MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

Prepared for

FLOOD CONTROL DISTRICT of MARICOPA COUNTY 1959

GLENDALE AZ

CITY OF PEORIA

Revised May 2000
FCD Contract 97-04
Stantec Consulting Project Number 28900058

Prepared by

Stantec

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

PREPARED FOR:

FLOOD CONTROL DISTRICT
of
Maricopa County

Registered Professional Engineer (Civil)
CERTIFICATE NO
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June 1999
Revised: May 2000

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FLOOD CONTROL DISTRICT of MARICOPA COUNTY 1959

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Foreward

The Middle New River Watercourse Master Plan report and conceptual engineering plans and its companion document, the Middle New River Watercourse Master Plan Technical Documentation Notebook, were submitted for final review to the Flood Control District of Maricopa County, the City of Glendale and the City of Peoria in early June 1999 by Stantec Consulting Inc. (Stantec). Several delays were necessary to resolve issues raised during the review of the final documents in June 1999 and subsequent items.

- The study identified potential flooding from New River into the Bell Park subdivision. The risk was identified as the potential for static water in New River during a 100-year flood event to enter the street system via the subdivision's interior drainage outlet channels that discharge to New River. In June 1999, Stantec was requested to delay completion of the Master Plan by the City of Peoria until additional detailed studies by Stantec and the subdivision's design engineer could be completed. Two separate reports entitled, "Bell Park Subdivision Flood Analysis Review" by Stantec, and the "Bell Park Subdivision Flood Analysis" by DEI, Inc., present the results.

- In September 1999, the Flood Control District of Maricopa County, the City of Glendale and the City of Peoria were advised by the Phoenix office of the U.S. Army Corps of Engineers - Los Angeles District, that an individual Section 404 permit was required for the entire 8.5 mile long Watercourse Master Plan. This was a unique request that had never before been required for a master plan of this type in Arizona. Stantec commenced with the preparation of the Section 404 permit application and supporting work in October 1999.

- In April 2000, Stantec was advised that because of some of the unique non-structural flood protection measures that affected only the City of Peoria, approval was required by the Peoria City Council for submittal of the Section 404 permit application. Since non-structural flood protection was not called for in the City of Glendale, city representatives determined that it was not necessary to gain approval from the Glendale City Council for submittal of the Section 404 permit application. The Middle New River Watercourse Master Plan and a request for authorization to submit the Section 404 permit application for it was made to the Peoria City Council on 16 May 2000. The request was approved unanimously by the Peoria City Council. The Section 404 permit application was delivered to the Phoenix office of the U.S. Army Corps of Engineers - Los Angeles District on 25 May 2000.

EXECUTIVE SUMMARY

The Flood Control District of Maricopa County (District), the City of Peoria (Peoria), and the City of Glendale (Glendale), have prepared the Middle New River Watercourse Master Plan. Pursuant to Arizona Revised Statutes 48-3609.01, the District is authorized to conduct watercourse master plans for river reaches within Maricopa County. The study reach is located along New River extends approximately 8.5 miles from Skunk Creek north to the New River Dam. This portion of New River is currently under development pressure. The Middle New River Watercourse Master Plan provides both the Cities of Glendale and Peoria with a comprehensive approach to river management. The Watercourse Master Plan also honors commitments to the U. S. Corps of Engineers to maintain a floodwater conveyance corridor downstream of New River Dam.

The Middle New River Watercourse Master Plan was developed over a period of approximately 18 months. A Steering Committee, consisting of staff from the District, the City of Glendale and the City of Peoria, met monthly to review and direct the Watercourse Master Plan efforts. The public also played an important role in the development of the Watercourse Master Plan. A total of nine public meetings were held to inform the public and gain input on the alternatives being evaluated. Newsletters were also used to keep the public informed. A telephone Hot Line and e-mail was provided to receive public input.

The Middle New River Watercourse Master Plan Preferred Alternative consists of the following:

- From above the New River confluence with Skunk Creek to Pinnacle Peak Road (approximately 5.5 miles) – Proposed new channel bank improvements will consist of rock filled wire baskets for bank armoring. The channel bottom will be graded as required and will remain natural. Three new grade control structures are proposed at 83rd Avenue, Deer Valley Road and Pinnacle Peak Road to maintain the expected long term slope of the channel bottom. The plan utilizes most of the existing bank armoring.

- From Pinnacle Peak Road to below the New River Dam (approximately 3.0 miles) – This portion of the Watercourse Mater Plan proposes to use a non-structural approach by utilizing the existing natural channel to convey floodwaters. An erosion setback buffer zone has been delineated along the 100-year floodplain of New River to identify the potential lateral (or sideways) movement of the channel by erosional forces. New structures can not be built in this buffer zone. Existing structural bank armoring is present on the east bank of New River at the Terramar Subdivision.

- The Middle New River Watercourse Master Plan report presents the preferred plan. Conceptual engineering construction plans are included to convey the intent of the Watercourse Master Plan and to direct future development along New River. These conceptual plans are not for construction purposes and some adjustment to the Watercourse Master Plan's proposed improvements can be expected during final engineering design.


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List of Figures

List of Figures

List of Figures

List of Tables

List of Tables

List of Tables

1.0 INTRODUCTION

PURPOSE OF REPORT

The Flood Control District of Maricopa County (District), the City of Peoria (Peoria), and the City of Glendale (Glendale), jointly concluded that the Middle New River Watercourse Master Plan study should be conducted for New River. The study reach is located along New River from Skunk Creek north to the New River Dam. Presently, this reach is under development pressure. Several residential development projects, which include construction within the floodplain and/or channelization of the New River, have been proposed for completion within the next few years. This Watercourse Master Plan will provide both the Cities of Glendale and Peoria with a comprehensive approach to river management. The District also desires to honor commitments to the U. S. Corps of Engineers to maintain a floodwater conveyance corridor downstream of New River Dam.

This report, the Middle New River Watercourse Master Plan, presents the preferred plan and documents hydrology and hydraulic data, assumptions, procedures and criteria used in conducting the study. Conceptual engineering construction plans are included to convey the intent of the Watercourse Master Plan and to direct future development along New River. These conceptual plans are not for construction purposes. Preparation of final construction plans and specifications are necessary and will require the engineer to conduct further in-depth design and analyses that is project specific. Some adjustment to the Watercourse Master Plan's proposed improvements can be expected.

A separate report entitled, " Middle New River Watercourse Master Plan - Technical Documentation Notebook", provides detailed results of all analyses conducted during the development of the Master Plan.

Analyses conducted in the preparation of the Watercourse Master Plan evaluate strategies for incorporating undeveloped portions of the river with existing development. The Plan Master will provide a uniform and coordinated approach to floodplain management. This multi-faceted approach will best ensure that present and future residents are protected from the damaging effects of flooding.

As part of the scope of work for the Watercourse Master Plan, topographic field surveys, archeological and historic property surveys, biological documentation surveys and hazardous waste surveys are conducted. Results of the surveys are presented in the following separate reports:

1. Middle New River Watercourse Master Plan Study - Hazmat Database Review.

2. Middle New River Watercourse Master Plan Study - Cultural Resources Overview

3. Middle New River Watercourse Master Plan Study - Photogrammetric Control and Topographic Survey

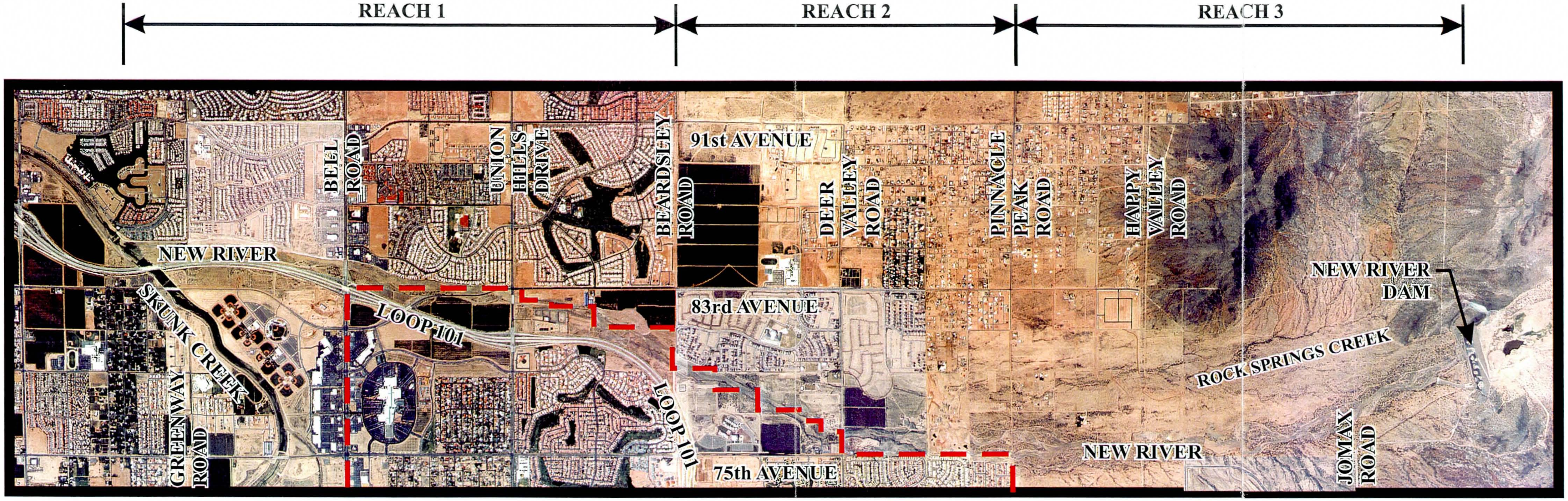
4. Overview of Biological Resources in the Middle New River Watercourse (Confluence With Skunk Creek To New River Dam).

AUTHORITY FOR STUDY

Pursuant to Arizona revised Statutes 48-3609.01 the District is authorized to conduct watercourse master plans for river reaches within Maricopa County. Stantec Consulting Inc. (Stantec) was awarded the Middle New River Watercourse Master Plan study (Contract FCD 97-04) in January of 1998.

LOCATION

The project is located within unincorporated areas in Maricopa County, and within the jurisdictional limits of the City of Glendale and the City of Peoria. Commencing at the confluence of New River with Skunk Creek the project extends upstream along New River for approximately 8.5 miles to the New River Dam. The project area is located on land that is publicly or privately held. Figure 1-1 displays the location of the study area.



Legend

CITY OF PEORIA/GLENDALE BOUNDARY

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

Figure No.
1-1

Title
Vicinity Map

Date: December 21, 1999
Project Number:28900058

HYDROLOGIC/HYDRAULIC SETTING

The Army Corps of Engineers conducted hydrologic, hydraulic and design studies in the 1970's and the 1980's, to develop a comprehensive plan for the Phoenix valley to mitigate experienced and potential flooding. Excerpts, from the COE's studies concerning the flooding history of the Phoenix valley are presented below.

Storm types experienced over the New River watershed include general winter storms, normally of northern Pacific origin, general summer storms, normally beginning in the Pacific Ocean and the Sea of Cortez and summer thunderstorms. Floods from summer thunderstorms often provide little or no warning to affected communities.

Flows are generated from two distinct sub-areas of approximately equal size, a mountainous sub-area and a flat valley sub-area. Flows are not perennial and are experienced only after relatively heavy precipitation. Flooding is experienced after flood flows overtop the generally dry streambeds and spread as overbank flow. Mountainous areas are characterized by well-defined and incised streambeds. Flat valley areas, however, have poorly defined, braided streams that are overtopped by larger flow. The resultant characteristic of wide overbank flow within the existing and rapidly urbanizing areas produces a severe flooding problem. Overbank flow produced by a standard project flood (SPF), should it occur, would inundate approximately 79 square miles, approximately 50 percent of which are within urbanized areas.

As a comprehensive plan for flood control for the metropolitan Phoenix area, the Dreamy Draw, Cave Buttes, Adobe, and New River Dams are utilized to reduce storm water flow originating in the watershed north of the metropolitan Phoenix area to nondamaging storm water flow. In addition, the Arizona Canal diversion channel (ACDC) diverts controlled flows from Dreamy Draw and Cave Buttes Dams and local runoff generated in areas below the dams to Skunk Creek and then downstream to the New and Agua Fria Rivers.

The Middle New River Watercourse Master Plan study area lies below New River Dam and within watersheds contributing runoff to New River. Upstream of the dam, the New River watershed is comprised of 164 square miles of primarily undeveloped desert and desert mountains, whereas below the dam, the New River watersheds are highly urbanized. Downstream of the dam, stormwater is conveyed as concentrated flow within defined and braided channels and as overland flow within overbank areas of New River.

GOALS AND OBJECTIVES

The following goals and objectives are established for the Middle New River Watercourse Master Plan.

Project Goals

- To assure the requirements of the U.S.Army Corps of Engineers for the future condition 100-year conveyance capacity of the New River channel below the New River Dam.
- To establish a Watercourse Master Plan for planned developments bordering or within the New River floodplain for both GLENDALE and PEORIA.
- To include in the Master Plan Study the size, alignment, grades and construction requirements of proposed channel/floodplain improvements in sufficient detail to permit incorporation of the Master Plan into development plans for adjoining areas and individual parcels.

Project Objectives

- To update existing topographic mapping in areas which have subsequently been developed.
- To update 100-year water surface profiles that were used to establish the existing FEMA floodplain to reflect developments within the floodplain, which have previously been completed or are currently being planned.
- To identify and document the existing quality of biological habitat within the reach of the New River.
- To conduct a literature search of all known archaeological sites.
- To conduct public hearings and publish hearing notices for this study.
- To formulate development alternatives to be studied.

- To conduct feasibility level studies of the alternatives to evaluate areas required for water conveyance (not developable), project costs and impacts to the existing environment.

- To select a specific preferred plan.

- To conduct pre-design studies of the preferred plan to refine designs and construction requirements.

- To adopt and develop the Master Plan in accordance with State of Arizona Statutes.

- To conduct a records search and identify potential illegal waste deposits or hazardous materials along the reach.

- To survey literature and evaluate general scour/aggradation.

- If authorized, submit to FEMA updated topographic mapping and new maps if significantly changed.

- To determine minimum Rights of Way requirements.

ACKNOWLEDGMENTS

The Middle New River Watercourse Master Plan is prepared by Stantec Consulting Inc., under the direction of the Flood Control District of Maricopa County, the City of Glendale and the City of Peoria. The District formulated a Steering Committee that consisted of the District, City of Glendale and City of Peoria personnel. The committee provided guidance and direction to Stantec staff during the study. The Steering Committee meetings were also open to interested parties. The project team would like to thank the following Steering Committee members and interested participants for their time, dedication, and guidance provide during the development of the Watercourse Master Plan:

Flood Control District of Maricopa County

Russ Miracle
Doug Williams
Dan Carroll

City of Glendale

Grant Anderson
Thomas Sedlmeier
Dan Sherwood
Shirley Medler

City of Peoria

David Moody
Burton Charron
David Fitzhugh
Scott Friend

Community of Joy

Wyane Skaff

2.0 WATERCOURSE MASTER PLAN

GENERAL

The development of the Middle New River Watercourse Master Plan was completed in progressive steps. The major steps in the development process are: hydraulic and sediment transport evaluations of existing conditions; identification of channel capacity deficiencies in the New River; formulation of alternatives that meet project objectives; hydraulic and sediment transport evaluations of proposed alternatives; selection of viable alternatives that will become the basis of the Master Plan; selection and refinement of a preferred alternatives; and development of conceptual plans and associated cost estimates. This section of the report presents the Watercourse Master Plan and also provides a summary of other alternatives considered.

STEERING COMMITTEE

The Steering Committee met on a monthly basis throughout the term of the project. Stantec staff provided project progress reports for each major step of the project at the Steering Committee meetings to inform and to obtain approval and guidance from the committee. In addition to providing guidance and direction, the Steering Committee participated in public meetings and City Council presentations.

PUBLIC MEETINGS

Seven public meetings and two special neighborhood meetings were held through the course of the project. Newsletters informing the public about the project and public meetings were sent to property owners that lived within 500 feet of the project boundaries (with the project boundaries being defined as the existing 100-year floodplain). In addition to the Newsletters, notices of the public meeting were posted in the Arizona Republic newspaper.

The first three of public meetings were held on May 5th, May 6th, and May 12th of 1998. The purpose of the first public meetings were for the project team to introduce the project goals and objectives. Citizens identified items of concern, needs or wishes relating to the Middle New River Watercourse Master Plan.

The top five consensus items were safety, environmental/aesthetics, flood control, transportation, and recreation.

The next two public meetings were held on January 12, and January 19, 1999. New River channel alternatives that had been formulated for the project were presented. Citizens had the opportunity to review each alternative, ask questions and provide comments and concerns.

Citizens from the Bell Park Subdivision (City of Peoria) and the Hillcrest Subdivision (City of Glendale) that were attending the January 1999 public meetings, requested separate meetings for their neighborhood. Additional meetings were held for citizens of each subdivision on March 3, 1999 and March 11, 1999. Citizens of each subdivision were notified of each public meeting by hand bills.

The final two public meetings were held on May 25th and 26th of 1999. Plans depicting the preferred alternatives were presented to the public.

CITY COUNCILS

The Watercourse Master Plan was presented to the City of Peoria Council on May 16, 2000. City of Glendale representatives felt it was not necessary to present the Watercourse Master Plan to the Glendale City Council.

EXISTING CONDITIONS

Existing Channel Physical Characteristics

The Middle New River Watercourse Master Plan study reach of New River commences at the confluence and extends approximately 8.5 miles north to the New River Dam. The study reach is sub-divided into three sub-reaches which have similar physical and hydraulic characteristics. Reach numbering is from downstream to upstream. Reach location nomenclature is in river miles above the confluence with the Aqua Fria River. Figure 1-1 displays reach location and identification.

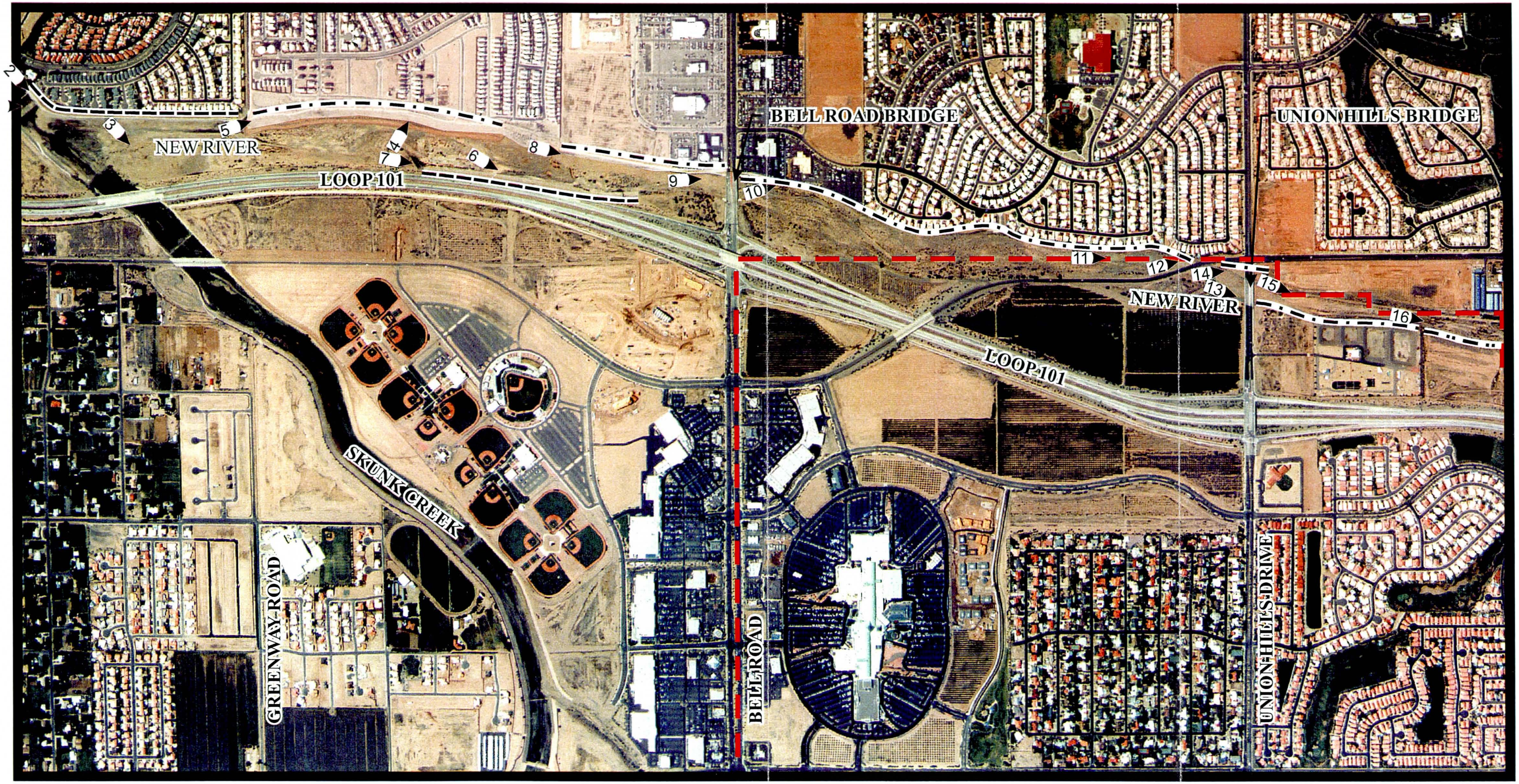
Reach 1 extends from River Mile (RM) 8.655 to RM 11.949 (confluence with Skunk Creek to Beardsley Road alignment) and is characterized by a by a trapezoidal shaped section with the majority of the west channel side slope being armored with a rock filled wire baskets. The trapezoidal section is a result of encroachment of the natural channel/floodplain by development. The channel side slopes for portions of the lower segment of Reach 1 are armored with soil cement. The east channel side slope of Reach 1 is typically not armored. The channel bed material consists of cobbles and sand.

Reach 2 extends from RM 11.949 to RM 14.197 (Beardsley Road alignment to Pinnacle Peak Road alignment). Reach 2 has similar characteristic as Reach 1, with the exception of approximately 1500 linear feet of rock filled wire baskets along the west bank upstream of Beardsley Road, channel side slopes are unlined.

Reach 3 extends from RM 14.197 (Pinnacle Peak Road alignment) to the New River Dam. Reach 3 is a natural channel segment with overbanks floodplain areas. The channel is braided in various locations. Varying vegetation densities are noted in channel and floodplain areas. Channel bed material predominately consists of cobbles. Outside of the channel areas base material consists of a combination of firm soil, coarse sand and fine gravels. From approximately RM 15.596 to RM 15.792, bank armoring has been designed for protection of the eastbank as part of the Terramar development.

Inventory of Existing Bank Armoring

An inventory of existing bank protection is conducted to determine the type and distribution of existing bank conditions and bank protection materials utilized in the study area. Figure 2-1 displays types and locations of bank protection identified in the study area. Figure 2-2 through Figure 2-24 are photographs depicting existing channel conditions and bank material types.



Legend

- CITY OF PEORIA/GLENDALE BOUNDARY
- ◀01 PHOTOGRAPH VIEW DIRECTION AND LOCATION
- SOIL CEMENT
- GABIONS
- DUMPED RIPRAP

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

Figure No.
2-1A

Title
Existing Bank Armoring Location Map

Date: May 25, 1999
Project Number: 28900058

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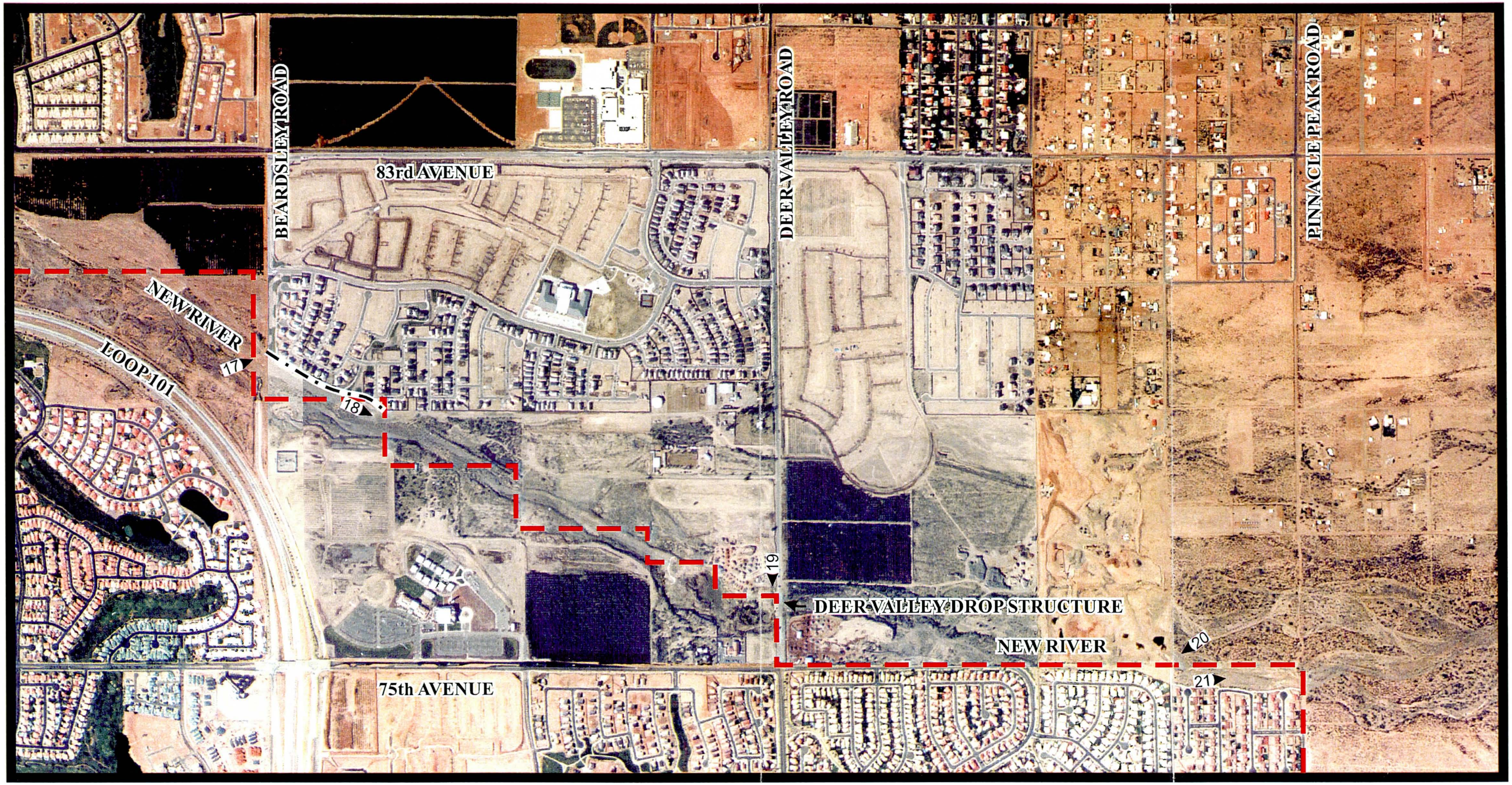

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- CITY OF PEORIA/GLENDALE BOUNDARY
- ◀01 PHOTOGRAPH VIEW DIRECTION AND LOCATION
- GABIONS

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
MIDDLE NEW RIVER WATERCOURSE
MASTER PLAN

Figure No.
2-1B

Title
Existing Bank Armoring Location Map

Date: May 25, 1999
Project Number: 28900058

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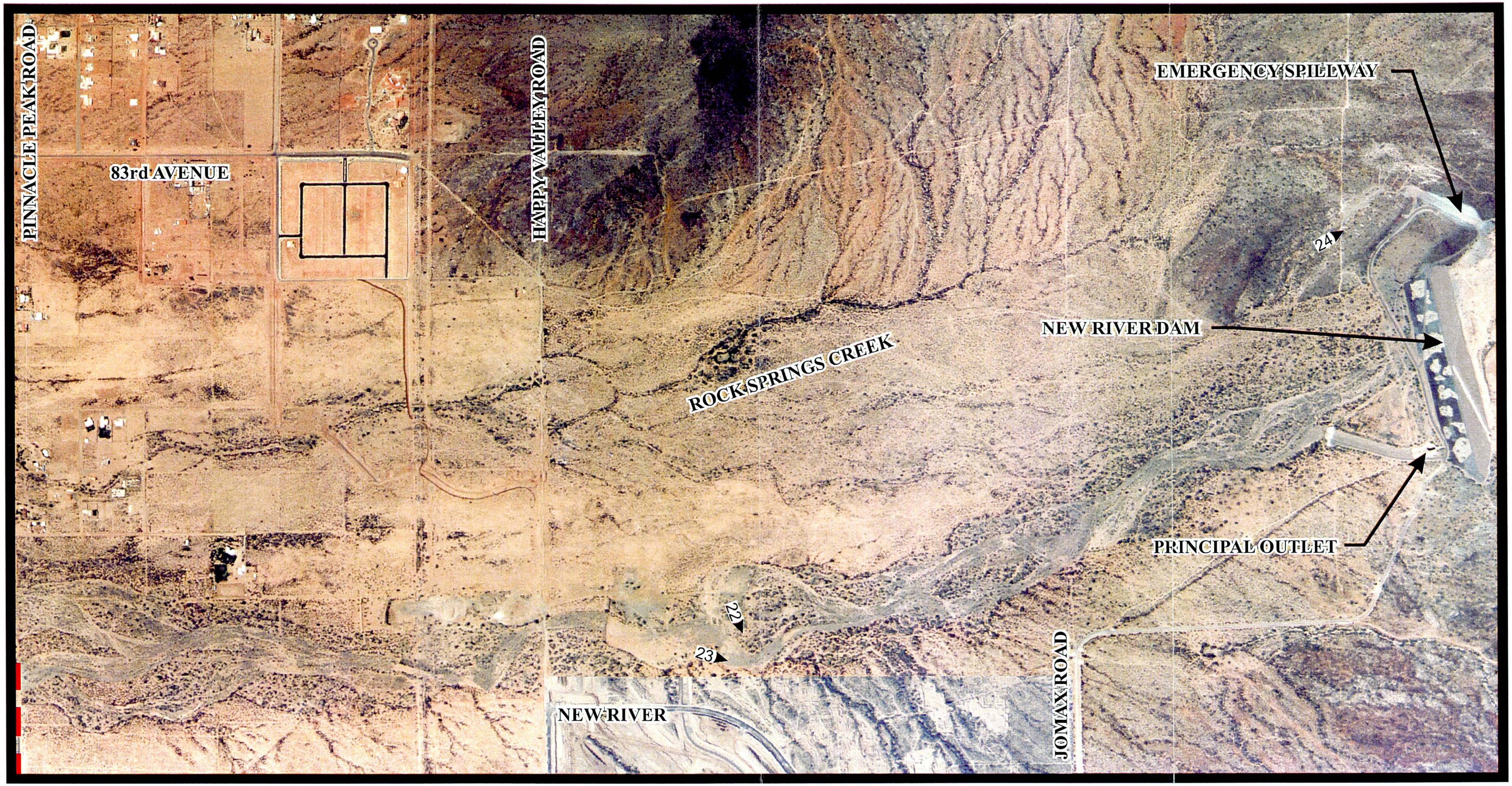

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CITY OF PEORIA/GLENDALE BOUNDARY

◀01 PHOTOGRAPH VIEW DIRECTION AND LOCATION

GABIONS

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P:\28900058\mnr-technical data notebook-June 00-Final\FIG6_1C.CDR

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN AND MANNINGS "n" VALUE PHOTO LOCATIONS

Figure No.

2-1C

Title

Existing Bank Armoring Location Map

Date: May 25, 1999

Project Number: 28900058

PHOTO 1

Figure 2-2
Roller compacted concrete grade control structure below confluence of New River with Skunk Creek. Channel side slopes are armored with soil cement.

PHOTO 2

Figure 2-3
South bank of New River below confluence with Skunk Creek. Channel side slopes are armored with soil cement.

PHOTO 3

Figure 2-4
East bank of New River upstream of confluence with Skunk Creek. No armoring on channel side slopes.

PHOTO 4

Figure 2-5
Gabion mattress channel side slope armoring along west bank of New River between Bell Road and the confluence of New River with Skunk Creek

PHOTO 5

Figure 2-6
Gabion mattress channel side slope armoring along west bank of New River between Bell Road and the confluence with New River with Skunk Creek

PHOTO 6

Figure 2-7
Soil cement side slope armoring along east bank of New River adjacent to Loop 101 between Bell Road and the New River confluence with Skunk Creek

PHOTO 7

Figure 2-8
Soil cement side slope armoring along east bank of New River adjacent to Loop 101 between Bell Road and the New River confluence with Skunk Creek

PHOTO 8

Figure 2-9
Gabion mattress channel side slope armoring along west bank of New River downstream of Bell Road

PHOTO 9

Figure 2-10
Gabion mattress channel side slope armoring and sidewalk along west bank of New River upstream of Bell Road

PHOTO 10

Figure 2-11
Gabion mattress channel side slope armoring and local concrete spillway along west bank of New River upstream of Bell Road Bridge

PHOTO 11

Figure 2-12
Gabion mattress channel side slope armoring along west bank of New River between Bell Road and Union Hills Drive

PHOTO 12

Figure 2-13
Stacked gabion baskets at storm drain outlet, west bank of New River downstream of Union Hills Drive

PHOTO 13

Figure 2-14
Gabion mattress armoring east bank of New River, downstream of Union Hills Bridge

PHOTO 14

Figure 2-15
Gabion mattress armoring west bank of New River, downstream of Union Hills Bridge

PHOTO 15

Figure 2-16
Gabion mattress channel side slope armoring, west and east bank of New River, upstream of Union Hills Bridge

PHOTO 16

Figure 2-17
Transition from gabion mattress channel side slope armoring to unprotected channel side slope, east bank upstream of Arrowhead Waste Water Treatment Facility

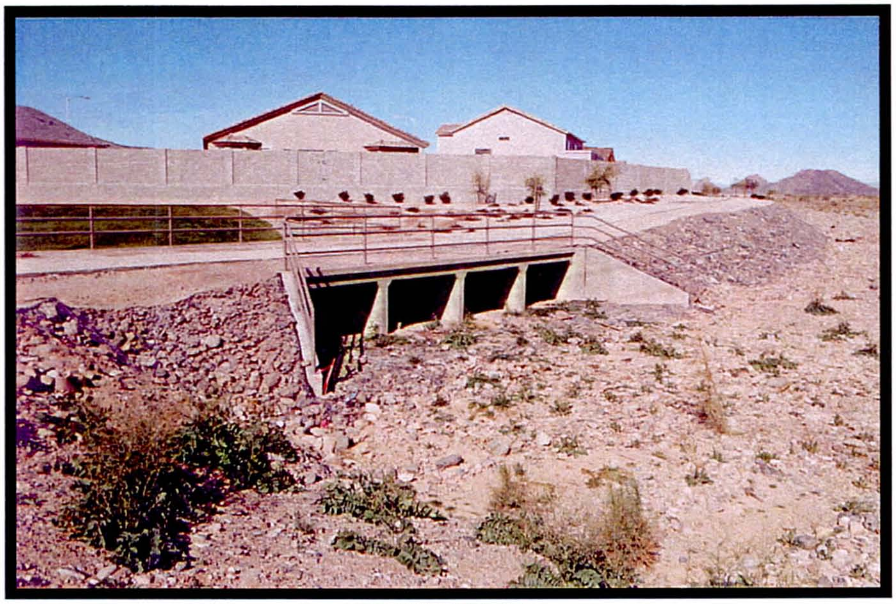


PHOTO 17

Figure 2-18
Gabion mattress channel side slope armoring, west bank of New River upstream of Beardsley Road

PHOTO 18

Figure 2-19
Gabion mattress channel side slope armoring west bank of New River upstream of Beardsley Road

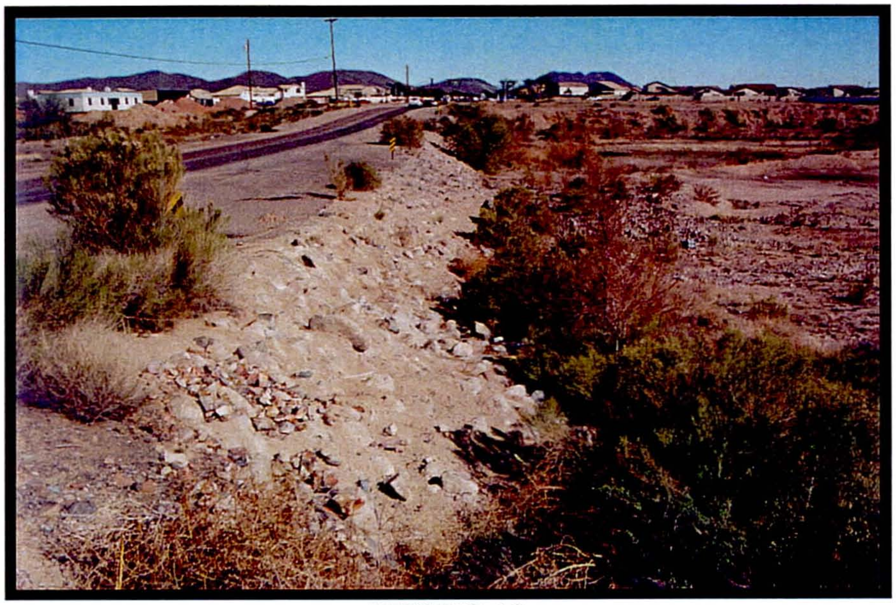


PHOTO 19

Figure 2-20
Grouted rip-rap drop structure, Deer Valley Road crossing of New River

PHOTO 20

Figure 2-21
Drainage outlet channel to New River, downstream of Pinnacle Peak Road

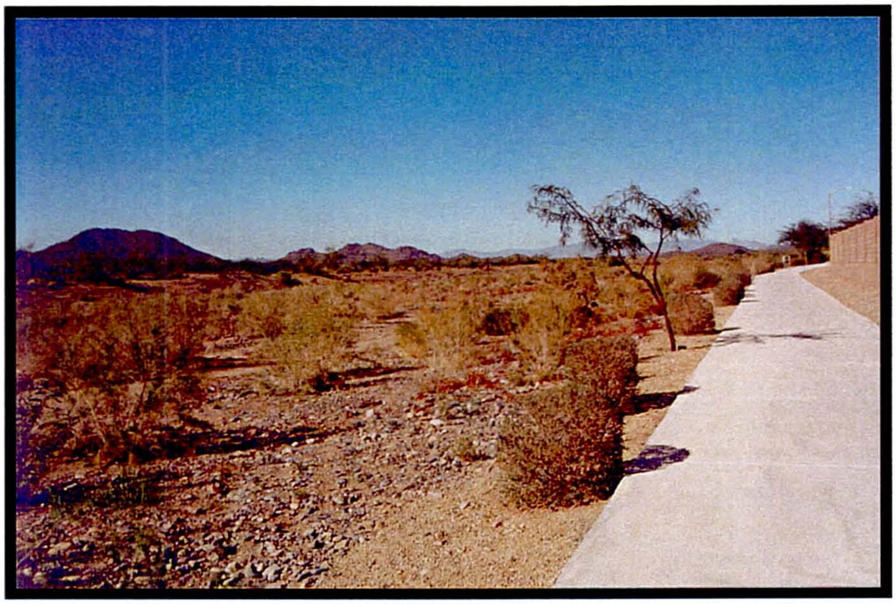


PHOTO 21

Figure 2-22
New River channel looking upstream near Pinnacle Peak Road

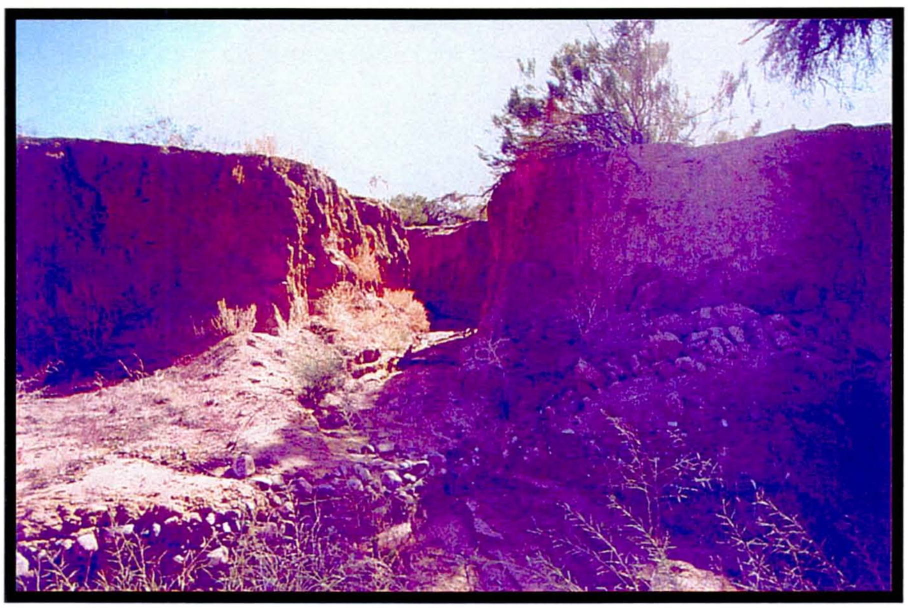


PHOTO 22

Figure 2-23
East bank of New River upstream of Happy Valley Road.

PHOTO 23

Figure 2-24
Scour hole along east bank of New River upstream of Happy Valley Road.

PREFERRED ALTERNATIVE

Selection of a preferred, comprehensive channel improvement alternative for Middle New River involved consideration by the Steering Committee members of the various alternative evaluation parameters. Some of these quantitative and qualitative parameters include: existing and future hydrology and hydraulics of the river, public comments, safety and aesthetics, social and environmental impacts, advantages and disadvantages, construction cost, existing infrastructure (bank armoring and bridges), and practicality of implementation

Public interest and comments for the project have been positive. However, no clear understanding of a "preferred" alternative was gained from the public regarding a structural channel type. Five viable structural channel alternatives were presented. During one-on-one discussions with the public at the meetings, people tended to have an individual prioritization and preference with regard to the channel alternatives presented. However, when presented with cost and other factors in in-depth discussions, some tended to modify their understanding and adjust their initial preferences. Utilization of existing bank armoring versus the cost for constructing entirely new bank armoring weighed heavily in considering the alternatives within Reach 1 and Reach 2. A large investment has been made in the existing bank armoring that for the most part presently conveys the 100-year peak discharges that FEMA has established for New River. Also, viable alternatives for these two reaches are structural so one would only be changing the material type. The majority of existing bank armoring is rock filled wire baskets.

Non-structural flood protection, by way of establishing an erosion setback buffer zone along the 100-year floodplain, was a popular alternative amongst the Steering Committee and the public alike. However, because of the rapid pace of development within Reach 1 and Reach 2, it was determined that a non-structural alternative was only viable in Reach 3 (north of Pinnacle Peak Road).

One thing is clear from the public meetings; safety, property and access issues related to the potential provision of paths and trails along the River's bank raised concern. While this Watercourse Master Plan accommodates paths and trails, it was relayed to the public that paths and trails will be implemented by the Cities of Glendale and Peoria in the future as part of recreation oriented projects.

The Watercourse Master Plan Preferred Alternative includes the following:

- Reach 1 and Reach 2 (Skunk Creek Confluence to Pinnacle Peak Road) – New channel bank improvements will consist of, rock filled wire baskets for new bank armoring being proposed. The plan utilizes as much of the existing bank armoring as possible. It evaluates and protects existing bridges at Bell Road and Union Hills Road.
- Reach 3 (Pinnacle Peak Road to New River Dam) – Non-structural approach utilizing an erosion setback buffer zone along the 100-year floodplain. (Except approximately 700 lineal foot section of new bank armoring near Terramar subdivision).

Conceptual Construction Plans

Table 2-1 list a summary of proposed improvements depicted on the plans. Improvements summarized in the table are categorized in Improvement Segments with each segment being defined by the type and extent of the improvement. Master Plan improvements are limited to channel improvements only. Earthwork for channel improvements was estimated using a computer model. Development improvements necessary to property adjacent to the channel were not evaluated. At locations where the proposed channel banks are to be filled, banks are set with a fifteen foot top width, 2:1 (horizontal/vertical) slope on the channel side and a 4:1 side slopes on the overbank side to tie to existing ground. It is inferred that the overbank area will be reclaimed in the future by fill for development purposes.

TABLE 2-1

PROPOSED IMPROVEMENT SUMMARY

Improvement Segment	Station (along construction line)	Proposed Improvements
1	26+30 to 55+00	Realign and grade east bank, provide rock filled wire armoring. Minor earthwork within channel.

TABLE 2-1, (cont.)

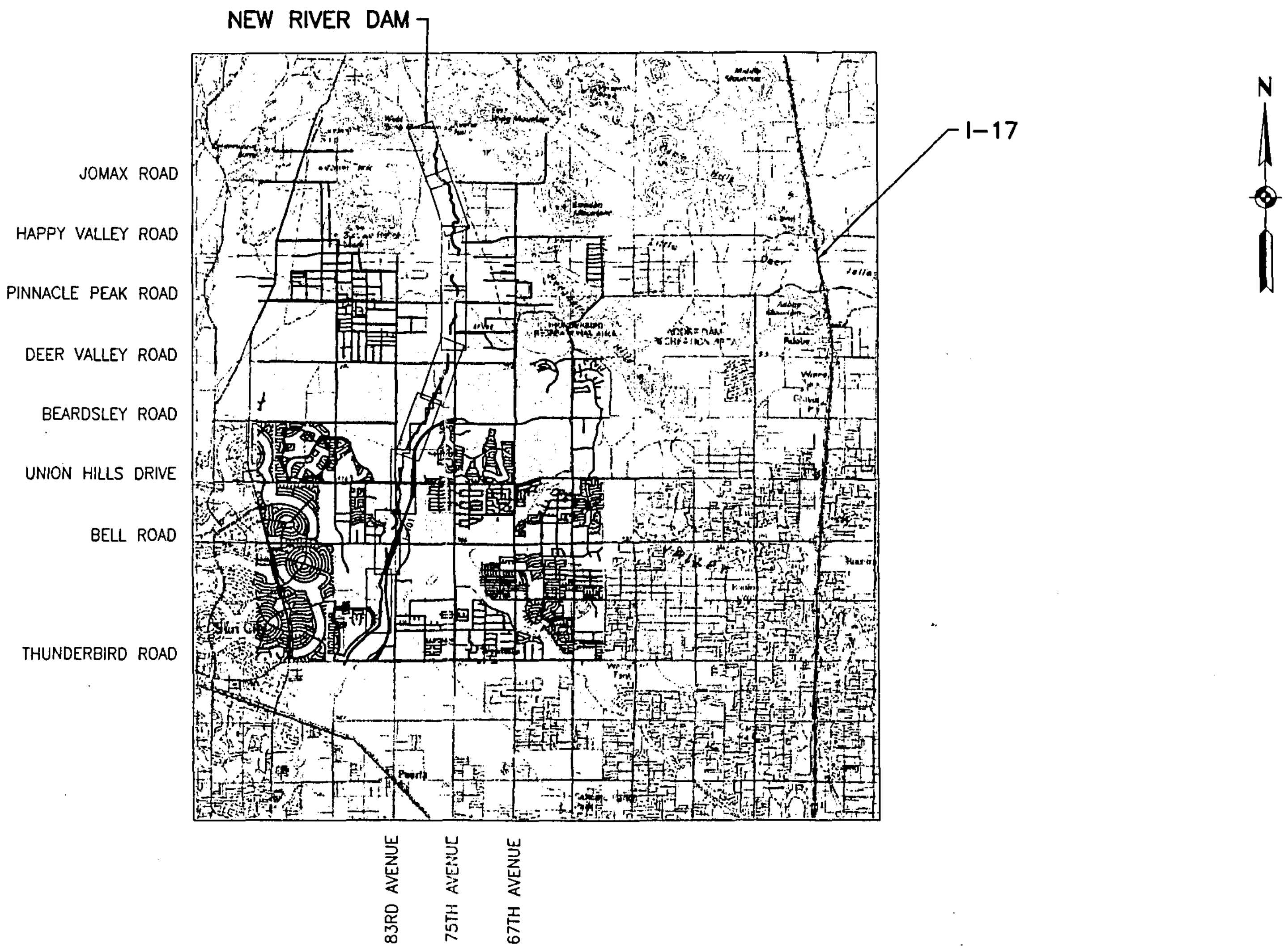
PROPOSED IMPROVEMENT SUMMARY

Improvement Segment	Station (along construction line)	Proposed Improvements
2	61+50 to 69+50	Realign and grade west bank, provide rock filled wire armoring. Minor earthwork within channel.
3	78+50 to 86+50	Realign and grade east bank, provide rock filled wire armoring. Minor earthwork within channel.
4	88+50 to 140+90	Realign and grade east bank, provide rock filled wire armoring. Minor earthwork within channel from stations 88+50 to 109+00. Channel excavation from stations 109+00 to 133+00 and 136+00 to 140+90. Provide grade control structure and river bottom access /maintenance ramp at Station 133+00.
5	144+80 to 159+500	Realign and grade west bank, provide rock filled wire armoring. Minor earthwork within channel.
6	159+50 to 314+00	Realign and grade east and west bank, provide rock filled wire armoring, excavate channel. Provide grade control structure and river bottom access /maintenance ramp at Stations 258+18 and 311+00.
7	314+00 to 460+00	Erosion setback limits are utilized to define development limits. Some minor channelization and/or bank armoring at bend locations in the channel is proposed. Approximately 700 LF of bank armoring near Terramar subdivision. The need for grade control structures at proposed roadway crossings of New River will need to be evaluated in the future.

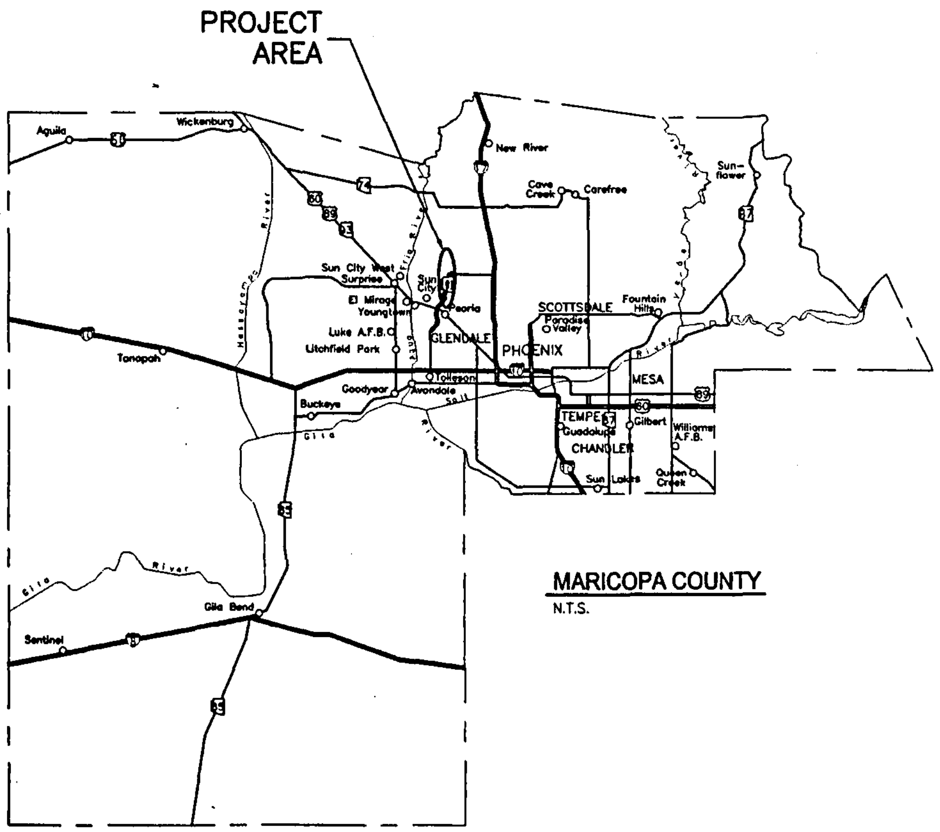
Conceptual construction plans depicting the preferred alternative for each reach are prepared at a scale of 1"=200'. The purpose of the plans are present the intent of the proposed improvements and to aid in the development of construction cost estimates for improvements. Location of existing channel features and proposed improvements depicted on the conceptual construction plans are approximate and are referenced to a construction line. The Conceptual Construction Plans for the Middle New River Watercourse Master Plan improvements are presented as Sheets 1 through 23.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

CONCEPTUAL PLANS FOR THE MIDDLE NEW RIVER WATERCOURSE MASTER PLAN IMPROVEMENTS



LOCATION PLAN - GLENDALE/PEORIA, AZ.
MIDDLE NEW RIVER AND SKUNK CREEK
N.T.S.



MARICOPA COUNTY
N.T.S.

THE MIDDLE NEW RIVER WATERCOURSE MASTER PLAN ACCOMODATES RECREATIONAL TRAILS.
FOR A DESCRIPTION AND LOCATION OF RECREATIONAL TRAILS OR MULTI-USE TRAILS, CONTACT THE PLANNING DEPARTMENTS FOR THE CITIES OF PEORIA AND GLENDALE

PRELIMINARY PLAN
NOT FOR CONSTRUCTION OR RECORDING
ARIZONA TECH. BOARD OF REGISTRATION R4-30-304

Stantec
Stantec Consulting Inc.
7776 POINTE PARKWAY W, STE 290
Phoenix AZ 85044 U.S.A.
Tel. 602.438.2200
Fax. 602.431.9562
www.stantec.com

MARICOPA COUNTY FLOOD CONTROL DISTRICT

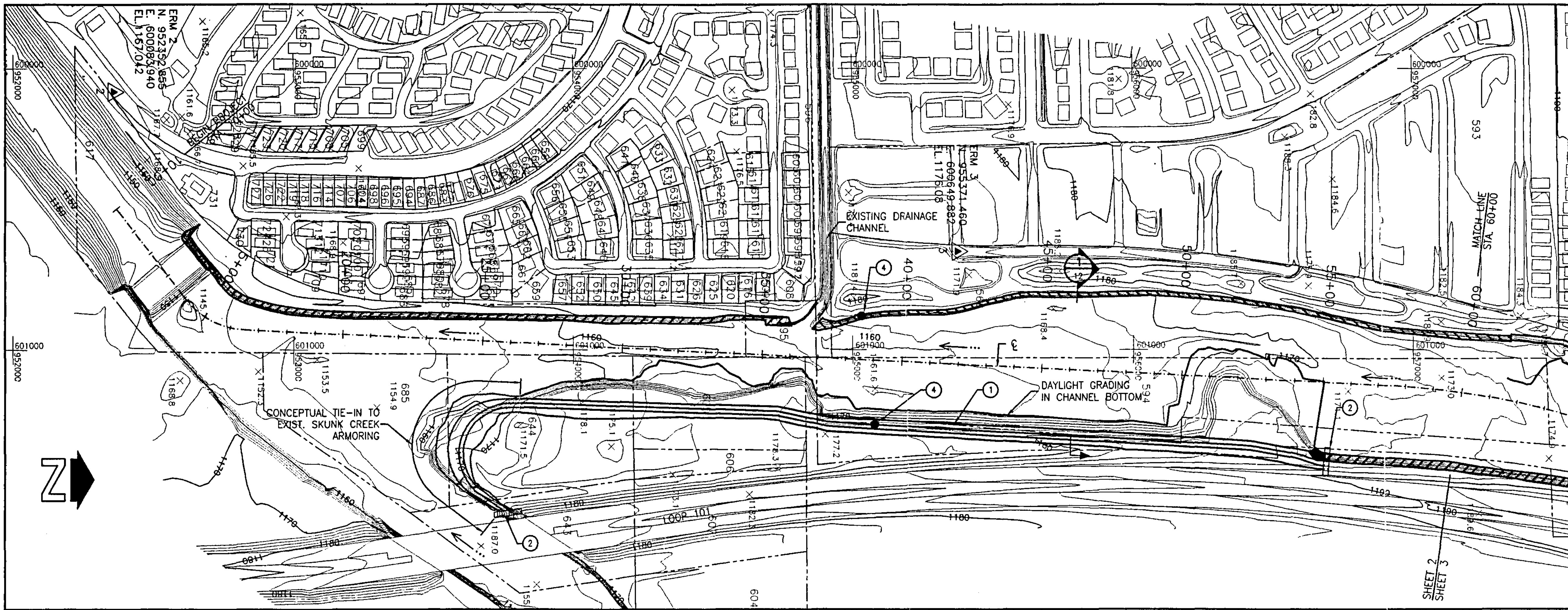
ISSUED FOR PUBLIC BIDDING BY:

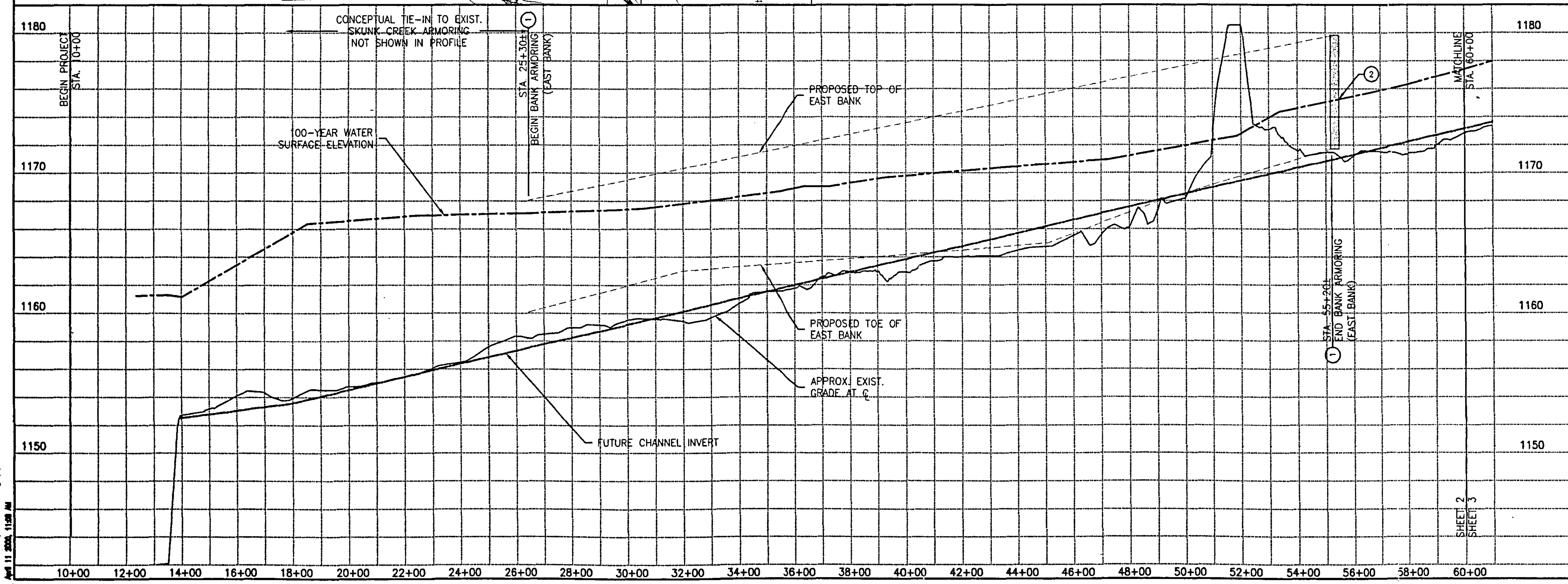
N/A	N/A
PROJECT MANAGER	DATE

COUNTY BOARD OF SUPERVISORS

JIM BRUNER - CHAIRMAN

DISTRICT 1	FULTON BROCK
DISTRICT 2	DON STAPLEY
DISTRICT 3	ANDREW KUMASEK
DISTRICT 4	JANICE BREWER
DISTRICT 5	MARY ROSE WILCOX





CONSTRUCTION NOTES

1. PROVIDE ROCK FILLED WIRE BASKETS TYPE BANK PROTECTION ON GRADED CHANNEL SLOPES.
2. TIE INTO EXISTING BANK PROTECTION. SIDE SLOPE TRANSITION MAY BE REQUIRED.
3. PROVIDE RCC STEPPED DROP STRUCTURE WITH RIP-RAP INLET/OUTLET PROTECTION.
4. PROVIDE CHANNEL ACCESS RAMP PER DETAIL (LOCATION APPROXIMATE) 2/13.
5. EXCAVATE CHANNEL BOTTOM.
6. MATCH EXISTING CHANNEL INVERT ELEVATION.
7. ALIGNMENT OF LOW FLOW CHANNEL TO MINIMIZE BANK EROSION.
8. RE-GRADE AND PROVIDE NATIVE VEGETATION. FINISH GRADING AND VEGETATION SHOULD APPEAR NATURAL.
9. EROSION SETBACK LIMITS. FOR CHANNEL SEGMENTS WITH OBVIOUS BENDS EROSION SETBACK IS EQUAL TO 2.5 TIMES THE VALUE CALCULATED FOR RELATIVELY STRAIGHT CHANNEL REACHES.
10. PROVIDE MULTI-USE TRAIL CROSSING AT BRIDGES PER DETAIL 1/13.
11. PROPOSED FLOOD WALL OR CONCRETE WALL (BY OTHERS).
12. PROPOSED GABION EMBANKMENT (BY OTHERS).
13. PROVIDE COLLECTOR CHANNEL.

