

To: Kathryn Gross, Valerie Swick – Flood Control District of Maricopa County, AZ

From: Anthony Alvarado, E.I., William J. Spitz, R.G.

Date: December 20, 2004

Re: **Technical Memorandum FCD 2002C027-T2.6.5**
Buckeye/Sun Valley ADMS Delineation of Erosion Hazard Setbacks (Subtask 2.6.5)

This Technical Memorandum (TM) is submitted by Ayres Associates in support of Subtask 2.6.5 of the Buckeye/Sun Valley Area Drainage Master Study (ADMS) Scope of Work (Contract FCD 2002C027).

The Buckeye/Sun Valley ADMS is being performed for the Flood Control District of Maricopa County (District) and the Town of Buckeye. The purpose of the Buckeye/Sun Valley ADMS is to quantify the extent of drainage, flooding, and erosion problems, sources, and hazards in the Buckeye/Sun Valley area, and develop preliminary solutions to mitigate the identified concerns. Arizona Revised Statutes Title 48, Chapter 21, requires the Board of Directors to identify flood control problems and prepare plans that, when implemented, will eliminate or minimize flooding problems.

Task 2.6 represents the Geomorphic Evaluation and Landform Stability Assessment portion of the Scope of Work (SOW). The purpose of Task 2.6 is to provide a qualitative assessment of potential erosion and sedimentation hazards of primary washes, lateral and vertical stream instability, and piedmont landform stability within the drainage networks of Area 3 (Buckeye Structures) and Area 4 (North Sun Valley) of the Buckeye/Sun Valley ADMS watershed.

1. OBJECTIVE

This TM documents the methodology and results of the delineation of erosion hazard setbacks performed under Subtask 2.6.5 by Ayres Associates. The objective of Subtask 2.6.5 was to delineate erosion hazard setbacks for watercourses within Areas 2 and 3 that have existing FEMA Flood Insurance Study (FIS) floodplain delineations.

2. METHODS

Hydraulic and hydrologic data used to delineate the erosion hazard setbacks were provided by the District for watercourses in Area 3 from existing Flood Insurance Study (FIS) floodplain delineations (detailed), and hydraulic and hydrologic studies prepared by PBS&J as part of this SOW were used for the watercourses in Area 2. Once the Level 1 setbacks were delineated, a field reconnaissance was conducted to review the adequacy of the defined setback and identify those reaches where the Level 1 approach is inadequate or inappropriate. Where the Level 1 approach is not adequate or appropriate, erosion hazard setbacks were delineated using geomorphic methods.

2.1. Erosion Hazard Setback Delineation

The erosion hazard setbacks were delineated using the Level 1 approach as specified by the Draft Erosion Hazard Zone Delineation and Development Guidelines (EHZDDG) (JE Fuller, 2003). The Level 1 approach is for channels with a drainage area that is less than fifty square miles, with any type of development, and with no unusual conditions existing. The Level 1 erosion hazard setback is estimated using the equations shown in **Table 2.1**.

Table 2.1. Level 1 Erosion Hazard Setback Requirements (JE Fuller, 2003).

Drainage Area	Setback Equations	
	Straight Channel	Outside of Bend
< 50 sq miles	$2 * Q100^{0.5}$	$4 * Q100^{0.5}$
> 50 sq miles	Use Level 2 or Level 3 Methodology	
Minimum setback	Edge of Floodplain + 50 ft.	

The Q100 is the 100-year flood flow at the location of the setback. The setback equation for the outside of a channel bend is used where there is a 20° change in direction of the low flow channel. The transition from the straight reach of the upstream limb into a bend and back to a straight reach in the downstream limb requires a 1:1 upstream transition and a 4:1 downstream transition between setback boundaries. The minimum Level 1 erosion hazard setback is 50 feet landward from the edge of the 100-year floodplain. The setback distance is the distance from the nearest bank of the main channel or the edge of the floodplain. **Figure 2.1** provides an illustration of the typical Level 1 setback criteria.

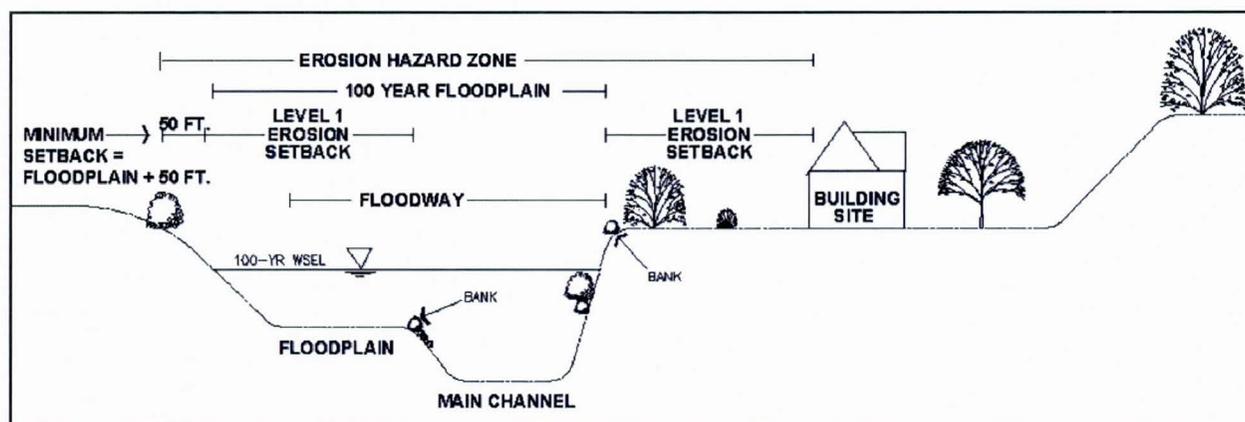


Figure 2.1. Illustration of the Level 1 erosion hazard zone and building setback (Fuller, 2003).

The low flow channel banklines were delineated using Geographic Information Systems (GIS) software package, ArcGIS for both Area 2 and 3. Ten-foot contour topography and 2003 MrSID orthophotography were obtained from the District and overlaid in ArcGIS. The topography and orthophotography were then utilized to determine the low flow banklines.

Once the low flow banklines were delineated, Bentley MicroStation, a CAD software package, was used to establish which reaches have bends that have greater than a 20° change in

direction and which reaches are straight. With these low flow banklines and depending on whether the reach was a bendway or straight, the setback was calculated using the given discharge for that reach and then applied to the bankline.

The 100-year floodplain for Area 3 (including White Tank Wash and its tributaries) was obtained from the FIS Floodplain maps for the area. The 100-year floodplain mapping for Area 2 was provided by PBS&J. MicroStation was used to delineate the 100-year floodplain plus fifty feet setback boundary.

The 100-year floodplain plus fifty feet setback boundary was then overlain and compared to the calculated erosion hazard setbacks. The more conservative or furthest of the two boundaries from the channel was then used as the final erosion hazard setback.

2.2. Field Verification

All Terrain Vehicles (ATVs) with utility racks (**Figure 2.2**) were the main mode of transportation used in the field reconnaissance of the channels in Area 3. The ATVs were used because of the large extent and relative inaccessibility of the study area, and allowed for quick and efficient movement across the landscape to verify the boundaries and check for problem areas in a short amount of time. Having less travel time allowed for more time to accurately verify the erosion hazard setback boundaries. The channels in Area 2 were examined by car at road crossings where private property restrictions were an issue, and on foot or by ATV where there were no private property restrictions.



Figure 2.1. The Trimble GeoXT handheld GIS-based GPS unit (arrow) mounted on the ATV.

The Trimble GeoXT, which is shown mounted on the ATV in Figure 2.2, is part of the Trimble GeoExplorer CE Series, a handheld Windows CE device with an integrated Trimble GPS receiver. With Windows CE, the device is capable of incorporating mobile GIS field software. For this project, ESRI's ArcPad 6.0, which is the mobile form of ArcGIS with GPSCorrect, was used. Using ArcPad with the georeferenced aerial orthophotography and the pre-defined setback boundary GIS files, the Trimble GeoXT enabled quick navigation and tracking along the erosion setback boundaries. Mobility was accomplished by mounting the Trimble GeoXT on the front utility rack of the ATV and allowed for easy tracking of the current location and navigation along the delineated boundaries. The Trimble GeoXT provides sub-meter GPS accuracy with the portability of a fully editable mobile GIS database.

2.3. Erosion Hazard Setback Mapping

The erosion hazard setback boundaries for Area 2 and Area 3 are delineated on the attached map sheets. The setback boundaries are based on either the equations provided in the Level 1 approach, the 100-year floodplain plus 50 feet approach, or on field evidence of potential hazards that are not encompassed by the boundaries defined by the previous two approaches. Typical setbacks as delineated for White Tank Wash in Area 3 are shown in **Figure 2.2**. The Erosion Hazard Zone boundaries would be the boundary farthest from the channel as defined either by the 100-year floodplain plus 50 feet or the erosion hazard setback. The cross sections with the 100-year floodplain, erosion hazard setbacks, and erosion hazard zone locations are shown in **Figure 2.3**.

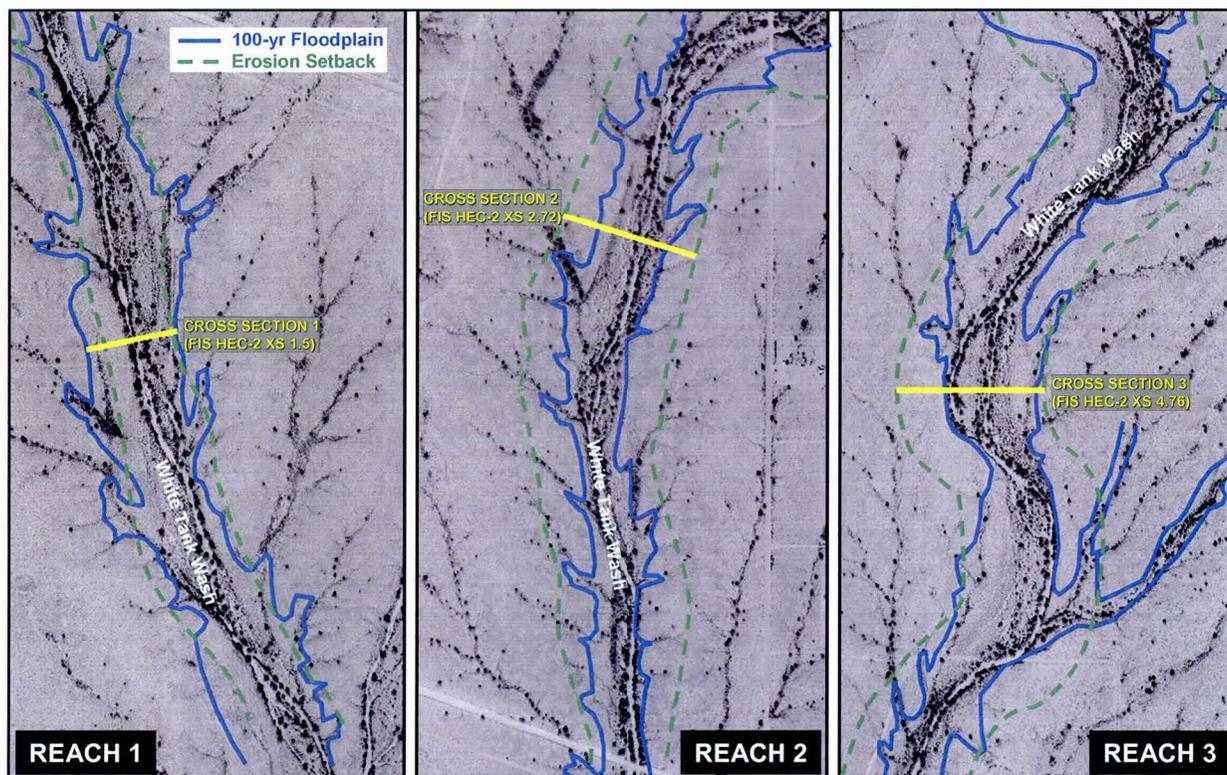


Figure 2.2. Reaches of White Tank Wash in Area 3 showing 100-year floodplain, erosion setback boundaries, and specific cross section locations.

