RAINBOW VALLEY

Area Drainage Master Plan

Contract FCD 2006C029

Recommended Plan Report

Submitted to

Flood Control District of Maricopa County

Submitted by

URS

in cooperation with

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

RBF CONSULTING

epg

Terracon

Dibble Engineering

June 2011 – Revised August 2011

Recommended Plan Report

for the

Rainbow Valley Area Drainage Master Plan
Maricopa County, Arizona

Prepared for the
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

Prepared by
URS Corporation
7720 North 16th Street, Suite 100
Phoenix, Arizona 85020

and

JE Fuller/Hydrology and Geomorphology, Inc.
EPG, Inc.
Dibble Engineering
RBF

June 2011
Revised August 2011

URS

Registered Professional Engineer (Civil)
CERTIFICATE NO. 33656
ELLIOT SILVERSTON
Date Signed 8-29-11
ARIZONA, U.S.A.

Exp Date 6-30-14

Rainbow Valley Area Drainage Master Plan
Recommended Plan Report

Registered Professional Engineer (Civil)
CERTIFICATE NO.
33656
ELLIOT
SILVERSTON
Date Signed 8-29-11
ARIZONA, U.S.A.

Exp Date: 6-30-14

Elliot Silverston is the Consultant Team Project Manager and oversaw preparation of the Rainbow Valley Area Drainage Master Plan reports.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
21684
BRIAN J.
FRY
Date Signed 8.29.11
ARIZONA, U.S.A.

Expires: 12-31-11

Brian Fry is the Task Lead for the planning task and was responsible for alternatives formulation and analysis leading to the selection and development of the recommended plan and the organization and editing of the Rainbow Valley Area Drainage Master Plan reports.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
37872
M. C. F.
McINTOSH
Date Signed 8.29.11
ARIZONA, U.S.A.

EXPIRES 9.30.2011

Marc McIntosh is the Task Lead for the hydrology, hydraulic, sediment yield, and transportation components of the Rainbow Valley Area Drainage Master Plan reports in support of the alternatives analysis and recommended plan.

REGISTERED LANDSCAPE ARCHITECT
CERTIFICATE NO.
50055
JOHN J.
GRIFFIN
Date Signed 8.29.11
ARIZONA, U.S.A.

EXPIRES 9.30.2012

John Griffin is the Task Lead responsible for the landscape architecture. This seal applies to the Rainbow Valley Area Drainage Master Plan reports sections pertinent to landscape architecture.

TABLE OF CONTENTS

Registered Professional Engineer (Civil) CERTIFICATE NO. 33656 ELLIOT SILVERSTON Date Signed 8-29-11 ARIZONA, U.S.A.

Exp Date: 6-30-14

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ADMP	Area Drainage Master Plan
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
ASLD	Arizona State Land Department
BLM	U.S. Bureau of Land Management
cfs	cubic feet per second
Corridor Study	Waterman Wash Conceptual Corridor Study
CSFHM	Context Sensitive Flood Hazard Mitigation
CSFHMPDM	Context Sensitive Flood Hazard Mitigation Planning and Design Model
District	Flood Control District of Maricopa County
EHZ	Erosion Hazard Zone
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESDA	Environmentally Sensitive Development Areas
FEMA	Federal Emergency Management Agency
fps	feet per second
H&H	hydrologic and hydraulic
I-8	Interstate 8
km	kilometer
LDR	Low-Density Residential
LIA	Landscape Inventory and Analysis
LID	Low Impact Development
L-MDR	Low-Medium Density Residential
LOS	level of service
MAG	Maricopa Association of Governments
PAC	Project Advisory Committee
PAD	Planned Area Development
PIR	Phoenix International Raceway
PGO	policy, guideline, and ordinance documents
PTOS	Parks, Trails, and Open Space
RMP	Resource Management Plan
RR	Rural Residential
SR	State Route
SWC	significant wash corridors
TDR	transfer of development rights
Team	Consultant Team
UPRR	Union Pacific Railroad
URS	URS Corporation
WR	wash reach

1.0 INTRODUCTION

1.1 PURPOSE

This Recommended Plan Report was prepared for the Flood Control District of Maricopa County (District) as part of the Rainbow Valley Area Drainage Master Plan (ADMP). It describes the process used to further develop the Recommended Plan where the Recommended Plan embodies the results of the alternatives analysis, recommendations from the Value Analysis, and detailed analyses performed to fully develop an implementable plan. The Consultant Team (Team) utilized a functional analysis in developing performance functions, design criteria, and regulatory tools to achieve the goals of the project. The Recommended Plan was then validated to ensure its effective performance if implemented by the District, and agency and private stakeholders. A regulatory framework and regulatory tools are recommended that include methods for mitigating existing flood hazards and providing guidance in deterring potential future flooding issues. The Recommended Plan recognizes the importance of the context sensitive approach to flood hazard mitigation where acceptability and compatibility are important factors in addition to the basic factor of whether the Recommended Plan is simply effective when mitigating flood hazards.

1.2 LOCATION

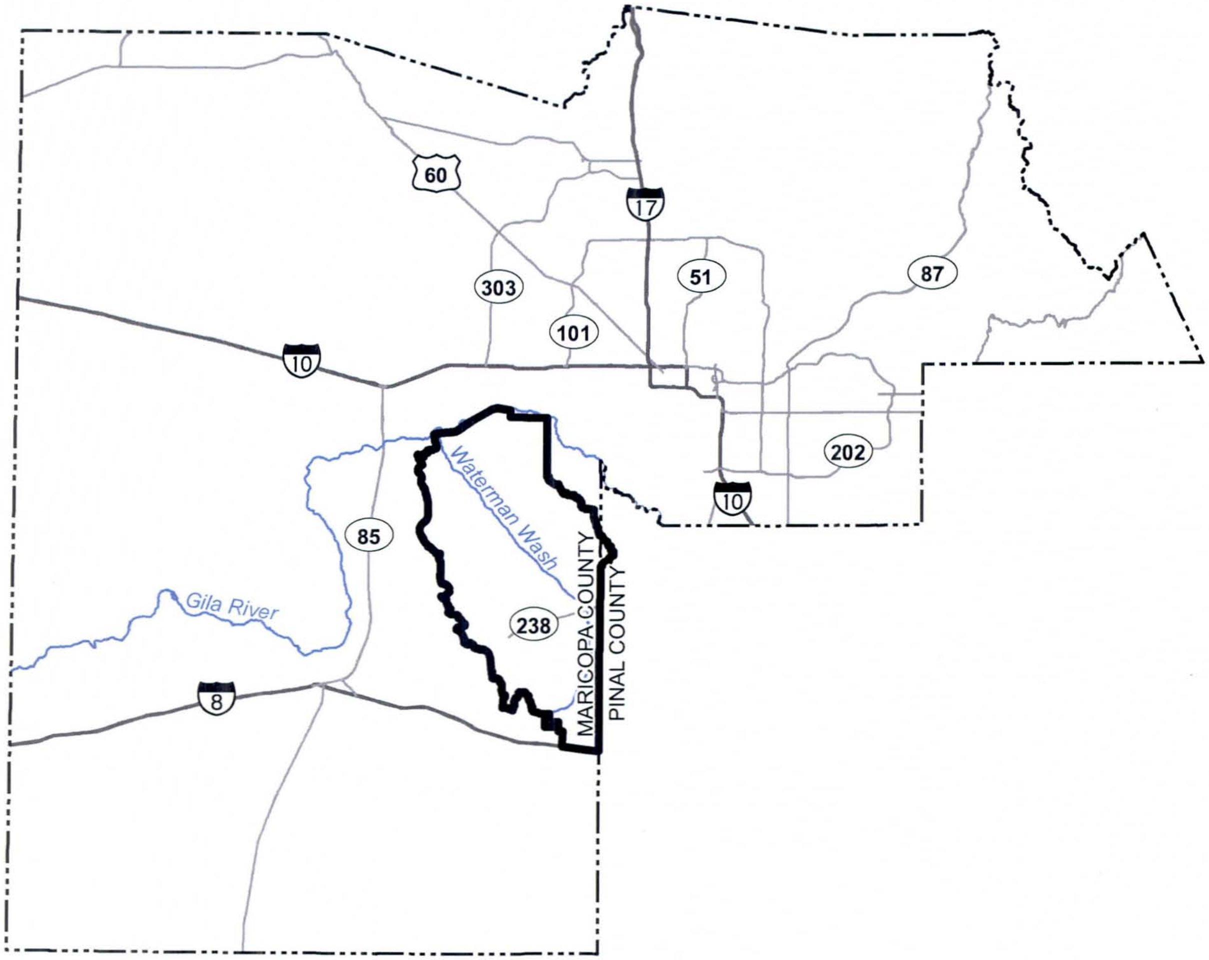
Rainbow Valley is located approximately 30 miles west of downtown Phoenix, Arizona and drains a 515 square mile watershed that originates at the Vekol Wash drainage divide south of State Route 238 and the town of Mobile. Rainbow Valley is drained by Waterman Wash which flows northwesterly through the watershed to its outfall at the Gila River near Buckeye. Prominent features within Rainbow Valley include the Sierra Estrella Mountains which form the easterly watershed divide along with the North and South Maricopa Mountains which form the westerly watershed divide. Rainbow Valley is just beyond the developed area of the Phoenix Valley and with the exception of agricultural lands along Waterman Wash is still in a relatively natural and undisturbed state. The project location is shown on **Figure 1-1**. Rainbow Valley is just beyond the development edge that was expanding during the development boom of the late 1990's through 2005. The area is poised for substantial development activity when the economy strengthens.

1.3 STAKEHOLDERS

The District is the lead agency for the study. Due to its county wide jurisdiction, the District is uniquely positioned to provide regional planning for flood hazard mitigation on a watershed scale without being limited by political boundaries that hinder municipalities and other entities such as utility and transportation providers. In this role, the District recognizes the importance and opportunity that is afforded by the support and cooperation of these partner agencies in realizing multiple benefits resulting from a multi-objective planning approach. As such, the District has identified multiple project stakeholders and has invited them to actively participate in the project from start to finish. Agency stakeholders have been defined as those stakeholders with political or land management jurisdiction within the study area. These stakeholders have regulatory authority and will likely be involved with implementation or enforcement of the Recommended Plan. Private stakeholders include interested members of the public and large landowners, such as developers, that own 160 acres or more within the study area. The project stakeholders listed in Table 1-1 were invited to participate in the project as the "Agency Stakeholder Group" (Agency Stakeholders).

Table 1-1 Agency Stakeholders

Agency	Representative	Title
Arizona Game and Fish Department	Dana Warnecke	Habitat Specialist II
Arizona State Land Department	Manny Patel	Engineering Section
Bureau of Land Management	Jack Ragsdale	Planner
City of Avondale	Charles Andrews	Senior Engineering Project Manager
City of Avondale	Kathy Mathiesen	Plan Review Engineer
City of Goodyear	Keith Brown	Assistant City Engineer
City of Goodyear	Joe Schmitz	Planning Manager
City of Goodyear Parks and Recreation Department	Mike Svetz	Parks and Recreation Director
Maricopa Association of Governments	Bob Hazlett	Senior Engineer
Maricopa County Parks and Recreation Department	Christopher Coover	Maricopa Trail Manager
Maricopa County Department of Transportation	Denise Lacey	Senior Planner
Maricopa County Department of Transportation	Mitch Wagner	Project Manager
Town of Buckeye	Tom Dixon	Planning and Zoning Manager



Project Features

- Maricopa County
- Rainbow Valley ADMP Boundary
- Interstate
- Highway/Freeway
- River/Stream

NORTH

0 10 20 Miles

Data Sources:
Flood Control District of Maricopa County
Base Vector Data, 2008
ALRIS Base Map, 2007-2009
ADOT Transportation, 2009

Rainbow Valley
Area Drainage Master Plan
Project Location Map

Figure 1-1

1.4 REPORT ORGANIZATION

This report is the third volume of the Rainbow Valley ADMP Report. The first volume is the *Data Collection Report*, which documents the existing conditions within the study area and identifies planning influences as a resource for flood hazard mitigation planning. The second volume is the *Proposed Alternatives Analysis Report*, which documents the formulation, evaluation, and selection of alternative flood hazard mitigation plans on a planning unit basis resulting in the selection of a preferred alternative for each planning unit within the study area. The preferred alternative is further developed in this volume as the Recommended Plan. The three volumes together constitute the Rainbow Valley ADMP. As a result, the information contained within each volume is not repeated in subsequent volumes, except on a limited basis for ease of reading.

1.5 PREFERRED ALTERNATIVE

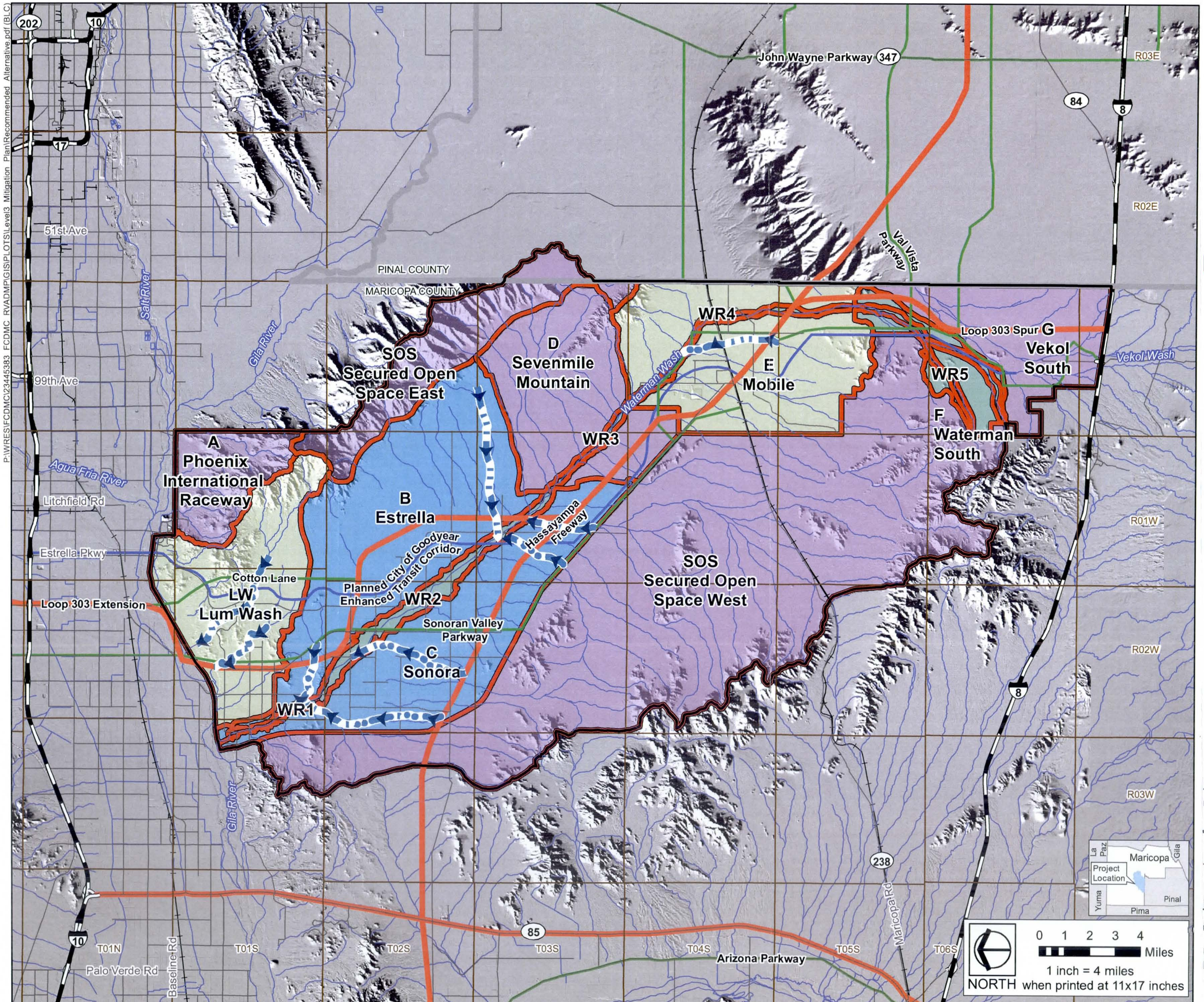
The alternatives analysis process, documented in the *Proposed Alternatives Analysis Report*, resulted in the identification of a preferred alternative for each planning unit. None of the selected mitigation strategies were structural in nature. The selected alternatives included no new action (do nothing), protect existing significant wash corridors (SWCs), or develop new regulations to guide development. The results of the evaluation are summarized in Table 1-2 which shows the alternatives receiving the highest composite score when evaluated against the performance criteria that were identified at the beginning of the project. The table also shows the alternative that was determined to be the most context sensitive for each planning unit. In every case, the highest scoring alternative was also the most context sensitive. The preferred alternative from the alternatives analysis is carried forward as the recommended alternative to be developed in this report as the Recommended Plan. The Recommended Plan for each planning unit is shown graphically on **Figure 1-2**. The Estrella and Sonora planning units were initially identified as "protect significant wash corridors"; however, the identified wash corridors only addressed a portion of the planning unit so the remaining portions of these two planning units will be subject to "new regulations," thus forming a hybrid solution.

Table 1-2 Evaluation Results

Planning Unit	Highest Performance Alternative	Most Context Sensitive Alternative
A – Phoenix International Raceway	1 – No New Action	N/A – Only one alternative
B – Estrella	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
C – Sonora	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
D – Sevenmile Mountain	1 – No New Action	N/A – Only one alternative
E – Mobile	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
F – Waterman South	2 – New Regulations	2 – New Regulations
G – Vekol South	1 – No New Action	N/A – Only one alternative
LW – Lum Wash	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
SOS – Secured Open Space	1 – No New Action	N/A – Only one alternative
WR1, WR2, WR3	2 – New Regulations	2 – New Regulations
WR4, WR5	2 – New Regulations	2 – New Regulations

As the recommended plan developed, two modifications were deemed necessary to provide a realistic and implementable solution. The first modification designated Waterman Wash as a significant wash corridor. The second modification included a conveyance corridor within the agricultural fields (disturbed area) adjacent to Waterman Wash in the Estrella and Sonora planning units. Further discussion occurs in Sections 3.4.8 and 3.4.9.

P:\WRES\FCDMC\23445383 FCDMC RVADMP\GIS\PLOTS\Level3 Mitigation Plan\Recommended Alternative.pdf (BLC)



Rainbow Valley Area Drainage Master Plan Recommended Plan

Figure 1-2

Project Features

Planning Unit Boundary

Planning Unit Recommended Alternative

- No New Action
- Protected Wash Corridor
- New Regulations
- Hybrid (New Regulations & Protected Wash Corridor)
- Protected Wash

Future Corridor Type

- Freeway
- Parkway
- Transit Corridor

Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reaches

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

2.0 THE WATERMAN WASH WATERSHED

Waterman Wash is the primary watershed that makes up the Rainbow Valley ADMP study area. Additional small watersheds within the Recommended Plan boundaries are found in the Lum Wash and Phoenix International Raceway (PIR) planning units, which are composed of ephemeral wash networks that drain directly to the Gila River. General planning for these adjacent watersheds is considered similar to that of the Waterman Wash watershed because of their regional proximity. Specific functions and design criteria for these planning units are identified in later sections of this report.

2.1 STUDY AREA DESCRIPTION

The Rainbow Valley ADMP study area is comprised of the Waterman Wash watershed, a portion of the Vekol Wash watershed, and adjacent land north and east of the Waterman Wash watershed that has not been previously studied by the District. The study area is bounded to the north by the Gila River, to the south by the South Maricopa Mountains and Interstate 8 (I-8), to the east by the Sierra Estrellas, and to the west by the Maricopa Mountains. The study area is within the area bounded by approximately Township 1 South to Township 7 South and Range 3 West to Range 2 East. The study area covers approximately 515 square miles and includes unincorporated Maricopa County, City of Goodyear, City of Avondale, City of Maricopa, and Town of Buckeye. Significant portions of the study area are controlled or managed by the U.S. Bureau of Land Management (BLM), Arizona State Land Department (ASLD), Maricopa County, and the Gila River Indian Community.

The Sonoran Desert National Monument is located in the southwestern portion of the study area, and the Union Pacific Railroad (UPRR) crosses the southernmost portion of the study area. Waterman Wash flows south to north and flows into the Gila River in the Town of Buckeye. The Vekol Valley watershed was initially included in the southern portion of the study area to determine whether there was any inter-basin flow to Waterman Wash. Early in the study, it was determined that the flow from the Vekol Valley watershed, if any, does not significantly contribute to the flood flows of the Waterman Wash and its tributaries during the 100-year storm event. Therefore, ADMP development did not extend to Vekol Valley. The study area, along with jurisdictions and surface management within the study area, is shown on **Figure 2-1**.