LEGEND

- EROSION SETBACK
- EXISTING SOIL CEMENT BANK ARMORING.
- EXISTING ROCK FILLED WIRE TIED MATTRESS TYPE ARMORING.
- EXISTING CONCRETE ARMORING.
- TIE-IN TO EXISTING SLOPE CONDITIONS SEE (2).
- PROPOSED RCC STEPPED DROP STRUCTURE. SEE (3).
- EXISTING DUMPED RIP-RAP.
- AREA OF REGRADING AND REVEGETATION.
- PROPERTY LINE (LOCATION APPROXIMATE)
- EXISTING UTILITY POLE.
- FLOW DIRECTION

200' 0' 200' 400'

CONTOUR INTERVAL:2 FEET

NO.	REVISION	BY	DATE
3			
2	RED LINE CORRECTIONS	P.J.E.	04/10/00
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

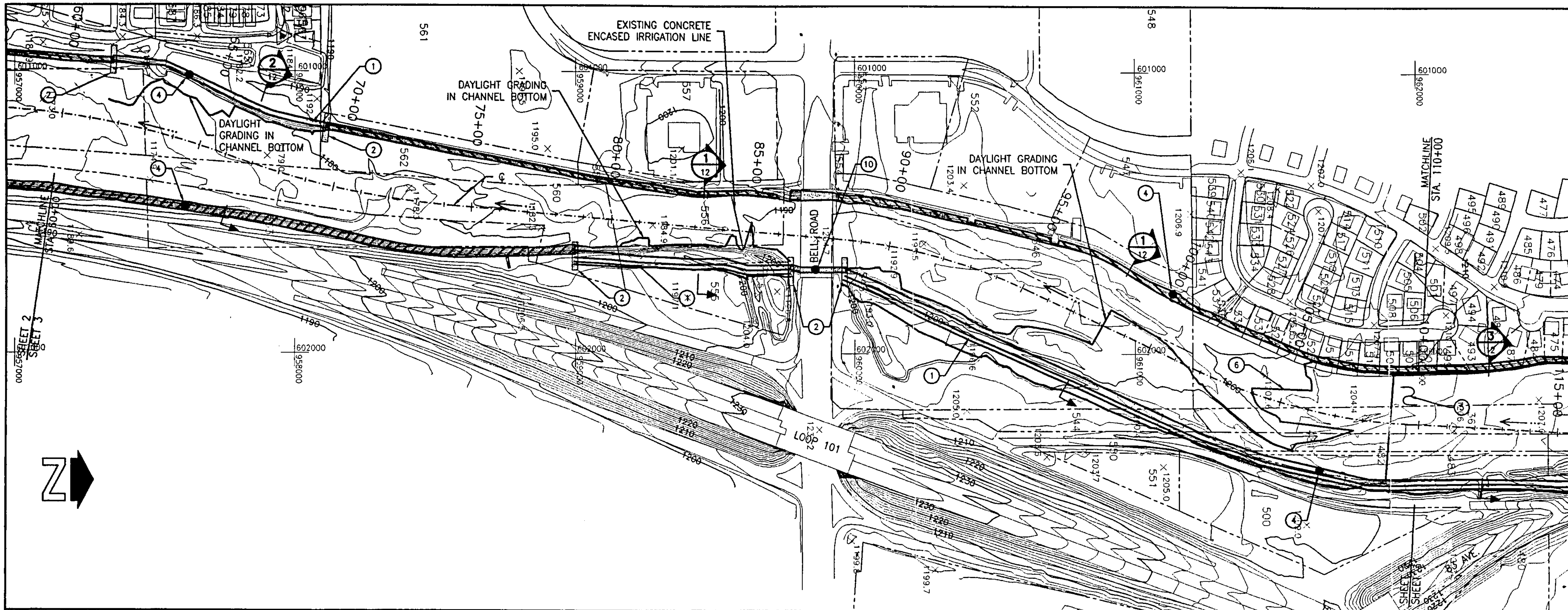
	BY	DATE
DESIGNED	P.J.E./C.A.S.	05/21/99
DRAWN	P.W./P.R.	05/21/99
CHECKED	S.S.S./P.J.E.	05/21/99

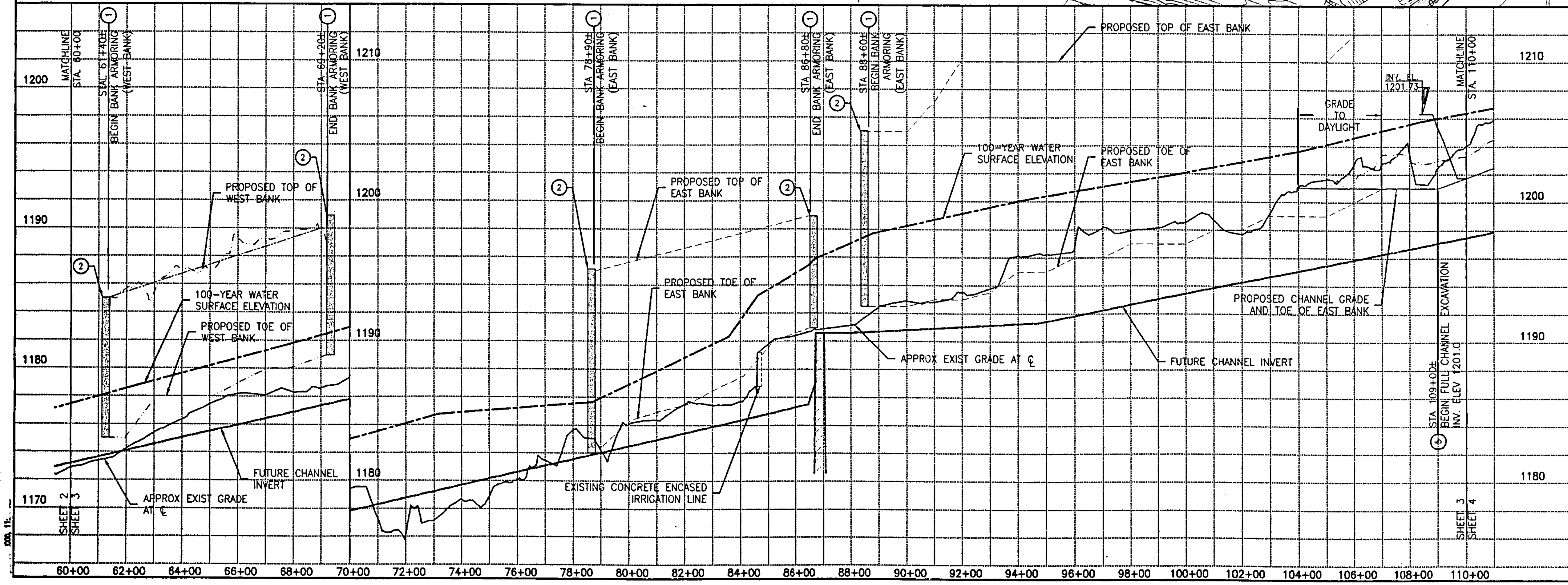
PRELIMINARY NOT FOR CONSTRUCTION

Stantec

PLAN AND PROFILE
STA. 10+00.00 TO 60+00.00

SHEET 2 OF 23





CONSTRUCTION NOTES

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- AREA OF REGRADING AND REVEGETATION.
- PROPERTY LINE (LOCATION APPROXIMATE)
- EXISTING UTILITY POLE.
- FLOW DIRECTION

200' 0' 200' 400'

CONTOUR INTERVAL:2 FEET

NO.	REVISION	BY	DATE
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2	RED LINE CORRECTIONS	P.J.E.	04/10/00
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER
WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

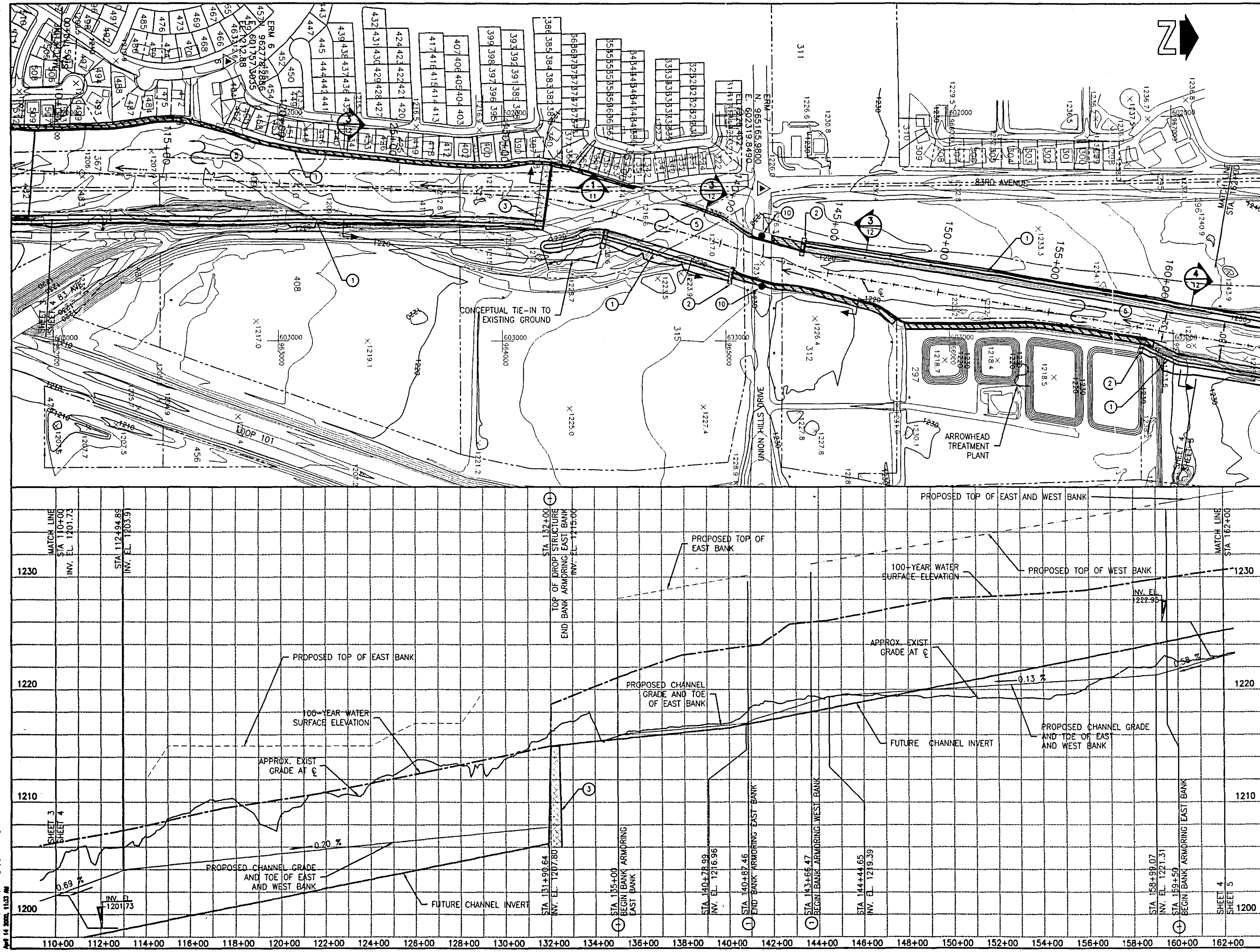
	BY	DATE
DESIGNED	P.J.E./C.A.S.	05/21/99
DRAWN	P.W./P.R.	05/21/99
CHECKED	S.S.S./P.J.E.	05/21/99

PRELIMINARY NOT FOR CONSTRUCTION

Stantec

PLAN AND PROFILE
STA. 60+00 TO 110+00

SHEET 3 OF 23



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- FLOW DIRECTION

200' 0' 200' 400'

CONTOUR INTERVAL: 2 FEET

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

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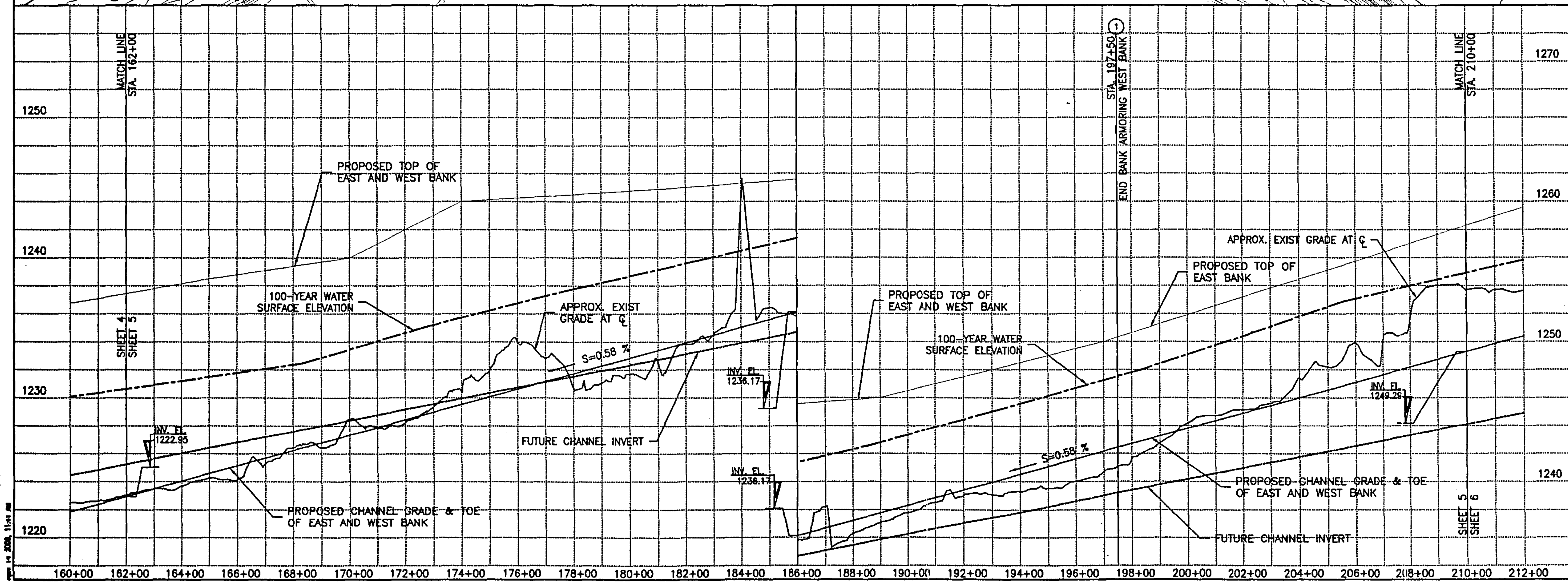
PRELIMINARY NOT FOR CONSTRUCTION

Stantec

PLAN AND PROFILE
STA. 110+00 TO 162+00

SHEET 4 OF 23



CONSTRUCTION NOTES

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- FLOW DIRECTION

200' 0' 200' 400'

CONTOUR INTERVAL:2 FEET

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

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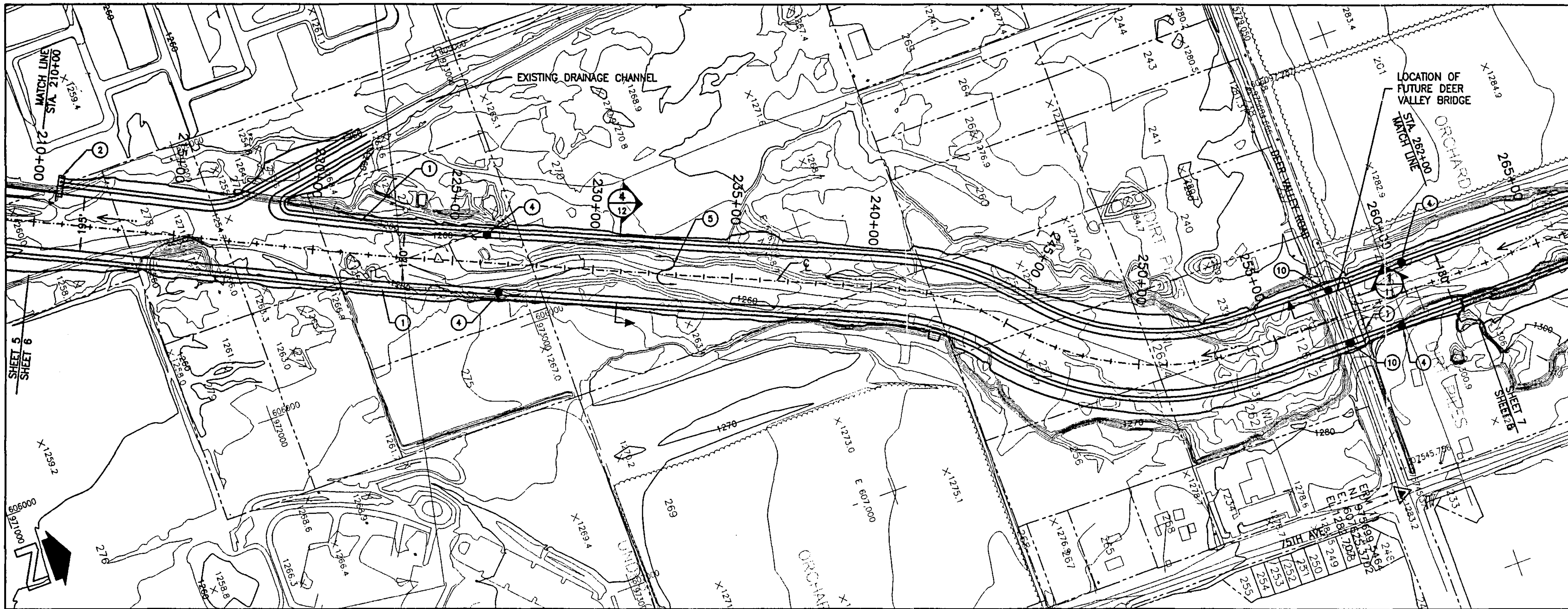
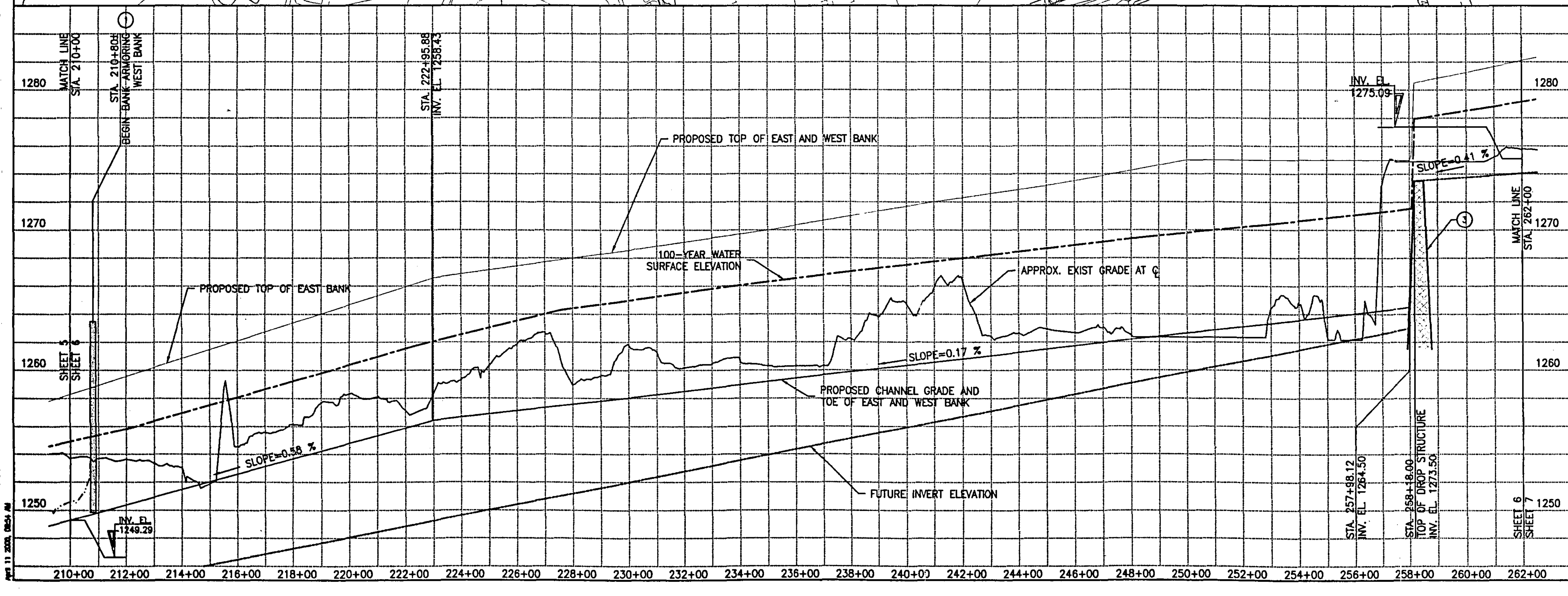
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	P.J.E./C.A.S.	05/21/99
	DRAWN	P.W./P.R.	05/21/99
	CHECKED	S.S.S./P.J.E.	05/21/99

Stantec

PLAN AND PROFILE
STA. 162+00 TO 210+00

SHEET 5 OF 23





CONSTRUCTION NOTES

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- EXISTING UTILITY POLE.
- FLOW DIRECTION

200' 0' 200' 400'

CONTOUR INTERVAL:2 FEET

NO.	REVISION	BY	DATE
3			
2	RED LINE CORRECTIONS	P.J.E.	04/10/00
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

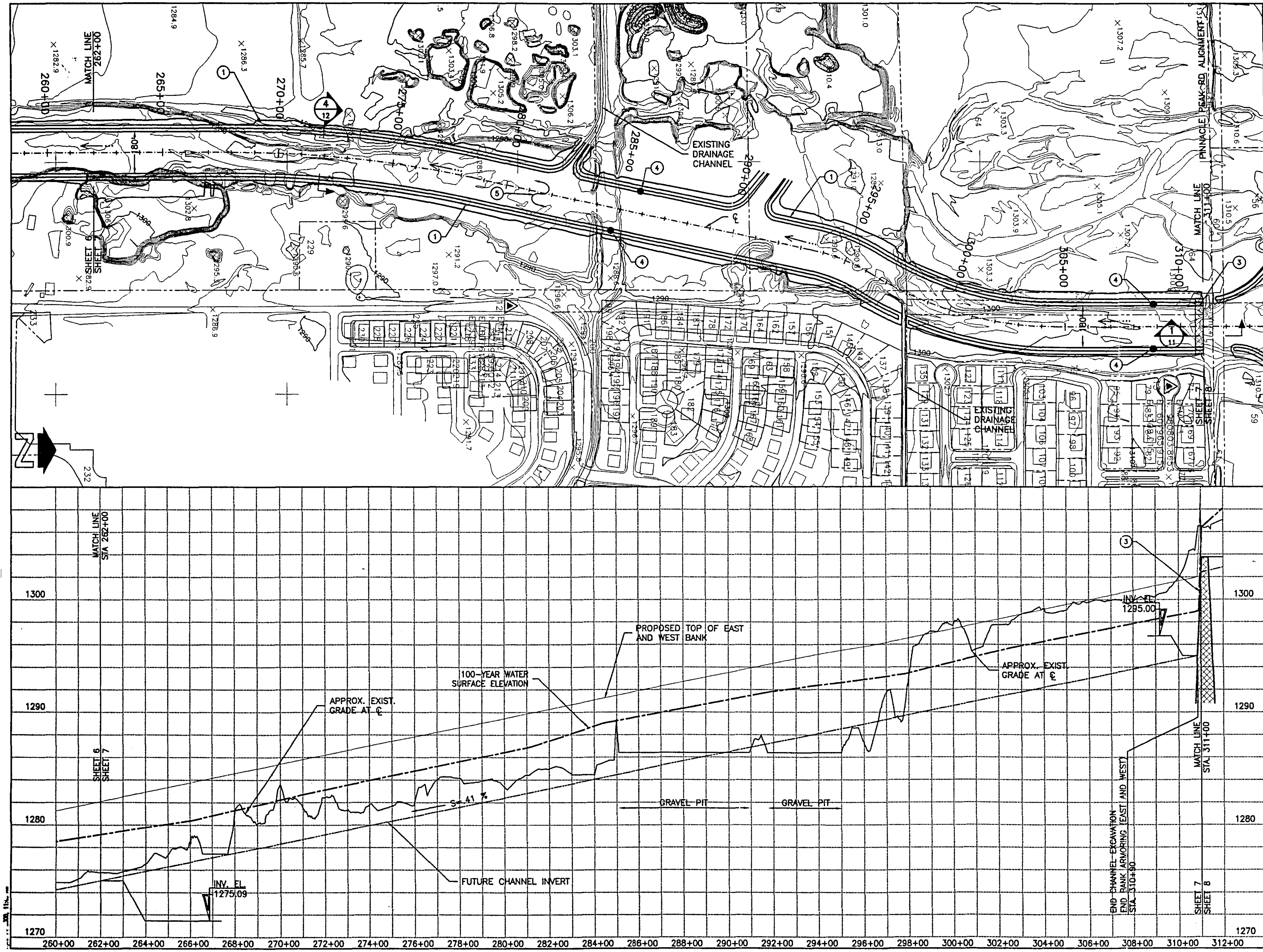
MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	P.J.E./C.A.S.	05/21/99
	DRAWN	P.W./P.R.	05/21/99
	CHECKED	S.S.S./P.J.E.	05/21/99

Stantec

PLAN AND PROFILE
STA. 210+00 TO 262+00

SHEET 6 OF 23



CONSTRUCTION NOTES

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- FLOW DIRECTION

200' 0' 200' 400'

CONTOUR INTERVAL:2 FEET

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
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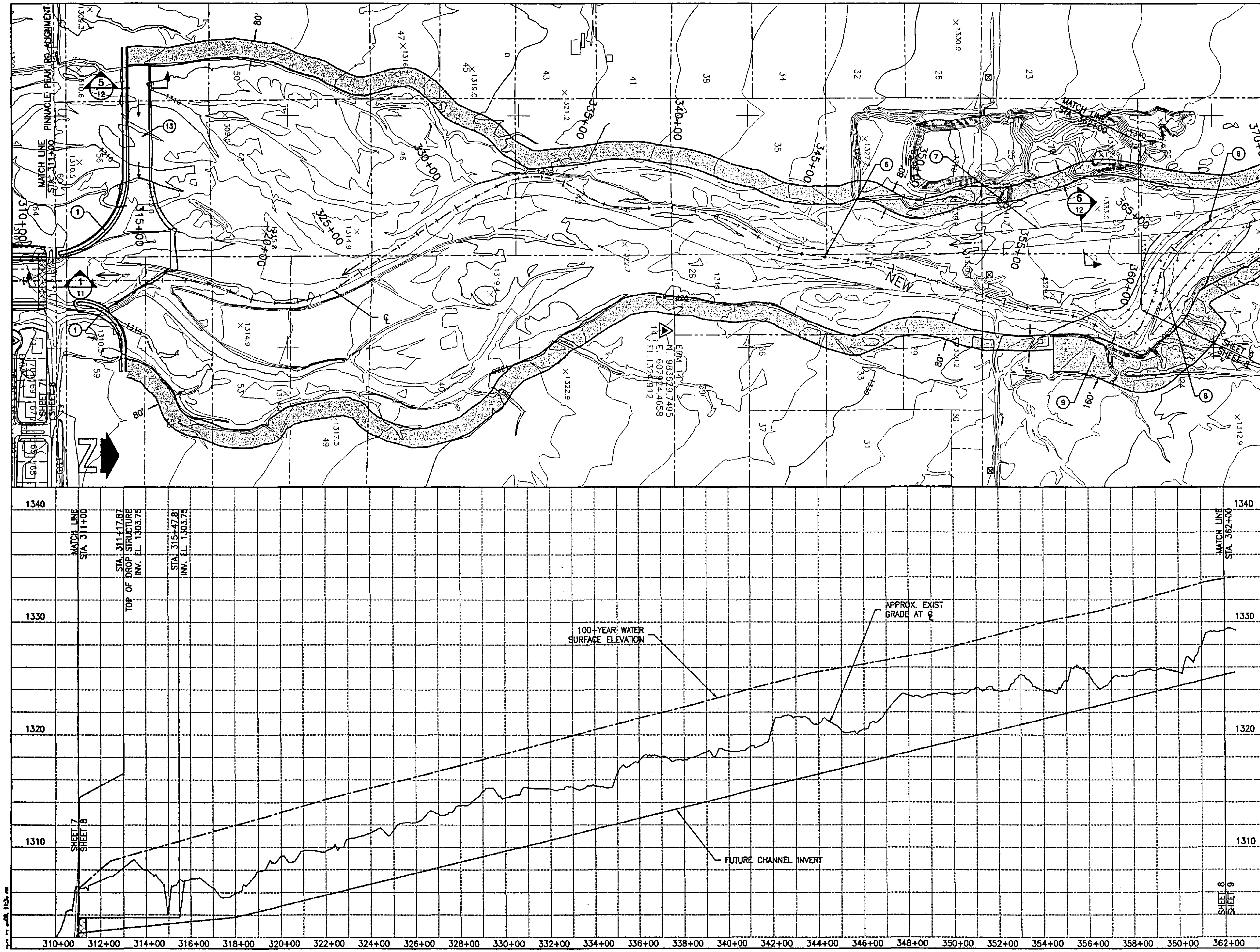
DRAWN	P.W./P.R.	05/21/99
CHECKED	S.S.S./P.J.E.	05/21/99

PRELIMINARY NOT FOR CONSTRUCTION

Stantec

PLAN AND PROFILE
STA. 262+00 TO 311+00

SHEET 7 OF 23



CONSTRUCTION NOTES

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200' 0' 200' 400'

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

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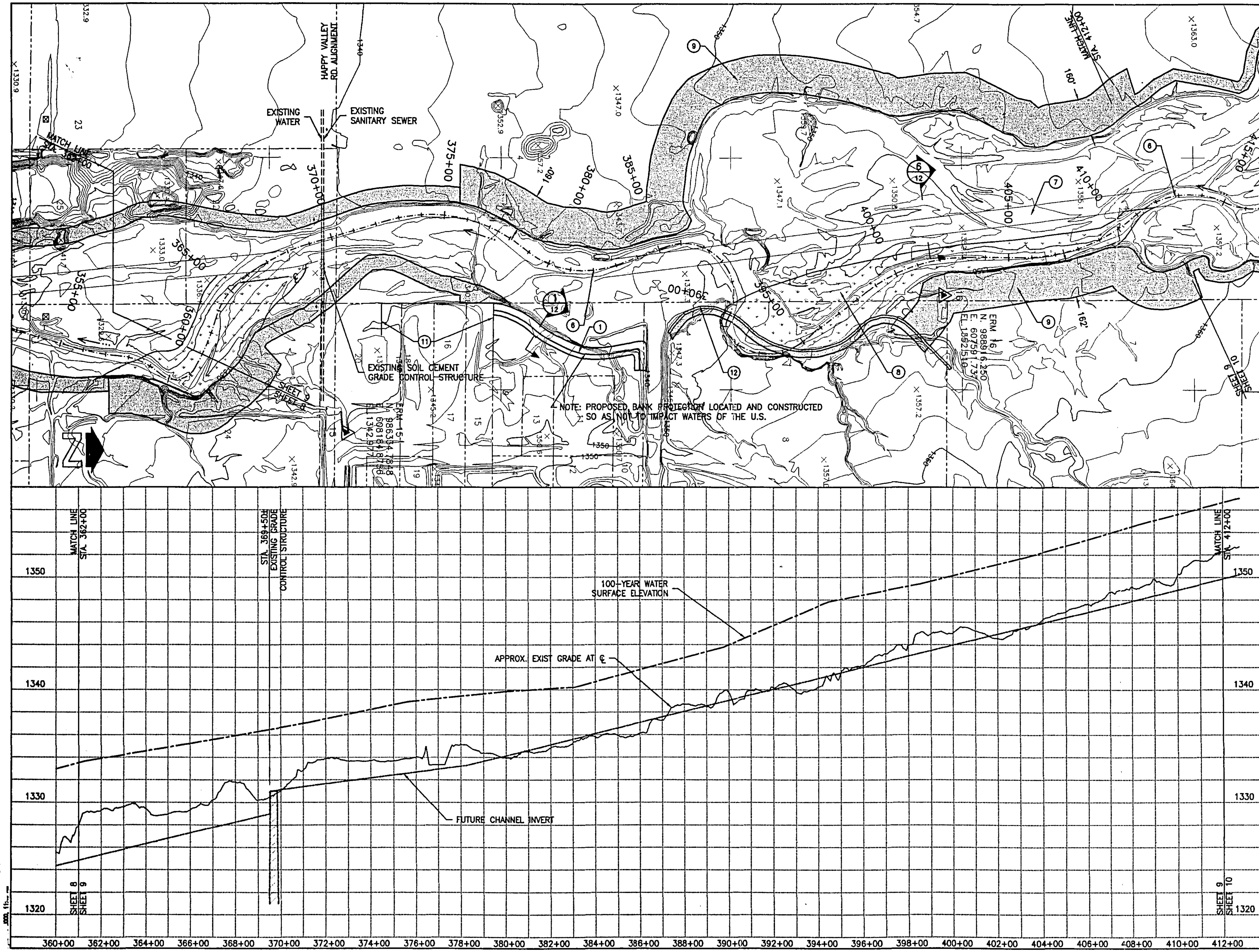
DRAWN	P.W./P.R.	05/21/99
CHECKED	S.S.S./P.J.E.	05/21/99

Stantec

PLAN AND PROFILE
STA. 311+00 TO 362+00

SHEET 8 OF 23



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200' 0' 200' 400'

CONTOUR INTERVAL:2 FEET

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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PRELIMINARY NOT FOR CONSTRUCTION

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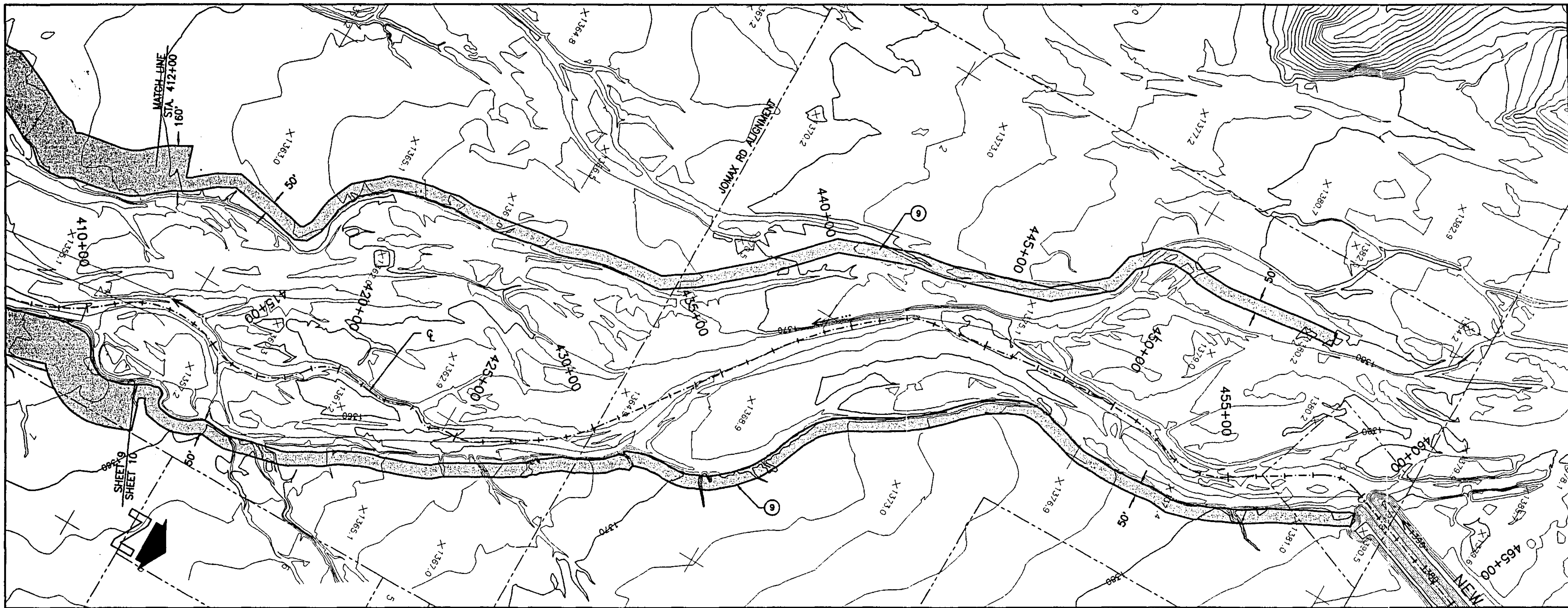
PLAN AND PROFILE
STA. 362+00 TO 412+00

SHEET 9 OF 23



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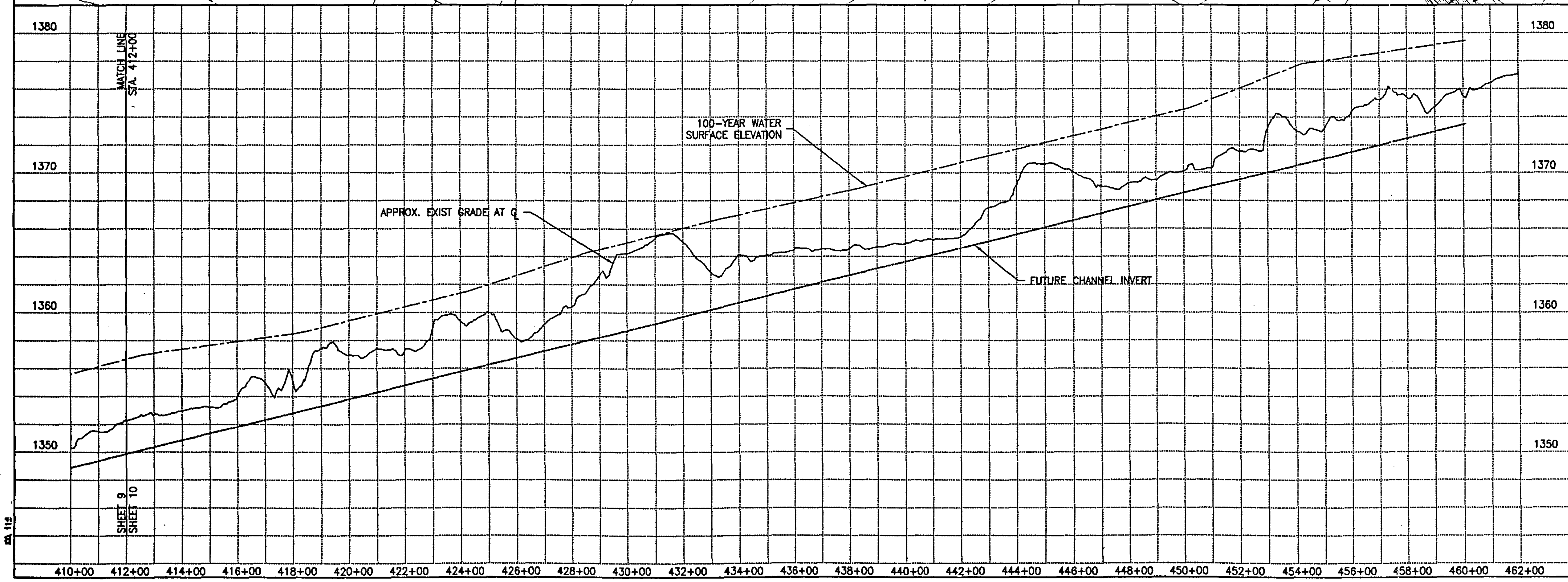
2. TIE INTO EXISTING BANK PROTECTION. SIDE SLOPE TRANSITION MAY BE REQUIRED.
3. PROVIDE RCC STEPPED DROP STRUCTURE WITH RIP-RAP INLET/OUTLET PROTECTION.
4. PROVIDE CHANNEL ACCESS RAMP PER DETAIL (LOCATION APPROXIMATE) (2/13).
5. EXCAVATE CHANNEL BOTTOM.
6. MATCH EXISTING CHANNEL INVERT ELEVATION.
7. ALIGNMENT OF LOW FLOW CHANNEL TO MINIMIZE BANK EROSION.
8. RE-GRADE AND PROVIDE NATIVE VEGETATION. FINISH GRADING AND VEGETATION SHOULD APPEAR NATURAL.
9. EROSION SETBACK LIMITS. FOR CHANNEL SEGMENTS WITH OBVIOUS BENDS EROSION SETBACK IS EQUAL TO 2.5 TIMES THE VALUE CALCULATED FOR RELATIVELY STRAIGHT CHANNEL REACHES.
10. PROVIDE MULTI-USE TRAIL CROSSING AT BRIDGES PER DETAIL (1/13).
11. PROPOSED FLOOD WALL OR CONCRETE WALL (BY OTHERS).
12. PROPOSED GABION EMBANKMENT (BY OTHERS).
13. PROVIDE COLLECTOR CHANNEL.

LEGEND

- EROSION SETBACK
- EXISTING SOIL CEMENT BANK ARMORING.
- EXISTING ROCK FILLED WIRE TIED MATTRESS TYPE ARMORING.
- EXISTING CONCRETE ARMORING.
- TIE-IN TO EXISTING SLOPE CONDITIONS SEE (2).
- PROPOSED RCC STEPPED DROP STRUCTURE. SEE (3).
- EXISTING DUMPED RIP-RAP.
- AREA OF REGRADING AND REVEGETATION.
- PROPERTY LINE (LOCATION APPROXIMATE)
- EXISTING UTILITY POLE.
- FLOW DIRECTION

200' 0' 200' 400'

CONTOUR INTERVAL:2 FEET



NO.	REVISION	BY	DATE
3			
2	RED LINE CORRECTIONS	P.J.E.	04/10/00
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

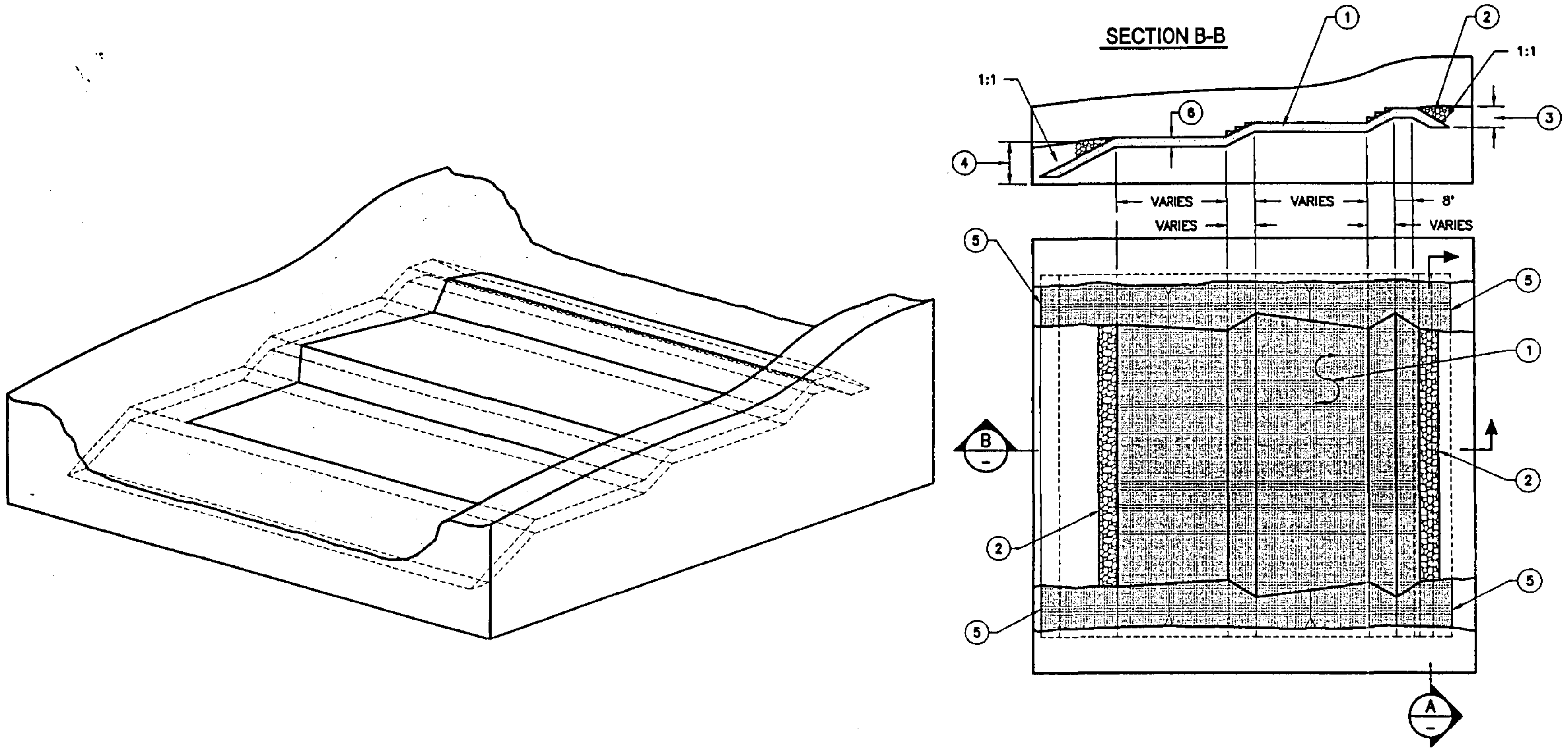
	BY	DATE
DESIGNED	P.J.E./C.A.S.	05/21/99
DRAWN	P.W./P.R.	05/21/99
CHECKED	S.S.S./P.J.E.	05/21/99

PRELIMINARY NOT FOR CONSTRUCTION

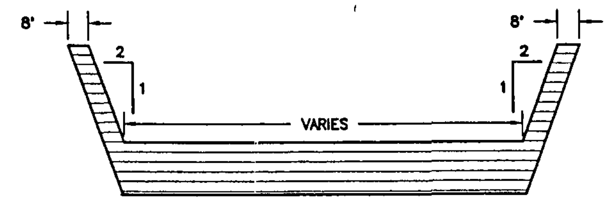
Stantec

PLAN AND PROFILE
STA. 412+00 TO 462+00

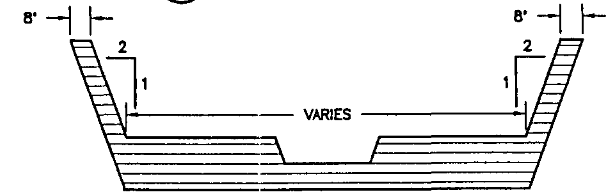
SHEET 10 OF 23



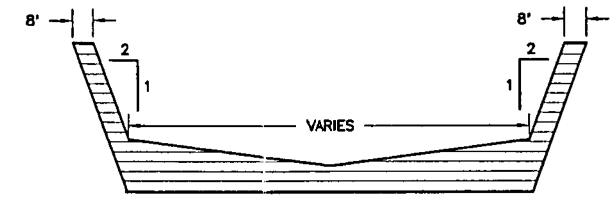
DOUBLE STAGE DROP STRUCTURE (ALTERNATE)
N.T.S.



A LEVEL BOTTOM OPTION

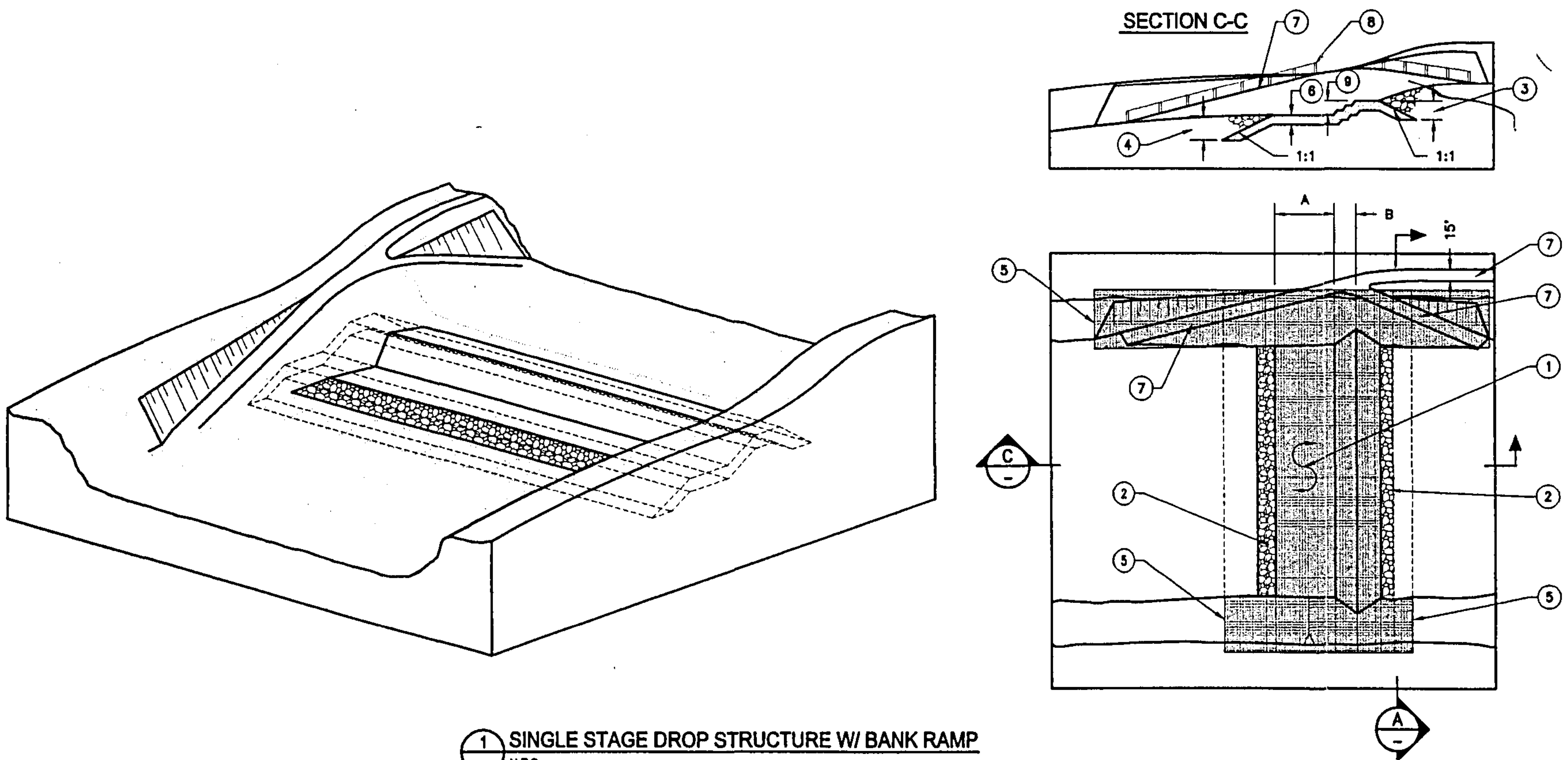


A LOW FLOW CHANNEL NOTCH OPTION



A "V" SHAPED CHANNEL OPTION

ROLLER COMPACTED CONCRETE DROP STRUCTURE DIMENSIONS SINGLE STAGE DROP STRUCTURE						
STATION 1	DIMENSION (3) (ft) 2	DIMENSION (4) (ft) 3	DIMENSION (6) (ft) 4	DIMENSION (9) (ft) 5	DIMENSION A (ft) 6	DIMENSION B (ft) 7
132+00	10	10	5	7.5	55	15
258+18	10.5	12.5	5	9	62	18
311+10	10	11.5	5	7.5	44	15



1 SINGLE STAGE DROP STRUCTURE W/ BANK RAMP
N.T.S.

DOUBLE STAGE DROP STRUCTURE

1 ROLLER COMPACTED CONCRETE (RCC) STEPPED DROP STRUCTURE
2 DUMPED RIP-RAP
3 UPSTREAM DROP STRUCTURE TOE DOWN
4 DOWNSTREAM DROP STRUCTURE TOE DOWN
5 TIE RCC ARMORING INTO ROCK FILLED WIRE BASKETS
6 DROP STRUCTURE FLOOR THICKNESS

SINGLE STAGE DROP STRUCTURE

1 ROLLER COMPACTED CONCRETE STEPPED DROP STRUCTURE
2 DUMPED RIP-RAP
3 UPSTREAM DROP STRUCTURE TOE DOWN
4 DOWNSTREAM DROP STRUCTURE TOE DOWN
5 TIE RCC ARMORING INTO ROCK FILLED WIRE BASKETS
6 DROP STRUCTURE FLOOR THICKNESS
7 ACCESS RAMP. RAMP SLOPE NOT TO EXCEED 10%
8 PROVIDE SAFETY RAIL

NO.	REVISION	BY	DATE
3	RED LINE CORRECTIONS	P.J.E.	05/25/00
2	RED LINE CORRECTIONS	P.J.E.	04/10/00
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

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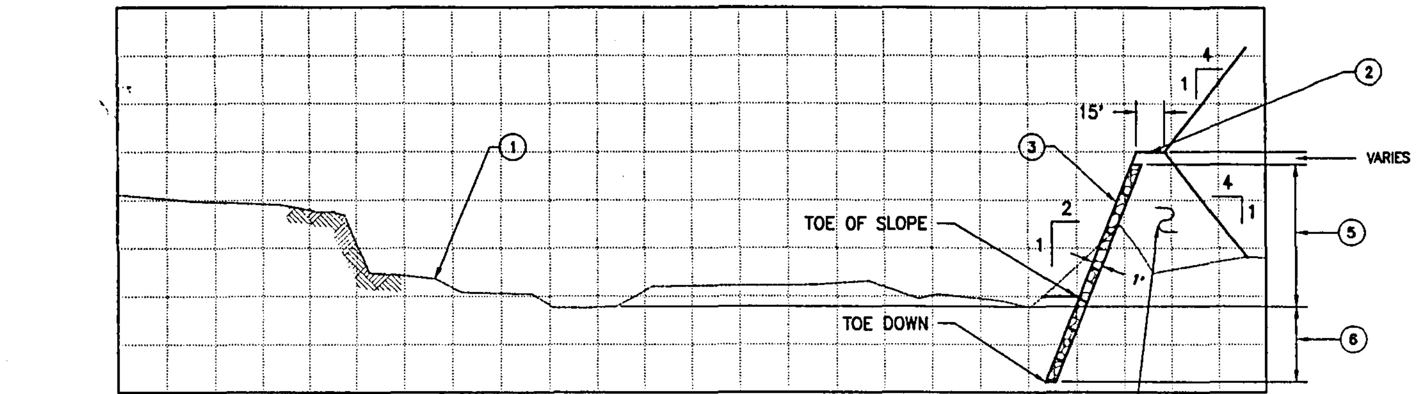
DETAIL SHEET
DROP STRUCTURE ALTERNATIVES

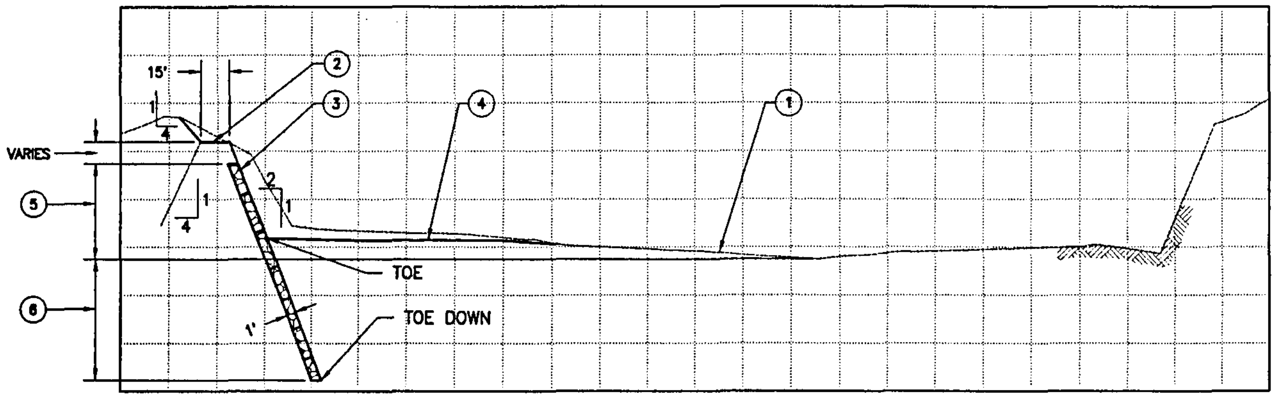
SHEET 11 OF 23



1 CHANNEL IMPROVEMENT DETAIL
SCALE: 1" = 50'-0"

KEYNOTES:

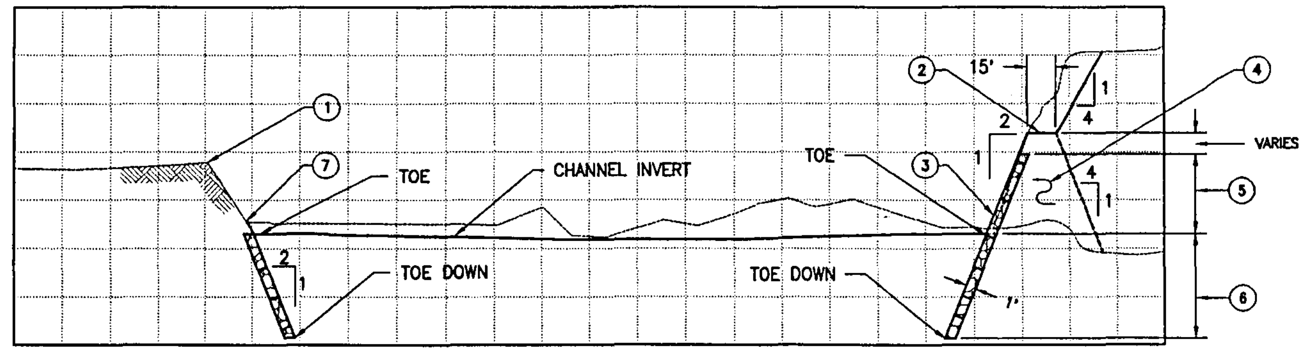
1 EXISTING GROUND
2 15 FOOT WIDE CORRIDOR TO ACCOMMODATE RECREATIONAL TRAIL SYSTEM AND/OR MAINTENANCE ACCESS
3 1 FOOT THICK ROCK FILLED WIRE BASKET BANK ARMORING
4 EARTHEN FILL MATERIAL
5 ARMORED CHANNEL HEIGHT, SEE TABLE D-1
6 TOE-DOWN DEPTH, SEE TABLE D-1



2 CHANNEL IMPROVEMENT DETAIL
SCALE: 1" = 50'-0"

KEYNOTES:

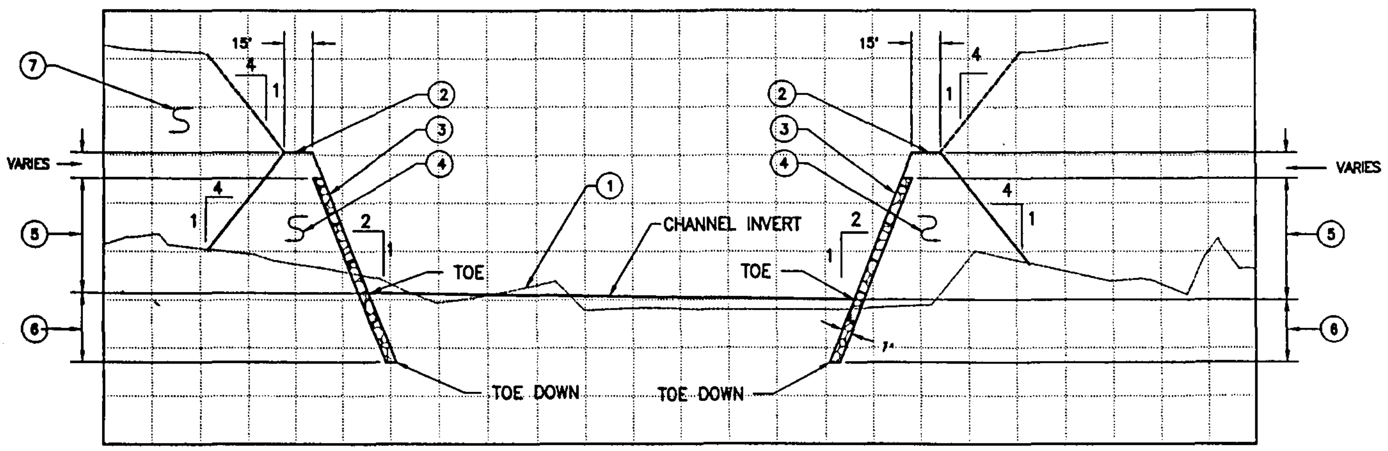
1 EXISTING GROUND
2 15 FOOT WIDE CORRIDOR TO ACCOMMODATE RECREATIONAL TRAIL SYSTEM AND/OR MAINTENANCE ACCESS
3 1 FOOT THICK ROCK FILLED WIRE BASKET BANK ARMORING
4 GRADE FROM TOE OF SLOPE TO CHANNEL DAYLIGHT
5 ARMORED CHANNEL HEIGHT, SEE TABLE D-1
6 TOE-DOWN DEPTH, SEE TABLE D-1



3 CHANNEL IMPROVEMENT DETAIL
SCALE: 1" = 50'-0"

KEYNOTES:

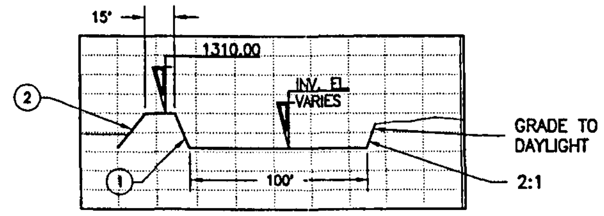
1 EXISTING GROUND
2 15 FOOT WIDE CORRIDOR TO ACCOMMODATE RECREATIONAL TRAIL SYSTEM AND/OR MAINTENANCE ACCESS
3 1 FOOT THICK ROCK FILLED WIRE BASKET BANK ARMORING
4 EARTHEN FILL MATERIAL
5 ARMORED CHANNEL HEIGHT
6 TOE-DOWN DEPTH
7 TIE IN TO EXISTING BANK PROTECTION, TOE DOWN MAY NEED TO BE EXTENDED, POT HOLE FOR FINAL DESIGN



4 CHANNEL IMPROVEMENT DETAIL
SCALE: 1" = 50'-0"

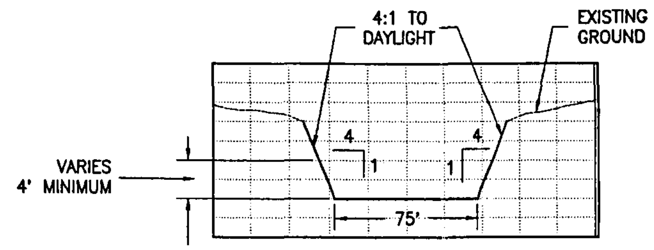
KEYNOTES:

1 EXISTING GROUND
2 15 FOOT WIDE CORRIDOR TO ACCOMMODATE RECREATIONAL TRAIL SYSTEM AND/OR MAINTENANCE ACCESS
3 1 FOOT THICK ROCK FILLED WIRE BASKET BANK ARMORING
4 EARTHEN FILL MATERIAL
5 ARMORED CHANNEL HEIGHT
6 TOE-DOWN DEPTH



5 COLLECTOR CHANNEL SECTION

1 2:1 SIDE SLOPES
2 4:1 SIDE SLOPE TO EXISTING GROUND



6 LOW FLOW CHANNEL SECTION

ARMORED CHANNEL HEIGHT AND TOW DOWN DEPTH				
BEGINNING STA 1	ENDING STA 2	AVERAGE ARMORED CHANNEL HEIGHT (ft) 3	AVERAGE TOE DOWN DEPTH (z:1) 4	AVERAGE ARMORED CHANNEL HEIGHT +TOE DOWN DEPTH (ft) 5
26+30	43+00	10.5	10	20.50
43+00	55+00	8	10	18.00
61+50	69+50	11	10	21.00
78+50	86+50	7	10	17.00
88+50	108+50	8	13	21.00
108+50	126+60	7.5	13	20.50
126+60	132+00	7.5	10.5	18.00
135+00	140+90	9.5	10.5	20.00
143+80	163+00	11	10.5	21.50
163+00	182+70	7.5	10.5	18.00
182+70	222+50	7	14	21.00
222+50	248+50	9.5	14	23.50
248+50	258+00	9.5	10.5	20.00
258+00	311+00	8	12	20.00
379+00	384+50	7	8.5	15.50

COLUMN 3 – AS MEASURED FROM MINIMUM CHANNEL INVERT ELEVATION TO FREEBOARD ELEVATION.

COLUMN 4 – AS MEASURED FROM CHANNEL INVERT.