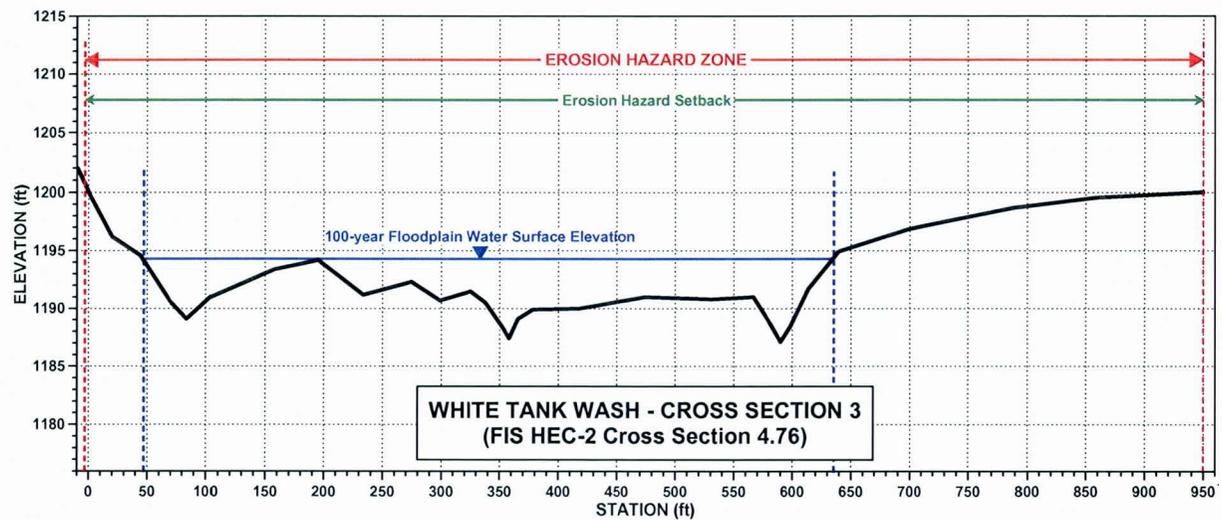
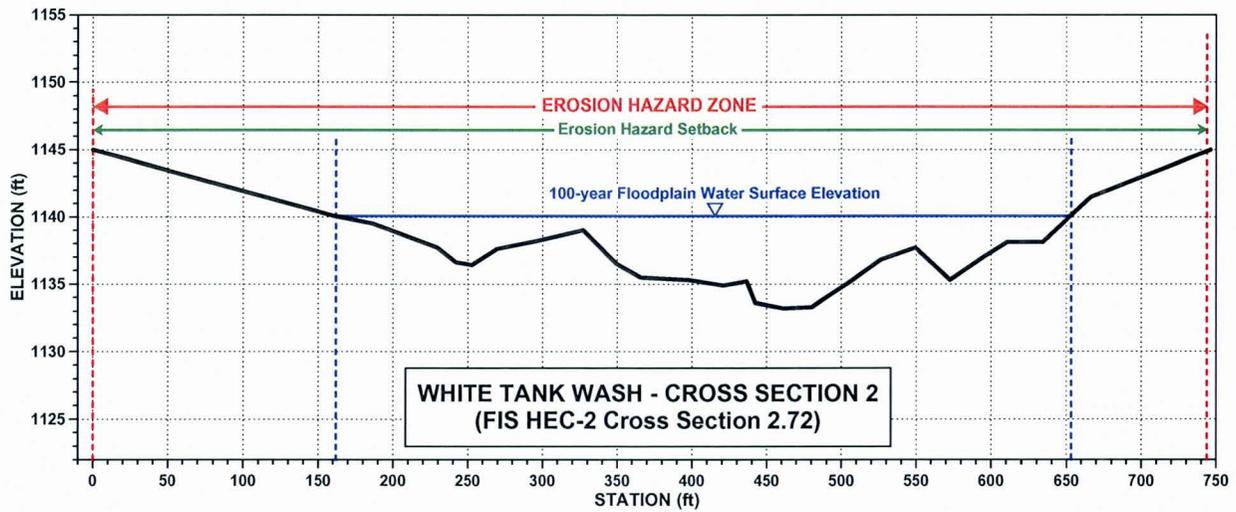
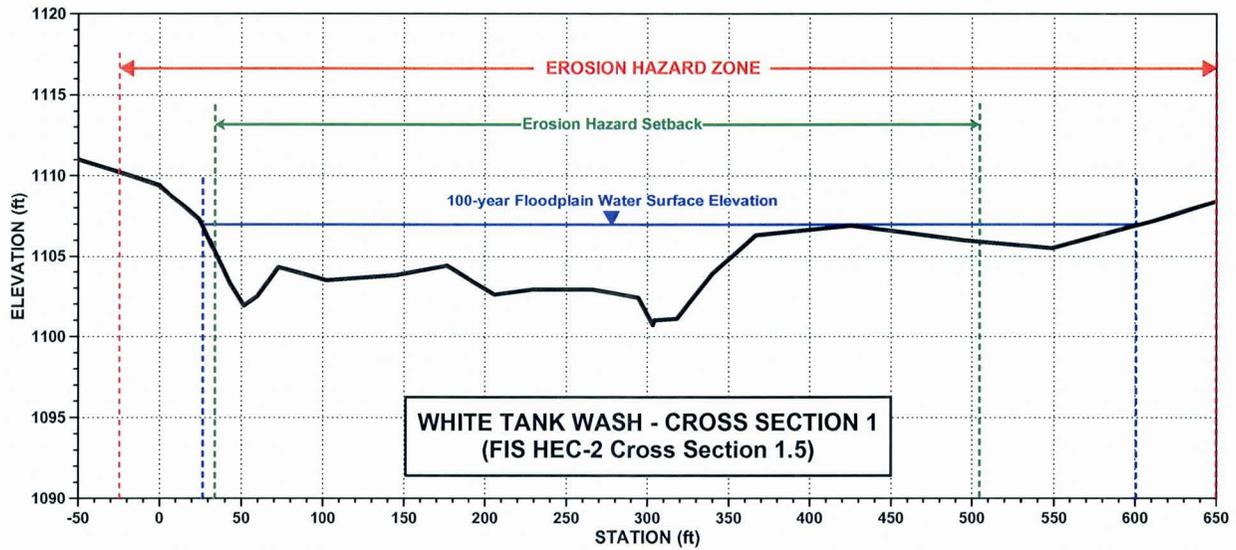


Figure 2.3. Cross sections and boundaries as shown in Figure 2.2.

The erosion setback boundaries were modified at five major locations where the setback boundary was inappropriate or inadequate. One reach was modified in Area 2 and 4 reaches were modified in Area 3 as follows:

Area 2, Sheet 5, Map 09 – The modified setback boundary is located between approximately 700 and 1,200 feet upstream of match line F-F on the left bank area. The calculated setback boundary in this area was shifted to the east because the area shows evidence of an old or inactive split flow channel along the left side of the floodplain. It does not appear that the 100-year floodplain is mapped to the east far enough. This may be a function of the cross-section spacing and the model constraints, which may not have identified the flow split. It appears that overbank flow may occur well upstream and supply flow to this split flow channel. If this were to occur, the split flow channel or the area along it may be susceptible to associated flood and erosion hazards further east than the boundaries defined by the current 100-year floodplain and the calculated erosion hazard setback. Therefore, the modified setback reflects these potential hazards and the boundary is defined as the top of the entrenched valley wall as a minimum.

Area 3, Sheet 1, Map 02 – The modified setback boundary is located between approximately 600 and 1,000 feet upstream of match line B-B on the right bank side of the valley. The calculated setback boundary in this area was shifted to the east because the area shows evidence of an old or inactive split flow channel north of the existing main channel. Although the downstream end of the split flow channel is within the 100-year floodplain, it does not appear that the 100-year floodplain is mapped far enough north to account for the middle and upper end of the split flow channel. This may be a function of the cross-section spacing and the model constraints, which may not have identified the upper end of the flow split. It appears that a portion of high flows may split well upstream and supply flow to this channel. If this were to occur, the split flow channel or the area along it may be susceptible to associated flood and erosion hazards further north than the boundaries defined by the current 100-year floodplain and the calculated erosion hazard setback. Therefore, the modified setback reflects these potential hazards and the boundary is defined as the right bank of the split flow channel plus 50 feet as a minimum.

Area 3, Sheet 5, Map 09 – The modified setback boundary is located from about 200 feet upstream of match line B-B to approximately 3,000 upstream of the match line on the right bank side of the valley. The area has recently been identified as an active alluvial fan (BSV Site #14) in a previous technical memo to the District (see Ayres Associates TM2.6.3). Therefore, the setback boundary along the right bank of the channel in this reach is inappropriate. The location of the setback along this reach will be dependent upon further study of the active alluvial fan to determine the exact fan boundaries and it is recommended that the right bank setback boundary be defined as the north fan boundary plus 50 feet as a minimum.

Area 3, Sheet 5, Map 10 – The modified setback boundary is located between approximately 400 and 700 feet downstream of match line H-H along the right bank area. The calculated setback boundary in this area was shifted to the north because the area contains what appears to be an active split flow channel along the right side of the floodplain. It does not appear that the 100-year floodplain is mapped far enough north. This may be a function of the cross-section spacing and the model constraints, which may not have identified the flow split. It appears that overbank flow occurs at the upstream end and frequently supplies flow to this split flow channel. It is likely that the split flow channel or the area along it is susceptible to associated flood and erosion hazards further north than the boundaries defined by the current 100-year floodplain and the calculated erosion hazard setback. Therefore, the modified setback reflects these

potential hazards and the boundary is defined as the right bank of the split flow channel plus 50 feet as a minimum.

