Memorandum JE Fuller/ Hydrology & Geomorphology, Inc.

DATE: June 14, 2011

TO: Elliot Silverston, P.E.; Marc McIntosh, P.E.

FROM: Mike Kellogg, R.G.

RE: Rainbow Valley ADMP Task 9.2.8

Introduction

Task 9.2 of the Rainbow Valley Area Drainage Master Plan (RVADMP) requires that a reconnaissance level geomorphic overview of the watershed study area be performed to identify the varying flood hazards. The geomorphic overview was performed by interpreting features observed on digital, orthorectified color aerial photographs, Arizona Geological Survey (AZGS) surficial mapping, and digital topography. Specifically, Task 9.2.2 includes the following:

- Development of a flow characteristics map to identify portions of the study area that are subject to alluvial fan flooding, distributary flow, sheet flooding, ponding, and riverine flooding based on a watershed geomorphic assessment. This includes a GIS map showing coverages for each flow characteristic type and a polygon showing mountain areas where the land slope exceeds 15% using a digital elevation model provided by the District. This map will be used to identify appropriate tools for hydrology and floodplain delineation.

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The deliverables for the geomorphic overview component (Task 9.2.8) includes the following:

- A brief written technical memorandum of the geomorphic landforms in the study area, with particular emphasis on areas potentially subject to alluvial fan flooding, stable distributary flow, sheet flow, and ponding. The technical memorandum shall be coordinated with the GIS coverages showing the approximate areal boundaries of the specific hazard types.

GIS Shapefiles. The following shapefiles are provided as attachments to this memorandum:

- A GIS shapefile showing the approximate boundaries of the specific landform hazard types.
- GIS data showing mountain areas where the land slope exceeds 15%, using a digital elevation model provided by the District.

Methodology

The landform-flood hazard type delineation was done using the following data sets:

- Flow Bifurcations
- Channel Pattern
- Topography
- NRCS Soils Mapping
- AZGS Surficial Geologic Mapping
- Existing Floodplain Delineations

Flow Bifurcations[1]. The distribution of bifurcation points, as shown in Figure 1, can be used to identify distributary flow areas and alluvial fans. For the RVADMP study area, most of the mapped bifurcations occur on the piedmont surfaces, with a fewer number occurring on the major rivers and tributaries.

Channel Pattern. Aerial photographs indicate the two primary channel patterns within the RVADMP study area are 1) distributary and 2) tributary. The distributary pattern is dominant within most of the piedmont slopes while the tributary pattern is dominant within and near the base of the mountains. The major river and tributary drainages are characterized by a low sinuosity channel pattern.

Topography. Available watershed topography included the District's 10-foot contour interval mapping (Figure 2), 2-foot contour interval mapping, and the USGS topographic quadrangle maps. Topographic data were used to identify areas of steep slopes (darkened areas on Figure 2 due to close contour spacing), as well as alluvial fans (radial contours) and sheet flow areas (low crenulation planar surfaces).

NRCS Soils Mapping. NRCS soils unit mapping (Figure 3) were used to identify broad areas of similar soils type. However, the NRCS soil landform descriptions correlated poorly with actual landform characteristics in the study area.

AZGS Surficial Geologic Mapping. AZGS mapping for the RVADMP study area (Figure 4) was used to identify older versus younger geomorphic surfaces, distinguish piedmont alluvium from areas underlain by shallow bedrock, identify distributary versus tributary channel patterns, and identify areas of sheet flow.

Existing Floodplain Delineations. A number of floodplain delineations were previously completed by the District (Figure 5). These floodplains were used to identify the major rivers and tributaries within the study area.

Landform Slope. A landform slope analysis was performed using the District's 10-foot contour interval digital topography. The primary purpose of this analysis was to identify slopes greater than 15%. The 10-foot topography provided sufficient resolution and was

[1] A channel bifurcation is where a stream channel divides into two or more flow paths in the downstream direction.

available for the entire study area. The 2-foot topography was not available for the entire study area, thus was not included. Figure 6 shows the result of the analysis.

Landform Delineation

The data sets and information described above were used to define the following types of landforms in the RVADMP study area:

- Mountain Slope Areas (> 15% slope)
- Piedmont Areas with Tributary Drainage Systems
- Piedmont Areas with Distributary Drainage Systems
- Alluvial Fans
- Sheet Flow/Unconfined Flow Areas
- Major Riverine Floodplains
- Disturbed Areas
- Ponding Areas

The landform map for the RVADMP study area is shown in Figure 7.

Mountain Slope Areas. The Mountain Slope Area landform consists of steep mountainous terrain underlain by shallow or exposed bedrock. Mountain slope areas were identified from the aerial photographs, topographic maps and AZGS geologic maps. The Mountain Slope Area landform unit was observed primarily within the northeast and southwest quarters with other, smaller mountain areas distributed throughout (Figure 7). The channels in the Mountain Slope Area landform consist of well-defined, low sinuosity tributary streams located in bedrock or mountain canyons.