2.2 PLANNING WITHIN THE WATERSHED CONTEXT

Many agencies have recognized the need to manage resources at appropriate, regional scales. The U.S. Environmental Protection Agency (EPA) endorsed the importance of managing hydrologic systems at watershed scales in the Southwest, stating:

> *"Managing from a watershed context is more effective than focusing on a specific site such as an individual ephemeral or intermittent stream segment, because actions by humans, wildlife, and nature can have widespread effects crossing political boundaries and impacting downstream water quality and ecosystem health. The accumulation of impacts over large areas in the rapidly developing southwest suggests a landscape or watershed-scale approach that considers the cumulative effects on overall watershed function."*
>
> *(Levick et al. 2008)*

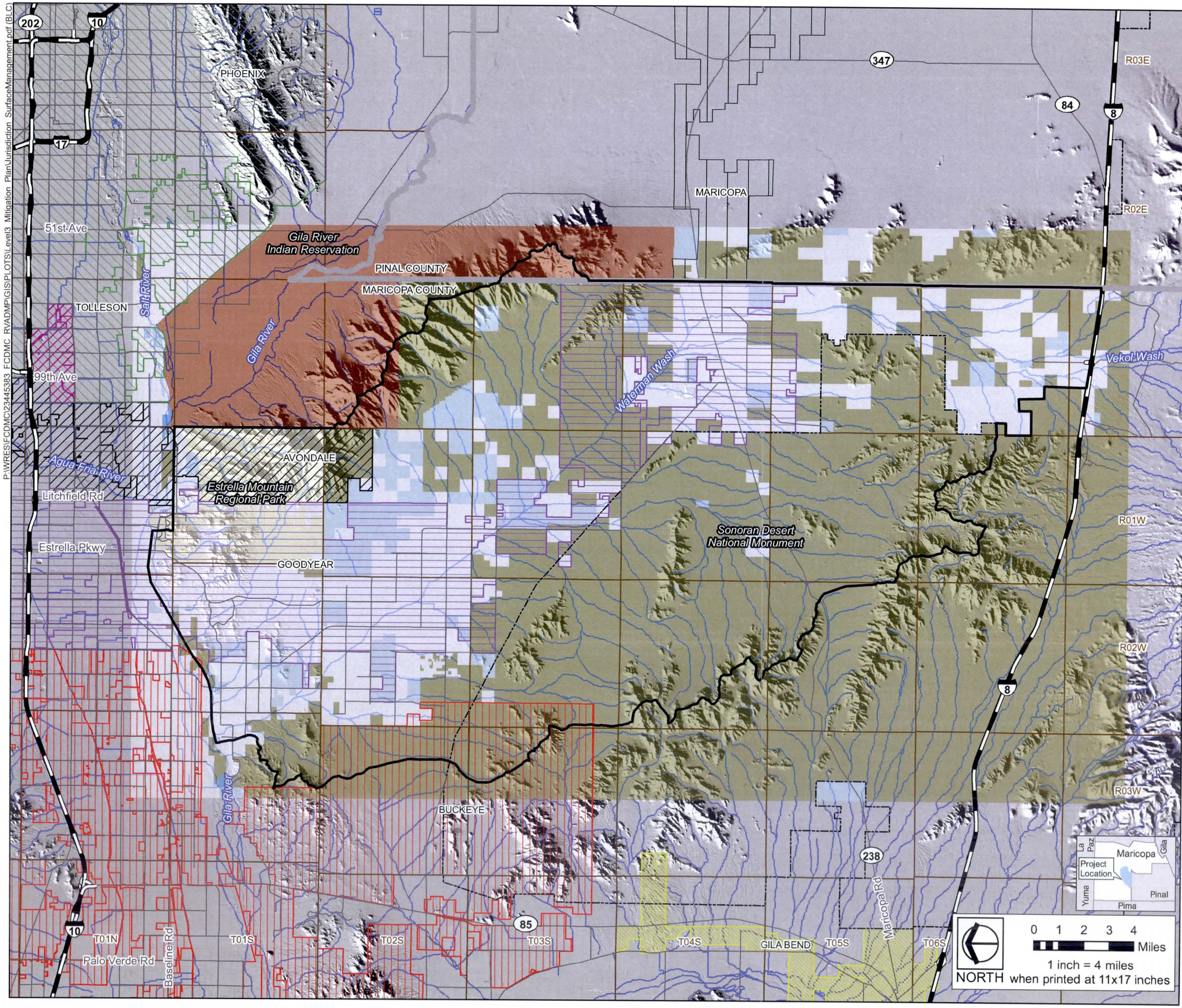
Natural, undeveloped landscapes within the Sonoran Desert are complex systems that have evolved over time as a result of widely varied climatic events. The intermittent and annually bi-modal occurrence of precipitation and drought-flood cycles that form the common hydrologic cycle of the Rainbow Valley ADMP study area is typical of the Southwest, resulting in a system of headwaters, piedmonts, and ephemeral and intermittent washes that are uniquely adapted to the local environment and fluctuations in precipitation for self-maintenance. These ecosystems provide a range of hydrologic as well as ecologic functions that provide diverse and significant value to environmental and human-societal end-users (Levick et al. 2008).

Changes to these natural landscapes, such as agricultural and urban expansion, are expected to continue throughout the Phoenix-Metro area, including the City of Goodyear and other municipalities within the Rainbow Valley ADMP study area. The City of Goodyear expects a population increase from over 57,000 residents in 2007 to potentially 162,623 residents by 2020 (Goodyear 2010). Much of this growth is expected to occur south of the Gila River within the Rainbow Valley ADMP study area. Providing a desirable community that is attractive to potential new residents, developers, and businesses is an important goal for local municipalities and is a significant component in understanding the community context of the watershed as a whole.

Changes to the natural landscape such as urbanization can disrupt the connectivity of those functions that are required to sustain the existing natural systems. These natural functions and their associated values can be costly to replace or replicate through technological means, while the limited precipitation in the arid Southwest, as well as the adaptive traits of native vegetation to the harsh desert climate, make re-establishing these natural functions a very slow process—if full recovery can be achieved at all. The beneficial functions and values provided by the existing ecosystem often become disrupted by single-focus mitigation methods because development frequently focuses on the site-specific hazards associated with flow regimes over the local site. The ecosystem relies on the connectivity, or continuity of watershed functions from one end to the other.

Rainbow Valley
Area Drainage Master Plan
Jurisdictions and Surface Management

Figure 2-1



Project Features

- Sonoran Desert National Monument

City/Town

- Avondale
- Buckeye
- Gila Bend
- Goodyear
- Maricopa
- Phoenix
- Tolleson
- Unincorporated Area

Surface Management

- Bureau of Land Management
- Gila River Indian Reservation
- State Trust Land
- Arizona Game and Fish Department (State Land)
- County, Park and Outdoor Recreation Area
- Private Land

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008

The Federal Emergency Management Agency's (FEMA) *"Floodplain Management – Principles and Current Practice"* describes the importance of applying a holistic approach to floodplain management:

> *"...natural processes influence human activities and are, in turn, affected by our activities. They represent important natural functions and beneficial resources and provide both opportunities and limitations for particular uses and activities. Traditionally, while much attention has been focused on the hazards associated with flooding and floodplains, less attention has been directed toward the natural and cultural resources of floodplains or to evaluation of the full social and economic returns from floodplain use.*
>
> ...
>
> *In response to these development pressures, knowledge and information regarding the natural resources, processes and functions of floodplains can contribute to assessments of the ecological, economic and social impacts on further floodplain development. This knowledge and information can help to protect and better utilize the benefits and values these resources provide."*
>
> *(Wright 2008)*

This same rationale applies to watershed management and the consideration of impacts to the functions and values of resources at the watershed scale (Miller 2005).

To effectively integrate flood hazard mitigation planning into other watershed resource management needs and goals, the important functions of the watershed resources need to be identified and understood. Additionally, the connectivity of the various functions and their inter-relationship is important to develop a sustainable, multi-context flood hazard mitigation plan where the definition of a sustainable watershed is "*... one that, over the normal cycle of disturbance events, maintains its characteristic diversity of major functional groups, productivity, and rates of biogeochemical cycling"* (Chapin et al. 1996).

Peter Black (1997) identified five general functions associated with natural, undisturbed watersheds as well as two important integrative responses to these five functions. These include three hydrologic functions, two ecological functions, and two integrative responses:

Hydrologic Functions

- collection of the water from rainfall, snowmelt, and storage that becomes runoff
- storage of various amounts and durations
- discharge of water as runoff

Ecological Functions

- provision of diverse sites and pathways along which vital chemical reactions take place
- provision of habitat for the flora and fauna that constitute the biological elements of ecosystems

Integrative Responses

- hydrologic attenuation of the energy inherent in storm runoff
- movement of mobilized chemicals through periodic flushing of the water body

The District's leadership role in Maricopa County in regional and watershed-scale management and planning is demonstrated through the many ongoing programs, planning tools, and resources that focus on providing Maricopa County residents with effective flood hazard mitigation solutions that accommodate these multi-context functions and their associated benefits. These include the *Comprehensive Flood Management Plan and Program* (FCDMC 2009) and the *Context Sensitive Flood Hazard Mitigation Planning and Design Approach* (FCDMC 2010) on which the Rainbow Valley ADMP was based. The District has identified natural and beneficial functions served by floodplains in the *Comprehensive Flood Management Plan*. These are divided into Hydraulic Functions, Biological Functions, and Societal Values, and include (Table 2-1):

Table 2-1 District-Identified Beneficial Functions of Natural Floodplains

Hydraulic Functions	Biological Functions	Societal Values
Provide natural flood and sediment storage and conveyance	Support high rate of plant growth	Provide an area for active and passive recreation
Reduce erosive energy	Preserve integrity of ecosystems	Offer open space, scenic views, and aesthetic relief
Reduce peak flows	Provide habitat for fish and wildlife, including rare and endangered species	Provide an area for scientific study and outdoor education
Maintain water quality	Serve as a travel corridor for wildlife	Contain significant archaeological resources
Filter nutrients and impurities from runoff	Moderate temperature fluctuations	Increase value for property adjacent to riparian floodplains and open space
Recharge groundwater		Are a source of natural and agricultural products

Source: *Comprehensive Flood Management Plan and Program*, Flood Control District of Maricopa County 2009

The District's *Context Sensitive Flood Hazard Mitigation Planning and Design Approach*, as applied to the Rainbow Valley ADMP, is focused on flood hazard mitigation solutions that integrate multiple context resources, along with their functions and associated values, into sustainable flood hazard mitigation and community development practices at the watershed level.

2.3 PLANNING UNIT SUMMARY DESCRIPTIONS

Each of the planning units identified in this plan exhibit unique characteristics in terms of flood hazards, development patterns, and/or land and resource management. As a result, a unique flood hazard mitigation plan was selected for each unit based on those characteristics. The planning units are briefly described in the following sections. The Recommended Plan and the flood, land and resource, and community context for each planning unit are summarized on **Figure 2-2 through Figure 2-12** at the end of this chapter.

2.3.1 Planning Unit A – Phoenix International Raceway

The Sierra Estrella Mountains form the easterly drainage boundary for the Waterman Wash watershed, which for the most part is also the easterly study boundary for this project. The PIR Planning Unit A is outside the Waterman Wash watershed and is situated at the northeast corner of the study area. The PIR Planning Unit includes the watershed that drains the northeast slopes of the Sierra Estrella Mountains with its outfall into the Gila River in the vicinity of PIR. The watershed consists of mountains and steep tributary washes with a disturbed area at PIR. The steep, tributary drainage network is typical of mountain slope systems with characteristic flood hazards that, although real and present, are not particularly unique.

The PIR Planning Unit is within portions of the cities of Avondale and Goodyear and is mostly contained within the Estrella Mountain Regional Park. Due to the tributary nature of the drainage network it is anticipated that development can be effectively regulated using FEMA Regulatory Floodplains and the existing regulations associated with FEMA floodplains. As a result, the No New Action Alternative is recommended for this area. The Recommended Plan for the PIR Planning Unit A is shown on **Figure 2-2**.

2.3.2 Planning Unit B – Estrella

The Estrella Planning Unit B extends from the Sierra Estrella Mountains to Waterman Wash and consists of a large piedmont landform which exhibits alluvial fan flooding, sheet flooding, and includes disturbed areas of agricultural land uses near Waterman Wash. The Estrella Planning Unit extends northerly to the drainage divide with Lum Wash, which drains to the Gila River, and southerly to the Sevenmile Mountain Planning Unit. The Sevenmile Mountain Planning Unit is differentiated from the Estrella Planning Unit primarily by the limit of BLM lands which contain a significant designated wildlife corridor. However, the planning unit boundary is aligned along drainage boundaries rather than along land management boundaries.

The key flood hazard considerations within the Estrella Planning Unit are the alluvial fans situated along the base of the mountains and the broad shallow sheet flooding which occurs downstream from the fans. Due to the paucity of defined channels, combined with the potential uncertain flow path from runoff leaving the alluvial fan landforms, design and layout of subdivisions and land development projects is challenged to adequately address the runoff conveyance and continuity functions within the planning unit.

Due to the unique conditions within the Estrella Planning Unit, existing development regulations are inadequate to address the alluvial fan and sheet flow flooding conditions within the unit. As a result, the New Regulations Alternative is proposed for this area. There are also two SWCs identified within the planning unit, which are identified for protection with the Protect Significant Wash Corridors Alternative. The Recommended Plan for the Estrella Planning Unit is shown on **Figure 2-3**.

Farming occurred on the portions of the planning unit adjacent to Waterman Wash. Disturbance in these agricultural areas have disrupted the natural sheet flow patterns. The Loop 303 corridor is planned at the boundary of the sheet flow and disturbed areas. Channels could be used to convey flows. Locating the channels needs to be coordinated between MCDOT, ADOT, affected development, Goodyear, and unincorporated Maricopa County.

2.3.3 Planning Unit C – Sonora

The Sonora Planning Unit C extends from the BLM lands of the Sonoran Desert National Monument to Waterman Wash and consists of a large piedmont landform which primarily exhibits distributary flood characteristics with some sheet flooding areas that flow through disturbed agricultural lands before reaching Waterman Wash. The Sonora Planning Unit extends north to the Gila River and south to the Sevenmile Mountain Planning Unit and is contained within portions of the City of Goodyear and unincorporated Maricopa County.

The principal flood hazards within the Sonora Planning Unit are from the unstable and changing nature of the flow splits that define the distributary nature of the piedmont. The distribution of flow between the diverging washes can vary with discharge and can change abruptly from erosion processes or a new obstruction resulting from debris accumulating at the split. Once the channel bank is overtopped a new flow path may be formed, creating a completely different flow distribution that could be perpetuated for a long distance downstream. The uncertain and changing flow split characteristics associated with distributary systems create hazards and difficulty for design of subdivisions in the area downstream from the flow split that require new regulations as well as regional planning to address the significant flow splits. There are also four SWCs identified for protection with the Protect Significant Wash Corridors Alternative in the Sonora Planning Unit. The Recommended Plan for the Sonora Planning Unit C is shown on **Figure 2-4**.

Channels could be used to convey flow through the agricultural areas adjacent to Waterman Wash because the distributary flow patterns are already disrupted. The location of the flow corridors will depend on cooperation and coordination between land owners and jurisdictional public agencies.

2.3.4 Planning Unit D – Sevenmile Mountain

The Sevenmile Mountain Planning Unit D extends across Waterman Wash from the Sierra Estrella Mountains to the Sonoran Desert National Monument. The planning unit has flow characteristics similar to the Estrella Planning Unit; however, it is almost entirely within BLM lands and is not expected to be developed. The Planning Unit contains an important wildlife corridor that has been identified for protection. Figure 5-2 in the *Data Collection Report* shows the actual limits of the designated wildlife corridor. The No New Action Alternative is selected for this area since the planning unit is already managed and protected by BLM. The Recommended Plan for the Sevenmile Mountain Planning Unit is shown on **Figure 2-5**.

2.3.5 Planning Unit E – Mobile

The Mobile Planning Unit E is within the City of Goodyear and contains the community of Mobile. A significant part of the Mobile Planning Unit E was planned for development under the name of Amaranth prior to the recent economic downturn, which resulted in the halt of almost all development activity within the Rainbow Valley area. The future plans for the area are uncertain, but it is anticipated that the planning and design that was previously completed would be carried forward with minimal changes. Waterman Wash flows through the Mobile Planning Unit. The flow characteristics outside of Waterman Wash are identified as predominantly sheet flooding with some distributary areas as well. A SWC is identified as a tributary to Waterman Wash within the Mobile Planning Unit, resulting in the Protect Significant Wash Corridors as the Recommended Plan for the area. New Regulations will be required to implement the SWC concept. The raised embankment from the UPRR passes through the planning unit, impacting the FEMA floodplain delineation by ponding runoff reaching the embankment. The Recommended Plan for the Mobile Planning Unit E is shown on **Figure 2-6**.

2.3.6 Planning Unit F – Waterman South

The Waterman South Planning Unit F is at the upstream limit of the Waterman Wash watershed and is adjacent to the Vekol South Planning Unit, which is actually outside the Waterman Wash watershed. The planning unit is made up of BLM lands that are not expected to be developed and State Trust Lands which will be developed, all within unincorporated Maricopa County. The flow characteristics include mountain, sheet flow, tributary, and distributary flooding. Due to the wide variety of flood hazards in the Waterman South Planning Unit, the New Regulations Alternative is selected. The Recommended Plan for the Waterman South Planning Unit F is shown on **Figure 2-7**.

2.3.7 Planning Unit G – Vekol South

The Vekol South Planning Unit G is recommended for No New Action as part of the Rainbow Valley ADMP. The Vekol South Planning Unit has been removed from planning as part of this project due to the determination that Vekol Wash does not contribute significant runoff into Waterman Wash.

2.3.8 Planning Unit LW – Lum Wash

The Lum Wash Planning Unit LW is situated north of the Estrella Planning Unit and west of the PIR Planning Unit. The Lum Wash Planning Unit and PIR Planning Unit are the only two units that drain into the Gila River. The other units all drain into Waterman Wash. LW is characterized by piedmont tributary flooding which is adequately managed with current regulations. Nearly half of the unit, including its headwaters, is within the Estrella Mountain Regional Park. Two SWCs have been identified for protection with the Protect Significant Wash Corridors Alternative. The Recommended Plan for the Lum Wash Planning Unit LW is shown on **Figure 2-8**.

2.3.9 Planning Unit SOS – Secured Open Space

Areas that are identified as secure open space are protected due to their status as BLM lands. Due to the existing protections in place, No New Action is the Recommended Plan for these areas. The Recommended Plan for the Secured Open Space Planning Unit SOS is shown on **Figure 2-9** for the east side SOS area and **Figure 2-10** for the west side SOS area.

2.3.10 Planning Unit WR – Waterman Wash Reaches 1, 2, and 3

Waterman Wash itself is identified separately as two planning units. Within those planning units Waterman Wash is further divided into five reaches. The downstream three reaches are grouped together into Planning Unit WR123, which extends from the Gila River confluence upstream to the Mobile Planning Unit. The Recommended Plan for Planning Unit WR123 is to implement

New Regulations to aid in the implementation of the concepts identified in the City of Goodyear's *Waterman Wash Conceptual Corridor Study*, which was published in draft form in February 2008. The new regulations will be similar to those for SWCs. The Corridor study extends to State Route (SR) 238, which passes through the middle of the Mobile Planning Unit. The Recommended Plan for the Waterman Wash Reaches 1, 2, 3 (Planning Unit WR123) is shown on **Figure 2-11**.

2.3.11 Planning Unit WR – Waterman Wash Reaches 4 and 5

Waterman Wash Reaches 4 and 5 (Planning Unit WR45) extend from SR 238 in Mobile, upstream to the study limit, which is also the headwaters of Waterman Wash. Only a small portion of this planning unit is within the City of Goodyear, with the majority being within unincorporated Maricopa County. As a result, Reaches 4 and 5 are not included in the City of Goodyear *Waterman Wash Conceptual Corridor Study*. New Regulations are proposed to guide development within this reach of Waterman Wash. The new regulations will be similar to those for SWCs. The Recommended Plan for the Waterman Wash Reaches 4 and 5 (Planning Unit WR45) is shown on **Figure 2-12**.

2.4 LANDFORM FUNCTIONS AND VALUES

The Waterman Wash watershed is somewhat typical of many areas in south central Arizona. The watershed is partially developed and includes areas where agriculture has modified the landscape, though most of the agricultural land is fallow at this time. The watershed is bounded by mountain ranges along the eastern and western edges (Sierra Estrella and Maricopa Mountains, respectively), while its southern boundary is represented by a much less obvious topographic break where there is a divide with the Vekol Wash Watershed. The mountain areas provide the headwaters for the flows that traverse the piedmonts to and between the network of ephemeral washes that then outfall into the axial stream, which is Waterman Wash. Waterman Wash, a significant ephemeral wash with many large, continuous stands of riparian vegetation, collects these flows along its length as it drains north and outfalls into the Gila River.

For simplicity in considering functional connectivity, the Recommended Plan divides the watershed into three landforms (**Figure 2-13**):

- Mountains
- Piedmont areas (upper bajada, lower bajada, and valley plain)
- Riverine watercourses (Waterman Wash and its adjacent floodplain)

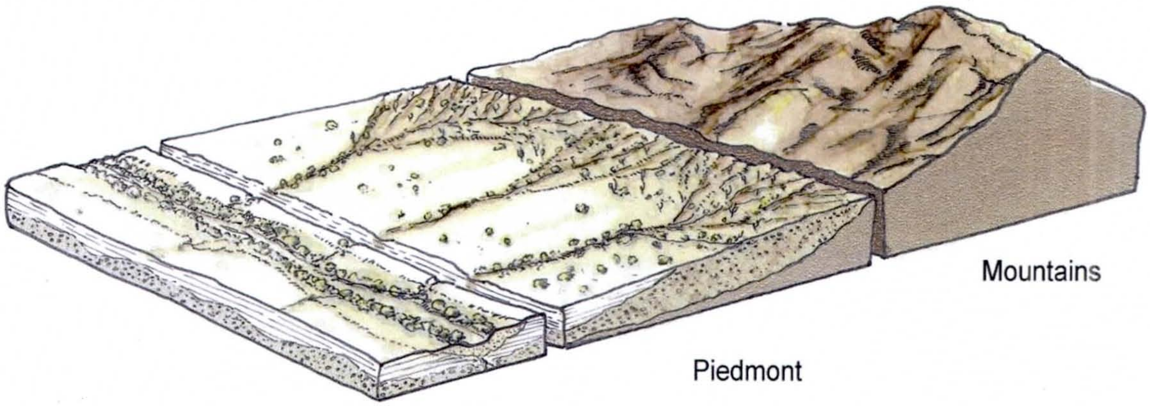


Figure 2-13 Landform Schematic – Rainbow Valley

Each of these landforms has unique functional characteristics from a land and resources, flood hazard mitigation, and community context. Flow characteristics across these landforms vary, with the greatest variety found in the piedmont landforms.

There is interdependency between the functions of each landform and their value to the community that extends from the mountains to the riverine watercourses. Many functions are also linked laterally across planning unit boundaries, and are dependent on cross-boundary interactions to preserve the value that the functions provide. All adjacent planning unit functions within the watershed ultimately interact with the Waterman Wash Reaches 1-5, which in turn interact with the Gila River ecosystem. Recognizing this inter-relationship and preserving the continuity between the landforms, Waterman Wash and the receiving waters of the Gila River is extremely important in maintaining overall watershed resource functionality and value.

2.4.1 Existing/Natural Function Continuity

The largely natural, undeveloped state of the Waterman Wash watershed allows the processes of the hydrologic cycle to seamlessly occur across the three landform boundaries and beyond into the receiving waters of the Gila River. The illustrations below demonstrate how these functions relate to the landforms and rely on this interconnection (**Figures 2-14**, **2-15**, and **2-16**).