NO.	REVISION	BY	DATE
3	ADDED STATION 379+00 TO 384+50	P.J.E.	05/25/00
2	RED LINE CORRECTIONS	P.J.E.	04/10/00
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

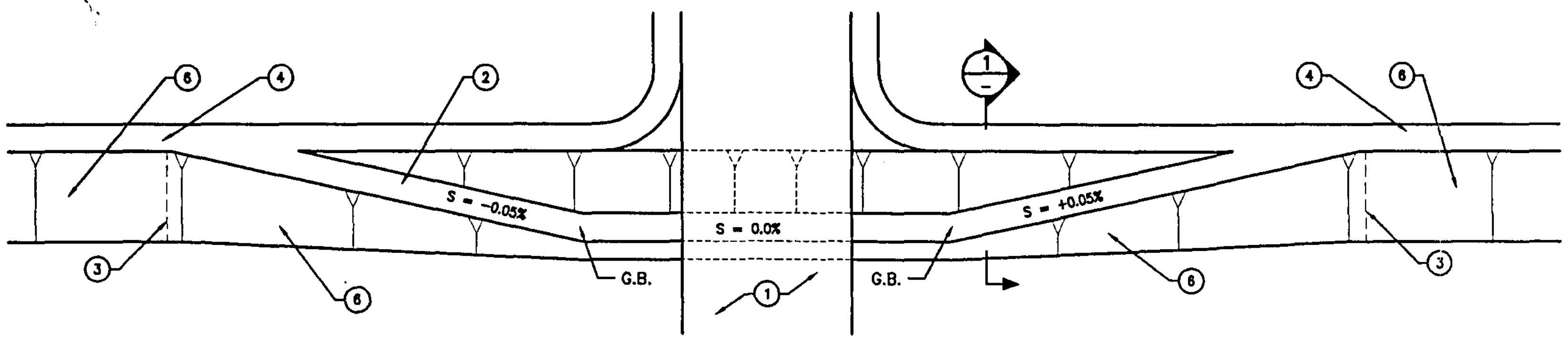
MIDDLE NEW RIVER
WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	P.J.E./C.A.S.	05/05/99
	DRAWN	P.W./P.R.	05/05/99
	CHECKED	S.S.S./P.J.E.	05/05/99

Stantec

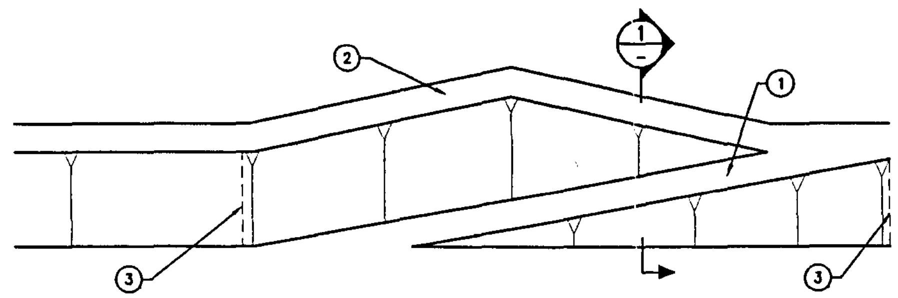
PLAN AND PROFILE
TYPICAL ARMORING DETAILS

SHEET 12 OF 23



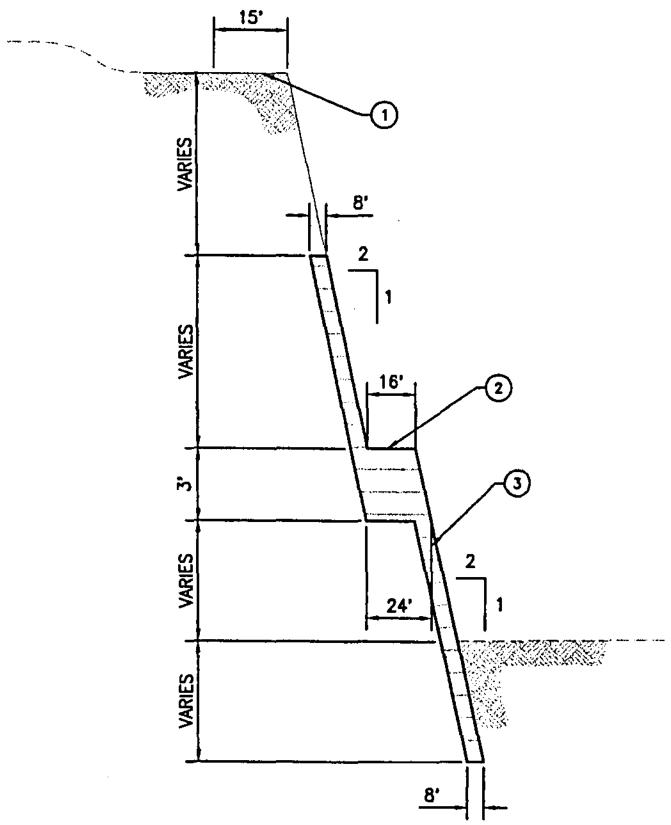
1. BRIDGE DECK
2. TRAIL/ACCESS RAMP
3. TIE SOIL CEMENT ARMORING TO ROCK FILLED WIRE BASKETS
4. AREA TO ACCOMMODATE MULTI-USE RECREATIONAL TRAIL
5. SOIL CEMENT ARMORING
6. ROCK FILLED WIRE BASKETS

(1/–) MULTI-USE TRAIL CROSSING DETAIL AT BRIDGES
SCALE: 1" = 50'

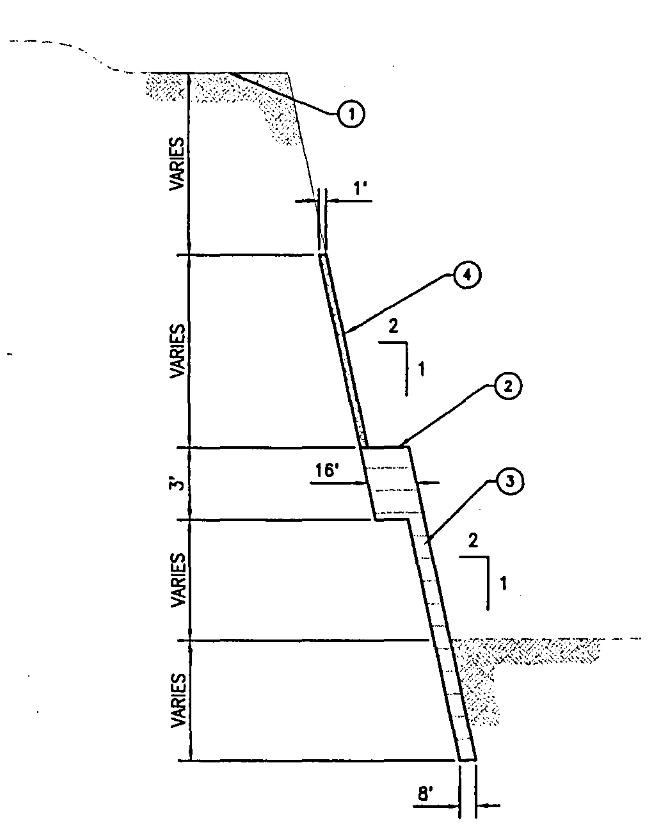


1. TRAIL/ACCESS RAMP. MAXIMUM RAMP GRADE =10%
2. AREA TO ACCOMMODATE MULTI-USE USE RECREATIONAL TRAIL
3. TIE SOIL CEMENT ARMORING TO ROCK FILLED WIRE BASKETS

(2/–) ACCESS RAMP DETAIL
SCALE: 1" = 50'



SOIL CEMENT OPTION



SOIL CEMENT AND ROCK FILLED WIRE BASKETS OPTION

(1/–) MULTI-USE TRAIL CROSSING OR RAMP DETAILS

(1) AREA TO ACCOMMODATE MULTI-USE RECREATIONAL TRAIL
(2) TRAIL/ACCESS RAMP
(3) SOIL CEMENT ARMORING
(4) ROCK FILLED WIRE BASKETS

NO.	REVISION	BY	DATE
3			
2	RED LINE CORRECTIONS	P.J.E.	04/10/00
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

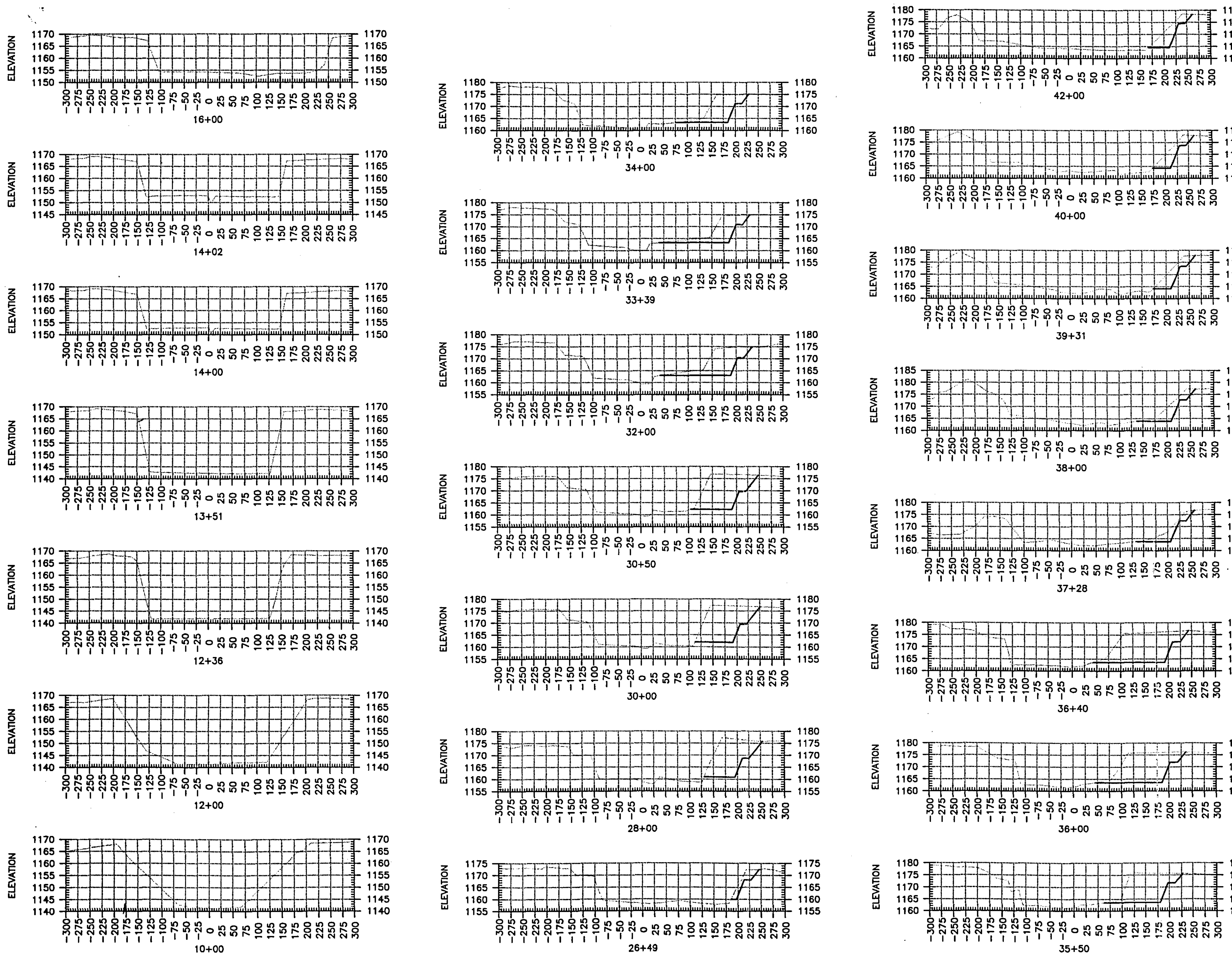
	BY	DATE
DESIGNED	P.J.E./C.A.S.	05/24/99
DRAWN	P.J.R.	05/24/99
CHECKED	S.S.S./P.J.E.	05/24/99

PRELIMINARY NOT FOR CONSTRUCTION

Stantec

DETAIL SHEET
MULTI-USE TRAIL CROSSING

SHEET 13 OF 23



NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

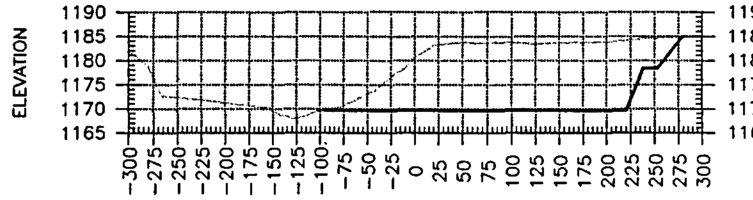
MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	C.A.S.	05/18/99
	DRAWN	C.A.S.	05/18/99
	CHECKED	S.S.S./P.J.E.	05/18/99

Stantec

CROSS SECTIONS
STA. 10+00 TO 42+00

SHEET 14 OF 23



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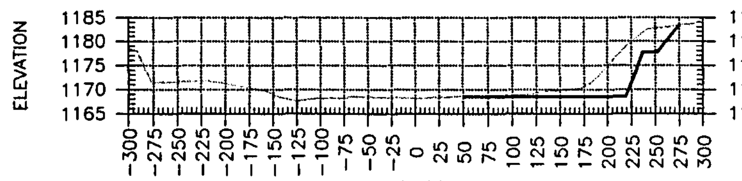
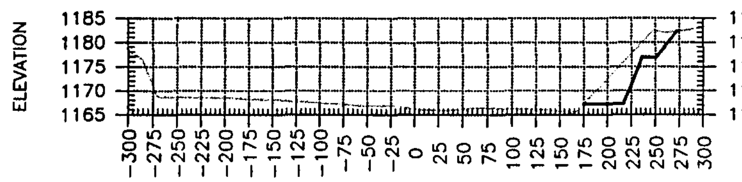
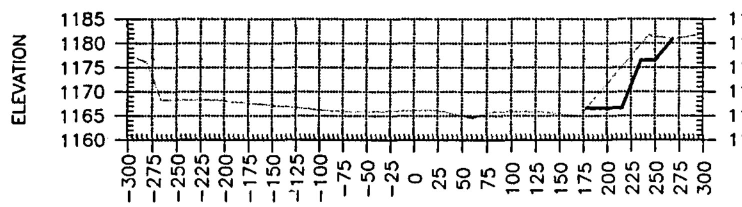


50+00



48+00



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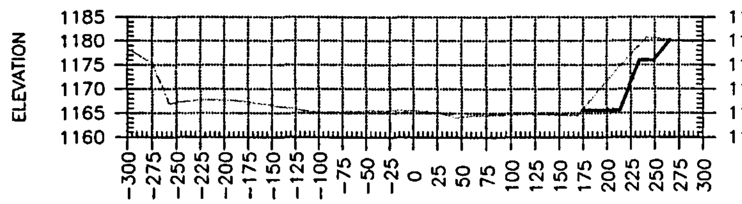

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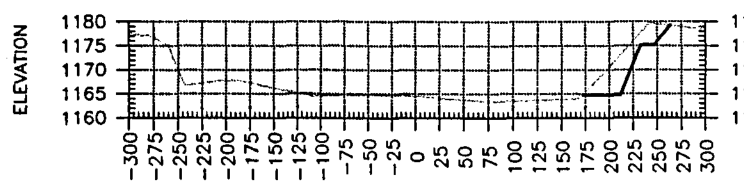

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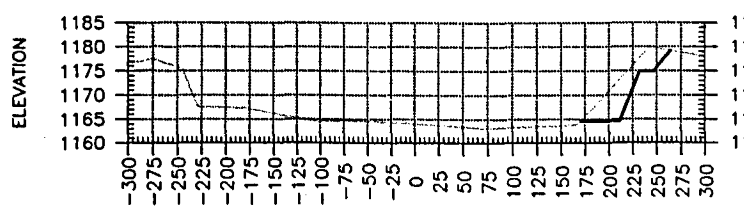

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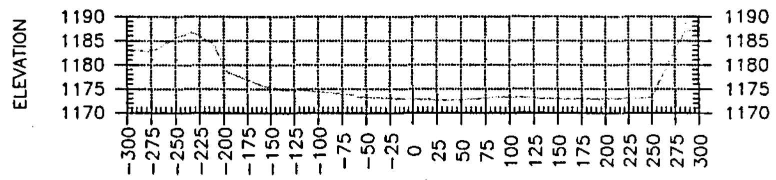

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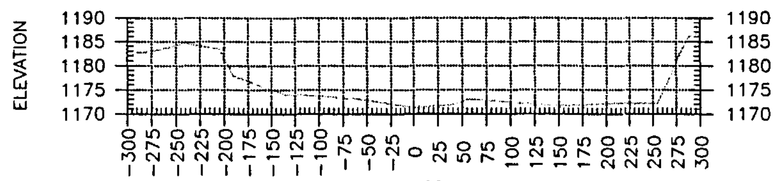

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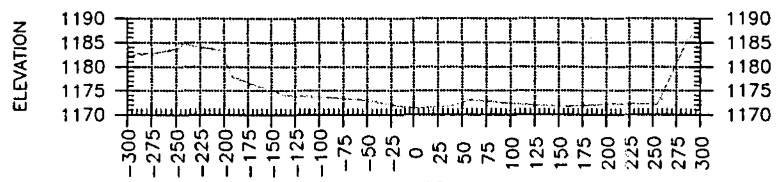

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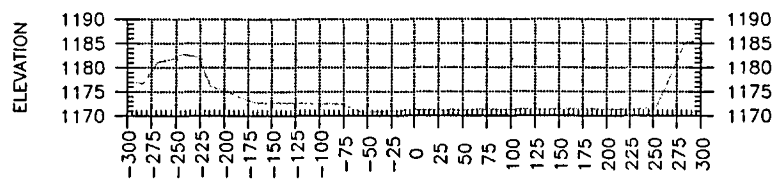

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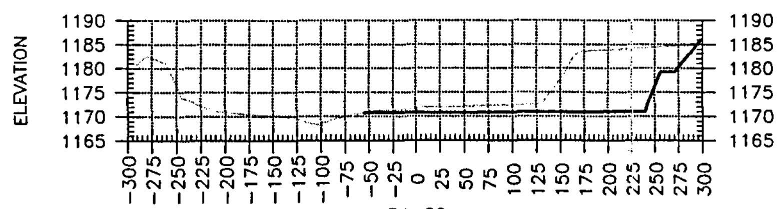

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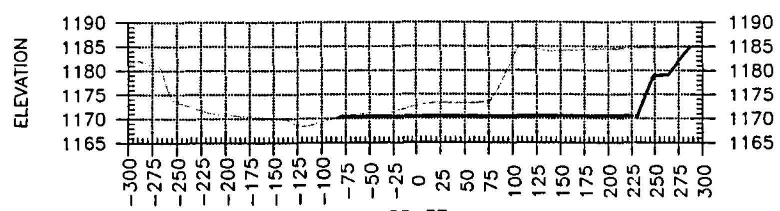

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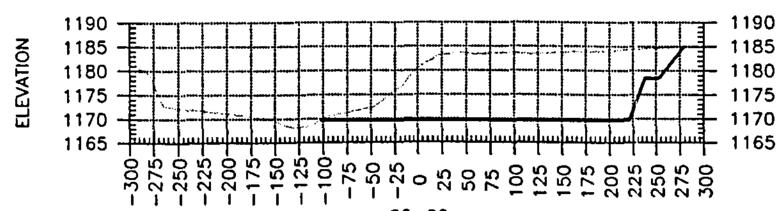

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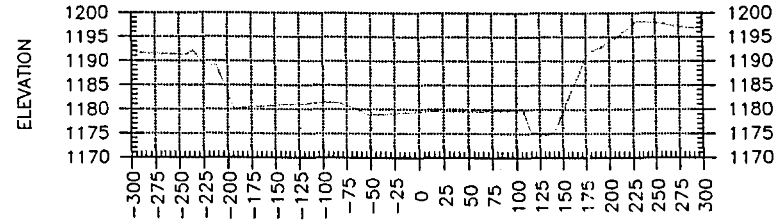

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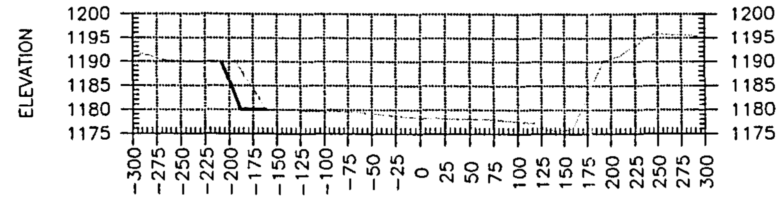

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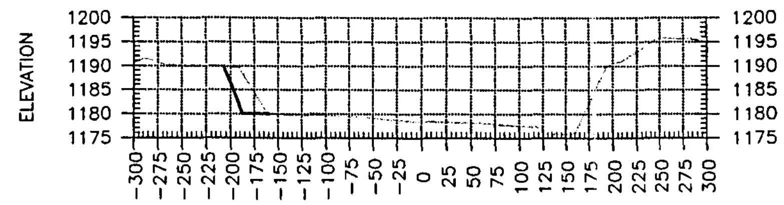

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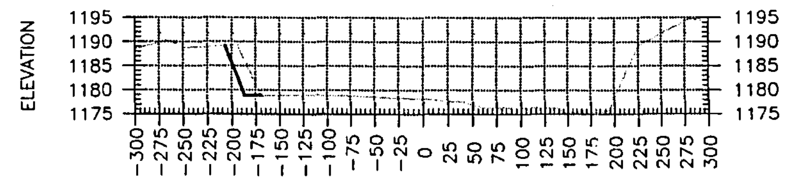

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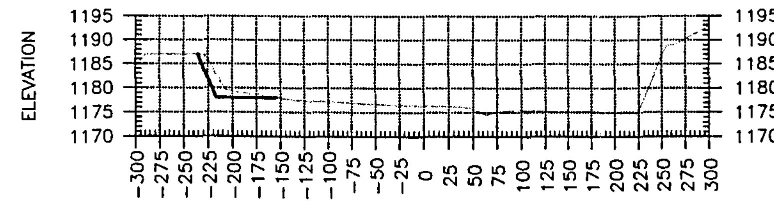

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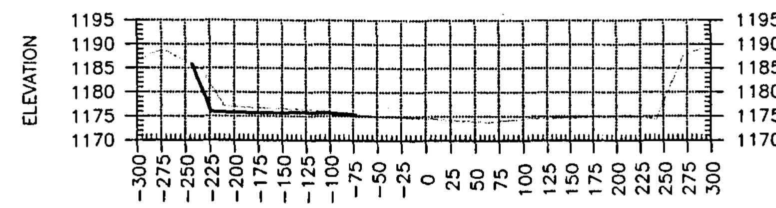

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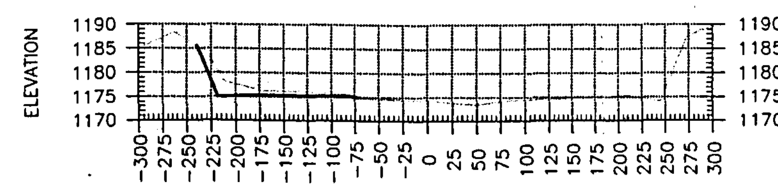

62+00

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER
WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

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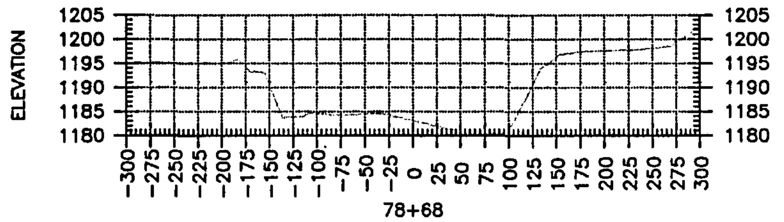
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	C.A.S.	05/18/99
	DRAWN	C.A.S.	05/18/99
	CHECKED	S.S.S./P.J.E.	05/18/99

Stantec

CROSS SECTIONS
STA. 43+34 TO 70+00

SHEET 15 OF 23



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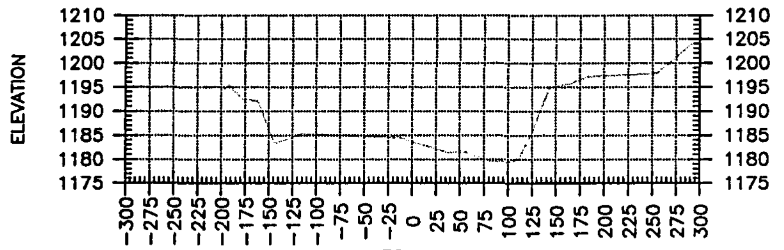

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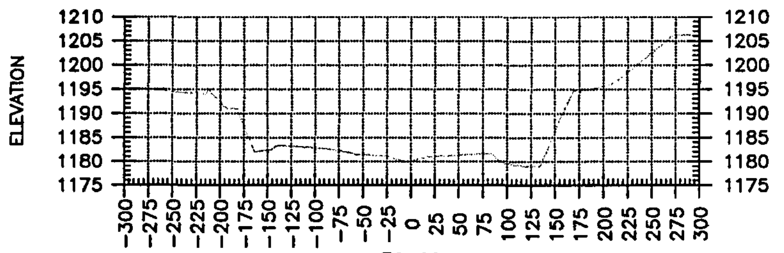

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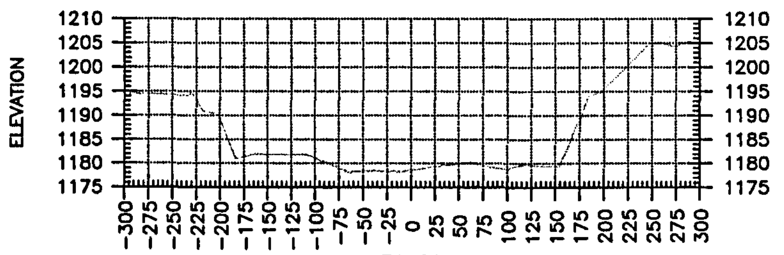
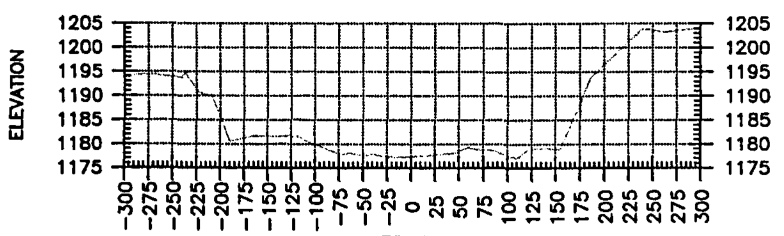


74+00



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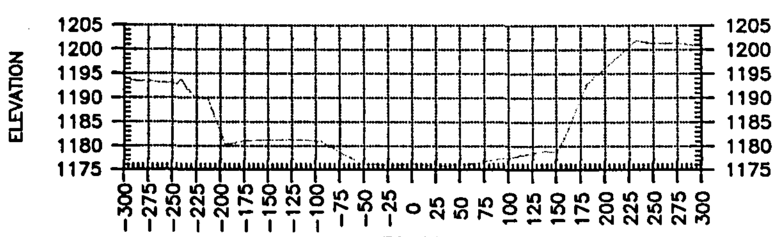

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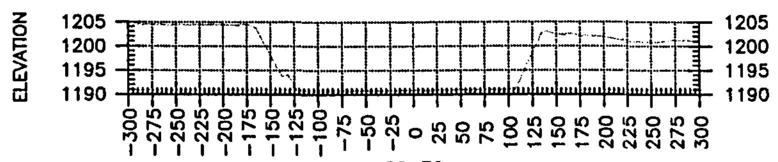

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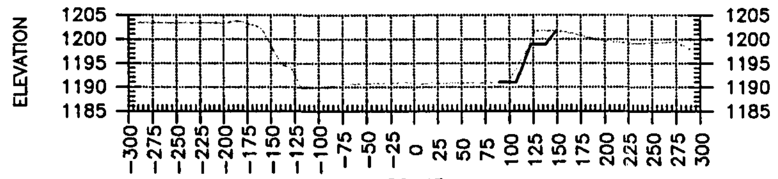

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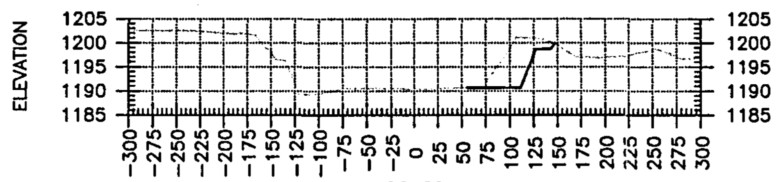

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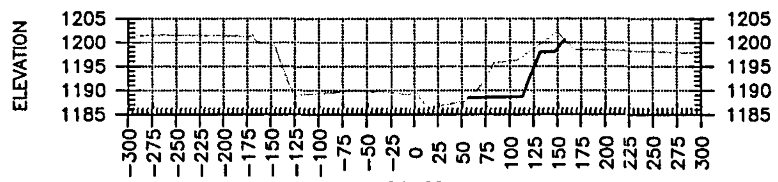

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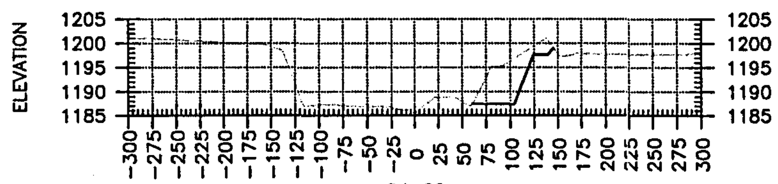

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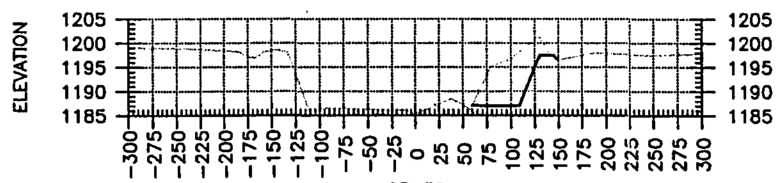

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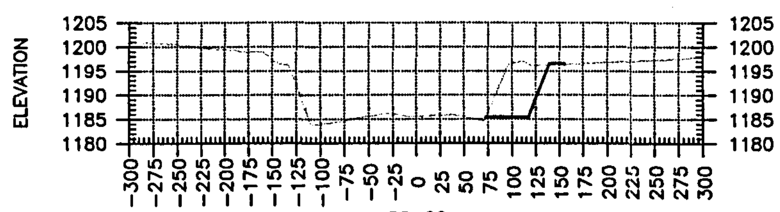

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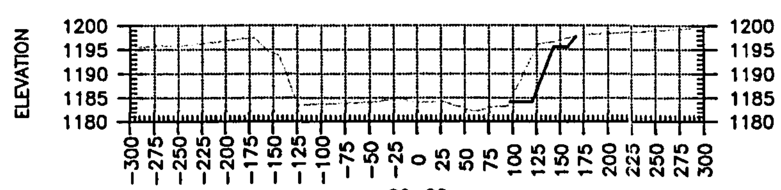

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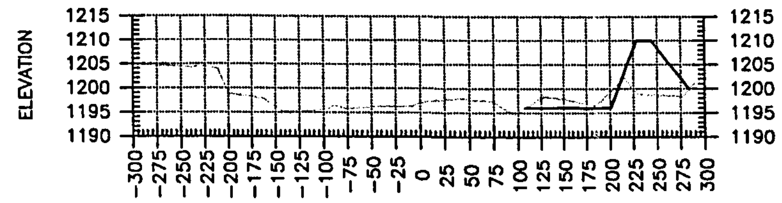

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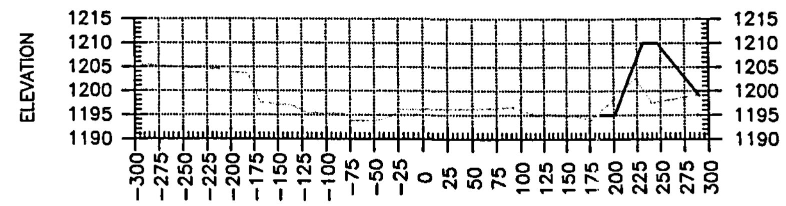

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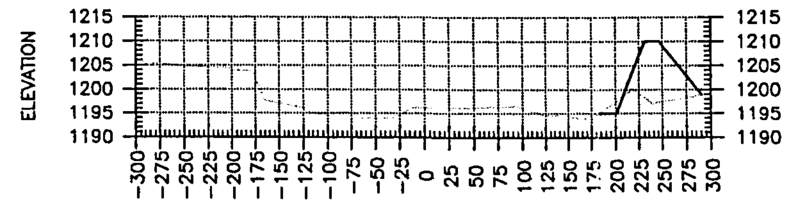

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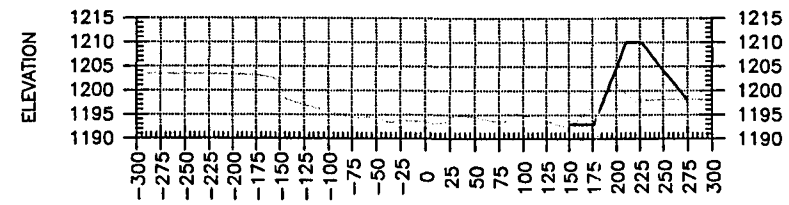

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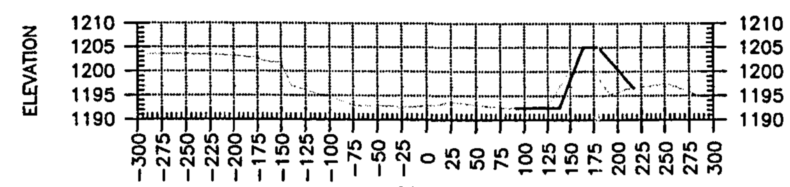

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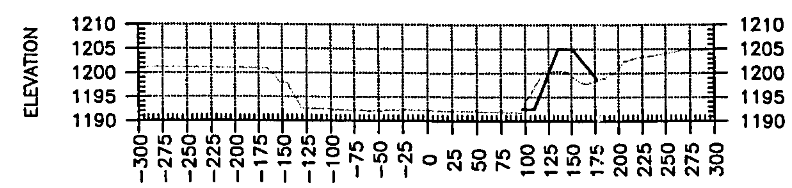

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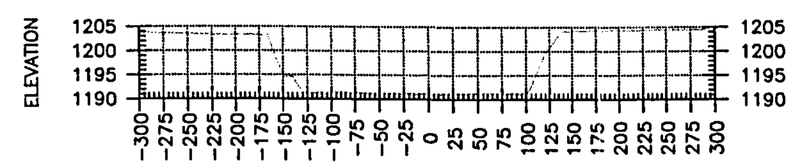

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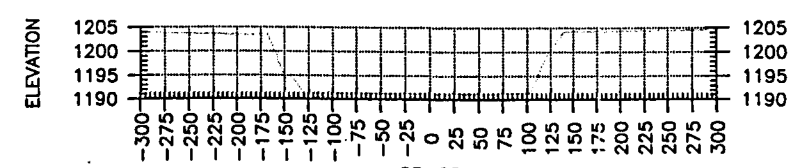


88+00

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

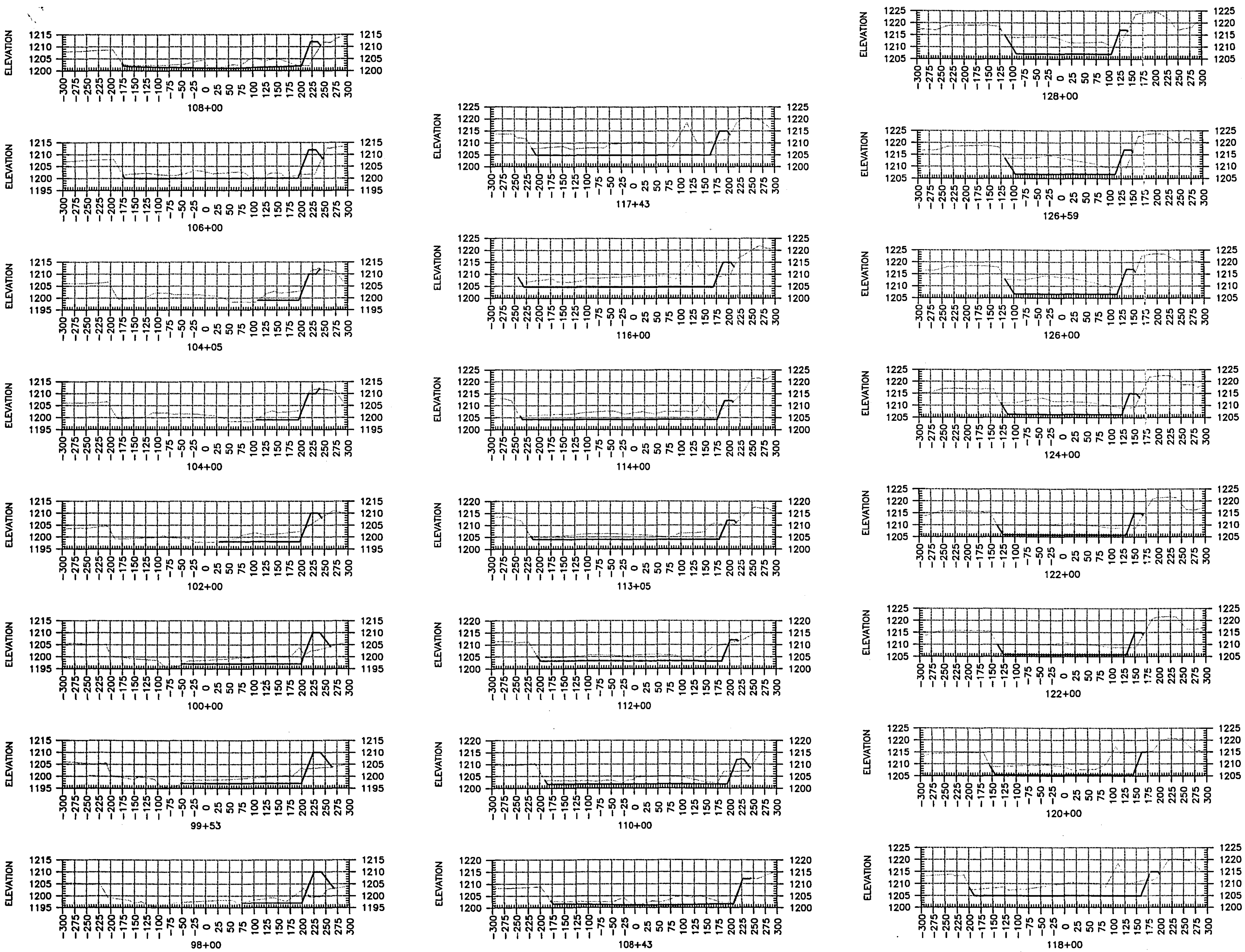
MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	C.A.S.	05/18/99
	DRAWN	C.A.S.	05/18/99
	CHECKED	S.S.S./P.J.E.	05/18/99

Stantec

CROSS SECTIONS
STA. 72+00 TO 96+00

SHEET 16 OF 23



NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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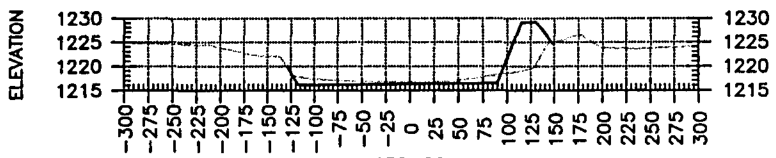
Stantec

CROSS SECTIONS
STA. 98+00 TO 128+00

SHEET 17 OF 23



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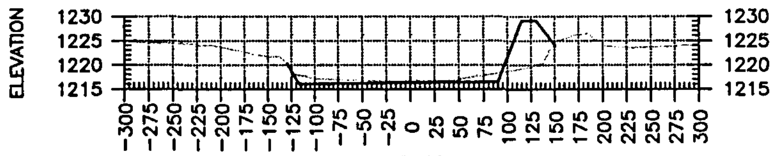
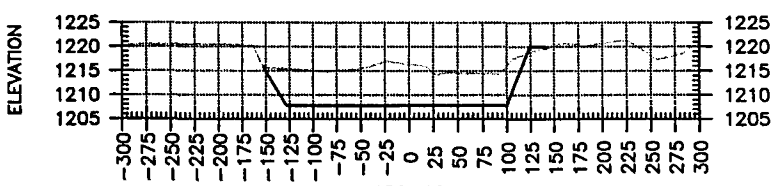


137+89

136+00

135+13

134+00



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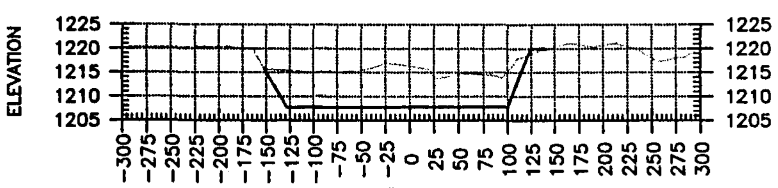

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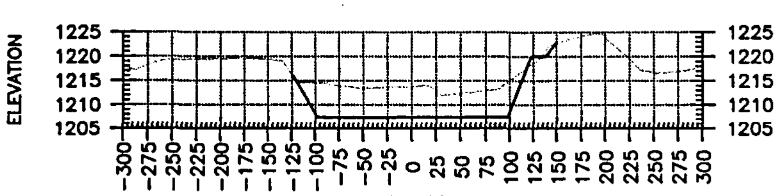

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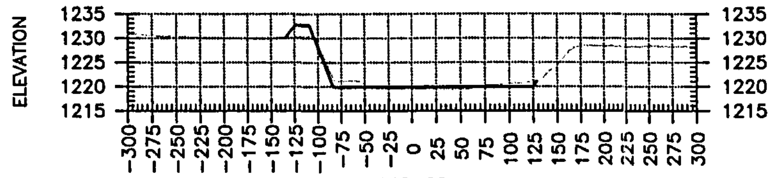

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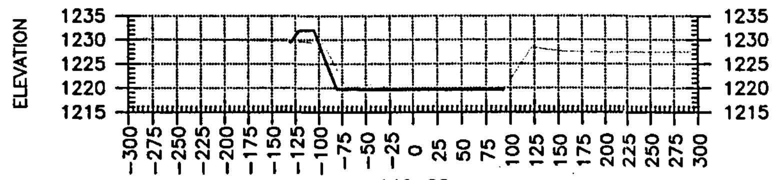

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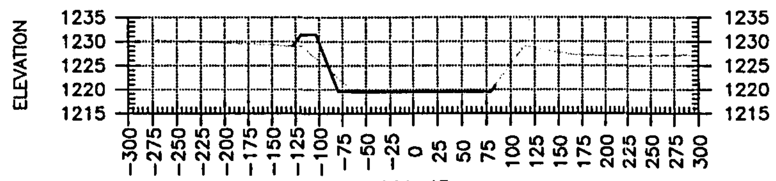

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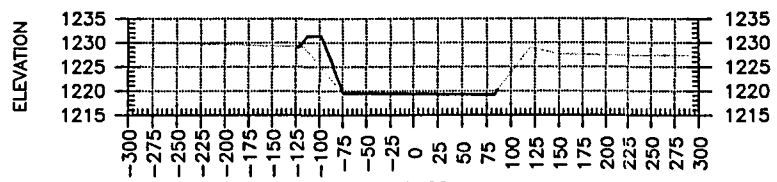

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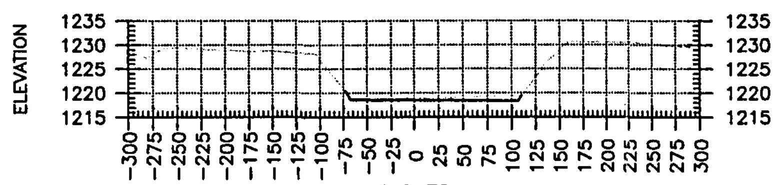

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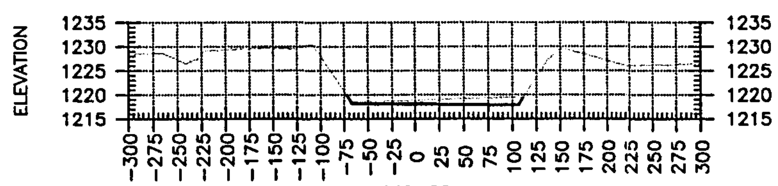

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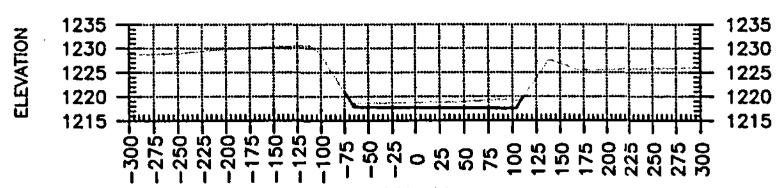

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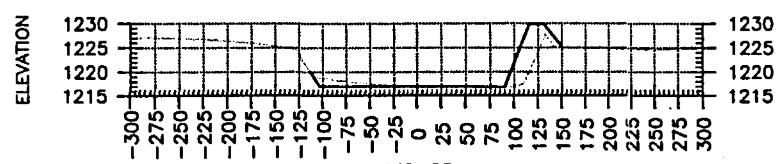

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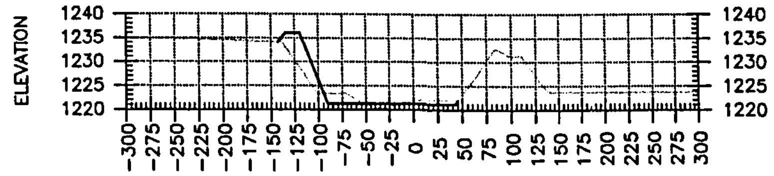

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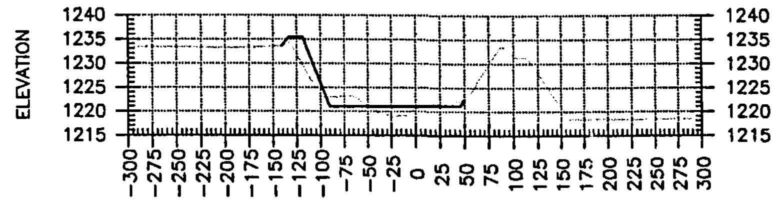

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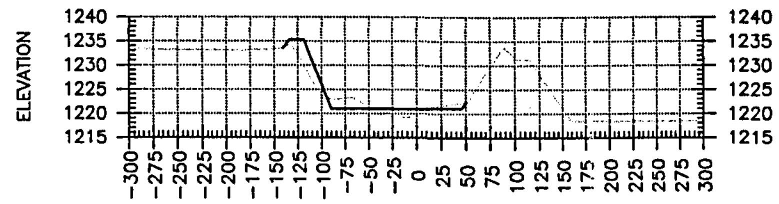

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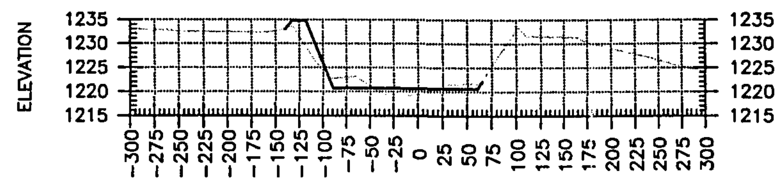

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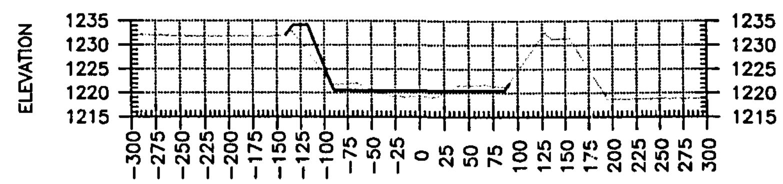

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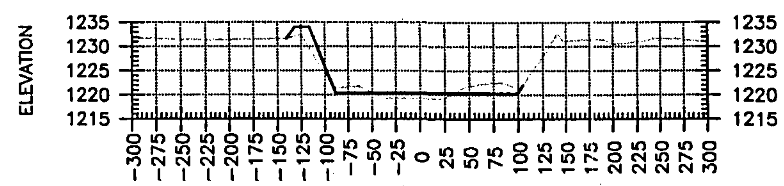

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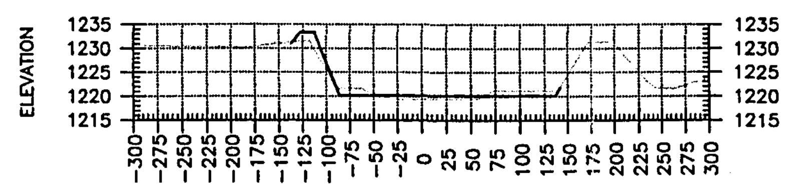

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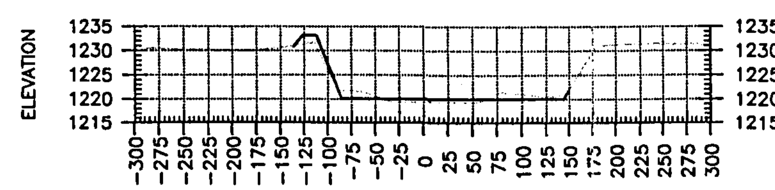

149+57

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	C.A.S.	05/18/99
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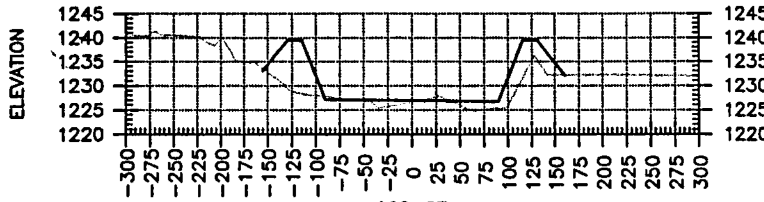
CHECKED	S.S.S./P.J.E.	05/18/99

Stantec

CROSS SECTIONS
STA. 130+00 TO 158+00

SHEET 18 OF 23



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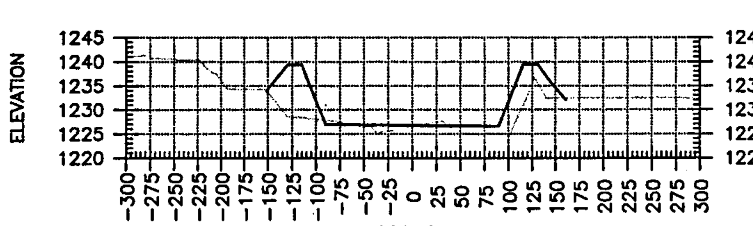

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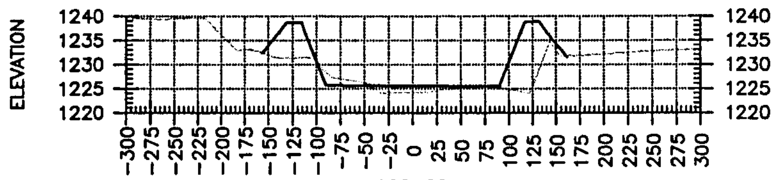

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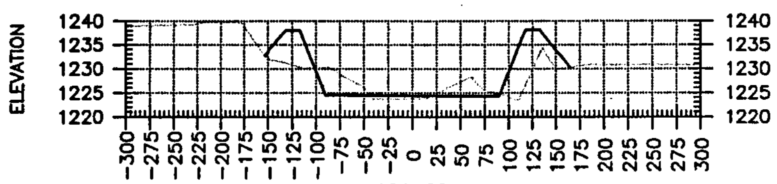

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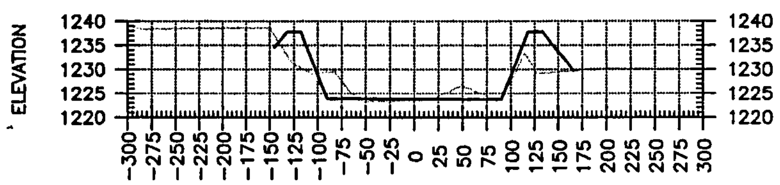

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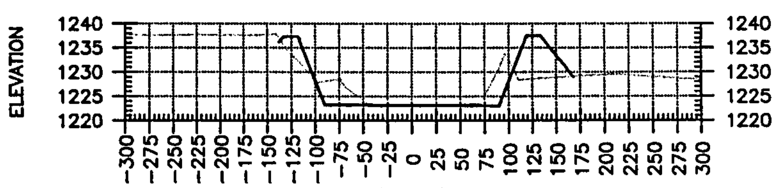

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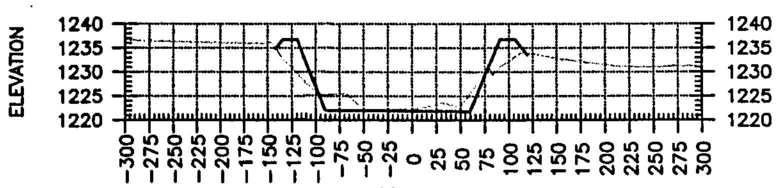

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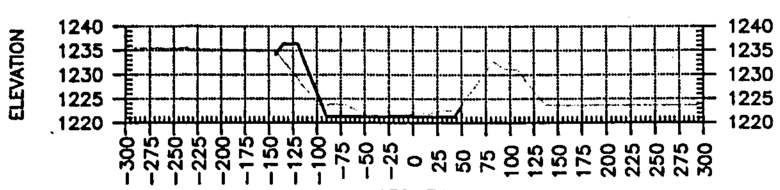

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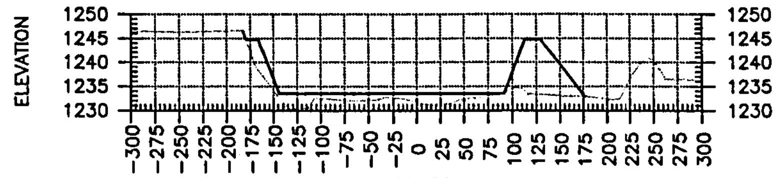

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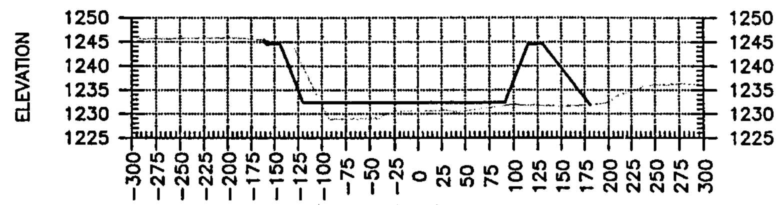

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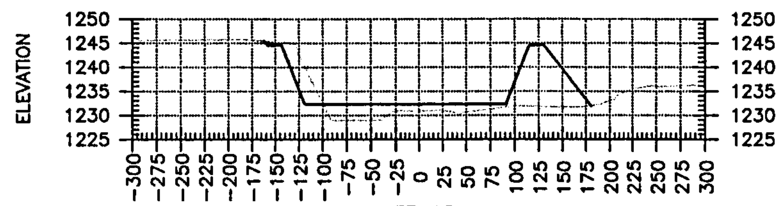

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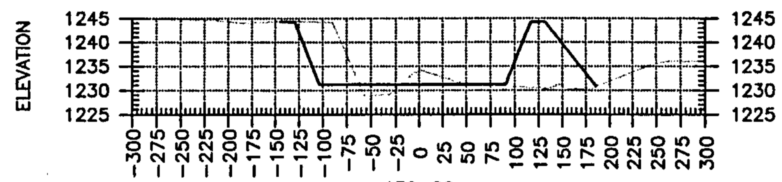

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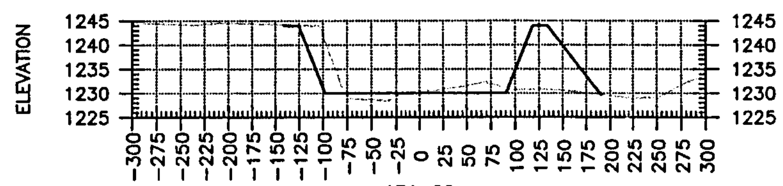

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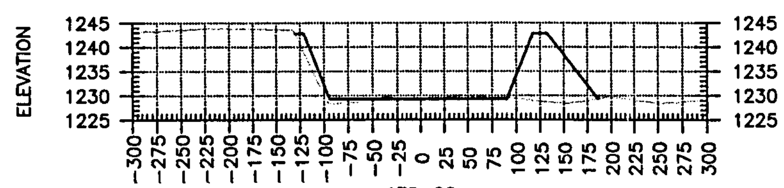

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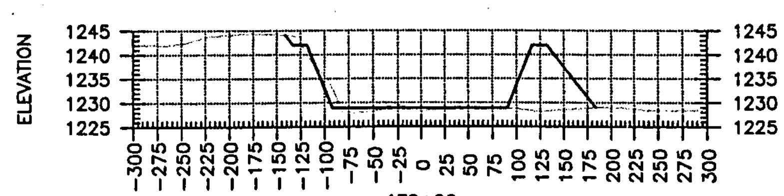

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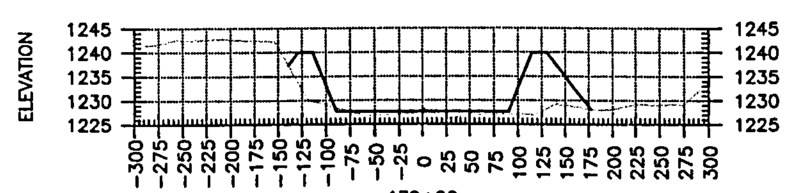

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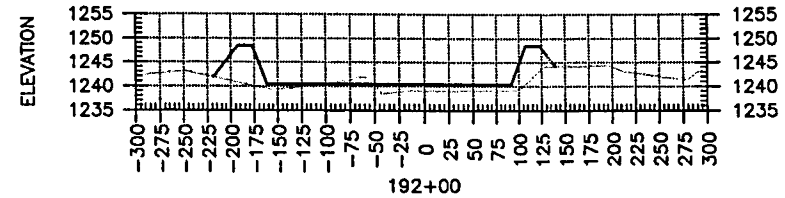

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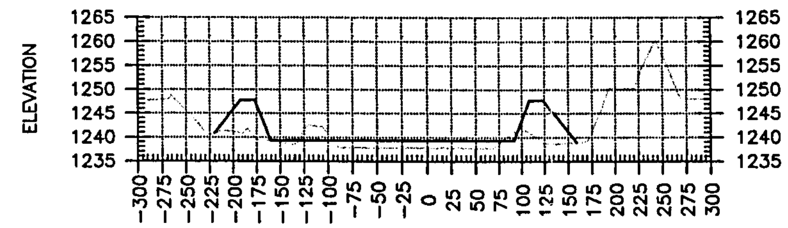

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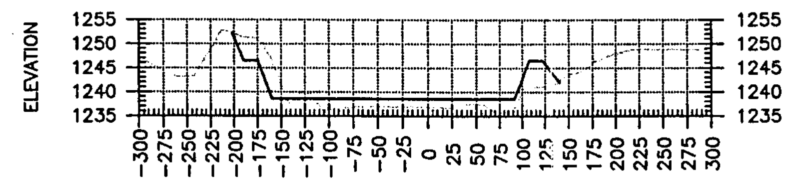

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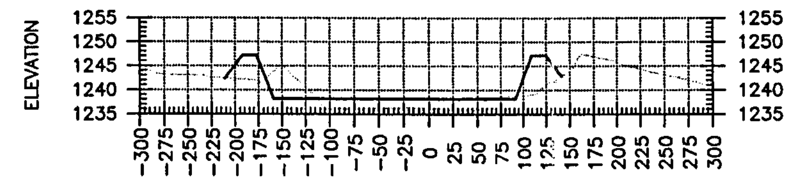

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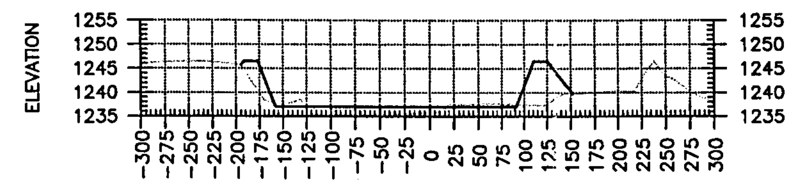

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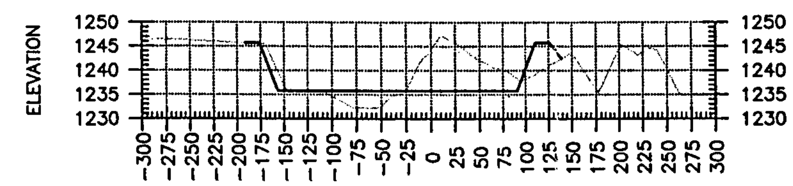

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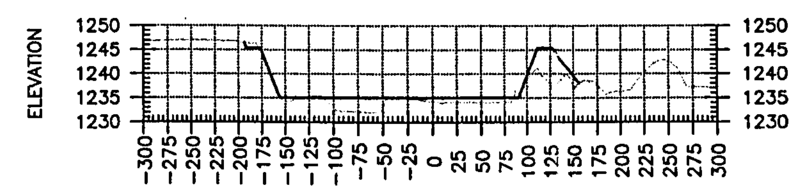

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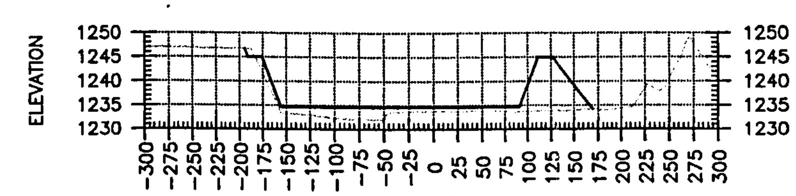

182+00

NO.	REVISION	BY	DATE
3			
2			
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

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	CHECKED	S.S.S./P.J.E.	05/18/99

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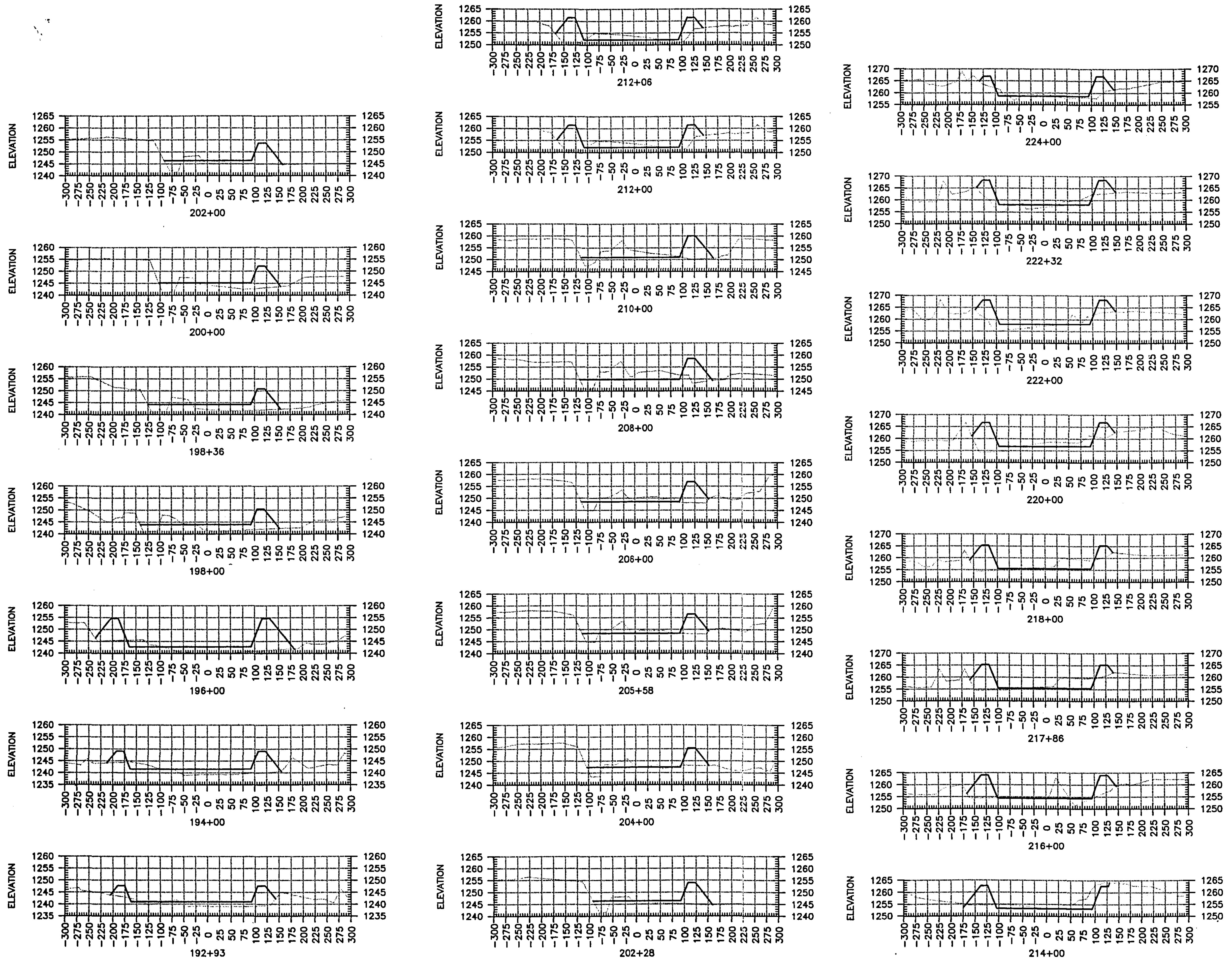
CROSS SECTIONS
STA. 158+72 TO 192+00

SHEET 19 OF 23



NO.	REVISION	BY	DATE
3			
2			
1	RED LINE CORRECTIONS	P.J.E.	01/10/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

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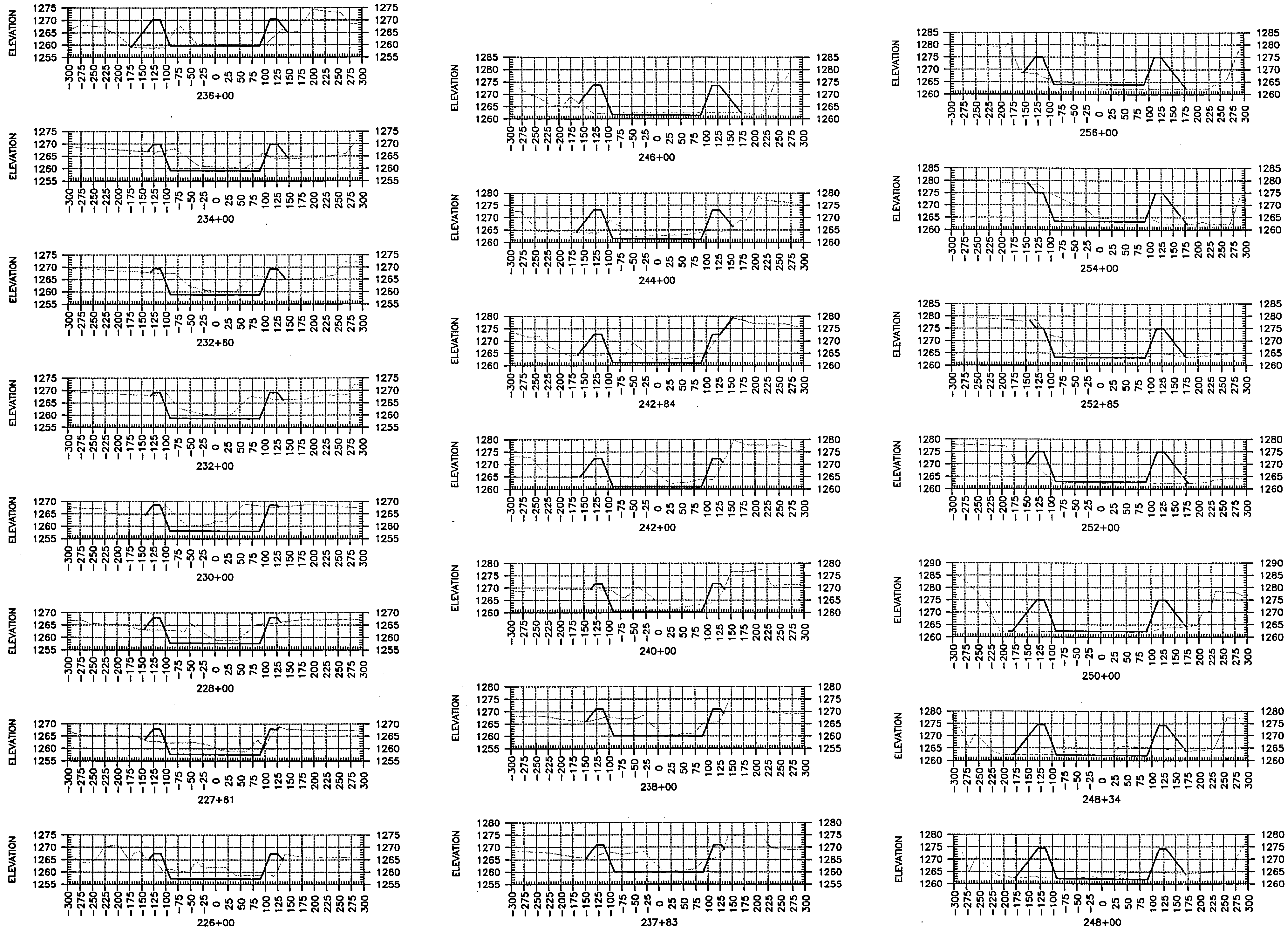
Stantec

CROSS SECTIONS
STA. 192+93 TO 224+00

SHEET 20 OF 23



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

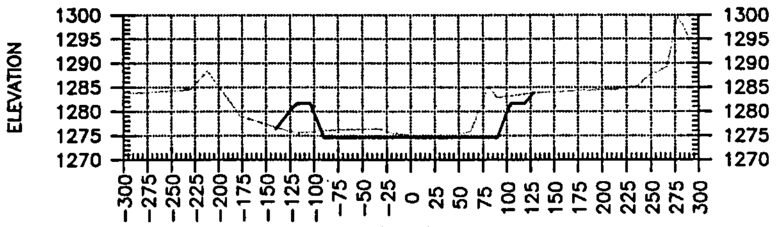
MIDDLE NEW RIVER
WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	C.A.S.	05/18/99
	DRAWN	C.A.S.	05/18/99
	CHECKED	S.S.S./P.J.E.	05/18/99

Stantec

CROSS SECTIONS
STA. 226+00 TO 256+00

SHEET 21 OF 23



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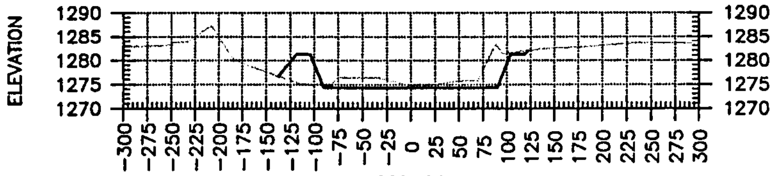

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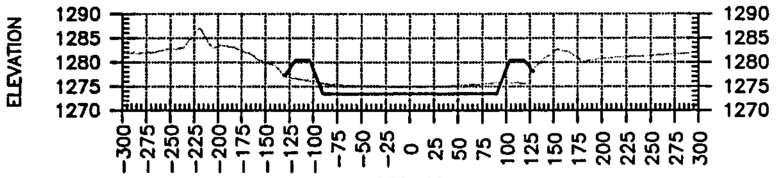

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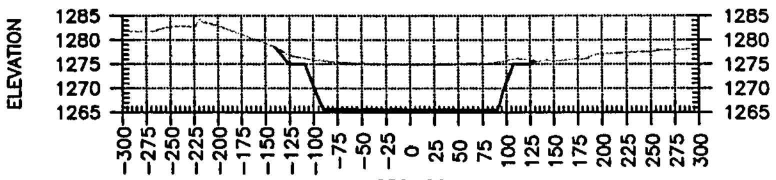

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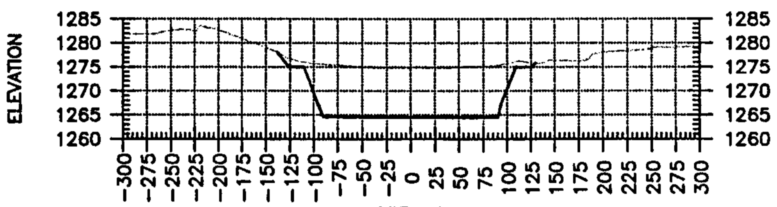