Piedmont[1] Areas with Tributary Drainage Systems. This landform unit consists of mildly sloping alluvial surfaces with dendritic tributary drainage networks. Piedmont areas with tributary systems were identified from aerial photographs, the bifurcation delineations, topographic maps, NRCS soils maps, and AZGS geologic maps. The Piedmont Area with Tributary Drainage System landform occurs as a buffer between the Mountain Slope Landform and the low-sloping piedmont or alluvial plain. The watercourses in the Piedmont Areas with Tributary Drainage Systems landform consist of moderately steep, well-defined channels with narrow floodplains.

Piedmont Areas with Distributary Drainage Systems. This landform unit consists of mild-to-low sloping alluvial surfaces with distributary[2] drainage networks. Piedmont areas with distributary systems were identified from aerial photographs, the bifurcation delineation, topographic maps, NRCS soils maps, and AZGS geologic maps. The Piedmont Area with Distributary Drainage System landform was the dominant landform within the study area. Both stable and unstable distributary drainage patterns were observed. In general, the

[1] The piedmont is a sloping landform located at the base of a mountain and is usually composed of or mantled by unconsolidated alluvium.

[2] Distributary flow areas have channels that branch and split in the downstream direction.

western piedmont sloping off of the Maricopa Mountains was identified as a stable distributary system. The stable distributary network is being actively created through the process of stream capture rather than the avulsion dominated processes on active distributary systems. The distributary portion of the Sierra Estrella Mountain piedmont is an active, unstable distributary system.

Alluvial Fans. Alluvial fans are characterized by specific landform characteristics relating to their composition, morphology, and location. Alluvial fans are composed of eroded rock material transported and deposited from the upstream watershed. Alluvial fans have the shape of a fan, either partially or fully extended, with a radial pattern of topographic contours. Alluvial fans are located near a topographic break, which may be expressed either laterally or vertically. Alluvial fan areas were identified from aerial photographs, the bifurcation delineations, topographic maps, and AZGS geologic maps. The reconnaissance level landform identification process used roughly corresponds to the Level 1 procedure outlined in the District's Piedmont Flood Hazard Assessment Manual. The Alluvial Fan landform occurs within the Piedmont Area landform. Potential alluvial fans were identified throughout the study area; however 25 fans were selected for detailed analysis in the RVADMP study. The 25 fans are identified in Figure 7 by a red star located at the fan apex.

Sheet Flow/Unconfined Flow Areas. Sheet and unconfined flow occurs where there is no well-developed or defined drainage network to convey the majority of floodwater. The term "sheet flow" refers to any form of unconfined runoff that occurs over a broad, expansive area. This broad definition of sheet flow incorporates several more narrowly defined flow types, including natural (classic) sheet flow, urban sheet flow, agricultural sheet flow, overland flow, perched flow, anastomosing flow, and distributary flow. Although sheet flow is the dominant process on high, geologically old swales, these individual landforms were not specifically identified as sheet flow due to their scale. Large sheet flow areas were identified within the study area and are shown on Figure 7.

Major Riverine Floodplains. A floodplain is a planar surface adjacent to a watercourse that is periodically inundated by flood water. Floodplains consist of relatively fine-grained, unconsolidated alluvium recently deposited by the watercourse. Floodplains were identified from aerial photographs, the bifurcation delineations, topographic mapping, AZGS mapping, and maps of existing and pending FEMA floodplain delineations. Of the watercourses in the RVADMP, only Waterman Wash and it major tributaries were large enough to be mapped as a distinct landform at the mapping scale used.

Ponding. Areas of ponding were identified throughout the study area, primarily as stockponds. Although minor ponding likely occurs on the upstream side of roadway, railroad, and other levee-like structures, they were not individually identified at the scale of mapping for this study.

Flood Diversion/Detention Structures. Several large flood diversion/detention structures were identified in the southeast portion of the study area.

Landscape Characteristics

The District has identified and delineated landscape characteristic zones within the RVADMP study area. A comparison of the flow characteristics developed for this study with the District's landscape characteristics provides valuable information to planners. Figure 8 shows the flow and landscape characteristics plotted together. The figure shows a strong correlation between the units. Table 1 lists the landscape characteristics and the approximate corresponding flow characteristics.