Area 3, Sheet 5, Map 10 – The modified setback boundary is located between approximately 400 and 1,400 feet upstream of match line I-I on the right bank area. The calculated setback boundary in this area was shifted to the south because the area shows what appears to be an active split flow channel along the left side of the floodplain. It does not appear that the 100-year floodplain is mapped far enough south. This may be a function of the cross-section spacing and the model constraints, which may not have identified the flow split. It appears that overbank flow occurs at the upstream end and frequently supplies flow to this split flow channel. It is likely that the split flow channel or the area along it is susceptible to associated flood and erosion hazards further south than the boundaries defined by the current 100-year floodplain and the calculated erosion hazard setback. Therefore, the modified setback reflects these potential hazards and the boundary is defined as the left bank of the split flow channel plus 50 feet as a minimum.

3. CONCLUSIONS AND RECOMMENDATIONS

For the most part, the Level 1 setback boundaries appear reasonable. However, as described above, there are locations where the setback boundary has been shifted to account for flow splits that do not appear to have been identified and accounted for in the floodplain mapping. In these locations, it is recommended that the setback boundary be shifted away from the associated bank of the split flow channel by a minimum of 50 feet. In one area, the recent identification of an active alluvial fan along the right bank of the channel precludes the use of an erosion hazard setback until further studies are conducted to identify the exact fan margins and potential alluvial fan flooding. Once these have been identified and delineated, it is recommended that a 50-foot buffer be established between the fan margins and the setback boundary.

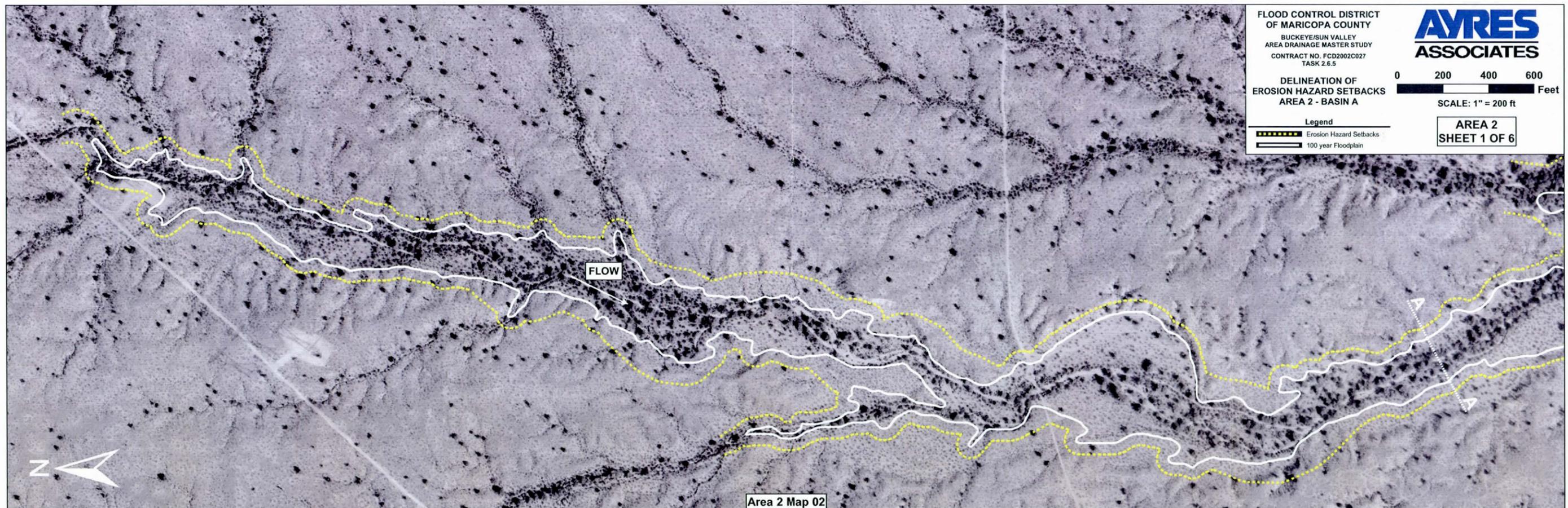
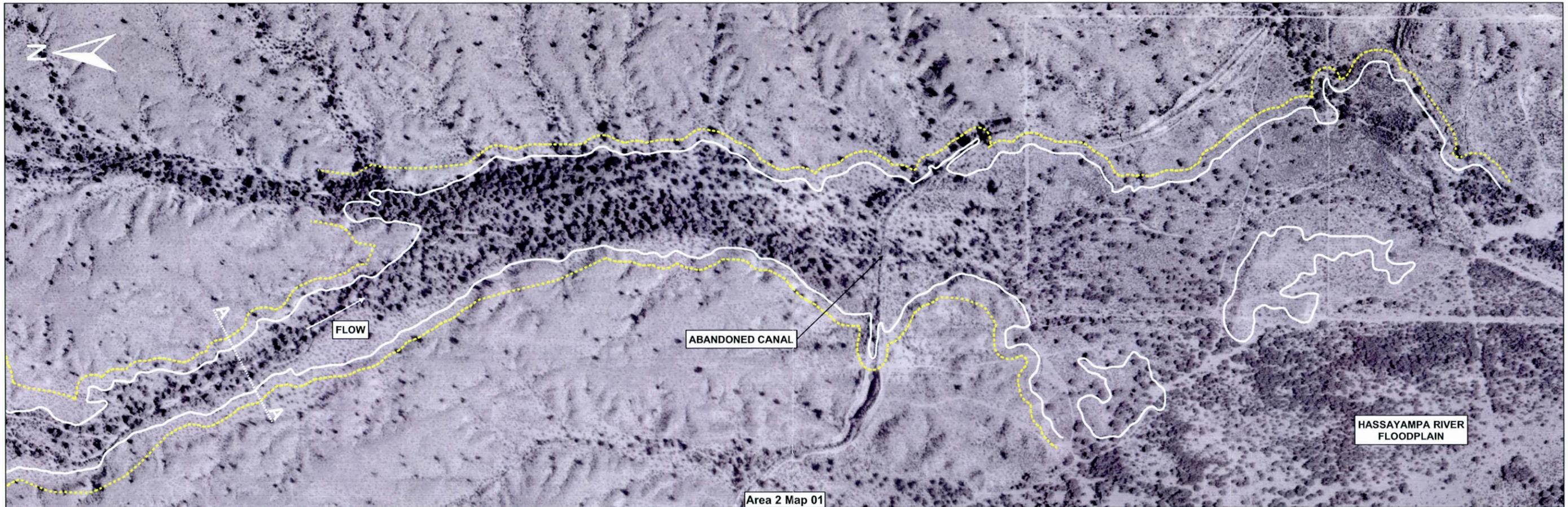
In several locations, it appears that the setback may be excessive. This often occurs where there is a meander bend in the main channel, but the main channel and floodway are deeply entrenched and bound by relict fan surfaces (see Cross Section 3 in Figures 2.2 and 2.3). It is evident that the channel has not encroached into these areas in tens of thousands of years and will likely not do so in the near future. Thus, there will likely be some resistance from developers where the setback is several hundred feet away from the main channel and encompasses several hundred feet of higher relict fan surface between the channel and the setback. However, it is also noted that there are provisions for conducting a Level 2 erosion hazard setback analysis if the developer feels that the Level 1 setback is excessive or too conservative.

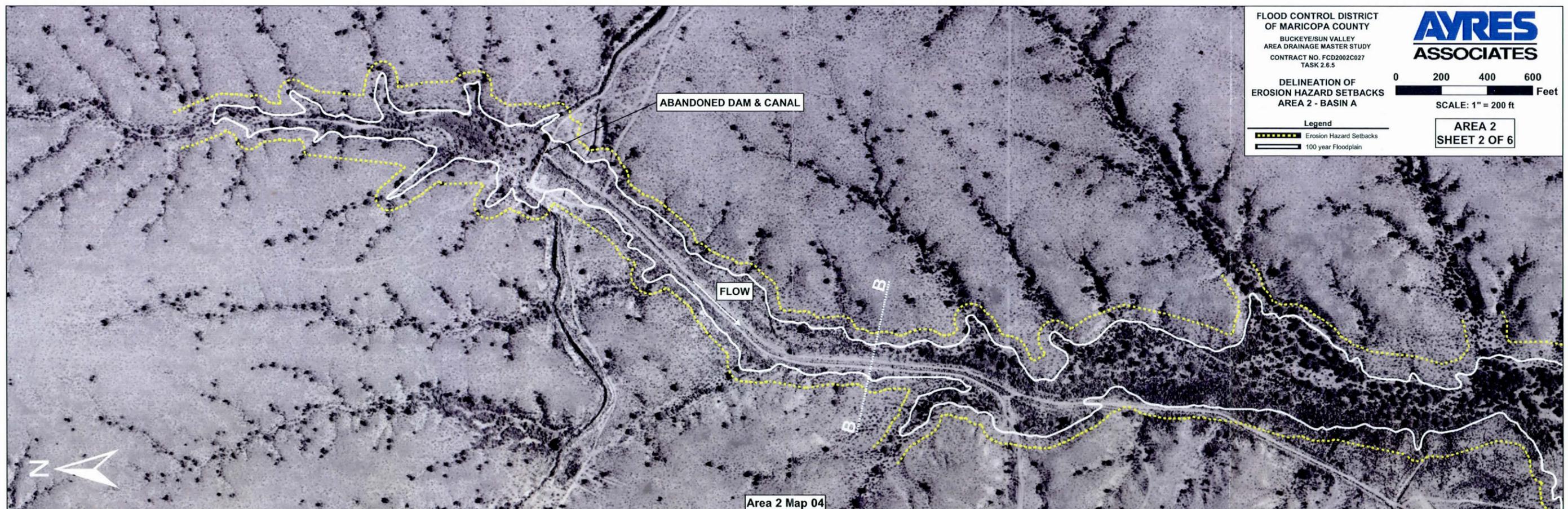
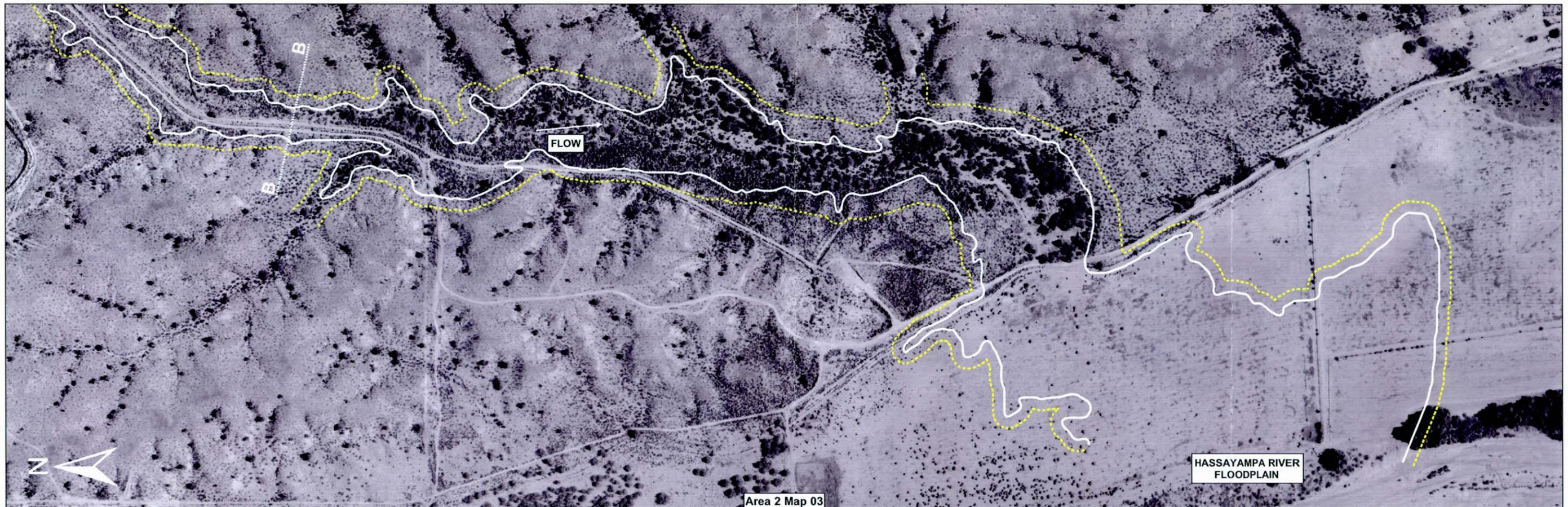
4. REFERENCES