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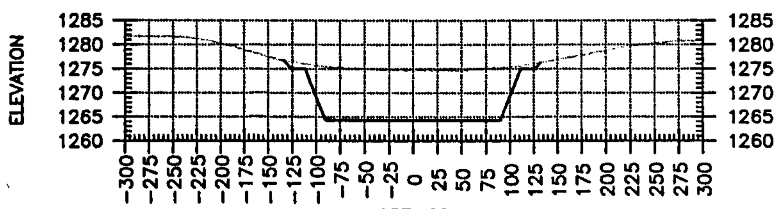

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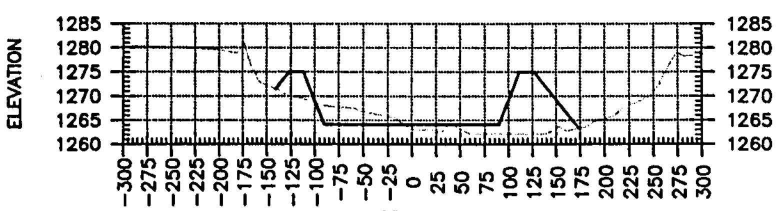

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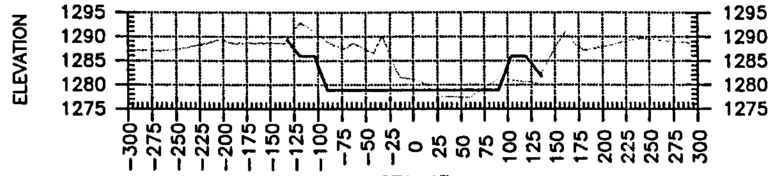

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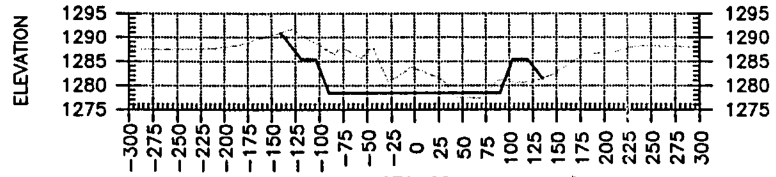

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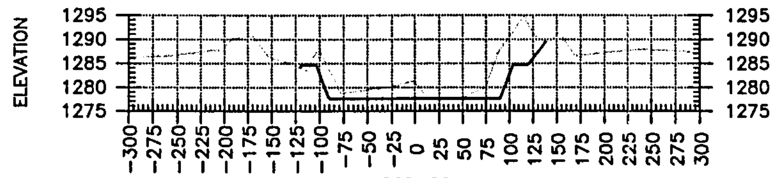

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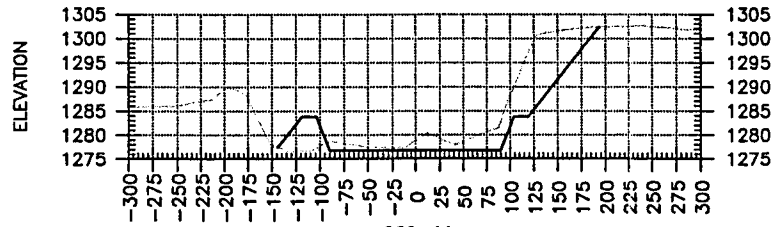

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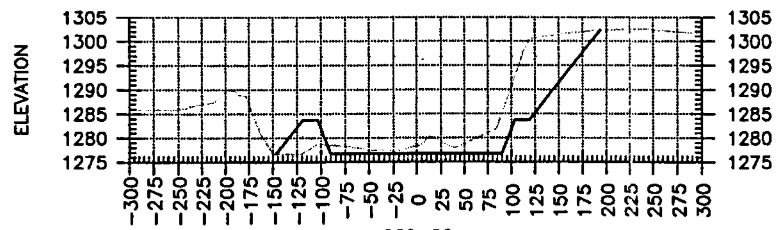

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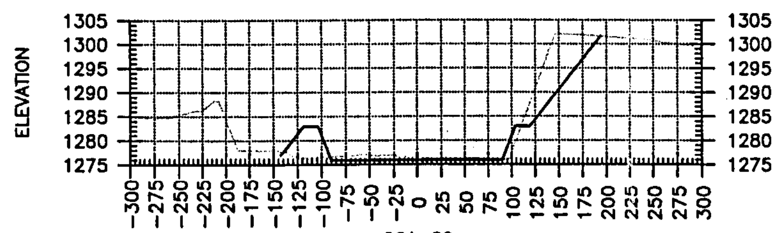

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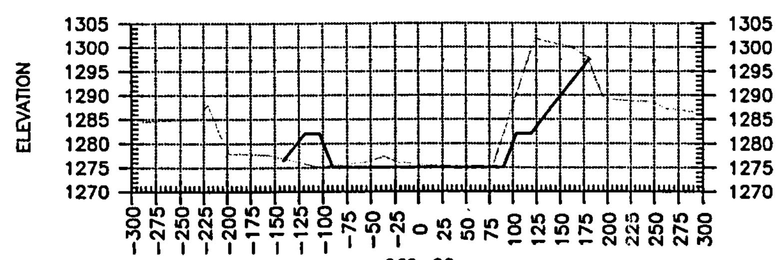

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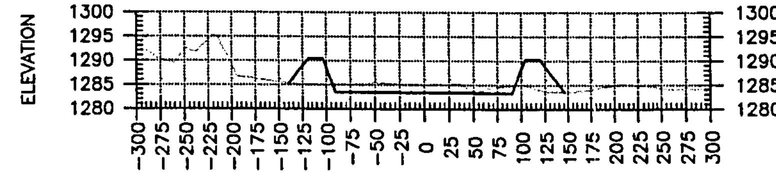

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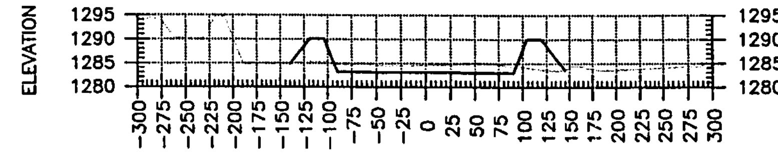

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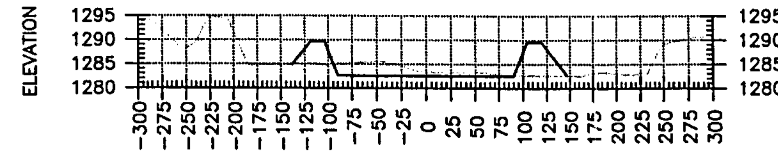

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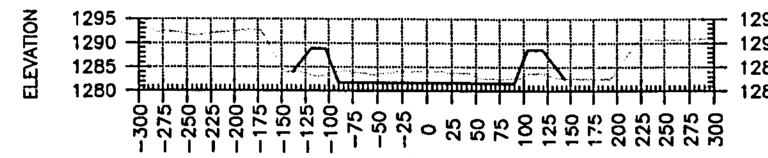

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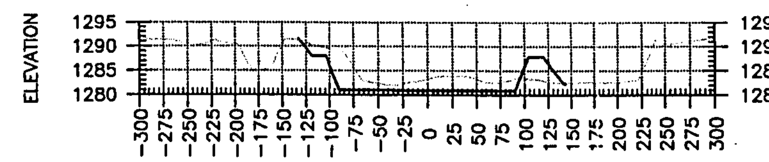

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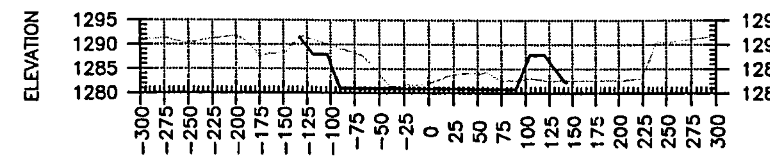

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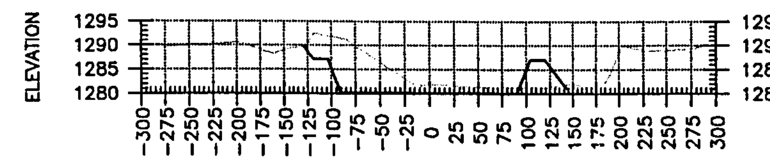

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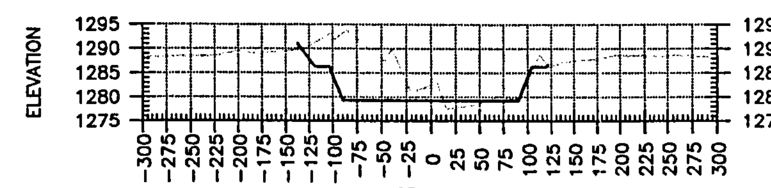

272+00

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
PROJECT NO. 28900058

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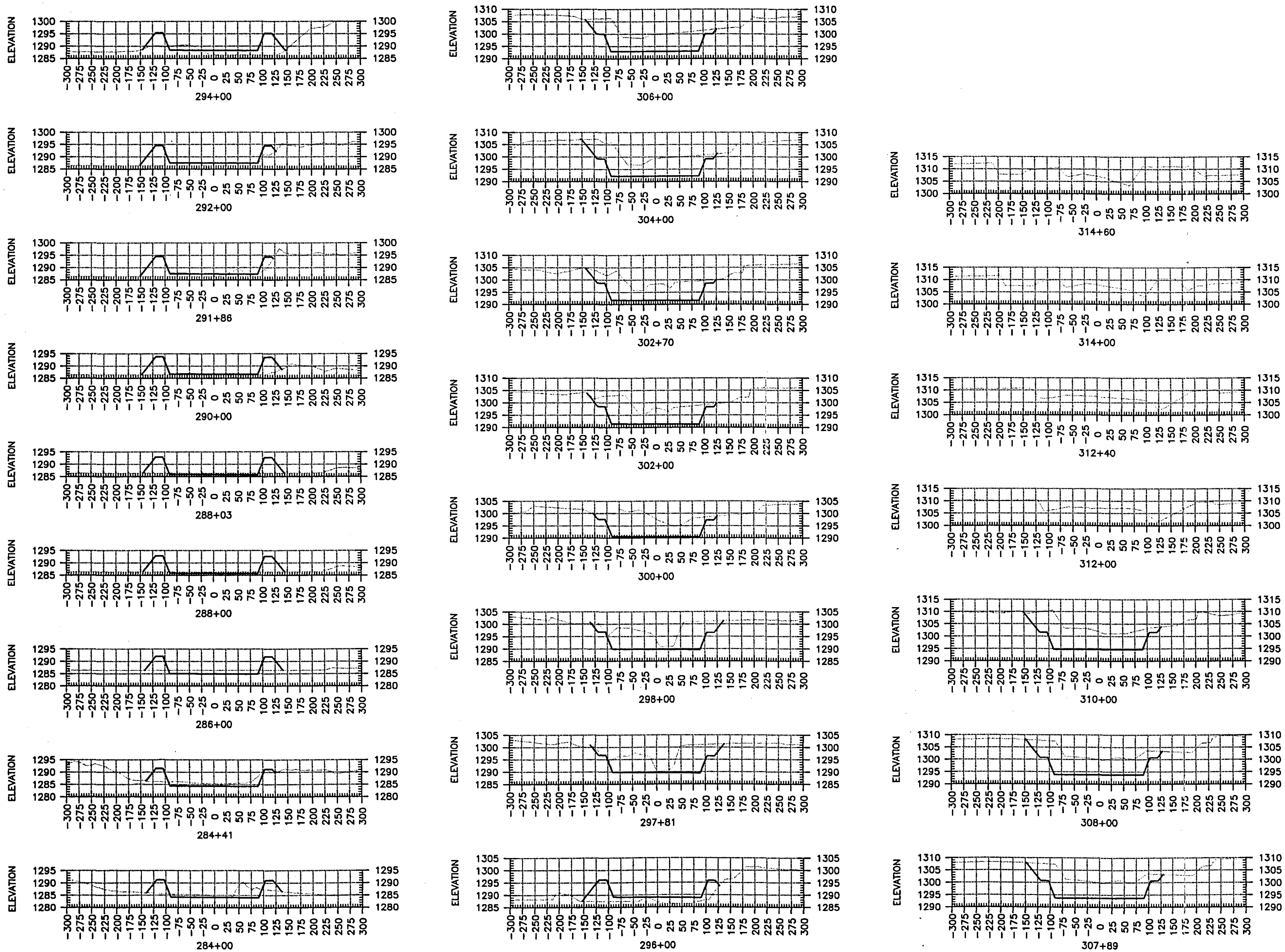
Stantec

CROSS SECTIONS
STA. 256+70 TO 282+00

SHEET 22 OF 23



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN
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Stantec

CROSS SECTIONS
STA. 264+00 TO 314+60

SHEET 23 OF 23

Construction Cost Estimates

Estimates of probable construction cost were prepared for the preferred alternatives. Quantities are calculated for earthwork (channel excavation and/or fill or back fill) volume of bank armoring material required, volume of drop structure material required (if applicable) for each Improvement Segment.

Unit costs were compiled from a Stantec database, including bid tabs for the City of Phoenix, the City of Scottsdale and the Arizona Department of Transportation construction projects for 1998. Table 2-2 lists a summary of unit cost utilized to determine cost estimates for each alternative.

TABLE 2-2
SUMMARY OF UNIT COST
PREFERRED ALTERNATIVE

Item	Unit	Cost
Earth Work	Cubic Yards (cy)	$3.00/cy
Soil Cement	Cubic Yards (cy)	$35.00/cy
Roller Compacted Cement	Cubic Yards (cy)	$50.00/cy
Gabion Mattress	Cubic Yards (cy)	$70.00/cy

Given the level of design (conceptual) of the preferred alternative, a contingency cost is applied to account for design detail that is not undertaken at this stage. Contingency cost is estimated at 15 percent of the cost of the proposed channel improvements. Contingency cost also includes relocation of utilities.

Cost estimates developed for each Improvement Segment reflect the proposed channel elements over the length of a given segment. Cost estimates do not include construction activities associated with development adjacent to proposed improvements. The overall total for proposed master plan improvements is $12,163,000. Table 2-3 through Table 2-9 provides cost estimates for the preferred alternative improvements.

TABLE 2-3
IMPROVEMENT SEGMENT 1 STA 26+30 TO STA 55+00

Pay Item No.	Description	Quantity	Unit	Engineer's Estimate Unit Price	Amount
	Earth Work (Excavation)	99,213	CY	$3.00	$297,639.00
	Earth Work(Fill)	5	CY	$3.00	$15.00
	Gabion Mattress	4249	CY	$70.00	$297,430.00
	Access Ramp	2	LS	$96,500.00	$193,000.00
	Misc. Work (15%)	1	LS	$135,012.60	135,012.60
	SUBTOTAL OF BID ITEMS				$1,035,096.60

TABLE 2-4
IMPROVEMENT SEGMENT 2 STA 61+50 TO STA 69+50

Pay Item No.	Description	Quantity	Unit	Engineer's Estimate Unit Price	Engineer's Estimate Amount
	Earth Work (Excavation)	5,294	CY	$3.00	$15,882.00
	Earth Work(Fill)	1	CY	$3.00	$3.00
	Gabion Mattress	1016	CY	$70.00	$71,120.00
	Access Ramp	2	LS	$96,500.00	$193,000.00
	Misc. Work (15%)	1	LS	$42,000.75	$42,000.75
	SUBTOTAL OF BID ITEMS				$322,005.75

TABLE 2-5
IMPROVEMENT SEGMENT 3 STA 78+50 TO STA 86+50

Pay Item No.	Description	Quantity	Unit	Engineer's Estimate Unit Price	Engineer's Estimate Amount
	Earth Work (Excavation)	11,371	CY	$3.00	$34,113.00
	Earth Work(Fill)	139	CY	$3.00	$417.00
	Gabion Mattress	1126	CY	$70.00	$78,820.00
	Trail Crossing at Bridge	1	LS	$157,000.00	$157,000.00
	Misc. Work (15%)	1	LS	$40,552.50	$40,552.50
	SUBTOTAL OF BID ITEMS				$310,902.50

TABLE 2-6
IMPROVEMENT SEGMENT 4 STA 88+50 TO STA 140+90

Pay Item No.	Description	Quantity	Unit	Engineer's Estimate Unit Price	Amount
	Earth Work (Excavation)	141,123	CY	$3.00	$423,369.00
	Earth Work(Fill)	29,137	CY	$3.00	$87,411.00
	Gabion Mattress	7,209	CY	$70.00	$504,630.00
	Roller Compacted Cement	6,135	CY	$50.00	$306,750.00
	Access Ramp	2	LS	$96,500.00	$193,000.00
	Trail Crossing at Bridge	2	LS	$157,000.00	$314,000.00
	Misc. Work (15%)	1	LS	$274,374.00	$274,374.00
	SUBTOTAL OF BID ITEMS				$2,103,534.00

TABLE 2-7
IMPROVEMENT SEGMENT 5 STA 144+80 TO STA 159+50

Pay Item No.	Description	Quantity	Unit	Engineer's Estimate Unit Price	Engineer's Estimate Amount
	Earth Work (Excavation)	6,324	CY	$3.00	$18,972.00
	Earth Work(Fill)	9,330	CY	$3.00	$27,990.00
	Gabion Mattress	2,617	CY	$70.00	$183,190.00
	Trail Crossing at Bridge	2	LS	$157,000.00	$314,000.00
	Misc. Work (15%)	1	LS	$81,622.80	$81,622.80
	SUBTOTAL OF BID ITEMS				$625,774.80

TABLE 2-8
IMPROVEMENT SEGMENT 6 STA 159+50 TO STA 311+00

Pay Item No.	Description	Quantity	Unit	Engineer's Estimate Unit Price	Engineer's Estimate Amount
	Earth Work (Excavation)	224,062	CY	$3.00	$672,186.00
	Earth Work(Fill)	187,734	CY	$3.00	$563,202.00
	Gabion Mattress	43,725	CY	$70.00	$3,060,750.00
	Roller Compacted Cement	11,172	CY	$50.00	$558,600.00
	Access Ramp	10	LS	$96,500.00	$965,000.00
	Trail Crossing at Bridge	2	LS	$157,000.00	$314,000.00
	Misc. Work (15%)	1	LS	$920,060.70	$920,060.70
	SUBTOTAL OF BID ITEMS				$7,053,798.70

TABLE 2-9
IMPROVEMENT SEGMENT 7 STA 346+00 TO STA 413+00

Pay Item No.	Description	Quantity	Unit	Engineer's Estimate Unit Price	Engineer's Estimate Amount
	Earth Work (Excavation)	82,000	CY	$3.00	$246,000.00
	Earth Work(Fill)	82,000	CY	$3.00	$246,000.00
	Gabion Mattress	1,412	CY	$70.00	$98,840.00
	Revegetation (hydroseed)	1	LS	$28,000.00	$28,000.00
	Misc. Work (15%)	1	LS	$92,826.00	$92,826.00
	SUBTOTAL OF BID ITEMS				$711,666.00

Prioritization of Proposed Improvements

Proposed improvements have been prioritized based on their significance to mitigate potential flood damage from a major storm event or to insure that the river reach will convey the existing and future condition 100-year discharge. The priority categories are defined as follows:

1) High — The channel does not have the capacity to convey the 100-year peak discharge and/or during a major storm event there is risk of significant damage to structures and/or major roadways.

2) Medium — During a major storm event there is a potential for some loss of land without structures and/or damage to roadways. However, the potential for loss of structures or significant damage to major roadways is minimal.

3) Low — Some loss of land without structures will occur in a major storm event. No loss of structures or damage to major roadways is expected.

Table 2.10 list the priority ranking and a description summary of proposed improvements.

TABLE 2-10

Prioritization of Proposed Improvements

Improvement Segment	Priority Rating	Station (along construction line)	Proposed Improvements
1	Low	26+30 to 55+00	Realign and grade east bank, provide rock filled wire armoring. Minor earthwork within channel.
2	Medium	61+50 to 69+50	Realign and grade west bank, provide rock filled wire armoring. Minor earthwork within channel.
3	Low	78+50 to 86+50	Realign and grade east bank, provide rock filled wire armoring. Minor earthwork within channel.
4	Low	88+50 to 109+00	Realign and grade east bank, provide rock filled wire armoring. Minor earthwork within channel from stations 88+50 to 109+00.
4	High	109+00 to 140+90	Channel excavation from stations 109+00 to 133+00 and 136+00 to 140+90. Provide grade control structure and river bottom access /maintenance ramp at Station 133+00.
5	Low	144+80 to 159+50	Realign and grade west bank, provide rock filled wire armoring. Minor earthwork within channel.
6	Low	159+50 to 255+00	Realign and grade east and west bank, provide rock filled wire armoring, excavate channel.
6	High	255+00 to 260+00	Realign and grade east and west bank, provide rock filled wire armoring, excavate channel. Provide grade control structure and river bottom access /maintenance ramp at Station 258+18.
6	Low	260+00 to 298+00	Realign and grade east and west bank, provide rock filled wire armoring, excavate channel.
6	Medium	298+00 to 314+00	Realign and grade east and west bank, provide rock filled wire armoring, excavate channel. Provide grade control structure and river bottom access /maintenance ramp at Station 311+00.
7	Low	314+00 to 460+00	Erosion setback limits are utilized to define development limits. Some minor channelization and/or bank armoring at bend locations in the channel is proposed. Approximately 700 LF of bank armoring near Terramar subdivision. The need for grade control structures at proposed roadway crossings of New River will need to be evaluated in the future.

Compatibility of Preferred Alternative with Other Planning Efforts

Compatibility of the preferred alternative with other planning type efforts within the Cities of Glendale and Peoria, and Maricopa County are discussed in this section. The City of Glendale's General Plan, Arrowhead Ranch Specific Plan and Circulation Plan, and the City of Peoria's Comprehensive Plan, Transportation Plan and Rivers and Trails Master Plan were consulted. Discussions with each City's staff at Steering Committee meetings also aided the evaluation with respect to the Watercourse Master Plan.

Transportation

There are seven major roads that are aligned to cross New River within the study area that are classified with an Arterial designation. These roadways are typically located on section lines and are expected to carry large volumes of traffic flow. All are oriented in an east-west direction with the exception of 83rd Avenue that is oriented north-south. Information was compiled from the City of Glendale's Circulation Plan and the City of Peoria's Transportation Plan. Below is a list of the arterial roads and their current or future method (bridged or at-grade) of crossing New River.

- Bell Road - Existing Bridge
- 83rd Avenue - Existing At-Grade
- Union Hills Drive - Existing Bridge
- Deer Valley Road - Existing At-Grade, Future Bridge
- Pinnacle Peak Road - None Existing, Future At-Grade
- Happy Valley Road - None Existing, Future Bridge
- Jomax Road - None Existing, Future At-Grade

Beardsley Road, that is in the study area, is not anticipated to cross New River since there is an alignment conflict with the Loop 101 Freeway to the east.

The Master Plan has evaluated existing bridge and at-grade crossings and did not discover any hydraulic deficiencies. The existing at-grade crossing at Deer Valley

Road is currently undergoing an engineering evaluation for structure selection to construct a bridge crossing and grade control structure.

The future bridge crossing anticipated at Happy Valley Road is located in the non-structural section of the Watercourse Master Plan. Since this portion of New River is intended to remain in a natural state, the future bridge should not be allowed to encroach into the 100-year floodplain. Bridge encroachment into the 100-year floodplain typically disrupts a river's state of equilibrium by rapidly changing the hydraulic conditions for some distance upstream and downstream of the bridge. This could have adverse impacts on adjacent property owners. Bridges shall be designed to pass the 100-year future peak discharge identified in this Master Plan and will not be allowed to effect the sediment transport of the river. This is also the case with any bridge crossings in the non-structural section.

Future at-grade crossings anticipated at Pinnacle Peak and Jomax Roads are also located in the non-structural section of the Watercourse Master Plan. The crossings are required to allow the river to remain in a natural state and must span the 100-year floodplain. Hydraulic and sediment transport analyses is required to ensure adequate scour protection is provided for the roadway crossing. This is also the case with any at-grade crossings in the non-structural section.

Recreation

Recreational path and trails have been accommodated by the Watercourse Master Plan. The following discussion is intend to identify to the reader existing planning efforts by others with regard to trails. The Master Plan does not recommended paved or permanent trails be place in the channel bottom of New River because of erosive forces. Trails on top of the channel banks is recommended. Along certain locations where right-of way is limited (i.e., Bell Park Subdivision), the trails can be integrated (benched) into the channel bank armoring. This application is also proposed for trails at all bridge crossings to allow pedestrians to cross beneath the bridge and not cross the heavily traveled roads.

The Maricopa Association of Government's "West Valley Recreation Corridor" project will link 17 West Valley recreation trails. The proposed recreation trail system will include hiking trails, equestrian trails, pedestrian trails and bikeways. In addition to providing trails that linking existing and proposed trails within the cities

Phoenix, Peoria, Glendale and Avondale the trails the project would provide parks, picnic areas, and possibly golf courses. The West Valley Recreation Corridor project area includes the Middle New River Watercourse Master Plan study area.

The City of Glendale's "Arrowhead Ranch Specific Plan" and the City of Peoria's "Rivers and Trails Master Plan" call for a multi-use trail along New River. The Watercourse Master Plan accommodates a trail system and identifies locations where access ramps into and out of the river channel could be provided. A fifteen foot wide trail or path is recommended for channel access for safety and maintenance vehicles. These issues shall be addressed by future development along New River and developers are required to contact staff at the City of Glendale and the City of Peoria regarding the design of multi-use trails along the river.

Land Use

Approximately 4 miles of the City of Glendale's corporate limits fall immediately adjacent or within the Watercourse Master Plan for New River. Channel banks within the City of Glendale are typically not armored with the exception of a segment adjacent to the Arrowhead Wastewater Treatment Plant. Improvements proposed along the 4 miles consists of providing a trapezoidal shaped channel with rock filled wire basket bank armoring.

Most of the 8.5 mile long study reach for the Watercourse Master Plan for New River is in the City of Peoria. Channel banks within the City of Peoria where development has occurred are typically armored. However, many areas still require bank armoring. Improvements proposed by the Master Plan consist of providing a trapezoidal shaped channel with rock filled wire bank armoring, grade control structures, channel excavation, and a non-structural erosion set-back buffer for the area north of Pinnacle Peak Road.

Land use within the Watercourse Master Plan study area does not conflict with City of Glendale's or the City of Peoria's current land use plans. Some private property is affected in the non-structural erosion setback buffer located from Pinnacle Peak to the New River Dam.

Density transfer credits may be considered for land that lay within the erosion setback buffer.

Potential Permits Required for Implementation of the Preferred Alternative

Permitting requirements for the Middle New River Watercourse improvements cannot be accurately determined at this time. It is currently unknown who the responsible parties will be for construction. If the recommended improvements occur during numerous, separate projects, it will have an effect upon permitting requirements. The following are the major permits which will most likely be required, regardless of construction schedules or responsibilities.

Army Corps of Engineers

Permit: Section 404 permit under the Clean Water Act (Dredging and Filling waters of the U.S.)

How to Obtain:

- Meet with the Corps to discuss the project with existing aerial photos and preliminary plans.
- Conduct a jurisdictional delineation of the project area.
- Acquire aerial photos at a scale of 1 x 100 or 1 x 200 to check and revise the Jurisdictional Delineation of Waters of the U.S. utilizing field determination.
- Contact U.S. Fish and Wildlife Service or obtain County species list by Internet.
- Contact SHPO, or document the completion of the cultural resource survey.
- Work with the project engineers to minimize the impact to jurisdictional washes.
- Map the necessary jurisdictional impact and compute the ground measurements, acreage and cubic yards of fill impacts.
- Develop a detailed Alternatives Analysis (if an Individual permit is required) per Corps requirements.
- Prepare maps for submission, the application form, a detailed narrative regarding the project and the impact and tables indicating the measurements for each impact area.

- If required by the Corps, prepare and submit an additional application package to the Arizona Department of Environmental Quality for Sec. 401 Water Quality Certification.

Time Required: In addition to preparation of the application, the review time for a Nationwide permit is two to three months. Review time for an Individual Permit is six months to a year.

Life of Permit: Single application, as long as impact remains the same.

Arizona Department of Environmental Quality

Permit: Section 401 permit under the Clean Water Act (Water Quality)

How to Obtain: Contact should be made with ADEQ early in the project planning process in order to determine if water quality certification is required. If it is needed, a form must be completed which provides ADEQ with information regarding location of the proposed work and details regarding what is proposed. Required information usually includes, contact name, project description, fill material description, elevations, site revegetation plan, photographs, dates of construction, etc. It normally helps to provide ADEQ with a copy of the 404 application to assist them in their review.

Time Required: Time of review is variable, depending on the complexity of the proposed project. Minimum review time is 20 days; some applications can take up to a year.

Life of Permit: Permanent, unless project changes occur.

Permit: Aquifer Protection Permit

How to Obtain: In the event that groundwater recharge is planned, an aquifer protection permit (APP) will be required. The application procedure is a complex, iterative process, but basically includes a pre-application meeting, a pre-application proposal, an application, a hydrologic study, as well as other data which may be requested by ADEQ. Of particular importance, the applicant must demonstrate that the best available demonstrated control technology (BADCT) is employed, that water quality standards will not be violated and that the applicant has the financial and technical capability to implement the project. Public review is a component of the permitting process.

Time Required: Variable; can range from six months to over two years depending upon the complexity of the proposed project. Substantial fees are required for review of the application and writing of the permit by ADEQ.

Life of Permit: Individual permits are issued for the operational life of the facility.

Environmental Protection Agency

Permit: Section 402 permit under the Clean Water Act – National Pollutant Discharge Elimination System – Storm Water Permits (NPDES for Construction)

How to Obtain: Submittal of Notice of Intent form, which includes information related to the facility operator, site activity description, the site location, project start and completion dates and areas of proposed disturbance. If the application is made by an individual, additional required information includes outfall locations(s), site drainage map, all proposed improvements, a description of any pollutant sources, and information related to storm discharge.

A specific requirement of the NPDES program is the formulation and implementation of a storm water pollution prevention plan.

Time Required: The Notice of Intent form must be submitted a minimum of 48 hours prior to start of activity. Actual processing time is dependent upon the type of project.

Life of Permit: Relates to construction period for projects disturbing over five acres of land.

Maricopa County Environmental Services Department

Permit: Earth Moving Permit, Demolition & Dust Control Plan

How to Obtain: This permit is required of all persons planning to disturb a total surface area of .10 acre or more. It consists of filling out an application which requires information such as location, size of project, acreage to be disturbed, a plot plan, etc. In addition, the application requires that a dust control plan be included.

Time Required: Application review requires 14 days. Fees are required based upon amount of acreage to be disturbed.

Life of Permit: The permit term is one year from date of issue.

GROUNDWATER RECHARGE

Groundwater recharge potential was evaluated in this study in accordance with the requirement of Arizona Revised Statutes §48-3609.01 for watercourse master plans. Research was conducted to determine the feasibility of groundwater recharge of the aquifer in the study area of the Watercourse Master Plan. Research considered several elements: recharge objectives, water supply, hydrogeology, and recharge technology. Recharge technology can be incorporated with the preferred alternative presented in this Master Plan. Chapter 7 - Groundwater Recharge addresses specific findings and recommendations required for implementation of recharge within the Master Plan area.

OTHER MASTER PLAN ALTERNATIVES CONSIDERED

As part of the Watercourse Master Plan alternative formulation, numerous channel alternatives are identified for the study reach of New River. The channel alternatives were developed using input from public and Steering Committee meetings. A total of over 20 initial channel cross-section combinations were considered during early phases of the alternatives evaluation. Alternatives were eliminated from further consideration based on hydraulic performance, social/environmental impacts and practicality of implementation.

As an example, during the initial channel alternative formulation, an alternative referred to as an Indian Bend Wash type alternative was evaluated. The Indian Bend Wash type alternative provided a channel that conveyed floodwaters at a shallow depth and a flow rate of 5 fps or less. The channel minimizes the need for armoring and provides the potential for a multi-use flood conveyance corridor similar to Indian Bend Wash in Scottsdale, Arizona. However, the channel width required to provide an Indian Bend type alternative is significant and would require the removal and/or relocations of existing residences and businesses along the study reach. The Steering Committee determined that this alternative was not practical for Middle New River Watercourse Master Plan.

Master Plan Alternatives Hydraulic Evaluation

Hydraulic evaluations of project alternatives are conducted to evaluate the flow capacity of each alternative. The flow conveyance of proposed channel alternatives are developed utilizing criteria developed for the Watercourse Master Plan. The criteria are:

1. Structural alternatives will consist of an alluvial channel bottom and armored channel side slopes. Top widths of proposed channel improvement will be restricted to floodway widths for a given reach to allow for full development in floodplain fringes.

2. Non-structural alternatives avoids construction within the floodplain, leaving the river in its natural state. Erosion set-back limits shall be provided. Channel bank stabilization may be allowed at selected locations.

3. Average channel physical elements (slope, bottom width, top width, side slope, etc.) are used for each reach.

4. Channel grade control structures will be considered.

5. Proposed channel improvements shall convey FEMA's 100-year peak discharge. The COE future condition peak discharges shall be conveyed within the limits defined by the calculated channel freeboard.

Preliminary Channel Alternatives

Engineering analysis for each channel alternative was conducted to ensure that the proposed channel would have adequate flow capacity to contain the 100-year flood and could be implemented within the average existing FEMA floodway for each subject reach. As a result, six preliminary channel alternative concepts were considered as a planning tool to guide new development and construction activities within the three defined reach areas of New River. The selection of a preferred channel alternative was based on public and community preference, engineering feasibility and cost of construction.

The preliminary channel alternatives formulated for the Middle New River Watercourse Master are:

Alternative 1: Structural Type Trapezoidal Section. This section provides a natural channel bottom with soil cement armoring material type for channel side slopes. This channel section is appropriate for reaches 1, 2 and 3.

Alternative 2: Structural Type Trapezoidal Section. This section provides a natural channel bottom with wire tied gabion mattress armoring material type for channel side slopes. This channel section is appropriate for reaches 1, 2 and 3.

Alternative 3: Structural Type Trapezoidal Section With Landscape Enhancement. This channel section provides a uniform natural bottom with bank armoring consisting of wire baskets and adds a cover of earthen material to provide for landscape enhancement. This channel section is appropriate for reaches 1, 2 and 3.

Alternative 4: Structural Type Trapezoidal Section With Trail Bench. This section is similar to Alternative 1, but with an offset recreation trail. This channel section is appropriate for reaches 1, 2 and 3.

Alternative 5: Low Flow Channel Section. This channel section provides a low-flow channel with a natural bottom and over-bank area. Flow conditions in the overbank area are such that in either natural or landscape enhanced conditions, minimal impact would occur in the area during a flood event. The low flow channel element will have bank armoring consisting of wire baskets mattress. This channel section is appropriate for reaches 1, 2 and 3.

Alternative 6: Non-Structural Channel Section. This channel section provides a non-structural approach that includes enhancements to the channel capacity and the bank erosion buffer. Opportunities would exist for passive recreation and trails within this type of buffer area. Establishment of an erosion buffer could be accomplished through proactive Floodplain Management and, possibly, development density transfer credits. This channel section is appropriate for Reach 3 only.

Preliminary channel alternative cross-sections that are considered viable and were presented to the Steering Committee and public are depicted on Figures 2-25 through Figure 2-29.

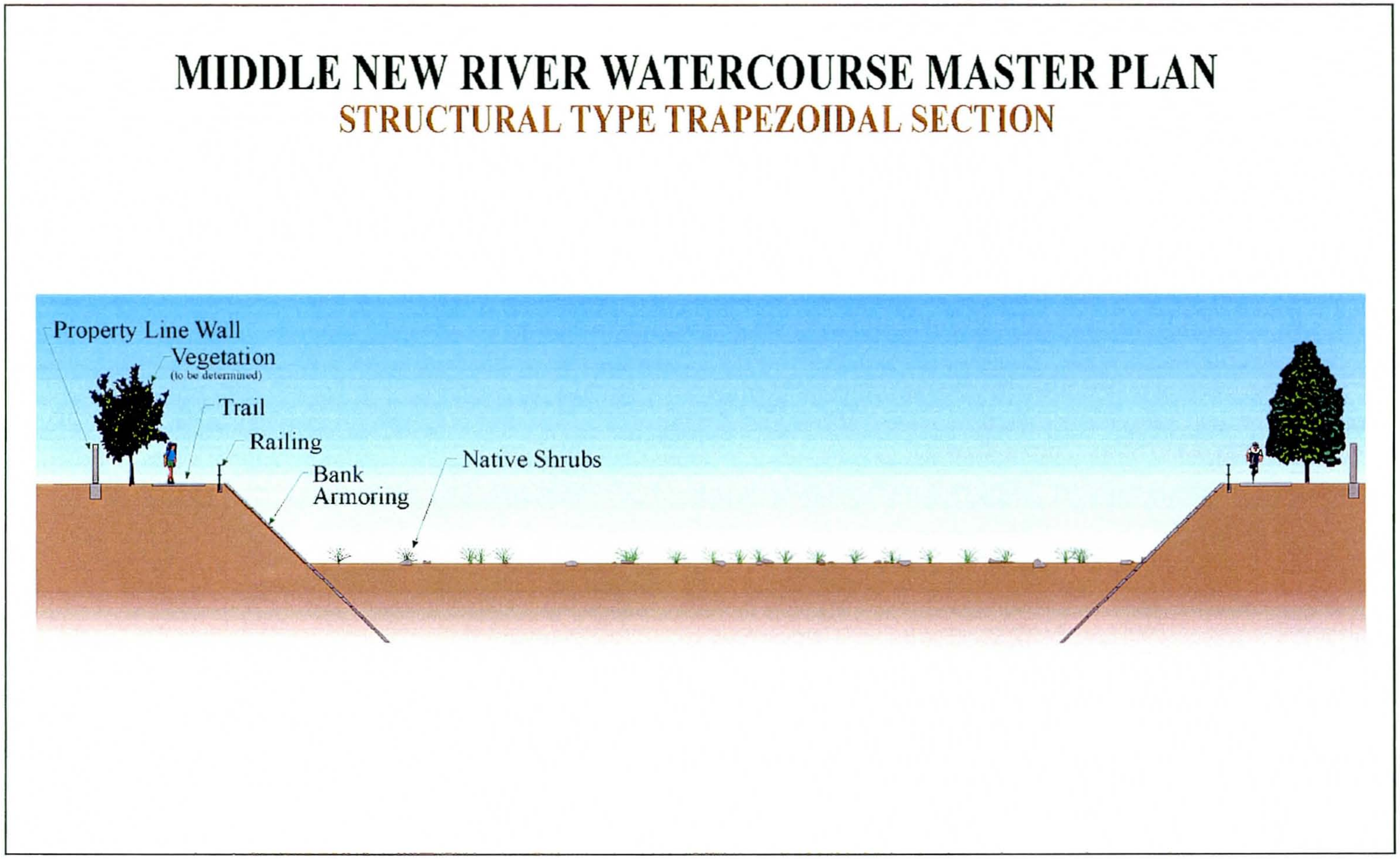


Figure 2-25

Typical Channel Section for Alternatives 1 and 2

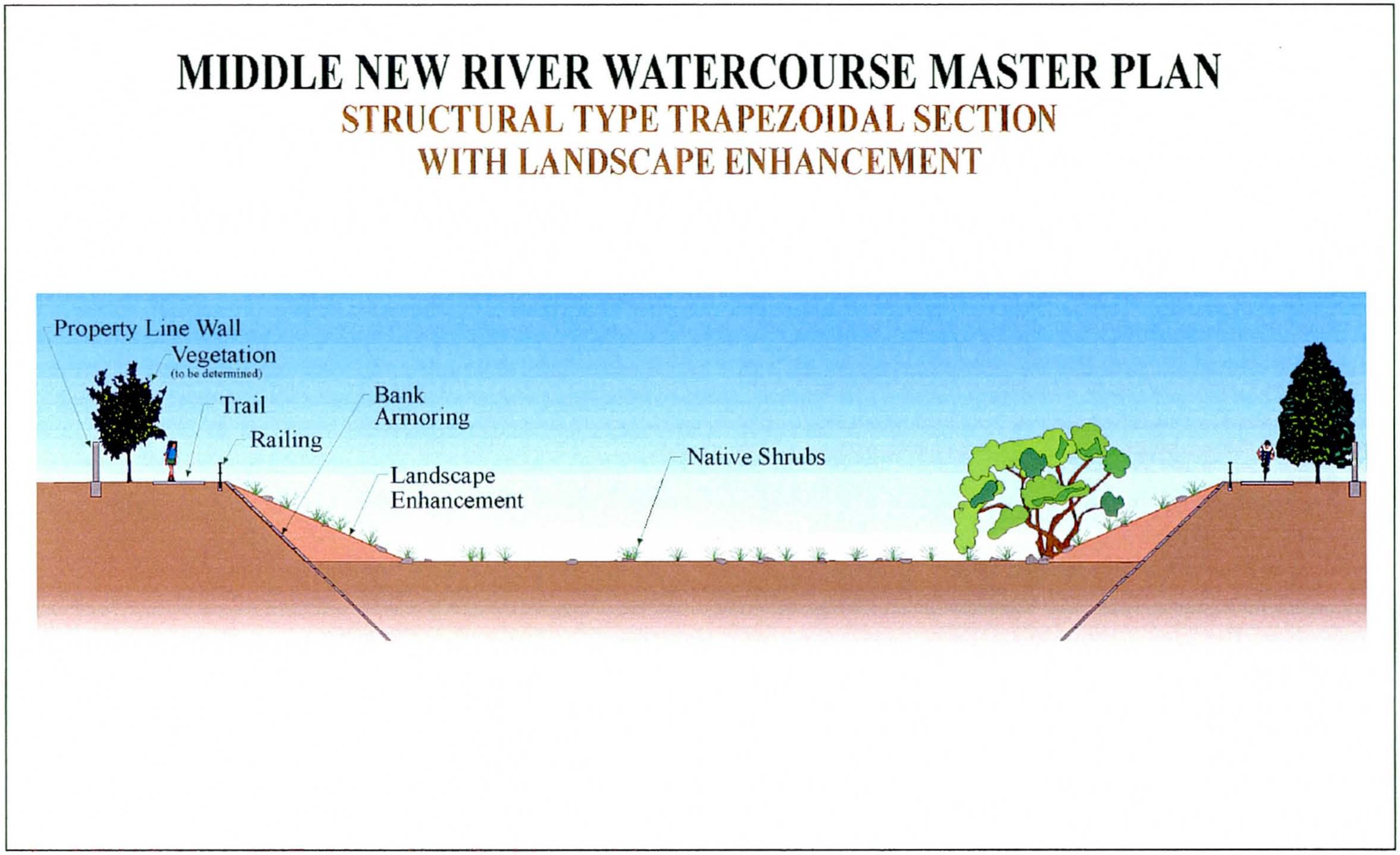


Figure 2-26

Typical Channel Section for Alternative 3

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

STRUCTURAL TYPE TRAPEZOIDAL SECTION WITH TRAIL BENCH

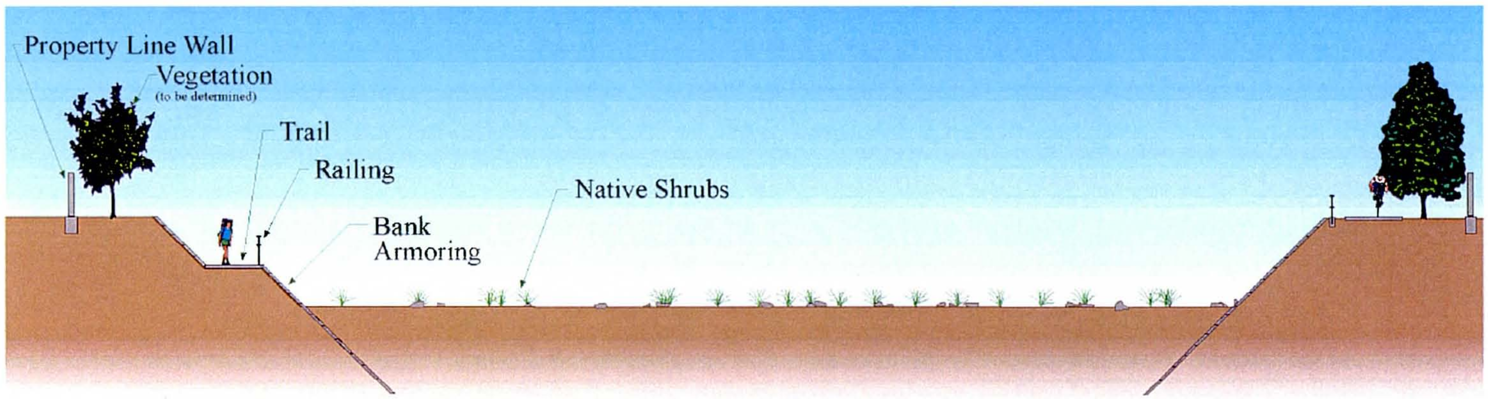


Figure 2-27

Typical Channel Section for Alternative 4

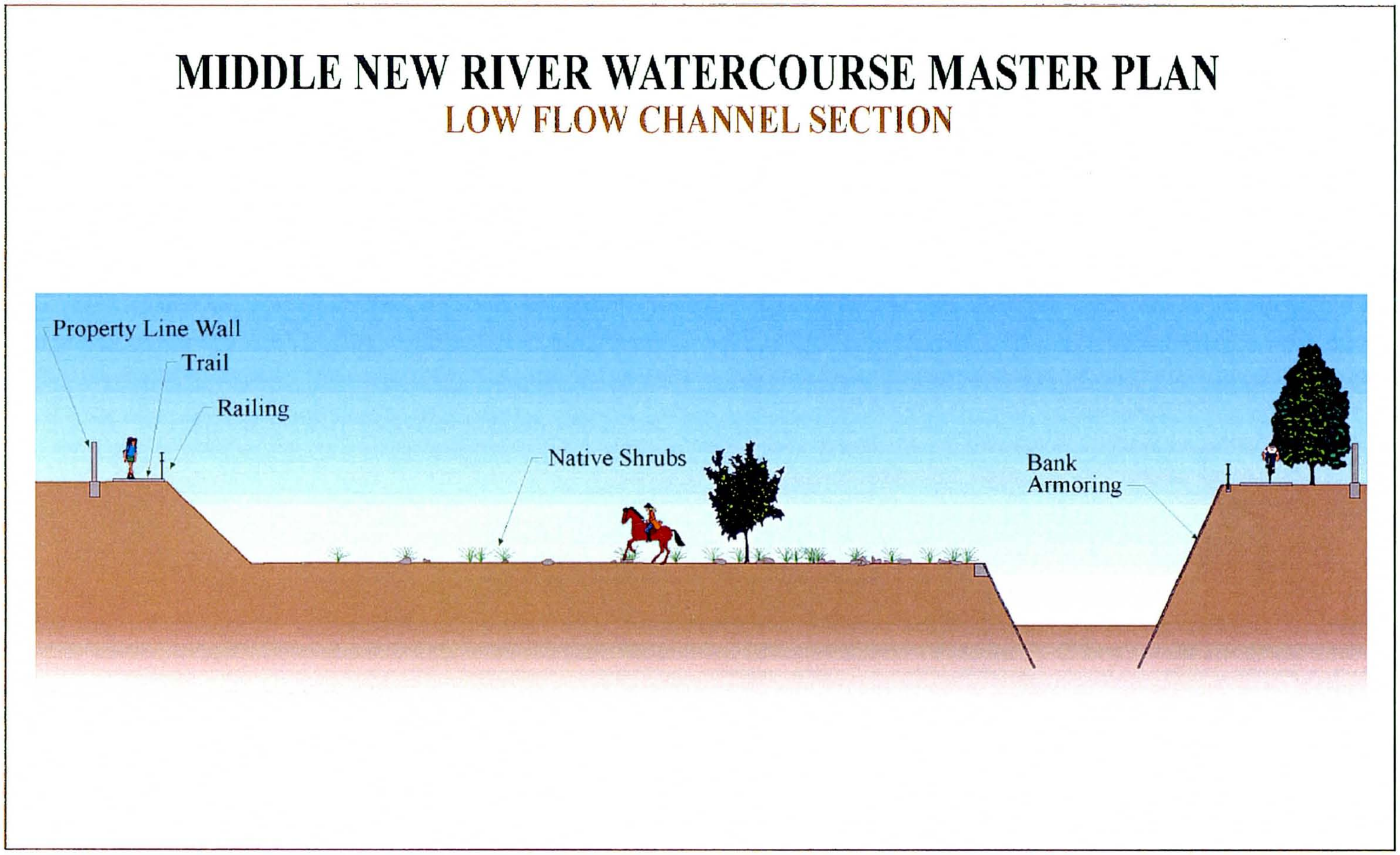


Figure 2-28

Typical Channel Section for Alternative 5

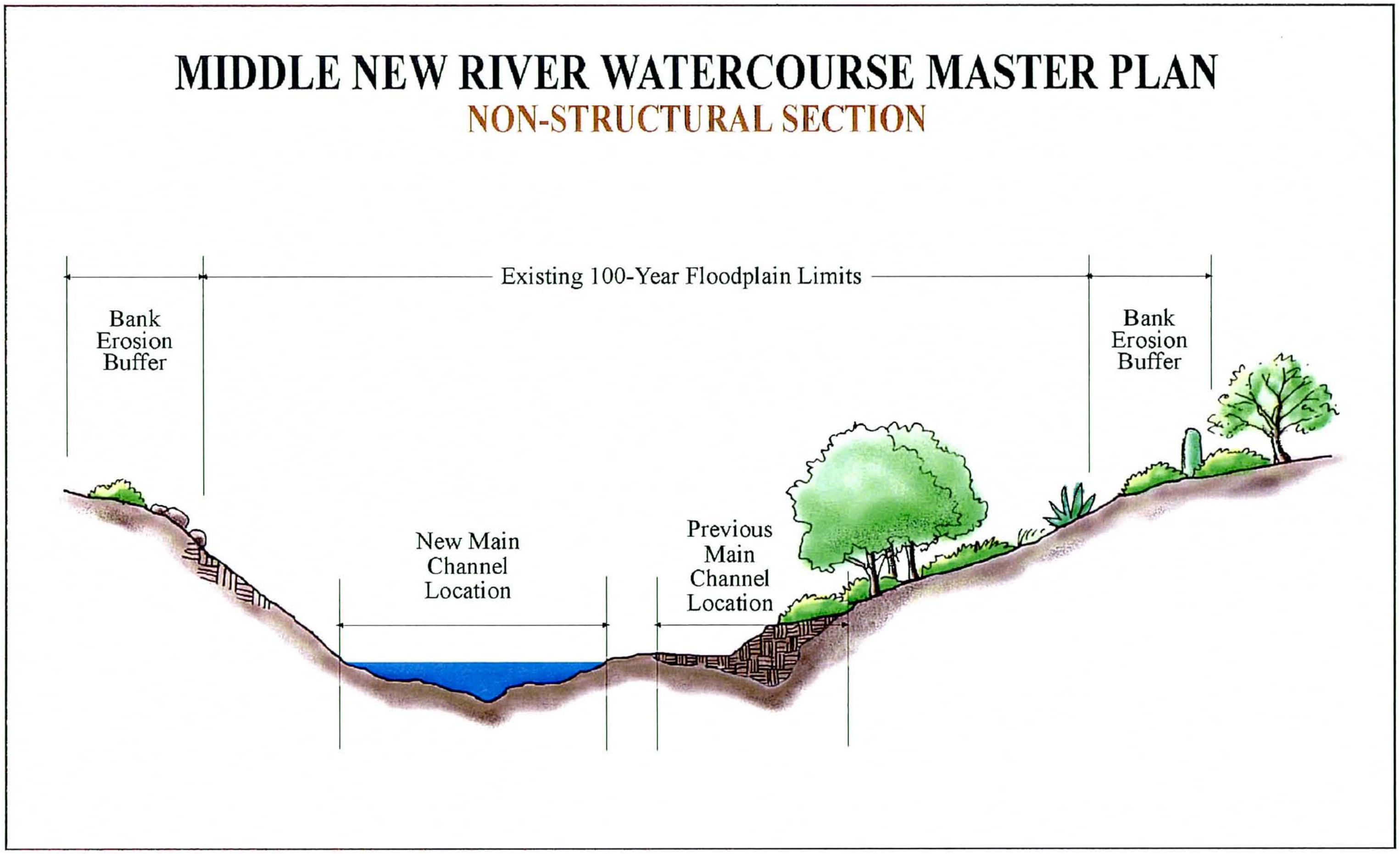


Figure 2-29

Typical Channel Section for Alternative 6

Preliminary Alternatives' Cost Estimates

Preliminary estimates of probable construction cost are prepared for each alternative. Cost estimates are used as an aid in the selection process of a preferred alternative. Quantities are calculated for earthwork (channel excavation and/or fill or back fill) volume of bank armoring material required, volume of drop structure material required and re-vegetation (landscape treatment) if applicable, for each alternative.

Unit costs were compiled form a Stantec database, including bid tabs for the City of Phoenix, the City of Scottsdale and the Arizona Department of Transportation construction projects for 1998. Table 2-11 lists a summary of unit cost utilized to determine cost estimates for each alternative.

TABLE 2-11
SUMMARY OF UNIT COST

Item	Unit	Cost
Earth Work	Cubic Yards (cy)	$3.00/cy
Soil Cement	Cubic Yards (cy)	$35.00/cy
Roller Compacted Cement	Cubic Yards (cy)	$50.00/cy
Gabion Mattress	Cubic Yards (cy)	$70.00/cy
Revegetation and Irrigation	Square Foot (sf)	$1.50/sf

Given the level of design (conceptual) of the proposed alternatives, a contingency cost is applied to account for design detail that is not undertaken at this stage. Contingency cost is estimated at 15 percent of the cost of the proposed channel improvements. Contingency cost also includes relocation of utilities.

Cost estimates developed for each alternative reflect the proposed channel elements over the length of a given reach. However, channel elements (slope, bottom width and depth) may vary within in a given reach at the time of final engineering design. Cost estimates were refined for the selected alternative to account for varying channel elements. Table 2-12 lists cost estimates for the proposed alternatives.

TABLE 2-12
PROJECT COST PER MILE

Alternative No. 1	Description of Alternatives (Bank Material) 2	Cost Per Mile In Millions Of Dollars		
		Reach # 1 ($/mile) 3	Reach # 2 ($/mile) 4	Reach # 3 ($/mile) 5
1	Trapezoidal Channel (Soil Cement Option)	$3.24M	$4.20M	$2.68M
2	Trapezoidal Channel (Gabion-Mattress Option)	$2.45M	$3.39M	$1.75M
3	Landscape Enhanced Trapezoidal Channel (Gabion-Mattress)	$4.53M	$4.08M	$2.85M
4	Benched Trapezoidal Channel (Soil Cement)	$4.12M	$4.44M	$3.52M
5	Low-Flow Channel (Gabion Mattress)	$2.34M	$2.72M	$1.99M

Steering Committee and Public Input

Proposed alternatives and associated cost estimates were presented to the Steering Committee and public to obtain input to the selection of a preferred alternative. Comments obtained from citizens at public meetings primarily pertained to recreational and safety issues associated with recreational trails. Recreational trails are only a component of this study to a degree that access for trails are accommodated into the Master Plan alternatives. Specific details concerning trial amenities and safety will be addressed by the Cities of Glendale and Peoria in other projects. A summary of public comments is located in Appendix E. Comments about the typical cross-sections presented to define each alternative generally lend themselves to the following themes:

1. The use of native shrubs for landscaping is good.
2. Provide a buffer zone between trail and residences. Keep trail away from residences.
3. For Alternatives 1 and 2, a sidewalk on top of the bank is not desirable.

4. The gentler slope depicted for the landscaped enhanced area in Alternative 3 is desirable.

5. The trail bench depicted in Alternative 4 is desirable, however, the cost is not. For some the trail would be more desirable if it was located on the east side of the channel.

6. Appearance of Alternative 4 is sterile.

7. A combination of Alternatives 3 and 5 and Alternatives 3 and 4 is desirable.

8. Trees should not be located close to adjacent property.

9. Guardrail should be considered along both banks for Alternative 5.

10. Low flow channel depicted in Alternative 5 should be bridged.

11. Alternative 6 was listed as a favorite.

Advantages and Disadvantages

Each preliminary channel alternatives have advantages and disadvantages. Table 2-13 lists the initial evaluation of each alternative.

TABLE 2-13
Summary of Alternatives Advantages and Disadvantages

ALTERNATIVE	ADVANTAGES	DISADVANTAGES
Alternative 1 (Soil Cement Bank Armoring)	• 100-year peak discharges conveyed within floodway limits. • Low maintenance. • Long life cycle	• Expensive option relative to other alternatives. • Type of armoring is only consistent with existing armoring types at specific locations below Bell Road. • Armoring type precludes vegetation growth on channel side slopes.

TABLE 2-13 (cont.)

Summary of Alternatives Advantages and Disadvantages

ALTERNATIVE	ADVANTAGES	DISADVANTAGES
Alternative 2 (Gabion Mattress Bank Armoring)	• 100-year peak discharges conveyed within floodway limits. • Low maintenance relative to Alternative 3. • Type of proposed armoring is consistent with existing channel side slope armoring. • Growth of natural volunteer vegetation will not be prevented along channel side slopes. • One of the least costly alternatives.	• Precludes a benched trail as displayed in Alternative 4.
Alternative 3 (Gabion Mattress Bank Armoring with Landscape Enhancement).	• 100-year peak discharges conveyed within floodway limits. • Provides unique opportunities for landscape enhancement of channel side slopes.	• Expensive relative to other alternatives. • High maintenance relative to other alternatives.
Alternative 4 (Trail Bench)	• 100-year peak discharges conveyed within floodway limits. • Low maintenance relative to Alternative 3. • Good alternative for transitioning a trail form top of bank to channel bottom.	• Most expensive option relative to other alternatives. • Type of armoring is only consistent with existing armoring types at specific locations below Bell Road. • Armoring type precludes vegetation growth on channel side slopes.

TABLE 2-13 (cont.)
Summary of Alternatives Advantages and Disadvantages

Alternative 5 (low Flow channel Section)	• 100-year peak discharges conveyed within floodway limits. • Provides unique opportunities for landscape enhancement of overbank areas. • One of the least costly alternatives however landscape enhancement costs have not been included in cost estimates. • Type of proposed armoring is consistent with existing. Channel side slope armoring. • Growth of natural volunteer vegetation will not be prevented along channel side slopes.	• Precludes a benched trail as displayed in Alternative 4. • Maintenance cost in overbank areas could be costly. • Providing a dry crossing over the low flow channel would be expensive and would reduce hydraulic capacity of channel during high flow runoff events.
Alternative 6 (Non Structural)	• Maintains natural channel appearance.	• Floodplain fringe is not developable. • Unknown long term maintenance costs.

3.0 DATA COLLECTION

GENERAL

Data relevant to the project such as previous flood hazard and hydrologic reports, existing topographic mapping, historical flooding information, as-built plans for existing structures, and FEMA Flood Hazard Boundary were collected from various sources and reviewed. In addition to historical or existing data, field surveys were conduct for updated topographic mapping, hydraulic analyses and planing tasks. Data collected for the Middle New River Watercourse Master Plan are categorized into one of the following categories: Survey, Mapping or Reference Material. Detailed descriptions of type and source of data can be found in separate reports entitled, "Middle New River Watercourse Master Plan-Technical Data Notebook" (TDN), and "Flood Plain Delineation and Topographic Mapping for Middle New River Watercourse Master Plan Study, Confluence with Skunk Creek to New River Dam, PHOTOGRAMMETRIC CONTROL AND TOPOGRAPHIC SURVEY".

SURVEY

As part of the Middle New River Watercourse Master Plan study, field surveys were conducted for structures, to establish aerial mapping control points, to establish additional monumentation, and to provide elevation reference markers for the study area. Alcocer Land Surveyors conducted all field surveys. Results of the survey are located in the report entitled "Flood Plain Delineation and Topographic Mapping for Middle New River Watercourse Master Plan Study, Confluence with Skunk Creek to New River Dam, PHOTOGRAMMETRIC CONTROL AND TOPOGRAPHIC SURVEY". Elevation Reference Markers (ERM's) established for the project, and results of field surveys are provided in the TDN.

MAPPING

Mapping prepared for this project includes portions of the New River from the confluence with Skunk Creek north to New River Dam. Mapping of the project area was prepared at a scale of 1"=400', having a contour interval of two feet. The mapped area is approximately 4,000 feet wide from New River Dam to approximately Pinnacle Peak Road and 1,500 feet wide from approximately Pinnacle Peak Road to the confluence with Skunk Creek. Mylar copies of topographic mapping are provided to the District under separate cover.

REFERENCE MATERIAL

Reference material used in the study was obtained from the Flood Control District of Maricopa County, the City of Peoria, the City of Glendale or Stantec's reference library. Reference material is subcategorized into Reports, Manuals, Documents, Improvement Plans, Drainage and Grading Plans and As-Built Plans. A list of referenced material collected is provided in the TDN.

4.0 HYDROLOGY

HYDROLOGIC METHOD DESCRIPTION

General

Peak discharges developed for previous hydrologic studies conducted by the Federal Emergency Management Agency (FEMA) and the Army Corp's of Engineers (COE) are used in the hydraulic evaluations in this study. Design peak discharges for proposed improvements are based on both FEMA's and the COE's 100-year peak discharges for New River.

FEMA's Peak Discharges

One hundred year peak discharges cited in the FEMA's "Flood Insurance Study (FIS), Maricopa County, Arizona and Incorporated Areas" (1995), and 100-year peak discharges listed in the FEMA, HEC-2 hydraulic computer model for the effective New River Floodplain/Floodway delineation's are utilized in existing condition and future condition hydraulic evaluations for this study. FEMA 100-year peak discharges are used as the design peak discharges in the Watercourse Master Plan. FEMA 100-year peak discharges utilized in the study are listed in Table 4-1.

COE's Peak Discharges

The COE, in their design process for the New River Dam, developed a hydrologic model to determine future condition 100-year peak discharges at two specific concentration points downstream of the dam. The concentration points are located at the confluence of New River with Rocks Springs Creek and at the confluence of New River with Skunk Creek. These discharges are to be used when evaluating future flow capacity of New River downstream of the Dam and are to be contained within the freeboard of a designed channel.

Interpolations of the future condition 100-year peak discharges cited in the Army Corp's of Engineers' (COE) document entitled, "Gila River Basin, Phoenix, Arizona and Vicinity (Including New River), New River Dam (Including New River to Skunk Creek) Design Memorandum No. 3", dated November 1982, are made to determine potential peak discharges at locations other than the locations cited in the COE's report. The interpolated 100-year peak discharges are evaluated for planning purposes in the Middle New River Watercourse Master Plan study. Peak discharges at various concentration points were estimated by determining a unit discharge per square mile of drainage area from the COE study and applying that unit discharge to updated New River watershed area delineation's. The results of the analysis are summarized in Table 4-1. Details concerning the method of interpolating discharges are located in the TDN.

Revisions to Peak Discharges

Drainage areas that historically have drained to specific concentration points have been altered both in size and in the location of the drainage area outfall to New River. The alteration is primarily a result of sand and ground mining and land development. The Rock Springs Creek watershed, historically discharged to New River below Deer Valley Road at approximately River Mile 12.313. Due to sand and gravel mining operations and housing development, the confluence of Rock Springs Creek to New River has been moved approximately 1.5 miles upstream from its historical location. Rock Springs Creek currently joins New River above Deer Valley Road at approximately River Mile 13.820.

The location of peak discharges impacting New River have been adjusted to account for the change in location of the Rock Springs Creek confluence to New River. Under historical conditions the Rock Springs Creek drainage area was approximately 10.3 square miles in size, under current conditions the drainage area is reduced in size by approximately 0.5 square miles due to the location change of the confluence. Since the reduction in drainage area is small relative to its original size, no adjustment to the magnitude of the peak discharge is attempted. The concentration point of peak discharges are moved upstream from the historical location (River Mile 12.313 to River Mile 13.820).

TABLE 4-1

SUMMARY OF PEAK DISCHARGES

Location	X-Sec Sta. (river mile)	Contributing Drainage Area [A] (mile^2)	CORPS 221 Q's (cfs)	221 Q's Interpolation By Drainage Area[B] (cfs)	221 Q's Adopted for Watercourse Master Plan (cfs)	FEMA 100-Year Design Peak Discharges for Watercourse Master Plan (cfs)
New River Dam			2350	2350	2350	**2350**
	15.966		2350	2350	2350	**2350**
	15.533	1.95		4177	4200	
	14.945					**4200**
Pinnacle Peak Rd	14.197	4.51		6575	6600	
	14.013					**6100**
Deer Valley Rd	13.161	6.9		8815	~~8800~~[C] 12000	
	13.076					**~~7900~~[C] 9800**
	12.313	<10.3>	12000	12000	12000	**9800**
Beardsley Rd	12.034	13.77		13426	13400	
	11.188					**10350**
Union Hills	10.996	14.31		13860	13900	
	10.271					**10900**
Bell Rd	9.960	16.3		15461	15500	
	9.492					**11450**
	8.807					
Skunk Creek	8.655	27.0 <20.7>	19000	19000	19000	**12000**

A) 6.9 from ACDC ADMS, <20.7> From COE STUDY.
B) Use COE drainage area to determine Unit Q.
C) Strikethrough values have been revised to reflect location change in confluence with Rock Springs Creek,

5.0 HYDRAULICS

METHOD DESCRIPTION

General

Hydraulic computations performed for the Middle New River Watercourse Master Plan are completed following procedures and guidelines listed in the "Drainage Design Manual for Maricopa County, Volume II Hydraulics"; the "ProHEC2, Program Documentation Manual" (Dodson and Associates, Inc.); and the U.S. Army Corps of Engineers', "HEC-RAS River Analysis System User Manual". Water surface profiles determined from the hydraulic computations for present conditions are compared to FEMA's effective water surface profiles to determine changes that may have occurred since FEMA's study was conducted. Water surface profiles are also determined for the proposed Watercourse Master Plan to insure that improvements will convey the FEMA and COE peak discharges referenced in Section 4.

The U.S. Army Corps of Engineers' "HEC-RAS, River Analysis System", computer program (Version 2.2) and an enhanced version of the standard Corps of Engineers' "Flood Plain Analysis Computer Program" (Dodson and Associates, Inc. Version 4.6), are used to conduct floodplain delineation hydraulic analyses.