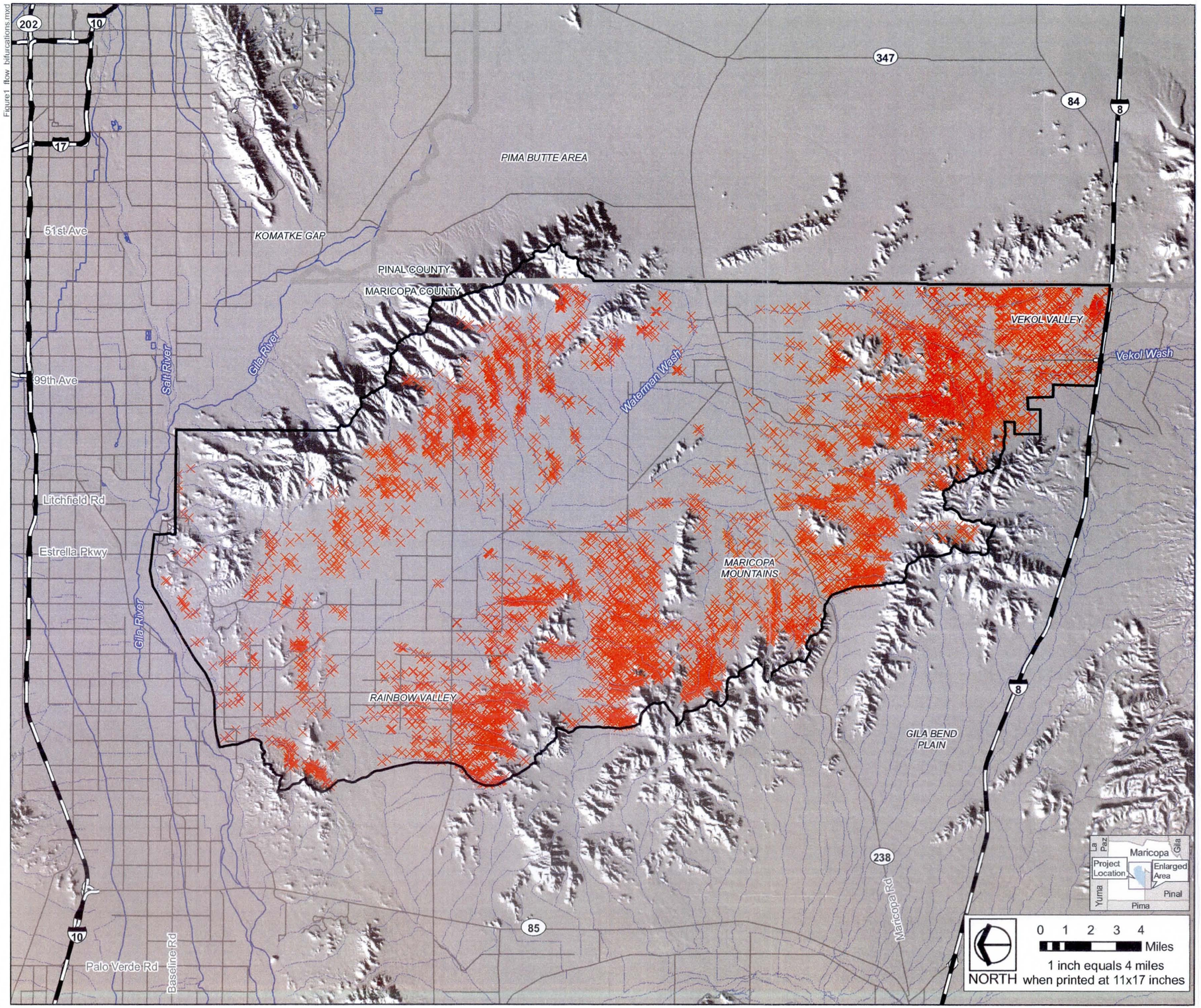
Table 1. Landscape and Flow Characteristics Comparison

Landscape Characteristic	Flow Characteristic
River Channel	Major River and Tributary Flooding
River Terrace	Major River and Tributary Flooding
Valley Wash	Major River and Tributary Flooding
Valley Plain	Sheet Flooding
Arroyo	Major River and Tributary Flooding
Foothills	Tributary Flooding
Lower Bajada	Distributary Flooding
Upper Bajada	Tributary Flooding
Mountains	Mountains