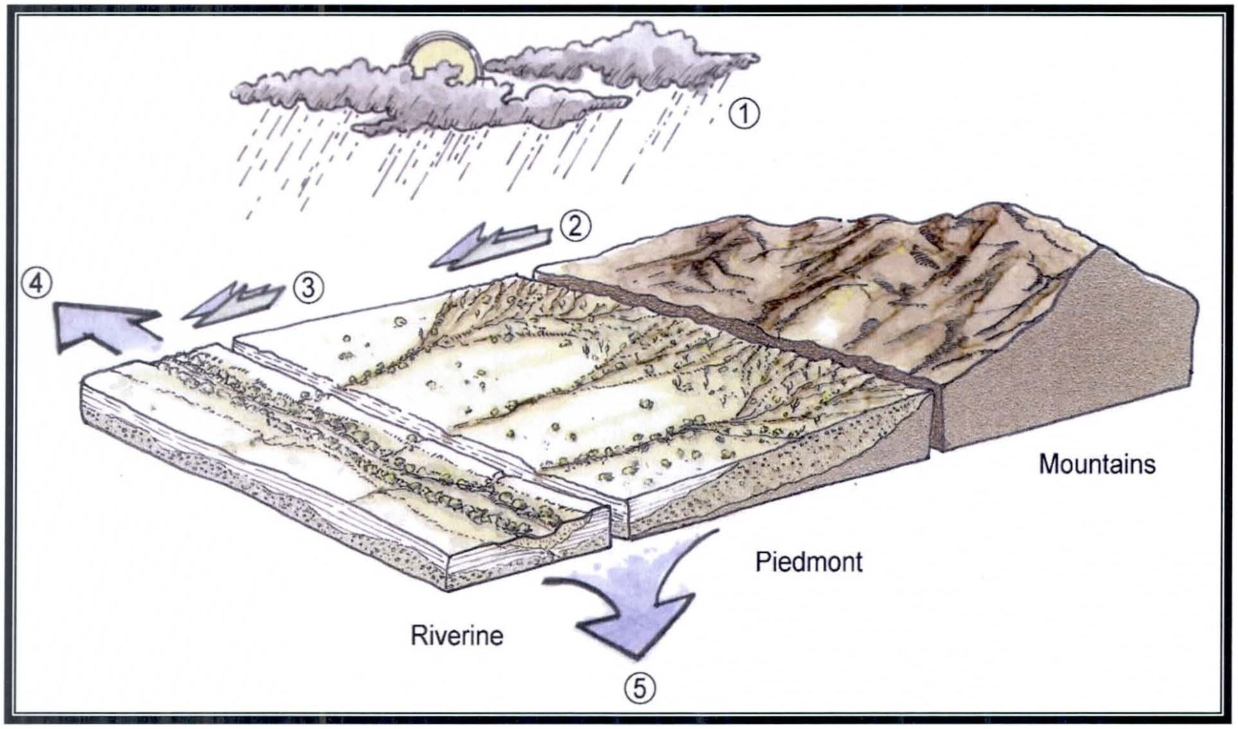


Figure 2-14 Relationship of Hydraulic Functions – Natural Condition

Hydraulic Functions

1 – Precipitation in the form of rainfall on the mountains, piedmont, and riverine landforms provides the foundation of the hydrologic processes for the watershed.

2 – Rainfall from the mountains in the form of runoff accumulates sediments that feed the piedmont bajadas and washes.

3 – Runoff emanating from the mountain is attenuated and dampened by surface storage as runoff spreads across the piedmont surface as sheet flow.

4 – Runoff from the piedmont continues to carry sediments to the riverine landform, maintaining sediment equilibrium that sustain vital geochemical reactions.

5 – Flows within the wash (riverine land form) carry water and sediments downstream into the waters of the Gila River.

6 – Runoff and flows from all three landforms infiltrate into the soil, recharging storage and groundwater reserves.

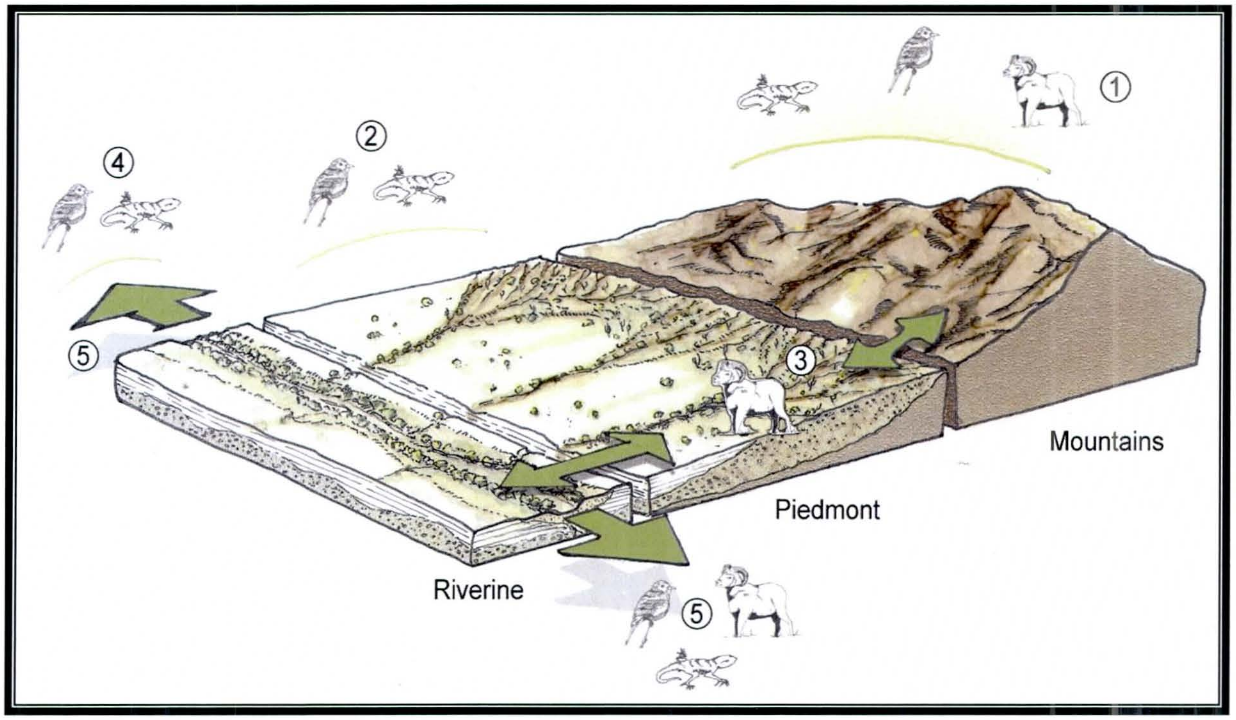


Figure 2-15 Relationship of Biological and Cultural Functions – Natural Condition

Biological and Cultural Functions

1 – The mountain landform is home to a diverse number of plant and animal species. These include large mammal species such as mule deer, big horn sheep, and other species that are of concern to the Arizona Game and Fish Department. Mountain lands often had traditional cultural significance, and can be home to numerous undisturbed archaeological sites and artifacts.

2 – The piedmont landform also supports a diverse number of plant and animal species. Aboriginal groups exploited the natural resources of the piedmont and sometimes farmed on the lower bajadas, creating many potential archaeological sites, some of which may be buried in alluvial fans.

3 – Large mammal species forage on the piedmont landform, while migration through the piedmont to other mountain areas is critical for maintaining genetic diversity within each herd. SWCs within the piedmont landform aid in maintaining biodiversity and serve as cover for migrating animals. Prehistoric groups also exploited indigenous food plants along wash corridors.

4 – The riverine landform supports high densities of vegetation, and serves as habitat for diverse animal species including amphibians, mammals, reptiles, and birds.

5 – Unobstructed, natural washes provide critical corridors for wildlife movement. These axial streams also transport nutrient material into downstream receiving waters. Nutrients help to support fish and other wildlife that live in the receiving perennial streams and rivers. The Gila River receives nutrients and flows from Waterman Wash. Sources of surface water and associated natural resources were important to prehistoric societies and often were the focus of seasonal or permanent habitation.

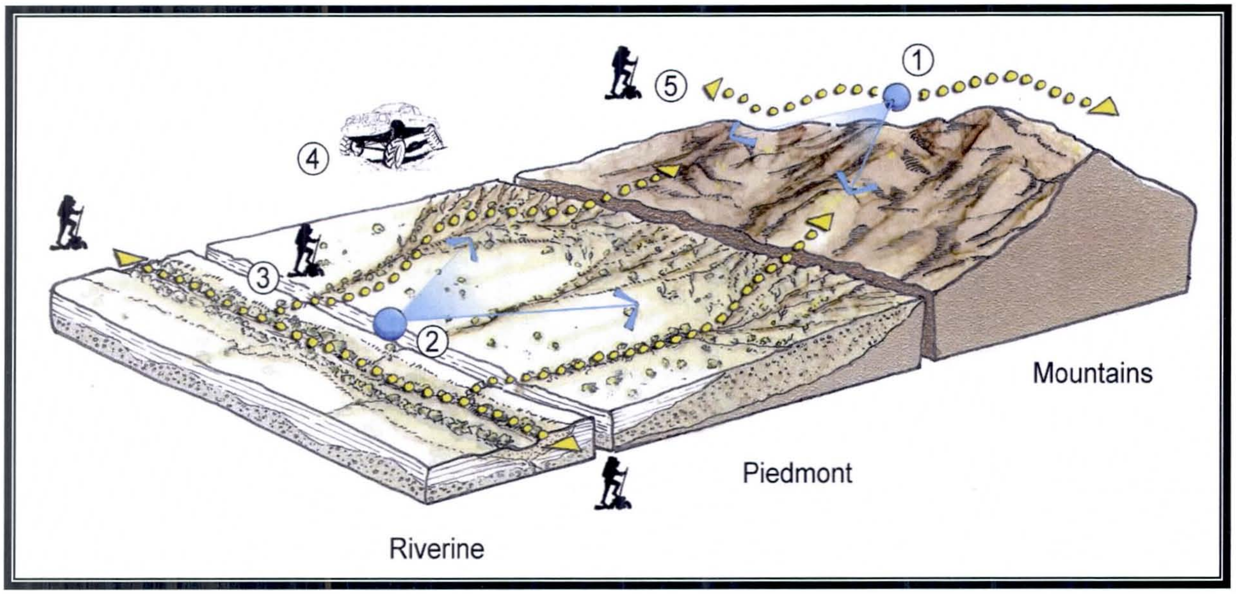


Figure 2-16 Relationship of Scenery, Recreation, Open Space Functions – Natural Condition

Scenery, Recreation, and Open Space Functions

1 – Panoramic views from the mountains of the undeveloped natural Rainbow Valley have high scenic value, while the natural, rugged mountain areas create visually interesting skylines. The value of the mountain lands that bound the Waterman Wash watershed is evidenced by the number of protected wilderness areas and other secured open spaces they contain.

2 – The views of the upper bajada and mountains from the piedmont and riverine landforms are valued as evidenced by the goals and objectives identified by the ADMP stakeholders (Section 3.2). The scenic quality of Waterman Wash and other significant washes in the piedmont add to the visual variety and interest of the watershed.

3 – The natural piedmont and washes provide opportunities for non-programmed recreation uses such as hiking, equestrian riding, birding and off-road vehicle travel. The vast landscapes of the undeveloped piedmont allow users to transition relatively freely from the riverine to the mountain landforms and back.

4 – The open spaces of the undeveloped piedmont landform provide room for a wide range of non-programmed recreation uses. The unprogrammed nature of these uses can include many potentially conflicting activities such as off-roading, shooting, and hiking.

5 – Many existing trail systems provide opportunities for hiking and related recreation activities.

2.4.2 Traditional Development and Functional Disruption

As development expands within the Waterman Wash watershed, common development planning and stormwater management practices can lead to wide-spread modification of the associated watershed functions. The illustrations below diagram the fragmentation that typical land development and other activities can have on watershed functions when continuity becomes interrupted through single-context land-use and flood hazard mitigation planning, development, and design approaches (**Figures 2-17**, **2-18**, and **2-19**).

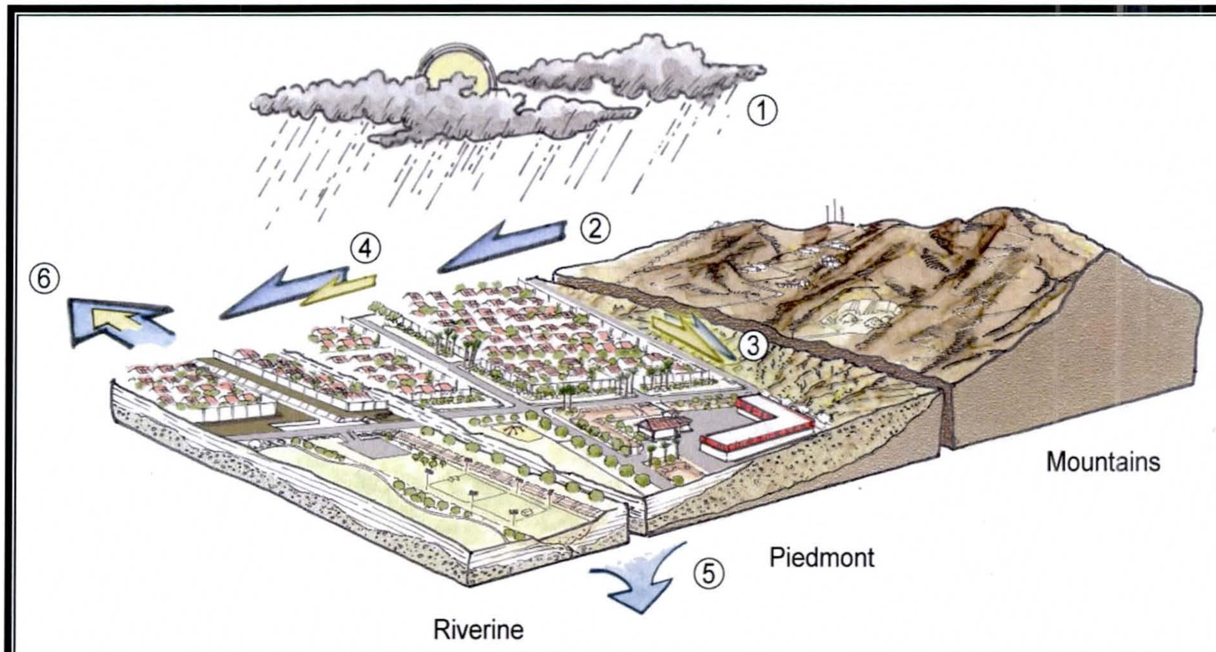


Figure 2-17 Relationship of Hydraulic Functions – Traditional Development Practices

Hydraulic Functions

1 – Precipitation in the form of rainfall on the mountains, piedmont, and riverine landforms continues to provide the foundation of the hydraulic functions of the watershed.

2 – Development and changes within the mountains can cause impacts to runoff timing, discharge volumes, routing and location of discharge, and impede sediment delivery to the piedmont.

3 – Natural flow paths can be altered by development, creating impacts both upstream and downstream. Blocked sediments can no longer replenish natural wash deposits or sustain geochemical processes while redirected discharge may result in flooding of property in new flow paths.

4 – The expansion of impervious surface areas increase runoff volumes, change timing, and increase flow velocities while reducing sediment loads. This results in an increase in wash scour and limits the opportunities for vital geochemical processes to occur within the watershed. Alternatively, retention requirements may result in a severe reduction in flows arriving in the downstream wash areas, impacting their abilities to sustain other non-hydraulic watershed functions.

5 – Increased runoff may reduce ground water recharge and floodplain storage.

6 – Encroachment into the floodplain reduces natural recharge and downstream attenuation. The introduction of man-made features such as hardened channels and active recreation areas reduces sediment load in the flows, resulting in downstream scour where the flows reenter a natural system. Peak discharges are also increased, sometimes by an order of magnitude, at the lower portions of the piedmont.

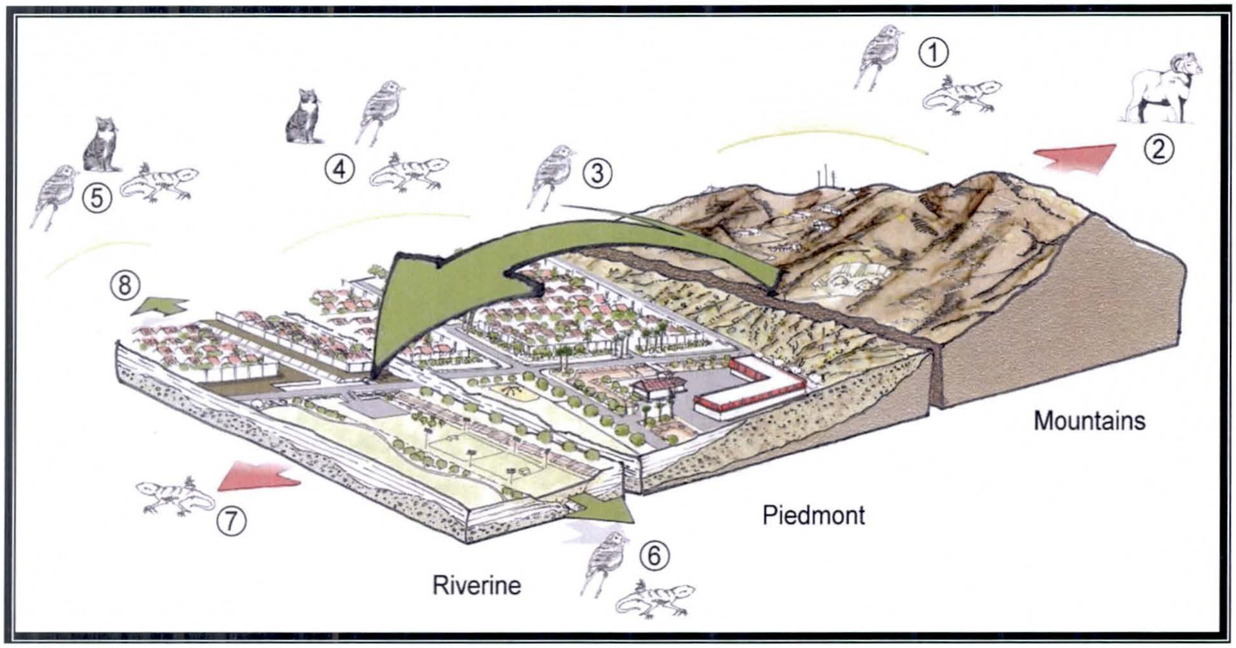


Figure 2-18 Relationship of Biological and Cultural Functions – Traditional Development Practices

Biological and Cultural Functions

1 – Increased development such as housing, quarries, and utilities can negatively impact biological resources, reducing habitat quality, quantity, and biodiversity as well as inhibiting wildlife movement.

2 – Biodiversity decreases as populations of species leave, lose genetic diversity, or die-off as development encroaches.

3 – Development can cut off terrestrial movement routes, leaving only flying and urban-acclimated species to move through or fly over the piedmont.

4 – Smaller, fragmented open space patches have lower biological value when compared to contiguous larger open spaces. The introduction of domesticated animals, such as house cats, has negative impacts on existing wildlife in the area. Edge conditions along development extend the negative impacts associated with development into the preserved open spaces of the mountains and washes, which can decrease biodiversity.

5 – Changes to the washes caused by development result in the displacement of native species by non-native species.

6 – Use of washes for wildlife migration decreases as development cuts off access from surrounding areas and habitat quality of the wash is degraded or replaced by man-made landscapes.

7 – Local populations of sensitive species, such as amphibians, birds, and small mammals that rely on the washes for habitat, may die off.

8 – Modified washes are less effective in providing critical corridors for wildlife habitat, movement routes, and nutrient transport. Reduced nutrient influx can have far-reaching consequences for the downstream receiving waters that support fish and other wildlife in the Gila River.

9 – Disturbance or destruction of archaeological sites may or may not be mitigated.

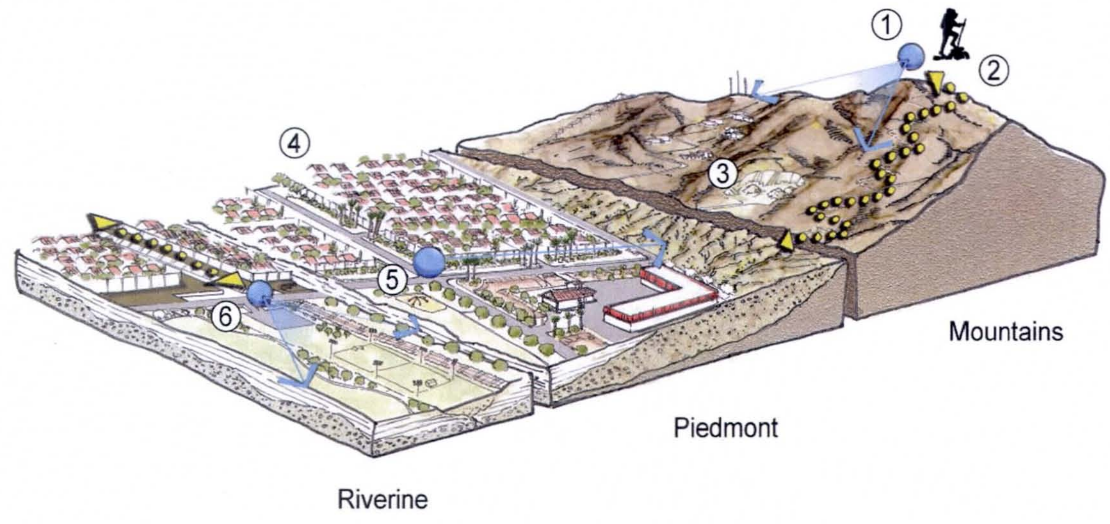


Figure 2-19 Relationship of Scenery, Recreation, and Open Space Functions – Traditional Development Practices

Scenery, Recreation, and Open Space Resources

1 – Panoramic views from the mountains of the developed natural Rainbow Valley are modified though access to these views is likely to increase through development of established trail systems and trailheads. The natural skyline of the rugged mountain areas is modified by introduced man-made elements such as utilities.

2 – Established trails to prominent peaks can become major recreation attractants, such as found in other areas of Maricopa County.

3 – Disturbance to the mountain vegetation and surface, as occurs with intensive man-made uses such as quarries and housing, modify and potentially degrade the scenic quality of the mountains.