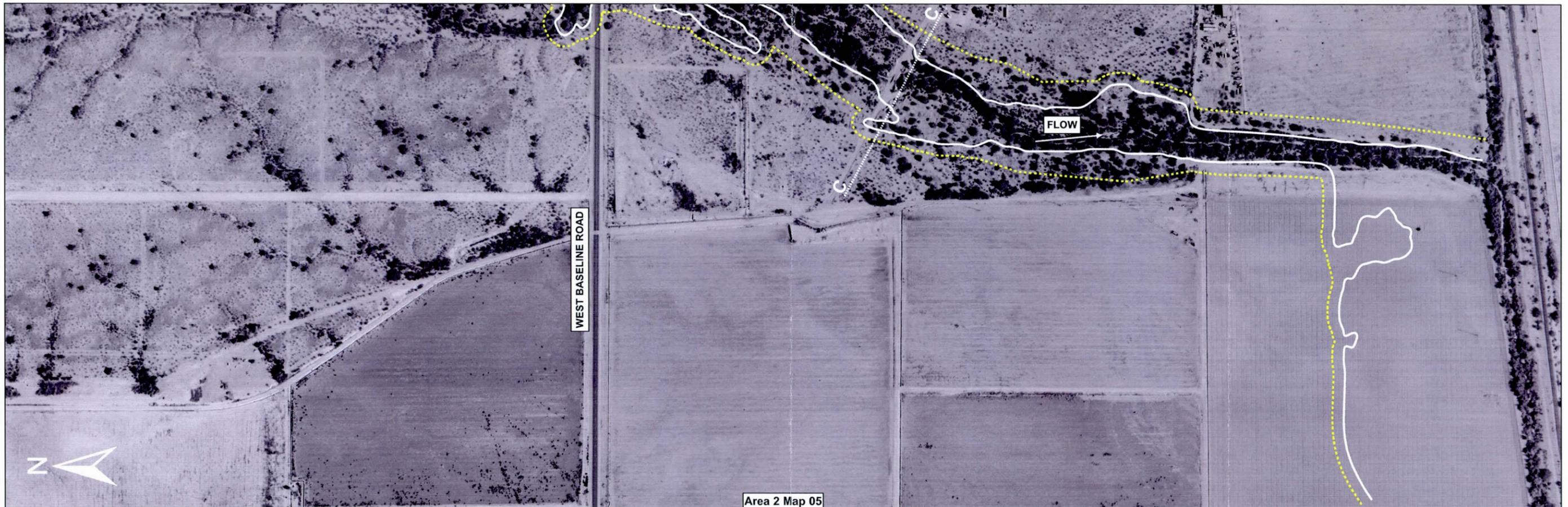
JE Fuller/Hydrology & Geomorphology, Inc. 2003. Draft Erosion Hazard Delineation and Development Guidelines, Prepared for Flood Control District of Maricopa County, Phoenix, AZ.

5. ATTACHMENTS

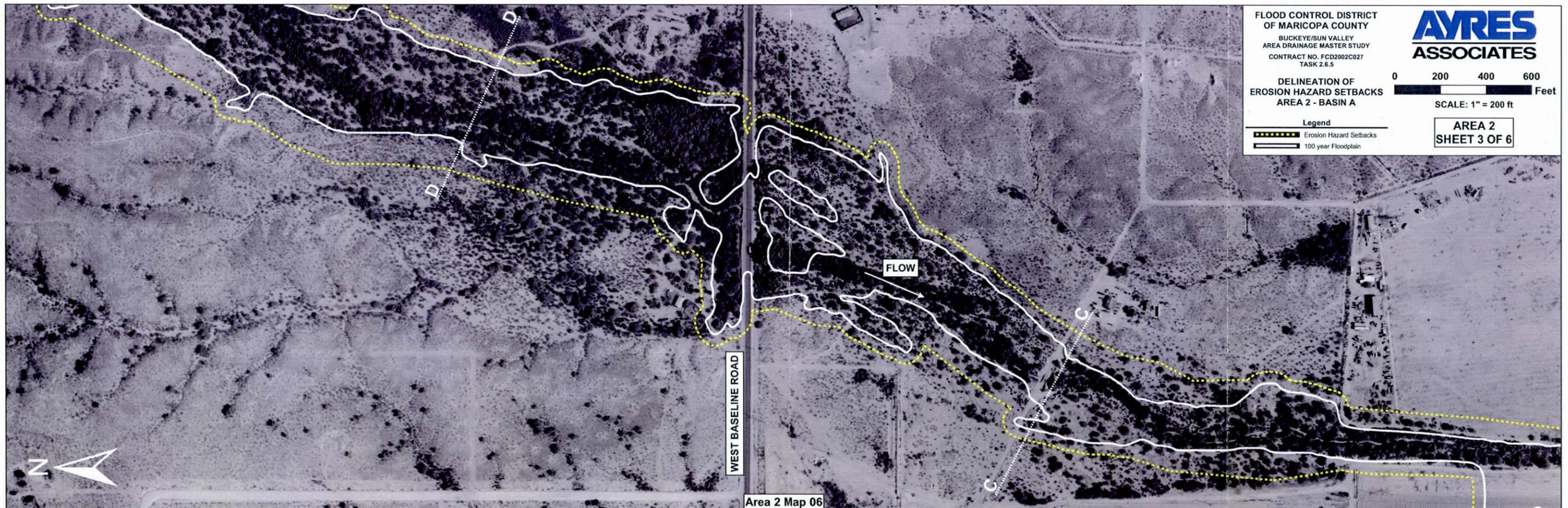
Erosion Hazard Setback Delineation Maps, Area 2 Sheets 1-6 and Area 3 Sheets 1-6 Original Scale: 1 inch = 200 feet. (Note: Scale of attached maps is approximately 1 inch = 444 feet)







Area 2 Map 05



Area 2 Map 06

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
BUCKEYE/SUN VALLEY
AREA DRAINAGE MASTER STUDY
CONTRACT NO. FCD2002C027
TASK 2.6.5

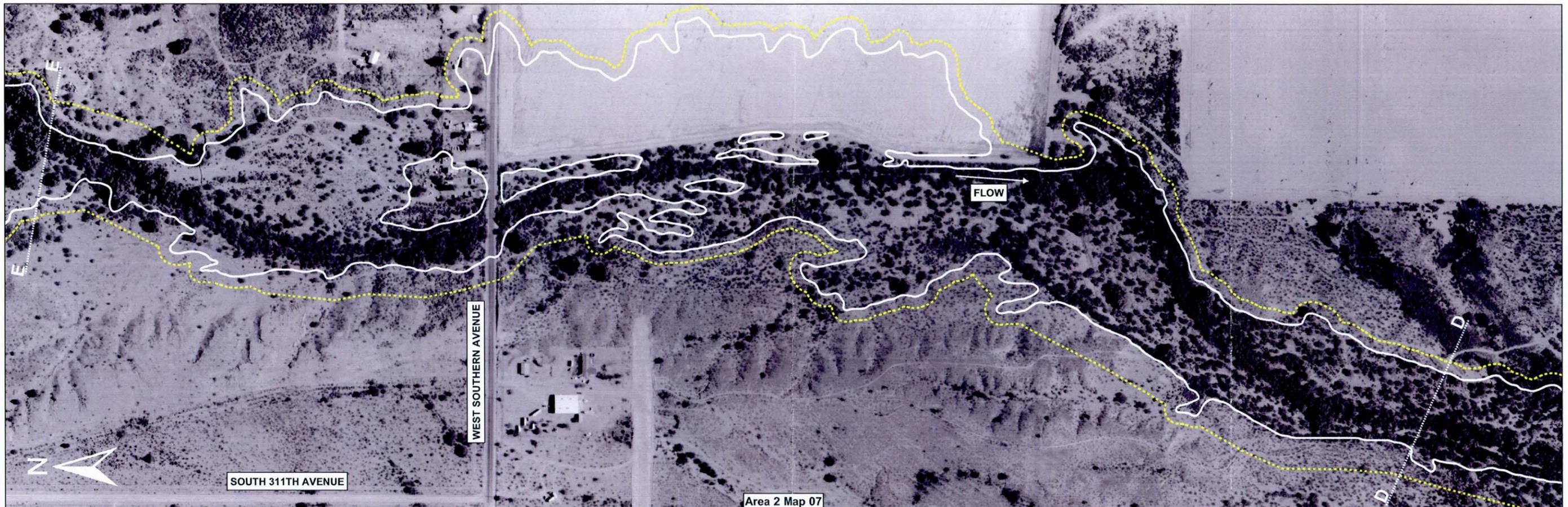
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SCALE: 1" = 200 ft