Figure1 flow bifurcations.mxd

Rainbow Valley Area Drainage Master Plan Flow Bifurcations

Figure 1



Project Features

- Flow Bifurcations

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

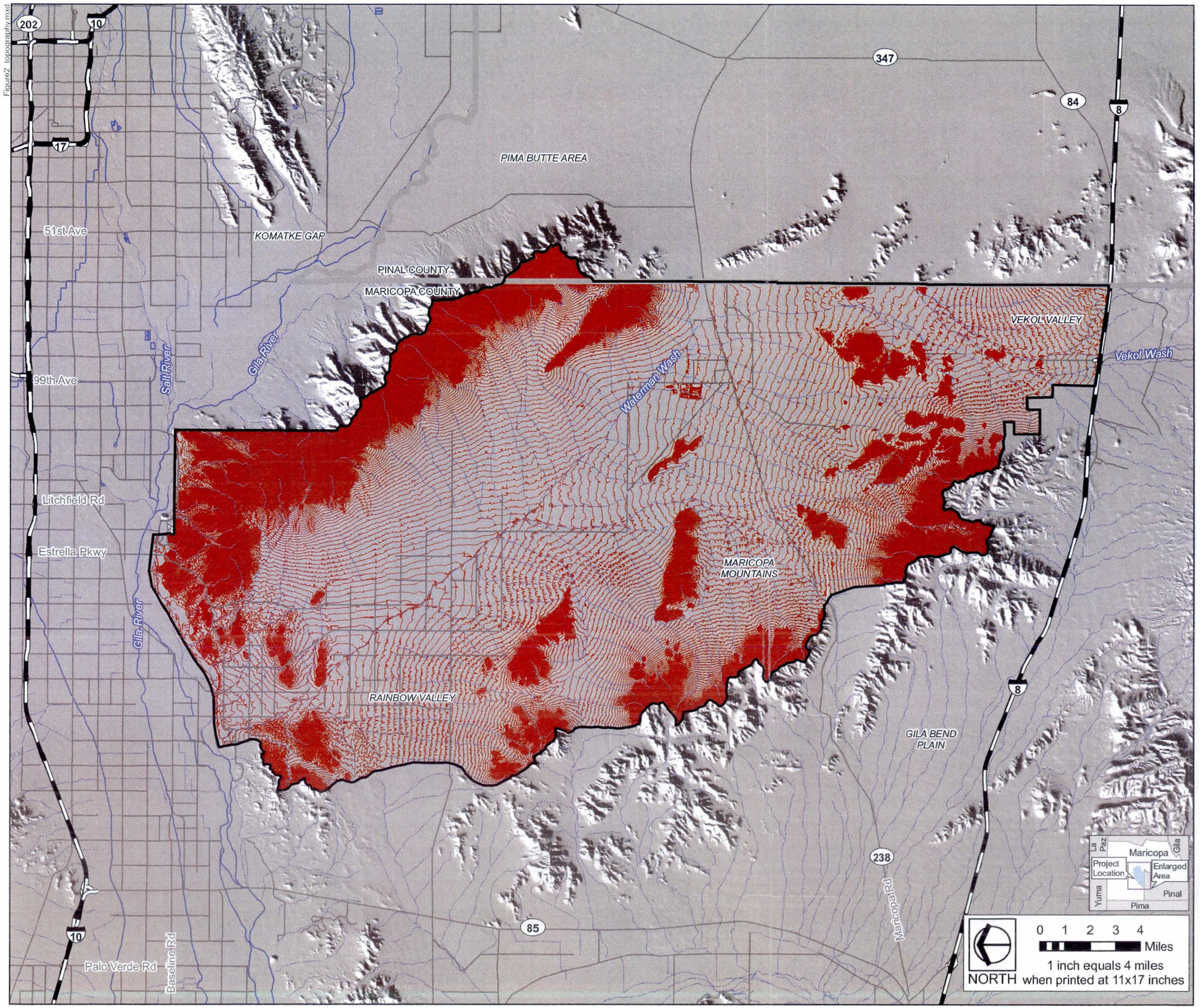
Data Sources

JE Fuller/Hydrology & Geomorphology flow bifurcation data (2008).

Figure2_topography.mxd

Rainbow Valley Area Drainage Master Plan Topography

Figure 2



Project Features

- Elevation Contours (contour interval 10-feet)

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

Data Sources

Flood Control District of Maricopa County:
County- Wide 10-foot contour interval digital topography (December 2000).

Figure3_soils.mxd

Rainbow Valley
Area Drainage Master Plan
National Resource Conservation Service Soils

Figure 3

PIMA BUTTE AREA

KOMATKE GAP

PINAL COUNTY

MARICOPA COUNTY

VEKOL VALLEY

MARICOPA MOUNTAINS

RAINBOW VALLEY

GILA BEND PLAIN

51st Ave

99th Ave

Litchfield Rd

Estrella Pkwy

Palo Verde Rd

Baseline Rd

Salt River

Gila River

Waterman Wash

Vekol Wash

Maricopa Rd

202 10 17 347 84 8 238 85

0 1 2 3 4 Miles

1 inch equals 4 miles when printed at 11x17 inches

NORTH

Project Features

Note: Unit descriptions are available from District GIS information and are not repeated here as there are over hundred individual units represented. The objective of this illustration is to highlight the location of large areas of uniform soil types.

