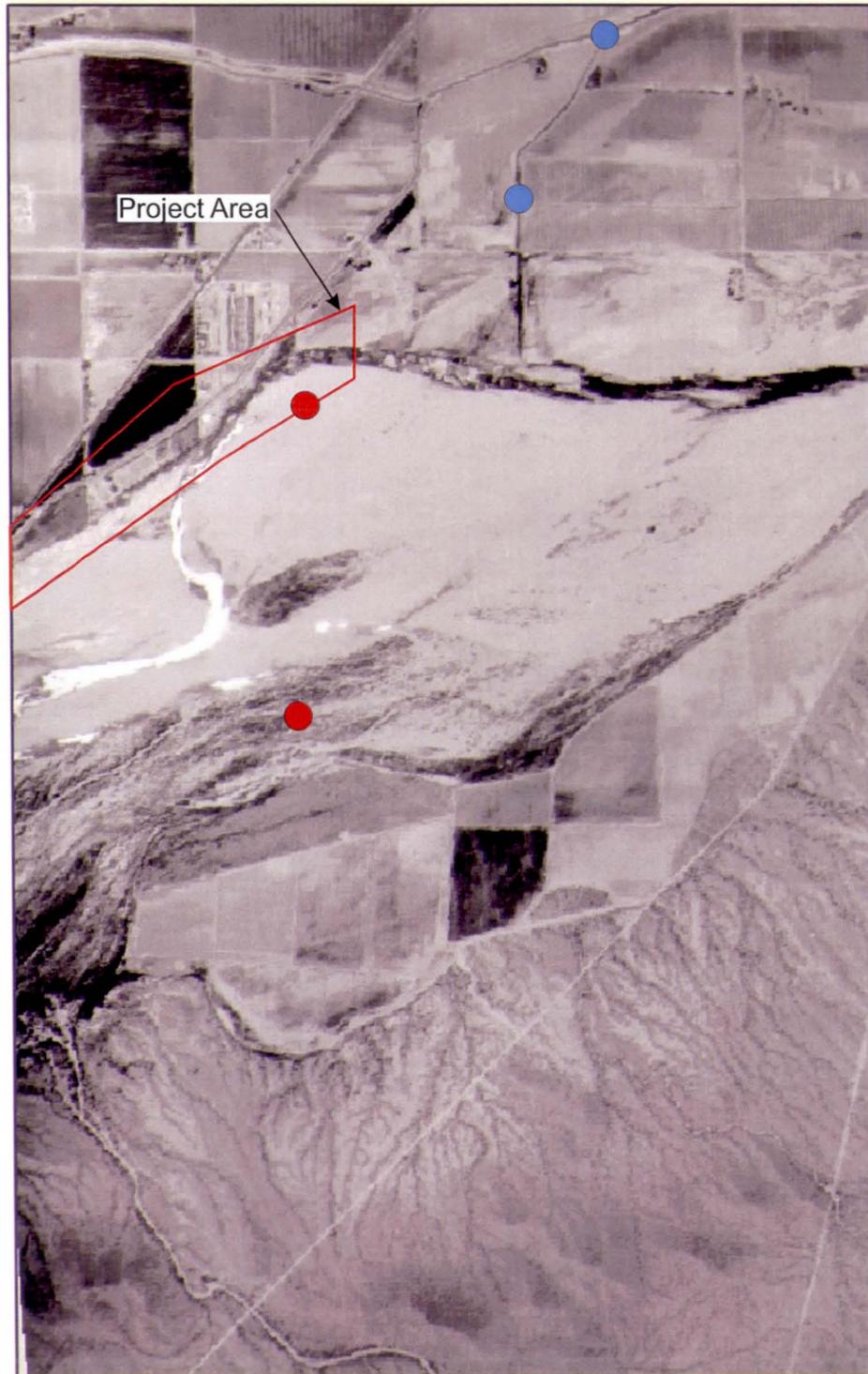


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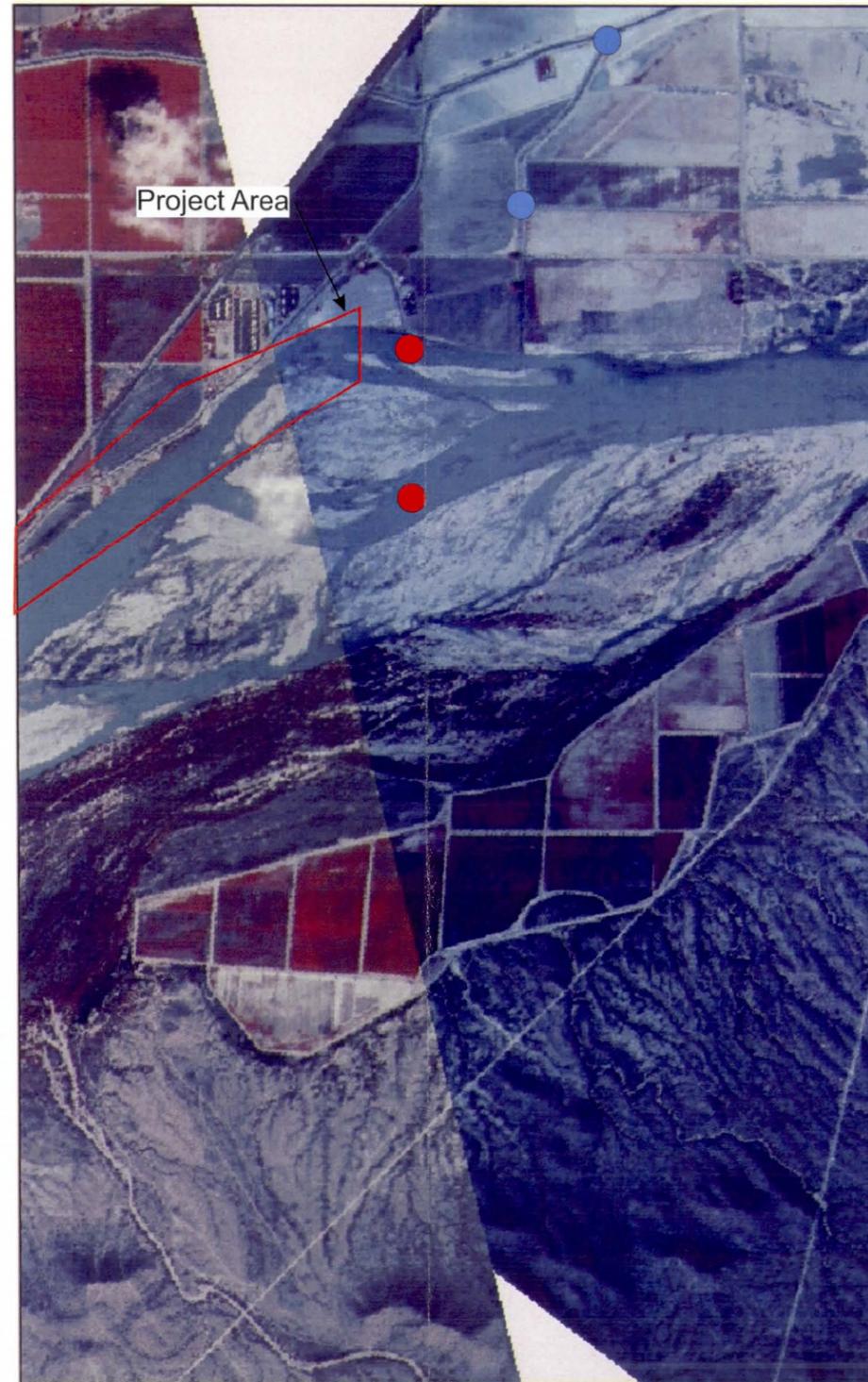
## Historic Photo Comparison