DELINEATION OF
EROSION HAZARD SETBACKS
AREA 2 - BASIN A

**AREA 2
SHEET 3 OF 6**

Legend
 - - - - - Erosion Hazard Setbacks
 _____ 100 year Floodplain



Area 2 Map 07



Area 2 Map 08

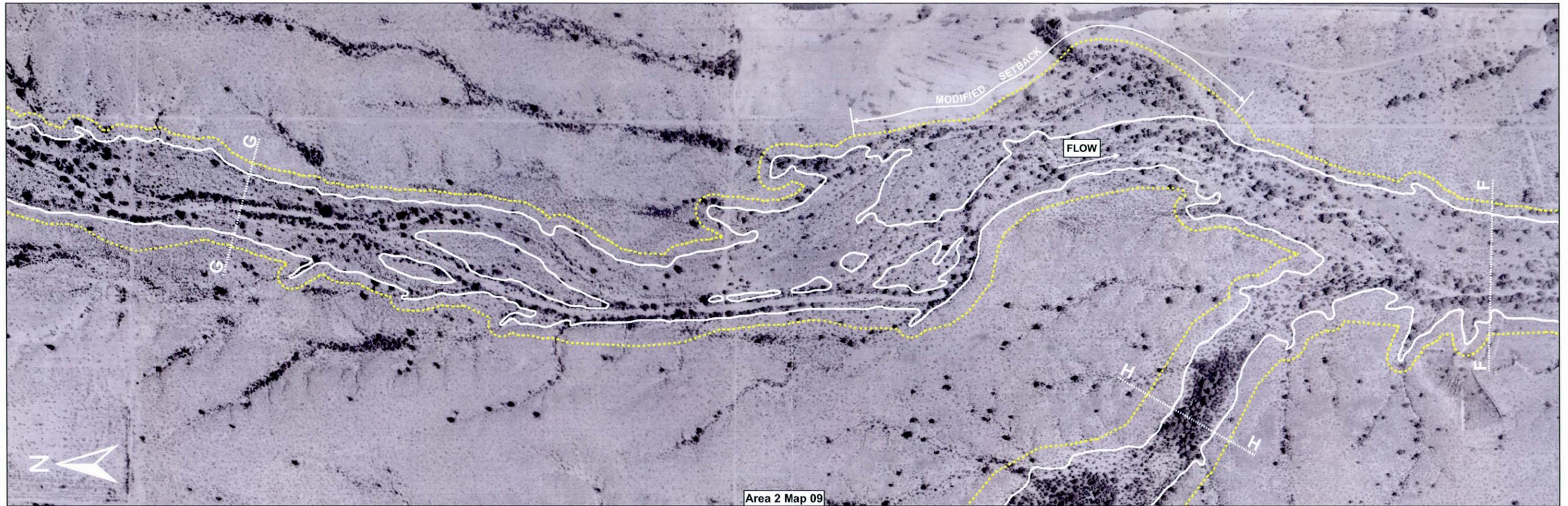
FLOOD CONTROL DISTRICT
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CONTRACT NO. FCD2002C027
TASK 2.6.5

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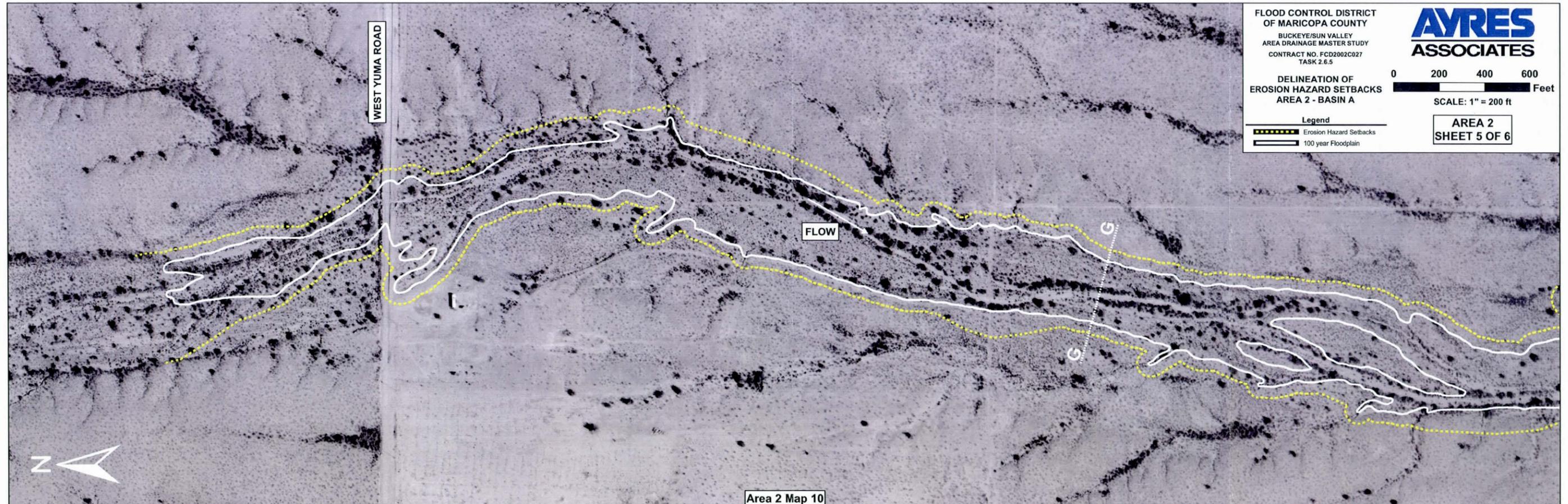
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**AREA 2
SHEET 4 OF 6**

Legend
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 _____ 100 year Floodplain



Area 2 Map 09



Area 2 Map 10

FLOOD CONTROL DISTRICT
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AREA DRAINAGE MASTER STUDY
CONTRACT NO. FCD2002C027
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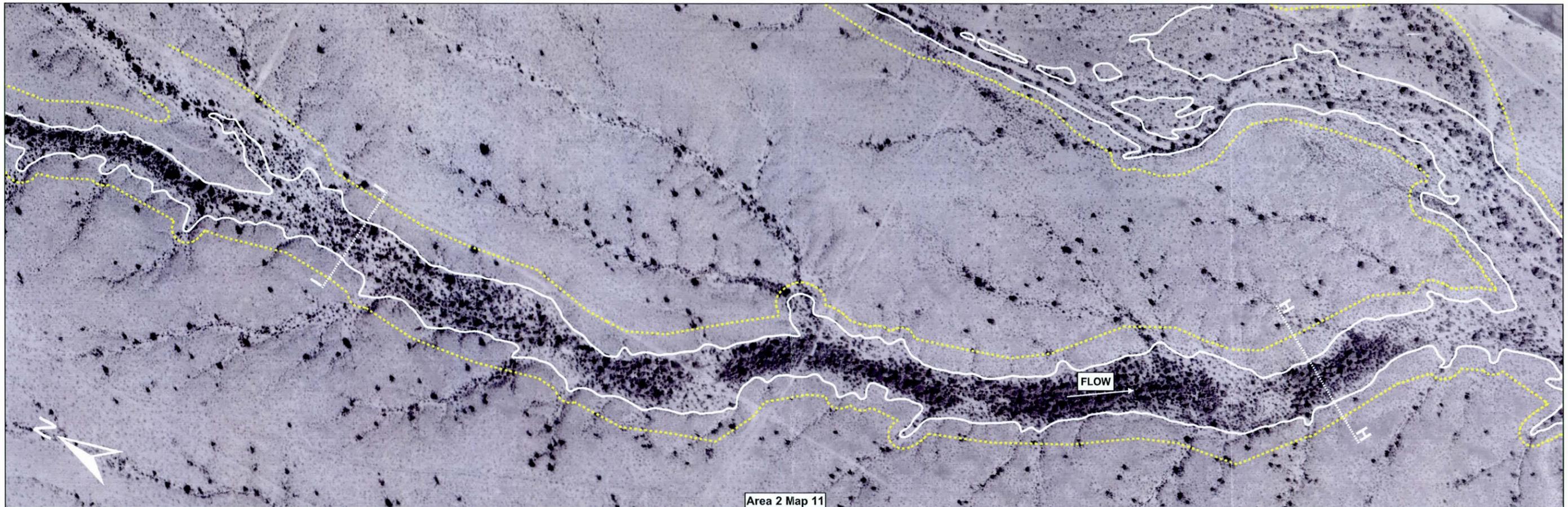
DELINEATION OF
EROSION HAZARD SETBACKS
AREA 2 - BASIN A

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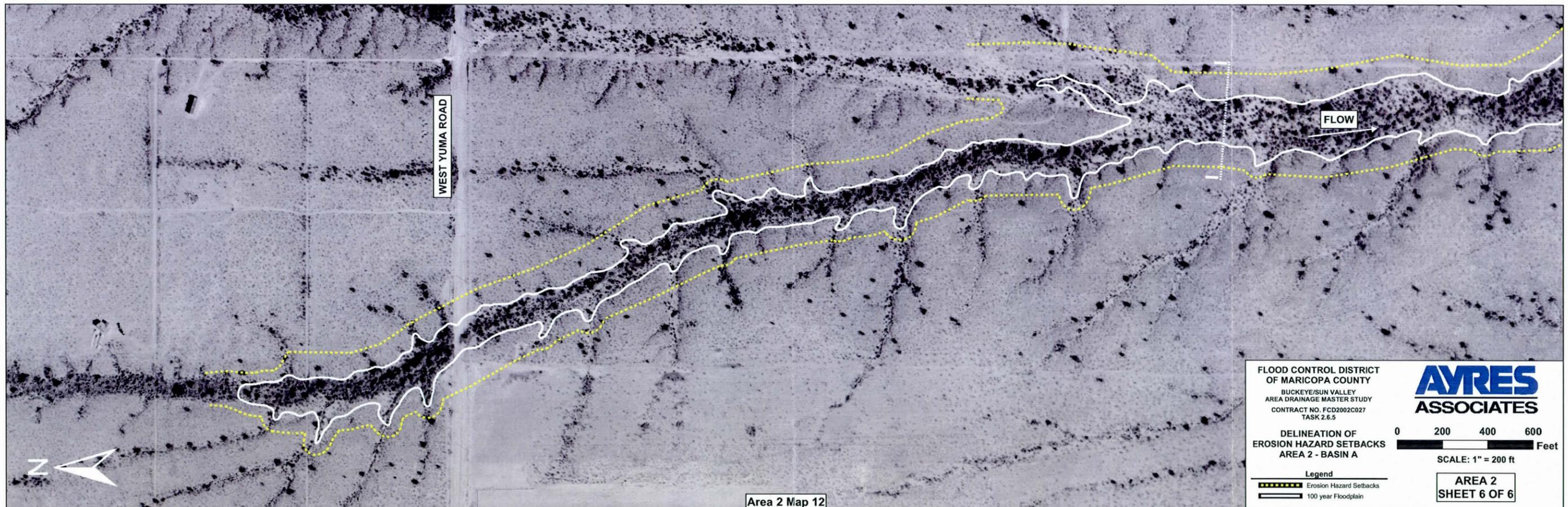
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**AREA 2
SHEET 5 OF 6**