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

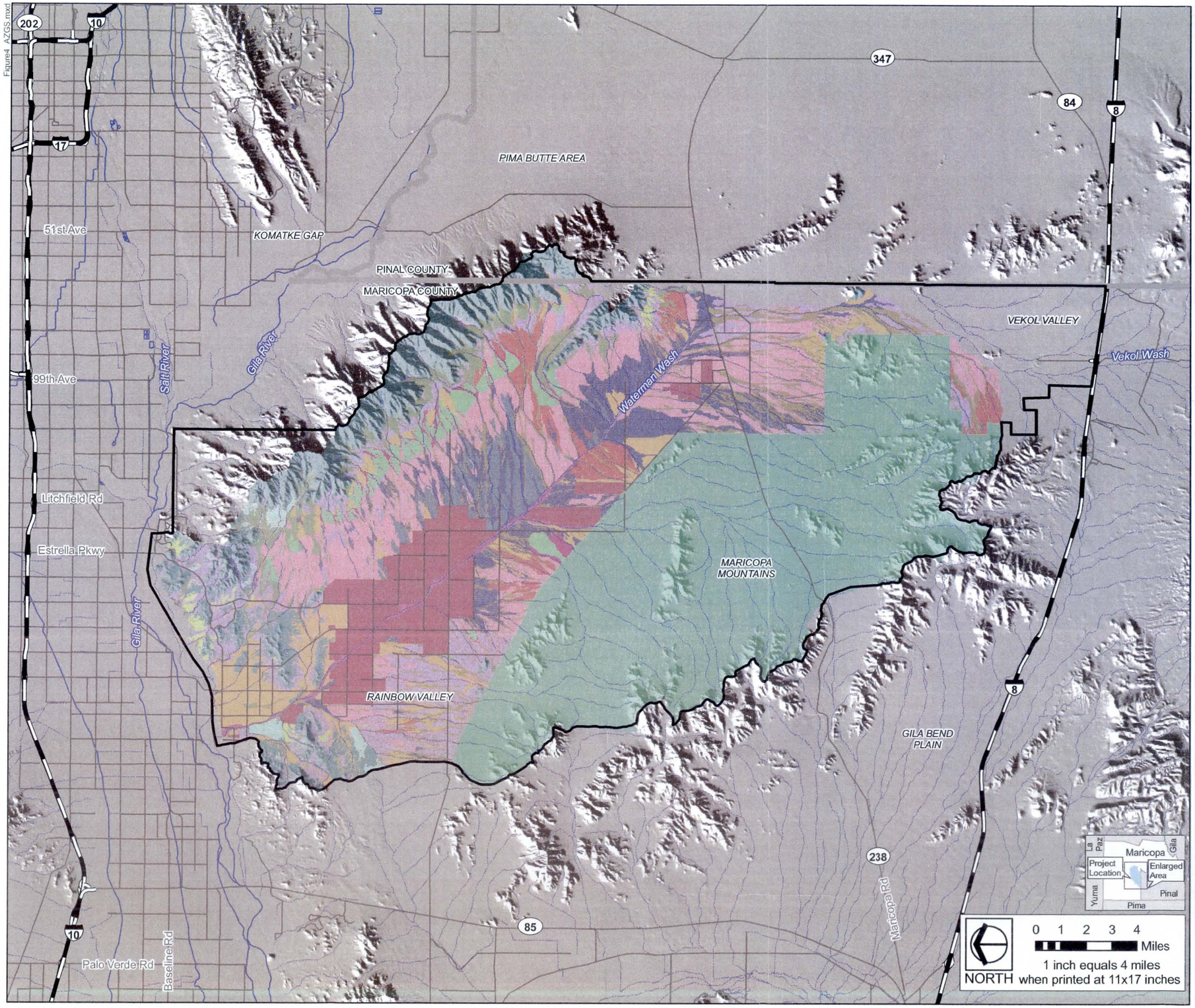
Data Sources

National Resource Conservation Service Digital Soils Mapping Sources:
1. Gila Bend-Ajo Area, Arizona, Parts of Maricopa and Pima Counties (NRCS Area Symbol AZ653)
2. Gila River Indian Reservation, Parts of Maricopa and Pinal Counties, Arizona (NRCS Area Symbol AZ 658)
3. Maricopa County, Arizona, Central Part (NRCS Area Symbol AZ651)

Figure4_AZGS.mxd

Rainbow Valley
Area Drainage Master Plan
Arizona Geological Survey Geologic Mapping

Figure 4



Project Features

- Active alluvial fans
- Active channels, bars and low terraces
- Active swales and sheetflood areas
- Agricultural Land
- Bedrock, undivided
- Channels of large tributary washes
- Colluvium and talus
- Early Pleistocene alluvium
- Existing channels and drainageway associated with active alluvial fans
- Holocene alluvium, undivided
- Holocene and Pleistocene alluvium on piedmont slopes
- Inactive Holocene alluvial fans and terraces
- Late Pleistocene alluvium
- Middle Pleistocene alluvium
- Mixed Holocene alluvial and eolian deposits on lower piedmont slopes
- Modern river channels
- Modern river terraces and bars
- Pleistocene and Holocene oninactive alluvial fans and piedmont slopes
- River terraces
- Sonoran National Monument
- Tertiary sediment, undivided
- Ditches
- Tanks