- Location of Canals
- Location of Channels

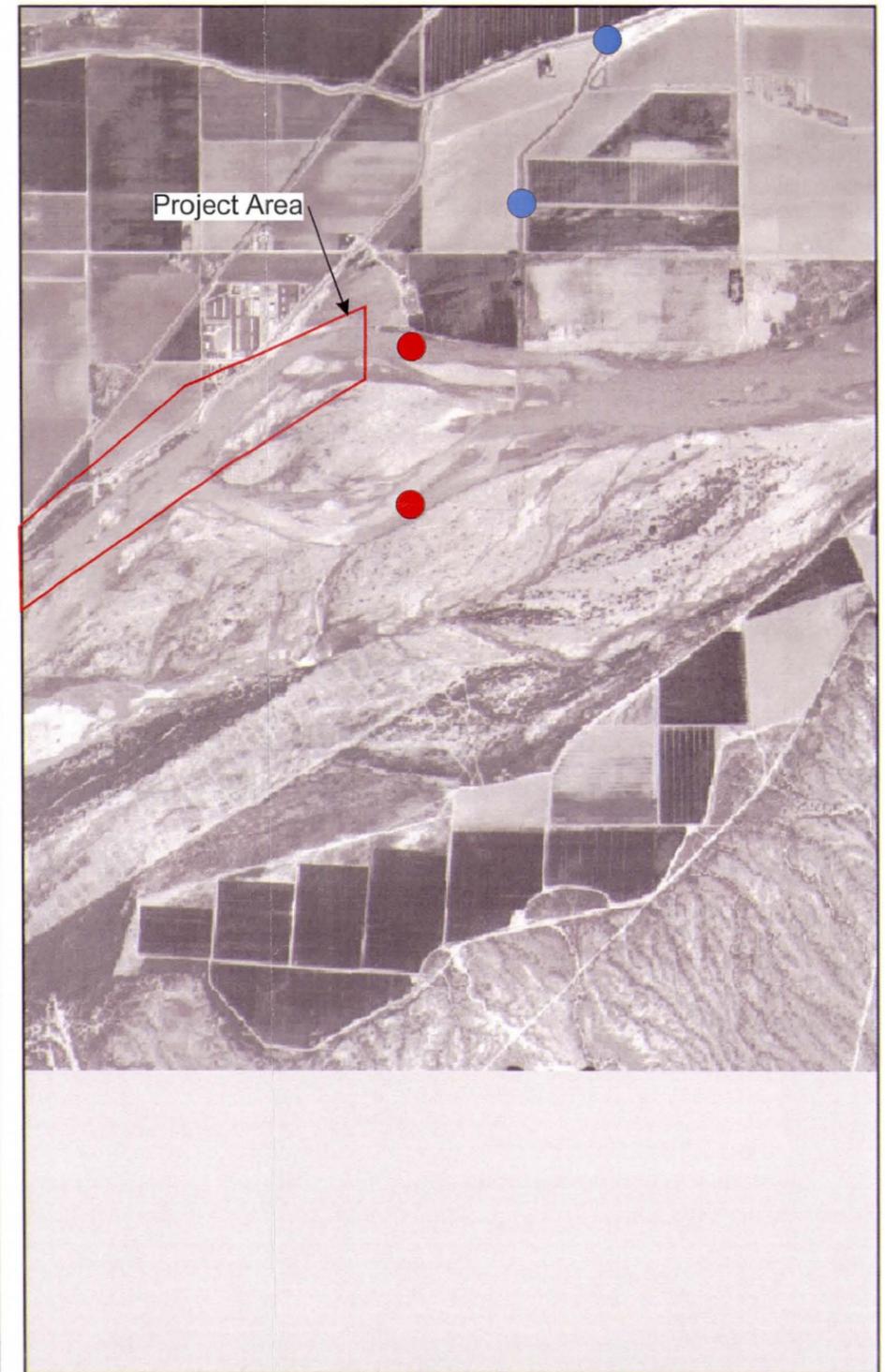
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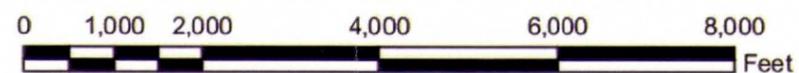
May 13, 1979 (USDA)  
(photo set is repeated)



October 14, 1983 (USGS)



March 22, 1985 (Aerial Mapping Co.)