Legend
 - - - - - Erosion Hazard Setbacks
 _____ 100 year Floodplain



Area 2 Map 11



Area 2 Map 12

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
BUCKEYE/SUN VALLEY
AREA DRAINAGE MASTER STUDY
CONTRACT NO. FCD2002C027
TASK 2.6.5

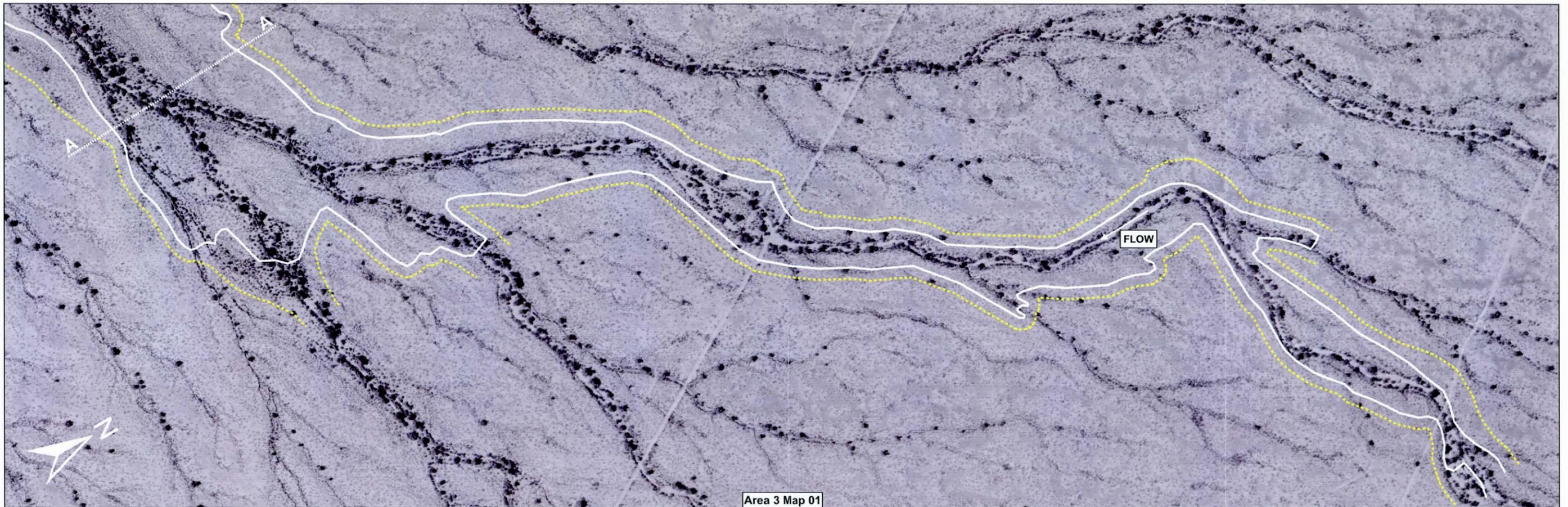
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DELINEATION OF
EROSION HAZARD SETBACKS
AREA 2 - BASIN A

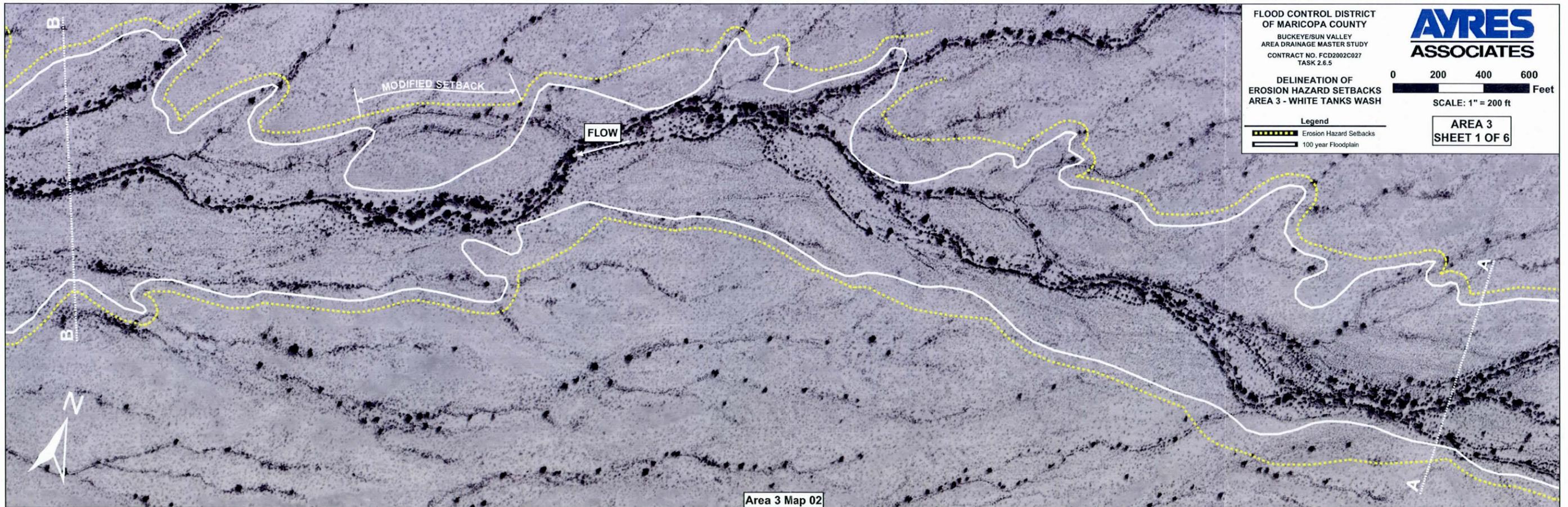
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 - - - - - Erosion Hazard Setbacks
 _____ 100 year Floodplain

**AREA 2
SHEET 6 OF 6**



Area 3 Map 01



Area 3 Map 02

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
BUCKEYE/SUN VALLEY
AREA DRAINAGE MASTER STUDY
CONTRACT NO. FCD2002C027
TASK 2.6.5

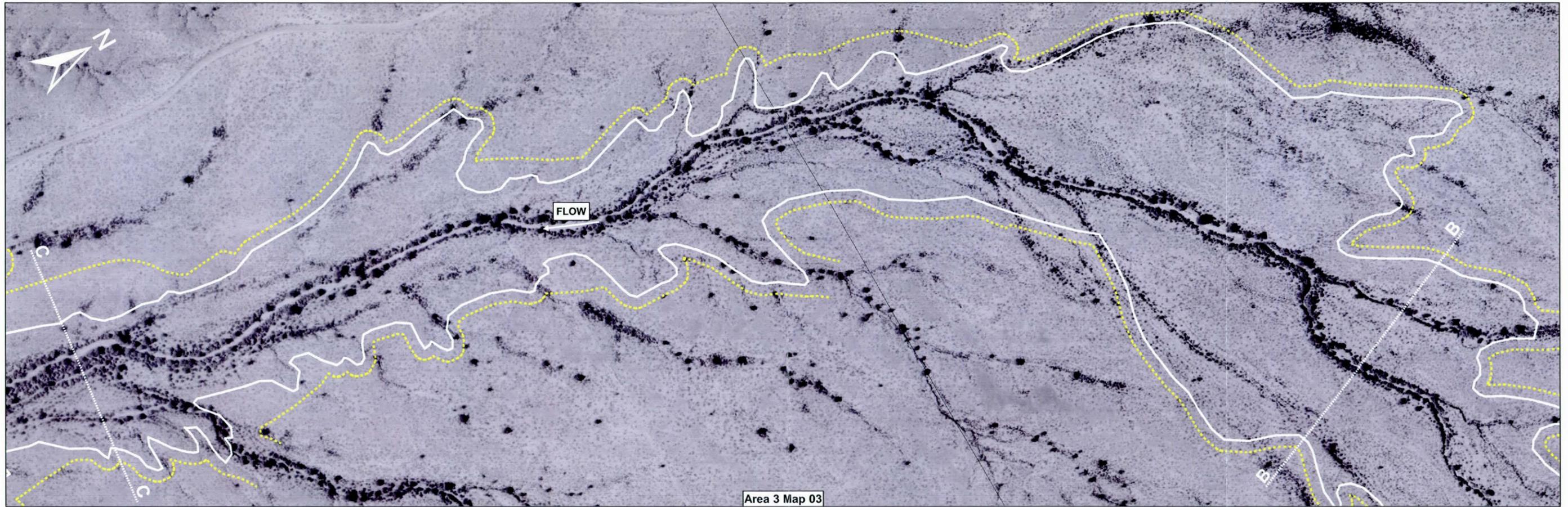
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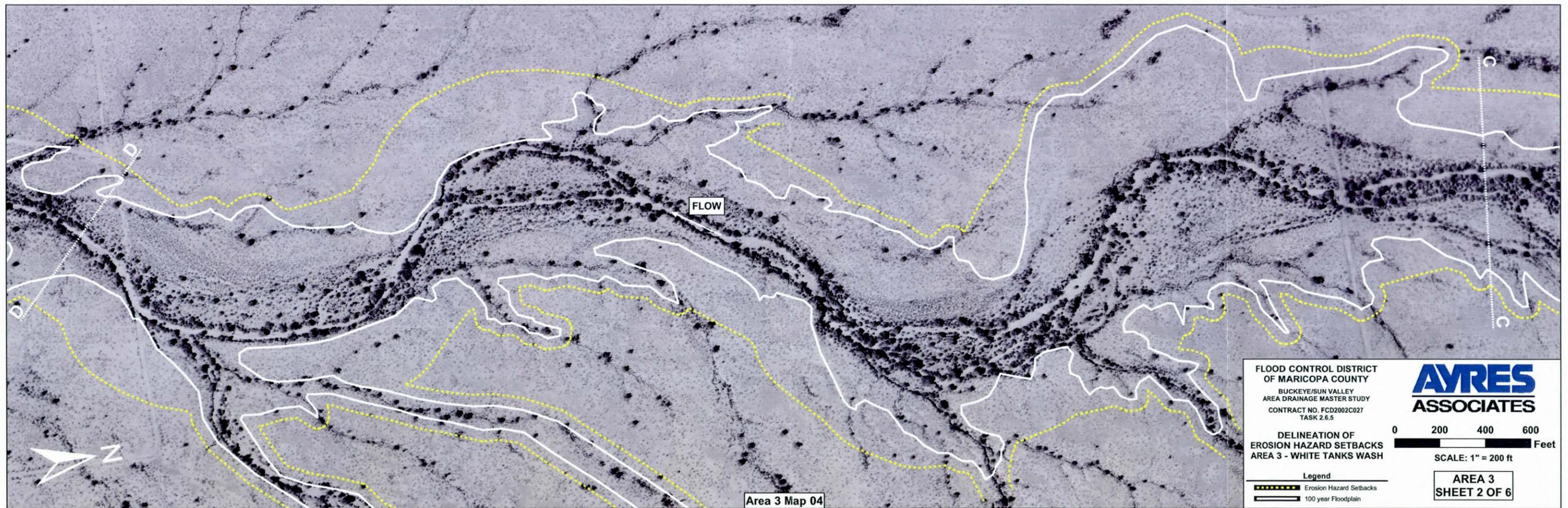
DELINEATION OF
EROSION HAZARD SETBACKS
AREA 3 - WHITE TANKS WASH