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

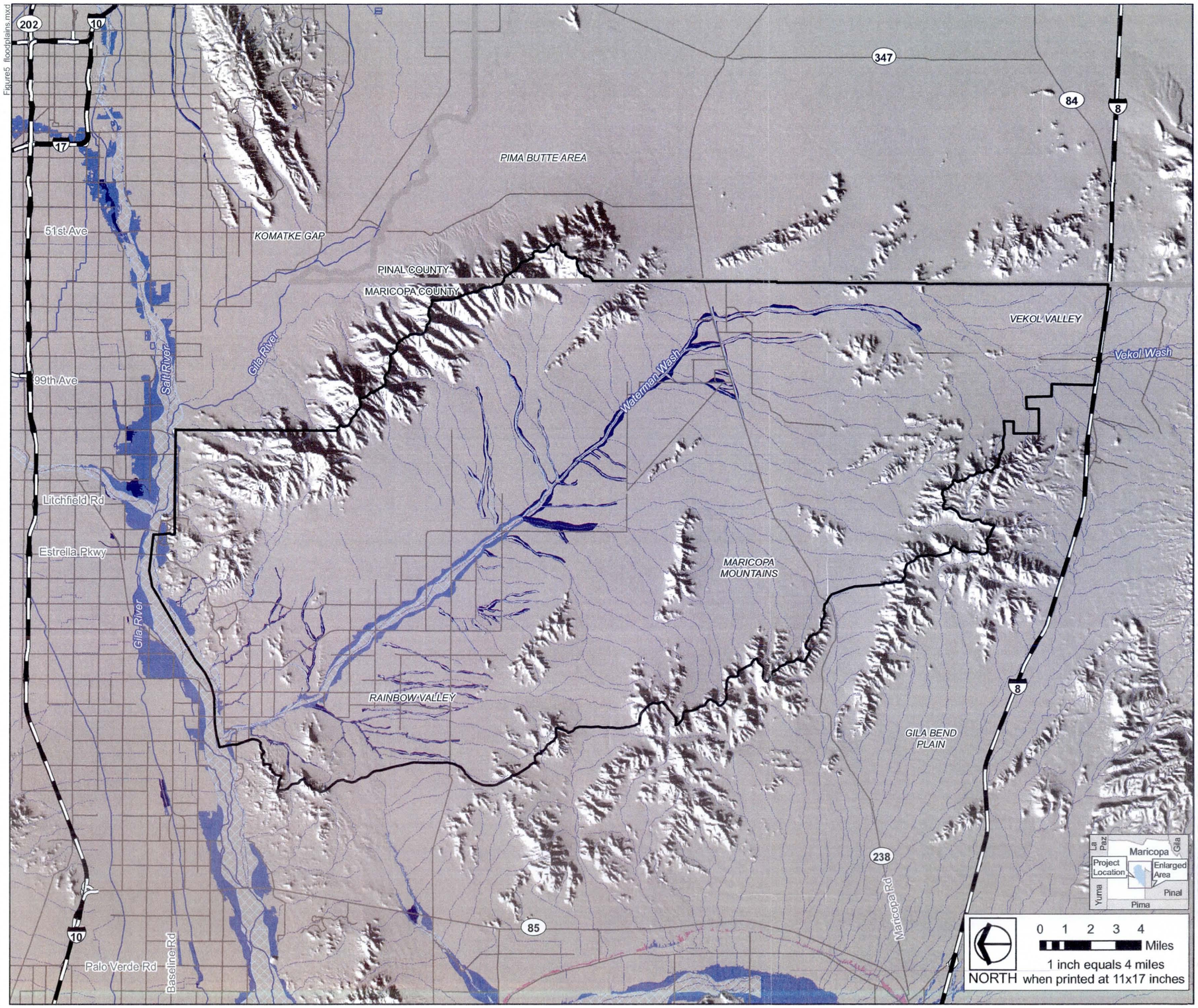
Data Sources

Arizona Geological Survey Digital Geologic Maps:
1. Geologic Map for the Buckeye 7.5' Quadrangle, Maricopa County, Arizona (AZGS DGM-15).
2. Geologic Map for the Avondale SW 7.5' Quadrangle, Maricopa County, Arizona (AZGS DGM-16).

Figure5_floodplains.mxd

Rainbow Valley Area Drainage Master Plan Mapped Floodplains

Figure 5



Project Features

Flood Zones

- Floodway
- Administrative Floodway
- 100-year flood with base flood elevations
- 100-year flood with no base flood elevations
- 100-year shallow flooding (depths >1<3 feet)