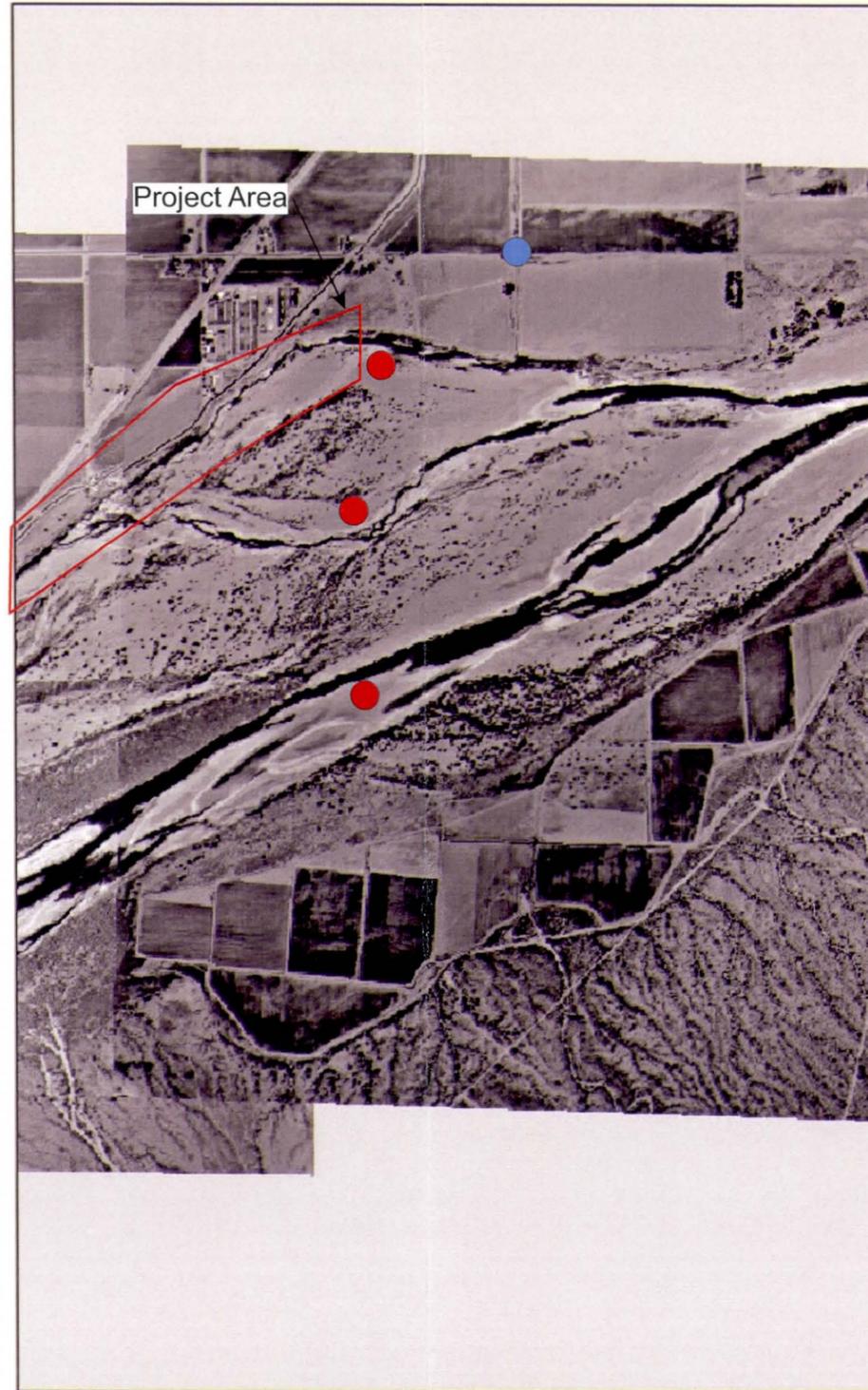
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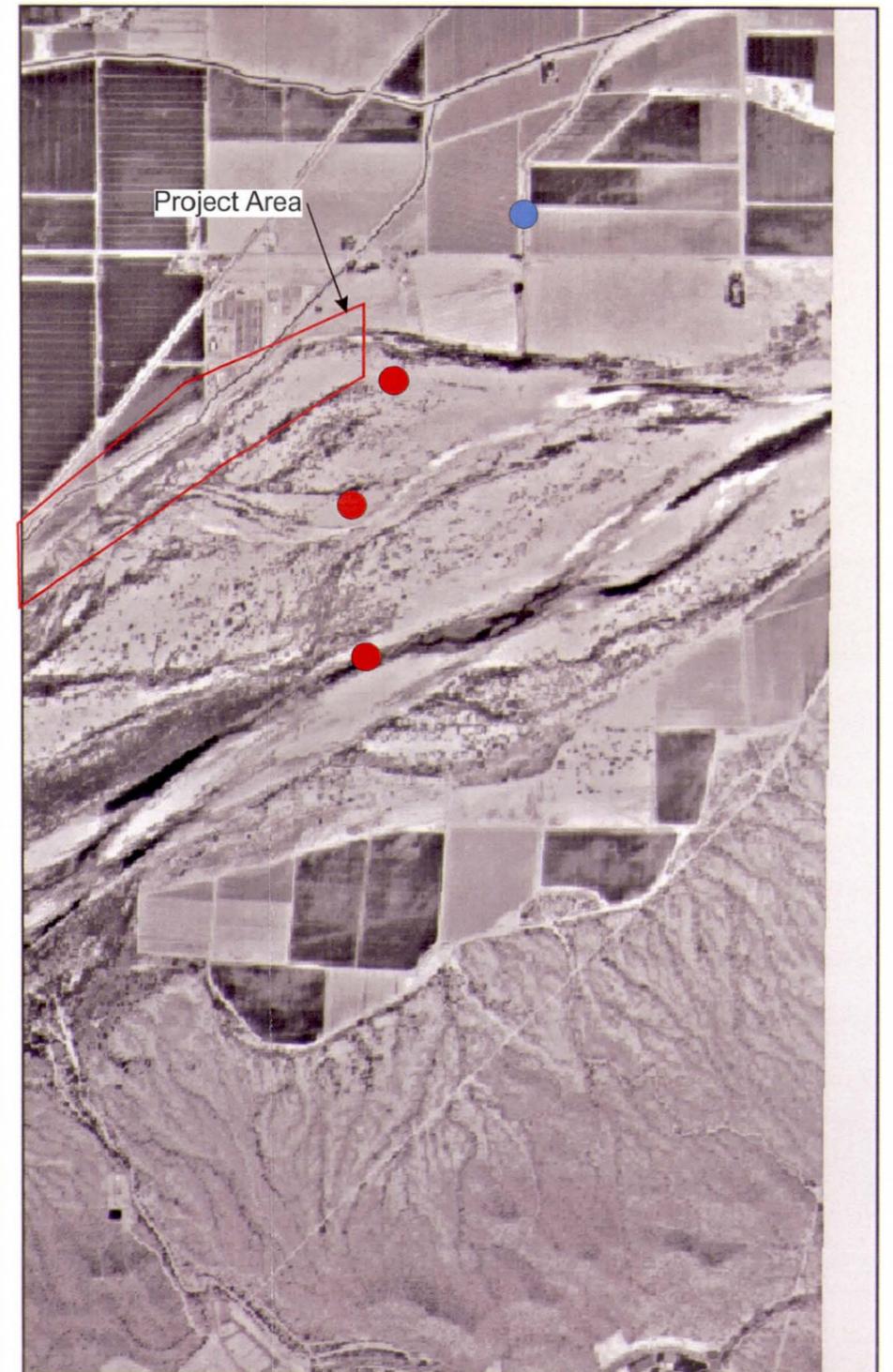
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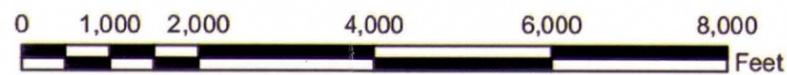
April 18 and September 6, 1992 (USGS DOQQ)



June 26, July 1, 1993 (USGS)



April 30, 1997 (USGS NAPP)