Legend
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 _____ 100 year Floodplain

AREA 3
SHEET 1 OF 6



Area 3 Map 03



Area 3 Map 04

FLOOD CONTROL DISTRICT
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CONTRACT NO. FCD2002C027
TASK 2.6.5

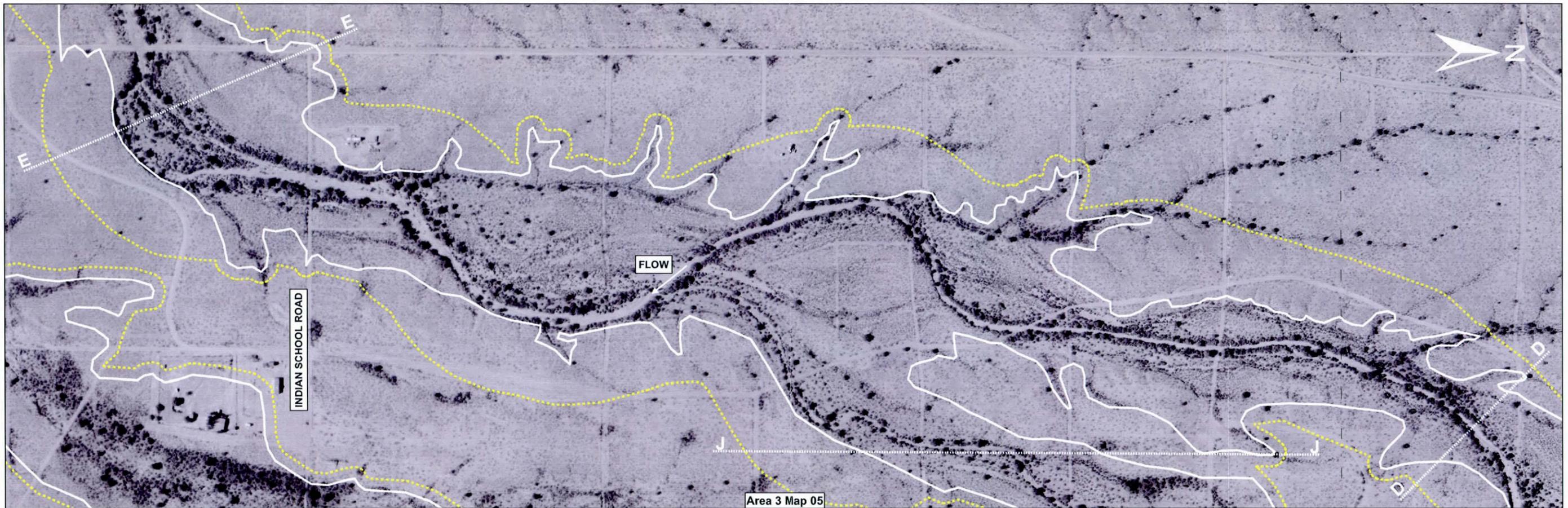
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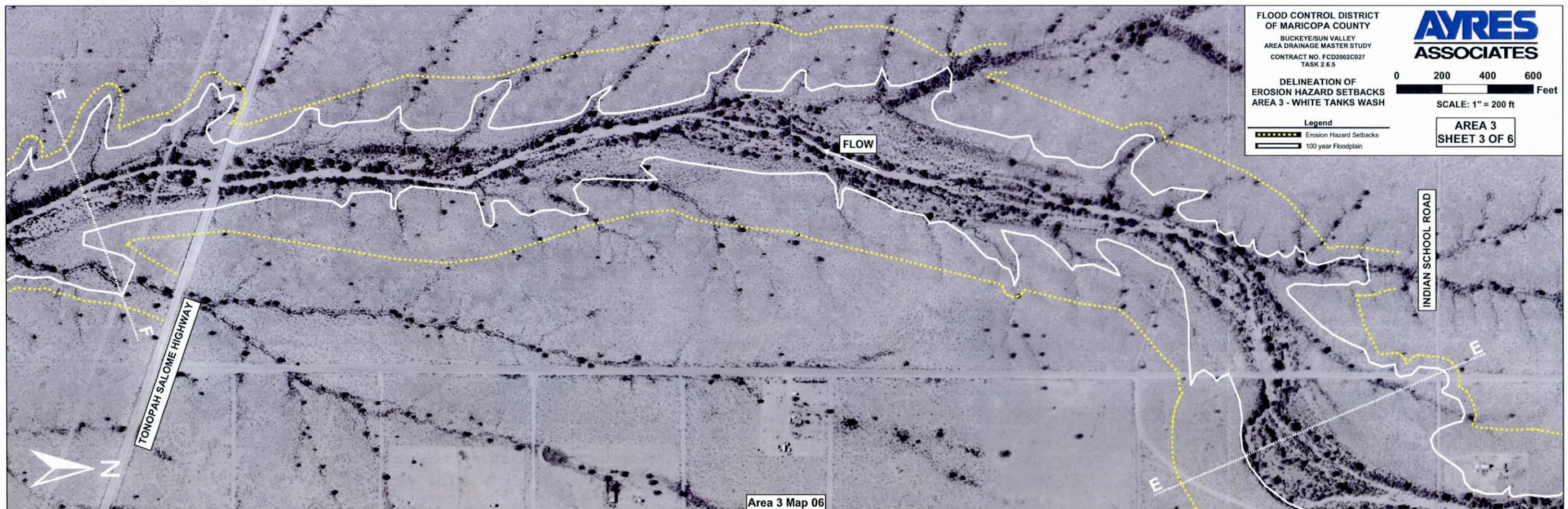
DELINEATION OF
EROSION HAZARD SETBACKS
AREA 3 - WHITE TANKS WASH

Legend
 - - - - - Erosion Hazard Setbacks
 _____ 100 year Floodplain

**AREA 3
SHEET 2 OF 6**



Area 3 Map 05



Area 3 Map 06

FLOOD CONTROL DISTRICT
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BUCKEYE/SUN VALLEY
AREA DRAINAGE MASTER STUDY
CONTRACT NO. FCD2002C027
TASK 2.6.5

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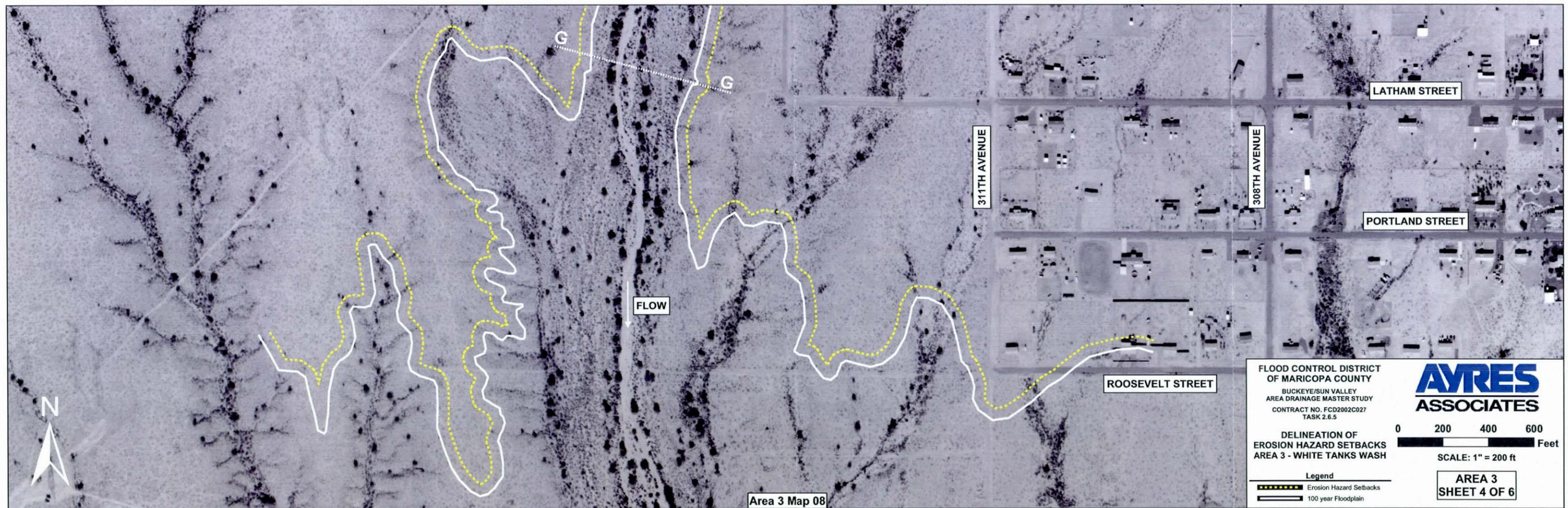
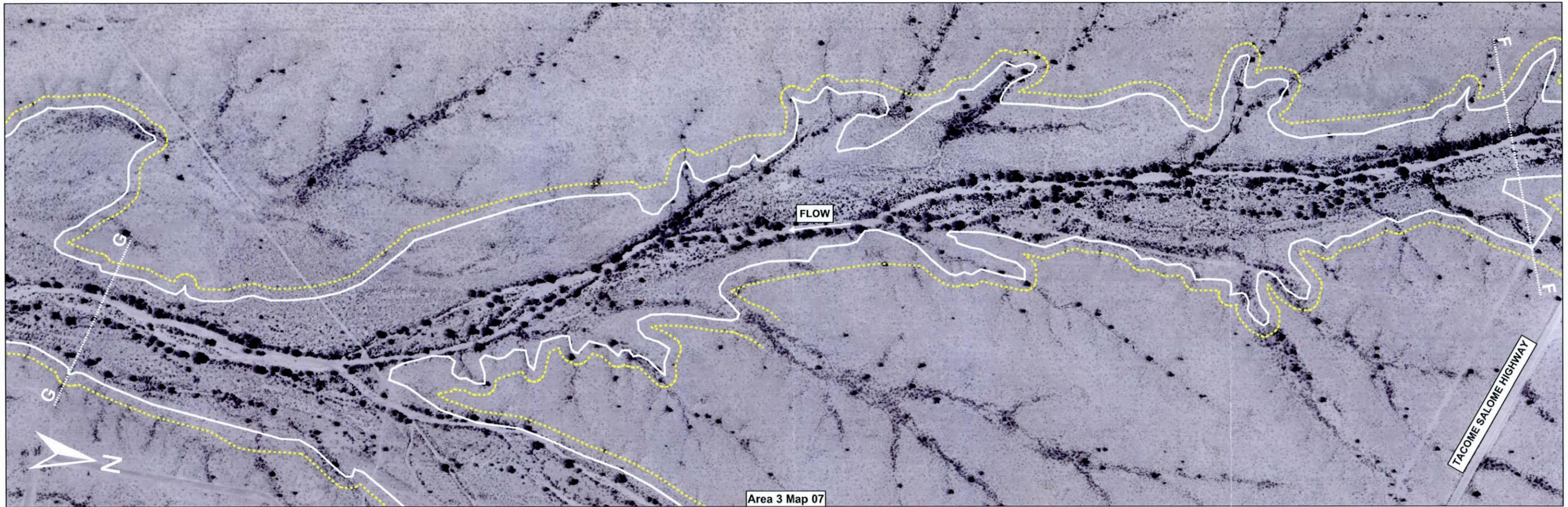
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**AREA 3
SHEET 3 OF 6**