Hydraulic Models

HEC-2 and HEC-RAS hydraulic computer models are reviewed and/or developed for the hydraulic evaluation of the subject reach. The hydraulic models evaluate both existing and proposed (Master Plan) conditions. Existing and proposed condition hydraulic models that are developed using FEMA's 100-year peak discharges. The proposed condition hydraulic model also models the COE 100-year future condition peak discharges to insure that the future condition peak discharges are contained within proposed freeboard limits. All models commence below the confluence of New River with Skunk Creek and extend upstream to just below the New River Dam. Below the confluence with Skunk Creek, the future condition peak discharge is the same as the existing condition peak discharge. Description of each model developed or reviewed, hydraulic parameters utilized in the hydraulic models and model output files are located in the TDN.

HYDRAULIC ANALYSIS RESULTS

This section of the report summarizes the results of the hydraulic models used to determine flood profiles. Models developed for this study are compared with models previously developed by others for the study reach of New River.

Updated Existing Condition Model

The Updated Existing Condition HEC-2 Model was developed in progressive stages with each stage being an independent hydraulic model and compared to the effective FEMA/COE HEC-2 Model to document any differences. A review of the results of the hydraulic models indicate that the major differences between effective models and the updated existing condition models can be attributed to: 1) starting water surface elevation, 2) the location at which the model starts, 3) changes in topography, and 4) modeling techniques since the time the effective models were developed. The major change in modeling techniques, is the use of a greater number of cross sections in the hydraulic analysis. Discussion and summary tables listing 100-year water surface elevations determined in the hydraulic analyses for the effective FEMA Model, updated existing condition model and proposed condition model are located in the TDN.

In most instances, the water surface elevation estimated in the Updated Existing Condition HEC-2 Model is lower than the effective FEMA/COE HEC-2 Model, especially for the reach below Bell Road. The difference in water surface elevations between the models for the reach below Bell Road is attributed to channel improvements both upstream and downstream of the confluence of New River with Skunk Creek and channel degradation that has occurred since the original FEMA model was developed.

Downstream of Union Hills Drive Bridge (Cross Section 10.980 to Cross Section 10.517), water surface elevations determined with the Updated Existing Condition HEC-2 Model are higher than the effective FEMA/COE HEC-2 Model, and at locations the 100-year peak discharge is not contained within the banks of New River. The higher water surface elevations are attributed to changes in channel geometry, over bank geometry and changes in modeling technique.

Upstream of the Union Hills Drive Bridge, water surface elevations determined with the Updated Existing Condition HEC-2 Model are generally lower than the effective FEMA/COE HEC-2 Model, however, there are segments that are higher. Differences in water surface elevations are attributed to changes in channel geometry and modeling techniques.

Conversion of HEC-2 Model to a HEC-RAS Model

The Updated Existing Condition HEC-2 model was converted to a HEC-RAS model per District requirements. After conversion to a the HEC-RAS model, Manning's roughness coefficients were revised to reflect the Districts current estimation techniques. Water surface elevations determined in the Updated Existing Condition HEC-2 Model are compared with results of the Updated Existing Condition HEC-RAS model to determine differences between the models. A detailed summary of 100-year Water Surface Elevations (WSEL) is located in the TDN.

The 100-year water surface elevation estimations between the two hydraulic models (HEC-2 and HEC-RAS) compare well. In most instances, the comparison is within hundredths of feet. In instances where the comparison is within feet or tenths of feet, the difference is attributed to modeling techniques and/or procedures at bridges, such as analyzing in a mixed flow regime or revisions to Manning's n-values.

Manning's n-values differed between models along two segments of the study reach. In the Updated Existing Condition HEC-RAS Model, commencing at approximately Bell Road (Cross Section 9.889) and extending to the north to the Arrowhead WasteWater Treatment facility (Cross Section HEC-2 11.386), an n-value of 0.035 was utilized. In the effective FEMA model, a channel n-value of 0.030 was utilized. Upstream of Cross Section 13.918, New River is characterized by distributary flow patterns. The Updated Existing Condition HEC-2 Model, staying consistent with the Effective FEMA HEC-2 Model, models the distributary flow reach utilizing right overbank, left overbank and channel n-values cross section segments, where as the Updated Existing Condition HEC-RAS Model better defines n-value variation along a cross section by utilizing n-value sub-segments along a cross section.

Work Study Maps

Work Study Maps displaying topography, cultural features, effective 100-year Floodplain and Floodway Limits and updated 100-year floodplain limits are prepared at a scale of 1" = 400' and a contour interval of 2 feet. A reduce scale of the work study maps are presented as Figure 5-1 Plates FP1 through FP6.

Proposed Condition Hydraulic Model

The intent of the Master Plan design is to let nature shape the future channel bottom (stable slope) where possible. Chapter 6, Erosion and Sediment Transport, discusses the river's trend to degrade or adjust its bottom downward because of erosion. The Master Plan design proposes grading only the portion of the channel that is absolutely necessary to convey the design discharges. Nature will do the rest of the work.

The Updated Existing Condition HEC-RAS model was revised to create a proposed condition model to reflect Master Plan improvements. Proposed improvements that were modeled vary from grading and armoring of existing channel banks along with minor grading of the channel bottom, to realignment and redefinition of channel banks with major grading within the channel bottom and channel grade control structures. Major grading in the channel bottom consists of providing a new channel invert slope and a uniform geometric bottom. In areas where channel bank and channel bottom grading and realignment is proposed, bottom widths ranged from a 185 feet to 250 feet. Channel improvements are typically within Effective FEMA Floodway limits.

Water surface elevations determined in the Proposed Condition HEC-RAS Model are compared with results of the Updated Existing Condition HEC-RAS model and the Effective FEMA HEC-2 Model to determine water surface elevation differences between the models. A detailed summary of 100-year Water Surface Elevations (WSEL) for existing and proposed conditions is located in the TDN. A general summary of the differences in water surface elevations is provided below.

With the exception of RM segments 11.566 to 12.194 and 13.68 to 13.818 water surface elevations for proposed conditions are lower when compared to both the Effective FEMA HEC-2 model and the Updated Existing Condition HEC-RAS model. For all locations, with the exception of the cross section located at RM 11.759

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN FLOODWAY AND FLOODPLAIN MAP

F.C.D. CONTRACT NO. 97–04

LEGEND

HYDRAULIC BASE LINE
EFFECTIVE FEMA 100–YEAR FLOODPLAIN
EFFECTIVE FEMA 100–YEAR FLOODWAY
UPDATED 100–YEAR FEMA FLOODPLAIN
CROSS SECTION (9.047)
ELEVATION REFERENCE MARK (12)
CORPORATE LIMITS

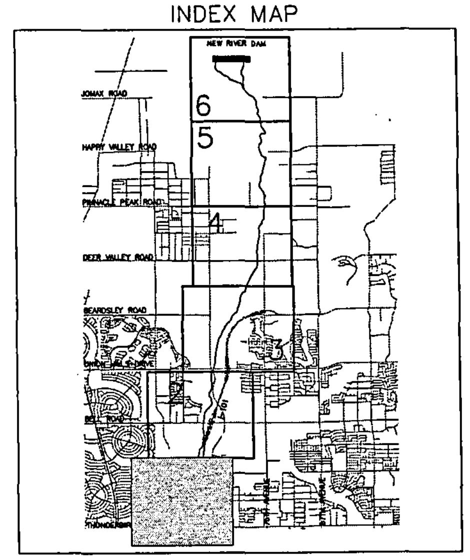
ELEVATION REFERENCE MARKS

ERM #1 – Elevation 1158.237
C.O.P. brass cap (flush) +/– 600' east of 91st Avenue on Desert Harbor Drive.

ERM #2 – Elevation 1167.042
C.O.P. brass cap in handhole @ centerline P.C. +/– 300' north of intersection of Acoma Drive & Desert Harbor Drive

ERM #3 – Elevation 1176.08
Top of brass cap (flush) at 86th Drive and Betty Elyse Lane.

INDEX MAP



400' 0' 400' 800'
SCALE: 1"=400'
CONTOUR INTERVAL: 2 FEET

Stantec JOB# 28900058

	BY	DATE	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN	PAW	04/01/99	RECOMMENDED BY: DATE
DESIGN CHK.	PJE	04/13/00	APPROVED BY: DATE
PLANS	PAW	04/20/99	CHIEF ENGINEER AND GENERAL MANAGER
PLANS CHK.	PJE	04/13/00	PLATE FP–1 OF FP–6
SUBMITTED BY:		DATE:	

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May 25 2000, 04:14 PM

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN FLOODWAY AND FLOODPLAIN MAP

F.C.D. CONTRACT NO. 97–04

LEGEND

HYDRAULIC BASE LINE
EFFECTIVE FEMA 100–YEAR FLOODPLAIN
EFFECTIVE FEMA 100–YEAR FLOODWAY
UPDATED 100–YEAR FEMA FLOODPLAIN
CROSS SECTION 9.047
ELEVATION REFERENCE MARK 12
CORPORATE LIMITS

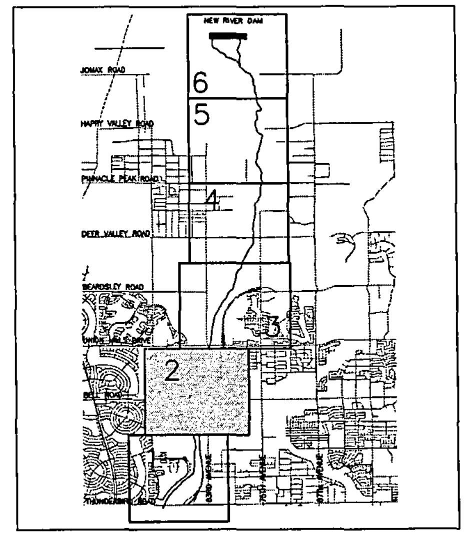
ELEVATION REFERENCE MARKS

ERM #4 – Elevation 1187.90
Top of brass cap (flush) at intersection of 86th Avenue and Paradise Lane.

ERM #5 – Elevation 1202.16
C.O.G. brass cap in handhole at intersection of 83rd Avenue and Bell Road.

ERM #6 – Elevation 1212.88
Top brass cap in handhole at 83rd Drive and 84th Avenue.

INDEX MAP



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Stantec JOB# 28900058

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DESIGN CHK.	PJE	04/13/00
PLANS	PAW	04/20/99
PLANS CHK.	PJE	04/13/00

SUBMITTED BY: DATE:

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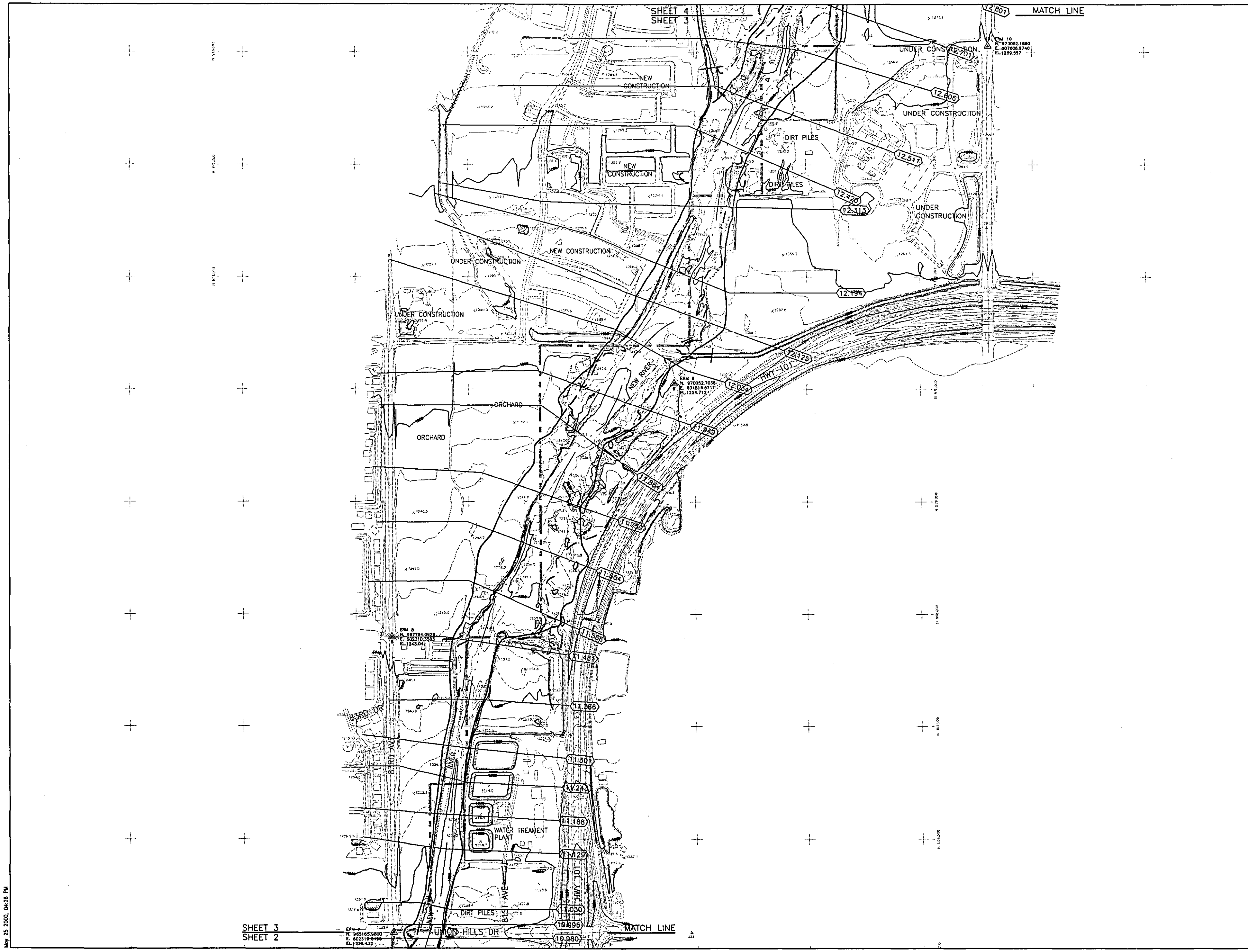
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
PLATE FP–2 OF FP–6



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN FLOODWAY AND FLOODPLAIN MAP

F.C.D. CONTRACT NO. 97–04

LEGEND

HYDRAULIC BASE LINE
EFFECTIVE FEMA 100–YEAR FLOODPLAIN
EFFECTIVE FEMA 100–YEAR FLOODWAY
UPDATED 100–YEAR FEMA FLOODPLAIN
CROSS SECTION (9.047)
ELEVATION REFERENCE MARK (12)
CORPORATE LIMITS

ELEVATION REFERENCE MARKS

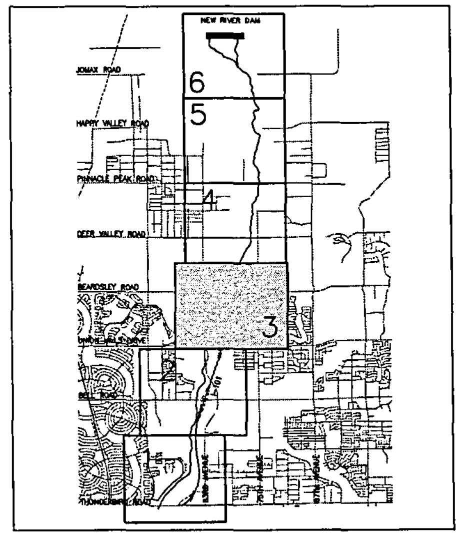
ERM #7 – Elevation 1228.432
C.O.P. brass cap in handhole at 83rd Avenue and Union Hills Drive.

ERM #8 – Elevation 1243.04
Top of 2" iron pipe in handhole at intersection of 83rd Avenue and Village Parkway.

ERM #9 – Elevation 1254.712
Top of ADOT aluminum cap along the north side of 101 Freeway, P.O.C. Sta 918+00.00.

ERM #10 – Elevation 1269.557
C.O.G. brass cap in handhole at intersection of 75th Avenue and Rose Garden Lane.

INDEX MAP



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Stantec JOB# 28900058

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DESIGN CHK.	PJE	04/13/00	APPROVED BY: DATE
PLANS	PAW	04/20/99	CHIEF ENGINEER AND GENERAL MANAGER
PLANS CHK.	PJE	04/13/00	PLATE FP–3 of FP–6
SUBMITTED BY:		DATE:	

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN FLOODWAY AND FLOODPLAIN MAP

F.C.D. CONTRACT NO. 97-04

LEGEND

HYDRAULIC BASE LINE
EFFECTIVE FEMA 100-YEAR FLOODPLAIN
EFFECTIVE FEMA 100-YEAR FLOODWAY
UPDATED 100-YEAR FEMA FLOODPLAIN
CROSS SECTION (9.047)
ELEVATION REFERENCE MARK (12)
CORPORATE LIMITS

ELEVATION REFERENCE MARKS

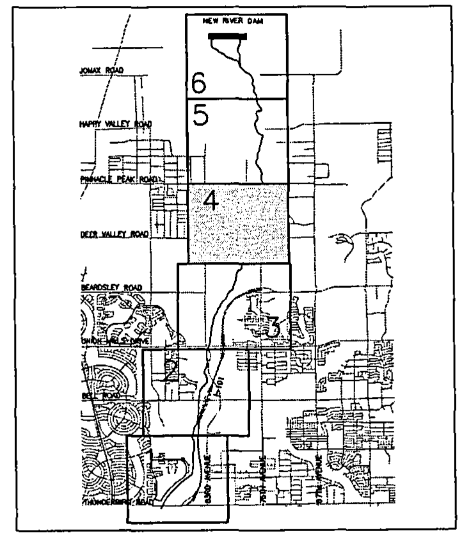
ERM #10 – Elevation 1269.557
C.O.G. brass cap in handhole at intersection of 75th Avenue and Rose Garden Lane.

ERM #11 – Elevation 1282.707
MC brass cap in handhole at intersection of 75th Avenue and Deer Valley Road.

ERM #12 – Elevation 1292.2328
Top of brass cap (flush) on 75th Avenue and Centerline P.C., +/–400' south of the East Quarter Corner of Section 14, T4N, R1E, G&SRBM.

ERM #13 – Elevation 1308.215
Top of brass cap (flush) at center of cul de sac at 7431 W. Monte Lindo.

INDEX MAP



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PLANS	PAW	04/20/99	APPROVED BY: DATE
PLANS CHK.	PJE	04/13/00	CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY:		DATE:	PLATE FP-4 of FP-6

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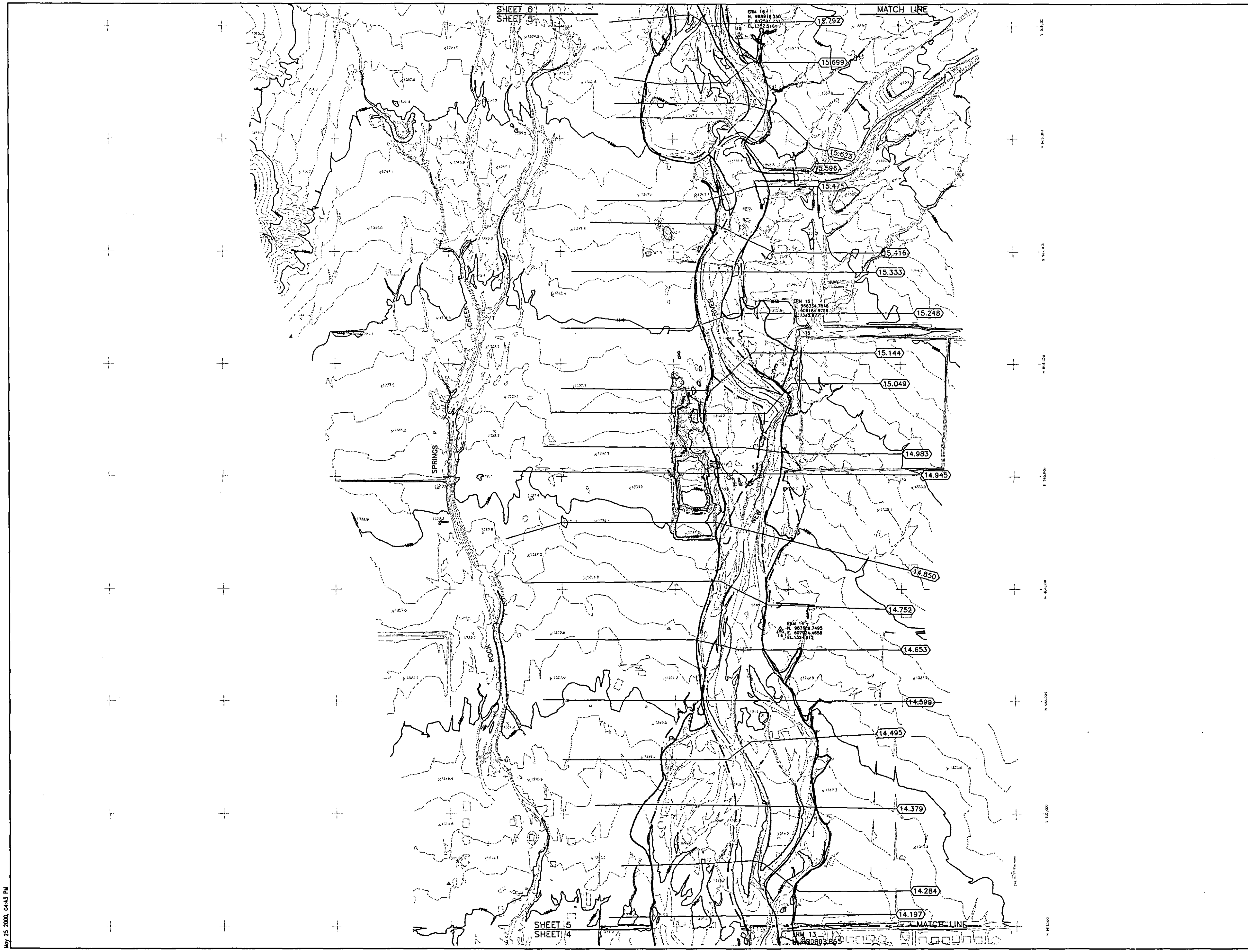


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN FLOODWAY AND FLOODPLAIN MAP

F.C.D. CONTRACT NO. 97-04

LEGEND

- HYDRAULIC BASE LINE
- EFFECTIVE FEMA 100-YEAR FLOODPLAIN
- EFFECTIVE FEMA 100-YEAR FLOODWAY
- UPDATED 100-YEAR FEMA FLOODPLAIN
- CROSS SECTION (9.047)
- ELEVATION REFERENCE MARK (12)
- CORPORATE LIMITS

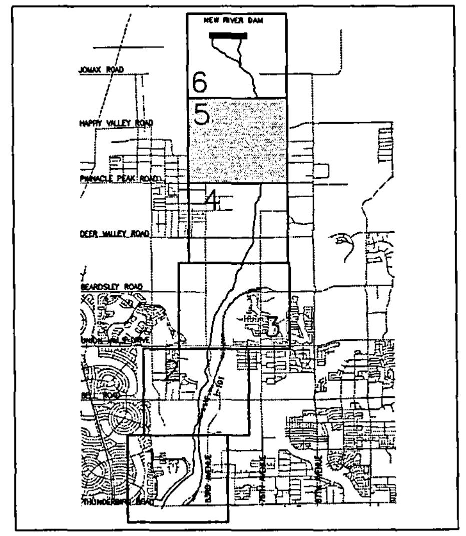
ELEVATION REFERENCE MARKS

ERM #14 – Elevation 1324.912
Chiseled 'X' on center of top of west end of 4' x 10' storm culvert +/– 300' east of the West Quarter Corner of Section 12, T4N, R1E, G&SRBM.

ERM #15 – Elevation 1342.977
Chiseled 'X' on center of top of west end of 4' x 10' storm culvert +/– 573' east of Southwest Corner of Section 1, T4N, R1E, G&SRBM.

ERM #16 – Elevation 1352.51
Set FCDMC brass cap in concrete, +/– 20' west of the East Quarter Corner of Section 2, T4N, R1E, G&SRBM.

INDEX MAP



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PLANS CHK.	PJE	04/13/00	CHIEF ENGINEER AND GENERAL MANAGER
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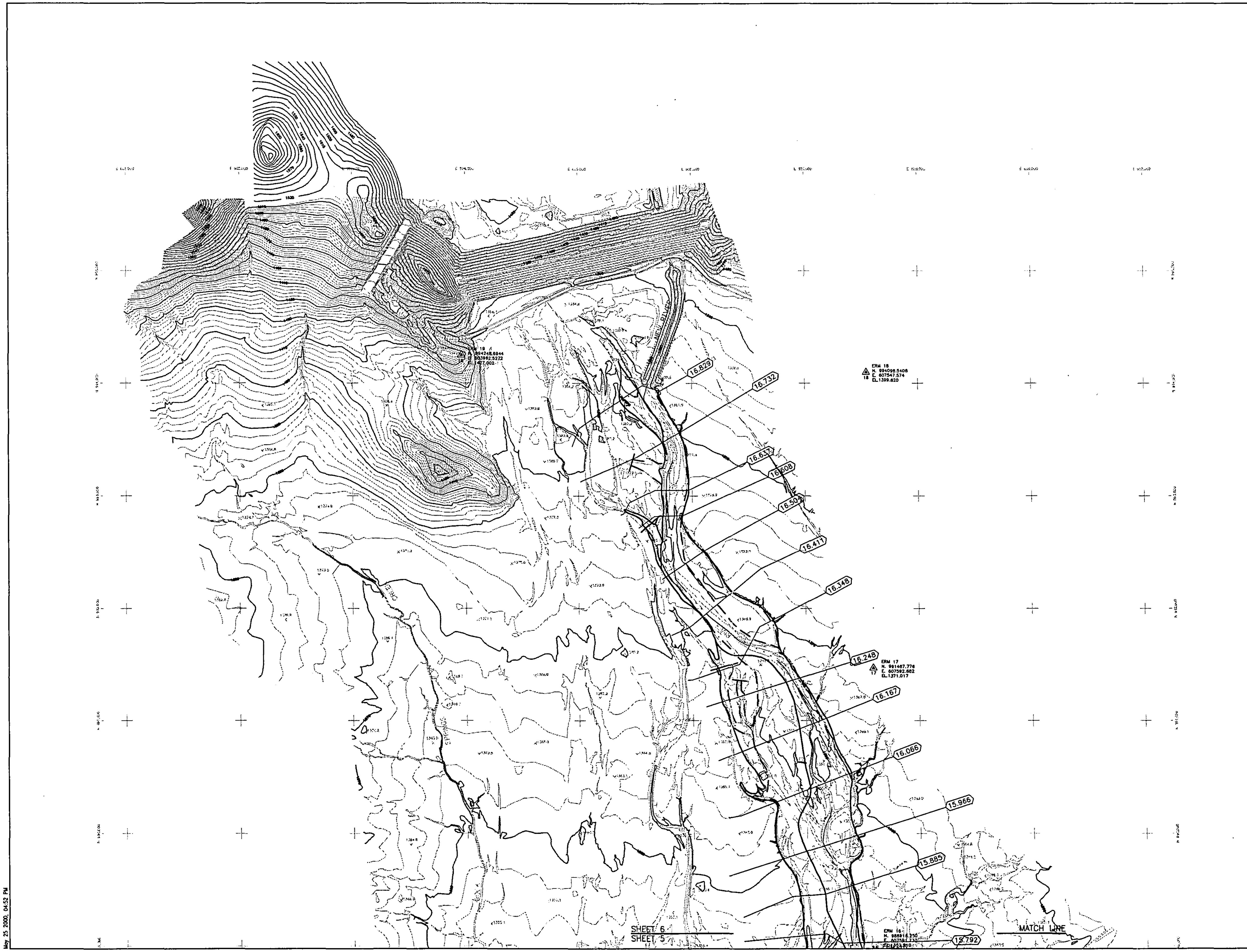


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN FLOODWAY AND FLOODPLAIN MAP

F.C.D. CONTRACT NO. 97-04

LEGEND

HYDRAULIC BASE LINE
EFFECTIVE FEMA 100-YEAR FLOODPLAIN
EFFECTIVE FEMA 100-YEAR FLOODWAY
UPDATED 100-YEAR FEMA FLOODPLAIN
CROSS SECTION 9.047
ELEVATION REFERENCE MARK 12
CORPORATE LIMITS

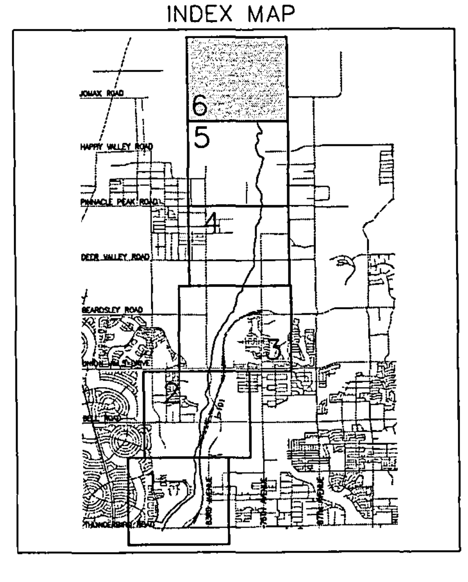
ELEVATION REFERENCE MARKS

ERM #17 – Elevation 1371.017
Top of ADOT Aluminum cap (BM517-6), Northeast Corner of Section 2,T4N, R1E, G&SRBM.

ERM #18 – Elevation 1399.62
Top of 1" aluminum cap (CBA), set in concrete at the East Quarter Corner of Section 35, T4N, R1E, G&SRBM.

ERM #19– Elevation 1427.002
Top of 3/4' rod with 2" copper cap, USCE NR3, at top of hill +/- 500' south of the west end of New River Dam.

INDEX MAP



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PLANS CHK.	PJE	04/13/00

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

PLATE FP-6 OF FP-6

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proposed condition water surface elevations are lower when compared to just the FEMA Effective HEC-2 model.

Proposed condition water surface elevations between RM segments 11.566 to 12.194 and RM 13.68 to 13.818 are 0.64 feet to 2.89 feet higher than that determined in the Updated Existing Condition HEC-RAS model for the same segments. At RM 11.759 the proposed condition water surface elevation is 1.7 feet higher when compared to the Effective FEMA HEC-2 model. The increase in water surface elevation is a result of the proposed improvements. Improvements for each segment consist of providing a uniform channel with well-defined banks that tie into upstream and downstream improvements with minor or gradual transitions. Under existing conditions, RM segment 11.5666 to 12.194 is characterized by a channel geometry that varies in bottom width, bank location and height and in channel roughness. Throughout this segment there are remnant gravel piles and it appears that this area may have been a gravel mining area. Under existing conditions, RM segment 13.68 to 13.818 is an active mining operation. The increase in water surface elevations do not adversely impact any structures.

6.0 EROSION AND SEDIMENT TRANSPORT

GENERAL

Four methods are used for the erosion and sediment transport analyses of the Middle New River Watercourse Master Plan Study. The four analytical methods used are: bed degradation (or scour) analysis to evaluate the required toe-down depths of channel structures, equilibrium slope analysis to determine the stable bed slopes in the channel, bed armoring analysis to evaluate the minimum bed material size for armoring condition, and lateral migration analysis to compute the erosion setback along the river. Bed degradation and equilibrium slope/streambed armoring analyses are employed for existing and proposed river conditions while the lateral migration analysis is employed for existing conditions and in areas where a non-structural approach is proposed as a plan alternative.

The 100-year FEMA peak discharges are used as the design discharge for all analyses except the equilibrium slope analysis, bed armoring analysis, and the long-term scour evaluation where 10-year peak discharges were used. Flow hydraulics associated with the 100-year FEMA peak discharges determined from HEC-RAS models are used for the lateral migration and bed degradation (or total scour) analyses.

Summaries of the four analyses used in the erosion and sediment transport analysis are described and presented in the sections that follow. Detailed discussions of the four methods, assumptions made in the analyses, calibration of analyses and special problems are presented in the TDN.

Bed Degradation Analysis

The degree by which a streambed degrades due to a single flood event and the combined factors of flow hydraulics and sediment characteristics in the channel provide a way to determine the extent of toe-down requirements for channel structures. Toe-down requirements for bank lining and grade control structures are essential design information for channel stability. These are estimated from the consideration of various scour components expected to occur along the stream that include the local scour, bend scour, long-term scour, low-flow incisement, anti-dune trough depth, and general scour. The total bed degradation is the summation of the above scour components plus a 30% factor of safety. The 30% safety factor is added to account for the non-uniformity of flow hydraulics in the channel and sediment characteristics in the streambed (SLA, 1989).

Long-Term Scour Analysis

There are two conditions by which long-term degradation in watercourses could be evaluated. They are bed armoring and attaining equilibrium slope in the channel. Bed armoring is the condition in the channel, in which removal and transport of finer bed materials are involved from the bed layer forming a more homogenous layer of coarser materials. The displacement of finer bed materials from the layer results in the lowering of the channel bed. The degree by which the bed is degraded due to bed armoring depends on a number of factors such as: the magnitude of the dominant discharge, size distribution of bed materials, and the potential armoring size. Pemberton and Lara (1984) presented some useful relations by which bed armoring size can be determined. These relations are employed to determine the threshold material size (or the bed armoring size) from which the percentage of transportable bed materials is based. Attaining equilibrium (or stable) slope, on the other hand, is the condition along the stream in which a long-term balance is achieved between the amount of sediments supplied and the amount of sediments transported. Such condition produces a scenario where no net gain or loss of sediment materials is attained maintaining a stable bed profile in the channel.

The depth of degradation based on the equilibrium slope concept can be determined by the following relation:

$$d_{gs} = \frac{L_g \Delta S_g}{1.625}$$

Where:

d_{gs} = depth of degradation due to stable slope, in feet.

L_g = length of the degraded channel reach in feet;

ΔS_g = difference between the existing streambed slope, S_b, and the stable slope, S_L, in ft/ft.

The depth of degradation based on bed armoring in the channel can be evaluated as follows:

$$d_{ga} = y_a\left(\frac{1}{\Delta p} - 1\right)$$

Where:

d_{ga} = depth of degradation or the depth from original streambed to top of armoring layer in feet.

y_a = thickness of armoring layer which varies from one to three times the value of the armor size, D_c, in feet.

□p = decimal percentage of original bed material larger than the armor size, D_c.

Between bed armoring and equilibrium slope, the condition that controls is the smaller of the two bed scour values. This is because attainment of one condition limits the occurrence of the other. For example, if bed armoring occurs first, then further adjustment of the bed profile to achieve a stable slope condition is limited because the coarser materials comprising the armored layer impedes the bed from further vertical adjustments. Similarly, if stable slope is attained first, then the bed profile cannot be adjusted much further to reach bed armoring condition in the channel.

Long-term degradation based on the bed armoring condition occurs in channels with coarser bed materials because such condition limits the attainment of equilibrium slope. Long-term degradation based on an equilibrium slope condition occurs in streams with finer bed materials where stream bed armoring condition would typically not occur.

Long-term degradation analyses uses hydraulic information determined from backwater models such as HEC-2 or HEC-RAS models for the dominant discharge. This dominant discharge has the characteristics that, if allowed to flow constantly, would have the same overall channel shaping effect as the natural fluctuating discharges. The dominant discharge is typically between a 5-year and 10-year event (SLA, 1994). The 10-year event is assumed applicable for the Middle New River.

Lateral Migration Analysis

ADWR (1996) presented three levels of analysis in the determination of recommended setback distances for developments in areas adjacent to watercourses. Level I analysis provides an estimate of safe setback distance based on minimum data on the channel reach and watershed hydrology. Level II analysis involves a number of developed approaches that evaluate the stability of the channel banks. Level III analysis, on the other hand, involves an in depth-evaluation of the potential bank migration by examining historical data such as aerial photos and topographic maps of the area and the development of sediment transport model of the river. For this project, only Levels I and II analyses will be performed. The relations recommended for these analyses are presented below:

Level I Analysis

For drainage areas of less than 30 square miles, the recommended setback distances for Level I can be estimated from the following relations:

For straight channel reaches or reaches with minor curvature:

$$D_{es} = 1.0(Q_{100})^{0.5} \qquad (6.1)$$

Where: D_{es} = Erosion setback distance, in ft;

Q_{100} (FEMA existing condition) = Design discharge, in cfs.

For channels with obvious curvature or channel bend:

$$D_{es} = 2.5(Q_{100})^{0.5} \qquad (6.2)$$

Where: D_{es} = Erosion setback distance, in ft;

Q_{100} (FEMA existing condition) = Design discharge, in cfs.

Minimum setback distances are 20 feet for straight channel reaches, and 50 feet for channels with obvious curvatures. ADWR (1996) defined obvious curvature as one when the channel has a radius of curvature less than 5 times the channel top width (i.e., $r_c < 5T$).

Level II Analysis

This approach is employed when a lesser setback requirement is being considered than the ones provided by Level I. The analyses that are involved in the procedure check the stability of the channel bank materials. The four approaches considered under Level II analysis are:

a. Allowable velocity analysis

b. Tractive stress analysis

c. Tractive power analysis

d. Bank lining adequacy analysis

The allowable velocity method compares the channel velocity within the watercourse adjacent to the site with the computed allowable velocity. This comparison determines if the channel is erodible or not. For the tractive stress method, the tractive stress in the channel is compared with the computed allowable tractive stress. Similarly, this comparison determines if the channel is erodible or not. For the tractive power method, a plot involving unconfined compressive strength and tractive power is used. The channel is classified whether it is erosive (i.e., if data points are above the curve) or non-erosive (i.e., if data points are below the curve). For the bank lining adequacy analysis, existing bank protection measures are evaluated to assess their adequacy against potential lateral bank migration.

The channel classifications evaluated from at least two methods shall be used as a basis whether the erosion setback determined by Level I analysis could be reduced or not. The detailed procedures for the Level II analysis are provided in the State Standard Attachment No. SSA 5-96 (ADWR, 1996).

EXISTING CONDITION RESULTS

The existing condition of the Middle New River is used to evaluate prevailing hydraulic and sediment transport conditions. The results of both the hydraulic modeling and sediment transport analysis conducted for the Middle New River are to be compared with the results of future developed conditions. Existing conditions may exhibit inadequate channel capacity and show excessive flow hydraulic and sediment transport conditions that may not be the ideal situations desired. Various design alternatives are considered to improve both the existing hydraulic and sediment transport conditions in the river.

Results of the sediment transport analysis performed on the existing river condition include the erosion setback corridor along the river evaluated from lateral migration analysis, the extent of bed degradation from scour analysis, and the stable slope of the river channel from equilibrium slope or bed armoring analysis. Although the analyses performed were made by cross-section stations, results are presented by reach since the data used are representative of each reach.

Lateral Migration and Erosion Setback

Table 6.1 lists the results of the Level I analysis on the entire Middle New River. Existing 100-year discharges and contributing drainage areas from FEMA FIS (FEMA, 1995) were used in the analysis with channel curvatures evaluated from 1998 topographic map developed by Aerial Mapping Inc.. Erosion setback limits are depicted on Figures 6-1, Sheets ES1 through ES6. In summary, the ranges of setback for the three reaches are provided as follows:

Reach 1 (Skunk Creek to Beardsley Rd.)	=	100 ft to 110 ft
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.)	=	80 ft to 100 ft
Reach 3 (Pinnacle Peak Rd. to New River Dam)	=	50 ft to 160 ft

Further in Table 6.2, an attempt to verify and refine the results of Level I analysis is made using two methods that include the allowable velocity approach and the tractive power approach (ADWR, 1996). Representative cross-sections for each reach were used for the Level II analysis involving the two methods. Sixteen cross-section stations were used for Reach 1 (out of 52 cross-section stations), 15 cross-section stations for Reach 2 (out of 24 cross-section stations), and 13 cross-section stations for Reach 3 (out of 31 cross-section stations). The flow hydraulic parameters and the geometric data used in Level II analysis were taken from the HEC-RAS model of the existing river condition. Each of the evaluations made for each cross-section in Table 6.2 reflects whether or not the river channel is erodible. For the allowable velocity approach, Reaches 1 and 3 are entirely erodible as the computed channel velocities in column (5) are greater than the maximum allowable velocities in column (20). Some segments of Reach 2, however, are non-erodible which explains that the computed erosion setback in Level I could be reduced. It is necessary, however, to use the tractive power approach to verify and validate the results of the allowable velocity approach. From the results of the analysis using the tractive power approach, it is shown that the river channel banks are generally erodible. This conclusion is based on the assumed unconfined compressive strength (UCS) of the bank materials of 100 psf. With the bank materials observed to be predominantly non-cohesive, the UCS design of 100 psf is very conservative. Overall, the Level II analysis provided the following results:

Reach 1 (Skunk Creek To Beardsley Rd.)	= Erodible Channel
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.)	= Erodible Channel
Reach 3 (Pinnacle Peak Rd. to New River Dam)	= Erodible Channel

TABLE 6-1
Level 1 Lateral Migration Analysis for Existing River Condition

Location	STATION	Existing FEMA 100-Year Discharge	Contributing Drainage Area [A]	Channel Curvature [B]	Computed Erosion Setback
	(River Miles)	(cfs)	(sq.miles)	(Straight or Obvious Bend)	(feet)
(1)	(2)	(3)	(4)	(5)	(6)
New River Dam		2350			
	15.966	2350		Bend	50.0
	15.533	4200	1.95	Obvious Bend	160.0
	14.945	4200		Bend	60.0
Pinnacle Peak Rd	14.197	6100	4.51	Straight	80.0
	14.013	6100		Straight	80.0
Deer Valley Rd	13.161	9800	6.9	Straight	100.0
	13.076	9800		Straight	100.0
	12.313	9800	<10.3>	Straight	100.0
Beardsley Rd	12.034	10350	13.77	Straight	100.0
	11.188	10350		Straight	100.0
Union Hills	10.996	10900	14.31	Straight	100.0
	10.271	10900		Straight	100.0
Bell Rd	9.960	11450	16.3	Straight	110.0
	9.492	11450		Straight	110.0
	8.807	12000		Straight	110.0
Skunk Creek	8.655	12000	27.0 <20.7>	Straight	110.0

NOTES:

(A) Drainage areas are taken from ACDC ADMS (FCDMC,199?); drainage areas in brackets (e.g., <20.7>) are from the study by Corps of Engineers (COE, 19??)..

(B) Determination of channel curvatures was based on the existing topographic map of the project area. Obvious curvature is used when the channel has a radius of curvature (rc) less than 5 times the channel top width (i.e., rc < 5T).

(C) Reach 1 is from Skunk Creek to Beardsley Rd., Reach 2 is from Beardsley Rd. to Pinnacle Peak Rd., and Reach 3 is from Pinnacle Peak Rd. to the New River Dam.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN EROSION SETBACK MAP

F.C.D. CONTRACT NO. 97-04

LEGEND

- HYDRAULIC BASE LINE
- EROSION SETBACK
- EXISTING SOIL CEMENT ARMORING
- EXISTING GABION MATTRESS ARMORING
- 100-YEAR EXISTING CONDITION PEAK DISCHARGE — Q= 4200 cfs
- CROSS SECTION — 9.047
- ELEVATION REFERENCE MARK — 12
- CORPORATE LIMITS

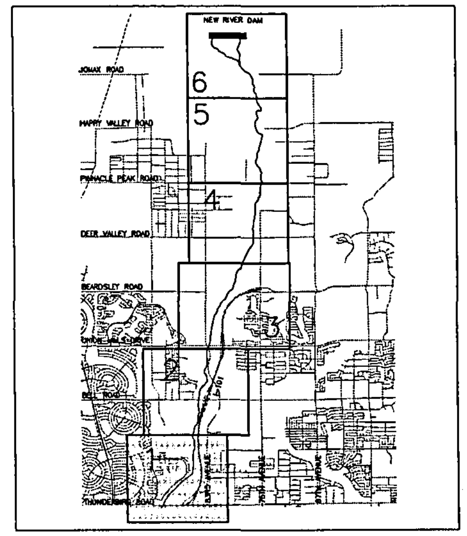
ELEVATION REFERENCE MARKS

ERM #1 – Elevation 1158.237
C.O.P. brass cap (flush) +/- 600' east of 91st Avenue on Desert Harbor Drive.

ERM #2 – Elevation 1167.042
C.O.P. brass cap in handhole @ centerline P.C. +/- 300' north of intersection of Acoma Drive & Desert Harbor Drive

ERM #3 – Elevation 1176.08
Top of brass cap (flush) at 86th Drive and Betty Elyse Lane.

INDEX MAP



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PLANS CHK.	PJE	04/13/00	CHIEF ENGINEER AND GENERAL MANAGER
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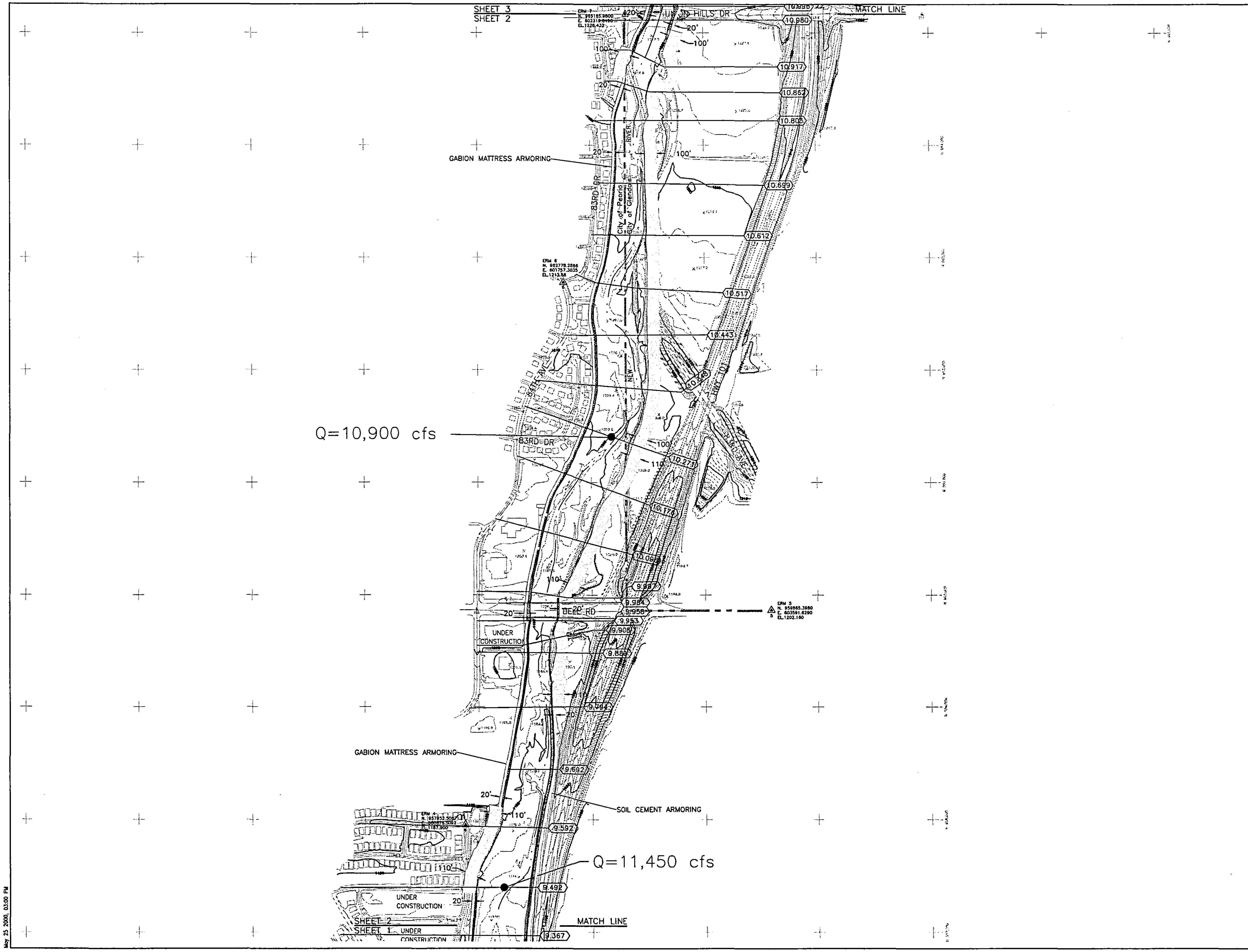


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN EROSION SETBACK MAP

F.C.D. CONTRACT NO. 97-04

LEGEND

- HYDRAULIC BASE LINE
- EROSION SETBACK
- EXISTING SOIL CEMENT ARMORING
- EXISTING GABION MATTRESS ARMORING
- 100-YEAR EXISTING CONDITION PEAK DISCHARGE — Q= 4200 cfs
- CROSS SECTION — 9.047
- ELEVATION REFERENCE MARK — 12
- CORPORATE LIMITS

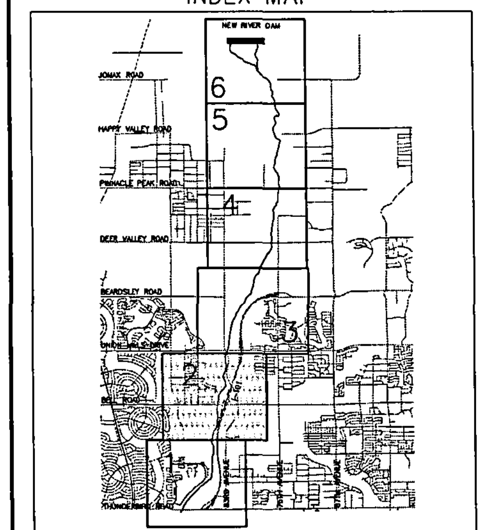
ELEVATION REFERENCE MARKS

ERM #4 - Elevation 1187.90
Top of brass cap (flush) at intersection of 86th Avenue and Paradise Lane.

ERM #5 - Elevation 1202.15
C.O.G. brass cap in handhole at intersection of 83rd Avenue and Bell Road.

ERM #6 - Elevation 1212.88
Top brass cap in handhole at 83rd Drive and 84th Avenue.

INDEX MAP



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PLANS CHK.	PJE	04/13/00	CHIEF ENGINEER AND GENERAL MANAGER
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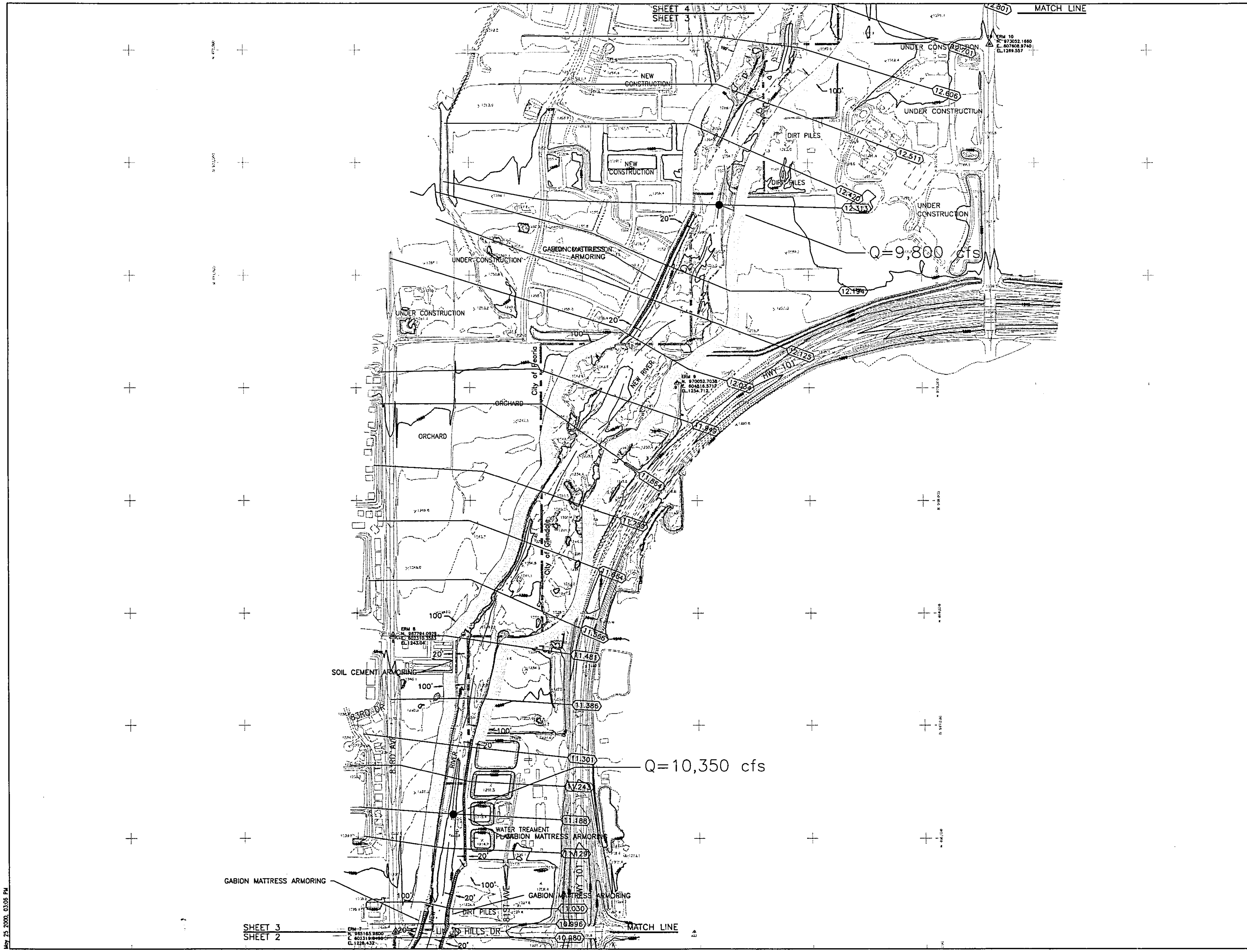


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN EROSION SETBACK MAP

F.C.D. CONTRACT NO. 97–04

LEGEND

HYDRAULIC BASE LINE
EROSION SETBACK
EXISTING SOIL CEMENT ARMORING
EXISTING GABION MATTRESS ARMORING
100–YEAR EXISTING CONDITION PEAK DISCHARGE — Q= 4200 cfs
CROSS SECTION — 9.047
ELEVATION REFERENCE MARK — 12
CORPORATE LIMITS

ELEVATION REFERENCE MARKS

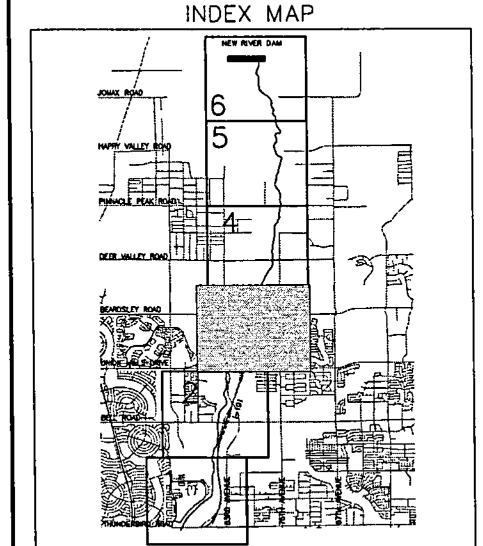
ERM #7 – Elevation 1228.432
C.O.P. brass cap in handhole at 83rd Avenue and Union Hills Drive.

ERM #8 – Elevation 1243.04
Top of 2" iron pipe in handhole at intersection of 83rd Avenue and Village Parkway.

ERM #9 – Elevation 1254.712
Top of ADOT aluminum cap along the north side of 101 Freeway, P.O.C. Sta 918+00.00.

ERM #10 – Elevation 1269.557
C.O.G. brass cap in handhole at intersection of 75th Avenue and Rose Garden Lane.

INDEX MAP



400' 0' 400' 800'
SCALE: 1"=400'
CONTOUR INTERVAL: 2 FEET

Stantec JOB# 28900058

	BY	DATE
DESIGN	PAW	04/01/99
DESIGN CHK.	PJE	04/13/00
PLANS	PAW	04/20/99
PLANS CHK.	PJE	04/13/00

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
PLATE ES-3 OF ES-6

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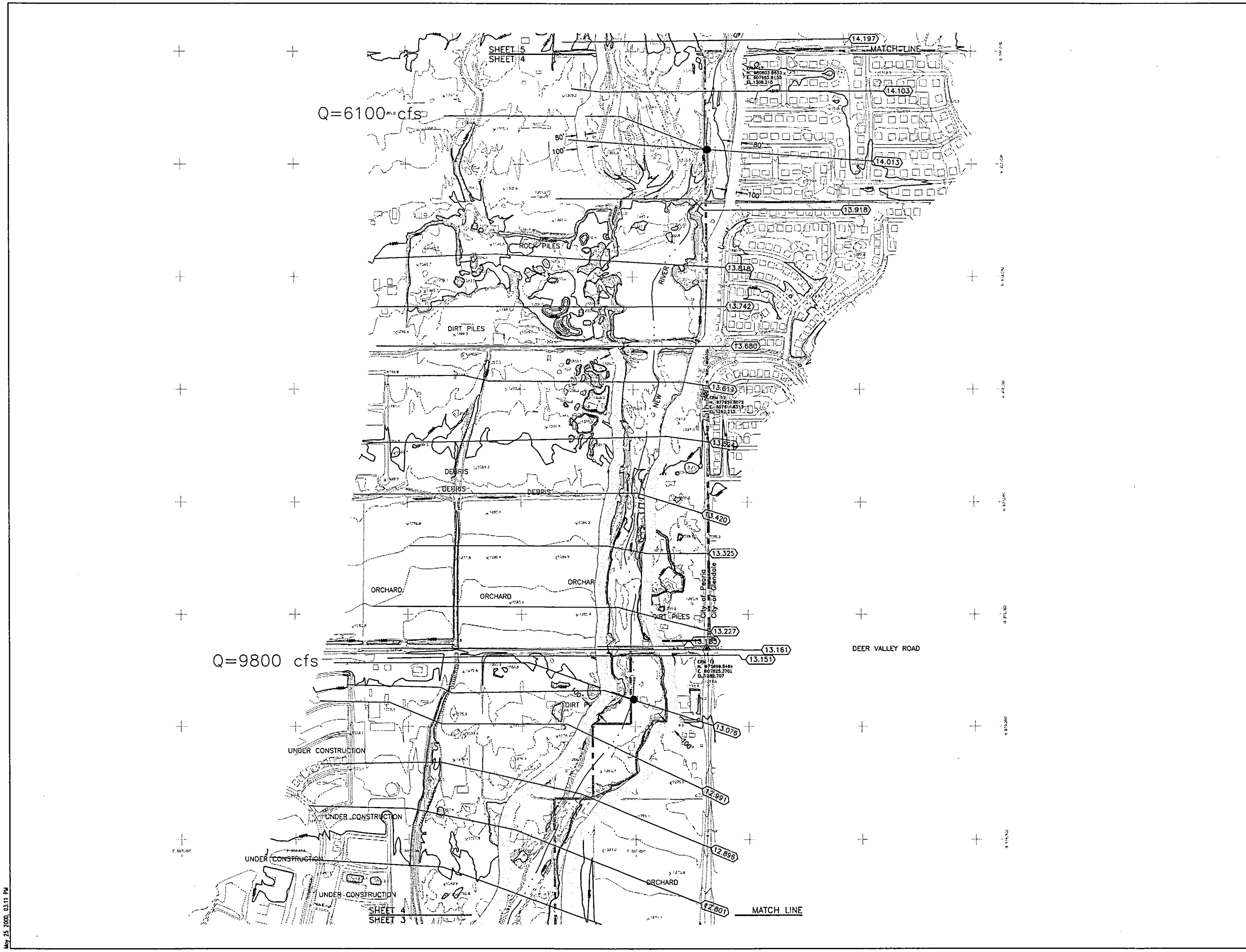


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN EROSION SETBACK MAP

F.C.D. CONTRACT NO. 97-04

LEGEND

- HYDRAULIC BASE LINE
- EROSION SETBACK
- EXISTING SOIL CEMENT ARMORING
- EXISTING GABION MATTRESS ARMORING
- 100-YEAR EXISTING CONDITION PEAK DISCHARGE — Q= 4200 cfs
- CROSS SECTION — 9.047
- ELEVATION REFERENCE MARK — 12
- CORPORATE LIMITS

ELEVATION REFERENCE MARKS

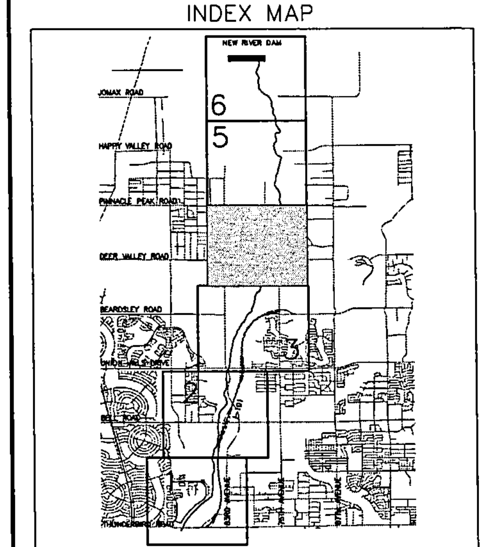
ERM #10 - Elevation 1269.557
C.O.G. brass cap in handhole at intersection of 75th Avenue and Rose Garden Lane.

ERM #11 - Elevation 1282.707
MC brass cap in handhole at intersection of 75th Avenue and Deer Valley Road.

ERM #12 - Elevation 1292.2328
Top of brass cap (flush) on 75th Avenue and Centerline P.C., +/-400' south of the East Quarter Corner of Section 14, T4N, R1E, G&SRBM.

ERM #13 - Elevation 1308.215
Top of brass cap (flush) at center of cul de sac at 7431 W. Monte Lindo.

INDEX MAP



N

400' 0' 400' 800'

SCALE: 1"=400'

CONTOUR INTERVAL: 2 FEET

Stantec JOB# 28900058

	BY	DATE
DESIGN	PAW	04/01/99
DESIGN CHK.	PJE	04/13/00
PLANS	PAW	04/20/99
PLANS CHK.	PJE	04/13/00

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

PLATE ES-4 of ES-6

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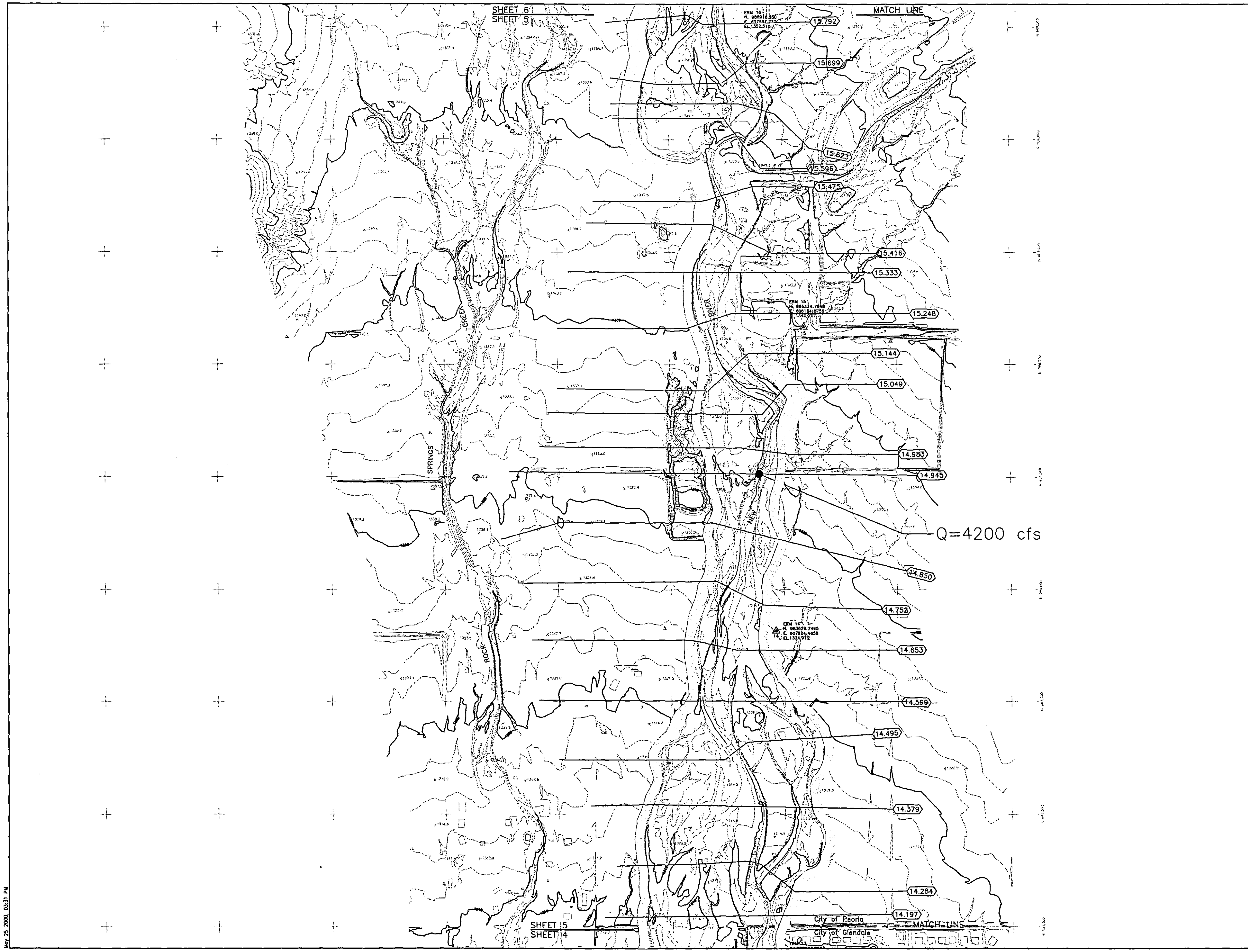


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN EROSION SETBACK MAP

F.C.D. CONTRACT NO. 97-04

LEGEND

HYDRAULIC BASE LINE

EROSION SETBACK

EXISTING SOIL CEMENT ARMORING

EXISTING GABION MATTRESS ARMORING

100-YEAR EXISTING CONDITION PEAK DISCHARGE — Q= 4200 cfs

CROSS SECTION — 9.047

ELEVATION REFERENCE MARK — 12

CORPORATE LIMITS

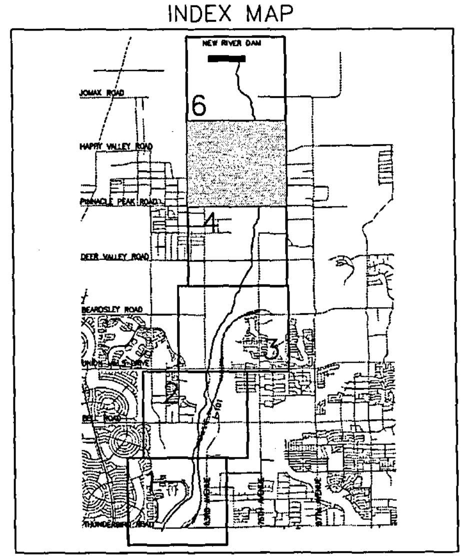
ELEVATION REFERENCE MARKS

ERM #14 – Elevation 1324.912
Chiseled 'X' on center of top of west end of 4' x 10' storm culvert +/- 300' east of the West Quarter Corner of Section 12, T4N, R1E, G&SRBM.