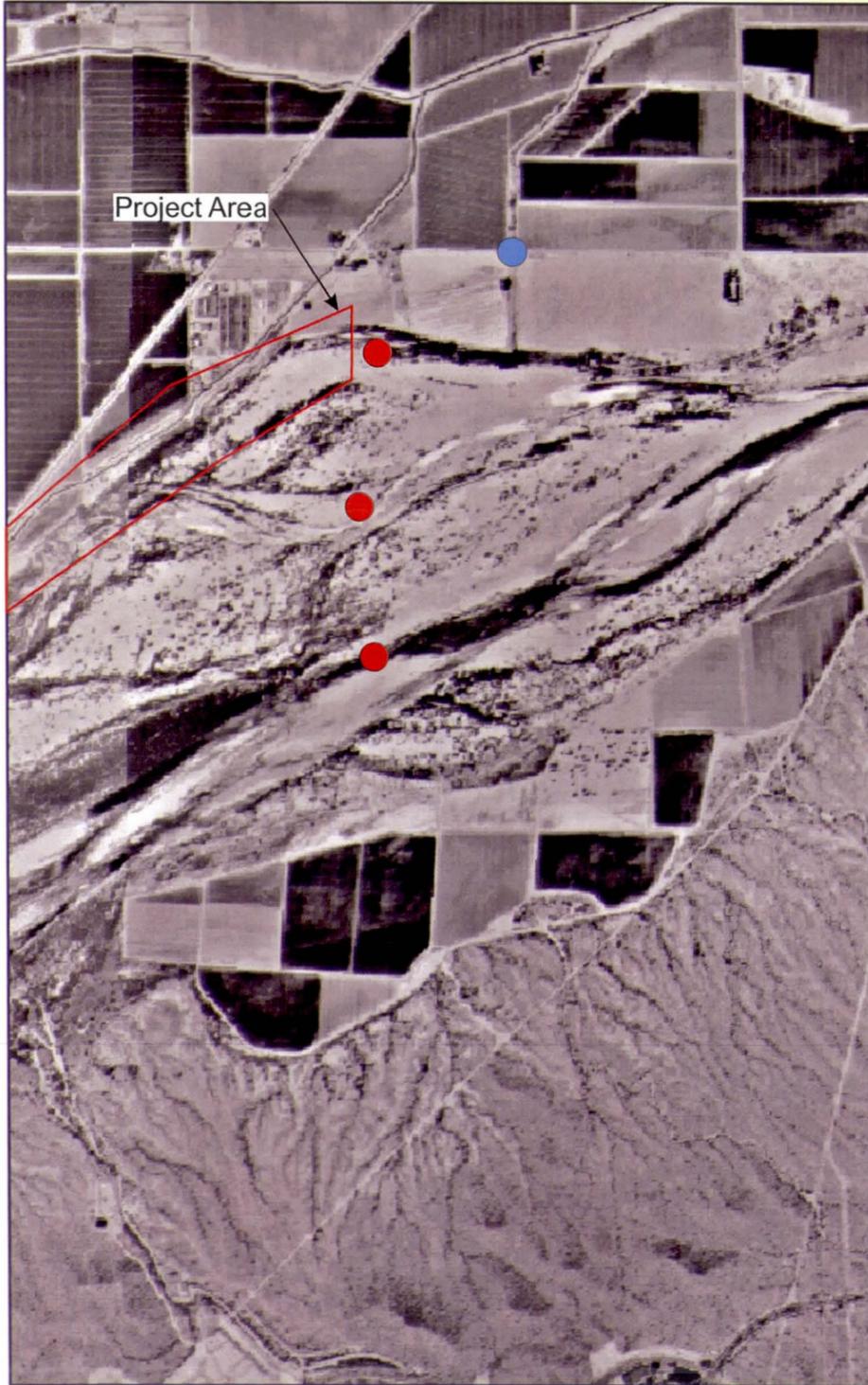




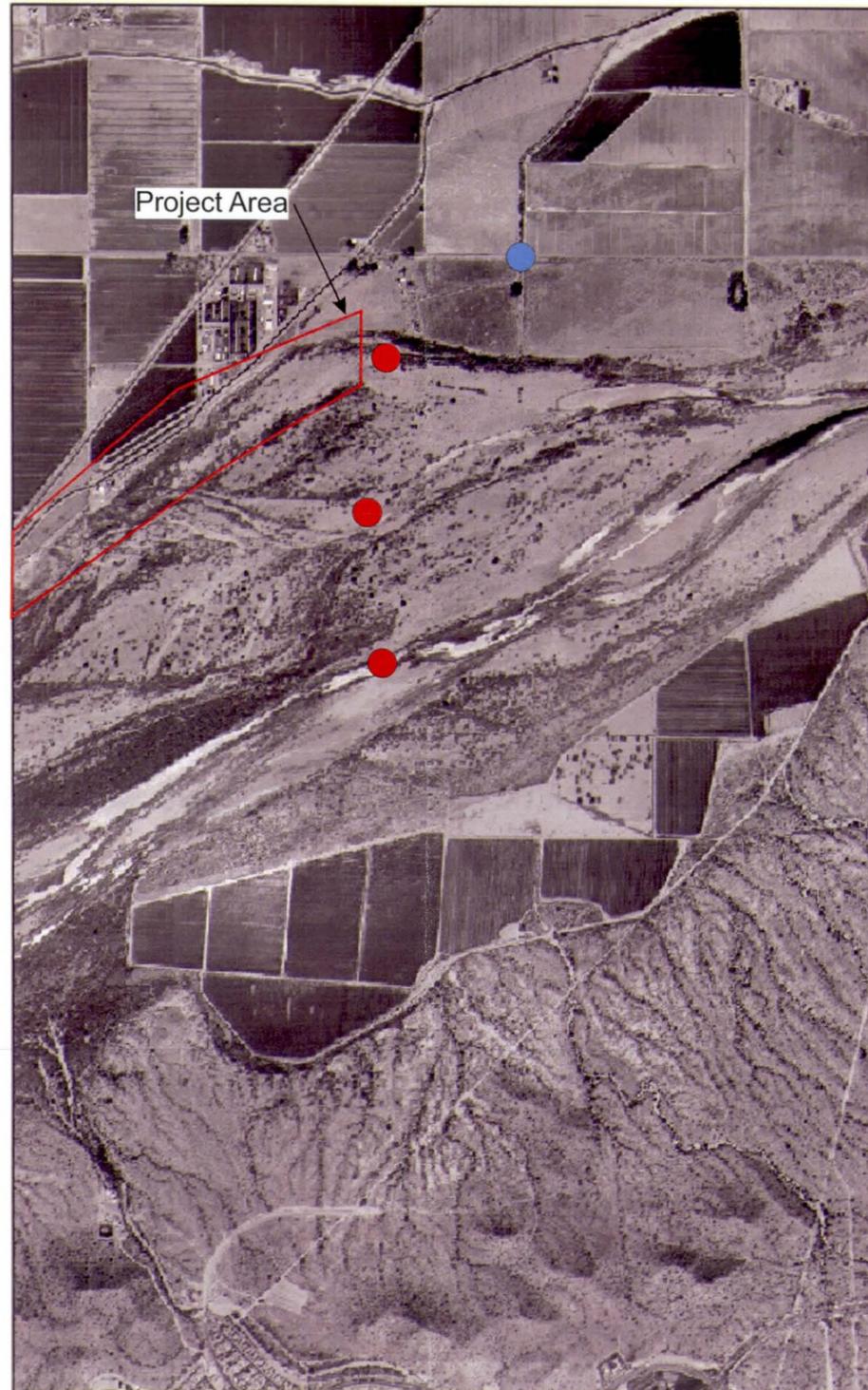
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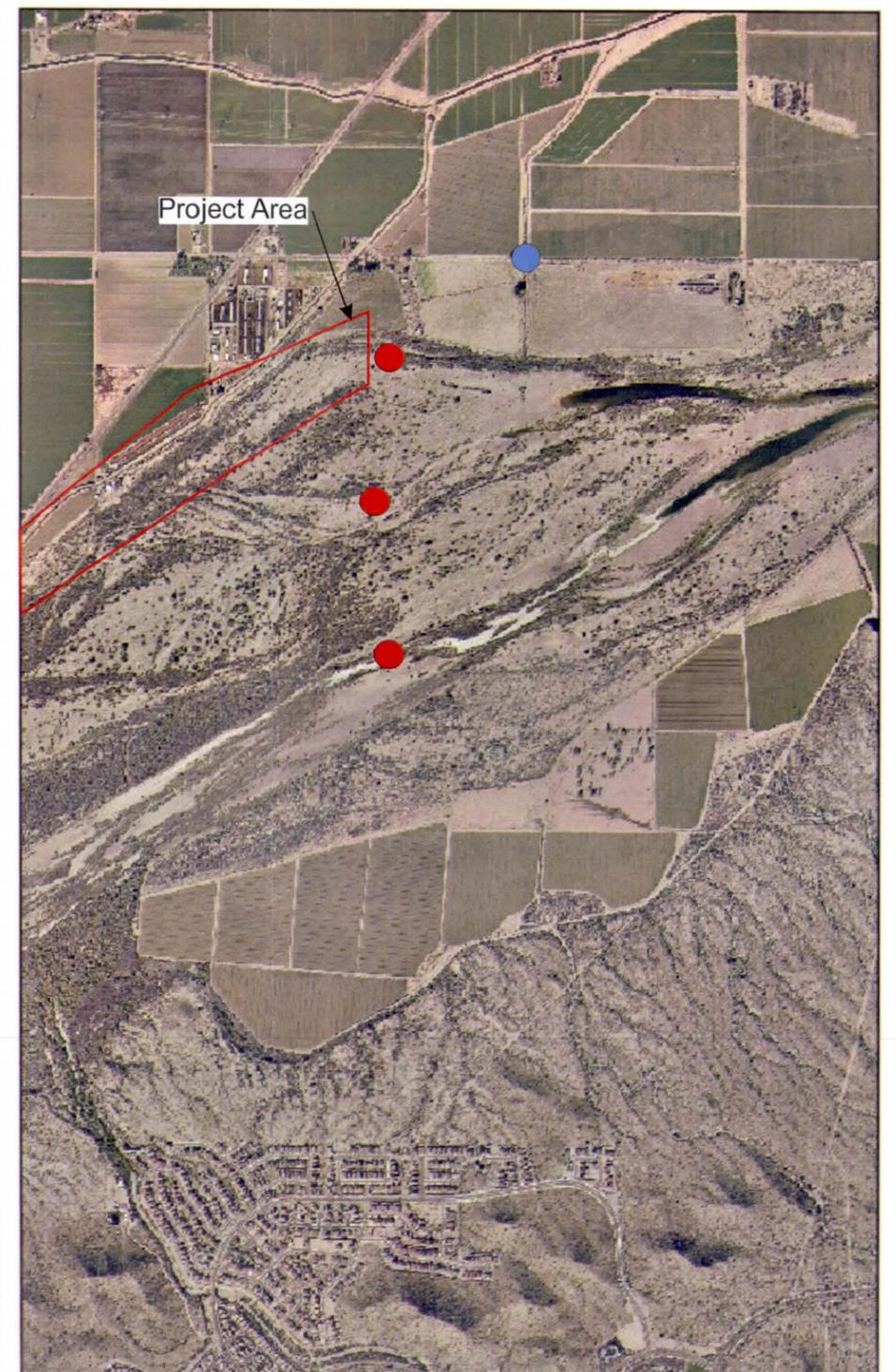
## Reach 7