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

Data Sources

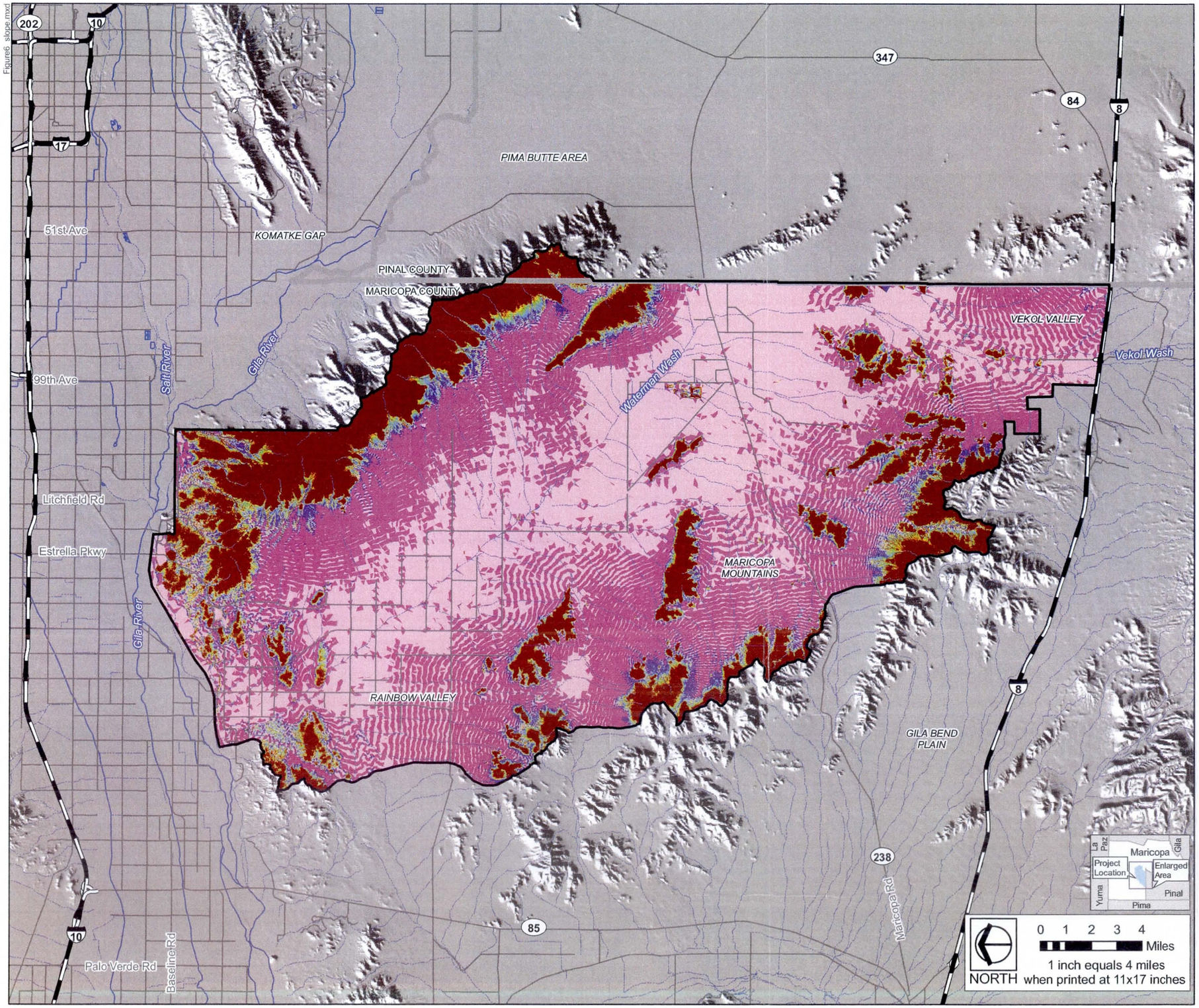
Flood Control District of Maricopa County Digital Floodplain Dataset:

1. Salt/Gila River Master Plan (1991)
2. Waterman Wash FDS (1989) (2005)

Figure6_slope.mxd

Rainbow Valley
Area Drainage Master Plan
Slope Analysis

Figure 6



Project Features

- 0 % slope
- 1 - 2 % slope
- 3 - 4 % slope
- 5 - 6 % slope
- 7 - 8 % slope
- 9 - 10 % slope
- 11 - 12 % slope
- 13 - 15 % slope
- >15 % slope