ERM #15 – Elevation 1342.977
Chiseled 'X' on center of top of west end of 4' x 10' storm culvert +/- 573' east of Southwest Corner of Section 1, T4N, R1E, G&SRBM.

ERM #16 – Elevation 1352.51
Set FCDMC brass cap in concrete, +/- 20' west of the East Quarter Corner of Section 2, T4N, R1E, G&SRBM.

INDEX MAP



400' 0' 400' 800'
SCALE: 1"=400'
CONTOUR INTERVAL: 2 FEET

Stantec JOB# 28900058

	BY	DATE	
DESIGN	PAW	04/01/99	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	PJE	04/13/00	RECOMMENDED BY: DATE
PLANS	PAW	04/20/99	APPROVED BY: DATE
PLANS CHK.	PJE	04/13/00	CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY:		DATE:	PLATE ES-5 OF ES-6

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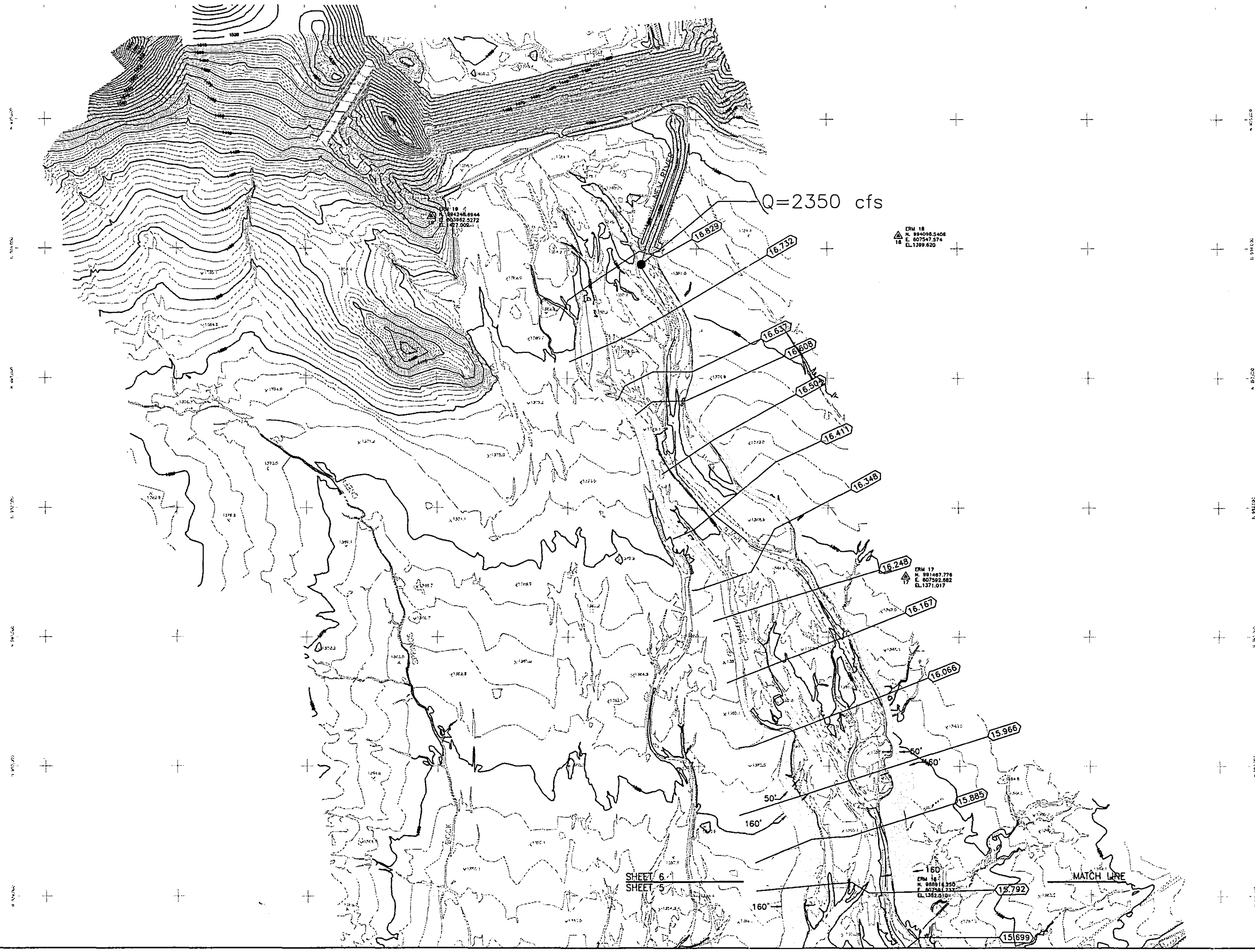
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN EROSION SETBACK MAP

F.C.D. CONTRACT NO. 97-04



LEGEND

HYDRAULIC BASE LINE	
EROSION SETBACK	
EXISTING SOIL CEMENT ARMORING	
EXISTING GABION MATTRESS ARMORING	
100-YEAR EXISTING CONDITION PEAK DISCHARGE	Q= 4200 cfs
CROSS SECTION	9.047
ELEVATION REFERENCE MARK	12
CORPORATE LIMITS	

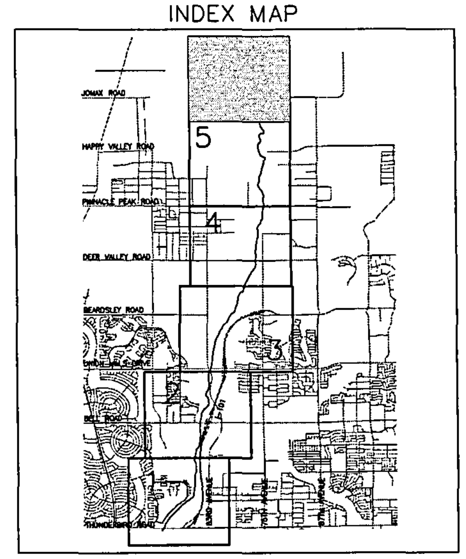
ELEVATION REFERENCE MARKS

ERM #17 – Elevation 1371.017
Top of ADOT Aluminum cap (BM517-6), Northeast Corner of Section 2,T4N, R1E, G&SRBM.

ERM #18 – Elevation 1399.62
Top of 1" aluminum cap (CBA), set in concrete at the East Quarter Corner of Section 35, T4N, R1E, G&SRBM.

ERM #19– Elevation 1427.002
Top of 3/4' rod with 2" copper cap, USCE NR3, at top of hill +/- 500' south of the west end of New River Dam.

INDEX MAP



400' 0' 400' 800'
SCALE: 1"=400'
CONTOUR INTERVAL: 2 FEET

Stantec JOB# 28900058

	BY	DATE
DESIGN	PAW	04/01/99
DESIGN CHK.	PJE	04/13/00
PLANS	PAW	04/20/99
PLANS CHK.	PJE	04/13/00

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

PLATE ES-6 OF ES-6

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TABLE 6-2

Level 2 Lateral Migration Analysis for Existing River Condition

															Allowable Velocity Approach						Tractive Power Approach				
																Correction Factor									
Item No.	Reach No.	Station No.	Discharge (cfs)	Channel Velocity (ft/s)	Flow Depth (ft)	Channel Manning's	E.G. Slope (ft/ft)	Reach Length (ft)	Channel Top Width (ft)	Channel Slope (ft/ft)	Radius of Curvature (ft)	Bank Slope (HOR:VER) (ft/ft)	Unconfined Compressive Strength (UCS)[1] (psf)	Grain Size D_{75} (ft)	V_b [2] (ft/s)	C_a [3]	C_b [4]	C_d [5]	Maximum Velocity (ft/s)	Erosion Possible? (yes or no)	Computed r/b	τ_{sc}/τ_s	Computed Tractive Force	Allowable Tractive Force	Tractive Power Approach
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
1	3	16.608	2350	4.86	4.39	0.038	0.00489	500.7	201.7	0.00373	27515	3.4	100	0.00115	2.00	1.00	0.84	1.09	1.83	yes	136.40	1.00	0.36	0.03	erodible
2	3	16.504	2350	4.34	4.40	0.038	0.00306	481.4	235.3	0.00501	27515	19.5	100	0.00115	2.00	1.00	0.84	1.09	1.83	yes	116.92	1.00	0.13	0.03	erodible
3	3	16.411	2350	6.17	4.39	0.038	0.00664	481.8	179.2	0.00376	27515	4.6	100	0.00115	2.00	1.00	0.84	1.09	1.83	yes	153.53	1.00	0.10	0.03	erodible
4	3	16.348	2350	4.33	4.10	0.038	0.00357	497.9	382.9	0.00478	27515	28.1	100	0.00115	2.00	1.00	0.84	1.07	1.81	yes	71.87	1.00	0.18	0.03	erodible
5	3	16.066	2350	4.11	4.18	0.038	0.00539	584.2	438.0	0.00442	27515	11.0	100	0.00115	2.00	1.00	0.84	1.08	1.81	yes	62.82	1.00	0.08	0.03	erodible
6	3	15.966	2350	3.43	5.11	0.038	0.00197	430.0	562.0	0.00800	27515	13.3	100	0.00115	2.00	1.00	0.84	1.12	1.88	yes	48.96	1.00	0.02	0.03	non-erodible
7	3	15.885	4200	6.74	6.34	0.038	0.00661	509.4	276.9	0.00628	27515	16.5	100	0.00115	2.00	1.00	0.84	1.16	1.96	yes	99.38	1.00	0.38	0.03	erodible
8	3	15.792	4200	6.73	6.56	0.038	0.00539	472.7	295.3	0.00104	27515	10.0	100	0.00115	2.00	1.00	0.84	1.17	1.97	yes	93.18	1.00	0.27	0.03	erodible
9	3	14.850	6100	5.55	4.85	0.038	0.00587	536.7	557.2	0.00613	27515	15.4	100	0.00115	2.00	1.00	0.84	1.11	1.87	yes	49.38	1.00	0.15	0.03	erodible
10	3	14.752	6100	4.14	5.71	0.038	0.00251	547.5	758.1	0.00342	27515	15.5	100	0.00115	2.00	1.00	0.84	1.14	1.92	yes	36.30	1.00	0.09	0.03	erodible
11	3	14.653	6100	6.93	4.89	0.038	0.00865	536.6	740.0	0.00527	27515	28.6	100	0.00115	2.00	1.00	0.84	1.11	1.87	yes	37.18	1.00	0.14	0.03	erodible
12	3	14.599	6100	4.77	4.73	0.038	0.00465	542.2	549.2	0.00537	27515	1.6	100	0.00115	2.00	1.00	0.56	1.10	1.23	yes	50.10	1.00	0.13	0.03	erodible
13	3	14.495	6100	6.07	5.36	0.038	0.00448	561.7	1022.7	0.00531	27515	15.6	100	0.00115	2.00	1.00	0.84	1.13	1.90	yes	26.90	1.00	0.08	0.03	erodible
14	2	13.619	7900	3.57	5.28	0.035	0.00107	505.6	534.6	0.00310	27515	14.0	100	0.03905	5.50	1.00	0.84	1.13	5.21	no	51.47	1.00	4.06	0.03	erodible
15	2	13.524	7900	6.30	5.52	0.035	0.00322	522.6	294.4	0.00855	27515	5.9	100	0.03905	5.50	1.00	0.84	1.14	5.25	yes	93.46	1.00	0.11	0.03	erodible
16	2	13.420	7900	7.83	7.67	0.035	0.00437	514.1	214.7	0.00142	27515	7.2	100	0.03905	5.50	1.00	0.84	1.20	5.54	yes	128.17	1.00	0.32	0.03	erodible
17	2	13.325	7900	7.80	6.00	0.035	0.00501	571.0	240.6	0.00317	27515	5.4	100	0.03905	5.50	1.00	0.84	1.15	5.33	yes	114.36	1.00	0.54	0.03	erodible
18	2	13.227	7900	6.77	5.59	0.035	0.00354	315.3	264.3	0.00000	27515	8.4	100	0.03905	5.50	1.00	0.84	1.14	5.26	yes	104.10	1.00	0.12	0.03	erodible
19	2	13.185	7900	6.57	4.28	0.035	0.00520	33.6	382.5	0.00715	27515	27.8	100	0.03905	5.50	1.00	0.84	1.08	5.01	yes	71.94	1.00	1.30	0.03	erodible
20	2	13.151	7900	3.33	9.13	0.035	0.00056	393.1	390.9	-0.00043	27515	10.1	100	0.03905	5.50	1.00	0.84	1.23	5.69	no	70.40	1.00	0.84	0.03	erodible
21	2	13.076	7900	2.80	8.82	0.035	0.00033	454.2	403.9	0.00000	27515	4.9	100	0.03905	5.50	1.00	0.84	1.22	5.66	no	68.13	1.00	0.85	0.03	erodible
22	2	12.991	9800	2.78	8.68	0.035	0.00031	527.0	514.9	-0.00025	27515	3.5	100	0.03905	5.50	1.00	0.84	1.22	5.64	no	53.44	1.00	2.36	0.03	erodible
23	2	12.896	9800	3.84	8.18	0.035	0.00084	508.2	569.8	0.00447	27515	6.4	100	0.03905	5.50	1.00	0.84	1.21	5.59	no	48.29	1.00	0.09	0.03	erodible
24	2	12.801	9800	4.05	9.83	0.035	0.00165	524.6	666.3	0.00025	27515	9.6	100	0.03905	5.50	1.00	0.84	1.24	5.74	no	41.29	1.00	0.05	0.03	erodible
25	2	12.701	9800	6.57	8.33	0.035	0.00325	505.6	429.8	0.00237	27515	26.8	100	0.03905	5.50	1.00	0.84	1.21	5.61	yes	64.01	1.00	0.05	0.03	erodible
26	2	12.606	9800	7.83	7.16	0.035	0.00559	582.3	479.9	0.00704	27515	33.4	100	0.03905	5.50	1.00	0.84	1.19	5.48	yes	57.34	1.00	0.15	0.03	erodible
27	2	12.511	9800	7.57	8.80	0.035	0.00336	467.6	458.1	0.00064	27515	13.1	100	0.03905	5.50	1.00	0.84	1.22	5.65	yes	60.07	1.00	0.18	0.03	erodible
28	2	12.420	9800	10.86	5.70	0.035	0.00848	578.1	276.4	0.00697	27515	19.7	100	0.03905	5.50	1.00	0.84	1.14	5.28	yes	99.54	1.00	0.65	0.03	erodible
29	1	11.949	10350	6.52	5.46	0.035	0.00323	452.3	576.9	0.00736	27515	12.5	100	0.00184	2.20	1.00	0.84	1.13	2.10	yes	47.69	1.00	0.18	0.03	erodible
30	1	11.864	10350	9.62	5.87	0.035	0.00705	615.3	535.5	0.00577	27515	10.9	100	0.00184	2.20	1.00	0.84	1.15	2.12	yes	51.38	1.00	0.62	0.03	erodible
31	1	11.759	10350	7.67	6.41	0.035	0.00455	501.2	502.4	0.00642	27515	2.0	100	0.00184	2.20	1.00	0.76	1.17	1.95	yes	54.77	1.00	0.57	0.03	erodible
32	1	11.664	10350	9.98	6.06	0.035	0.00776	513.8	345.6	0.00093	27515	22.2	100	0.00184	2.20	1.00	0.84	1.16	2.13	yes	79.62	1.00	0.59	0.03	erodible
33	1	11.566	10350	4.37	5.93	0.035	0.00131	468.9	493.6	0.00749	34770	7.1	100	0.00184	2.20	1.00	0.84	1.15	2.13	yes	70.44	1.00	0.08	0.03	erodible
34	1	10.917	10900	6.40	6.78	0.035	0.00292	292.2	364.6	0.00445	34770	17.2	100	0.00184	2.20	1.00	0.84	1.18	2.17	yes	95.36	1.00	0.25	0.03	erodible
35	1	10.862	10900	8.71	6.41	0.035	0.00474	313.2	241.1	0.00425	34770	3.4	100	0.00184	2.20	1.00	0.84	1.17	2.15	yes	144.21	1.00	0.59	0.03	erodible
36	1	10.803	10900	7.72	6.38	0.035	0.00509	567.3	533.2	0.00818	34770	19.7	100	0.00184	2.20	1.00	0.84	1.16	2.15	yes	65.21	1.00	0.41	0.03	erodible
37	1	10.699	10900	9.29	7.18	0.035	0.00706	462.2	276.4	0.00149	34770	13.9	100	0.00184	2.20	1.00	0.84	1.19	2.19	yes	125.79	1.00	0.79	0.03	erodible
38	1	10.612	10900	6.30	6.61	0.035	0.00241	504.9	326.2	0.00265	34770	2.7	100	0.00184	2.20	1.00	0.83	1.17	2.15	yes	106.60	1.00	0.23	0.03	erodible
39	1	10.517	10900	8.54	5.52	0.035	0.00660	519.3	528.1	0.00545	34770	2.9	100	0.00184	2.20	1.00	0.73	1.14	1.83	yes	65.84	1.00	0.15	0.03	erodible
40	1	9.692	11450	5.55	7.65	0.035	0.00174	565.2	369.6	0.00265	34770	2.1	100	0.00184	2.20	1.00	0.84	1.20	2.21	yes	94.08	1.00	0.97	0.03	erodible
41	1	9.592	11450	9.72	6.08	0.035	0.01043	606.9	349.0	0.00290	34770	2.8	100	0.00184	2.20	1.00	0.84	1.16	2.14	yes	99.63	1.00	0.21	0.03	erodible
42	1	9.492	11450	5.96	5.36	0.035	0.00305	463.5	472.6	0.00563	34770	5.2	100	0.00184	2.20	1.00	0.84	1.13	2.09	yes	73.58	1.00	0.08	0.03	erodible
43	1	9.367	12000	4.54	7.33	0.035	0.00113	489.7	464.9	0.00608	34770	8.9	100	0.00184	2.20	1.00	0.84	1.19	2.20	yes	74.80	1.00	0.13	0.03	erodible
44	1	9.318	12000	5.31	9.58	0.035	0.00133	155.6	353.8	0.00289	34770	5.0	100	0.00184	2.20	1.00	0.84	1.24	2.29	yes	98.29	1.00	0.13	0.03	erodible

NOTES:

(1) The unconfined compressive strength (UCS) in column (14) was assumed to be at most 100 psf for the sediment materials because the materials are predominately non-cohesive.

(2) The values for the basic allowable velocity, V_b, in column (16) were taken from Figure 1 of the Arizona Department of Water Resources Manual (ADWR, 1996) using the sediment laden curve.

(3) The values of correction factor C_a for channel alignment in column (17) were taken from Figure 2 (ADWR, 1996). Since the computed ratio between radius of curvature (r_c) and the water surface width is greater than 16, a C_a value of 1.0 is used.

(4) The values of correction factor C_b for bank slope in column (18) were calculated from an equation that represents Figure 3 (ADWR, 1996). If the side slope was greater then 3:1, the extreme value of 0.84 was used.

(5) The values of correction factor C_d for depth of flow in column (19) were calculated from two equations that were created to represent Figure 4 (ADWR, 1996). The first equation represents the correction factor for depths less than 9.0 ft, and the second for depths greater than 9.0 ft.

(6) The side slopes were calculated from the HEC-RAS model for the main channel and then averaged to one number from the left and right slope.

(7) The data from columns (4) to (10) were taken from the HEC-RAS model of the river.

The two analytical approaches of Level II used to refine the results of the Level I analysis show that the existing channel bank conditions are generally erodible. This means that the erosion setbacks computed in Level I analysis are sufficient for the existing river conditions.

Equilibrium Slopes

In the evaluation of equilibrium slopes for the three reaches, representative cross-sections for each reach were used as in the lateral migration analysis. All the four equations presented in Section 5.1.2 (TDN) are used in the analysis. The flow hydraulic data and information required for the equilibrium slope analysis are based on the dominant discharge. These are evaluated from the HEC-RAS model run of the existing river model. As shown in Table 6-3, the average equilibrium slopes evaluated for the three reaches are:

Reach 1 (Skunk Creek to Beardsley Rd.)	= 0.00105 ft/ft
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.)	= 0.00125 ft/ft
Reach 3 (Pinnacle Peak Rd. to New River Dam)	= 0.00129 ft/ft

From the analysis made, it is observed that equilibrium slopes are significantly impacted by the bed material size in the channel. The relatively flat slopes for the equilibrium slopes in the New River indicate that the river will continue to adjust laterally and change vertically until the stable or quasi-equilibrium slopes are attained.

Bed Armoring Sizes

In the evaluation of bed armoring sizes for the three reaches, representatives cross-sections for each reach were used. All the five equations presented in Section 5.1.3 (TDN) are used in the analysis. The flow hydraulic data and information required for the bed armoring analysis are based on the dominant discharge. These are evaluated

TABLE 6-3
Stable Slope Analysis for Existing Condition
Middle New River Watercourse Master Plan

Item No.	Station No.	Reach No.	Dominant Discharge (cfs)	Reach Length (ft)	Channel Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Velocity Channel (ft/s)	E.G. Slope (ft/ft)	Manning's n (-)	Froude No.	Average Grain Size D50 (mm)	D50 (ft)	D90 (mm)	Schoklitsch Method (ft/ft)	MPM Method (ft/ft)	Shields Diagram Method (ft/ft)	Lane's Tract. Force Method (ft/ft)	Average Stable Slope (ft/ft)	Sub-Reach Average Stable Slope (ft/ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(18)	(19)	(20)	(21)	(22)
1	16.608	3	1700	500.72	198.61	3.94	1.98	4.32	0.00495	0.038	0.54	8.74	0.0287	82.06	0.00177	0.00104	0.00054	0.00060	0.00113	
2	16.504	3	1700	481.43	207.73	3.82	2.07	4.01	0.00338	0.038	0.48	8.74	0.0287	82.06	0.00183	0.00107	0.00062	0.00062	0.00103	
3	16.411	3	1700	481.78	160.84	3.96	2.07	5.34	0.00563	0.038	0.60	8.74	0.0287	82.06	0.00151	0.00103	0.00052	0.00060	0.00091	
4	16.348	3	1700	497.94	334.03	3.67	1.46	4.07	0.00384	0.038	0.49	8.74	0.0287	82.06	0.00261	0.00111	0.00063	0.00064	0.00145	
5	16.066	3	1700	584.23	409.48	4.01	1.31	3.35	0.00384	0.038	0.46	8.74	0.0287	82.06	0.00304	0.00102	0.00057	0.00059	0.00155	
6	15.966	3	1700	429.98	353.62	4.22	1.43	4.00	0.00442	0.038	0.51	8.74	0.0287	82.06	0.00272	0.00097	0.00051	0.00056	0.00142	
7	15.885	3	1874	509.42	195.25	4.89	1.83	5.41	0.00801	0.038	0.69	8.74	0.0287	82.06	0.00162	0.00084	0.00038	0.00048	0.00098	
8	15.792	3	1874	472.66	211.04	5.33	2.01	4.83	0.00415	0.038	0.52	8.74	0.0287	82.06	0.00172	0.00077	0.00039	0.00044	0.00098	
9	14.850	3	2052	536.65	468.78	3.54	1.11	4.51	0.00786	0.038	0.65	8.74	0.0287	82.06	0.00292	0.00115	0.00056	0.00067	0.00158	
10	14.752	3	2052	547.53	430.99	4.15	1.70	2.80	0.00255	0.038	0.38	8.74	0.0287	82.06	0.00274	0.00098	0.00060	0.00057	0.00143	
11	14.653	3	2052	536.63	326.81	3.54	1.35	5.07	0.00744	0.038	0.66	8.74	0.0287	82.06	0.00223	0.00115	0.00056	0.00067	0.00135	
12	14.599	3	2052	542.23	436.77	3.35	1.37	3.36	0.00510	0.038	0.51	8.74	0.0287	82.06	0.00277	0.00122	0.00066	0.00070	0.00156	
13	14.495	3	2052	561.68	405.23	3.98	1.44	4.41	0.00393	0.038	0.50	8.74	0.0287	82.06	0.00262	0.00103	0.00057	0.00059	0.00141	*0.00129*
14	13.619	2	2221	505.64	515.05	2.82	1.79	2.41	0.00149	0.035	0.32	9.83	0.0323	68.86	0.00323	0.00151	0.00113	0.00089	0.00187	
15	13.524	2	2221	522.56	276.6	2.84	1.77	4.54	0.00537	0.035	0.60	9.83	0.0323	68.86	0.00203	0.00150	0.00097	0.00088	0.00147	
16	13.420	2	2221	514.13	186.69	5.09	2.57	4.64	0.00341	0.035	0.51	9.83	0.0323	68.86	0.00151	0.00083	0.00053	0.00049	0.00095	
17	13.325	2	2221	571.01	209.88	3.44	2.02	5.24	0.00600	0.035	0.65	9.83	0.0323	68.86	0.00165	0.00123	0.00074	0.00073	0.00120	
18	13.227	2	2221	315.32	245.25	3.39	2.45	3.69	0.00230	0.035	0.42	9.83	0.0323	68.86	0.00185	0.00125	0.00094	0.00074	0.00128	
19	13.185	2	2221	33.56	300.62	2.32	1.75	4.22	0.00467	0.035	0.56	9.83	0.0323	68.86	0.00216	0.00183	0.00128	0.00108	0.00169	
20	13.151	2	2221	393.13	294.84	5.56	3.77	2.00	0.00038	0.035	0.18	9.83	0.0323	68.86	0.00212	0.00076	0.00057	0.00045	0.00111	
21	13.076	2	2221	454.21	384.55	5.29	3.70	1.56	0.00024	0.035	0.14	9.83	0.0323	68.86	0.00259	0.00080	0.00060	0.00047	0.00129	
22	12.991	2	2400	527.02	475.97	5.22	3.90	1.30	0.00015	0.035	0.11	9.83	0.0323	68.86	0.00287	0.00081	0.00061	0.00048	0.00139	
23	12.896	2	2400	508.24	407.16	4.90	2.87	2.11	0.00059	0.035	0.22	9.83	0.0323	68.86	0.00255	0.00087	0.00065	0.00051	0.00131	
24	12.801	2	2400	524.61	258.28	6.52	2.60	3.58	0.00201	0.035	0.39	9.83	0.0323	68.86	0.00182	0.00065	0.00044	0.00038	0.00095	
25	12.701	2	2400	505.60	232.76	5.43	2.58	4.00	0.00252	0.035	0.44	9.83	0.0323	68.86	0.00168	0.00078	0.00052	0.00046	0.00097	
26	12.606	2	2400	582.30	213.19	4.11	1.86	6.04	0.00885	0.035	0.78	9.83	0.0323	68.86	0.00157	0.00103	0.00054	0.00061	0.00107	
27	12.511	2	2400	467.59	195.43	5.31	2.61	4.70	0.00344	0.035	0.51	9.83	0.0323	68.86	0.00147	0.00080	0.00050	0.00047	0.00091	
28	12.420	2	2400	578.07	176.79	2.87	2.11	6.45	0.00860	0.035	0.78	9.83	0.0323	68.86	0.00137	0.00148	0.00085	0.00087	0.00124	*0.00125*
29	11.949	1	2529	452.25	295.98	2.48	1.78	4.81	0.00594	0.035	0.63	7.79	0.0256	65.83	0.00162	0.00137	0.00076	0.00090	0.00130	
30	11.864	1	2529	615.28	225.24	3.55	2.31	4.91	0.00421	0.035	0.56	7.79	0.0256	65.83	0.00132	0.00096	0.00053	0.00063	0.00097	
31	11.759	1	2529	501.24	426.52	3.66	1.34	5.45	0.00743	0.035	0.71	7.79	0.0256	65.83	0.00214	0.00093	0.00046	0.00061	0.00123	
32	11.664	1	2529	513.83	307.74	3.91	1.77	5.22	0.00495	0.035	0.60	7.79	0.0256	65.83	0.00167	0.00087	0.00045	0.00057	0.00104	
33	11.566	1	2529	468.92	453.92	2.54	1.66	3.35	0.00318	0.035	0.46	7.79	0.0256	65.83	0.00224	0.00134	0.00087	0.00088	0.00149	
34	10.917	1	2586	292.21	254.25	3.11	2.36	4.30	0.00327	0.035	0.49	7.79	0.0256	65.83	0.00142	0.00109	0.00067	0.00072	0.00108	
35	10.862	1	2586	313.15	220.62	3.41	2.57	4.56	0.00331	0.035	0.50	7.79	0.0256	65.83	0.00128	0.00100	0.00060	0.00066	0.00088	
36	10.803	1	2586	567.30	265.32	3.54	2.11	4.63	0.00442	0.035	0.56	7.79	0.0256	65.83	0.00147	0.00096	0.00052	0.00063	0.00090	
37	10.699	1	2586	462.24	214.29	4.24	1.88	6.41	0.00990	0.035	0.82	7.79	0.0256	65.83	0.00125	0.00080	0.00036	0.00053	0.00086	
38	10.612	1	2586	504.93	309.44	3.61	2.51	3.33	0.00181	0.035	0.37	7.79	0.0256	65.83	0.00165	0.00094	0.00064	0.00062	0.00107	
39	10.517	1	2586	519.30	310.21	3.30	1.80	4.63	0.00546	0.035	0.61	7.79	0.0256	65.83	0.00165	0.00103	0.00054	0.00068	0.00112	
40	9.692	1	2643	565.23	356.15	4.43	2.52	2.95	0.00142	0.035	0.33	7.79	0.0256	65.83	0.00180	0.00077	0.00053	0.00050	0.00090	
41	9.592	1	2643	606.90	340.08	4.48	1.85	4.20	0.004326	0.035	0.54	7.79	0.0256	65.83	0.00174	0.00076	0.00039	0.00050	0.00085	
42	9.492	1	2643	463.47	375.84	2.19	1.33	5.29	0.01065	0.035	0.81	7.79	0.0256	65.83	0.00188	0.00155	0.00079	0.00102	0.00131	
43	9.367	1	2700	489.74	408.02	3.35	2.19	3.02	0.001783	0.035	0.36	7.79	0.0256	65.83	0.00197	0.00102	0.00071	0.00067	0.00109	
44	9.318	1	2700	155.57	334.87	5.47	2.52	3.20	0.001657	0.035	0.36	7.79	0.0256	65.83	0.00170	0.00062	0.00039	0.00041	0.00078	*0.00105*

NOTES:
(1) The dominant discharges in column (4) correspond to the 10-year discharges.
(2) The data from columns (5) to (12) were taken from the 10-year HEC-RAS run of the river model.
(3) The average stable slope in column (21) is the average of the four methods.
(4) Column (22) shows the average equilibrium slopes by reach.

from the HEC-RAS model run of the existing river model. As shown in Table 6-4, the average bed armoring size, evaluated for the three reaches are:

Reach 1 (Skunk Creek to Beardsley Rd.)	-	48.7 mm
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.)	-	34.2 mm
Reach 3 (Pinnacle Peak Rd to New River Dam)	-	48.2 mm

From the analyses made, it is observed that the bed armoring sizes are significantly impacted by energy slope. Comparing the bed armoring sizes evaluated for the reaches with their respective representative grain size gradations more than 18 percent of the current bed materials will be retained in the channel to comprise the armored layer.

Long-Term Degradation

Having evaluated both the equilibrium slopes and bed armoring conditions in the river, corresponding bed gradation are determined from the procedures outlined by Pemberton and Lara (1984). The smaller of the two scour values evaluated would control the future channel grade of the three reaches. Assuming a reach length of 1000 feet that is subject for degradation for each reach, degradation values from equilibrium slopes are generally deeper than those determined from bed armoring conditions. Table 6-5 lists the results of the long-term degradation analysis for the Middle New River. In summary, the long-term degradation by reach are :

Reach 1 (Skunk Creek to Beardsley Rd.)	-	2.503 ft.
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.)	-	1.315 ft.
Reach 3 (Pinnacle Peak Rd to New River Dam)	-	1.644 ft.

Conclusively from Table 6-5, the long-term degradation in the Middle New River will be controlled by bed armoring. This indicates that equilibrium slopes will only be attained locally at some locations but not for the entire river.

TABLE 6-4

Bed Armoring Analysis for Existing Condition
Middle New River Watercourse Master Plan

Item No.	Station No.	Reach No.	Dominant Discharge (cfs)	Reach Length (ft)	Channel Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Velocity Channel (ft/s)	E.G. Slope (ft/ft)	Manning's n (-)	Froude No.	Average Grain Size D_{50} (mm)	D_{50} (ft)	D_{90} (mm)	Kinematic Viscosity of Water (ft^2/s)	Yang Incip. Motion Method (mm)	MPM Method (mm)	Shields Diagram Method (mm)	Lane's Tract. Force Method (mm)	Competent Bot.Velocity Method (mm)	Average Bed Armor Size (mm)	Sub-Reach Average Bed Armor Size (mm)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1	16.608	3	1700	500.72	198.61	3.94	1.98	4.32	0.00495	0.038	0.54	8.74	0.0287	82.06	0.0000105	37.5	41.7	60.3	76.3	35.1	50.2	
2	16.504	3	1700	481.43	207.73	3.82	2.07	4.01	0.00338	0.038	0.48	8.74	0.0287	82.06	0.0000105	32.3	27.6	39.9	50.8	30.2	36.2	
3	16.411	3	1700	481.78	160.84	3.96	2.07	5.34	0.00563	0.038	0.60	8.74	0.0287	82.06	0.0000105	57.3	47.7	68.9	89.9	53.6	63.5	
4	16.348	3	1700	497.94	334.03	3.67	1.46	4.07	0.00384	0.038	0.49	8.74	0.0287	82.06	0.0000105	33.3	30.1	43.5	54.9	31.1	38.6	
5	16.066	3	1700	584.23	409.48	4.01	1.31	3.35	0.00384	0.038	0.46	8.74	0.0287	82.06	0.0000105	22.5	33.0	47.6	59.7	21.1	36.8	
6	15.966	3	1700	429.98	353.62	4.22	1.43	4.00	0.00442	0.038	0.51	8.74	0.0287	82.06	0.0000105	32.1	39.9	57.6	72.5	30.1	46.5	
7	15.885	3	1874	509.42	195.25	4.89	1.83	5.41	0.00801	0.038	0.69	8.74	0.0287	82.06	0.0000105	58.8	83.8	121.0	N/A	55.0	79.7	
8	15.792	3	1874	472.66	211.04	5.33	2.01	4.83	0.00415	0.038	0.52	8.74	0.0287	82.06	0.0000105	46.9	47.3	68.3	89.0	43.9	59.1	
9	14.850	3	2052	536.65	468.78	3.54	1.11	4.51	0.00786	0.038	0.65	8.74	0.0287	82.06	0.0000105	40.9	59.5	86.0	N/A	38.2	56.1	
10	14.752	3	2052	547.53	430.99	4.15	1.70	2.80	0.00255	0.038	0.38	8.74	0.0287	82.06	0.0000105	15.7	22.6	32.7	42.7	14.7	25.7	
11	14.653	3	2052	536.63	326.81	3.54	1.35	5.07	0.00744	0.038	0.66	8.74	0.0287	82.06	0.0000105	51.6	56.3	81.3	N/A	48.3	59.4	
12	14.599	3	2052	542.23	436.77	3.35	1.37	3.36	0.00510	0.038	0.51	8.74	0.0287	82.06	0.0000105	22.7	36.6	52.8	66.1	21.2	39.9	
13	14.495	3	2052	561.68	405.23	3.98	1.44	4.41	0.00393	0.038	0.50	8.74	0.0287	82.06	0.0000105	39.1	33.5	48.3	60.6	36.6	35.3	***48.2***
14	13.619	2	2221	505.64	515.05	2.82	1.79	2.41	0.00149	0.035	0.32	9.83	0.0323	68.86	0.0000105	11.7	9.8	13.0	17.4	10.9	12.5	
15	13.524	2	2221	522.56	276.60	2.84	1.77	4.54	0.00537	0.035	0.60	9.83	0.0323	68.86	0.0000105	41.4	35.3	47.1	59.1	38.7	44.3	
16	13.420	2	2221	514.13	186.69	5.09	2.57	4.64	0.00341	0.035	0.51	9.83	0.0323	68.86	0.0000105	43.2	40.2	53.7	67.2	40.5	49.0	
17	13.325	2	2221	571.01	209.88	3.44	2.02	5.24	0.00600	0.035	0.65	9.83	0.0323	68.86	0.0000105	55.2	47.8	63.8	81.6	51.6	60.0	
18	13.227	2	2221	315.32	245.25	3.39	2.45	3.69	0.00230	0.035	0.42	9.83	0.0323	68.86	0.0000105	27.3	18.0	24.1	32.3	25.6	25.5	
19	13.185	2	2221	33.56	300.62	2.32	1.75	4.22	0.00467	0.035	0.56	9.83	0.0323	68.86	0.0000105	35.8	25.1	33.5	43.6	33.5	34.3	
20	13.151	2	2221	393.13	294.84	5.56	3.77	2.00	0.00038	0.035	0.18	9.83	0.0323	68.86	0.0000105	8.0	4.9	6.5	8.2	7.5	7.0	
21	13.076	2	2221	454.21	384.55	5.29	3.70	1.56	0.00024	0.035	0.14	9.83	0.0323	68.86	0.0000105	4.9	2.9	3.9	4.6	4.6	4.2	
22	12.991	2	2400	527.02	475.97	5.22	3.90	1.30	0.00015	0.035	0.11	9.83	0.0323	68.86	0.0000105	3.4	1.8	2.4	2.8	3.2	2.7	
23	12.896	2	2400	508.24	407.16	4.90	2.87	2.11	0.00059	0.035	0.22	9.83	0.0323	68.86	0.0000105	8.9	6.7	8.9	11.5	8.4	8.9	
24	12.801	2	2400	524.61	258.28	6.52	2.60	3.58	0.00201	0.035	0.39	9.83	0.0323	68.86	0.0000105	25.7	30.3	40.4	51.4	24.1	34.4	
25	12.701	2	2400	505.60	232.76	5.43	2.58	4.00	0.00252	0.035	0.44	9.83	0.0323	68.86	0.0000105	32.1	31.6	42.2	53.4	30.1	37.9	
26	12.606	2	2400	582.30	213.19	4.11	1.86	6.04	0.00885	0.035	0.78	9.83	0.0323	68.86	0.0000105	73.3	84.2	112.3	N/A	68.6	84.6	
27	12.511	2	2400	467.59	195.43	5.31	2.61	4.70	0.00344	0.035	0.51	9.83	0.0323	68.86	0.0000105	44.4	42.3	56.5	70.9	41.5	27.8	
28	12.420	2	2400	578.07	176.79	2.87	2.11	6.45	0.00860	0.035	0.78	9.83	0.0323	68.86	0.0000105	83.6	57.1	76.2	103.7	78.2	79.8	***34.2***
29	11.949	1	2529	452.25	295.98	2.48	1.78	4.81	0.00594	0.035	0.63	7.79	0.0256	65.83	0.0000105	46.5	33.7	45.5	57.3	43.5	45.3	
30	11.864	1	2529	615.28	225.24	3.55	2.31	4.91	0.00421	0.035	0.56	7.79	0.0256	65.83	0.0000105	48.4	34.2	46.2	58.0	45.3	46.4	
31	11.759	1	2529	501.24	426.52	3.66	1.34	5.45	0.00743	0.035	0.71	7.79	0.0256	65.83	0.0000105	59.7	62.3	84.1	N/A	55.8	65.5	
32	11.664	1	2529	513.83	307.74	3.91	1.77	5.22	0.00495	0.035	0.60	7.79	0.0256	65.83	0.0000105	54.7	44.3	59.8	75.6	51.2	57.1	
33	11.566	1	2529	468.92	453.92	2.54	1.66	3.35	0.00318	0.035	0.46	7.79	0.0256	65.83	0.0000105	22.5	18.5	25.0	33.4	21.1	24.1	
34	10.917	1	2586	292.21	254.25	3.11	2.36	4.30	0.00327	0.035	0.49	7.79	0.0256	65.83	0.0000105	37.1	23.3	31.4	41.2	34.8	33.6	
35	10.862	1	2586	313.15	220.62	3.41	2.57	4.56	0.00331	0.035	0.50	7.79	0.0256	65.83	0.0000105	41.8	25.8	34.9	45.2	39.1	37.3	
36	10.803	1	2586	567.30	265.32	3.54	2.11	4.63	0.00442	0.035	0.56	7.79	0.0256	65.83	0.0000105	43.1	35.8	48.4	60.6	40.3	45.6	
37	10.699	1	2586	462.24	214.29	4.24	1.88	6.41	0.00990	0.035	0.82	7.79	0.0256	65.83	0.0000105	82.5	96.1	129.7	N/A	77.2	96.4	
38	10.612	1	2586	504.93	309.44	3.61	2.51	3.33	0.00181	0.035	0.37	7.79	0.0256	65.83	0.0000105	22.3	15.0	20.2	27.3	20.8	21.1	
39	10.517	1	2586	519.30	310.21	3.30	1.80	4.63	0.00546	0.035	0.61	7.79	0.0256	65.83	0.0000105	43.1	41.2	55.7	69.8	40.3	50.0	
40	9.692	1	2643	565.23	356.15	4.43	2.52	2.95	0.00142	0.035	0.33	7.79	0.0256	65.83	0.0000105	17.5	14.4	19.4	26.2	16.4	18.8	
41	9.592	1	2643	606.90	340.08	4.48	1.85	4.20	0.00433	0.035	0.54	7.79	0.0256	65.83	0.0000105	35.4	44.4	59.9	75.7	33.2	49.7	
42	9.492	1	2643	463.47	375.84	2.19	1.33	5.29	0.01065	0.035	0.81	7.79	0.0256	65.83	0.0000105	56.2	53.4	72.1	95.6	52.6	66.0	
43	9.367	1	2700	489.74	408.02	3.35	2.19	3.02	0.00178	0.035	0.36	7.79	0.0256	65.83	0.0000105	18.3	13.7	18.5	24.9	17.1	18.5	
44	9.318	1	2700	155.57	334.87	5.47	2.52	3.20	0.00166	0.035	0.36	7.79	0.0256	65.83	0.0000105	20.6	20.8	28.0	37.1	19.3	40.4	***44.7***

NOTES:
(1) The dominant discharges in column (3) correspond to the 10-year discharges.
(2) The data from columns (3) to (11) were taken from the 10-year HEC-RAS run of the river model.
(3) The kinematic viscosity in column (15) is associated with a water temperature of 68°F.
(4) The D_{50} and D_{90} in columns (12) and (14) are the representative sediment sizes for the three reaches.
(5) The average armor size in column (21) is the arithmetic average of the five methods.

TABLE 6-5
Long-Term Scour Analysis for Existing River Condition
Middle New River Watercourse Master Plan

Item No.	Station No.	Reach No.	Dominant Discharge (cfs)	Reach Length (ft)	Channel Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Velocity Channel (ft/s)	Bed Slope (ft/ft)	Recomm. Reach Length (ft)	Equilibrium Slope (ft/ft)	Degradation from Eq. Slope (ft)	Ave.Bed Armor Size (mm)	Degradation from B. Armoring (ft)	Long-Term Degradation (ft)	Long-Term Degradation by Reach (ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	16.608	3	1700	500.72	198.61	3.94	1.98	4.32	0.00373	1000	0.00129	1.503	48.9	1.301	1.301	
2	16.504	3	1700	481.43	207.73	3.82	2.07	4.01	0.00501	1000	0.00129	2.285	48.9	1.301	1.301	
3	16.411	3	1700	481.78	160.84	3.96	2.07	5.34	0.00376	1000	0.00129	1.517	48.9	1.301	1.301	
4	16.348	3	1700	497.94	334.03	3.67	1.46	4.07	0.00478	1000	0.00129	2.146	48.9	1.301	1.301	
5	16.066	3	1700	584.23	409.48	4.01	1.31	3.35	0.00442	1000	0.00129	1.922	48.9	1.301	1.301	
6	15.966	3	1700	429.98	353.62	4.22	1.43	4.00	0.00800	1000	0.00129	4.128	48.9	1.301	1.301	
7	15.885	3	1874	509.42	195.25	4.89	1.83	5.41	0.00628	1000	0.00129	3.071	48.9	1.301	1.301	
8	15.792	3	1874	472.66	211.04	5.33	2.01	4.83	0.00104	1000	0.00129	-0.157	48.9	1.301	1.301	
9	14.850	3	2052	536.65	468.78	3.54	1.11	4.51	0.00613	1000	0.00129	2.978	48.9	1.301	1.301	
10	14.752	3	2052	547.53	430.99	4.15	1.70	2.80	0.00342	1000	0.00129	1.307	48.9	1.301	1.301	
11	14.653	3	2052	536.63	326.81	3.54	1.35	5.07	0.00527	1000	0.00129	2.450	48.9	1.301	1.301	
12	14.599	3	2052	542.23	436.77	3.35	1.37	3.36	0.00537	1000	0.00129	2.507	48.9	1.301	1.301	
13	14.495	3	2052	561.68	405.23	3.98	1.44	4.41	0.00531	1000	0.00129	2.470	48.9	1.301	1.301	*1.692*
14	13.619	2	2221	505.64	515.05	2.82	1.79	2.41	0.00310	1000	0.00125	1.143	36.4	1.180	1.180	
15	13.524	2	2221	522.56	276.60	2.84	1.77	4.54	0.00855	1000	0.00125	4.496	36.4	1.180	1.180	
16	13.420	2	2221	514.13	186.69	5.09	2.57	4.64	0.00142	1000	0.00125	0.106	36.4	1.180	1.180	
17	13.325	2	2221	571.01	209.88	3.44	2.02	5.24	0.00317	1000	0.00125	1.183	36.4	1.180	1.180	
18	13.227	2	2221	315.32	245.25	3.39	2.45	3.69	0.00000	1000	0.00125	-0.768	36.4	1.180	1.180	
19	13.185	2	2221	33.56	300.62	2.32	1.75	4.22	0.00715	1000	0.00125	3.633	36.4	1.180	1.180	
20	13.151	2	2221	393.13	294.84	5.56	3.77	2.00	-0.00043	1000	0.00125	-1.034	36.4	1.180	1.180	
21	13.076	2	2221	454.21	384.55	5.29	3.70	1.56	0.00000	1000	0.00125	-0.768	36.4	1.180	1.180	
22	12.991	2	2400	527.02	475.97	5.22	3.90	1.30	-0.00025	1000	0.00125	-0.920	36.4	1.180	1.180	
23	12.896	2	2400	508.24	407.16	4.90	2.87	2.11	0.00447	1000	0.00125	1.981	36.4	1.180	1.180	
24	12.801	2	2400	524.61	258.28	6.52	2.60	3.58	0.00025	1000	0.00125	-0.615	36.4	1.180	1.180	
25	12.701	2	2400	505.60	232.76	5.43	2.58	4.00	0.00237	1000	0.00125	0.693	36.4	1.180	1.180	
26	12.606	2	2400	582.30	213.19	4.11	1.86	6.04	0.00704	1000	0.00125	3.565	36.4	1.180	1.180	
27	12.511	2	2400	467.59	195.43	5.31	2.61	4.70	0.00064	1000	0.00125	-0.373	36.4	1.180	1.180	
28	12.420	2	2400	578.07	176.79	2.87	2.11	6.45	0.00697	1000	0.00125	3.522	36.4	1.180	1.180	*1.534*
29	11.949	1	2529	452.25	295.98	2.48	1.78	4.81	0.00736	1000	0.00105	3.883	41.7	1.600	1.600	
30	11.864	1	2529	615.28	225.24	3.55	2.31	4.91	0.00577	1000	0.00105	2.902	41.7	1.600	1.600	
31	11.759	1	2529	501.24	426.52	3.66	1.34	5.45	0.00642	1000	0.00105	3.305	41.7	1.600	1.600	
32	11.664	1	2529	513.83	307.74	3.91	1.77	5.22	0.00093	1000	0.00105	-0.074	41.7	1.600	1.600	
33	11.566	1	2529	468.92	453.92	2.54	1.66	3.35	0.00749	1000	0.00105	3.958	41.7	1.600	1.600	
34	10.917	1	2586	292.21	254.25	3.11	2.36	4.30	0.00445	1000	0.00105	2.089	41.7	1.600	1.600	
35	10.862	1	2586	313.15	220.62	3.41	2.57	4.56	0.00425	1000	0.00105	1.965	41.7	1.600	1.600	
36	10.803	1	2586	567.30	265.32	3.54	2.11	4.63	0.00818	1000	0.00105	4.385	41.7	1.600	1.600	
37	10.699	1	2586	462.24	214.29	4.24	1.88	6.41	0.00149	1000	0.00105	0.270	41.7	1.600	1.600	
38	10.612	1	2586	504.93	309.44	3.61	2.51	3.33	0.00265	1000	0.00105	0.985	41.7	1.600	1.600	
39	10.517	1	2586	519.30	310.21	3.30	1.80	4.63	0.00545	1000	0.00105	2.705	41.7	1.600	1.600	
40	9.692	1	2643	565.23	356.15	4.43	2.52	2.95	0.00265	1000	0.00105	0.985	41.7	1.600	1.600	
41	9.592	1	2643	606.90	340.08	4.48	1.85	4.2	0.00290	1000	0.00105	1.136	41.7	1.600	1.600	
42	9.492	1	2643	463.47	375.84	2.19	1.33	5.29	0.00563	1000	0.00105	2.817	41.7	1.600	1.600	
43	9.367	1	2700	489.74	408.02	3.35	2.19	3.02	0.00608	1000	0.00105	3.096	41.7	1.600	1.600	
44	9.318	1	2700	155.57	334.87	5.47	2.52	3.2	0.00289	1000	0.00105	1.132	41.7	1.600	1.600	*2.079*

NOTES:
(1) The dominant discharges in column (4) correspond to the 10-year discharges.
(2) The data from columns (4) to (10) were taken from the 10-year HEC-RAS run of the river model.
(3) The reach lengths in column (11) are the assumed lengths that are subject to long-term degradation.
(4) The equilibrium slopes used in the calculation of the long-term scour are the average equilibrium slopes by reach.
(5) The bed armor sizes used in the calculation of long-term scour are the average armor sizes by reach.
(6) The recommended long-term scour is the lower degradation depth between the equilibrium slope and bed armoring.
(7) The evaluated long-term degradation in column (17) includes an additional 30% safety factor to account for the non-uniformity of hydraulic condition and sediment characteristics.

Total Scour

For the existing river condition, evaluation of total scour is made to determine the extent of toe-down requirements for channel structures such as bank protection and grade control structures. Also, the evaluated depths of scour are used to check if existing utility lines crossing the river underneath are impacted by the degradation. Table 6-6 lists the results of the total scour analysis involving the six scour components presented in Section 5.1.1 (TDN). The considerations made to evaluate the total scour by station identified are as follows:

> The anti-dune trough depth is only evaluated for supercritical and transitional flows when the evaluated Froude Number are at least equal to 0.86.
>
> The local scour for each station is evaluated from four methods that include Lacey's equation, Blench, USBR Method II, and the Neill's equation. The values shown reflect the computed average of three or four equations used. If the value evaluated from one method is odd and significantly different from the values evaluated from the other methods, that method is dropped from the computation of the average value.
>
> The river sinuosity in the Middle New River is generally straight and the bend scour is not evaluated at all. Scour due to slight bends at some locations in the river are considered in the local scour evaluation.
>
> A low-flow incisement of 2.0 ft is assumed for the Middle New River. This represents the thalweg depression in the channel.
>
> In the evaluation of the long-term scour, a reach length of 1000 ft is used as the length exposed to bed degradation and scour. The reach lengths between stations are not used in the analysis but instead a representative length that is typically observed in the river.

The range of scour depths evaluated for each reach in the channel are provided as follows:

Reach 1 (Skunk Creek to Beardsley Rd.) = 7.33 ft to 12.10 ft.
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.) = 6.50 ft to 13.18 ft.
Reach 3 (Pinnacle Peak Rd. to New River Dam) = 5.68 ft to 8.07 ft.

TABLE 6-6
Total Scour Analysis for Existing River Condition
Middle New River Watercourse Master Plan

Item No.	Station No.	Reach No.	Design Discharge (cfs)	Reach Length (ft)	Channel Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Channel Velocity (ft/s)	Scour Components: Long-Term Scour (ft)	Local Scour (ft)	Bend Scour (ft)	General Scour (ft)	Anti-Dune Trough (ft)	Low-Flow Thalweg (ft)	Safety Factor (ft)	Total Scour (ft)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1	16.608	3	2350	500.72	201.73	4.39	2.40	4.86	1.30	1.11	0.00	0.00	0.00	2.00	1.32	5.74	
2	16.504	3	2350	481.43	235.33	4.40	2.37	4.34	1.30	1.30	0.00	0.00	0.00	2.00	1.38	5.98	
3	16.411	3	2350	481.78	179.22	4.39	2.26	6.17	1.30	1.48	0.00	0.00	0.00	2.00	1.43	6.21	
4	16.348	3	2350	497.94	382.85	4.10	1.68	4.33	1.30	1.74	0.00	0.00	0.00	2.00	1.51	6.56	
5	16.066	3	2350	584.23	438.00	4.18	1.38	4.11	1.30	1.07	0.00	0.00	0.00	2.00	1.31	5.68	
6	15.966	3	2350	429.98	562.01	5.11	1.64	3.43	1.30	1.08	0.00	0.00	0.00	2.00	1.31	5.70	Min. = 5.68
7	15.885	3	4200	509.42	276.88	6.34	2.47	6.74	1.30	1.94	0.00	0.00	0.00	2.00	1.57	6.82	Max.= 8.07
8	15.792	3	4200	472.66	295.30	6.56	2.48	6.73	1.30	1.93	0.00	0.32	0.00	2.00	1.67	7.23	Rec. = 8.50
9	14.850	3	6100	536.65	557.24	4.85	2.16	5.55	1.30	1.99	0.00	0.00	0.00	2.00	1.59	6.88	
10	14.752	3	6100	547.53	758.08	5.71	2.13	4.14	1.30	1.44	0.00	0.00	0.00	2.00	1.42	6.16	
11	14.653	3	6100	536.63	740.00	4.89	1.49	6.93	1.30	1.66	0.00	0.70	0.00	2.00	1.70	7.36	
12	14.599	3	6100	542.23	549.24	4.73	2.31	4.77	1.30	1.17	0.00	0.00	0.00	2.00	1.34	5.81	
13	14.495	3	6100	561.68	1022.70	5.36	1.50	6.07	1.30	1.57	0.00	1.33	0.00	2.00	1.86	8.07	
14	13.619	2	7900	505.64	534.55	5.28	4.14	3.57	1.18	2.58	0.00	0.00	0.00	2.00	1.73	7.48	
15	13.524	2	7900	522.56	294.41	5.52	4.26	6.30	1.18	2.02	0.00	0.00	0.00	2.00	1.56	6.76	
16	13.420	2	7900	514.13	214.68	7.67	4.70	7.83	1.18	2.91	0.00	0.00	0.00	2.00	1.83	7.92	
17	13.325	2	7900	571.01	240.59	6.00	4.21	7.80	1.18	2.64	0.00	0.00	0.00	2.00	1.75	7.57	
18	13.227	2	7900	315.32	264.32	5.59	4.41	6.77	1.18	2.23	0.00	0.00	0.00	2.00	1.62	7.03	
19	13.185	2	7900	33.56	382.47	4.28	3.14	6.57	1.18	1.82	0.00	0.00	0.00	2.00	1.50	6.50	Min. = 6.50
20	13.151	2	7900	393.13	390.86	9.13	6.07	3.33	1.18	2.20	0.00	0.00	0.00	2.00	1.62	7.00	Max. = 13.18
21	13.076	2	7900	454.21	403.86	8.82	6.97	2.80	1.18	3.33	0.00	0.00	0.00	2.00	1.95	8.47	Rec. = 13.50
22	12.991	2	9800	527.02	514.86	8.68	6.95	2.78	1.18	3.36	0.00	0.00	0.00	2.00	1.96	8.50	
23	12.896	2	9800	508.24	569.80	8.18	4.77	3.84	1.18	3.21	0.00	0.00	0.00	2.00	1.92	8.31	
24	12.801	2	9800	524.61	666.34	9.83	3.63	4.05	1.18	2.10	0.00	0.00	0.00	2.00	1.59	6.87	
25	12.701	2	9800	505.60	429.83	8.33	3.58	6.57	1.18	2.19	0.00	0.29	0.00	2.00	1.70	7.36	
26	12.606	2	9800	582.30	479.88	7.16	2.94	7.83	1.18	3.33	0.00	0.68	0.00	2.00	2.16	9.34	
27	12.511	2	9800	467.59	458.08	8.80	3.11	7.57	1.18	2.85	0.00	1.88	0.00	2.00	2.37	10.28	
28	12.420	2	9800	578.07	276.41	5.70	3.40	10.86	1.18	4.30	0.00	1.05	1.62	2.00	3.04	13.18	
29	11.949	1	10350	452.25	576.94	5.46	3.17	6.52	1.60	2.81	0.00	0.44	0.00	2.00	2.05	8.90	
30	11.864	1	10350	615.28	535.51	5.87	2.41	9.62	1.60	3.93	0.00	1.78	0.00	2.00	2.79	12.10	
31	11.759	1	10350	501.24	502.37	6.41	3.72	7.67	1.60	2.65	0.00	0.27	0.00	2.00	1.95	8.47	
32	11.664	1	10350	513.83	345.58	6.06	3.61	9.98	1.60	3.60	0.00	0.66	0.00	2.00	2.36	10.22	
33	11.566	1	10350	468.92	493.59	5.93	4.80	4.37	1.60	2.04	0.00	0.00	0.00	2.00	1.69	7.33	
34	10.917	1	10900	292.21	364.60	6.78	4.67	6.40	1.60	2.45	0.00	0.00	0.00	2.00	1.82	7.87	Min. = 7.33
35	10.862	1	10900	313.15	241.11	6.41	5.19	8.71	1.60	3.55	0.00	0.00	0.00	2.00	2.15	9.30	Max. = 12.10
36	10.803	1	10900	567.30	533.21	6.38	2.71	7.72	1.60	2.66	0.00	0.96	0.00	2.00	2.17	9.38	Rec. = 12.50
37	10.699	1	10900	462.24	276.42	7.18	4.24	9.29	1.60	3.78	0.00	0.08	0.00	2.00	2.24	9.70	
38	10.612	1	10900	504.93	326.17	6.61	5.30	6.30	1.60	3.28	0.00	0.00	0.00	2.00	2.06	8.94	
39	10.517	1	10900	519.30	528.08	5.52	2.59	8.54	1.60	3.53	0.00	0.96	0.00	2.00	2.43	10.52	
40	9.692	1	11450	565.23	369.57	7.65	5.59	5.55	1.60	2.19	0.00	0.00	0.00	2.00	1.74	7.53	
41	9.592	1	11450	606.90	348.98	6.08	3.37	9.72	1.60	3.59	0.00	0.13	1.29	2.00	2.58	11.20	
42	9.492	1	11450	463.47	472.55	5.36	4.07	5.96	1.60	2.08	0.00	0.00	0.00	2.00	1.70	7.38	
43	9.367	1	12000	489.74	464.86	7.33	5.69	4.54	1.60	2.34	0.00	0.00	0.00	2.00	1.78	7.72	
44	9.318	1	12000	155.57	353.76	9.58	6.38	5.31	1.60	4.44	0.00	0.00	0.00	2.00	2.41	10.45	

NOTES:
(1) Long-term scour values in column (10) are based on bed armoring and stable slope analyses. The values reflect the scour depth associated with bed armoring condition in the channel.
(2) Local scour values in column (11) are evaluated from four equations provided by Pemberton and Lara (1984).
(3) Bend scour values in column (12) are zero because scour around bends are already incorporated in the evaluation of local scour in column (9).
(4) General scour values in column (13) are generally zero based on the equation provided by SLA (1989).
(5) Anti-dune trough depth values in column (14) are generally zero because anti-dune trough only occurs when flow conditions are either transitional or supercritical.
(6) Low-flow thalweg of 2.0 ft is used (see column 15) since the wash is classified as a regional watercourse (SLA, 1989).
(7) Thirty percent safety factor is used (see column 16) to account for non-uniformity of flow hydraulics and sediment characteristics in the channel.

The degrees by which the channel bed degrades are a function of the flow hydraulics and the bed material characteristics considered. If the flow hydraulics are changed or modified as the result of new channel design configuration, the extent of bed degradation will also change. For the existing river conditions, bank toe-down depths used for built bank structures must be checked against the evaluated bed degradation in Table 6-6. Also, all utility lines crossing the river underneath must be checked for adequate depth of installation.

Verification of Results

Results from various analyses for the existing river condition should be verified from field check and actual field data. Since the conditions considered were based on two hydraulic events (i.e., 10-year and 100-year peak discharges), verification of the results could be made ideally if such flow events would occur in the river. Although all the procedures used in the sediment transport analysis are standard procedures recommended by Federal and State agencies, verification works on the results presented are left to be done.

PROPOSED CONDITION RESULTS

As presented in the Section 2 – Watercourse Master Plan, the preferred alternative for Reach 1 and Reach 2 consists of a structural approach utilizing rock filled wire baskets for channel side slope protection. A non-structural approach is the preferred alternative for Reach 3 as the preferred alternative. The preferred alternative has design configurations that adequately meet various channel design criteria – the most important of which is having adequate channel capacity to contain 100-year FEMA discharges and the future condition 100-year discharges determined by the U.S. Corps of Engineers. The preferred alternative is evaluated using the future condition 100-year discharges determined by the U.S. Corps of Engineers. Adequate freeboard is to be provided to fully convey the future condition 100-year peak discharges without bank overtopping. The design configuration of the preferred alternative is modeled by HEC-RAS to evaluate the flow hydraulics involved. These flow hydraulics generated from HEC-RAS together with the bed material characteristics in the channel provide the needed input for the lateral migration analysis, equilibrium slope analysis, and the scour analysis.

Equilibrium Slopes

In the evaluation of equilibrium slopes for the improved channel conditions of the three reaches, the same representative cross-section stations used in the existing condition evaluation were used for comparison purposes. All the four equations presented in Section 5.1.2 (TDN) are used in the analysis. The flow hydraulic data and information required for the analysis are based on the 10-year dominant discharges. These are evaluated from the HEC-RAS model run of the new hydraulic model. As shown in Table 6-7, the average equilibrium slopes evaluated for the two improved reaches are:

Reach 1 (Skunk Creek to Beardsley Rd.	-	0.00141 ft/ft
Reach 2 (Beardsley Rd to Pinnacle Peak Rd.)	-	0.00129 ft/ft

Since non-structural improvements are proposed for Reach 3, no channel modifications were used. The results of the sediment transport analysis performed for the existing river condition are considered.