April 30, 1997 (USGS NAPP)  
(photo set is repeated)



February 2002 (FCDMC)

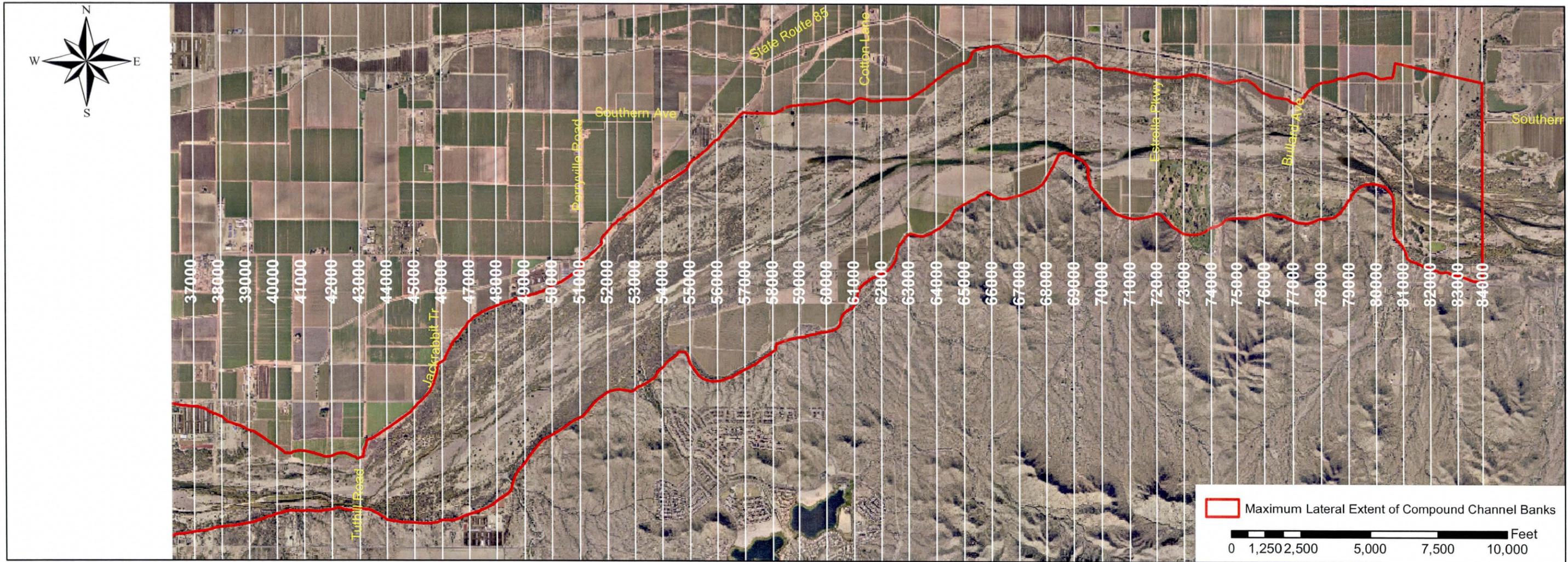


December 2004 (FCDMC)