4 – The development of the piedmont results in a change in the scenic character of the landscape, shifting from natural or rural character to more suburban or urban character.

5 – Views from the piedmont to the mountains are restricted as the open space value becomes restricted or lost.

6 – Recreation on the developed piedmont and riverine landforms shift to primarily programmed recreation uses. These include parks, trails, and recreational facilities. Views are likely to shift from panoramic landscape views to internal views of the built open spaces and wash/channel routes.

2.4.3 Development Integration and Functional Connectivity

The planning and development guidelines and design criteria identified in this ADMP have been selected and refined with the recognition that increasing development is a necessary and desirable change in the Rainbow Valley area. By recommending an approach that integrates development into the existing functional mosaic of the watershed rather than drastically modifying it, the loss of watershed hydraulic and other functions can be partially mitigated while protecting public safety and potentially enhancing property values (**Figures 2-20**, **2-21**, and **2-22**).

The figures diagram how implementation of the performance functions and benchmark achievement outlined in the Recommended Plan can lead to watershed function and value preservation and mitigation that accommodate development and other desirable community expansion. The key to successfully accomplishing the desired floodplain management strategy is to provide integrated, effective flood hazard mitigation that maintains functional continuity from the watershed headwaters through the Waterman Wash outfall into the Gila River and beyond.

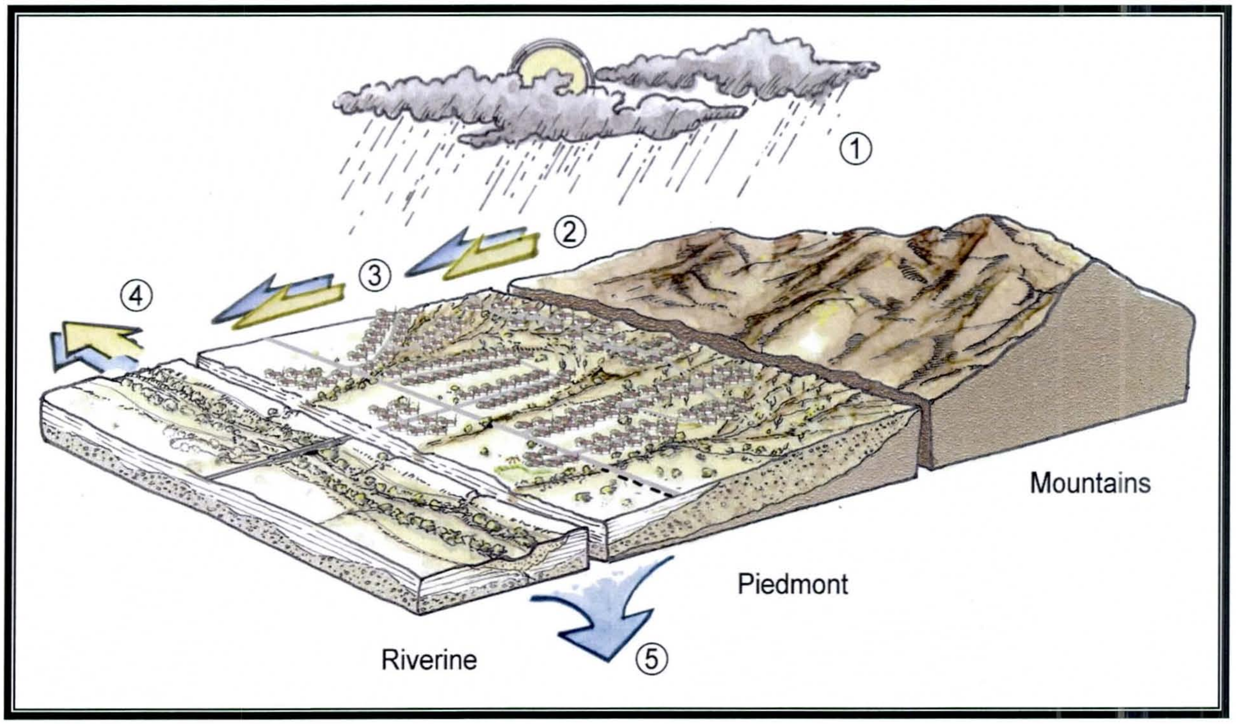


Figure 2-20 Relationship of Hydraulic Functions – Watershed Approach

Hydraulic Functions

1 – Precipitation in the form of rainfall on the mountains, piedmont, and riverine landforms continues to provide the foundation of the hydraulic functions of the watershed.

Minimizing disturbance to the mountain landform maintains functions that originate in the headwaters of the watershed. This in turn increases the potential for functional continuity through-out the remainder of the watershed.

2 – The preservation of dominant natural flow paths entering from the mountains are maintained through the watershed functional approach. Impacts to the watershed functions are restricted to limited areas where increases in impervious surface, discharge, flow timing, sediment loading and ground water recharge can be mitigated or controlled. Runoff from the mountains continue to support the hydraulic functions of the piedmont, providing base flows and sediment.

3 – Continuing to preserve the dominant natural flow paths across the piedmont and/or providing adequate preserved open space in sheet flow areas preserves basic watershed functionality while integrating development into the overall mosaic of uses. Incorporating pre-post storage basins with water-quality basins help to minimize downstream impacts while runoff over preserved open space areas help maintain infiltration, storage, and sediment transport into the riverine landform.

4 – Flows from the undisturbed open space and preserved washes carry water and sediments downstream into the Gila River.

5 – Runoff and flows from all three landforms infiltrate into the soil, recharging storage and groundwater reserves. The preservation of undisturbed floodplain beyond the floodway limits and existing vegetation helps mitigate downstream flooding potential while preserving floodplain storage and groundwater recharge.

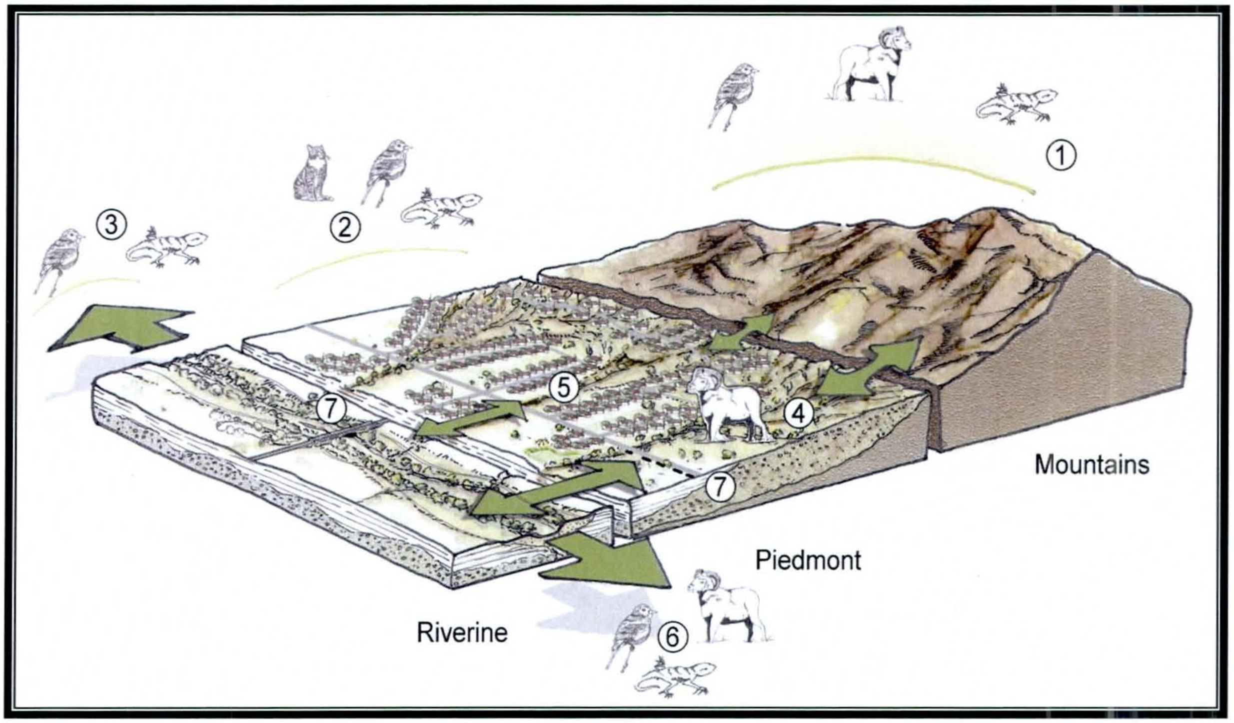


Figure 2-21 Relationship of Biological and Cultural Functions – Watershed Approach

Biological and Cultural Functions

1 – Minimizing disturbance to the mountain landform maintains biodiversity and protects their cultural resources and significance.

2 – The preservation of contiguous open space areas that connect the mountains to the piedmont to the riverine land forms helps preserve biodiversity and habitat value. The introduction of domesticated animals will still impact wildlife within the edge-areas of these open spaces, which would need mitigation.

3 – Preserving the existing vegetation in the riverine landform supports the diverse animal species including amphibians, mammals, reptiles, and birds that reside there.

4 – Large designated wildlife corridors, such as identified in the Sevenmile Mountain planning unit, allow large mammals to migrate and forage on the piedmont landform, maintaining genetic diversity within each herd. This helps mitigate the impacts associated with edge-condition habitats that will dominate the majority of preserved open spaces within the developed piedmont.

5 – Preserved SWCs within the piedmont landform also aid in maintaining biodiversity and serve as cover for migrating animals.

6 – The preserved axial streams continue to transport nutrient material into the downstream receiving waters, while allowing wildlife movement laterally through the watershed.

7 – Road crossings designed to accommodate large mammal movement are critical in areas that have high habitat value such as over Waterman Wash or across the wildlife corridor.

8 – Preservation of SWCs may provide opportunities to protect archaeological sites in place.

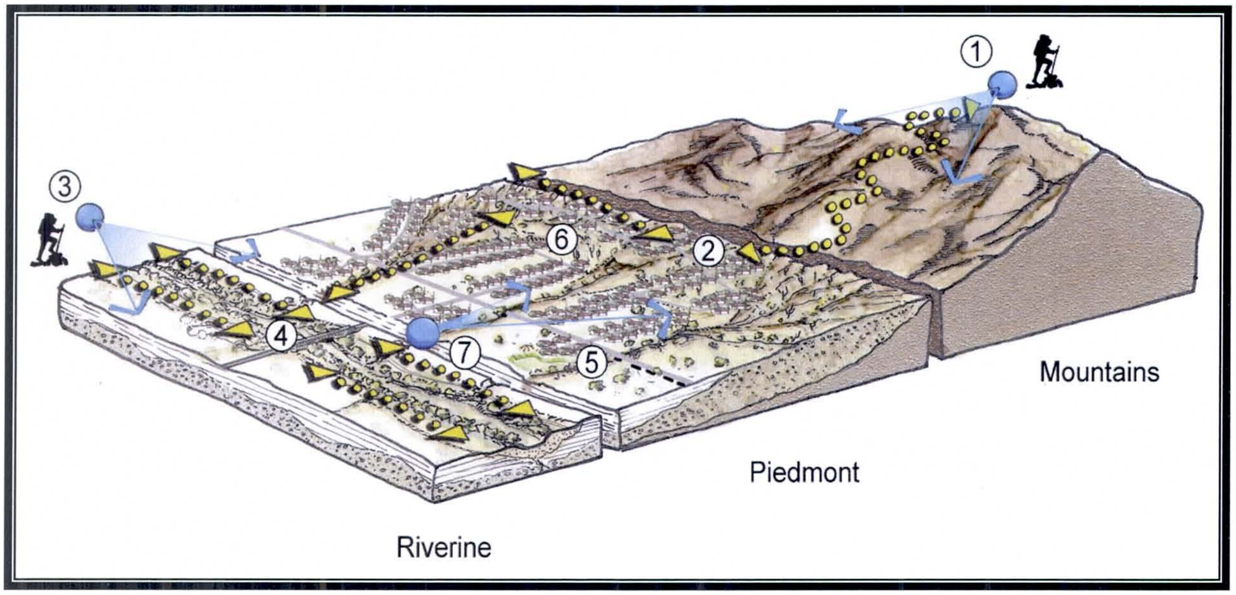


Figure 2-22 Relationship of Scenery, Recreation, and Open Space Functions – Watershed Approach

Scenery, Recreation, and Open Space Resources

1 – Panoramic views from the mountains of Rainbow Valley will be modified by development, but the use of the watershed functional approach helps retain the existing character of the valley. Preserving the natural, rugged mountain areas maintains their visually interesting skylines.

2 – Recreation such as trails and camping in the mountains will likely increase as development improves access to these areas. Proper recreation planning should consider impacts of trail design to the views and experience of both the users as well as the residents of Rainbow Valley.

3 – The establishment of Waterman Wash as a SWC with buffers and a trail system helps preserve its scenic value while mitigating against unprogrammed uses that can degrade the wash (i.e., off-roading).

4 – Limiting wash crossings to major arterial roads minimizes pedestrian-vehicle conflicts while incorporating separated crossings for the trail system can establish a continuous hiking/equestrian experience that is safer and desirable. Views within the wash become more important as development expands.

5 – Water quality basins and small disturbance areas can serve as ideal sites for neighborhood parks, limiting the amount of turf and other introduced landscapes to those areas already disturbed. Larger recreation facilities and sports fields may be better planned for sites where existing disturbance makes them more suitable for this use without losing other watershed functions and value from undisturbed landscapes.

6 – The open spaces of the preserved undeveloped piedmont landform provide room for a wide range of non-programmed recreation uses. The proximity to development along with police activities can mitigate for undesirable unprogrammed uses that would otherwise degrade the open spaces or endanger the public.

7 – By maintaining these open space areas continuously from the mountains to the riverine landform, the valley viewsheds can be preserved and focused.

2.5 FLOW CHARACTERISTICS AND FLOOD HAZARDS

The Rainbow Valley ADMP study area is a complex geomorphic system composed of multiple landforms exhibiting variable flow characteristics for storm runoff. A geomorphic assessment was conducted as part of the data collection effort to identify and describe the flow characteristics associated with the landforms within the study area. The geomorphic assessment is described in the Data Collection Report. The spatial relationship of the landforms and associated flow characteristics in the study area is shown on **Figure 2-23**. The flow characteristics and associated flood hazards are described below for the primary landforms identified within the study area.

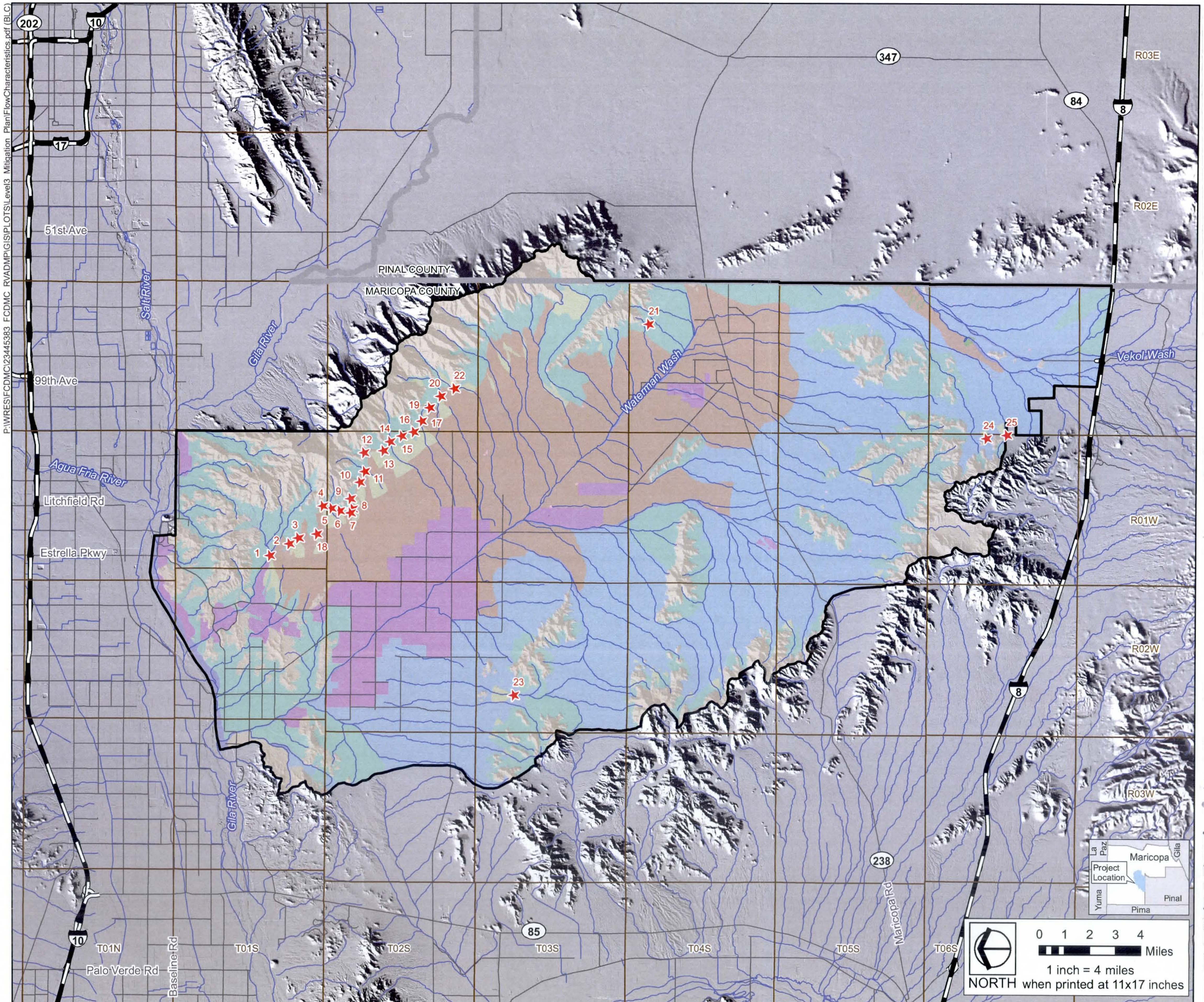
2.5.1 Mountain Slope Areas

The mountain slope area landform consists of steep mountainous terrain underlain by shallow or exposed bedrock. The mountain slope area landform is observed primarily within the northeastern and southwestern quarters of the study area, with other, smaller mountain areas distributed throughout. The channels in the mountain slope area landform consist of well-defined, low-sinuosity tributary streams in bedrock or mountain canyons. Flooding is characterized by deep, swift tributary channels. The primary flooding hazards are inundation and erosion. Due to the well-defined nature of the streams combined with the stability of the canyon and bedrock cross-sections, the flood hazards can be assessed with reasonable predictability and certainty for hazard mitigation.

P:\WRES\FCDMC\23445383 FCDMC RVADMP\GIS\PLOTS\Level3 Mitigation Plan\FlowCharacteristics.pdf (BLC)

Rainbow Valley
Area Drainage Master Plan
Flow Characteristics

Figure 2-23



Project Features

- Alluvial Fans Selected for Floodplain Delineation

Flow Characteristics

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

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
JE Fuller/Hydrology & Geomorphology
Alluvial fan identification and flow characteristics assessment, 2008

2.5.2 Piedmont[1] Areas with Tributary Drainage Systems

This landform consists of mildly sloping alluvial surfaces with dendritic tributary drainage networks. In the study area, the piedmont area with tributary drainage system landform occurs as a buffer between the mountain slope landform and the low-sloping piedmont or alluvial plain. The watercourses in this landform consist of moderately steep, well-defined channels with narrow floodplains. Flooding is generally constrained to the tributary channel network. Perched, geologically old surfaces are subjected to only very large magnitude flooding events. Primary flooding hazards are inundation, sedimentation, and erosion.

2.5.3 Piedmont Areas with Distributary[2] Drainage Systems

The dominant landform in the study area is the piedmont area with distributary drainage system. This landform consists of mild- to low-sloping alluvial surfaces with distributary drainage networks. Both stable and unstable distributary drainage patterns are observed. In general, the western piedmont sloping from the Maricopa Mountains was identified as a stable distributary system created through stream capture rather than by the avulsion-dominated processes found in active distributary systems. The distributary portion of the Sierra Estrella Mountain piedmont, however, is an active, unstable distributary system. These areas exhibit a high level of flow path uncertainty due to channel splits and are subject to frequent flooding of variable magnitudes. The primary flooding hazards are inundation, sedimentation, and erosion.

A typical distributary system from the study area is shown on **Figure 2-24**. The flow in this figure is from the bottom to the top of the figure. The upstream limit of the blue flow corridors is a single flow corridor where the runoff leaves the confined channel section at the base of the mountain. As it flows north multiple splits are seen such that by the downstream limit of the figure there are as many as five significant corridors. These flow splits can change from one storm event to another and can be influenced by debris or eroded vegetation blocking a path, resulting in the creation of a new corridor.

---

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

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

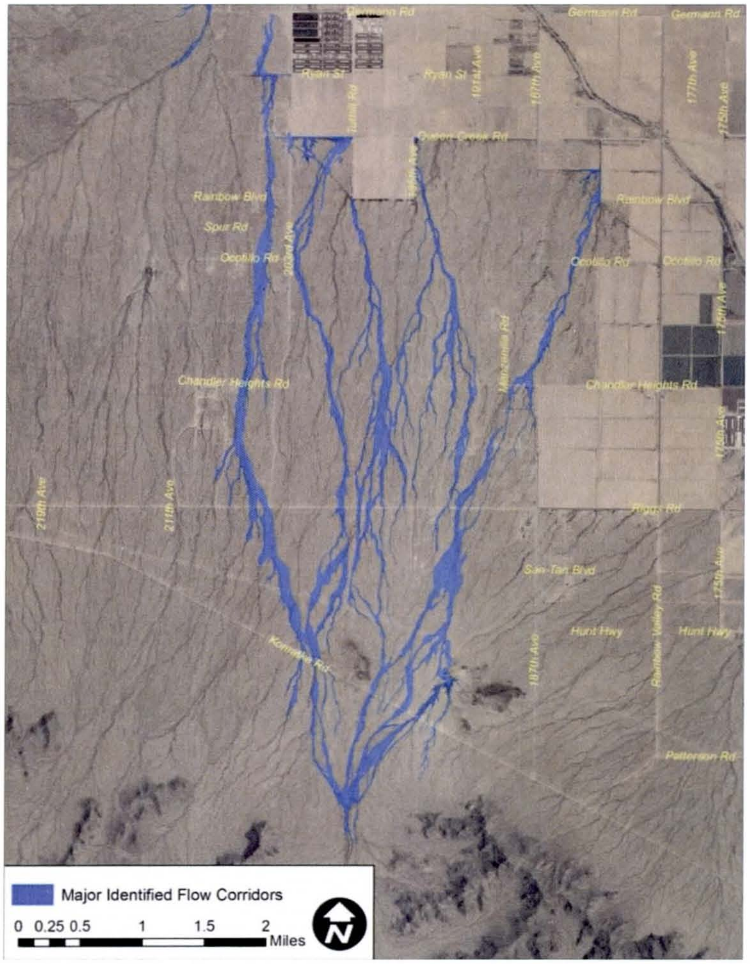


Figure 2-24 Piedmont Distributary Flow Area

2.5.4 Alluvial Fans

Alluvial fans are characterized by specific landform characteristics relating to their composition, morphology, and location. Alluvial fans are composed of eroded rock transported and deposited from an upstream watershed. They have the shape of a fan, either partially or fully extended, with a radial pattern of topographic contours. Alluvial fans are located near a topographic break, which may be expressed either laterally or vertically.