Bed Armoring Sizes

In the evaluation of bed armoring for the improved channel conditions of the Middle New River, the same representative cross-section stations were used. All the five equations presented in Section 5.1.3 (TDN) were used in the analysis. The flow hydraulic data and information required for the analysis are based on the 10-year dominant discharges. These are evaluated from the HEC-RAS model run of the new hydraulic model. As shown in Table 6-8, the average bed armoring sizes evaluated for the two improved reaches are:

Reach 1 (Skunk Creek to Beardsley Rd).	-	38.5 mm
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.)	-	35.8 mm

TABLE 6-7
Stable Slope Analysis
Middle New River Watercourse Master Plan

Item No.	Station No.	Reach No.	Dominant Discharge (cfs)	Reach Length (ft)	Channel Width (ft)	Flow Depth (ft)	Velocity Channel (ft/s)	E.G. Slope (ft/ft)	Manning's n (-)	Froude No.	Average Grain Size D_{50} (mm)	Average Grain Size D_{50} (ft)	Average Grain Size D_{90} (mm)	Schoklitsch Method (ft/ft)	MPM Method (ft/ft)	Shields Diagram Method (ft/ft)	Lane's Tract. Force Method (ft/ft)	Average Stable Slope (ft/ft)	Sub-Reach Average Stable Slope (ft/ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1	13.619	2	2400	500.33	190.40	2.60	4.98	0.00404	0.035	0.55	9.83	0.0323	68.86	0.00144	0.00163	0.00115	0.00096	0.00135	
2	13.524	2	2400	499.65	190.27	2.57	5.05	0.00420	0.035	0.56	9.83	0.0323	68.86	0.00144	0.00165	0.00116	0.00098	0.00136	
3	13.420	2	2400	506.43	190.25	2.59	5.01	0.00410	0.035	0.56	9.83	0.0323	68.86	0.00144	0.00164	0.00115	0.00097	0.00135	
4	13.325	2	2400	532.87	190.26	2.57	5.05	0.00422	0.035	0.56	9.83	0.0323	68.86	0.00144	0.00165	0.00116	0.00098	0.00136	
5	13.227	2	2400	240.04	190.43	2.61	4.97	0.00400	0.035	0.55	9.83	0.0323	68.86	0.00144	0.00163	0.00115	0.00096	0.00130	
6	13.183	2	2400	20.00	189.29	2.24	5.80	0.00661	0.035	0.69	9.83	0.0323	68.86	0.00144	0.00190	0.00124	0.00112	0.00142	
7	13.151	2	2400	385.89	192.08	3.02	4.27	0.00245	0.035	0.44	9.83	0.0323	68.86	0.00145	0.00141	0.00104	0.00083	0.00123	
8	13.076	2	2400	450.81	192.41	3.13	4.15	0.00223	0.035	0.42	9.83	0.0323	68.86	0.00146	0.00136	0.00101	0.00080	0.00120	
9	12.991	2	2400	550.48	192.99	3.37	3.96	0.00192	0.035	0.39	9.83	0.0323	68.86	0.00146	0.00126	0.00095	0.00074	0.00115	
10	12.896	2	2400	500.68	192.37	3.23	4.17	0.00226	0.035	0.42	9.83	0.0323	68.86	0.00146	0.00131	0.00098	0.00078	0.00118	
11	12.801	2	2400	522.71	192.26	3.16	4.20	0.00232	0.035	0.43	9.83	0.0323	68.86	0.00145	0.00134	0.00100	0.00079	0.00120	
12	12.701	2	2400	499.01	192.29	3.16	4.19	0.00230	0.035	0.43	9.83	0.0323	68.86	0.00146	0.00134	0.00100	0.00079	0.00120	
13	12.606	2	2400	529.88	192.26	3.16	4.20	0.00232	0.035	0.43	9.83	0.0323	68.86	0.00145	0.00134	0.00100	0.00079	0.00120	
14	12.511	2	2400	445.76	189.41	2.35	5.52	0.00563	0.035	0.64	9.83	0.0323	68.86	0.00144	0.00181	0.00122	0.00107	0.00144	
15	12.420	2	2400	580.01	195.01	2.33	5.40	0.00543	0.035	0.63	9.83	0.0323	68.86	0.00147	0.00182	0.00124	0.00108	0.00146	***0.00129***
16	11.949	1	2529	426.33	259.24	2.04	4.86	0.00521	0.035	0.60	7.79	0.0256	65.83	0.00147	0.00167	0.00101	0.00110	0.00141	
17	11.864	1	2529	596.49	256.76	1.99	5.03	0.00577	0.035	0.63	7.79	0.0256	65.83	0.00146	0.00171	0.00102	0.00112	0.00143	
18	11.759	1	2529	475.92	254.18	2.12	4.77	0.00475	0.035	0.58	7.79	0.0256	65.83	0.00145	0.00161	0.00099	0.00105	0.00137	
19	11.664	1	2529	512.96	218.46	2.29	5.16	0.00507	0.035	0.61	7.79	0.0256	65.83	0.00129	0.00149	0.00088	0.00098	0.00125	
20	11.566	1	2529	454.44	194.92	2.51	5.31	0.00479	0.035	0.60	7.79	0.0256	65.83	0.00119	0.00136	0.00080	0.00089	0.00114	
21	10.917	1	2586	276.24	223.20	3.21	3.74	0.00174	0.035	0.37	7.79	0.0256	65.83	0.00129	0.00106	0.00075	0.00070	0.00102	
22	10.862	1	2586	286.29	219.01	3.08	5.25	0.00522	0.035	0.62	7.79	0.0256	65.83	0.00127	0.00110	0.00060	0.00073	0.00103	
23	10.803	1	2586	50.00	231.06	0.53	21.76	0.63801	0.035	5.35	7.79	0.0256	65.83	0.00133	0.00642	0.00312	0.00422	0.00399	
24	10.699	1	2586	459.22	221.97	2.82	4.31	0.00276	0.035	0.46	7.79	0.0256	65.83	0.00129	0.00121	0.00079	0.00079	0.00110	
25	10.612	1	2586	456.66	267.87	2.35	4.23	0.00332	0.035	0.49	7.79	0.0256	65.83	0.00148	0.00145	0.00095	0.00095	0.00129	
26	10.517	1	2586	438.21	378.41	2.28	3.06	0.00179	0.035	0.36	7.79	0.0256	65.83	0.00192	0.00149	0.00110	0.00098	0.00146	
27	9.692	1	2643	526.34	299.12	4.52	2.99	0.00118	0.035	0.31	7.79	0.0256	65.83	0.00158	0.00075	0.00053	0.00049	0.00094	
28	9.592	1	2643	557.60	330.67	4.21	5.14	0.00816	0.035	0.73	7.79	0.0256	65.83	0.00171	0.00081	0.00038	0.00053	0.00102	
29	9.492	1	2643	433.72	471.44	2.65	3.91	0.00526	0.035	0.58	7.79	0.0256	65.83	0.00223	0.00128	0.00072	0.00084	0.00145	
30	9.367	1	2700	459.27	390.22	2.66	4.35	0.00568	0.035	0.61	7.79	0.0256	65.83	0.00190	0.00128	0.00071	0.00084	0.00134	
31	9.318	1	2700	154.63	464.04	3.61	3.54	0.00361	0.035	0.49	7.79	0.0256	65.83	0.00217	0.00094	0.00054	0.00062	0.00124	***0.00141***

NOTES:
(1) The dominant discharges in column (4) correspond to the 10-year discharges.
(2) The data from columns (5) to (11) were taken from the 10-year HEC-RAS run of the river model.
(3) The average stable slopes in column (19) are the computed average of the four methods.
(4) Column (20) shows the average equilibrium slopes by reach.

TABLE 6-8
Bed Armoring Analysis
Middle New River Watercourse Master Plan

Item No.	Station No.	Reach No.	Dominant Discharge (cfs)	Reach Length (ft)	Channel Width (ft)	Flow Depth (ft)	Hydr. Depth (ft)	Velocity Channel (ft/s)	E.G. Slope (ft/ft)	Manning's n (-)	Froude No.	Average Grain Size D_{50} (mm)	Average Grain Size D_{50} (ft)	Average Grain Size D_{90} (mm)	Yang Incip. Motion Method (mm)	MPM Method (mm)	Shields Diagram Method (mm)	Lane's Tract. Force Method (mm)	Competent Bot.Velocity Method (mm)	Average Bed Armor Size (mm)	Sub-Reach Average Bed Armor (mm)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1	13.619	2	2400	500.33	190.40	2.60	2.53	4.98	0.00404	0.035	0.55	9.83	0.0323	68.86	49.8	24.3	32.4	42.3	46.6	39.1	
2	13.524	2	2400	499.65	190.27	2.57	2.50	5.05	0.00420	0.035	0.56	9.83	0.0323	68.86	51.2	25.0	33.4	43.5	47.9	40.2	
3	13.420	2	2400	506.43	190.25	2.59	2.52	5.01	0.00410	0.035	0.56	9.83	0.0323	68.86	50.4	24.6	32.8	42.8	47.2	39.6	
4	13.325	2	2400	532.87	190.26	2.57	2.50	5.05	0.00422	0.035	0.56	9.83	0.0323	68.86	51.2	25.1	33.5	43.6	47.9	40.3	
5	13.227	2	2400	240.04	190.43	2.61	2.54	4.97	0.00400	0.035	0.55	9.83	0.0323	68.86	49.6	24.2	32.3	42.2	46.4	38.9	
6	13.183	2	2400	20.00	189.29	2.24	2.19	5.80	0.00661	0.035	0.69	9.83	0.0323	68.86	67.6	34.3	45.7	57.5	63.2	53.7	
7	13.151	2	2400	385.89	192.08	3.02	2.92	4.27	0.00245	0.035	0.44	9.83	0.0323	68.86	36.6	17.1	22.8	30.7	34.3	28.3	
8	13.076	2	2400	450.81	192.41	3.13	3.00	4.15	0.00223	0.035	0.42	9.83	0.0323	68.86	34.6	16.2	21.6	29.1	32.4	26.8	
9	12.991	2	2400	550.48	192.99	3.37	3.14	3.96	0.00192	0.035	0.39	9.83	0.0323	68.86	31.5	15.0	20.0	27.0	29.5	24.6	
10	12.896	2	2400	500.68	192.37	3.23	2.99	4.17	0.00226	0.035	0.42	9.83	0.0323	68.86	34.9	16.9	22.5	30.3	32.7	27.5	
11	12.801	2	2400	522.71	192.26	3.16	2.97	4.20	0.00232	0.035	0.43	9.83	0.0323	68.86	35.4	16.9	22.6	30.4	33.2	27.7	
12	12.701	2	2400	499.01	192.29	3.16	2.98	4.19	0.00230	0.035	0.43	9.83	0.0323	68.86	35.3	16.9	22.5	30.3	33.0	27.6	
13	12.606	2	2400	529.88	192.26	3.16	2.97	4.20	0.00232	0.035	0.43	9.83	0.0323	68.86	35.4	17.0	22.6	30.5	33.2	27.7	
14	12.511	2	2400	445.76	189.41	2.35	2.30	5.52	0.00563	0.035	0.64	9.83	0.0323	68.86	61.2	30.6	40.9	51.9	57.3	48.4	
15	12.420	2	2400	580.01	195.01	2.33	2.28	5.40	0.00543	0.035	0.63	9.83	0.0323	68.86	58.6	29.3	39.1	49.9	54.8	46.3	*35.8*
16	11.949	1	2529	426.33	259.24	2.04	2.01	4.86	0.00521	0.035	0.60	7.79	0.0256	65.83	47.4	24.3	32.8	42.8	44.4	38.4	
17	11.864	1	2529	596.49	256.76	1.99	1.96	5.03	0.00577	0.035	0.63	7.79	0.0256	65.83	50.8	26.3	35.5	45.8	47.6	41.2	
18	11.759	1	2529	475.92	254.18	2.12	2.09	4.77	0.00475	0.035	0.58	7.79	0.0256	65.83	45.7	23.1	31.1	40.8	42.8	36.7	
19	11.664	1	2529	512.96	218.46	2.29	2.24	5.16	0.00507	0.035	0.61	7.79	0.0256	65.83	53.5	26.6	35.9	46.3	50.1	42.5	
20	11.566	1	2529	454.44	194.92	2.51	2.44	5.31	0.00479	0.035	0.60	7.79	0.0256	65.83	56.6	27.5	37.1	47.7	53.0	44.4	
21	10.917	1	2586	276.24	223.20	3.21	3.10	3.74	0.00174	0.035	0.37	7.79	0.0256	65.83	28.1	12.8	17.2	23.2	26.3	21.5	
22	10.862	1	2586	286.29	219.01	3.08	2.25	5.25	0.00522	0.035	0.62	7.79	0.0256	65.83	55.4	36.8	49.6	62.2	51.8	51.2	
23	10.803	1	2586	50.00	231.06	0.53	0.51	21.76	0.63801	0.035	5.35	7.79	0.0256	65.83	N/A	N/A	N/A	N/A	N/A	N/A	
24	10.699	1	2586	459.22	221.97	2.82	2.70	4.31	0.00276	0.035	0.46	7.79	0.0256	65.83	37.3	17.8	24.1	32.3	34.9	29.3	
25	10.612	1	2586	456.66	267.87	2.35	2.28	4.23	0.00332	0.035	0.49	7.79	0.0256	65.83	35.9	17.9	24.1	32.4	33.6	28.8	
26	10.517	1	2586	438.21	378.41	2.28	2.23	3.06	0.00179	0.035	0.36	7.79	0.0256	65.83	18.8	9.3	12.6	16.7	17.6	15.0	
27	9.692	1	2643	526.34	299.12	4.52	2.96	2.99	0.00118	0.035	0.31	7.79	0.0256	65.83	18.0	12.2	16.4	22.1	16.8	17.1	
28	9.592	1	2643	557.60	330.67	4.21	1.56	5.14	0.00816	0.035	0.73	7.79	0.0256	65.83	53.1	78.6	106.1	201.1	49.7	97.7	
29	9.492	1	2643	433.72	471.44	2.65	1.43	3.91	0.00526	0.035	0.58	7.79	0.0256	65.83	30.7	31.9	43.1	54.4	28.7	37.8	
30	9.367	1	2700	459.27	390.22	2.66	1.59	4.35	0.00568	0.035	0.61	7.79	0.0256	65.83	38.0	34.6	46.6	58.6	35.6	42.7	
31	9.318	1	2700	154.63	464.04	3.61	1.64	3.54	0.00361	0.035	0.49	7.79	0.0256	65.83	25.2	29.8	40.2	51.2	23.6	34.0	*38.5*

NOTES:
(1) The dominant discharges in column (4) correspond to the 10-year discharges.
(2) The data from columns (5) to (12) were taken from the 10-year HEC-RAS run of the river model.
(3) The kinematic viscosity in column (15) is associated with a water temperature of 68°F.
(4) The D_{50} and D_{90} in columns (13) and (15) are the representative sediment sizes for the three reaches.
(5) The average armor size in column (21) is the computed average of the five methods.

Long-Term Bed Degradation

In the evaluation of both the equilibrium slopes and potential bed armoring for the improved channel conditions, long-term degradations are assessed from the equations defined by Pemberton and Lara (1984). Comparison between these two scour evaluations provides information which scenario would control the long-term behavior of the channel grade. Similar to the results evaluated from the existing river conditions, the long-term degradation in the channel for the improved conditions would be dictated by bed armoring (See Table 6-9). Results of the extent of the long-term degradation for the two reaches are:

Reach 1 (Skunk Creek to Beardsley Rd.) – 1.64 ft
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.) – 1.49 ft

Total Depths of Scour

For the improved river conditions, evaluation of total scour is made to determine the extent of toe-down requirements for channel structures such as bank protection and grade control structures. Also, the evaluated depths of scour are used to check if existing utility lines crossing the river underneath would be impacted by the degradation. Tables 6-10 and 6-11 list the results of the total scour analysis for bank protection structures and grade control structures, respectively.

The range of scour depths evaluated for bank protection structures for each reach in the channel are provided as follows:

Reach 1 (Skunk Creek to Beardsley Rd. – from 7.07 ft to 10.04 ft.
Reach 2 (Beardsley Rd. to Pinnacle Peak Rd.) – from 7.78 ft to 9.19 ft.

For the grade control structures evaluated at three locations, the scour depths are provided as follows:

Union Hills (Station 10.806, Reach 1) - 9.79 ft.
Deer Valley Road (Station 13.179, Reach 2) - 12.27 ft.
Happy Valley Road (Station 14.162, Reach 2) - 11.09 ft.

Also, all utility lines crossing the river underneath must be checked for adequate depth of installation.

TABLE 6-9
Long-Term Scour Analysis
Middle New River Watercourse Master Plan

Item No.	Station No.	Reach No.	Dominant Discharge (cfs)	Reach Length (ft)	Channel Width (ft)	Flow Depth (ft)	Hydr. Depth (ft)	Velocity Channel (ft/s)	Bed Slope (ft/ft)	Recomm. Reach Length (ft)	Equilibrium Slope (ft/ft)	Degradation from Eq. Slope (ft)	Average Armor Size (mm)	Degradation from B. Armoring (ft)	Long-Term Degradation (ft)	Long-Term Degradation by Reach (ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)
1	13.619	2	2400	500.33	190.40	2.60	2.53	4.98	0.00408	1000	0.00129	1.714	35.8	1.146	1.146	
2	13.524	2	2400	499.65	190.27	2.57	2.50	5.05	0.00418	1000	0.00129	1.779	35.8	1.146	1.146	
3	13.420	2	2400	506.43	190.25	2.59	2.52	5.01	0.00413	1000	0.00129	1.744	35.8	1.146	1.146	
4	13.325	2	2400	532.87	190.26	2.57	2.50	5.05	0.00417	1000	0.00129	1.768	35.8	1.146	1.146	
5	13.227	2	2400	240.04	190.43	2.61	2.54	4.97	0.00417	1000	0.00129	1.768	35.8	1.146	1.146	
6	13.183	2	2400	20.00	189.29	2.24	2.19	5.80	0.00400	1000	0.00129	1.666	35.8	1.146	1.146	
7	13.151	2	2400	385.89	192.08	3.02	2.92	4.27	0.00257	1000	0.00129	0.783	35.8	1.146	1.146	
8	13.076	2	2400	450.81	192.41	3.13	3.00	4.15	0.00257	1000	0.00129	0.788	35.8	1.146	1.146	
9	12.991	2	2400	550.48	192.99	3.37	3.14	3.96	0.00187	1000	0.00129	0.356	35.8	1.146	1.146	
10	12.896	2	2400	500.68	192.37	3.23	2.99	4.17	0.00214	1000	0.00129	0.520	35.8	1.146	1.146	
11	12.801	2	2400	522.71	192.26	3.16	2.97	4.20	0.00231	1000	0.00129	0.629	35.8	1.146	1.146	
12	12.701	2	2400	499.01	192.29	3.16	2.98	4.19	0.00230	1000	0.00129	0.623	35.8	1.146	1.146	
13	12.606	2	2400	529.88	192.26	3.16	2.97	4.20	0.00234	1000	0.00129	0.645	35.8	1.146	1.146	
14	12.511	2	2400	445.76	189.41	2.35	2.30	5.52	0.00545	1000	0.00129	2.559	35.8	1.146	1.146	
15	12.420	2	2400	580.01	195.01	2.33	2.28	5.40	0.00552	1000	0.00129	2.600	35.8	1.146	1.146	***1.49***
16	11.949	1	2529	426.33	259.24	2.04	2.01	4.86	0.00542	1000	0.00141	2.469	38.5	1.262	1.262	
17	11.864	1	2529	596.49	256.76	1.99	1.96	5.03	0.00540	1000	0.00141	2.457	38.5	1.262	1.262	
18	11.759	1	2529	475.92	254.18	2.12	2.09	4.77	0.00540	1000	0.00141	2.458	38.5	1.262	1.262	
19	11.664	1	2529	512.96	218.46	2.29	2.24	5.16	0.00540	1000	0.00141	2.458	38.5	1.262	1.262	
20	11.566	1	2529	454.44	194.92	2.51	2.44	5.31	0.00552	1000	0.00141	2.534	38.5	1.262	1.262	
21	10.917	1	2586	276.24	223.20	3.21	3.10	3.74	0.00315	1000	0.00141	1.073	38.5	1.262	1.262	
22	10.862	1	2586	286.29	219.01	3.08	2.25	5.25	0.00140	1000	0.00141	-0.005	38.5	1.262	1.262	
23	10.803	1	2586	50.00	231.06	0.53	0.51	21.76	0.00200	1000	0.00141	0.366	N/A	N/A	N/A	
24	10.699	1	2586	459.22	221.97	2.82	2.70	4.31	0.00198	1000	0.00141	0.354	38.5	1.262	1.262	
25	10.612	1	2586	456.66	267.87	2.35	2.28	4.23	0.00201	1000	0.00141	0.375	38.5	1.262	1.262	
26	10.517	1	2586	438.21	378.41	2.28	2.23	3.06	0.00212	1000	0.00141	0.441	38.5	1.262	1.262	
27	9.692	1	2643	526.34	299.12	4.52	2.96	2.99	0.00245	1000	0.00141	0.643	38.5	1.262	1.262	
28	9.592	1	2643	557.60	330.67	4.21	1.56	5.14	0.00346	1000	0.00141	1.265	38.5	1.262	1.262	
29	9.492	1	2643	433.72	471.44	2.65	1.43	3.91	0.00563	1000	0.00141	2.597	38.5	1.262	1.262	
30	9.367	1	2700	459.27	390.22	2.66	1.59	4.35	0.00636	1000	0.00141	3.048	38.5	1.262	1.262	
31	9.318	1	2700	154.63	464.04	3.61	1.64	3.54	0.00310	1000	0.00141	1.045	38.5	1.262	1.262	***1.64***

NOTES:
(1) The dominant discharges in column (4) correspond to the 10-year discharges.
(2) The data from columns (5) to (9) were taken from the 10-year HEC-RAS run of the river model.
(3) The reach lengths in column (10) are the assumed lengths that are subject to long-term degradation.
(4) The equilibrium slopes used in the calculation of the long-term scour are the average equilibrium slopes by reach.
(5) The bed armor sizes used in the calculation of long-term scour are the average armor sizes by reach.
(6) The recommended long-term scour is the lower degradation depth between the equilibrium slope and bed armoring.
(7) The evaluated long-term degradation in column (17) includes an additional 30% safety factor to account for the non-uniformity of hydraulic condition and sediment characteristics.

TABLE 6-10
Total Scour Analysis
Middle New River Watercourse Master Plan

Item No.	Station No.	Sub Reach No.	Design Discharge (cfs)	Channel Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Velocity Channel (ft/s)	Scour Components: Long-Term Scour (ft)	Local Scour (ft)	Bend Scour (ft)	General Scour (ft)	Anti-Dune Trough (ft)	Low-Flow Thalweg (ft)	Safety Factor (ft)	Total Scour (ft)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	13.619	2	9800	204.0	6.00	5.64	8.51	1.15	3.19	0.00	0.00	0.00	2.00	1.90	8.24	
2	13.524	2	9800	203.8	5.95	5.61	8.58	1.15	3.21	0.00	0.00	0.00	2.00	1.91	8.26	
3	13.420	2	9800	203.8	5.98	5.63	8.55	1.15	3.20	0.00	0.00	0.00	2.00	1.90	8.25	
4	13.325	2	9800	203.9	5.97	5.62	8.56	1.15	3.20	0.00	0.00	0.00	2.00	1.90	8.25	
5	13.227	2	9800	203.4	5.85	5.51	8.74	1.15	3.24	0.00	0.00	0.00	2.00	1.92	8.30	
6	13.183	2	9800	201.0	5.18	4.91	9.93	1.15	3.46	0.00	0.12	0.00	2.00	2.02	8.74	
7	13.151	2	9800	208.4	7.10	6.61	7.11	1.15	2.84	0.00	0.00	0.00	2.00	1.79	7.78	Min. = 7.78
8	13.076	2	9800	208.9	7.24	6.72	6.98	1.15	3.92	0.00	0.00	0.00	2.00	2.12	9.19	Max. = 9.19
9	12.991	2	9800	209.4	7.47	6.83	6.86	1.15	3.59	0.00	0.00	0.00	2.00	2.02	8.76	Rec. = 9.50
10	12.896	2	9800	208.4	7.24	6.62	7.11	1.15	3.65	0.00	0.00	0.00	2.00	2.04	8.84	
11	12.801	2	9800	208.1	7.12	6.56	7.18	1.15	2.86	0.00	0.00	0.00	2.00	1.80	7.81	
12	12.701	2	9800	207.8	7.03	6.48	7.29	1.15	2.90	0.00	0.00	0.00	2.00	1.81	7.85	
13	12.606	2	9800	206.8	6.79	6.27	7.56	1.15	2.97	0.00	0.00	0.00	2.00	1.84	7.95	
14	12.511	2	9800	201.7	5.43	5.14	9.46	1.15	3.38	0.00	0.07	0.00	2.00	1.98	8.57	
15	12.420	2	9800	206.8	5.29	5.02	9.44	1.15	2.69	0.00	0.06	0.00	2.00	1.77	7.67	
16	11.949	1	10350	270.0	4.73	4.56	8.41	1.26	3.00	0.00	0.00	0.00	2.00	1.88	8.14	
17	11.864	1	10350	267.4	4.64	4.48	8.64	1.26	3.05	0.00	0.00	0.00	2.00	1.89	8.21	
18	11.759	1	10350	266.3	5.16	4.96	7.83	1.26	2.92	0.00	0.00	0.00	2.00	1.86	8.04	
19	11.664	1	10350	231.7	5.58	5.31	8.41	1.26	3.29	0.00	0.00	0.00	2.00	1.97	8.52	
20	11.566	1	10350	207.7	5.71	5.39	9.24	1.26	4.41	0.00	0.05	0.00	2.00	2.32	10.04	
21	10.917	1	10900	289.8	6.78	5.41	7.12	1.26	2.88	0.00	0.13	0.00	2.00	1.88	8.16	
22	10.862	1	10900	233.3	5.75	4.69	9.96	1.26	3.87	0.00	0.14	0.00	2.00	2.18	9.46	Min. = 7.07
23	10.803	1	10900	237.8	1.88	1.83	25.11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Max. = 10.04
24	10.699	1	10900	237.9	6.00	5.60	8.18	1.26	3.31	0.00	0.00	0.00	2.00	1.97	8.55	Rec. = 10.50
25	10.612	1	10900	281.1	5.05	4.82	8.05	1.26	2.97	0.00	0.00	0.00	2.00	1.87	8.11	
26	10.517	1	10900	390.5	4.58	4.43	6.30	1.26	2.18	0.00	0.00	0.00	2.00	1.63	7.07	
27	9.692	1	11450	365.2	7.76	5.59	5.61	1.26	2.23	0.00	0.00	0.00	2.00	1.65	7.14	
28	9.592	1	11450	365.3	6.03	3.20	9.80	1.26	3.58	0.00	0.00	0.00	2.00	2.05	8.89	
29	9.492	1	11450	480.9	4.93	3.66	6.50	1.26	2.19	0.00	0.00	0.00	2.00	1.63	7.08	
30	9.367	1	12000	433.9	4.96	3.62	7.64	1.26	2.61	0.00	0.00	0.00	2.00	1.76	7.64	
31	9.318	1	12000	494.4	5.96	3.83	6.33	1.26	2.25	0.00	0.00	0.00	2.00	1.65	7.17	

NOTES:
(1) Long-term scour values in column (9) are based on bed armoring and stable slope analyses. The values reflect the scour depth associated with bed armoring condition in the channel.
(2) Local scour values in column (10) are evaluated from four equations provided by Pemberton and Lara (1984).
(3) Bend scour values in column (11) are zero because scour around bends are already incorporated in the evaluation of local scour in column (9).
(4) General scour values in column (12) are generally zero based on the equation provided by SLA (1989).
(5) Anti-dune trough depth values in column (13) are generally zero because anti-dune trough only occurs when flow conditions are either transitional or supercritical.
(6) Low-flow thalweg of 2.0 ft is used (see column 14) since the wash is classified as a regional watercourse (SLA, 1989).
(7) Thirty percent safety factor is used (see column 15) to account for non-uniformity of flow hydraulics and sediment characteristics in the channel.

TABLE 6-11
Computation of Scour at Grade Control Structures and Drop Step Length Requirement
Middle New River Watercourse Master Plan

											Average Grain Size		Scour Components											
														Local Scour										
Station No.	Sub Reach No.	Design Discharge (cfs)	Ave. Channel Width (ft)	Unit Discharge (cfs/ft)	Tailwater Depth (ft)	Head Difference (ft)	Froude No. (-)	WSE Difference (ft)	Total Drop Height (ft)	Critical Depth (ft)	Grain Size D_{85} (mm)	Grain Size D_{90} (mm)	Long-Term Scour (ft)	Schoklitsch (ft)	Veronese (ft)	Zimmerman (ft)	Average (ft)	Low-Flow Thalweg (ft)	Safety Factor (ft)	Total Scour (ft)	Proposed Toe-Down (ft)	Trajectory Length (ft)	Length of Jump (ft)	Protected Length (ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
14.162	2	6100	185.0	33.0	4.65	8.10	3.74	6.95	7.50	3.31	47.12	68.86	1.47	4.14	9.31	1.74	5.06	2.00	2.56	11.09	11.5	16.63	26.74	43.36
13.179	2	9800	180.0	54.4	7.04	8.10	3.56	7.40	9.00	4.43	47.12	68.86	0.95	4.80	11.26	3.41	6.49	2.00	2.83	12.27	12.5	21.80	39.56	61.36
10.806	1	10900	270.0	40.4	6.79	5.56	3.27	5.03	7.50	3.70	49.98	65.83	1.26	2.59	7.52	2.70	4.27	2.00	2.26	9.79	10.0	18.20	36.80	55.00

NOTES:
(1) Hydraulic data from columns (3) to (11) were obtained from hydraulic modeling of the Middle New River using HEC-RAS.
(2) Sediment data in columns (12) and (13) are the representative bed material data for reaches no. 1 and 2 (RAM, 1999) of the Middle New River.
(3) Long-term scour values in column (14) are from bed armoring analysis. The future channel bed grade would be limited by bed armoring and not by equilibrium slope.
(4) Local scour evaluations at drop structures in columns (15), (16) and (17) are from the application of three methods recommended by Pemberton and Lara (1984).
(5) Average local scour values in column (18) are the evaluated arithmetic average of the three methods.
(6) Low-flow thalweg of 2.0 ft is used (see column 19) since the wash is classified as a regional watercourse (SLA, 1989).
(7) Thirty percent safety factor is used (see column 20) to account for non-uniformity of flow hydraulics and sediment characteristics in the channel.
(8) Trajectory lengths in columns (23) describe the extent of flow trajectory for the design discharges from the drop face to the ground. Proposed protected lengths in column (25) include the jump lengths.

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7.0 GROUNDWATER RECHARGE

GENERAL

Groundwater recharge potential was evaluated in this study in accordance with the requirement of Arizona Revised Statutes §48-3609.01 for watercourse master plans. The focus of this work task was to perform a reconnaissance level assessment of the conceptual viability of groundwater recharge of the aquifer in the New River study reach. Assessment of groundwater recharge potential included several tasks, as follows: literature search/review, definition of recharge objectives, identification of water supply sources, evaluation of area hydrogeology, and proposed recharge technology.

The work product presented in this section is a summation of the research findings, including a concept overview of groundwater recharge potential in the study reach. Costs associated with the implementation of any of proposed recharge technologies are not computed.

AREA DESCRIPTION

Currently, the area is a mixture of urban development, agricultural land and undeveloped land. Urban development occupies the greatest amount of area in Reaches 1 and 2. Formerly, the area was occupied by agricultural land, mostly consisting of orchards. Reach 3 is mostly undeveloped, but soon to be developed.

OBJECTIVES

The main objective of evaluating recharge is to determine the potential to enhance the water supplies of the Cities of Peoria and Glendale. Other outside groups, such as Central Arizona Groundwater Replenishment District (CAGRD), WESTCAPS, and the Arizona Water Banking Authority (AWBA) could also be interested in using New River for groundwater recharge. The aquifer can be recharged during the winter months when municipal and other water demand is relatively low and surface water supplies are potentially higher. Similarly, the recharged aquifer can be pumped to augment water from other supply sources during the summer months when water user demands are highest. The water could also be stored long term to meet the Arizona

Department of Water Resources (ADWR) 100-year assured water supply requirement.

Other objectives include recreational, wildlife and aesthetic benefits. The recharge technology could include using a "live stream" within the New River floodplain. The recharge channel could be graded to provide access by users to the "live" stream, and the channel itself could be graded and contoured to provide a more natural pool and riffle appearance. The channel could potentially be stocked with fish. The area around the stream could include bike paths, playgrounds, and natural areas with trees.

The following sections only identify potential recharge water sources and technologies. Final decisions regarding the development and implementation of a groundwater recharge strategy for the New River study reach are predicated upon collective input from the stakeholders identified above.

WATER SUPPLY

Recharge can be accomplished by using stormwater runoff, reuse water from a wastewater treatment plant, or Central Arizona Project (CAP) water. The majority of the water would come from reuse or CAP water. Stormwaters are random events, and the magnitude and timing of the water can not be predicted. Often the flow rate is rapid through the river, providing little time for infiltration.

The availability of reuse water would depend on the seasonal demand. Currently, Peoria does not have any reuse water available for recharge in the New River. The amount of reuse water from Glendale is unknown at the time of this study. Prior to recharge into the aquifer via injection wells, the water would need to meet drinking water standards. Pretreatment could include lime precipitation, activated carbon filtration, and/or membrane filtration such as microfiltration and reverse osmosis. Another treatment option is soil treatment, where municipal wastewater is infiltrated into the overlying alluvium and receives treatment as it moves to the aquifer. Treatment processes include filtration of suspended solids and bacteria, absorption of bacteria and viruses, precipitation of phosphates and trace metals, biological degradation of organic species, recarbonation of high pH effluents, and denitrification (Asano, 1985).

The major source of recharge water is likely to be from the CAP. Peoria is allotted approximately 18,709 acre-feet per year (ac-ft/yr) and Glendale is allotted approximately 14,183 ac-ft/yr of CAP water (CAP, 1998). Also, the Arizona Water Banking Authority (AWBA) has estimated 229,675 acre-feet (ac-ft) of unused CAP water for the 1999 operating year (AWBA, 1998). The amount of water available for recharge would depend on the seasonal demand of CAP water and amount of water available to the AWBA. Water for the project could be transferred from the Hayden Rhodes Aqueduct CAP canal, located approximately 3.5 miles north of New River Dam, to the recharge site using a pipe line. Another method may include releasing water from the canal into the reach of New River located north of New River Dam and then releasing the recharge water from the dam.

KEY AGENCIES

Currently, Peoria and Glendale have jurisdiction over land surrounding New River. These cities are members of WESTCAPS, a coalition of CAP water subcontractors. WESTCAPS was formed to help the west Salt River Valley CAP water users to develop a plan to more fully use CAP water. WESTCAPS is composed of the following agencies: Arizona State Land Department, Arizona Water Company, Town of Buckeye, Citizens Utilities Company, Litchfield Park Water Service Company, Sunrise and Westend Water Companies, West Maricopa Combine, and the cities of Glendale, Goodyear, Peoria, Phoenix, and Surprise. The current director is Harold W. Thomas Jr. (Thomas, 1997).

If the cities desire to bank additional CAP water above their allotment they would contact the AWBA. The AWBA was created to help Arizona water users maximize use of the State's 2.8 million acre feet allotment of CAP water (AWBA, 1998). The authority also helps manage water supplies, set water aside for droughts, and provides a pool of water for Indian water rights settlements. The current chairperson is Rita Pearson, the Director of ADWR.

Another key agency is Central Arizona Groundwater Replenishment District (CAGRD). CAGRD provides a mechanism for developers and water providers to demonstrate an assured water supply under the new Assured Water Supply Rules. The CAGRD is an operational subdivision of the Central Arizona Water Conservation District (CAWCD). It is governed by CAWCD's Board of Directors and covers the same three-county service area as that served by CAWCD.

The following agencies would have to be contacted regarding permitting and approvals to recharge in New River:

- Flood Control District of Maricopa County
- U.S. Army Corps of Engineers
- Arizona Department of Environmental Quality
- Arizona Department of Water Resources

HYDROGEOLOGY

Regional Geology

The west Salt River Valley basin is composed of three units; the upper alluvial unit, middle alluvial unit, and lower alluvial unit. These units are similar to the US Geological Survey's (USGS) upper, middle, and lower units. The upper alluvial unit includes deposits from channel, floodplain, and alluvial fans, and mainly consists of silt, sand, and gravel. The middle alluvial unit includes sediments from playa, alluvial-fan, and fluvial deposits, and mainly consists of clay, silt, mudstone, and gypsiferous mudstone with some interbedded sand and gravel. The lower alluvial unit includes sediments from alluvial, fluvial, playa and evaporite deposits and mainly consists of fine-grained material (Corell and Corkhill, 1994 and Brown and Pool, 1989).

Local Geology

The geology beneath New River was evaluated using ADWR drilling records, previous soil borings located near the study area, and the ADWR regional groundwater flow model. An approximate cross-section is shown on Figure 7-1. Little is known about the conditions in the northern part of the study area because little drilling has been conducted. Perched groundwater conditions were not reported in the records studied.

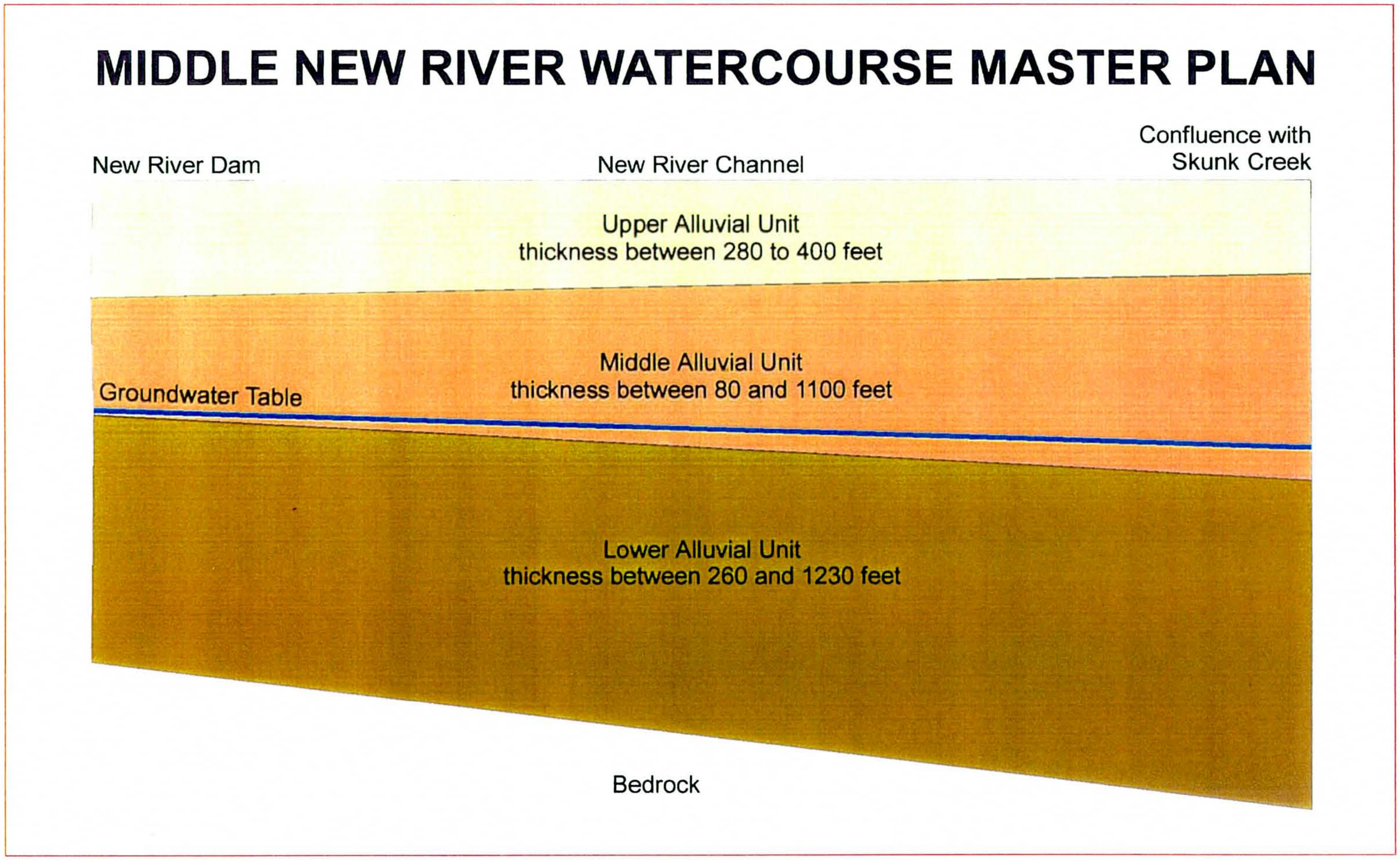


Figure 7-1

Approximate Cross-Section Along New River

Specific yield is defined as the volume of water that an unconfined aquifer releases from storage per unit surface area of aquifer per unit decline in water table (Freeze and Cherry, 1979). It is used as a measure for the amount of available water that can be extracted from an aquifer. Aquifers consisting of sand will have a higher specific yield than aquifers consisting of silts and clays.

The thickness of the upper alluvial unit ranges between 280 and 400 feet (Corell and Corkhill, 1994). According to the drilling records the unit consists of sandy gravel with clay lenses. Previous drilling activities have defined a clay layer with interbedded sands and gravels near the confluence of Skunk Creek and New River at 9 to 16 feet below the top of the channel bed. The results of the investigation indicated that the clay layer is approximately 5 to 11 feet thick (Hydrosystems, Inc., 1998). Information concerning the extent of the clay north of the confluence was not available. The regional groundwater flow model reports the specific yield to be 0.10 (Corell and Corkhill, 1994).

The thickness of the middle alluvial unit ranges between 80 feet at the northern section and 1100 feet at the southern section (Corell and Corkhill, 1994). The drilling records indicate the unit consists of clay with interbedded sands and gravels. The regional groundwater flow model reports the transmissivity and specific yield of the unit to be approximately 2500 $feet^2$/day and 0.9, respectively (Corell and Corkhill, 1994). Transmissivity is a measure of the aquifer's ability to transmit water. An aquifer consisting of sands and gravels will have a higher transmissivity than an aquifer consisting of silts and clays (Freeze and Cherry, 1979).

The thickness of the lower alluvial unit ranges from 260 to 1230 feet (Corell and Corkhill, 1994). The drilling records indicated the unit consists of gravel, sand and clay. The regional groundwater flow model reports the transmissivity and specific yield of the unit to be approximately 2700 $feet^2$/day and 0.9, respectively (Corell and Corkhill, 1994). Note that actual transmissivity and storage capacity can be impacted by local conditions; therefore, regional values should be interpreted accordingly. If the local transmissivity and storage capacity are lower than the regional values less water can be recharged.

Groundwater

Most of the upper alluvial unit is dewatered in the study area by previous irrigation and municipal pumping activities. The depth to water in the middle alluvial unit ranges between 470 feet below ground surface (bgs) near the northern end of the study area and 280 feet bgs near the southern end of the study area. The unit is partially dewatered in the northern section. The depth to water in the lower alluvial unit ranged between 470 feet bgs at the northern end to 270 feet bgs near the southern end (Corell and Corkhill, 1994). The groundwater generally flows to the south. The groundwater level has changed between a decrease of 21 ft and an increase of 23 feet during the period 1982-1983 to 1991-1992 (Hammett and Herther, 1995). The document did not indicate which unit has experienced the increases. A cone of depression is located roughly between the White Tank Mountains and the Agua Fria River. The depression is caused by extensive groundwater withdrawals that have greatly exceeded replenishment over time (Hammett and Herther, 1995).

Subsidence

The downward movement of land where groundwater pumping has exceeded natural or artificial recharge of the aquifer characterizes subsidence in the Phoenix Metropolitan area. It is greatest in areas where there is a large amount of pumping, and where the aquifer is the thickest and most compressible. Non-uniform subsidence can produce cracks or fissures in the earth. The cracks or fissures can damage buildings, tunnels, streets, highways, railroads, water and sewer lines, and power lines. Subsidence may be stopped or small rebounds may occur when pumpage is reduced to the safe yield. Long-term subsidence is essentially irreversible (Bouwer, 1978).

According to the ADWR, subsidence in the southern portion of the New River study area ranges between 3 to 8 cm/year (1 to 3 inches/year). The data were collected using satellite imagery and a single spot measurement. They currently do not provide information on the northern portion of the study area (Tatlow, 1999).

While subsidence is irreversible, decreasing groundwater withdrawals and/or implementing recharge technologies can reduce the rate at which it occurs. This fact is significant in consideration of the high cost of infrastructure damage as a result of subsidence.

Water Quality

Available water quality results have been gathered from the Arizona Department of Environmental Quality (ADEQ) and Peoria. Little data were found for the northern part of the study area because there are very few wells in this area. Water quality results have indicated concentrations of dibromochloropropane (DBCP) greater than the maximum contaminate level (MCL) of 0.2 mg/L for the south part of the study area (ADEQ, 1994). DBCP was used to exterminate nematodes in citrus groves. One water quality analysis result indicated a concentration of nitrate greater than the MCL of 10 mg/L of nitrate nitrogen (ADEQ, 1994). The water quality results did not indicate concentrations of arsenic, cadmium, or fluoride greater than the MCLs (ADEQ, 1994 and Peoria, 1998). The upper alluvial unit groundwater is probably of poor quality due to deep perculation of irrigation water. Irrigation water will have elevated levels of salt and nitrates, and possibly pesticides.

Groundwater Mounding Analysis

Broad assumptions were made to estimate a recharge project's impact to the aquifer from New River Dam to the confluence with Skunk Creek. A schematic cross-section of the resultant groundwater mound is shown on Figure 7-2. Additional information is required to more accurately estimate the impact (see Section Information Requirements). The height of the groundwater mound was analyzed using the equation developed by Hantush for various infiltration rates and channel bottom widths (Bouwer, 1978).

$$h_{x,y,t} - H = \frac{v_a t}{4f}\{F[(W/2+x)n,(L/2+y)n] + F[(W/2+x)n,(L/2-y)n] +$$
$$F[(W/2-x)n,(L/2+y)n] + F[(W/2-x)n,(L/2-y)n]$$

Where:

$h_{x,y,t}$ = height of water table above impermeable layer at x, y, and time t
H = original height of water table above impermeable layer
v_a = arrival rate at water table of water from infiltration basin
t = time since start of recharge
f = fillable porosity ($1>f>0$)
L = length of recharge basin (in y direction)
W = width of recharge basin (in x direction)

$$F(\alpha,\beta) = \int_0^1 erf(\alpha\tau^{-1/2}) \cdot erf(\beta\tau^{-1/2})d\tau$$

$$n = (4tT/f)^{-1/2}$$

The function $F(\alpha,\beta)$ was tabulated by Hantush and is included in *Groundwater Hydrology* on pages 284 and 285 (Bouwer, 1978). The calculation assumed constant flow for one year with no changes in infiltration rates, transmissivity, and specific yield with time or location within the study area. An infiltration rate of 2.5 feet/day was assumed for the study area (CDM, 1986). The mounding was limited to 30 feet bgs. An average evaporation rate of 72 inches/year was added to the recharge rate to calculate the inflow of water in the channel (Soil Conservation Service, 1977).

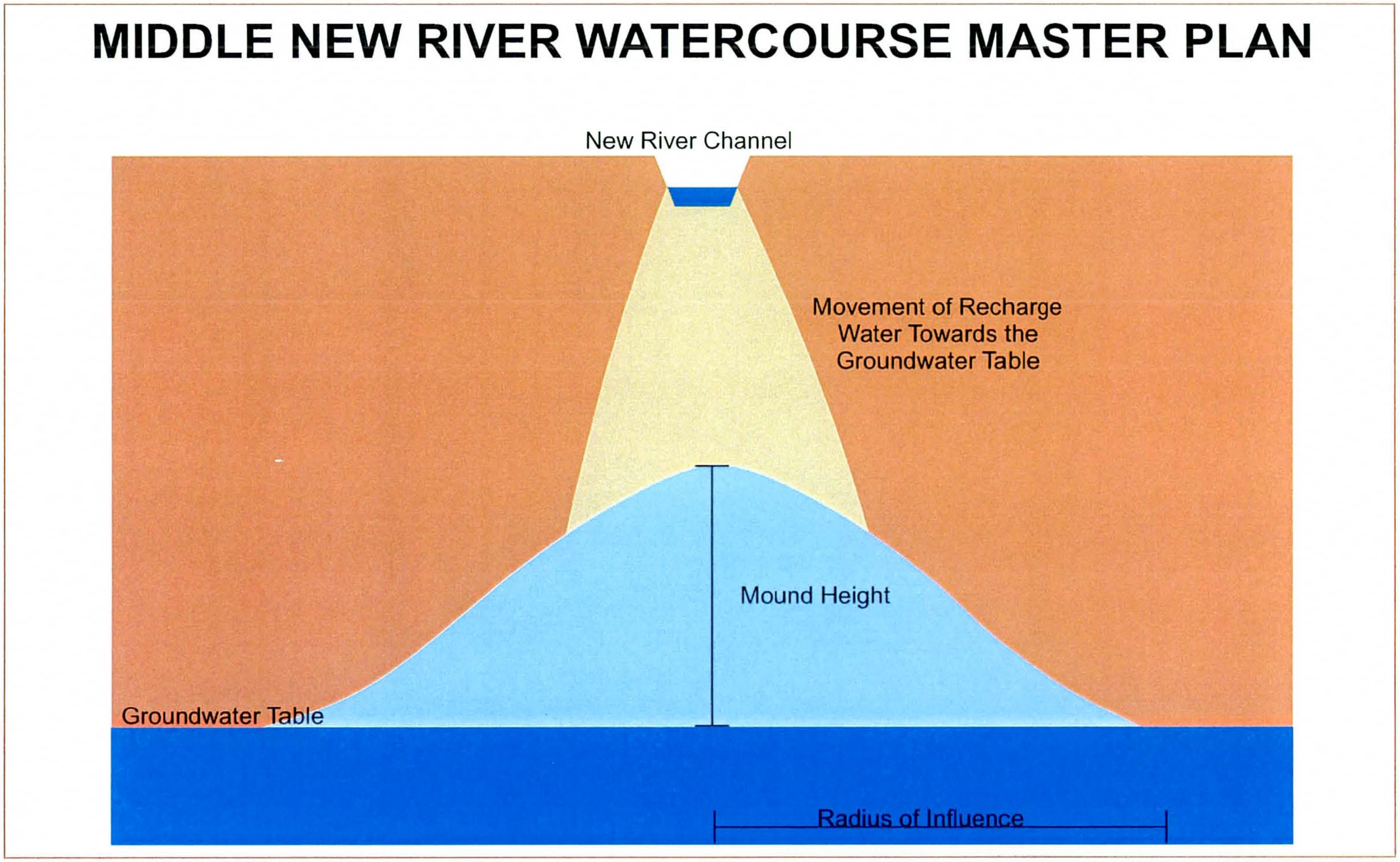


Figure 7-2

Groundwater Mound and Radius of Influence Schematic

The flow rates in the channel ranged between 4,000 and 234,000 ac-ft/yr for widths ranging between 20 and 1180 feet (see Figures 7-3 and 7-4). At these flow rates, all the water should be recharged by the time it reaches the confluence with Skunk Creek. For instance, for a channel width of 40 feet and assuming an infiltration rate of 1.5 feet/day, the channel could potentially infiltrate approximately 32 cfs (23,000 ac-ft/yr) (see Figure 7-3). Of the 32 cfs inflow in the channel, only slightly less (approximately 31.5 cfs) will be recharged because of evaporation. With the same set of values the groundwater table could potentially rise 9 feet above the original elevation (see Figure 7-4). The inflow in the channel is limited by the height of the groundwater mound of 30 feet bgs. If the groundwater mound was allowed to rise further it could begin to seep into basements, kill trees, and rise into depressed areas. Figure 7-5 shows the combination of infiltration rate and channel width that would result in a maximum groundwater table rise of 30 feet bgs. For instance, for an infiltration rate of 1 feet/day the maximum channel width is approximately 780 feet and channel flow rate is approximately 305,000 ac-ft/yr. The tabular data for the Figures are included at the end of this section.

Figure 7-3

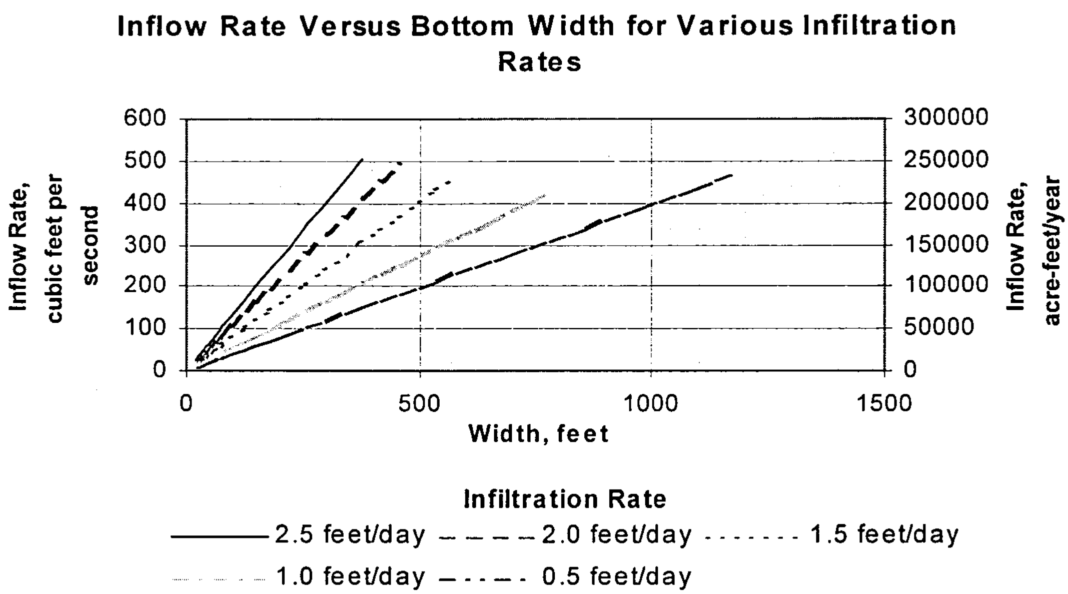


Figure 7-4

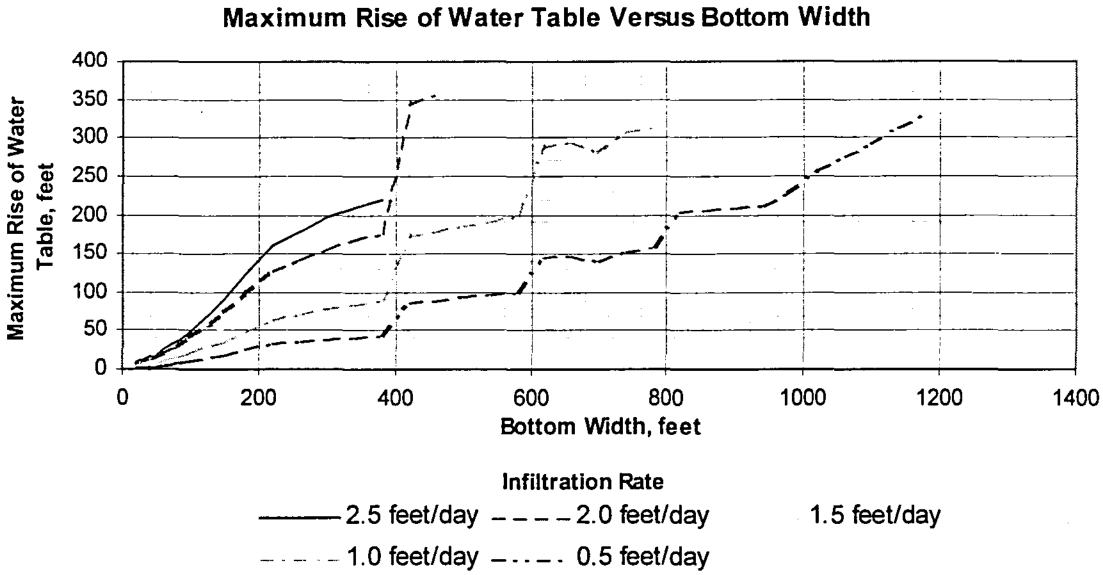
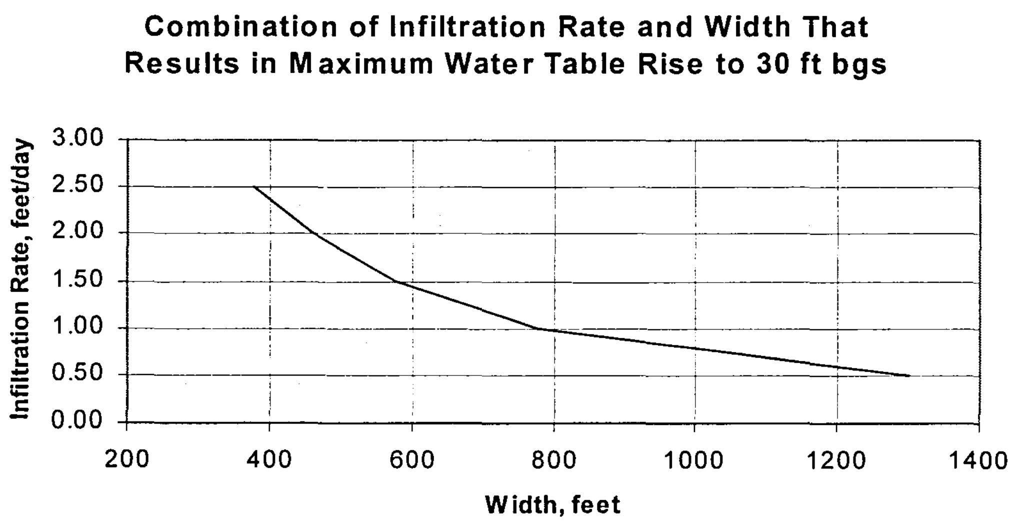


Figure 7-5



The radius of influence was analyzed using the following equation for the same infiltration rates.

$$\frac{q}{2} = T\left(\frac{h_s - h_1}{L}\right)$$

Where:

Q = discharge rate per unit length

H_2 = mound height

H_1 = 1 foot

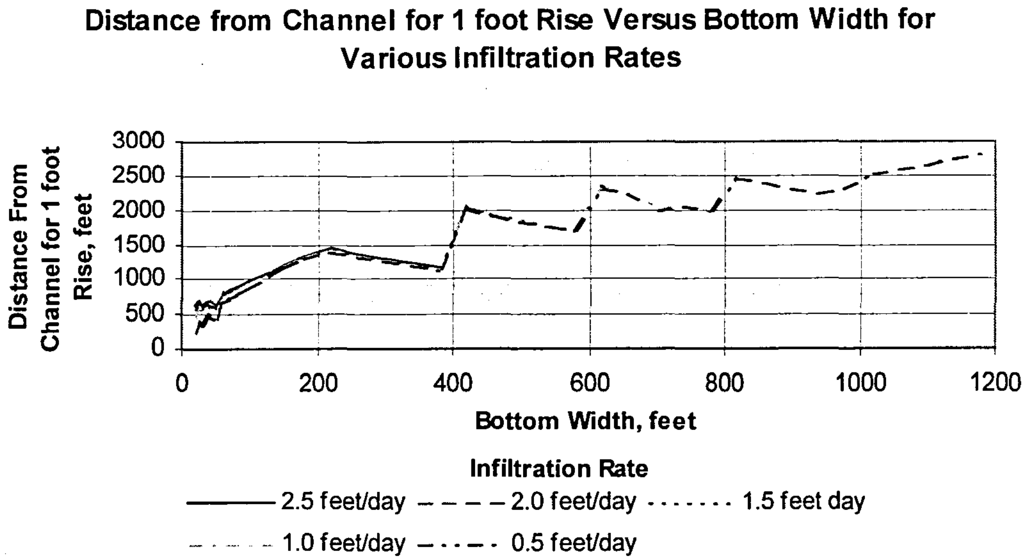
T= transmissivity

L = radius of influence

The calculation assumed constant flow for one year with no changes in infiltration rates, transmissivity, and specific yield with time or location within the study area. The maximum amount of water recharged was limited by a groundwater mound of 30 feet bgs and zero flow past the confluence with Skunk Creek.

Figure 7-6 shows the distance from the channel for a one foot rise in groundwater elevation. The radius of influence ranged from approximately 230 to 2,800 feet. For instance, for an infiltration rate of 1 feet/day and a channel width of 40 feet, the radius of influence is approximately 600 feet and the flow in the channel is approximately 22 cfs. The radius of influence is important in determining effects of recharge to the current private and municipal production wells. Also, it is important in determining if any new wells are necessary to recover the recharge water for future use.

Figure 7-6



Effective Recharge Transmissivity:

The effective transmissivity of the aquifer for recharge systems is less than the transmissivity of the entire aquifer. The deeper portions of the aquifer contribute very little to the flow and are stagnate or "passive" (Bouwer, 1978). The following figures show the effects of using a value of transmissivity that is approximately 20 percent less the transmissivity used in the previous section. The flow rate in the channel ranged between 4,000 and 142,000 ac-ft/yr for widths ranging between 20 and 740 feet. The maximum flow rate is approximately 40 percent less than the previous flow rates calculated. Conducting a pilot recharge project can assess the actual transmissivity of the system.

Figure 7-7

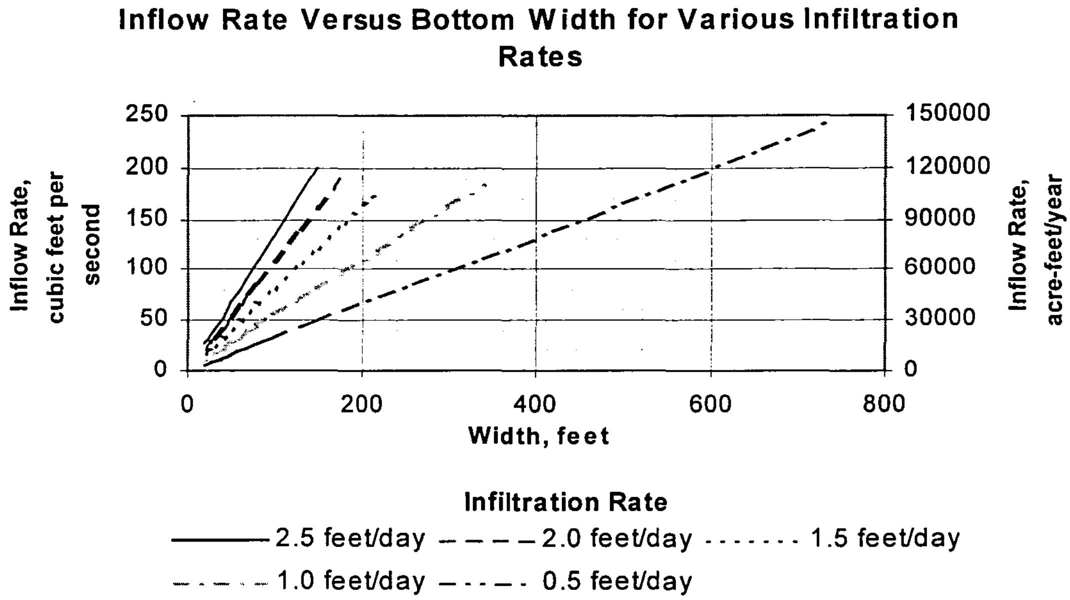


Figure 7-8

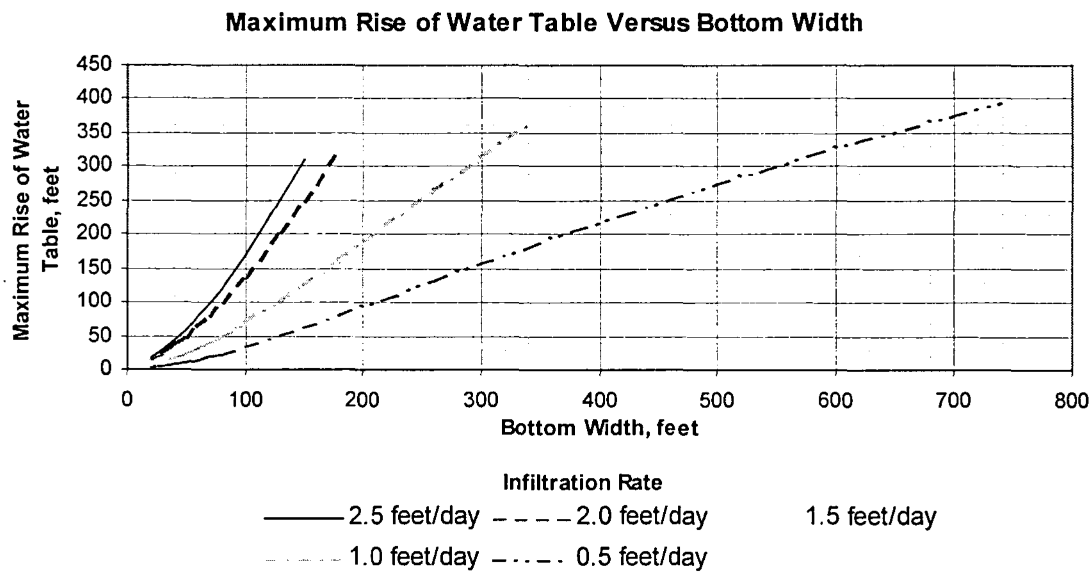


Figure 7-9

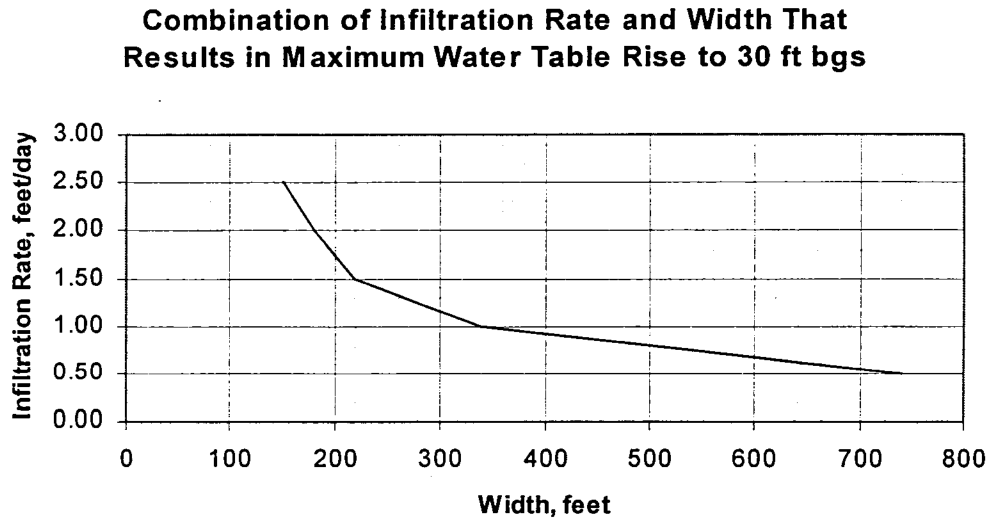
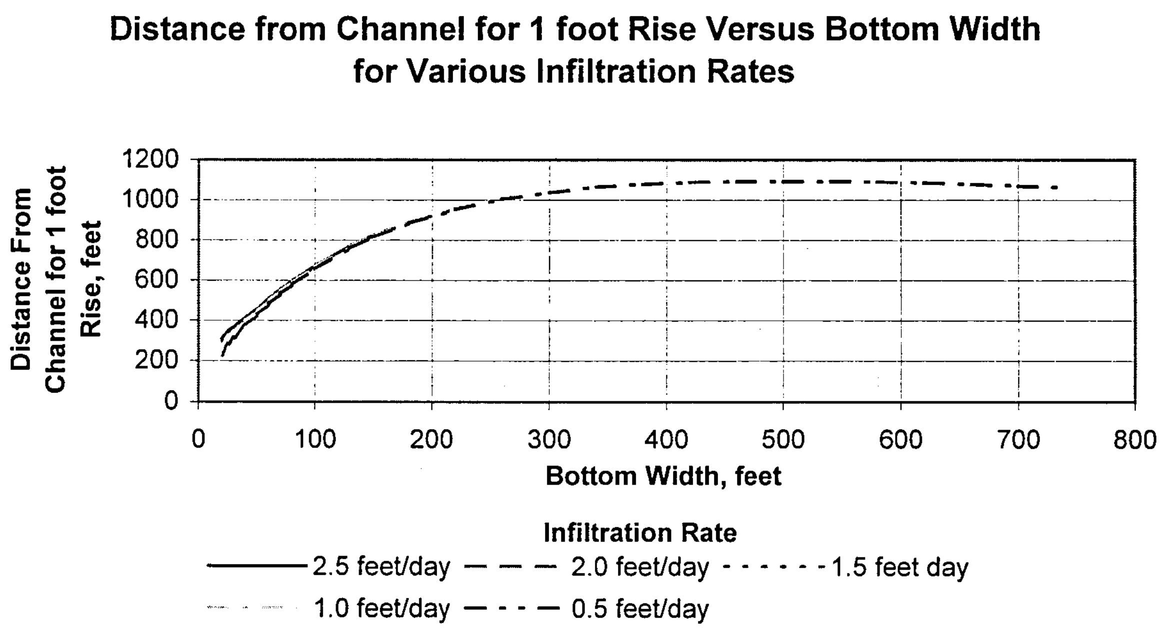


Figure 7-10



Recharge to Confluence with Aqua Fria River

The Hantush's equation and Neuman's solution of the Theis equation was also used to estimate recharge from New River Dam to the confluence with the Aqua Fria River. The analysis assumed the transmissivity, storativity, fillable porosity, and groundwater elevation did not change from the calculations in the previous section. This estimate should only be used for rough comparison purposes only. The flow rates in the channel ranged between 8,000 and 61,000 ac-ft/yr for widths ranging between 20 and 150 feet (see Figures 7-11 and 7-12). This is approximately twice the amount of water required to recharge to the confluence of Skunk Creek.