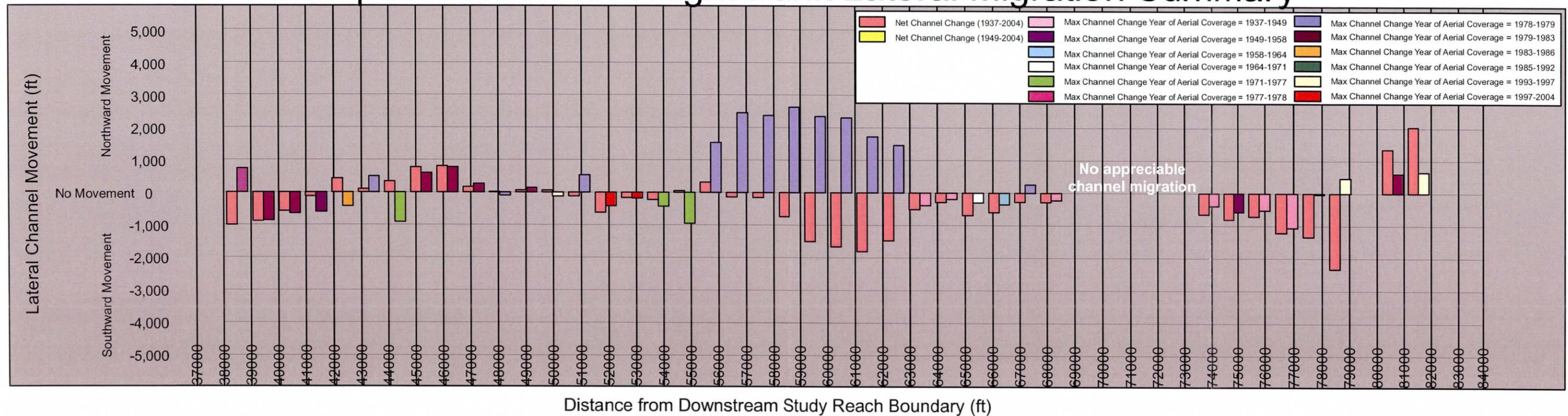


**Attachment C**

**Land Use Plans**



## Compound Channel - Right Bank Lateral Migration Summary

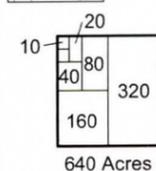


*Proud past.  
Vibrant future!*

**GOODYEAR**  
General Plan 2003 - 2013

**LAND USE PLAN**

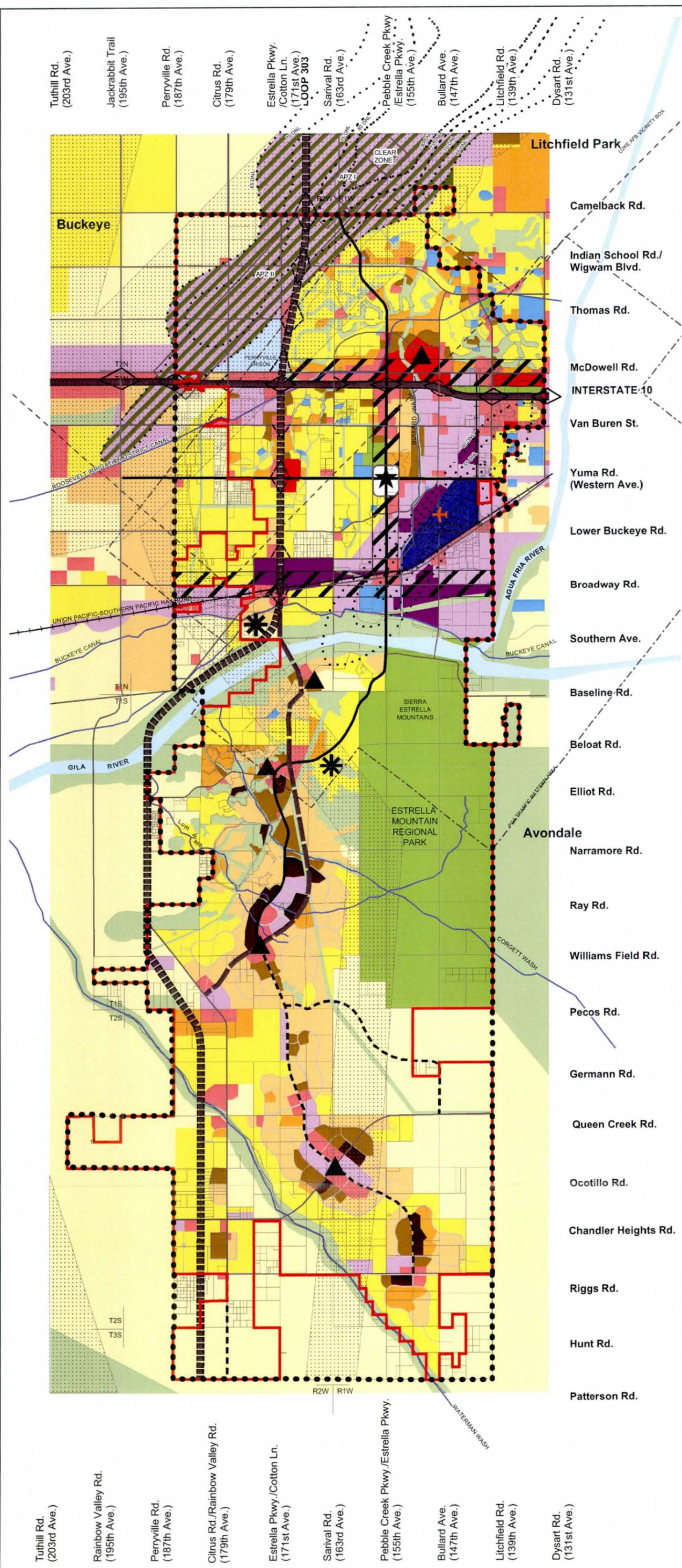
- Agricultural Preserve (AP)**  
(1.0 DU/AC)
- Rural Residential (RR)**  
(0 - 2.0 DU/AC)
- Low Density Residential (LDR)**  
(2.0 - 4.0 DU/AC)
- Low-Medium Density Residential (L-MDR)**  
(4.0 - 6.0 DU/AC)
- Medium Density Residential (MDR)**  
(6.0 - 10.0 DU/AC)
- Medium-High Density Residential (M-HDR)**  
(10.0 - 20.0 DU/AC)
- High Density Residential (HDR)**  
(20.0 + DU/AC)
- Community Commercial (CC)**
- Regional Commercial (RC)**
- City Center (CCTR)**
- Light Industrial (LI)**
- General Industrial (GI)**
- Luke Compatible Land Use Area (LCLUA)**
- Public/Quasi-Public (PQP)**
- Prison (PR)**
- Airport (A)**
- Parks (P)**
- Open Space (OS)**  
(1.0 DU/AC)
- High Intensity Mixed Use Corridor Overlay**
- Village Center Overlay**
- Resort Development Overlay**
- Freeway (Existing)**
- Freeway (Proposed)**
- Parkway (Existing)**
- Parkway (Proposed)**
- Scenic Arterial (Existing)**
- Scenic Arterial (Proposed)**
- Arterial Roads**
- City Incorporated Area**
- Planning Area**
- Canals/Washes**
- Regional Park**
- Luke AFB Range Access Routes**
- Aviation Noise Contours (DNL)**
- Parcel Boundary**



0 0.5 1 2 3 4 Miles



Source: MAG, July 2002; Luke AFB, April 2003; URS, May 2003  
v:/projects/goodyear/gis/project/general plan maps/fig\_2-3\_landuse\_plan.mxd



Tuthill Rd.  
(203rd Ave.)

Rainbom Valley Rd.  
(195th Ave.)

Perryville Rd.  
(187th Ave.)

Citrus Rd./Rainbow Valley Rd.  
(179th Ave.)

Estrella Pkwy./Cotton Ln.  
(171st Ave.)

Sarival Rd.  
(163rd Ave.)

Pebble Creek Pkwy./Estrella Pkwy.  
(155th Ave.)