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

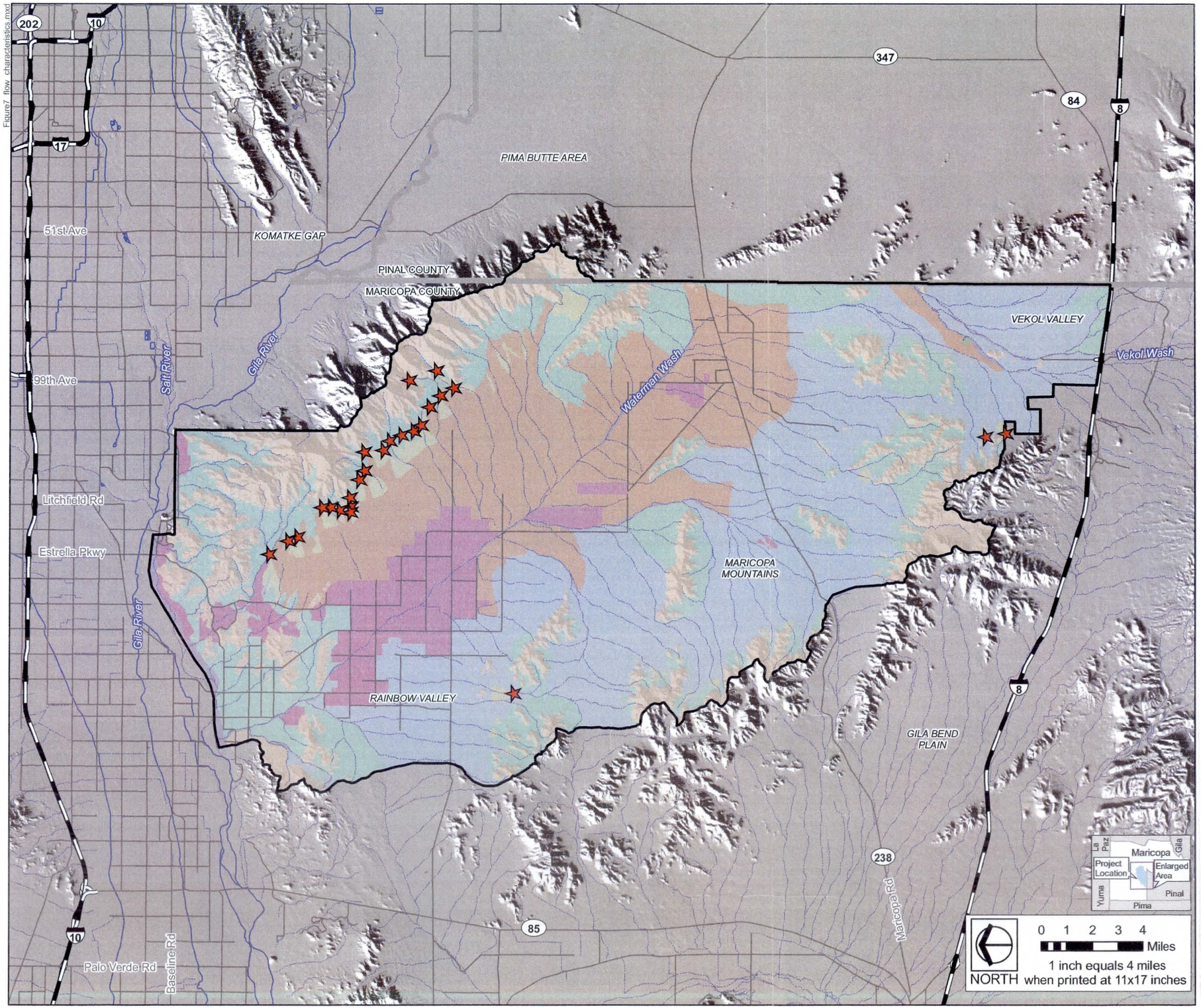
Data Sources

Flood Control District of Maricopa County:
County- Wide 10-foot contour interval digital topography (December 2000).

Figure7_flow_characteristics.mxd

Rainbow Valley Area Drainage Master Plan Flow Characteristics

Figure 7



Project Features

- Alluvial fans selected for floodplain delineation

Flow Characteristics

- Alluvial Fan Flooding
- Disturbed Area
- Flood Retarding Structure
- Major River and Tributary Flooding
- Mountains
- Piedmont Distributary Flooding
- Piedmont Tributary Flooding
- Sheet Flooding
- Stockpond

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

Data Sources

JE Fuller/Hydrology & Geomorphology alluvial fan identification and flow characteristics assessment (2008).

Figure8_flow-landscape_comparison.mxd

Rainbow Valley
Area Drainage Master Plan
Landscape and Flow Characteristics Comparison

Figure 8

PIMA BUTTE AREA
KOMATKE GAP
PINAL COUNTY
MARICOPA COUNTY
RAINBOW VALLEY
VEKOL VALLEY
MARICOPA MOUNTAINS
GILA BEND PLAIN
Gila River
Salt River
Waterman Wash
Vekol Wash
51st Ave
99th Ave
Litchfield Rd
Estrella Pkwy
Palo Verde Rd
Baseline Rd
Maricopa Rd
202
10
17
347
84
8
85
238

Project Features

- District Landscape Characteristic Zones

Flow Characteristics

- Alluvial Fan Flooding
- Disturbed Area
- Flood Retarding Structure
- Major River and Tributary Flooding
- Mountains
- Piedmont Distributary Flooding
- Piedmont Tributary Flooding
- Sheet Flooding
- Stockpond

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Interstate Highways/ Freeways
- State Highways
- Perennial Streams
- Intermittent Streams

NORTH

0 1 2 3 4 Miles

1 inch equals 4 miles when printed at 11x17 inches

Data Sources

Flood Control District of Maricopa County Landscape Inventory & Analysis (LIA) (2008).

JE Fuller/Hydrology & Geomorphology flow characteristics assessment (2008).