Figure 7-11

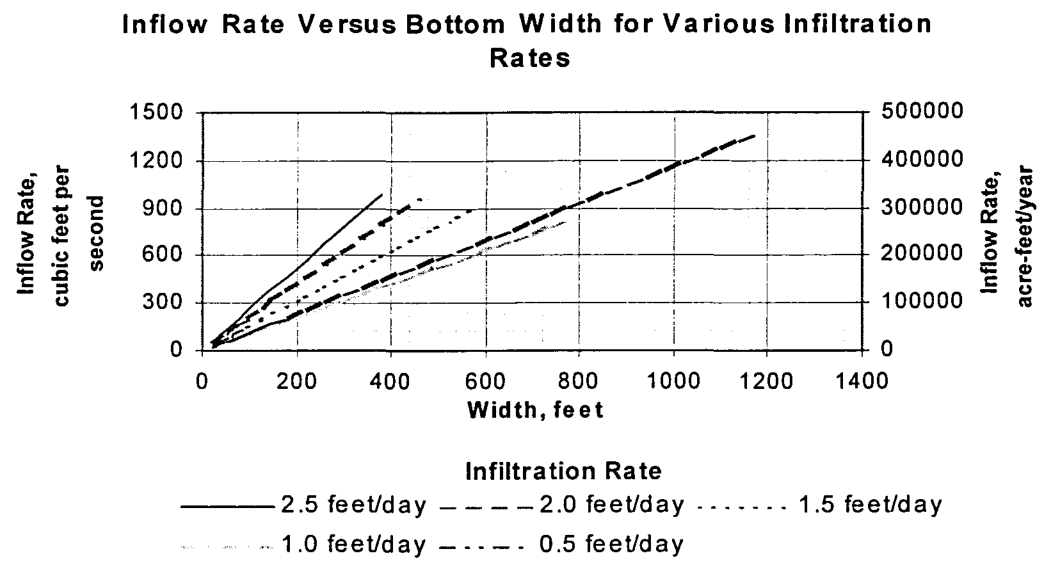


Figure 7-12

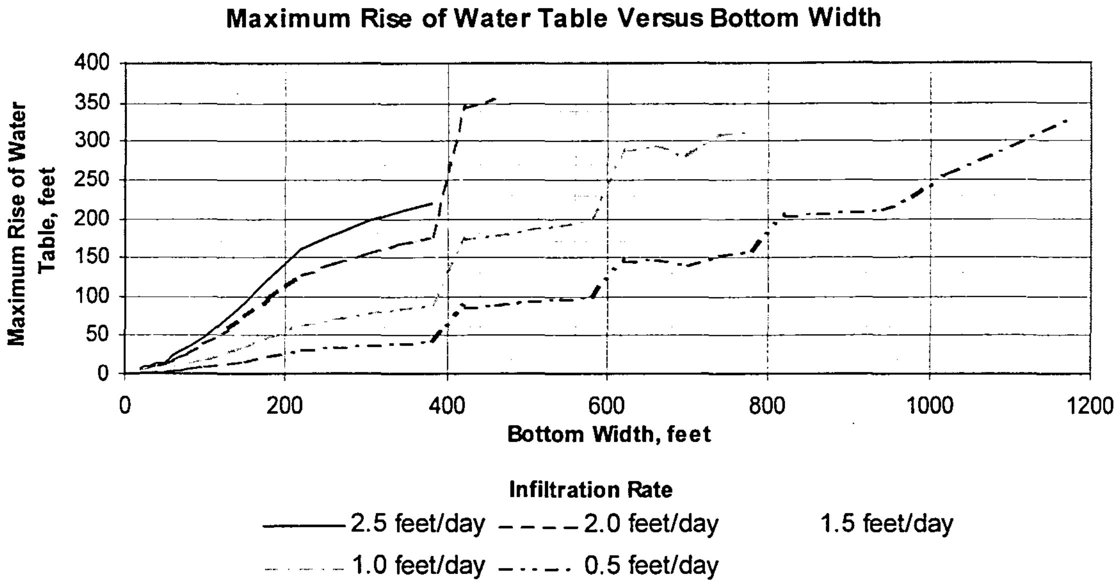


Figure 7-13

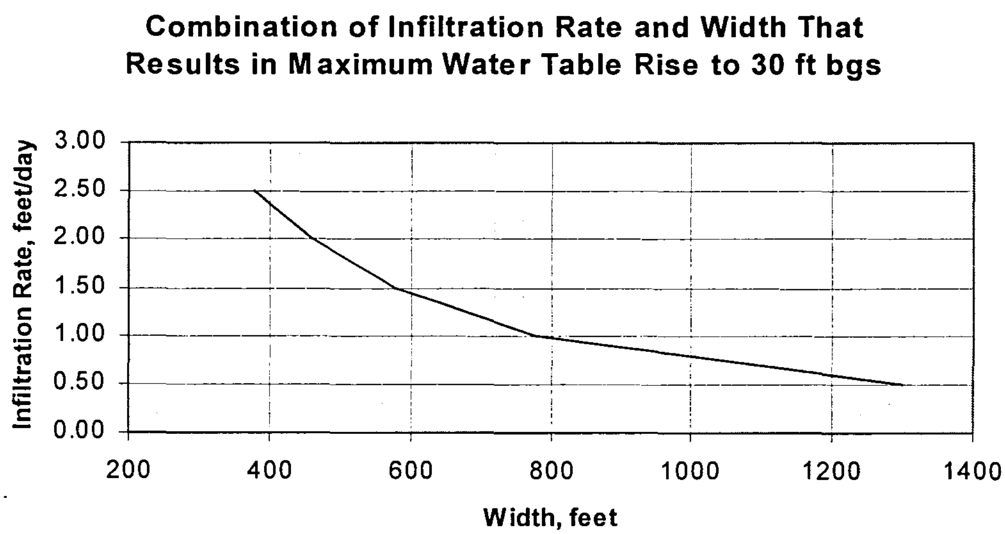
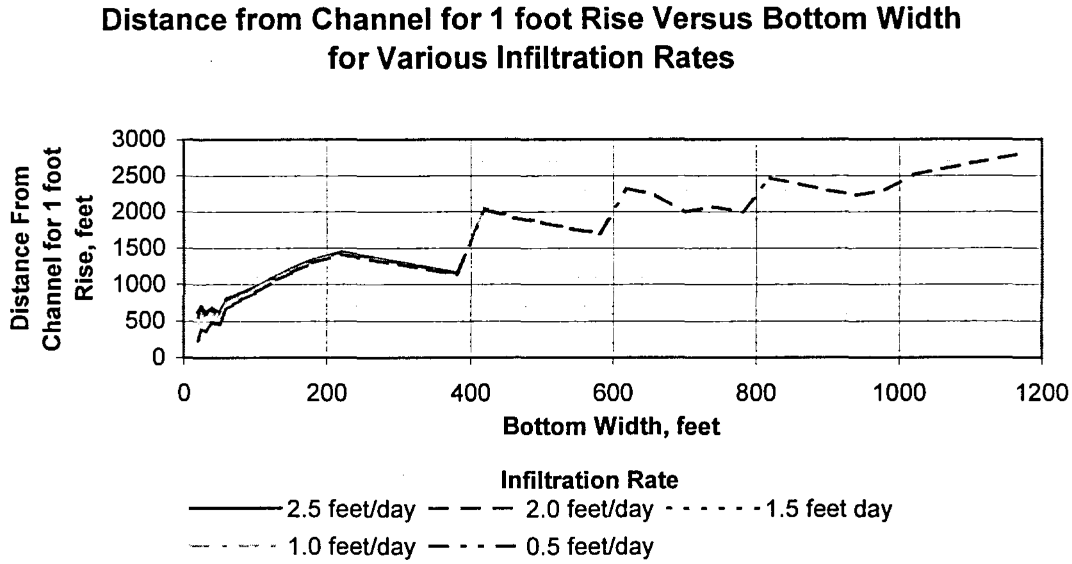


Figure 7-14



Summary of Mounding Analysis

Table A shows a summary of the mounding analysis calculations. Condition 1 is a summary of Figures 7-3 through 7.6. Condition 2 is a summary of the calculations using the effective recharge transmissivity (Figures 7-7 through 7-10). Condition 3 is a summary of the additional flows to the confluence to Aqua Fria River confluence (Figures 7-11 through 7-14). The table includes a range of what is "realistic" or potentially viable based on available data. Tighter numbers can only be validated by in depth hydrogeologic testing for the reach being evaluated.

Table A

Summary of Mounding Analysis

	Condition 1	Condition 2	Condition 3
Inflow Rate Range (cfs) [a]	5 to 500	5 to 200	10 to 980
Infiltration Rate Range (feet/day)	0.5 to 2.5	0.5 to 2.5	0.5 to 2.5
Bottom Width Range (feet)	20 to 1180	20 to 740	20 to 1180
Maximum Rise of Water Table (feet)	1 to 350	3 to 400	1 to 330
Radius of Influence Range (in feet) [b]	230 to 2510	230 to 1060	230 to 2510

[a] Inflow rate in New River from New River Dam

[b] Radius of influence is defined as the distance from New River to one foot rise in water table

RECHARGE TECHNOLOGY

The recharge technology could include using a "live stream" within the New River floodplain. A low flow channel could be excavated in the floodplain of the river to accommodate and direct "live stream" flow. Figures 7-15 and 7-16 show the low flow channel with the various alternatives. The width of the channel would depend on the desired flow rate, infiltration rate, and other objectives. The flow rate would depend on the availability of water and the length of the "live stream." The channel could meander between the banks of New River with cascades or waterfalls at grade control structures, providing a more natural appearance.

The infiltration rate of the channel could be improved by adding a layer of sand to the bottom of the channel to filter out the fine sediments (see Figure 7-17). Periodic maintenance would include replacement of the sand filter to keep the rate of recharge constant. Vadose zone wells or trenches filled with medium to coarse sand could be used to bypass areas with clay lenses. Clay lenses can slow the downward movement of the recharge water.

A "live stream" could also be developed by the use of spreader dikes and T-dikes (see Figure 7-18). These structures spread the water along the width of New River, increasing the infiltration volume. Small downstream detention basins and off-channel basins could be constructed in parts of the study area. The basins could also be used for recreation benefits, such as fishing. The type of technology should take into consideration economics, damage during flood events, and amount of potential recharge.

In lieu of an engineered live steam, the channel's natural thalweg could be utilized for recharge. Using this natural low flow channel may not be as efficient as an engineered system, however, long term maintenance costs would likely be significantly less. This approach may also be more practical if water is not always available to provide a "live stream."

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

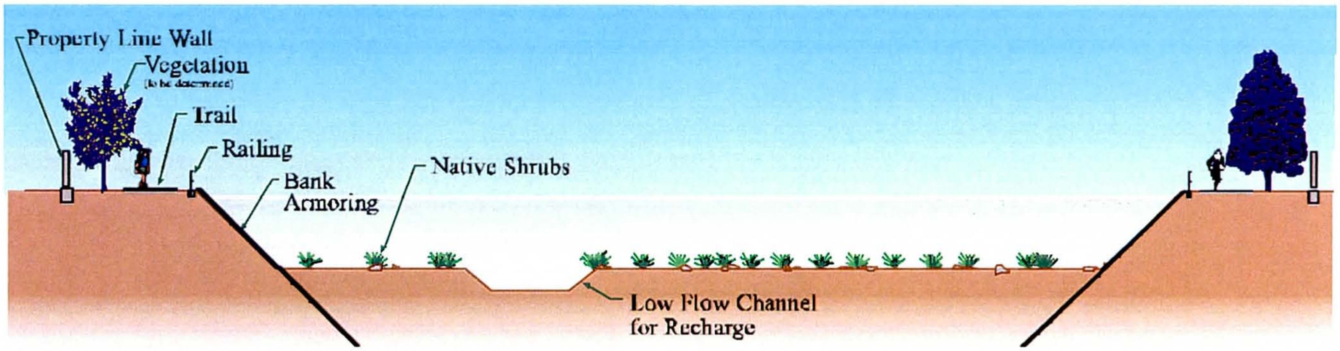


Figure 7-15

Typical Channel Section for Alternative 1 with Low Flow Channel

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

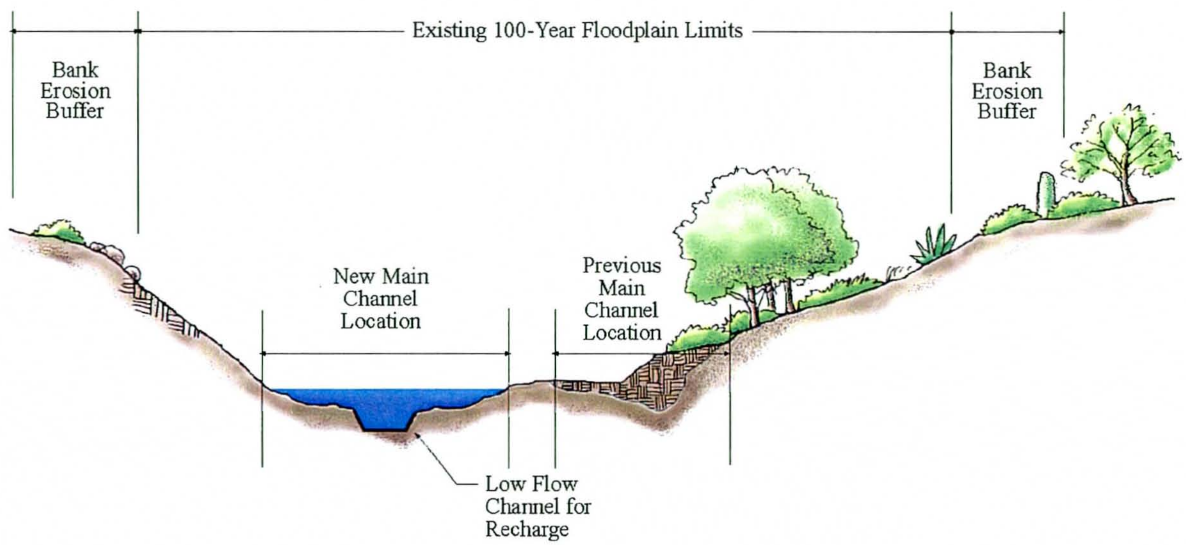


Figure 7-16

Typical Channel Section for Alternative 2 with Low Flow Channel

MIDDLE NEW RIVER WATERCOURSE MASTER PLAN

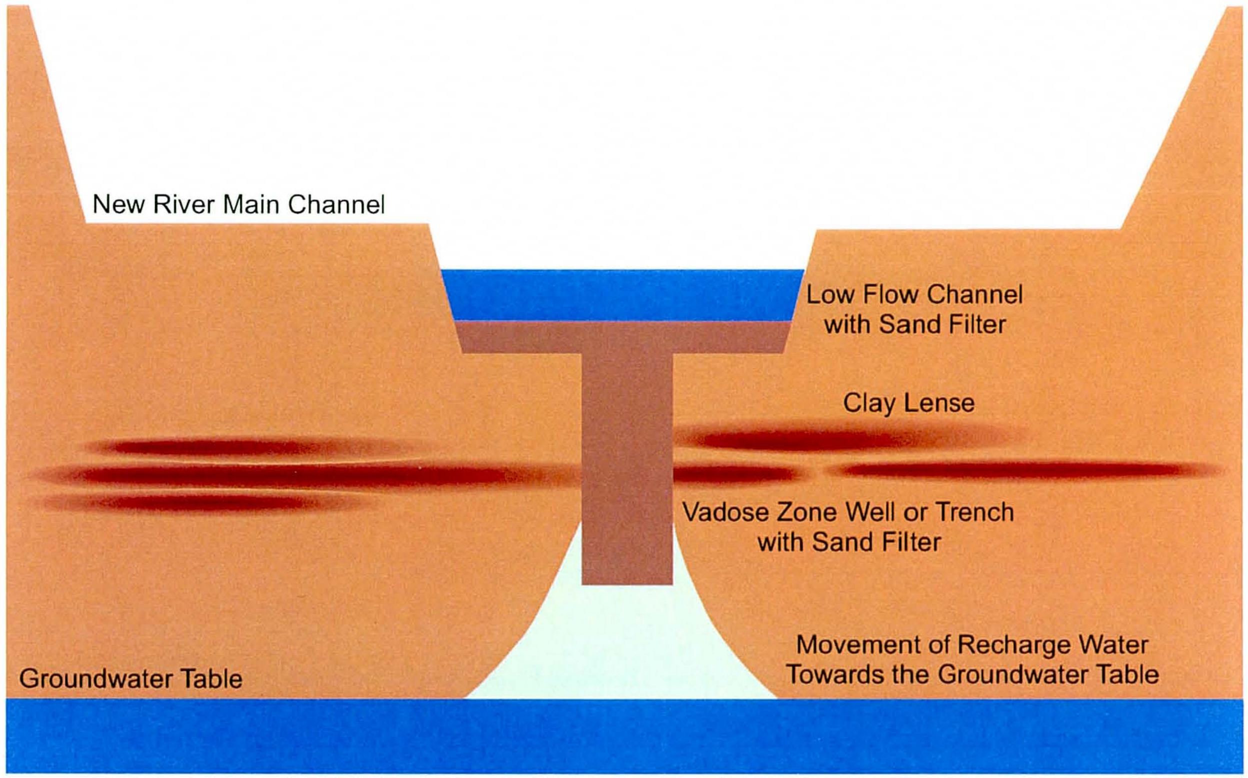


Figure 7-17

Low Flow Channel and Dry Well Cross Section

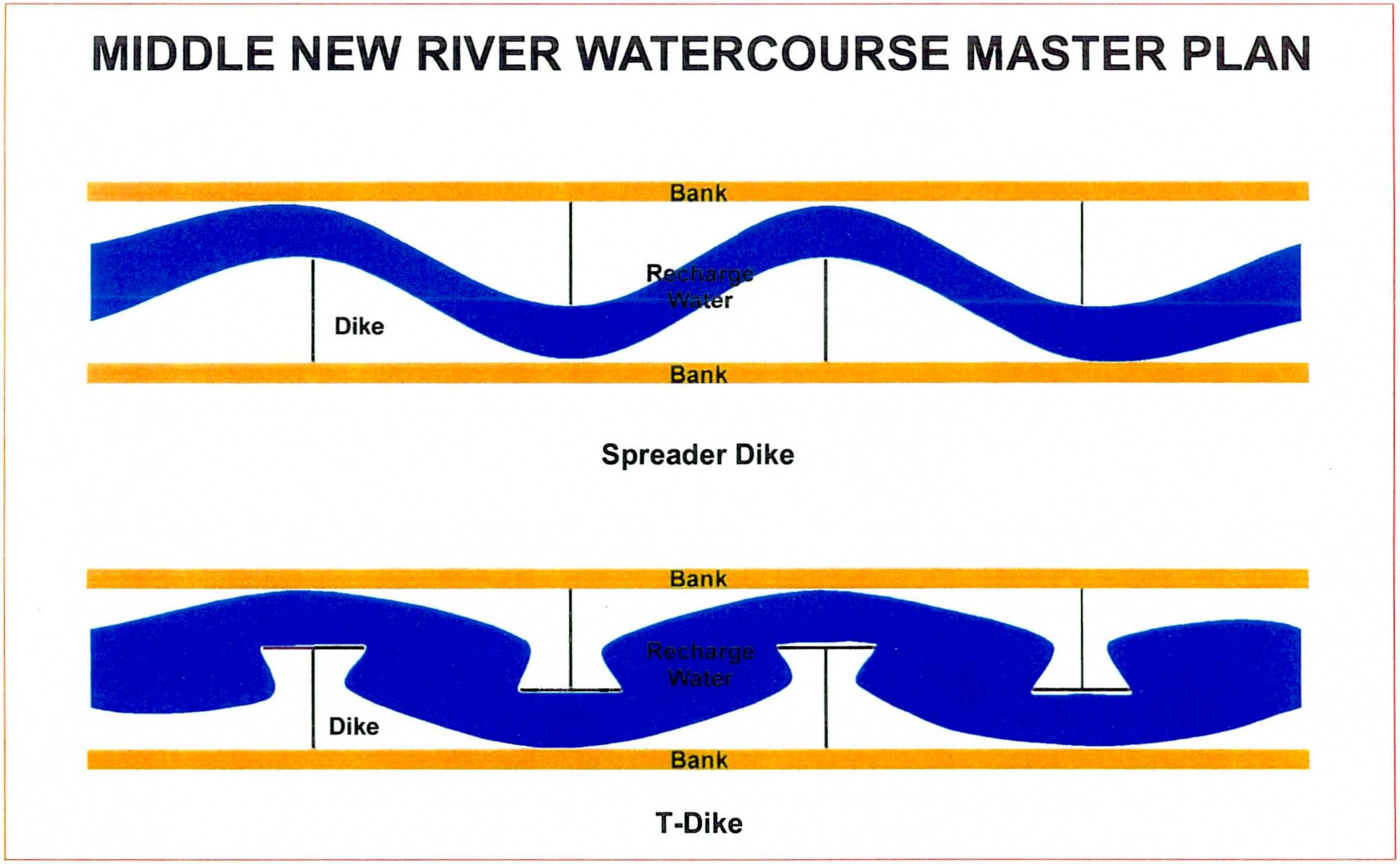


Figure 7-18

Spreader and T-Dike Plan View

SUMMARY AND RECOMMENDATIONS

The objective of the study was to evaluate the potential for groundwater recharge in New River between New River Dam and the confluence with Skunk Creek. The study included a literature search/review, definition of recharge objectives, identification of water supply sources, evaluation of area hydrogeology, and proposed recharge technology.

Based on a literature review and the mounding analysis, the site can be considered as a feasible recharge site on a technical basis. The site has a reasonable recharge rate and no problems with groundwater mounding (see Table 1). Recharging in New River may reduce subsidence and raise the groundwater table in the cone of depression. One drawback is the possibility of DBCP contamination for the southern part of the study area. The downstream portion could be shortened to avoid the contamination.

Prior to considering a full scale recharge project several major activities would have to be implemented. The activities include identification of the stakeholders, water supply availability, and hydrogeology. The cities of Peoria and Glendale, and any other stakeholders involved, would have to decide how to operate the recharge project. The discussions should also include division of any AWBA banking credits.

Detailed information regarding the amount of water available for recharge would have to be gathered, including the distribution of supply water on an annual basis and contingency plans for surplus and drought years. Also, a detailed plan would need to be developed for addressing the means by which the water will be delivered to the recharge site.

Additional information would be required concerning the lithology above and below the groundwater table, infiltration rates, hydraulic conductivity and soil and groundwater quality. This could include drilling soil borings in or near New River, conducting slug and well tests, and submitting soil and water samples for analysis of chemicals of concern. Data from the drilling events would be used to more accurately estimate the hydrologic parameters. Additionally, some of the soil borings could be converted into wells to monitor the impact of the recharge project on the aquifer. The data collected could be used to conduct a pilot recharge project on a selected reach of New River. Prior to conducting a pilot recharge project various permits would have to be obtained from federal, state, and local agencies. These permits include, among others:

- Aquifer recharge and recovery permit from the ADWR,
- 404 permit from the U.S. Army Corps of Engineers,
- Aquifer protection permit from ADEQ, if municipal waste water is used.

Table 7-1

Inflow Rate and Mound Height for Various Infiltration Rates to Skunk Creek Confluence

Width	Inflow Rate and Mound Height for Various Infiltration Rates														
	Va = 2.5 ft/day			Va=2.0 ft/day			Va=1.5 ft/day			Va=1.0 ft/day			Va=0.5 ft/day		
	Inflow		H	Inflow		H	Inflow		H	Inflow		H	Inflow		H
ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft
20	27	19,000	7	21	15,000	6	16	12,000	4	11	8,000	3	5	4,000	1
25	33	24,000	10	27	19,000	8	20	15,000	6	13	10,000	4	7	5,000	2
30	40	29,000	10	32	23,000	8	24	17,000	6	16	12,000	4	8	6,000	2
40	53	39,000	15	43	31,000	12	32	23,000	9	22	16,000	6	11	8,000	3
50	67	48,000	16	53	39,000	13	40	29,000	10	27	19,000	7	14	10,000	3
60	80	58,000	25	64	46,000	20	48	35,000	15	32	23,000	10	16	12,000	5
70	93	68,000	30	75	54,000	24	56	41,000	18	38	27,000	12	19	14,000	6
80	107	77,000	36	85	62,000	29	64	47,000	22	43	31,000	14	22	16,000	7
100	133	97,000	49	107	77,000	40	80	58,000	30	54	39,000	20	27	20,000	10
130	173	126,000	74	139	101,000	59	104	76,000	44	70	51,000	29	36	26,000	15
150	200	145,000	92	160	116,000	73	121	87,000	55	81	58,000	37	41	30,000	18
180	240	174,000	121	192	139,000	97	145	105,000	73	97	70,000	48	49	36,000	24
220	293	212,000	159	235	170,000	127	177	128,000	96	118	86,000	64	60	44,000	32
260	347	251,000	179	278	201,000	143	209	151,000	107	140	101,000	72	71	52,000	36
300	400	290,000	195	321	232,000	156	241	175,000	117	162	117,000	78	82	59,000	39
340	453	328,000	210	363	263,000	168	273	198,000	126	183	133,000	84	93	67,000	42
380	507	367,000	220	406	294,000	176	305	221,000	132	205	148,000	88	104	75,000	44
420				449	325,000	344	337	244,000	258	226	164,000	172	115	83,000	86
460				491	356,000	357	370	268,000	268	248	179,000	179	126	91,000	89
500							402	291,000	280	269	195,000	187	137	99,000	93
540							434	314,000	288	291	211,000	192	148	107,000	96
580							466	337,000	298	312	226,000	199	159	115,000	99
620										334	242,000	289	170	123,000	145
660										355	257,000	297	181	131,000	148
700										377	273,000	281	192	139,000	141
740										399	289,000	308	202	147,000	154
780										420	304,000	314	213	155,000	157
820													224	162,000	203
860													235	170,000	206
900													246	178,000	208
940													257	186,000	210
980													268	194,000	226
1020													279	202,000	257
1060													290	210,000	275
1100													301	218,000	294
1140													312	226,000	313
1180													323	234,000	332

Va = Infiltration Rate
Inflow = Inflow rate in New River from New River Dam to the confluence with Skunk Creek
H = Mound Height cfs = cubic feet per second
ac-ft/yr = acre-feet per year ft/day = feet per day

Table 7-2

Inflow and Recharge Rates for Various Infiltration Rates to Skunk Creek Confluence

	Inflow and Recharge Rate for Various Infiltration Rates									
Width	Va = 2.5 ft/day		Va=2.0 ft/day		Va=1.5 ft/day		Va=1.0 ft/day		Va=0.5 ft/day	
	I	R	I	R	I	R	I	R	I	R
Ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
20	27	26	21	21	16	16	11	11	5	5
25	33	33	27	26	20	20	13	13	7	7
30	40	40	32	32	24	24	16	16	8	8
40	53	53	43	42	32	32	22	21	11	11
50	67	66	53	53	40	40	27	26	14	13
60	80	79	64	64	48	48	32	32	16	16
70	93	93	75	74	56	56	38	37	19	19
80	107	106	85	85	64	64	43	42	22	21
100	133	132	107	106	80	79	54	53	27	26
130	173	172	139	138	104	103	70	69	36	34
150	200	199	160	159	121	119	81	79	41	40
180	240	238	192	191	145	143	97	95	49	48
220	293	291	235	233	177	175	118	117	60	58
260	347	344	278	276	209	207	140	138	71	69
300	400	397	321	318	241	238	162	159	82	79
340	453	450	363	360	273	270	183	180	93	90
380	507	503	406	403	305	302	205	201	104	101
420			449	445	337	334	226	223	115	111
460			491	487	370	366	248	244	126	122
500					402	397	269	265	137	132
540					434	429	291	286	148	143
580					466	461	312	307	159	154
620							334	328	170	164
660							355	350	181	175
700							377	371	192	185
740							399	392	202	196
780							420	413	213	207
820									224	217
860									235	228
900									246	238
940									257	249
980									268	260
1020									279	270

Table 7-2 (cont.)

Inflow and Recharge Rates for Various Infiltration Rates to Skunk Creek Confluence

	Inflow and Recharge Rate for Various Infiltration Rates									
Width	Va = 2.5 ft/day		Va – 2.0 ft/day		Va = 1.5 ft.day		Va = 1.0 ft/day		Va = 0.5 ft/day	
	I	R	I	R	I	R	I	R	I	R
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
1060									290	281
1100									301	291
1140									312	302
1180									232	313

Va = Infiltration Rate
I = Inflow rate in New River from New River Dam to the confluence with Skunk Creek
R = Recharge rate in New River from New River Dam to the confluence with Skunk Creek
cfs = cubic feet per second ft/day = feet per day

Table 7-3

Combination of Infiltration Rate and Width that Results in Maximum Water Table Rise of 30 feet bgs to the Skunk Creek Confluence

Infiltration Rate	Channel Width	Depth to Water	Channel Flow Rate	
ft/day	ft	ft	cfs	ac-ft/yr
2.50	380	175	507	367,000
2.00	460	38	491	356,000
1.50	580	97	466	338,000
1.00	780	81	420	305,000
0.50	1300	95	356	258,000

ft/day = feet per day
cfs = cubic feet per second
ac-ft/yr = acre-feet per year
Channel Flow Rate assumes water will be introduced at New River Dam and zero flow past the confluence with Skunk Creek.

Table 7-4

Radius of Influence for Flows to the Skunk Creek Confluence

	Inflow and Radius of Influence for Various Infiltration Rates									
Width	Va = 2.5 ft/day		Va=2.0 ft/day		Va=1.5 ft/day		Va=1.0 ft/day		Va=0.5 ft/day	
	I	ROI	I	ROI	I	ROI	I	ROI	I	ROI
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
20	27	630	21	605	16	563	11	480	5	230
25	33	699	27	679	20	645	13	579	7	379
30	40	623	32	606	24	578	16	523	8	356
40	53	680	43	668	32	647	22	605	11	480
50	67	617	53	607	40	590	27	557	14	457
60	80	798	64	790	48	776	32	748	16	665
70	93	840	75	833	56	821	38	798	19	726
80	107	878	85	872	64	862	43	841	22	778
100	133	968	107	963	80	955	54	938	27	888
130	173	1117	139	1113	104	1107	70	1094	36	1056
150	200	1211	160	1208	121	1203	81	1191	41	1158
180	240	1334	192	1331	145	1327	97	1317	49	1290
220	293	1440	235	1437	177	1434	118	1426	60	1403
260	347	1368	278	1366	209	1363	140	1357	71	1337
300	400	1295	321	1294	241	1291	162	1285	82	1269
340	453	1229	363	1227	273	1225	183	1220	93	1205
380	507	1154	406	1152	305	1150	205	1146	104	1133
420			449	2042	337	2040	226	2036	115	2024
460			491	1936	370	1934	248	1931	126	1920
500					402	1860	269	1856	137	1846
540					434	1769	291	1766	148	1757
580					466	1706	312	1703	159	1694
620							334	2323	170	2315
660							355	2240	181	2232
700							377	2000	192	1993
740							399	2073	202	2066
780							420	2004	213	1998
820									224	2464
860									235	2385
900									246	2297
940									257	2227
980									268	2298
1020									279	2513

Table 7-4 (cont.)

Radius of Influence for Flows to the Skunk Creek Confluence

Width	In flow and Radius of Influence for Various Infiltration Rates									
	Va = 2.5 ft/day		Va = 2.0 ft/day		Va = 1.5 ft/day		Va = 1.0 ft/day		Va = 0.5 ft/day	
	I	ROI	I	ROI	I	ROI	I	ROI	I	ROI
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
1060									290	2589
1100									301	2664
1140									312	2736
1180									323	2801

Va = Infiltration Rate
I = Inflow rate in New River from New River Dam to the confluence with Skunk Creek
ROI = Radius of Influence
The inflow rate assumes water will be introduced at New River Dam and zero flow past the confluence with Skunk Creek.
cfs = cubic feet per second ft/day = feet per day

Table 7-5

Flow Rate and Mound Height for Various Infiltration Rates Using Effective Transmissivity

Width	Inflow Rate and Mound Height for Various Infiltration Rates														
	Va = 2.5 ft/day			Va=2.0 ft/day			Va=1.5 ft/day			Va=1.0 ft/day			Va=0.5 ft/day		
	Inflow		H	Inflow		H	Inflow		H	Inflow		H	Inflow		H
Ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft
20	27	19,000	16	21	15,000	13	16	12,000	10	11	8,000	7	5	4,000	3
25	33	24,000	23	27	19,000	18	20	15,000	14	13	10,000	9	7	5,000	5
30	40	29,000	28	32	23,000	23	24	17,000	17	16	12,000	11	8	6,000	6
40	53	39,000	42	43	31,000	34	32	23,000	25	22	16,000	17	11	8,000	8
50	67	48,000	58	53	39,000	47	40	29,000	35	27	19,000	23	14	10,000	12
60	80	58,000	77	64	46,000	62	48	35,000	46	32	23,000	31	16	12,000	15
70	93	68,000	98	75	54,000	79	56	41,000	59	38	27,000	39	19	14,000	20
80	107	77,000	120	85	62,000	96	64	47,000	72	43	31,000	48	22	16,000	24
100	133	97,000	169	107	77,000	135	80	58,000	101	54	39,000	68	27	20,000	34
130	173	126,000	251	139	101,000	201	104	76,000	151	70	51,000	100	36	26,000	50
150	200	145,000	310	160	116,000	248	121	87,000	186	81	58,000	124	41	30,000	62
180				192	139,000	321	145	105,000	241	97	70,000	161	49	36,000	80
220							177	128,000	317	118	86,000	211	60	44,000	106
260										140	101,000	263	71	52,000	131
300										162	117,000	313	82	59,000	156
340										183	133,000	364	93	67,000	182
380													104	75,000	206
420													115	83,000	230
460													126	91,000	252
500													137	99,000	274
540													148	107,000	296
580													159	115,000	317
620													170	123,000	338
660													181	131,000	357
700													192	139,000	376
740													202	147,000	394

Va = Infiltration Rate
Inflow = Inflow rate in New River from New River Dam to the confluence with Skunk Creek
H = Mound Height cfs = cubic feet per second
ac-ft/yr = acre-feet per year ft/day = feet per day

Table 7-6

Inflow and Recharge Rates for Various Infiltration Rates Using Effective Transmissivity

	Inflow and Recharge Rate for Various Infiltration Rates									
Width	Va = 2.5 ft/day		Va=2.0 ft/day		Va=1.5 ft/day		Va=1.0 ft/day		Va=0.5 ft/day	
	I	R	I	R	I	R	I	R	I	R
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
20	27	26	21	21	16	16	11	11	5	5
25	33	33	27	26	20	20	13	13	7	7
30	40	40	32	32	24	24	16	16	8	8
40	53	53	43	42	32	32	22	21	11	11
50	67	66	53	53	40	40	27	26	14	13
60	80	79	64	64	48	48	32	32	16	16
70	93	93	75	74	56	56	38	37	19	19
80	107	106	85	85	64	64	43	42	22	21
100	133	132	107	106	80	79	54	53	27	26
130	173	172	139	138	104	103	70	69	36	34
150	200	199	160	159	121	119	81	79	41	40
180			192	191	145	143	97	95	49	48
220					177	175	118	117	60	58
260							140	138	71	69
300							162	159	82	79
340							183	180	93	90
380									104	101
420									115	111
460									126	122
500									137	132
540									148	143
580									159	154
620									170	164
660									181	175
700									192	185
740									202	196

Va = Infiltration Rate
I = Inflow rate in New River from New River Dam to the confluence with Skunk Creek
R = Recharge rate in New River from New River Dam to the confluence with Skunk Creek
cfs = cubic feet per second ft/day = feet per day

Table 7-7

Combination of Infiltration Rate and Width that Results in Maximum Water Table Rise of 30 feet bgs Using Effective Transmissivity

Infiltration Rate	Channel Width	Depth to Water	Channel Flow Rate	
ft/day	ft	Ft	cfs	ac-ft/yr
2.50	150	85	200	145,000
2.00	180	74	192	139,000
1.50	220	78	177	128,000
1.00	340	31	183	133,000
0.50	740	30	202	147,000

ft/day = feet per day
cfs = cubic feet per second
ac-ft/yr = acre-feet per year
Channel Flow Rate assumes water will be introduced at New Rivêr Dam and zero flow past the confluence with Skunk Creek.

Table 7-8

Radius of Influence for Flows Using Effective Transmissivity

	Inflow and Radius of Influence for Various Infiltration Rates									
Width	Va = 2.5 ft/day		Va=2.0 ft/day		Va=1.5 ft/day		Va=1.0 ft/day		Va=0.5 ft/day	
	I	ROI	I	ROI	I	ROI	I	ROI	I	ROI
ft	cfs	cfs	cfs	cfs	Cfs	cfs	cfs	cfs	cfs	cfs
20	27	310	21	305	16	297	11	280	5	230
25	33	347	27	343	20	336	13	323	7	283
30	40	367	32	363	24	358	16	347	8	313
40	53	414	43	412	32	408	22	399	11	374
50	67	458	53	456	40	452	27	446	14	426
60	80	510	64	508	48	505	32	500	16	483
70	93	556	75	554	56	552	38	547	19	533
80	107	596	85	595	64	593	43	589	22	576
100	133	672	107	671	80	670	54	666	27	656
130	173	770	139	769	104	768	70	765	36	758
150	200	823	160	822	121	821	81	819	41	812
180			192	889	145	889	97	887	49	881
220					177	957	118	956	60	951
260							140	1007	71	1003
300							162	1040	82	1036
340							183	1067	93	1064
380									104	1078
420									115	1089
460									126	1093
500									137	1091
540									148	1091
580									159	1089
620									170	1086
660									181	1078
700									192	1070
740									202	1063

Va = Infiltration Rate
I = Inflow rate in New River from New River Dam to the confluence with Skunk Creek
ROI = Radius of Influence
The inflow rate assumes water will be introduced at New River Dam and zero flow past the confluence with Skunk Creek.
cfs = cubic feet per second ft/day = feet per day

Table 7-9

Inflow Rate and Mound Height for Various Infiltration Rates to the Aqua Fria Confluence

Width	Inflow Rate and Mound Height for Various Infiltration Rates														
	Va = 2.5 ft/day			Va=2.0 ft/day			Va=1.5 ft/day			Va=1.0 ft/day			Va=0.5 ft/day		
	Inflow		H	Inflow		H	Inflow		H	Inflow		H	Inflow		H
ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft	cfs	ac-ft/yr	ft
20	52	38,000	7	42	30,000	6	31	23,000	4	21	15,000	3	11	8,000	1
25	65	47,000	10	52	38,000	8	39	28,000	6	26	19,000	4	13	10,000	2
30	78	56,000	10	62	45,000	8	47	34,000	6	31	23,000	4	16	12,000	2
40	104	75,000	15	83	60,000	12	63	45,000	9	42	30,000	6	21	15,000	3
50	130	94,000	16	104	75,000	13	78	57,000	10	52	38,000	7	27	19,000	3
60	156	113,000	25	125	90,000	20	94	68,000	15	63	46,000	10	32	23,000	5
70	182	132,000	30	146	105,000	24	109	79,000	18	73	53,000	12	37	27,000	6
80	208	150,000	36	166	120,000	29	125	91,000	22	84	61,000	14	43	31,000	7
100	259	188,000	49	208	151,000	40	156	113,000	30	105	76,000	20	53	39,000	10
130	337	244,000	74	270	196,000	59	203	147,000	44	136	99,000	29	69	50,000	15
150	389	282,000	92	312	226,000	73	235	170,000	55	157	114,000	37	80	58,000	18
180	467	338,000	121	374	271,000	97	281	204,000	73	189	137,000	48	96	69,000	24
220	571	413,000	159	457	331,000	127	344	249,000	96	231	167,000	64	117	85,000	32
260	675	488,000	179	540	391,000	143	406	294,000	107	272	197,000	72	138	100,000	36
300	778	564,000	195	624	452,000	156	469	340,000	117	314	228,000	78	160	116,000	39
340	882	639,000	210	707	512,000	168	532	385,000	126	356	258,000	84	181	131,000	42
380	986	714,000	220	790	572,000	176	594	430,000	132	398	288,000	88	202	147,000	44
420				873	632,000	344	657	475,000	258	440	319,000	172	224	162,000	86
460				956	692,000	357	719	521,000	268	482	349,000	179	245	177,000	89
500							782	566,000	280	524	379,000	187	266	193,000	93
540							844	611,000	288	566	410,000	192	288	208,000	96
580							907	657,000	298	608	440,000	199	309	224,000	99
620										650	470,000	289	330	239,000	145
660										692	501,000	297	351	254,000	148
700										734	531,000	281	373	270,000	141
740										775	562,000	308	394	285,000	154
780										817	592,000	314	415	301,000	157
820													437	316,000	203
860													458	332,000	206
900													479	347,000	208
940													500	362,000	210
980													522	378,000	226
1020													543	393,000	257
1060													564	409,000	275
1100													586	424,000	294
1140													607	440,000	313
1180													628	455,000	332

Va = Infiltration Rate
Inflow = Inflow rate in New River from New River Dam to the confluence with Aqua Fria River
H = Mound Height cfs = cubic feet per second
ac-ft/yr = acre-feet per year ft/day = feet per day

Table 7-10

Inflow and Recharge Rates for Various Infiltration Rates to the Aqua Fria Confluence

	Inflow and Recharge Rate for Various Infiltration Rates									
Width	Va = 2.5 ft/day		Va=2.0 ft/day		Va=1.5 ft/day		Va=1.0 ft/day		Va=0.5 ft/day	
	I	R	I	R	I	R	I	R	I	R
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
20	52	52	42	41	31	31	21	21	11	10
25	65	64	52	52	39	39	26	26	13	13
30	78	77	62	62	47	46	31	31	16	15
40	104	103	83	82	63	62	42	41	21	21
50	130	129	104	103	78	77	52	52	27	26
60	156	155	125	124	94	93	63	62	32	31
70	182	180	146	144	109	108	73	72	37	36
80	208	206	166	165	125	124	84	82	43	41
100	259	258	208	206	156	155	105	103	53	52
130	337	335	270	268	203	201	136	134	69	67
150	389	387	312	309	235	232	157	155	80	77
180	467	464	374	371	281	278	189	186	96	93
220	571	567	457	454	344	340	231	227	117	113
260	675	670	540	536	406	402	272	268	138	134
300	778	773	624	619	469	464	314	309	160	155
340	882	876	707	701	532	526	356	351	181	175
380	986	979	790	784	594	588	398	392	202	196
420			873	866	657	649	440	433	224	216
460			956	948	719	711	482	474	245	237
500					782	773	524	515	266	258
540					844	835	566	557	288	278
580					907	897	608	598	309	299
620							650	639	330	320
660							692	680	351	340
700							734	722	373	361
740							775	763	394	381
780							817	804	415	402
820									437	423
860									458	443
900									479	464
940									500	485
980									522	505
1020									543	526

Table 10 (cont)

Inflow and Recharge Rates for Various Infiltration Rates to the Agua Fria Confluence

Width	Inflow and Recharge Rate for Various Infiltration Rates									
	Va = 2.5 ft/day		Va = 2.0 ft/day		Va=1.5 ft/day		Va = 1.0 ft/day		Va = 0.5 ft/day	
	I	R	I	R	I	R	I	R	I	RFT
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
1060									564	546
1100									586	567
1140									607	588
1180									628	608

Va = Infiltration Rate
I = Inflow rate in New River from New River Dam to the confluence with Aqua Fria River
R = Recharge rate in New River from New River Dam to the confluence with Aqua Fria River
cfs = cubic feet per second ft/day = feet per day

Table 7-11

Combination of Infiltration Rate and Width that Results in Maximum Water Table Rise of 30 feet bgs to the Aqua Fria Confluence

Infiltration Rate	Channel Width	Depth to Water	Channel Flow Rate	
ft/day	ft	ft	cfs	ac-ft/yr
2.50	380	175	986	715,000
2.00	460	38	956	694,000
1.50	580	97	907	658,000
1.00	780	81	817	593,000
0.50	1300	95	692	502,000

ft/day = feet per day
cfs = cubic feet per second
ac-ft/yr = acre-feet per year
Channel Flow Rate assumes water will be introduced at New River Dam and zero flow past the confluence with Aqua Fria River.

Table 7-12

Radius of Influence for Flows to the Aqua Fria Confluence

Width	Inflow and Radius of Influence for Various Infiltration Rates									
	Va = 2.5 ft/day		Va=2.0 ft/day		Va=1.5 ft/day		Va=1.0 ft/day		Va=0.5 ft/day	
	I	ROI	I	ROI	I	ROI	I	ROI	I	ROI
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
20	52	630	42	605	31	563	21	480	11	230
25	65	699	52	679	39	645	26	579	13	379
30	78	623	62	606	47	578	31	523	16	356
40	104	680	83	668	63	647	42	605	21	480
50	130	617	104	607	78	590	52	557	27	457
60	156	798	125	790	94	776	63	748	32	665
70	182	840	146	833	109	821	73	798	37	726
80	208	878	166	872	125	862	84	841	43	778
100	259	968	208	963	156	955	105	938	53	888
130	337	1117	270	1113	203	1107	136	1094	69	1056
150	389	1211	312	1208	235	1203	157	1191	80	1158
180	467	1334	374	1331	281	1327	189	1317	96	1290
220	571	1440	457	1437	344	1434	231	1426	117	1403
260	675	1368	540	1366	406	1363	272	1357	138	1337
300	778	1295	624	1294	469	1291	314	1285	160	1269
340	882	1229	707	1227	532	1225	356	1220	181	1205
380	986	1154	790	1152	594	1150	398	1146	202	1133
420			873	2042	657	2040	440	2036	224	2024
460			956	1936	719	1934	482	1931	245	1920
500					782	1860	524	1856	266	1846
540					844	1769	566	1766	288	1757
580					907	1706	608	1703	309	1694
620							650	2323	330	2315
660							692	2240	351	2232
700							734	2000	373	1993
740							775	2073	394	2066
780							817	2004	415	1998
820									437	2464
860									458	2385
900									479	2297
940									500	2227
980									522	2298
1020									543	2513

<u>**Table 12 (cont)**</u>

Radius of Influence for Flows to the Aqua Fria Confluence

	Inflow and Radius of Influence to th Aqua Fria Confluence									
Width	Va = 2.5 ft/day		Va = 2.0 ft/day		Va = 1.5 ft/day		Va = 1.0 ft/day		Va = 0.5 ft/day	
	I	ROI	I	ROI	I	ROI	I	ROI	I	ROI
ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
1060									564	2589
1100									586	2664
1140									607	2736
1180									628	2801

Va = Infiltration Rate
I = Inflow rate in New River from New River Dam to the confluence with Aqua Fria River
ROI = Radius of Influence
The inflow rate assumes water will be introduced at New River Dam and zero flow past the confluence with Aqua Fria River.
cfs = cubic feet per second ft/day = feet per day

8.0 HAZMAT DATABASE REVIEW

GENERAL

Stantec coordinated data collected by EcoSearch Environmental Resources, Inc. (EER) to identify Hazardous Materials (HAZMAT) within the Middle New River Watercourse Master Plan study area. The data collection efforts included a review of Federal and State maintained environmental databases which contain records of sites and activities of environmental interest or concern within or adjacent to the project area. The Hazmat Database Review was completed in May 1998.

HAZMAT DATABASE REVIEW

The Federal databases that were reviewed for listings concerning the subject site, adjoining sites, and sites within ASTM-prescribed search radii included the National Priority List (NPL); Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS); Resource Conservation and Recovery Information System – Treatment, Storage, and Disposal Facilities (RCRIS - TSD); Resource Conservation and Recovery Information System – Large and Small Quantity Generators (RCRIS - Generator); RCRA Administrative Action Tracking System (RAATS); Emergency Response Notification System (ERNS); PCB Activity Database System (PADS); Toxic Release Inventory (TRI); Section Seven Tracking System (SSTS); Civil Enforcement Docket (Docket); and Toxic Substances Control Act Inventory (TSCA). There were no NPL, RCRA TSD, PADS, SSTS, Docket, or TSCA sites located within the ASTM search radius (1 mile) of the subject site. There are no TRI sites located within the ASTM search radius (0.5 mile) of the subject site.

The subject site is listed on the CERCLIS database. The listing is for the National Metals/Schultz Dump Site (75th Avenue and Deer Valley Road). Discovery of the Schultz Dump Site was reported in November 1992. Site screening inspection was completed in September 1994. There is no record of remedial action at the subject site. The site has been de-listed from CERCLIS and no further remedial action is planned for the site. There are no other CERCLA sites located within the ASTM search radius (1 mile) of the subject site.

There are four RCRA sites listed within the ASTM search radius (0.25 mile) of the subject site. Three of the four listings are within the subject site. Two of the listings within the subject site are RCRA Small Quantity Generators with no records of evaluations, violations, or enforcement actions. The third RCRA site is listed as a RCRA Notifier (a former RCRA site) and it is the Schultz Auto Shredder Dump (75th Avenue and Deer Valley Road) which was also listed as a CERCLA site. This site was evaluated in July 1990. A written informal enforcement action was issued in August 1990. The violations associated with the site were resolved in November 1993. There are no outstanding RCRA issues associated with this site. The fourth RCRA site, located 0.16 mile from the subject site, is also a RCRA Small Quantity Generator with no record of evaluation, violation, or enforcement action.

Environmental databases maintained by the State of Arizona which were reviewed for listings of the subject site, adjoining sites, or sites located within the ASTM-prescribed search radii were the Arizona Water Quality Assurance Revolving Fund Site List (WQARF); Arizona CERCLA Information and Data System List (ACIDS); Arizona Solid Waste Facilities List (SWF); Arizona Leaking Underground Storage Tank List (LUST); and Arizona Underground Storage Tank List (UST). There are no SWF sites listed within the ASTM search radius (1 mile) of the subject site.

The subject site is listed as a WQARF site. The listing is for the Schultz Fluff Dump site (75th Avenue and Deer Valley Road) which was also listed on the CERCLIS and RCRA federal databases searched. No additional information is provided for this site. No other WQARF sites are listed within the ASTM search radius (1 mile) of the subject site.

There are two ACIDS sites listed within the ASTM search radius (1 mile) of the subject site. One of these sites is the subject site and it is the Schultz Fluff Dump site (75th Avenue and Deer Valley Road) previously listed on the CERCLIS, RCRA, and WQARF site databases. The listing for this site contains no additional information. The second ACIDS site listed within the ASTM search radius is the Luke Air Force Base ILS (Instrument Landing System) Outer Marker Annex located 0.74 mile from the subject site at 91st Avenue and Bell Road. There is no indication that the Luke ILS site has had any impact on the subject site.

There are no registered UST sites within the subject site area. There are three UST sites within the ASTM search radius (0.25 mile) of the subject site. The UST site closest to the subject site is listed as Fletcher Farms, 79th Avenue and Deer Valley Road, at a distance of 0.16 mile from the subject site. The Fletcher Farms site contains no active tanks. All tanks have been removed from the site. There is no indication of any leaks or spills at the Fletcher Farms site.

The Southwest Savings Association UST site (8700 W. Bell Road), also listed as a LUST site, is located at a distance of 0.25 mile from the subject. This site no longer contains active tanks, all tanks were removed. The LUST file associated with this site was closed in October 1993. There is no indication that the subject site has been affected by the Southwest Savings Association UST site. There is one active UST site located within 0.25 mile of the subject site. It is Mobil Oil #18-AGN located at 8702 W. Bell Road. This site contains four active underground storage tanks. There is no record of leaks or spills at Mobil Oil #18-AGN which may have had an impact on the subject site.

RECOMMENDATIONS

It is recommended that ADEQ be contacted with regard to the Schultz Fluff Dump site. It should be ascertained that this listing does correspond to a single site. Further, the ADEQ files for this site should be reviewed to determine the horizontal and vertical extent of soil and groundwater contamination, if any, associated with and emanating from it. Existing and potential monitor well sites should be identified and located in order to assure that any planned construction within the subject site area does not destroy or interfere with on-going soil or groundwater monitoring or remediation. No soil or groundwater testing is recommended at this time. It does not appear that the subject site has been impacted by activities which occur or have occurred at any of the other sites identified by the federal and state environmental database searches.

9.0 CULTURAL RESOURCES OVERVIEW

GENERAL

Stantec conducted a cultural resource literature overview of the Middle New River Watercourse Master Plan study area from above the confluence of the Skunk Creek, north to the New River Dam. The Cultural Resources Overview was completed in June 1998. A thorough search of site and project files was completed at the State Historic Preservation Office (SHPO), the Arizona State Museum (ASM), the Arizona State University Cultural Resources Department (ASU), the Hayden Archives of the Arizona State University Library System (Hayden), the Arizona Department of Transportation (ADOT), and the Bureau of Land Management (BLM), as well as through consultation with several private libraries and sources, and *via* personal interviews. The primary purpose of this inquiry was to document previous archaeological research and identify cultural resources within the potential area of impact of the proposed activities.

A cultural resource overview is generally considered the vehicle to synthesize the knowledge of the cultural resources of a study area on the basis of existing data. Overviews are assembled for a bipartite purpose, reflective of both the need to inform the public, and the desire to engage the specialist in rigorous examination. The first task of this overview is to communicate to the non-cultural resource specialist, especially the land manager and regional planner, all they may need to know about the cultural resources of the area in question. This information they will use in management decisions regarding the development of the region. The second task of this overview is to present an in-depth summary of the status of current research in the area, with the goal of: 1) outlining the traditional major research questions; 2) exploring areas of specific interest and basic research goals; and 3) to highlight directions and suggest additional hypotheses or lines of investigations.

PREVIOUSLY LOCATED CULTURAL RESOURCES.

An initial review of the cultural resources of the project area can be made based upon those resources previously located. While this overview is certainly tentative, it may offer some guidelines as to future application of effort. This summary includes data from site files at SHPO, ASM, ASU, BLM, ADOT, and many additional private and public sources listed in the references consulted section.

EVIDENCE OF HISTORIC OCCUPATION

Anglo-American occupation of the project area was limited and generally recent in origin. The Rio Verde Canal Company included the area of the present New River Dam as a potential location of one of the reservoirs in its planned 140 mile long canal system for water diversion from the Verde River in 1899, but the project was never implemented (Jensen *et al.* 1996). This "New River Reservoir" was to impound water from the New River, and augment the Rio Verde canal system, irrigating lands between the Agua Fria and Hassayampa Rivers (Jensen *et al.* 1996). Similar plans were made by the Paradise-Verde Water Users Association in 1914, and later by the Paradise-Verde Irrigation District in 1918, but neither came to fruition (Karie 1973).

A wagon road, created as early as 1892, followed the course of the New River. This road was called the Frog Tanks to Phoenix Road, connecting the towns of Glendale with the small community of Frog Tanks in the vicinity of the present Lake Pleasant Dam (Granger 1960). Along this road stood the Verde Canal Company House, near the dam site known as the King's Dam site. The Verde Canal Company House was likely occupied during testing and drilling by the company at the turn of the century (Ciolek-Torello 1981). The land generally saw use as grazing after the State acquired the land from the Federal government throughout the 1930s, especially through large lease holdings by Bard's Cattle Company (Ciolek-Torello 1981).

Additional occupation of the project area may have included squatters, and in 1940, Midvale observed the tent camp, Donahue's Camp, along the eastern bank of the New River, eventually being abandoned by the late 1940s (Midvale n.d.). While mining was not a significant activity in the project area, the Sunrise-Relief Mine was noted by Midvale in the 1960s, and he reported it as an abandoned gold mine from the early part of the century (Midvale n.d.). During the 1930s and 1940s, winter resorts sprung up throughout the Paradise Valley area, and with the help of deep drilled groundwater wells, the cities of Glendale and Peoria grew rapidly.

The majority of historic cultural resources previously located within the project area were primarily what appeared to be expedient historic trash dumps [*e.g.*, AZ T:8:10 (ASM); AZ T:8:29 (ASM); AZ T:8:52 (ASM); and AZ T:8:17 (ASU)]. One of the historic sites, AZ T:8:10 (ASM), also included a linear alignment of rocks along its western edge, and rather distinctive historic ceramics, including American Bristol Ware and Tudor Rose China, suggestive of a domestic arrangement. Two sites [AZ T:8:52 (ASM) and AZ T:8:17 (ASU)], contained historic canal remnants associated with historic artifacts. Only one site [AZ T:8:69 (ASM)], contained evidence of a historic occupation, which included several L-shaped cement slabs, apparently building foundations, as well as several pits, unidentified mounds, and a staircase descending into one of the pits.

Recommendations

Any portion of the project area which will be impacted should be surveyed before a complete evaluation of the proposed projects' impact on historic cultural resources can be made. Only the most northern portion of the project area has been surveyed for historic resources, and, based upon the data available, few significant historic cultural resources appear to be within the project area. Those historic resources which may require additional research include: the Verde Canal Company House; the Donahue Camp; the Sunrise-Relief Mine; and the Frog Tanks to Phoenix Road.

EVIDENCE OF PREHISTORIC OCCUPATION

Highly detailed descriptions of the prehistoric and historic cultural history of the project area region can be found in excellent works by Ciolek-Torello (1981, 1982), Dittert (1976), Doyel and Elson (1985), and Weaver (1974). The earliest known occupation of the project area region appears to date to Archaic times. While it is likely that a Paleoindian occupation of the area occurred, no direct evidence of humans in association with evidence of this earlier time period has yet to be confirmed. Archaic hunter-gather groups are known to have utilized the New River area, and Archaic sites such as AZ T:8:22 (ASU) have been confirmed within the project area. While such sites have been identified within the region, detailed evidence of occupations before A.D. 300 is tentative (McQuestion and Gibson 1987).

Permanent occupations were firmly established in the New River region by the Hohokam Colonial period (A.D. 600), and by A.D. 900, the Hohokam had expanded well into the northern periphery of the Gila-Salt River Basin. The major village site of Palo Verde [AZ T:8:1 (ASU)], is comprised of multiple structures, including pithouses, large tracts of apparently cleared agricultural fields, ceramics, lithics, groundstone, exotic materials, ball courts, and even petroglyphs. Regional endeavors probably centered around sites such as this, and activities such as local resource procurement and regional resource redistribution, agriculture, and groundstone manufacture certainly took place at such a location (McQuestion and Gibson 1987).

The close of the Twelfth century, also the end of the Sedentary Period, evidenced a reduction in population density in the northern periphery of the Hohokam. Smaller sized settlements persisted through the Classic period (A.D. 1050-1350), but have been observed primarily along the Agua Fria drainage, with little along the New River. The close of the Hohokam cultural tradition was evident throughout the Salt-Gila River Valley by the middle of the Fifteenth century (McQuestion and Gibson 1987).

The Post-Classic Hohokam (A.D. 1350-1450), especially the temporal phase called Polvorón, has been characterized by reduced population, sociopolitical breakdown, diversification of subsistence patterning, evolving technological standards, and abandonment of the complex irrigation systems associated with the Classic Hohokam. Theories to explain this societal evolution include the breakdown of trade networks and new alliance formations beyond the earlier Hohokam sphere of influence. An additional if not primary factor may be shifting macro-environmental conditions, and the alteration of cultural characters that would follow such environmental change (Larkin and Giacobbe 1998). The activities of this time played a crucial role in determining the future of both the project area and the region itself, and an understanding of the events leading up to and following the collapse of the Hohokam are still being explained.

The New River appears to have been virtually abandoned until Euro-American incursions and eventual settlement of the late 1800s. More transient groups such as the Yavapai are known to have utilized the region from the eighteenth century, and appear to have been at least occasional occupants much earlier (Aguila *et al.* 1998). The founding of Phoenix in 1870 signaled both the return of permanent occupation and, eventually, the return of irrigated agriculture to the area (McQuestion and Gibson 1987).

Recommendations

Any portion of the project area which would be impacted should be surveyed before a complete evaluation of the projects' impact on prehistoric cultural resources can be made. While portions of the northern portion of the project area have been surveyed, most of these surveys were completed fifteen or more years ago. Research perspectives, survey techniques, artifact analysis, dating methods, and even locational techniques have greatly improved since these surveys were completed. In addition, the New River Drainage area has undergone dynamic alterations to its' *in situ* nature as the result of flooding, development, and human occupation, and the disposition of cultural resources has not remained consistent over time (Ciolek-Torello 1981, 1982; Doyel and Elson 1985).

The basic goals of the prehistoric research include a complete description of the extant prehistoric cultural resources to be impacted by the project. This description would include: the location and surface area of any cultural resource loci; the determination of the chronological and cultural affiliation of the observed remains; a systematic sampled analysis of the material culture; an assessment of site function and distribution; and an inter- and intra-site spatial analysis of site location. As a corollary to the data accumulation, the model generation and testing process will proceed from this basic research.

Other goals of the prehistoric research concern providing the fundamental and pragmatic management data needs of the various agencies involved in this project. This would include the assembly of maps and locational data designating cleared areas not presenting significant impact to cultural resources. For those areas that do contain cultural resources, significance assessments will be made, and testing and data recovery recommendations will be presented if necessary, and from this, management agency consultation will be enacted.

CULTURAL RESOURCE MANAGEMENT SUMMARY

The cultural resources overview provides a basic evaluation of the known cultural resources of the project area, and offers research and management goals based upon the expected impact of the proposed project and the resource character of the region. They are based upon the basic three phase system of cultural resource assessment, and include survey, testing, and data recovery if necessary. These goals can be summarized as follows:

1) All portions of the project area which will be impacted must undergo a pedestrian cultural resources survey. As the area is not substantial, a survey providing 100% coverage should be accomplished.

2) Upon analysis of the results of the survey, an assessment can be made as to the potential impacts of the proposed projects' activities on the currently viable cultural resources.

3) Areas of significant impact can be delineated, and consultation with project engineers made to evaluate the potential for resource avoidance.

4) If avoidance is not possible, plans can be developed to mitigate the impact on cultural resources, which may include testing and data recovery efforts.

5) Preliminary cultural resource model development may be selected as an option to aid in future management decisions regarding the New River area.

10. BIOLOGICAL RESOURCES OVERVIEW

GENERAL

Stantec contracted with Johnson & Associates, EEI, Inc., (J&A) to conduct a biological resources overview of a that portion of the Middle New River Drainage from above the confluence of the Skunk Creek, north to the New River Dam. Biological Resources Overview was completed in February 1999. A report was prepared by Johnson (1999) which provided a biological description of the project area an identification of potential sensitive species, and an evaluation of the likelihood that sensitive species would be impacted by the proposed projects activities.

BIOLOGICAL RESOURCES OVERVIEW

The report reviewed the common species and microenvironments of the project area and assesses potential habitats for sensitive species. The report states that there are six species that might possibly inhabit the proposed project area including: the Southwestern Willow Flycatcher (*Empidonax traillii extimus*); the Yuma Clapper Rail (*Rallus longirostris yumanensis*); the Cactus Ferruginous Pygmy Owl (*Glaucidium brasilianum cactorum*); the American Peregrine Falcon (*Falco peregrinus anatum*); the Bald Eagle (*Haliaeetus leucocephalus*); and the Lesser Long-Nose Bat (*Leptonycteris curasoae yerbabuenae*).

J&A considered that, as Southwestern Willow Flycatchers are migrant summer breeders, it was highly doubtful that these species would occur in or adjacent to the Middle New River as both live water and dense riparian vegetation are lacking. The Yuma Clapper Rails are extremely sensitive species and restricted to large marshes in extensive stands of emergent vegetation such as cattail and bulrush. As live water, marshes, and emergent vegetation are lacking in the project area, habitat to support this species is lacking and the species has not been recorded in the area.

The American Peregrine Falcon is a rare and irregular transient, winter resident species, and the few sightings of these species in the project area region consist of foraging individuals. No aeries or suitable aerie habitat for this species occurs near the project area. Bald Eagles occur as uncommon winter transient species along rivers and lakesides in central and southern Arizona, and most sightings of this species in the project area region are of single immature individuals. No live water or potential roost sites occur in or near the Middle New River.

Lesser Long-Nosed Bats are a summer resident species that feed primarily on nectar from saguaros and agaves, and roost sites are in mine tunnels and caves. The project area is within the northern range limit of this species, however, there is a general lack of roost sites and food sources in and adjacent to the project area. The only food plants in the project area consist of a few saguaros in areas just downstream of the New River Dam. Overall, the project are provides unsuitable habitats for the Lesser Long-Nosed Bat, and it is highly doubtful that this species occurs in the Middle New River except as sporadic transients.

Cactus Ferruginous Pygmy Owls are a resident species that occur primarily in riparian cottonwood forests and mesquite bosques of central and southern Arizona. This species also occurs in Sonoran desertscrub habitats where the vegetation is particularly dense and supports saguaro or mesquite of sufficient sizes to provide a dense nesting cavity and a high density understory. Suitable habitats within the project area include small remnant patches of terrace strand vegetation along the Middle New River , especially localized areas near the New River Dam, though at very small patches and at low densities. Overall, it is highly doubtful that pygmy-owls occur in or near the proposed project area.

Recommendations

Threatened and endangered species are absent from the general project area, such that implementation of a Middle New River Watercourse Master Plan will not directly or indirectly impact any individuals of threatened or endangered species. Consequently, further in-depth biological investigations of the area are not recommended. However, it is appropriate to send copies of the biological resource report and the accompanying habitat photographs to the U.S. Fish and Wildlife Service and the Arizona Department of Game and Fish for concurrence that this area does not provide suitable habitat for Cactus Ferruginous Pygmy Owls.