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Perryville Rd.  
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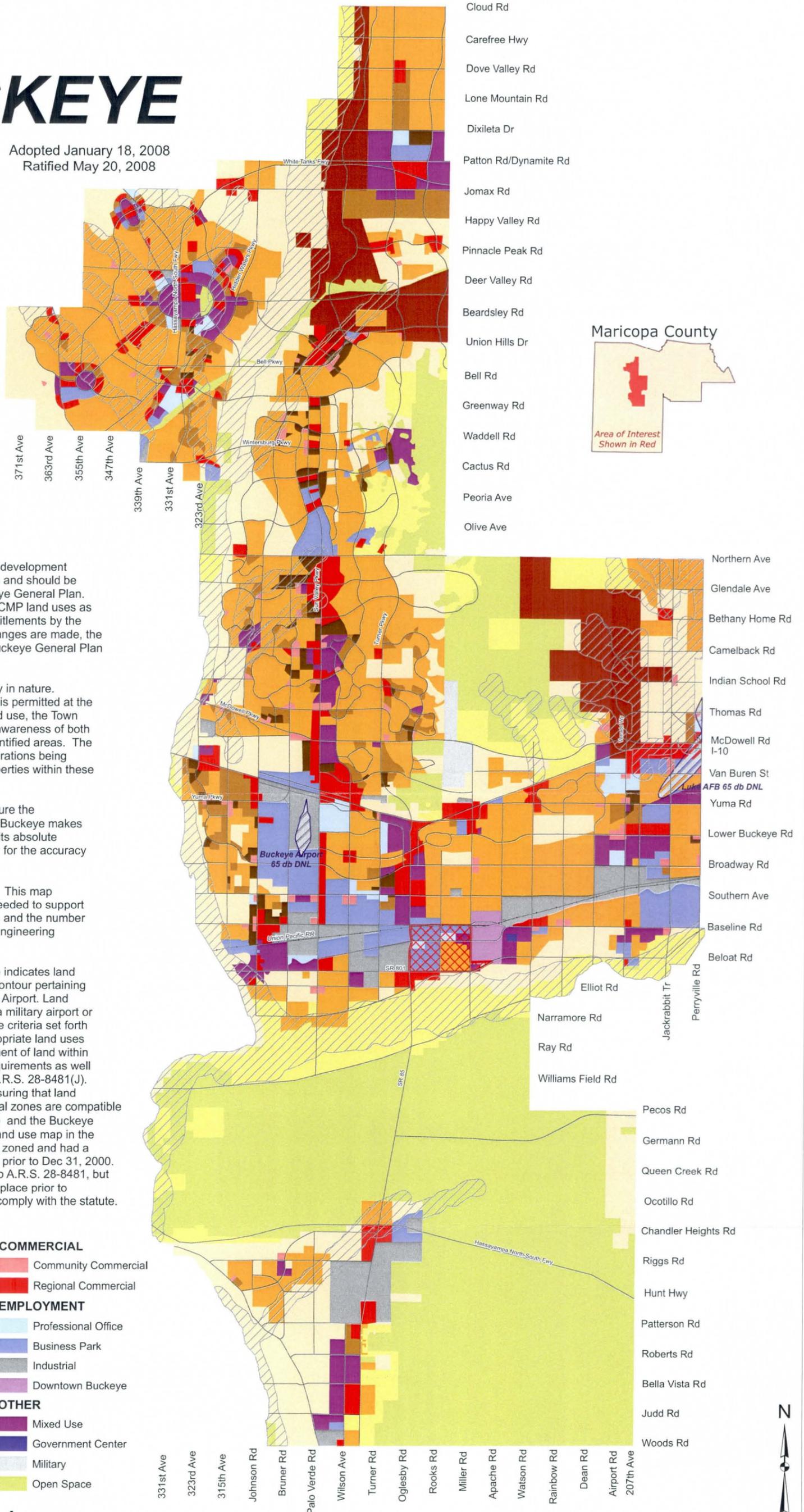
Bullard Ave.  
(147th Ave.)

Litchfield Rd.  
(139th Ave.)

Dysart Rd.  
(131st Ave.)

# Town of **BUCKEYE**

Adopted January 18, 2008  
Ratified May 20, 2008



**Notes:**

All Community Master Plans (CMP) and development agreements remain as valid entitlements and should be referred to in conjunction with the Buckeye General Plan. The Land Use Map strives to reflect the CMP land uses as accurately as possible. The adopted entitlements by the Town of Buckeye are valid and if any changes are made, the policies and guidelines outlined in the Buckeye General Plan will be followed.

Floodway Transitional Areas are advisory in nature. Though development within these areas is permitted at the level of the designated General Plan land use, the Town wishes to emphasize the importance of awareness of both the hazards and sensitivities in these identified areas. The Town strongly encourages these considerations being addressed in development plans for properties within these areas.

While every effort has been made to ensure the accuracy of this information, the Town of Buckeye makes no warranty, expressed or implied, as to its absolute accuracy and expressly disclaims liability for the accuracy thereof.

Arterial / River crossings are conceptual. This map demonstrates the number of crossings needed to support development at build-out. Final locations and the number of crossings will be determined through engineering and water studies.

Town of Buckeye General Plan Land Use indicates land within the 65 day-night noise level (dnl) contour pertaining to Luke Air Force Base and the Buckeye Airport. Land within the designated 65 dnl adjacent to a military airport or ancillary military facility is restricted by the criteria set forth in A.R.S. 28-8481(J) which outlines appropriate land uses for such land. Any General Plan Amendment of land within these areas must also comply with all requirements as well as the compatible land uses outlined in A.R.S. 28-8481(J). The Town of Buckeye is committed to ensuring that land uses in the high noise or accident potential zones are compatible with the operation of Luke Air Force Base and the Buckeye Airport. Residential uses shown on the land use map in the 65 dnl area for Luke Air Force Base were zoned and had a development plan in place for those uses prior to Dec 31, 2000. These properties continue to be subject to A.R.S. 28-8481, but the development plans that have been in place prior to December 31, 2000 for these properties comply with the statute.

- |                    |                                   |                   |                     |                      |
|--------------------|-----------------------------------|-------------------|---------------------|----------------------|
|                    | Floodway Transitional Areas       | <b>COMMERCIAL</b> |                     | Community Commercial |
|                    | 65 db noise contour               |                   | Regional Commercial |                      |
|                    | Downtown Expansion Area           | <b>EMPLOYMENT</b> |                     | Professional Office  |
| <b>RESIDENTIAL</b> |                                   |                   | Business Park       |                      |
|                    | Very Low Density 0-1 du/ac        |                   | Industrial          |                      |
|                    | Low Density 1.01-3 du/ac          |                   | Downtown Buckeye    |                      |
|                    | Medium Density 3.01-6 du/ac       | <b>OTHER</b>      |                     | Mixed Use            |
|                    | Medium High Density 6.01-10 du/ac |                   | Government Center   |                      |
|                    | High Density 10.01-15 du/ac       |                   | Military            |                      |
|                    | Master Planned Community          |                   | Open Space          |                      |

**FIGURE 3-4**



## **Attachment D**

### **Archival Map**

Source:

Rogers, James B., 2002, A Cultural Resources Assessment of the El Rio Archeological Research Locale in West-Central Maricopa County, Arizona, Prepared for the Flood Control District of Maricopa County, dated December 17, 2002.