In the study area, alluvial fans occur within the piedmont area landform. Potential alluvial fans were identified throughout the study area; however, 25 fans were selected for further analysis but no delineations. Those 25 fans are identified in **Figure 2-23** by a red star at the fan apex.

2.5.5 Sheet Flow/Unconfined Flow Areas

Sheet and unconfined flow occurs where there is no well-developed or defined drainage network to convey the majority of floodwater. The term "sheet flow" refers to any form of unconfined runoff that occurs over a broad, expansive area. This broad definition of sheet flow incorporates several more narrowly defined flow types, including natural (classic) sheet flow, urban sheet flow, agricultural sheet flow, overland flow, perched flow, anastomosing flow, and distributary flow. Although sheet flow is the dominant process on high, geologically old swales, these individual landforms were not specifically identified as having sheet flow due to their scale. Large areas of sheet flow were identified within the study area and are shown on **Figure 2-23**. Sheet flow flooding is very widespread and not constrained to a defined channel network, flow depths and velocities are generally low. The primary flooding hazard is inundation and sedimentation.

A typical sheet flooding area within the study area is shown on **Figure 2-25**. From a hydrology perspective, the sheet flow area provides a significant amount of watershed storage of runoff which attenuates the peak discharges as a large volume of rainfall is used to cover the extensive land area to a depth that is great enough to support runoff. This large area of surface contact also supports infiltration into the piedmont surface. As these wetting and drying processes are repeated over time, a fragile crusting forms over the surface which tends to hold the soil particles together, helping to resist erosion.

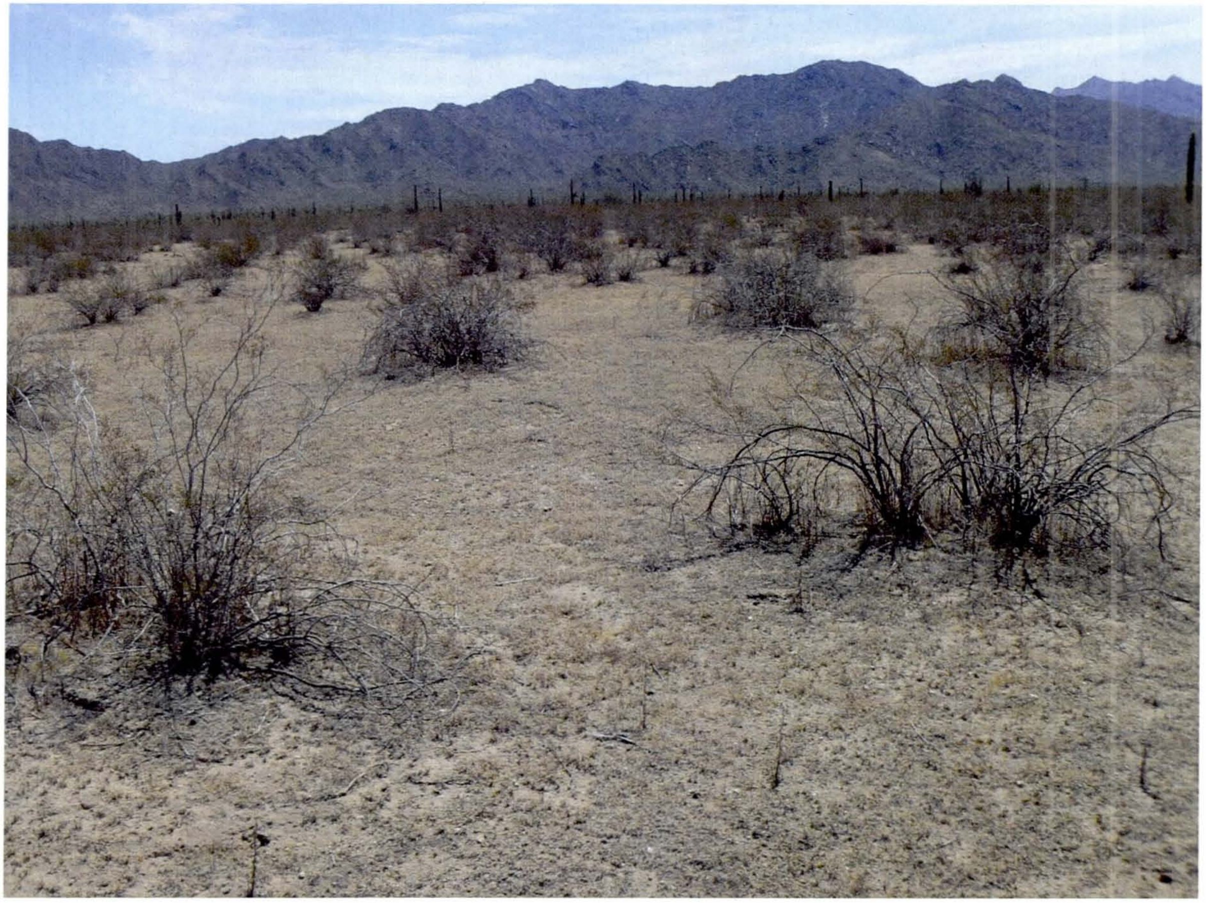


Figure 2-25 Typical Sheet Flooding Area in Rainbow Valley

2.5.6 Major Riverine Floodplains

A floodplain is a planar surface that is adjacent to a watercourse and is periodically inundated by flood water. Floodplains consist of relatively fine-grained, unconsolidated alluvium recently deposited by the watercourse. Of the watercourses in the Rainbow Valley ADMP, only Waterman Wash and its major tributaries were large enough to be mapped as a distinct landform at the mapping scale used. Riverine flooding is generally confined to active channel and floodplain corridors. The primary flooding hazards are inundation, sedimentation, and erosion.

2.6 INCORPORATED AREAS AND SURFACE MANAGEMENT

The Rainbow Valley Community is characterized by a multiplicity of jurisdictions and surface management agencies. Successful implementation of a watershed scale flood mitigation plan relies on the cooperation of these agencies to develop shared, or at least compatible, goals and objectives for the watershed. The incorporated cities and towns and the surface management agencies are shown on **Figure 2-1**.

The Bureau of Land Management manages the largest area of any surface management agency within the watershed. Much of the BLM land is within the Sonoran Desert National Monument, which is being preserved as secured open space and is therefore considered undevelopable. There is also a significant amount of Arizona State Trust lands within the watershed, which will eventually be auctioned off for development. Once acquired by developers, the development of State Trust lands will be regulated by the jurisdiction that contains the development.

The vast majority of private and State Trust lands, which could be potentially developed at some time in the future, are within the City of Goodyear municipal planning area which includes portions of unincorporated Maricopa County. As a result, the Recommended Plan implementation within this project is focused primarily on the City of Goodyear.

2.7 PLANNED LAND USE

Planned land use in the developable portions of the study area is primarily single family residential with higher intensity uses identified within the agricultural lands along Waterman Wash. Development is planned in two "nodes"; one at the north end of the valley in the areas currently being used for agriculture, and the other around SR 238 in the Mobile area due to BLM land ownership, which spans the entire valley for a portion of the central portion of the study area. Planned land use is shown on **Figure 2-26**. As a result of this development pattern, the recommended development regulations are based on a predominantly low density residential type development occurring within the developable piedmont areas that are currently in a natural and undisturbed state.

2.8 WATERSHED DEVELOPMENT IMPACTS

The flood hazards just described are hazards that exist in the relatively undisturbed state of each of the landforms. Since most of the Rainbow Valley area is in a natural and undisturbed state, the occurrence of these hazards is considered normal since the runoff flow characteristics have occurred throughout history with little or no harm to human activities or improvements. It is part of the natural ecosystem. As the area is changed from its natural condition via commercial development, disturbances to this ecosystem will typically create instabilities that can result in significant risk to life and property. It is important and customary to anticipate and mitigate these risks as part of the development process. Many of the landforms described within the Rainbow Valley area are typical of those occurring in other areas of the southwest. As a result, current development regulations are adequate to anticipate and mitigate the potential risks. However, there are some unique landforms which exhibit runoff flow characteristics that are not adequately anticipated or mitigated by conventional development practices. In particular, the alluvial fan, sheet flow, and piedmont distributary flow characteristics pose unique risks to development that will be briefly described in the following sections.

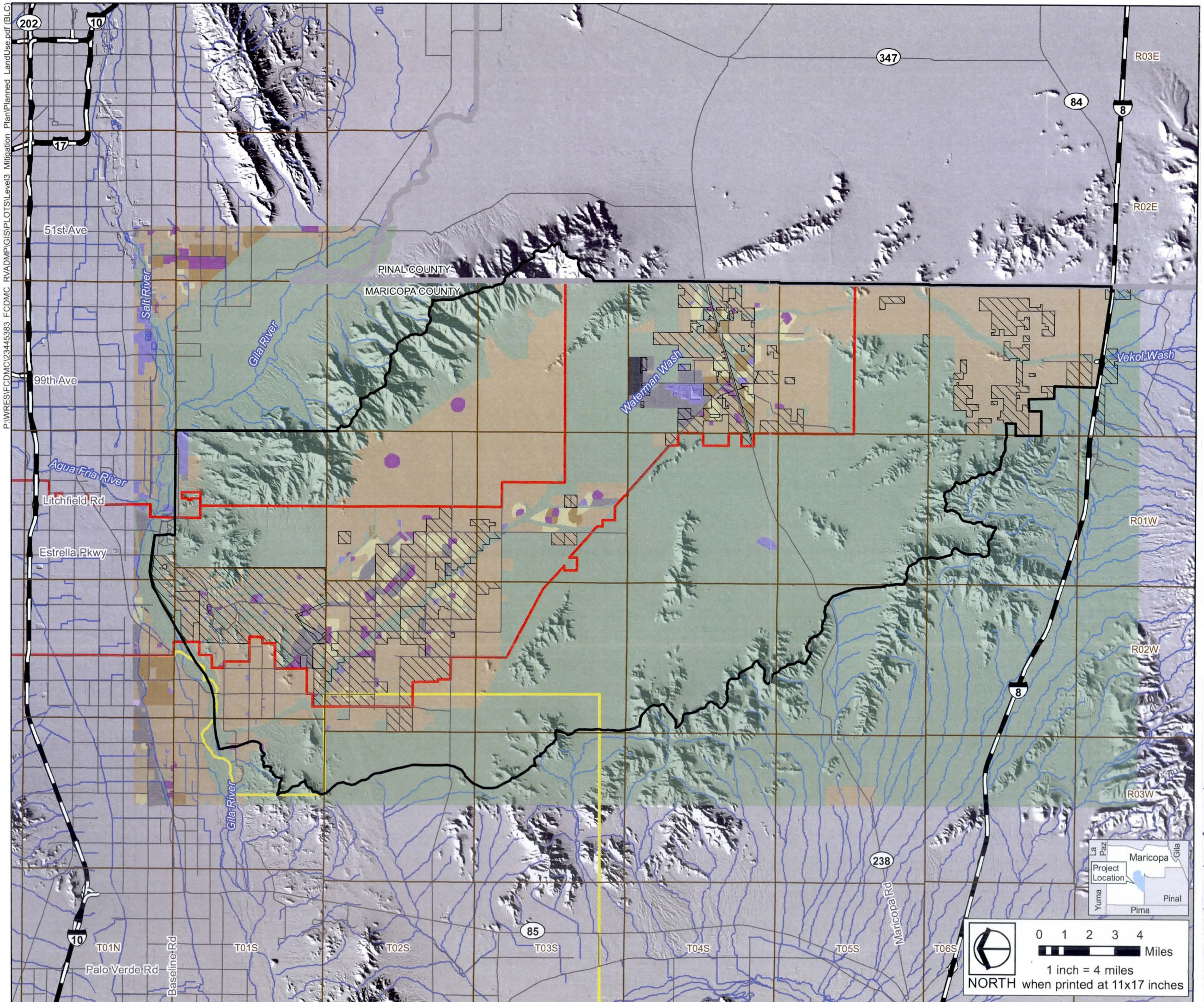
2.8.1 Development Impacts in Sheet Flooding Areas

As previously described, sheet flow areas are devoid of channels. This results in runoff spreading in a shallow depth over a large aerial extent which provides attenuation of peak discharges. The attenuation is a result of watershed storage and infiltration into the surface. Due to surface crusting and shallow flow depths, the surface remains fairly stable in its natural state. However, this fragile system is easily disturbed. Once runoff is concentrated and the fragile crusting is broken, erosion processes can begin that have the potential for significant damage. These processes are illustrated in a series of three photos (**Figures 2-27**, **2-28**, and **2-29**) showing the instability and resultant erosion and headcutting that can occur from simply driving across the piedmont surface.

Figure 2-27 shows a dirt road crossing the piedmont landform generally in an up and down slope direction. It is apparent from the loose sand on the roadway surface that it has intercepted runoff and become a conveyor of runoff. **Figure 2-28** is taken a short distance down slope from the first photograph. The road can be seen in the background, turning and leaving the photograph to the right. A new channel has formed from the runoff which does not turn with the road but continues down slope. Note the side channel flowing in from the left side of the photograph. **Figure 2-29** is taken a short distance upstream on that side channel. It is apparent that the side channel is forming as a headcut resulting from the formation of the new channel. The boundary can be seen where the crusting has broken, as evidenced by the sharp edge that defines the limit of the headcut.

Rainbow Valley
Area Drainage Master Plan
Planned Land Use

Figure 2-26



Project Features

- Master Planned Community (See Figure 7-1 for Community Information)
- Goodyear Planning Area
- Buckeye Planning Area

Residential

- Multi Family Residential
- Single Family Residential

Public/Quasi Public

- Other/Public Employment

Industrial/Commercial

- Industrial
- Office
- Retail

Other

- Open Space
- Transportation
- Multiple Use

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Modified Master Planned Communities Data, 2008

Figure 2-27 Unimproved Road – Estrella Planning Unit

Figure 2-28 Continuation and Concentration of Runoff

Figure 2-29 Headcutting

This small headcut has the potential to continue propagating upstream enlarging the area of piedmont surface instability. If this disturbance can be caused by the formation of a mere dirt path, imagine the potential disturbance that could result from a development.

2.8.2 Development Impacts in Piedmont Distributary Flow Areas

Piedmont distributary flow areas have similarities to sheet flow areas in that once the shallow channel capacity is exceeded, the overbank flooding functions much like sheet flooding, potentially connecting adjacent channels with a single floodplain. Development impacts from developing in piedmont distributary flow areas using conventional design requirements is illustrated from the September 4, 2009 Fort Mohave Storm in Mohave County, Arizona. The storm was over a distributary flow area and drained through a development near the downstream end of the piedmont (**Figures 2-30**, **2-31**, **2-32**, and **2-33**).

Figure 2-30 Erosion by Concentrating Flows – 1

Figure 2-31 Erosion by Concentrating Flows – 2

Figure 2-32 Deposition of Sediment as Flow Fans – 1

Figure 2-33 Deposition of Sediment as Flow Fans – 2

The flow corridors were blocked by the homes causing flow concentration as the flow was diverted to the narrow corridors between the homes. The flow concentration resulted in significant erosion and movement of sediments. The erosion formed new channels and undercut block walls. The sediment was then deposited in residential yards and driveways, as it fanned back out, no longer restrained.

2.8.3 Development Impacts in Alluvial Fan Areas

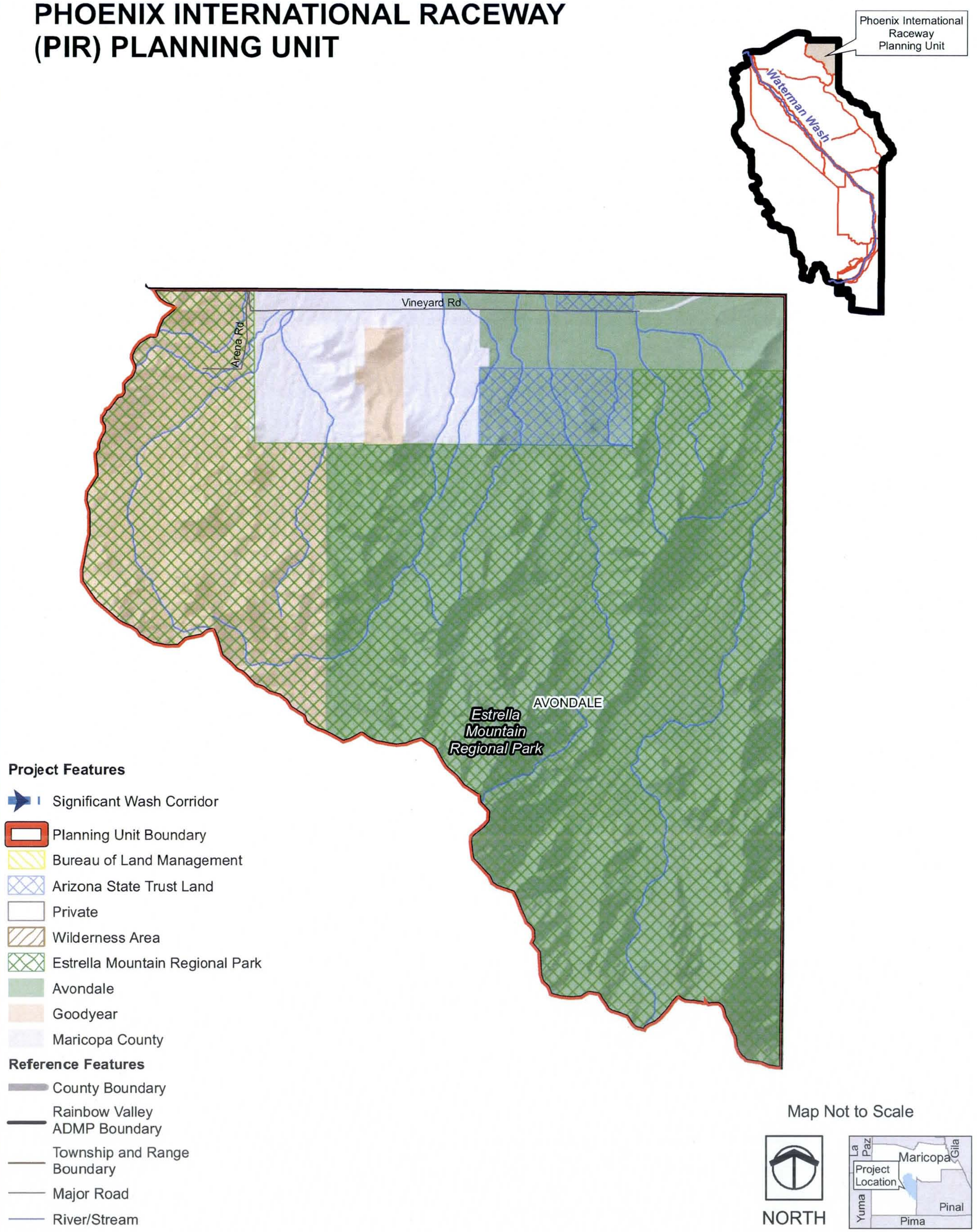
Alluvial fan areas can contain flood hazards associated with both distributary and sheet flow. The drainage areas upstream of the alluvial fan apices in the Rainbow Valley study area are relatively small, thereby limiting the severity of the potential for high hazard alluvial fan flooding under existing conditions. For most of the fans, the distributary flooding transitions relatively quickly to sheet flow downstream of the hydrographic apex. This indicates that the active portions of the alluvial fans are limited to a relatively small portion of the overall piedmont. Further, the landform characteristic assessment concluded that even though a large portion of the piedmont may be subject to active alluvial fan flooding, the nature of that flooding can be generally characterized as shallow, low-velocity sheet flooding (see Section 2.5.4). The piedmont landforms were classified as subject to active alluvial fan flooding due to FEMA's guidelines regarding sheet flow on alluvial fans.[3] The alluvial fans in Rainbow Valley follow unpredictable flow paths, although they do not necessarily carry high sediment concentrations.

Flood hazards can be exacerbated by development on active alluvial fan areas and/or areas downstream of the fans if a comprehensive flood control plan is not implemented. If not properly designed, development can cause erosion, sedimentation, and flooding similar to the development impacts discussed in Section 2.8.1 (Sheet Flow) and Section 2.8.2 (Distributary Flow).

---

[3] *Guidelines and Specifications for Flood Hazard Mapping Partners. Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping.* FEMA, 2003.