Legend

- Erosion Hazard Setbacks
- 100 year Floodplain



FLOOD CONTROL DISTRICT
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BUCKEYE/SUN VALLEY
AREA DRAINAGE MASTER STUDY
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TASK 2.6.5

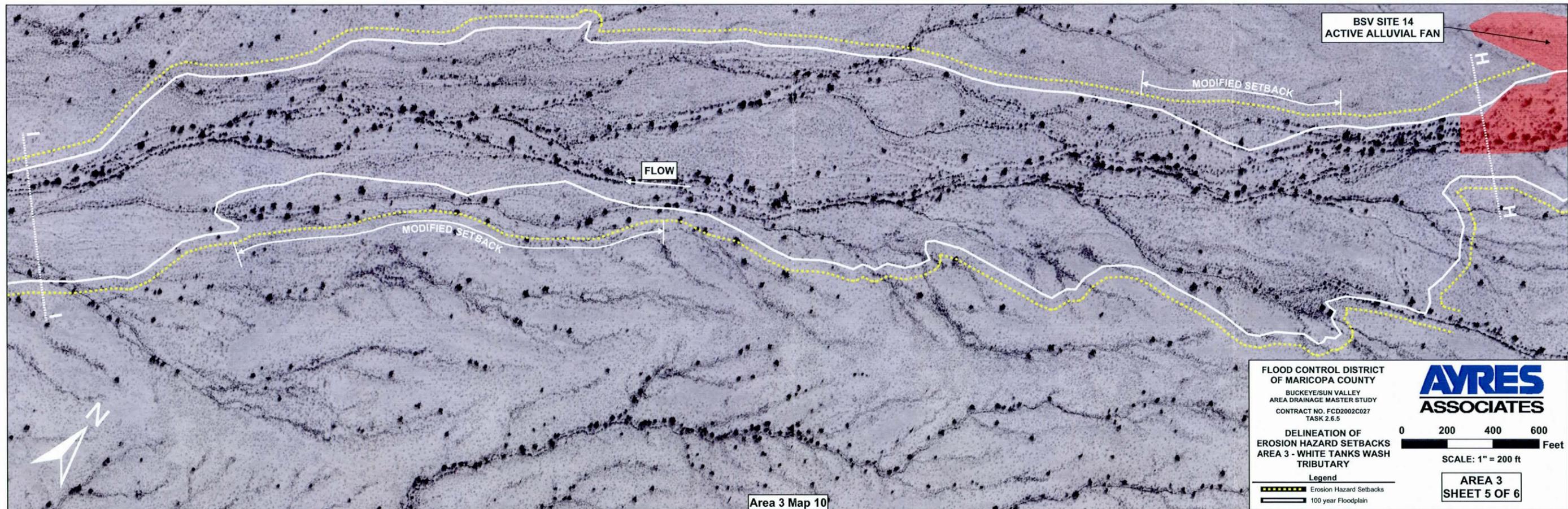
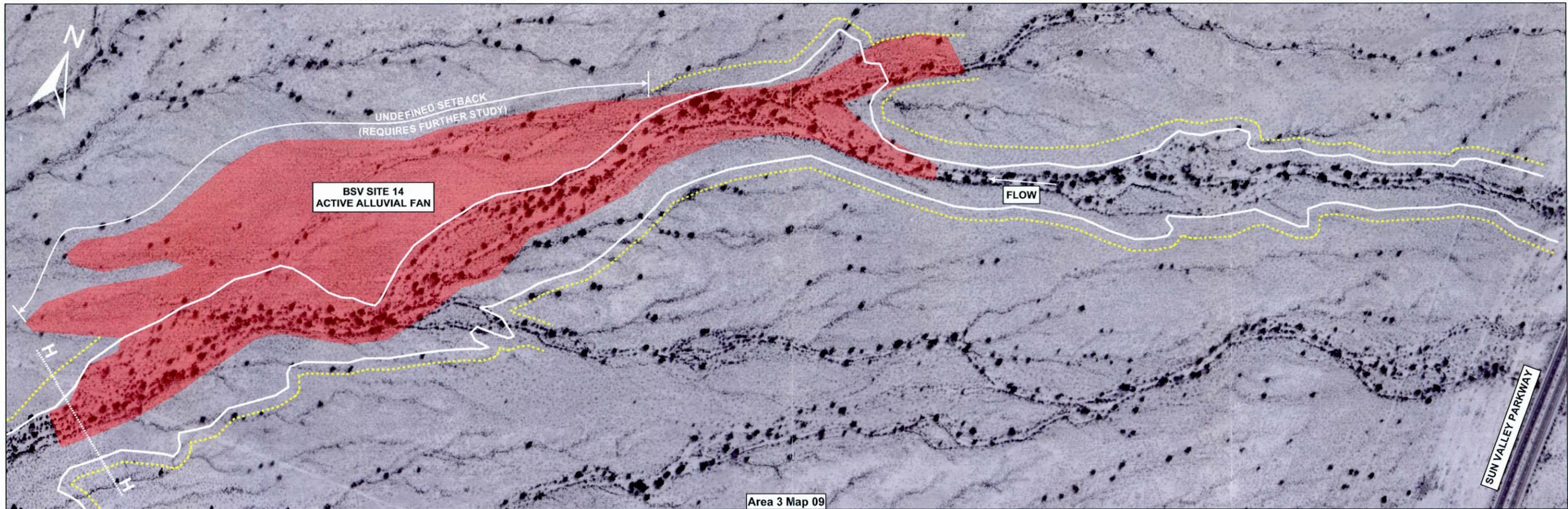
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DELINEATION OF
EROSION HAZARD SETBACKS
AREA 3 - WHITE TANKS WASH

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AREA 3 SHEET 4 OF 6

Legend
 - - - - - Erosion Hazard Setbacks
 _____ 100 year Floodplain



FLOOD CONTROL DISTRICT
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BUCKEYE/SUN VALLEY
AREA DRAINAGE MASTER STUDY
CONTRACT NO. FCD2002C027
TASK 2.6.5

DELINEATION OF
EROSION HAZARD SETBACKS
AREA 3 - WHITE TANKS WASH
TRIBUTARY

Legend

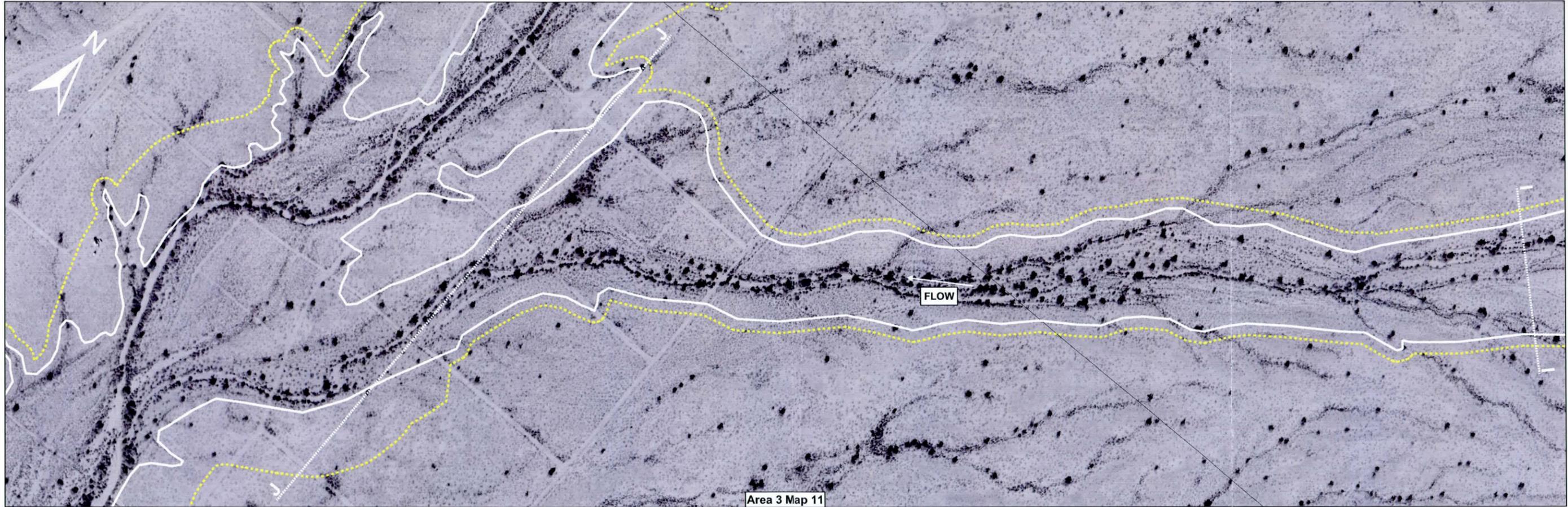
- Erosion Hazard Setbacks
- 100 year Floodplain

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AREA 3
SHEET 5 OF 6

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Area 3 Map 11

FLOOD CONTROL DISTRICT
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BUCKEYE/SUN VALLEY
AREA DRAINAGE MASTER STUDY
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TASK 2.6.5

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DELINEATION OF
EROSION HAZARD SETBACKS
AREA 3 - WHITE TANKS WASH
TRIBUTARY

0 200 400 600 Feet

SCALE: 1" = 200 ft

**AREA 3
SHEET 6 OF 6**

Legend
 - - - - - Erosion Hazard Setbacks
 _____ 100 year Floodplain