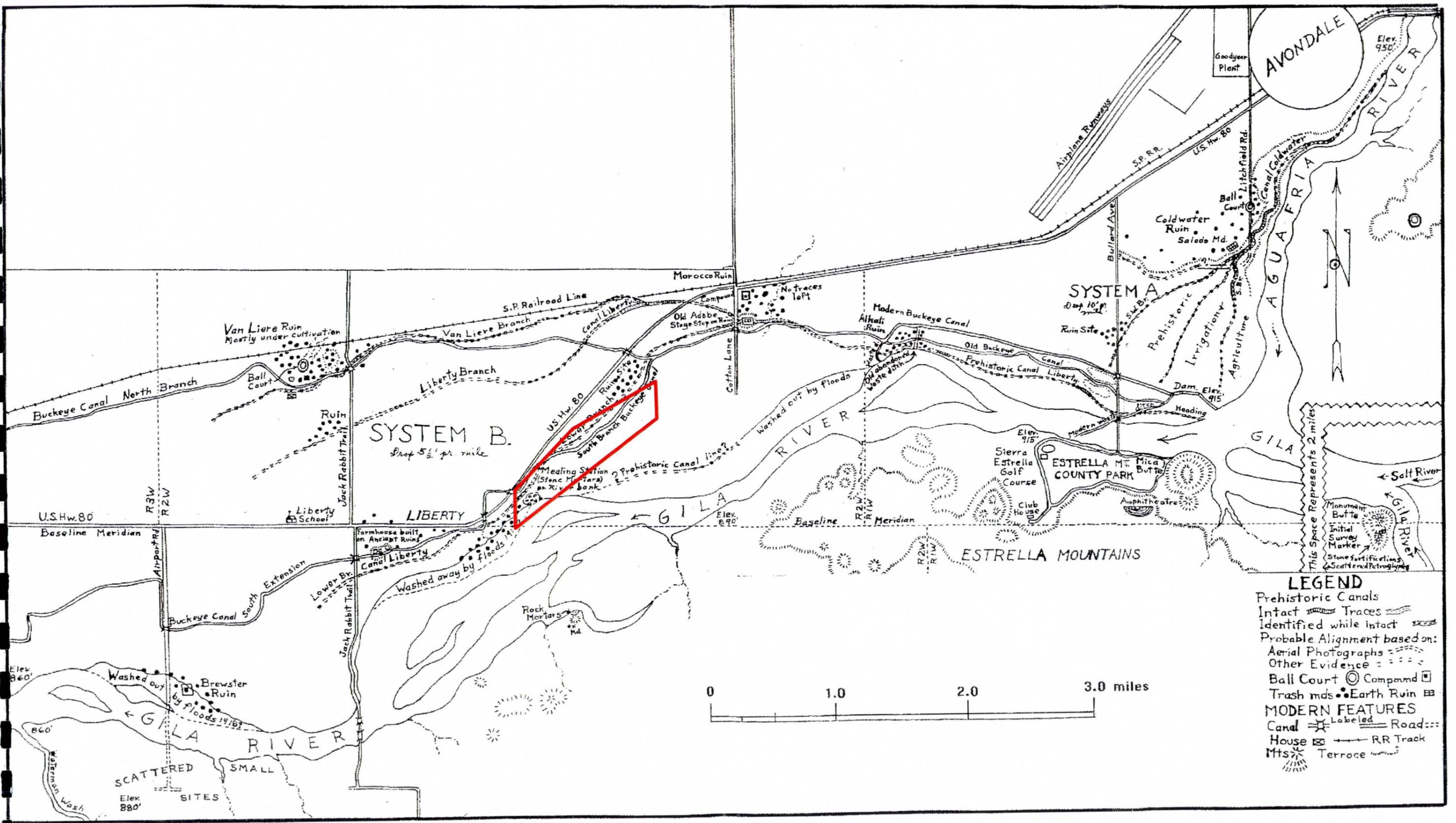


Figure 8. Archival map of the major Hohokam canals and adjacent villages of the eastern Buckeye Valley. (from Midvale 1971)

**Attachment E**

**Response to Comments**

**Gila River Bank Stabilization Pre-Design Study  
Baseline Condition Summary Memo**

**COMMENT FORM**

**Comments Due: March 10, 2009**

<b>Comment No.</b>	<b>Page No.</b>	<b>Reviewer</b>	<b>Comment</b>	<b>Comment Response</b> (this column is completed by FCD PM & Consultant)
1		Ed Gerak BWCCD	I would include Dos Rios in the partnership discussion, given their significant land holdings and possible long term benefits or requirements under a mining permit. It might be beneficial to address them as possible other partners on the project.	The District will approach all adjacent landowners for input in April/May following the development of a preliminary alignment.
2		R. Waskowsky FCD	For the proposed alignment, it appears that if the levee is extended to the southwest, it may provide added protection to the property shown circled in red --see photo on pg 4. However, since this property partially in the floodway, is this worth the added expense? Are the structures partially in the revised floodway? This option may be something to consider.	Extending the bank stabilization to protect the dairy farm would put the structure into a levee situation. Also the bank consists of non-engineered fill with significant geotechnical and environmental issues. From our understanding from JE Fuller's work and the alignment of the river, the river is not as prone to migration in this location.
3		M. Jones FCD	Please discuss potential for breakouts that may occur in the study area including water surface elevations, bank elevations, freeboard, etc.	Additional information was included in the memo.
4		M. Jones	Please describe the condition of the current erosion protection including toe	Additional information

**Gila River Bank Stabilization Pre-Design Study  
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**COMMENT FORM**

**Comments Due: March 10, 2009**

			down depth.	was included in the memo.
5		M. Jones	Add a description of the geotechnical information and the impact it may have on the project.	Additional information was included in the memo.
6		M. Jones	Identify the risks (damage due to flood or erosion) to the facilities in Table 1	Additional information was included in the memo.
7		M. Jones	Identify properties, facilities, and infrastructure that would benefit the proposed improvements and how to Table 1 and include any other properties, etc. that may benefit that are not included on table 1 (i.e. utilities, towns, farms, etc.)	Additional information was included in the memo.
8		M. Jones	How will the various jurisdictional boundaries/agencies impact the project including the COE, State, etc?	Additional information was included in the memo. The scope of work does not include a JD analysis, etc. A statement will be added that will suggest this type of work should be conducted as part of the 30% design plans.
9		M. Jones	One additional benefit would be that once completed FCD will have better O&M access to the area.	This will be added to the memo.
10		B. Lokey FCD	Per scope, please include a detailed accounting of the existing flooding condition and potential bank failure impacts by jurisdiction. This is important information for developing a "yardstick" against which the value of improvements could be measured.	Additional information was included in the memo.
11		B. Lokey	The graphics include some nice maps, but there are some figures that are hard to read and don't seem to contribute that much (they come across as filler). In	Additional information was included in the

**Gila River Bank Stabilization Pre-Design Study  
Baseline Condition Summary Memo**

**COMMENT FORM**

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			particular, the stream width vs time plots, the hydrologic timeline, and many of the excerpts from the El Rio Lateral Migration study.	memo. The JE Fuller figures for the erosion hazard boundary were removed. Unfortunately photos showing flood damage for this area of the river are not available.
12		D. Farar Goodyear	It doesn't appear as though a determination was made by the engineer regarding the change of flood and erosion hazard risk other than indicating that new floodplain, floodway, and erosion hazard zone was developed by a previous study. Language indicating the engineer's support of these findings or non-support and subsequent proposal of new linework appears to be warranted by the scope.	Further discussion was added to the memo.
13		D. Farar	The memo also appears to be unclear in addressing some of the bullet points that are part of the scope. I would propose that a table be provided much like that of Table 1 but expanded to include information for each of the bullet points.	Additional information was added to the memo including tables.
14		D. Farar	The section on Impacts per jurisdictional boundaries needs to be expanded to provide land uses for each property (see comment 2 for suggested table documentation).	Additional information was added to the memo.
15		D. Farar	The historic flood and erosion value of damages was not included as a part of the memo. This information would be helpful for Goodyear's consideration of the project.	Unfortunately BWCCD does not have any records, such as photos or repair costs, of the damage from various flood events. Costs from the CIP memo were added.
16		J. Pokorski	I suggest removing the Erosion Hazard Boundary maps. The presence of the old floodplain is confusing and the EHZ appears on other maps.	Okay

**Gila River Bank Stabilization Pre-Design Study  
Baseline Condition Summary Memo**

**COMMENT FORM**

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17		J. Pokorski	Remove the file name that the maps are saved as from the newly created maps, and add the FCD logo on the newly created maps and the memo.	Okay
18		J. Pokorski	Add "future 801" to list of facilities in lateral migration limits on page 3.	Per an email from Brian Bombardier, HDR, the SR 801 is about ½ mile northwest of the project area. He did mention that the SR 303L would cross the project.
19		J. Pokorski	On page 2, under historic flood and erosion events add "1500 feet" – last sentence, first paragraph.	Okay
20		J. Pokorski	On the Attachment A cover page, add the full reference to the JE Fuller report, and check that the report is referenced consistently throughout the document.	Okay

Gila River Bank Stabilization Pre-Design Study  
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