PHOENIX INTERNATIONAL RACEWAY (PIR) PLANNING UNIT



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- No New Actions

Flood Context - Effective

Typical Landform and Flood Characteristics

- Mountains
- Piedmont tributary flooding
- PIR - disturbed area
- Existing floodplain ordinance and Clean Water Act (404 permits) provides means to protect washes

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Historic and prehistoric sites
- Predominantly mixed upland desert scrub with some mixed creosote scrub
- Ephemeral riparian washes
- River terrace habitat adjacent to Gila River
- Wildlife connectivity between Sierra Estrellas and Gila River
- Initial point of Gila and Salt River baseline and Meridian

Aesthetic and Multi-Use Resources Opportunities

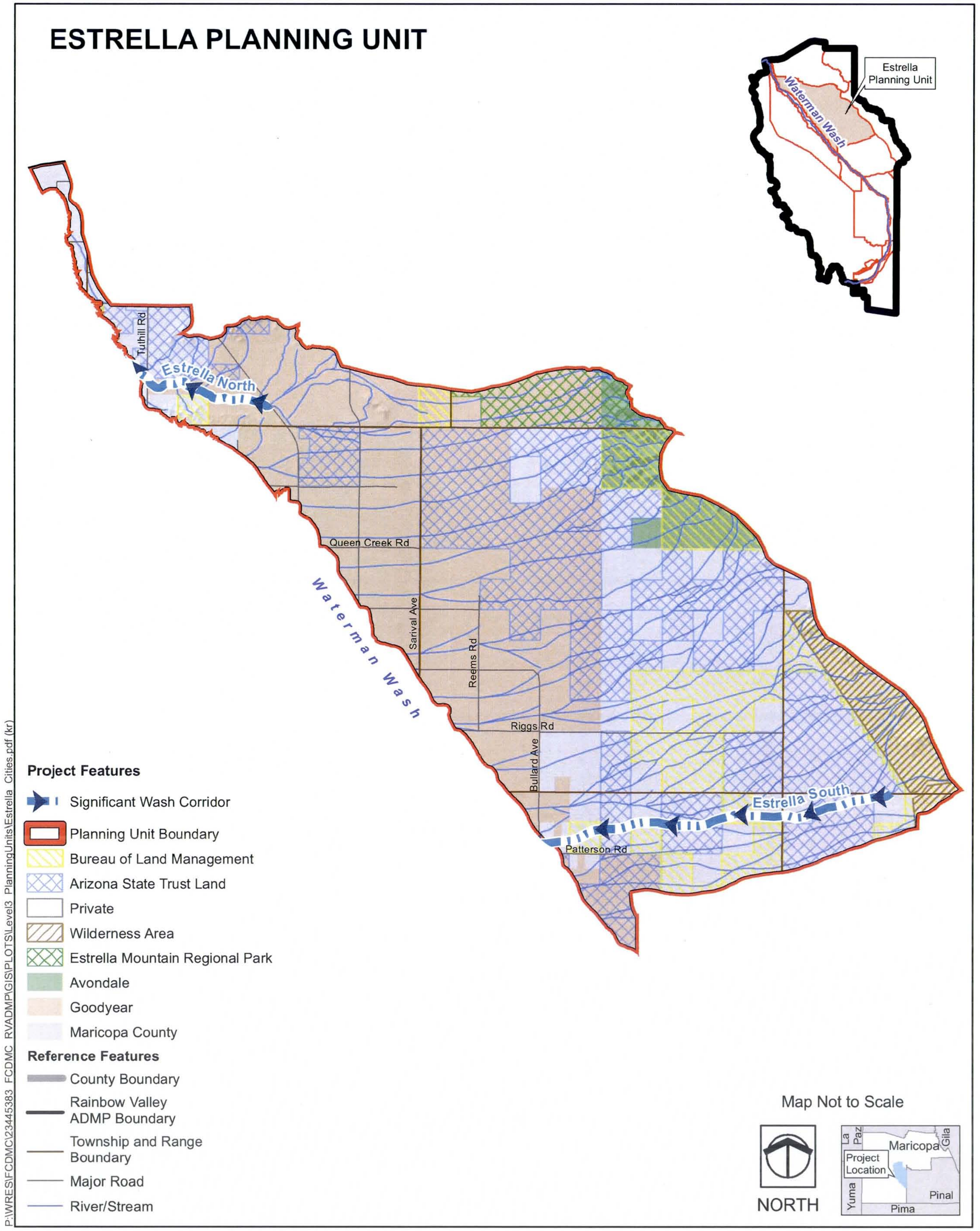
- PIR provides existing recreational opportunity
- Views of Sierra Estrellas and Gila River
- Specific opportunities with adjacent Gila River projects (Tres Rios and El Rio)
- Many community trails throughout regional park

Community Context - Acceptable

Land Management and Implementation

- Site of Phoenix International Raceway
- Estrella Mountain Regional Park - protected from development
- Some private property along Gila River - smaller parcels
- City of Avondale
- Existing regulations adequate
- Many public supply, domestic, and industrial wells
- Overhead powerlines (Western Area Power Administration and Public Service Company of New Mexico

Figure 2-2



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- Protect Significant Wash Corridors
- New Regulations

Flood Context - Effective

Typical Landform and Flood Characteristics

- Alluvial fans
- Sheet flow - unpredictable flow paths
- Disturbed Areas -unpredictable flow paths
- Two significant wash corridors
- Limited existing flood conveyance corridors
- Development to minimize adverse impacts to up and downstream properties

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Potential prehistoric sites (including petroglyphs) and prehistoric site in along SWCs
- Land area contiguous to Waterman Wash disturbed agricultural areas
- Mixed creosote scrub transitioning to mixed upland scrub towards the Sierra Estrellas
- Two relatively large patches of mixed salt desert scrub
- Two contiguous washes from Sierra Estrellas to Waterman Wash at the north and south boundaries of the watershed likely used as natural connections for wildlife to Waterman Wash
- Impacts to 404 Washes (mitigation banking opportunities)
- Clean Water Act considerations related to stormwater quality
- Secure natural flow ways
- Provide connectivity where blockages such as roads may impede wildlife movement

Aesthetic and Multi-Use Resources Opportunities

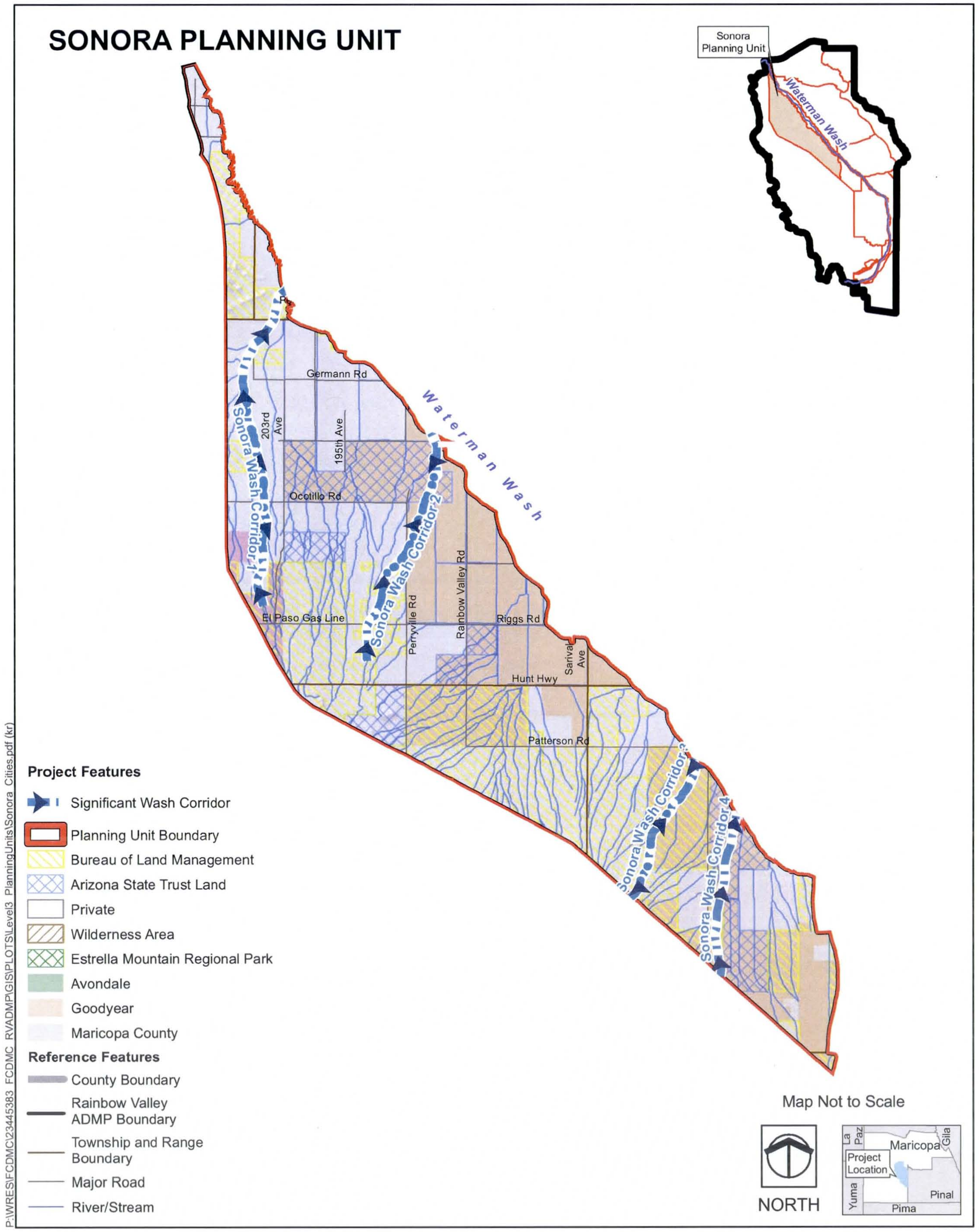
- Opportunities for interpretive themes for outdoor recreation facilities (prehistoric/ethno historic Komatke Trail, historic Rainbow Valley Community, and Unsustainability of deep well irrigation agriculture
- Maricopa Regional Trail System
- Local, County, and Regional Park Opportunites
- Desert views to Waterman Wash and Sierra Estrella Mountains
- Valley Plain/Lower Bajada
- Two wash corridors (south and north)
- Regional planning approach
- Attaining east - west connectivities

Community Context - Acceptable

Land Management and Implementation

- City of Goodyear General Plan
- Coordination with Regional Transportation Corridors such as the Loop 303 Extension
- Use of setbacks/easements to allow for migration of SWCs
- Modify land use plans and roadway system to be flow friendly
- Land swaps
- Coordinate with regional utility corridors
- Loop 303 Corridor Extension
- Planned Goodyear Enhanced Transit Corridor
- Public Supply, Domestic and Industrial wells
- Waste Water Treatment Plant
- Arizona Public Services Company overhead transmission line
- El Paso Corporation Active Gas Pipeline

Figure 2-3



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- Protect Significant Wash Corridors
- New Regulations

Flood Context - Effective

Typical Landform and Flood Characteristics

- Waterman Wash floodplain along eastern border
- Disturbed (agricultual) Areas in northeast along Waterman Wash - unpredictable flow paths
- Sheet flow areas in southeast along Waterman Wash - unpredictable flow paths
- Large areas of distributary flow - unpredictable flow paths
- Four (4) significant wash corridors identified
- Central area washes end prior to Waterman Wash in disturbed area. Zone A floodplains in distributary flow areas not delineated in disturbed areas
- West Prong Waterman Wash is the southern most SWC

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Sonoran Desert National Monument is western border
- Potential for prehistoric sites that could be protected at SWCs
- Land area contiguous to Waterman Wash disturbed agricultural areas
- Mixed creosote scrub with pockets of mixed upland desert scrub
- Impacts to 404 Washes (mitigation banking opportunities)
- Clean Water Act considerations related to stormwater quality
- Secure natural flow ways
- Provide connectivity where blockages such as roads may impede wildlife movement
- West Prong Waterman Wash wildlife access from Sonoran Desert National Monument to Waterman Wash

Aesthetic and Multi-Use Resources Opportunities

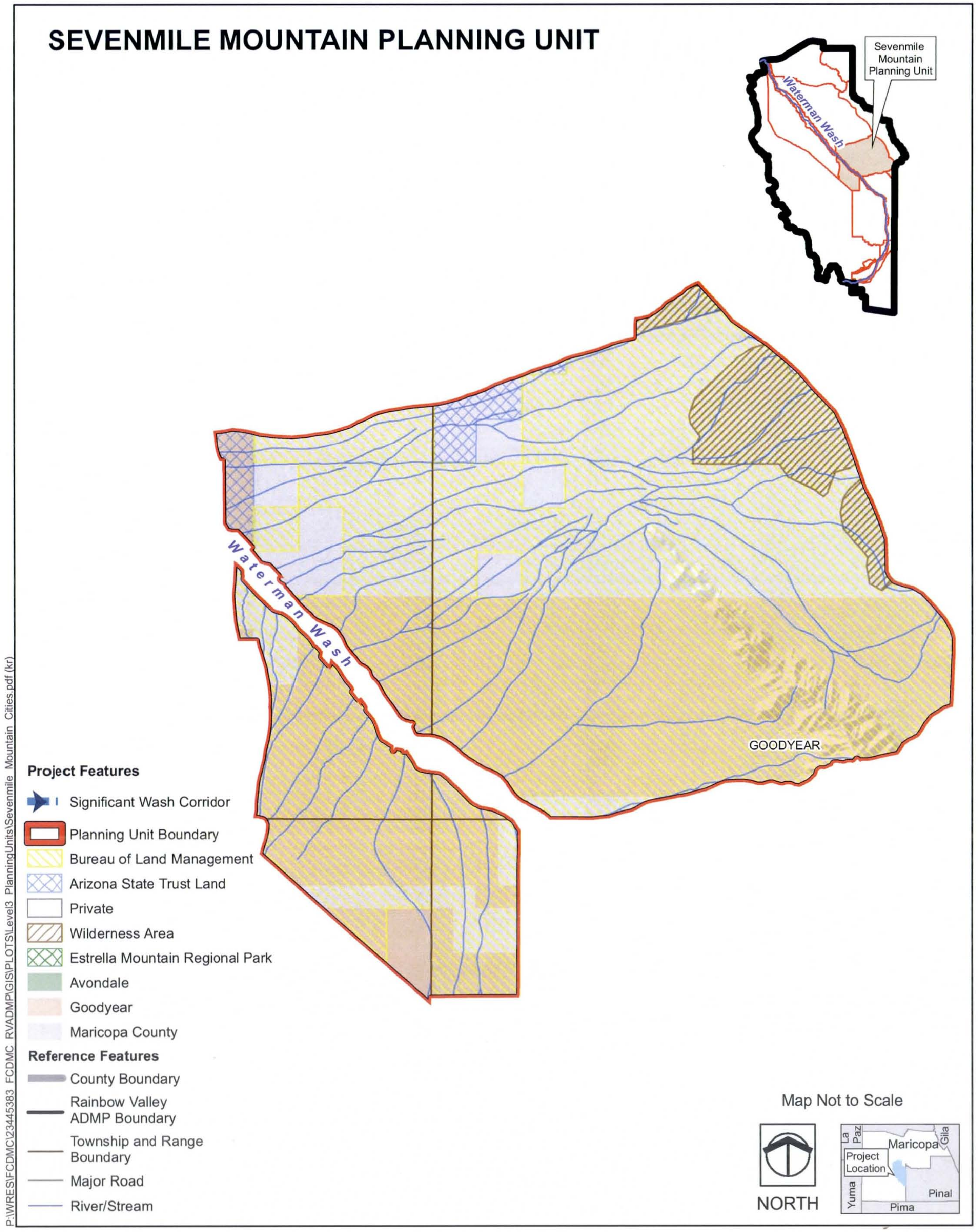
- Maricopa Regional Trail System
- Local, County, and Regional Park Opportunites
- Desert views to Waterman Wash and Sierra Estrella and North Maricopa mountains
- Valley Plain/Lower Bajada Scenery Resource
- Four significant wash corridors
- Regional planning approach
- Attaining east - west connectivities
- Natural Sonoran Desert Upland Riparian Scenery Resource
- Natural Lower Sonoran Desert Riparian Scenery Resource
- Non-structural, Soft-Structural, Semi-Soft Structural
- Possible interpretive themes for outdoor recreational facilities along SWCs including prehistoric/ethnohistoric Komatke Trail, history of Rainbow Valley Community and unsustainability of deep well irrigation agriculture

Community Context - Acceptable

Land Management and Implementation

- City of Goodyear General Plan
- Coordination with Regional Transportation Corridors such as Hassayampa Freeway and Sonoran Valley Parkway
- Use of setbacks/easements to allow for migration of SWCs
- Modify land use plans and roadway system to be flow friendly
- Land swaps
- Coordinate with regional utility corridors
- City of Buckeye
- Some parcels owned by ASLD
- Coordination with larger major landholders
- Some parcels under BLM management

Figure 2-4



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\GIS\PLOTS\Level3_PlanningUnits\Sevenmile_Mountain_Cities.pdf (kr)

PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- No New Actions

Flood Context - Effective

Typical Landform and Flood Characteristics

- Transected by Waterman Wash
- Sheet flows to Waterman Wash from the south west
- Mountain and piedmont tributary flows in the south east transitioning to sheet flow at slope break.
- Some washes are designated floodplains including administrative floodways.
- A few alluvial fans

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Designated wildlife corridor connecting Sierra Estrella Mountains with the Maricopa Mountains and Sonoran Desert National Monument
- Mixed creosote scrub with mixed upland desert scrub in the southeaster mountains
- There are a few continuous washes that flow from the east to Waterman Wash that could be SWC however since area is not planned for development SWC designation not required
- Some potential for prehistoric sites related to hunting and gathering of desert resources and perhaps petroglyphs
- Possible historic sites

Aesthetic and Multi-Use Resources Opportunities

- Southwest of Waterman Wash are the proposed corridors for the Loop 303, Sonoran Valley Parkway, and Hassayampa Freeway
- Planned open space designated by Goodyear in City limits
- Maricopa Regional trail system along northern boundary and Waterman Wash (PU - WR3)
- Tucson Electric Power - Existing overhead utility traverses east side
- Arizona Public Service Overhead Transmission Line and Active El Paso Gas Pipeline along western boundary

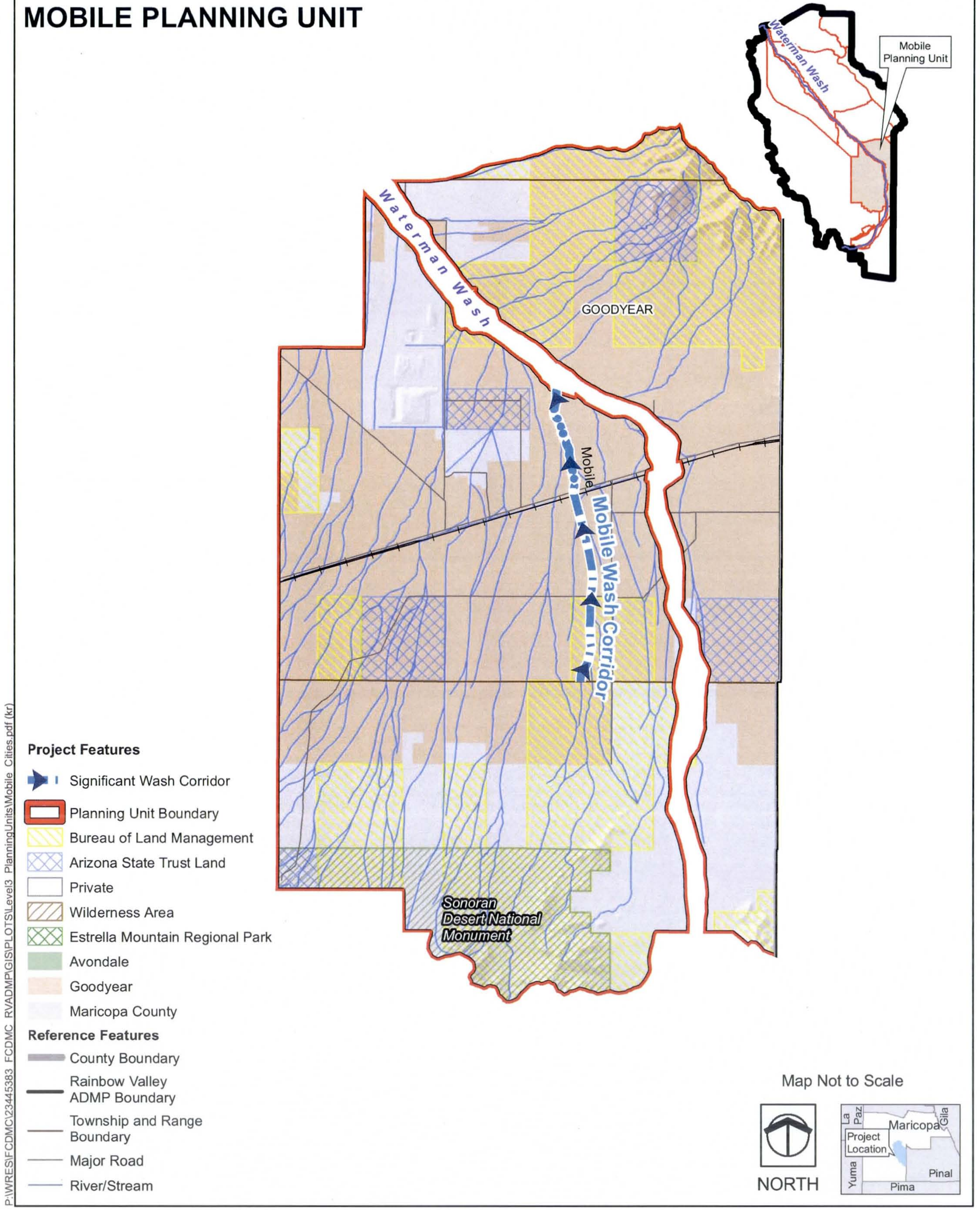
Community Context - Acceptable

Land Management and Implementation

- City of Goodyear
- Most of the land managed owned by the BLM
- There are a few scattered locations of private property
- Opportunities for land swaps where where private property bounded by BLM land

Figure 2-5

MOBILE PLANNING UNIT



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- Protect Significant Wash Corridors
- New Regulations

Flood Context - Effective

Typical Landform and Flood Characteristics

- Predominantly sheet flow west of Waterman Wash
- A few Iselbergs where at the slope breaks piedmont tributary flow occurs. Mostly east of Waterman Wash
- Waterman Wash separates the planning unit east and west
- SR 238 and UPRR separate the planning unit into a north and south
- UPRR acts as a levee like structure with many culverts/small bridges providing flow paths for ephemeral washes. Ponding areas form on the upstream (south) side of the structure.
- UPRR and SR238 can not be considered levees (not accredited) so hydrologic analysis considers two scenarios; 1- with levee and 2- no levee (no UPRR or SR 238)

Land and Resources Context - Compatible

Cultural and Environmental Resources

- History of African American Community and history of Southern Pacific Railroad
- Juan Bautista de Anza National Historic Trail crosses planning unit from east to west. Coincident is the Butterfield Overland Mail Road
- Some potential prehistoric and historic sites (North Tank - Mobile community used as a baptismal pond)
- Waterman Wash retains its native vegetation and character for wildlife
- Mixed Creosote Scrub dominate planning unit
- Riparian ephemeral Xeri-riparian washes
- Iselbergs have mixed upland desert scrub vegetation
- Wildlife Corridor along southern portion connecting Sierra Estrella Mountains and South Maricopa Mountains
- One significant wash corridors (SWC) designated, west of Waterman Wash. It extends south across the SR238/UPRR corridor.
- Impacts to 404 Washes and opportunities for mitigation banking
- Clean Water Act considerations related to stormwater quality

Aesthetic and Multi-Use Resources Opportunities

- Northeast protion designated City of Goodyear planned open space
- Waterman Wash is defined but not as well delineated farther south.
- Maricopa Regional Trail System along Waterman Wash and historic east west trail corridor
- Interpretive cultural themes for outdoor recreation along SWCs
- Public Supply, Domestic and Industrial Wells
- Regional planning approach

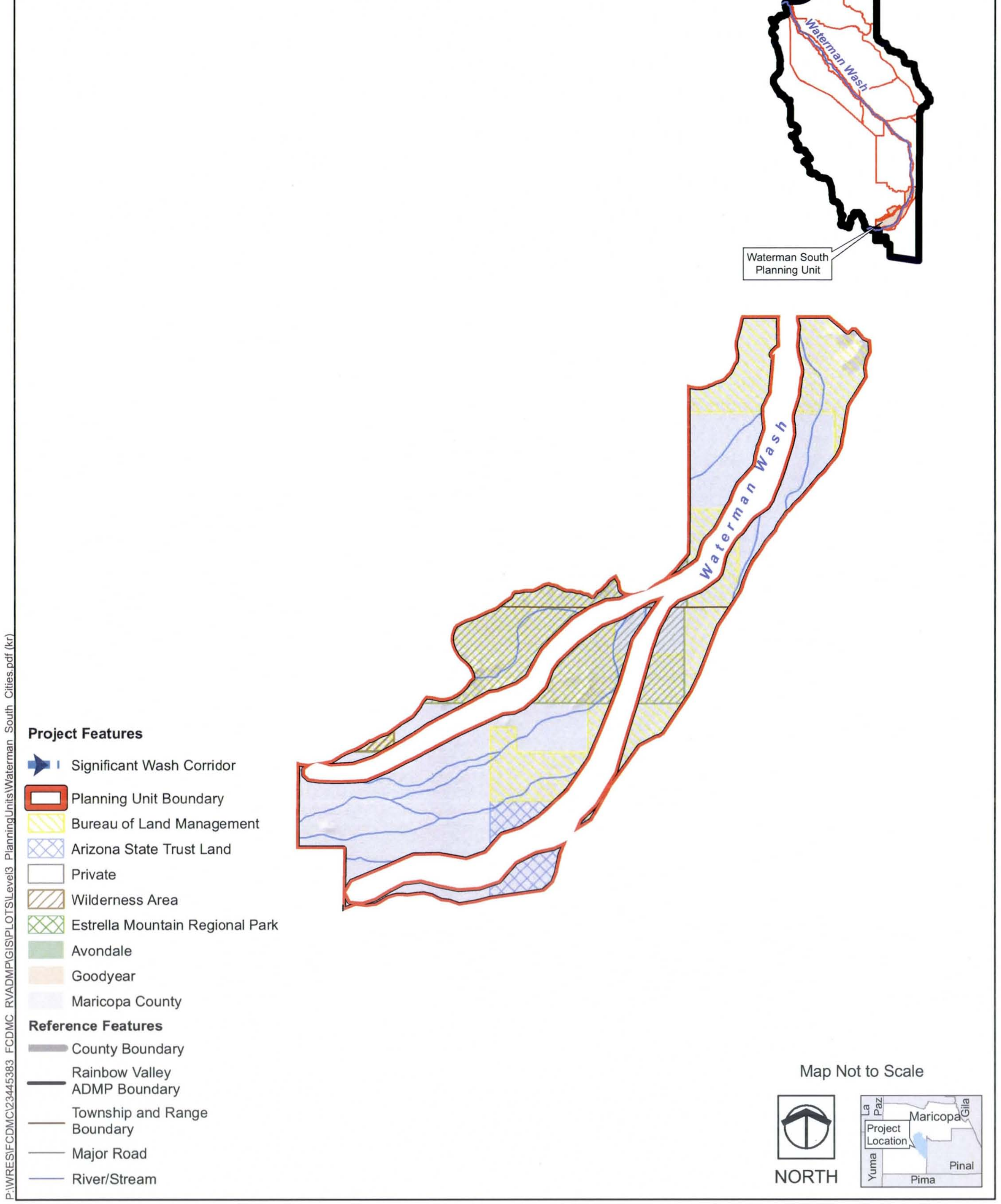
Community Context - Acceptable

Land Management and Implementation

- City of Goodyear
- Some parcels under BLM management
- Some parcels owned by the Arizona State Land Department
- Former Amaranth Development major property owner.
- Wildcat subdivisions prevelant south of UPRR.
- There is some disturbed area (Butterfield Landfill)
- Existing substation along SR238
- Overhead Transmission Lines - Arizona Public Service
- Gas Pipelines - El Paso Corporation - both active and abandoned
- Butterfield Landfill - Active
- Small plane airport

Figure 2-6

WATERMAN SOUTH PLANNING UNIT



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- New Regulations

Flood Context - Effective

Typical Landform and Flood Characteristics

- Headwaters of southern portion of Waterman Wash (WR5)
- Sheet flow adjacent to Waterman Wash
- Mountains and piedmont tributary flow divides Waterman Wash into two forks

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Some potential prehistoric sites related to hunting and gathering of desert resources
- Possible historic sites
- Portions in the Sonoran Desert National Monument
- Portions included in the Vekol Valley Grassland Species Habitat
- Mixed creosote scrub with some portions mixed desert upland scrub
- Clean Water Act requirements for stormwater quality in developing areas

Aesthetic and Multi-Use Resources Opportunities

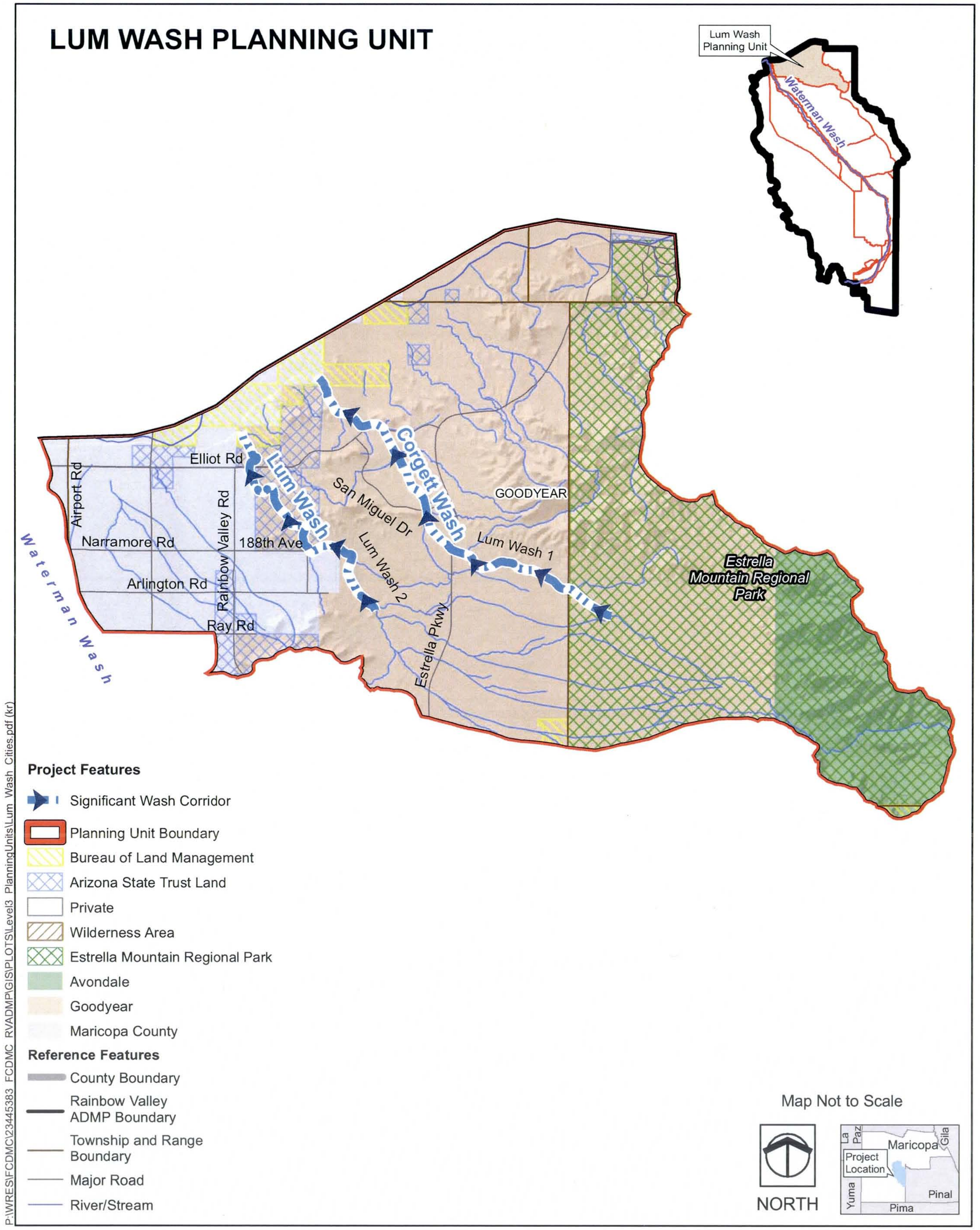
- Public Supply, domestic, and industrial wells
- Loop 303 Spur and Val Vista Parkway cross the planning unit
- Maricopa Regional Trail System connects Waterman Wash and Vekol Wash sections
- Scenic views of the Sierra Estrella Mountains and South Maricopa Mountain Wilderness
- Natural and rural sonoran valley plain

Community Context - Acceptable

Land Management and Implementation

- BLM managed public lands
- Some private land
- Some planned development in the southwestern part of planning unit

Figure 2-7



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- Protect Significant Wash Corridors

Flood Context - Effective

Typical Landform and Flood Characteristics

- Two significant Wash Corridors along named washes (Corgett Wash and Lum Wash)
- Flow is to the north and the Gila River
- Mountains and piedmont tributary flow
- Disturbed developed area
- A few alluvial fan type formations at the base of the mountains
- Planned development including drainage in Estrella Mountain Ranch
- Existing stormwater regulations should be adequate other than for SWCs

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Potential for Prehistoric Sites including petroglyphs
- Possible historic sites to be protected along SWCs
- Much of area previously cleared
- Mixed Creosote Scrub and Mixed Upland Desert Scrub
- Incised washes - 404 jurisdictional
- Clean Water Act considerations related to stormwater quality

Aesthetic and Multi-Use Resources Opportunities

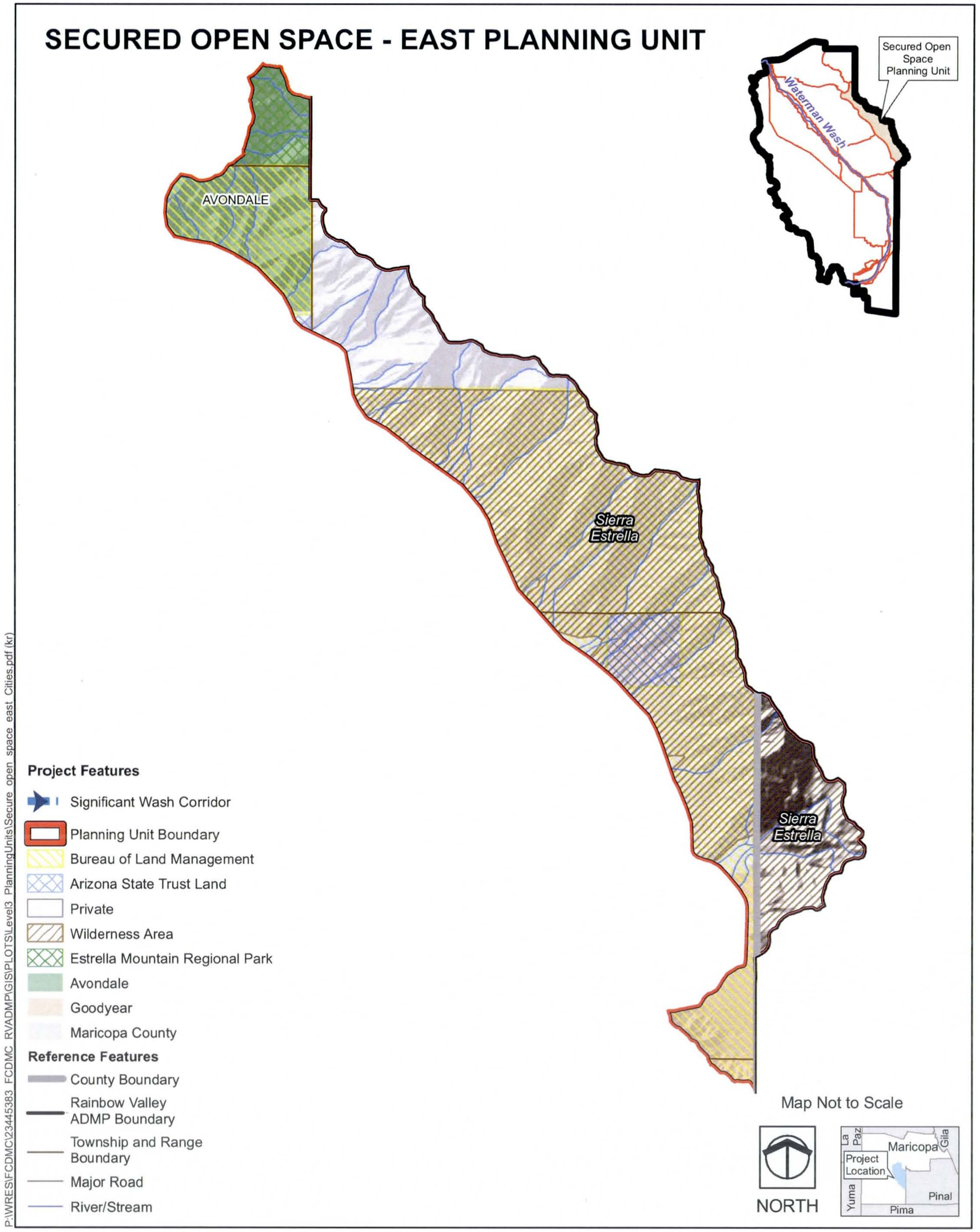
- Estrella Mountain Regional Park
- Loop 303 Extension, Cotton Lane Extension, Sonoran Valley Parkway and Planned City of Goodyear enhanced transit corridor
- Opportunities along SWCs for interpretive themes to include Hohokam Villages and hunting and gathering of upland deserts
- City of Goodyear Planned Open Space along Gila River - northern boundary
- Maricopa Regional Trail System
- Community, City and regional parks and trails
- Golf courses
- Views of Waterman Wash and the Gila River
- Views of the Sierra Estrella and Buckeye Mountains
- Scenic View Scapes of foothills

Community Context - Acceptable

Land Management and Implementation

- Cities of Goodyear and Avondale
- Unincorporated Maricopa County
- Use setbacks/easements for migration of SWCs
- Road systems parallel and perpendicular to SWCs to minimize flow impacts
- Wildlife crossings for SWCs at major proposed transportation crossings
- Public Supply, Domestic and Industrial Wells
- Waste Water Treatments Plants
- Overhead Transmission Arizona Public Service

Figure 2-8



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- No New Actions

Flood Context - Effective

Typical Landform and Flood Characteristics

- Mountain Landform
- Flows concentrate in canyons
- Steep terrain with high velocity flows
- Alluvial fan/distributary flow ina few areas of slope break in the upper bajada

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Potential for prehistoric sites (including petroglyphs) and possibly historic sites
- Quartz Peak Trail, prehistoric/ethnohistoric trail is a designated recreational trail in the Sierra Estrella Wildness
- Natural Mixed Upland Desert Scrub
- Eastern portion of the wildlife corridor between Sierra Estrellas, Waterman Wash and the Sonoran Desert National Monument
- Some prehistoric sites (Includes a portion of the Gila River Indian Community Reservation)
- Sierra Estrella Wilderness

Aesthetic and Multi-Use Resources Opportunities

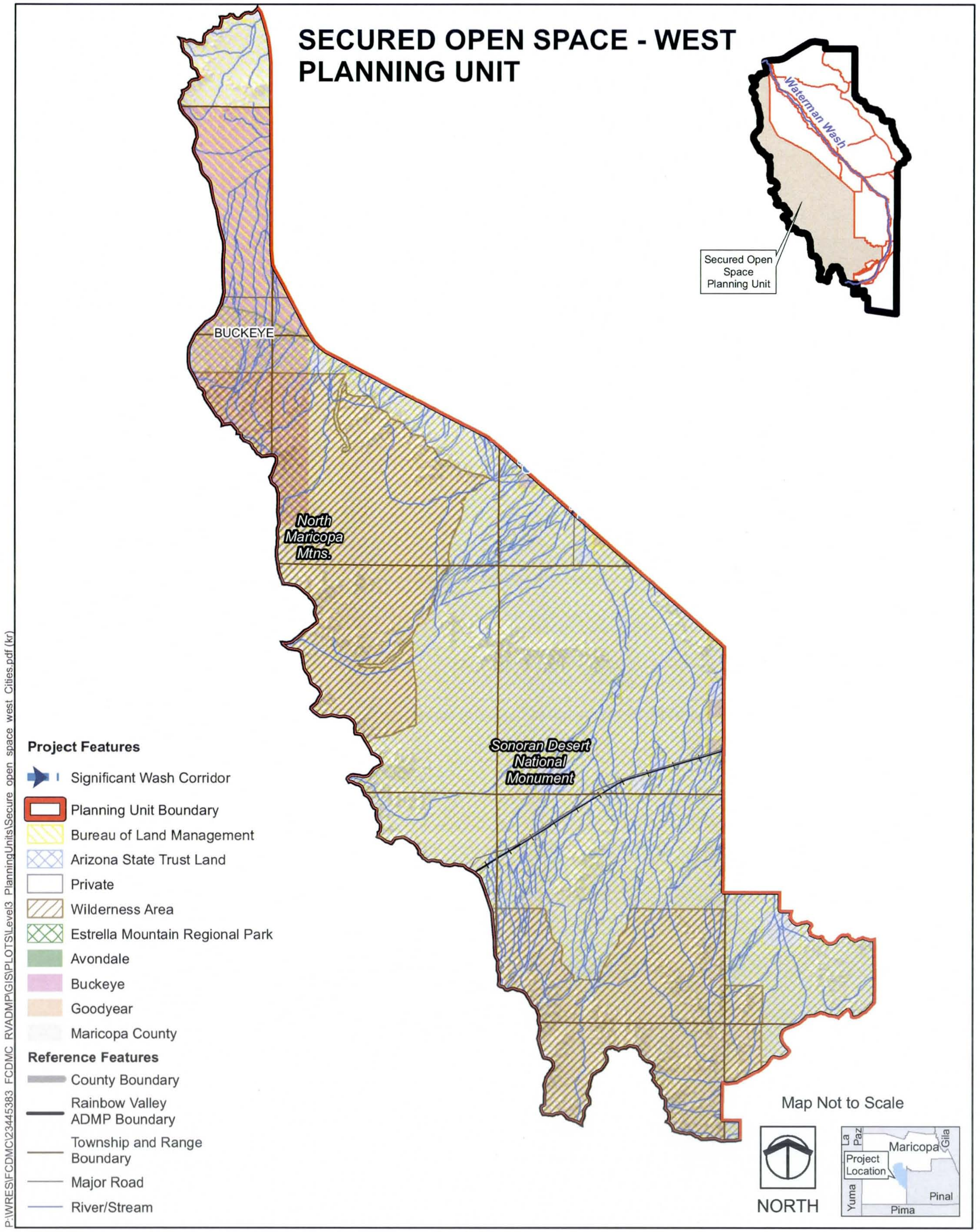
- Scenic views of Sierra Estrella Mountains
- Scenic views of Rainbow Valley
- Sierra Estrella Wilderness
- Destination for Maricopa Regional Train System
- Mountains and natural arroyos, and natural upper bajada at slope breaks

Community Context - Acceptable

Land Management and Implementation

- Gila River Indian Community
- Unincorporated Maricopa County
- Most of the land under Bureau of Land Management management
- Some Arizona State Trust Land
- Overhead Utilities (Tucson Electric Power Co. and Public Service Co. of NM)

Figure 2-9



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- No New Actions

Flood Context - Effective

Typical Landform and Flood Characteristics

- Predominantly distributary flow
- Portions of both the North and South Mariocpa Mountains
- Piemont tributary flow at slope breaks with mountains
- Some alluvial fans
- West Prong Waterman Wash and smaller ephemeral washes

Land and Resources Context - Compatible

Cultural and Environmental Resources

- State Wildlife Area
- Sonoran Desert National Monument
- Two identified Wildlife Corridor between Sierra Estrella Mountains and Maricopa Mountains
- Mixed Salt Desert Scrub
- Mixed Creosote scrub transitioning to Mixed Upland Desert Scrub
- Potential for numerous prehistoric sites reflecting hunting and gathering in the Sonoran Desert National Monument
- Possible historic sites
- Juan Bautista de Anza National Historic Trail/Butterfield Overland Mail road is a major interpreted historic resources in the monument
- Headwaters of West Prong Waterman Wash and other washes that flow northeast to Waterman Wash

Aesthetic and Multi-Use Resources Opportunities

- Maricopa Regional Trail System
- Town of Buckeye Regional Park
- Union Pacific Railroad Corridor
- State Road 238 Corridor
- APS Overhead Transmission Line
- Active EL Paso Corporation Gas Pipeline
- Public, domestic, industrial wells

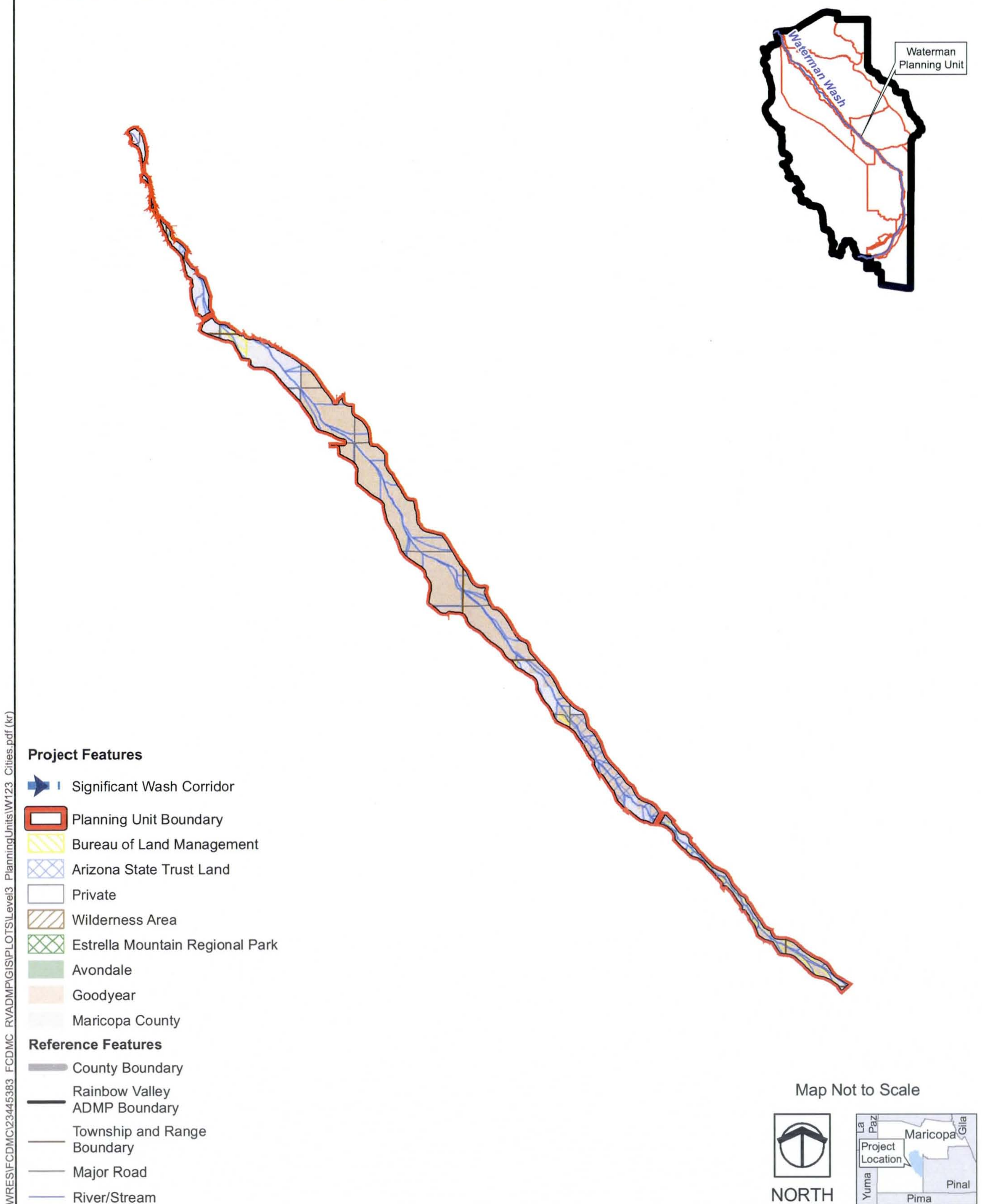
Community Context - Acceptable

Land Management and Implementation

- Sonoran Desert National Monument (BLM)
- Some private parcels within the National Monument
- Proposed Sonoran Valley Parkway along portions of northeast boundary
- Potential crossing by proposed Hassayampa Freeway north of the National Monument
- Town of Buckeye

Figure 2-10

WR 123 PLANNING UNIT



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\GIS\PLOTS\Level3_PlanningUnits\W123_Cities.pdf (kr)

PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- New regulations

Flood Context - Effective

Typical Landform and Flood Characteristics

- Ephemeral Wash with 100-year discharges ranging from 3,000 cfs to 12,000 cfs
- Major tributary flow from West Prong Waterman Wash at milepost xxx.
- Bankfull discharge channel - sandy bottom with riparian growth at bankfull limits
- Wide floodplain in many areas
- Confluence with the Gila river.
- Flow direction southeast to northwest
- Adjacent land sheet flow and disturbed agricultural except in north where flow patterns are piedmont tributary
- Delineated floodplain and floodway with BFEs - Allows development to encroach to floodway limit.
- Road crossing both by bridge/culvert structures and at grade

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Potential for prehistoric and historic sites
- Hohokam village (site AZ T:10:46(ASM) and Waterman farmstead located near confluence of Waterman Wash and Gila River
- Wildlife Corridor crosses wash in WR3
- Riparian and floodplain fringe vegetation
- Wash is wildlife habitat and is used as a wildlife corridor connecting Sierra Estrella and Maricopa Mountains with the Gila River
- Potential for mitigation banking and 404 permitting issues
- Development in adjacent planning units and in floodplain fringe need to conform to clean water act water quality criteria

Aesthetic and Multi-Use Resources Opportunities

- City of Goodyear Waterman Wash Guidelines
- Maricopa Regional Trail System
- Park and golf course use of floodplain fringe
- Connector trail heads to adjacent properties
- Natural river channel scenic resources
- Views of both theSierra Estrella and Maricopa Mountains
- Rural and suburban foothill views in northern areas

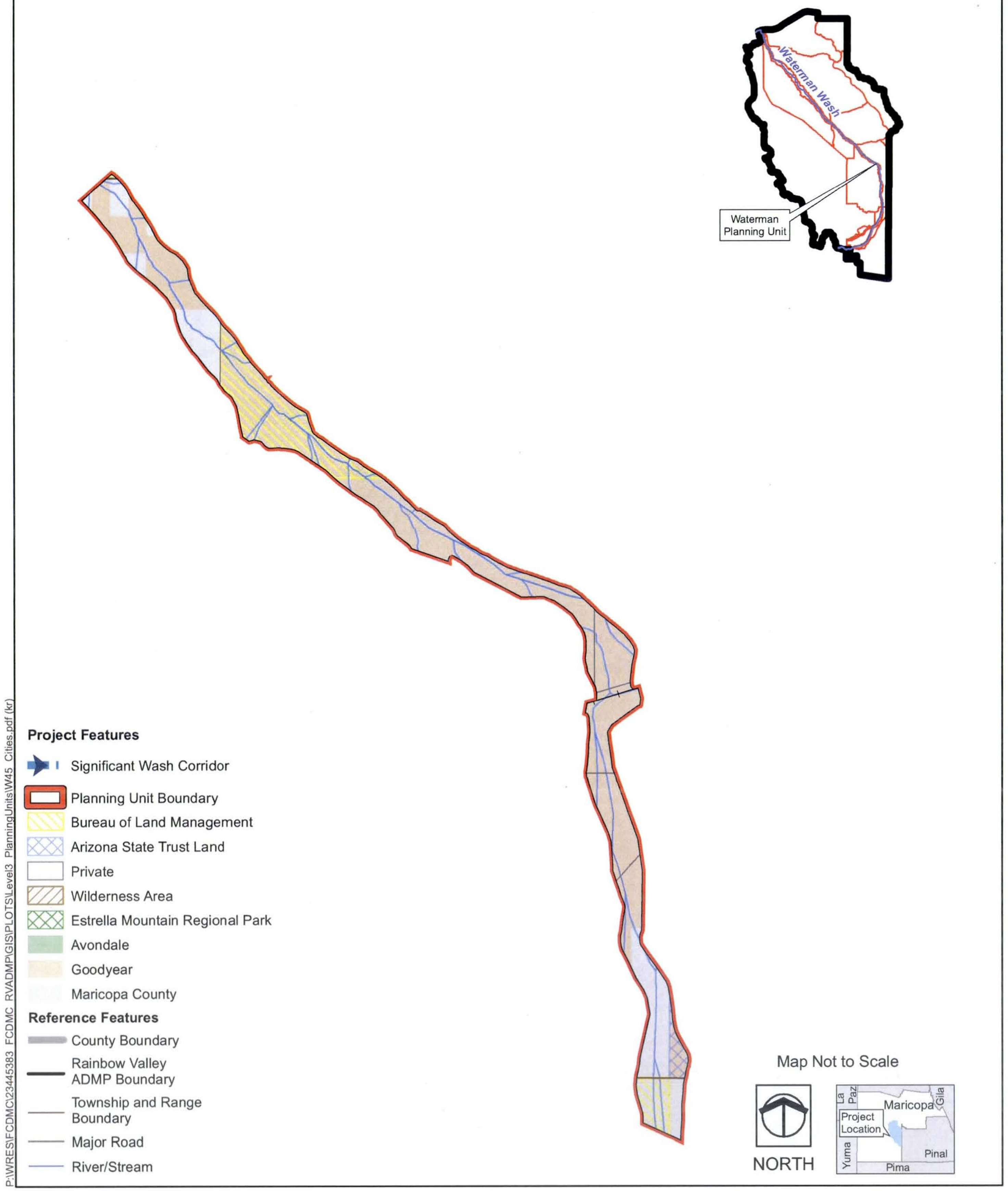
Community Context - Acceptable

Land Management and Implementation

- City of Goodyear
- Unincorporated Maricopa County
- State Trust Land in WR2
- Small pockets of BLM land in WR1, large track in WR3 adjacent to Sevenmile Mountain planning unit

Figure 2-11

WR 45 PLANNING UNIT



PLANNING UNIT SUMMARY DESCRIPTIONS

Recommended Plan

- New Regulations

Flood Context - Effective

Typical Landform and Flood Characteristics

- Ephemeral wash with the 100-year discharges being less than 3,000 cfs
- Floodplain and administrative floodway
- Bankfull sandy bottom channel with a wide floodplain
- Riparian growth at bankfull limits
- Channel in many areas not well formed especially south of the SR238/UPRR crossing
- Flow direction southeast to northwest
- Wash is divided in upper watershed
- Runoff to wash from sheet flow and distributary flow. Few tributary confluences.
- No contributary flow from Vekol Wash to the south

Land and Resources Context - Compatible

Cultural and Environmental Resources

- Potential for prehistoric and historic sites
- Waterman Wash crosses the Juan Bautista de Anza National Historic Trail and Butterfield Overland Mail Road and historic Southern Pacific Railroad
- Waterman Wash passes through historic Mobile African-American community
- A wildlife corridor crosses the wash that provides access for the Sierra Estrella and South Maricopa Mountain Wilderness
- Wash corridor is high quality Xeri-riparian with mixed creosote scrub in the floodplains
- The wash is wildlife habitat and is used as a wildlife corridor.
- Portions in the Sonoran Desert National Monument
- Portions included in the Vekol Valley Grasslands Species Habitat

Aesthetic and Multi-Use Resources Opportunities

- Some public suppy, domestic, and industrial wells are located along the wash
- Wash crossings of the Arizona Public Service overhead transmission line and Active El Paso Corporation Gas pipeline
- An abandoned El Paso pipeline also crosses the wash.
- Natural valley wash with adjacent valley plain floodplain
- Some areas are impacted by development
- Maricopa Regional Trail System
- Scenic views of the South Maricopa Mountains Wilderness, Sierra Estrella Mountains, and Sonoran Desert National Monument
- Proposed crossing by the Loop 303 Extension, Hassayampa Freeway and the Goodyear Enhanced Transit Corridor

Community Context - Acceptable

Land Management and Implementation

- Portions of Waterman Wash located in the City of Goodyear. The rest in unincorporated Maricopa County
- At this time not included in Waterman Wash Guidelines
- Property ownership of wash both private and BLM and is piecemeal
- Opportunities for land swaps to provide continuous ownership
- A significant portion of the private property had been part of the Amaranth Development

Figure 2-12

3.0 FLOOD HAZARD MITIGATION PLAN

3.1 INTRODUCTION

The foregoing discussion contained in Section 2.0 has identified the importance of planning on a watershed scale as a means to account for the cumulative impacts of development throughout the watershed as a whole. Planning at this scale is required to address the interactions between the various landform divisions extending from the mountaintops at the upstream edge of the watershed down to the Gila River at the watershed outlet. The importance of maintaining continuity between these landform divisions is identified in terms of runoff and sediment continuity, wildlife habitat and movement, as well as chemical and "flushing" functions of the watershed system. As people move into Rainbow Valley and development expands, communities will be built within the watershed context just described. The piedmont area situated between the mountains and the Waterman Wash floodplain provides the most attractive location for development due to the expanses of uniform and easily developed terrain. The study of watershed functions and values forms the basis for identifying land development practices that will minimize the adverse impacts to those watershed functions and will promote sustainable development practices. The essence of this approach is to preserve the continuity between the mountains and the river by promoting development practices that concentrate and limit ground disturbance, thereby limiting adverse impacts to a smaller area within each development. The result is to maximize areas of undisturbed natural land surfaces that form direct connections, or corridors, from the headwaters of the watershed to the outlet at the Gila River.

The proposed basic functions, specific performance functions, and design criteria described in the following sections are intended to provide designers and planners with the necessary framework to develop site-specific flood hazard mitigation solutions that, when achieved, will assist in integrating the individual project into the overall watershed mosaic. This holistic approach and the resulting suite of protective and regulatory design criteria address flood hazard mitigation.

3.2 STAKEHOLDER GOALS AND OBJECTIVES

As described in Section 1.3, an Agency Stakeholder Group was convened at the outset of the project to facilitate collaboration in identifying project goals and objectives that would guide the process of identifying and evaluating alternative flood mitigation strategies. The input received at the meeting was distilled into four primary project goals with a host of supporting goals and objectives. The following goals and objectives were adopted for the project as being descriptive of the community desires within the study area. These goals and objectives were foundational in developing the recommended plan that is presented in the following sections.

Goal No. 1 – Provide Flood Hazard Protection for Public Safety

- Resolve or manage existing identified flooding problems.
- Prevent development in floodplains and in flood-prone areas not identified as floodplains.
- Maximize the area receiving flood protection.
- Minimize or eliminate reliance on man-made or human intervention for operation during a storm event.
- Provide capacity in channels for anticipated mature vegetation requiring realistic levels of maintenance.
- Preserve or replace the storage capacity of natural channels to attenuate discharges.
- Preserve natural flow paths and drainage patterns.

Goal No. 2 – Provide Multipurpose Benefits to the Community

- Provide opportunities to implement the Maricopa Regional Trail.
- Provide opportunities to implement other local trail systems.
- Provide opportunities to implement local municipal and other stakeholder-identified recreational objectives and facilities.
- Establish an east-west recreation/open space connection between the Sierra Estrella and Maricopa Mountains/Sonoran Desert National Monument.
- Provide the opportunity to implement a recreation/open space feature at the confluence of the Gila River and Waterman Wash.
- Protect or enhance natural resources.
- Protect or enhance cultural resources.
- Preserve the wildlife movement corridor.
- Preserve and complement the desired visual character of future natural, rural, suburban, and urban cultural settings.
- Extend the natural scenic character of Waterman Wash to the south, in areas where it currently is not well defined.
- Preserve and enhance sensitive viewscapes.

- Improve and restore the areas containing visually discordant features, particularly along Waterman Wash.
- Retain and preserve distinctive natural and cultural scenic features and areas, i.e., riparian areas and washes, green-up areas, bajadas, and mountains.
- Maximize the creation/preservation of open space consistent with the Maricopa Association of Governments (MAG) *Desert Spaces Design Guidelines*.

Goal No. 3 – Regional Land Planning Compatibility

- Use best available general plan data for planning.
- Coordinate with development plans.
- Support City of Goodyear's open space and agricultural land use designations as identified in Goodyear General Plan 2003-2013.
- Recognize and support planned transportation corridors in planning.
- Coordinate with adjacent planning areas for regional connectivity.
- Coordinate with other agency plans in the study area.

Goal No. 4 – Develop an Implementable Plan

- Gain support for the plan from potential funding partners.
- Identify multiple partnering opportunities.
- Develop a phased plan for implementation to spread expenditures over time.
- Encourage implementation by others.
- Meet Clean Water Act requirements for protecting waters of the U.S.

3.3 PERFORMANCE FUNCTIONS & DESIGN CRITERIA

A total of 12 basic functions were identified within the Rainbow Valley ADMP study area that contribute to the quality of life within the watershed. These functions are derived from the general watershed functions as described by P.E. Black (1997), the District-identified natural and beneficial functions served by floodplains (FCDMC 2009), and the stakeholder-identified goals for the Rainbow Valley ADMP. In this report, the term "function" is used to describe those processes that represent the range of human and other natural activities, systems, and regimes that directly or indirectly make use of or impact the resources found within the Rainbow Valley ADMP study area.

These functions are loosely divided into two groups: those functions that are primarily associated with the hydrologic and hydraulic (H&H) regimes in the watershed (Flood Hazard Context) and those that are related to other non-H&H watershed resources (Land and Resources Context). It is important to recognize that, while these two divisions are useful for categorizing the basic functions, the processes and systems that facilitate these functional interactions, both internally and between landforms and planning unit boundaries, represent a complex web of connected benefits and impacts. Change that impacts one functional category will likely have direct and indirect impacts on the other functions, all of which will cause adjustments to the benefits and values derived from the watershed as a whole. Table 3-1 summarizes the development of design criteria that is proposed to guide development within the Rainbow Valley area. The table shows:

- Basic functions to be preserved
- Supporting performance functions which establish a goal or outcome
- General design criteria which establish a benchmark

This section describes the 12 basic functions that were identified as important to be preserved. For each basic function a series of specific performance functions are defined that, if achieved, would be expected to protect and support the basic functions. Design criteria are then proposed that could be incorporated into policies, guidelines, and ordinances as a means for implementation within any jurisdiction or agency that controls development.

Table 3-1 Performance Functions and Criteria

No.	Basic Function Performance Function	General Design Criteria	Estrella 1	Sonora 2	Lum Wash 3	WR123 4	Mobile 5	Waterman South 6	WR45 7
1	Restrict increases in storm water RUNOFF VOLUME to avoid adverse downstream impacts		X	X	X		X	X	
1.1	Store increased runoff volume resulting from development	Require maximum retention of 100-year 2-hour	O	O	O		O	O	
1.2	Preserve natural land storage and storm water infiltration properties	Waive retention requirement for undisturbed land areas	O	O	O		O	O	
1.3	Maintain adequate baseflow for vegetation	Require maximum undisturbed area directly connected to 404 washes	O	O	O		O	O	
2	Restrict increases in storm water PEAK DISCHARGE		X	X	X		X	X	
2.1	Limit reduction in time of concentration	Criteria for onsite drainage system layout to require longer flow paths	O	O	O		O	O	
2.2	Provide retention/detention to meter flows	Provide additional on-site retention/detention so peak discharges leaving site are not greater than existing conditions	O	O	O		O	O	
3	Maintain FLOW CONTINUITY to outfall		X	X	X		X	X	
3.1	Manage flow split uncertainty by "fixing" or regulating flow split potential	Classify flow splits to identify important splits to be addressed in plan		O					
3.2	Once concentrated, flows to be conveyed to suitable outfall	Demonstrate continuity to approved outfall in design report and development plan	O	O	O		O	O	
3.3	Maintain sub-basin continuity	Restrict inter-basin transfers of runoff	O	O					
3.4	Coordinate road alignments with drainage patterns	Road alignments to be generally parallel and perpendicular to drainage patterns	O	O					

No.	Basic Function Performance Function	General Design Criteria	Estrella 1	Sonora 2	Lum Wash 3	WR123 4	Mobile 5	Waterman South 6	WR45 7
4	Preserve wash STORAGE for peak flow attenuation				X	X	X	X	X
4.1	Mitigate loss of floodplain storage from encroachment	Modify floodway delineation based on encroached discharge			O	O	O	O	O
5	Preserve cross-section CONVEYANCE capacity				X	X	X	X	X
5.1	Maintain floodplain storage volume	See 2.1			O	O	O	O	O
6	Preserve SEDIMENT TRANSPORT capacity of washes to minimize erosion and deposition			X	X	X	X	X	X
6.1	Preserve dominant discharge low flow channel	Require analysis of channel forming discharge and low flow channel cross-section		O	O	O	O	O	O
6.2	Limit increase in maximum tractive shear at design discharge	Limit flow depth to width ratio in 100-year channel improvements		O	O	O	O	O	O
6.3	Design for potential changes in sediment supply from upstream development	Provide grade control based on equilibrium slope under developed watershed conditions		O	O	O	O	O	O
7	Maintain SEDIMENT CONTINUITY		X	X	X		X	X	
7.1	Minimize concentration of existing sheet flow	See 1.2	O	O	O		O	O	
7.2	Maintain sediment yield from individual development and overall watershed	Provide incentives for undisturbed areas (see 1.2) (also see 6.1-6.3)	O	O	O		O	O	
7.3	Maintain sediment delivery to Waterman Wash	Provide incentives for undisturbed areas (see 1.2) (also see 6.1-6.3)	O	O	O		O	O	

No.	Basic Function Performance Function	General Design Criteria	Estrella 1	Sonora 2	Lum Wash 3	WR123 4	Mobile 5	Waterman South 6	WR45 7
8	Complement planned future scenery resources		X	X	X	X	X	X	
8.1	Design to be compatible with planned cultural and physical setting (natural, rural, suburban, or urban)	Develop regional scale conveyance channels and storage basins using a soft- or semi-soft structural method; use publicly desirable design theme for drainage and storage features	O	O	O		O	O	
8.2	Flood hazard mitigation to be compatible with natural Sonoran desert wash in floodway	Preserve or restore existing wash character to natural condition. Include adjacent open space beyond xeroriparian zone	(O)	(O)	(O)	O	(O)		O
8.3	Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves		O	O	O	(O)	O		O
9	Accommodate regional and local multi-use		X	X	X	X	X	X	
9.1	Accommodate City of Goodyear parks	Include City of Goodyear identified park locations in plan update that could become storage facilities	O	O	O		O		
9.2	Accommodate other local parks	Compatible recreation uses to be co-located with drainage facilities to increase value density	O	O	O		O	O	
9.3	Establish Maricopa Region Trail segment(s)	Where segments are identified, incorporate Maricopa Regional Trail into conveyance design plans or zoning uses with easements	O	O	O	O	O		O
9.4	Accommodate other local trails	Preserve or restore existing wash character to natural condition. Include adjacent open space beyond xeroriparian zone	O	O	O	O	O	O	O

No.	Basic Function Performance Function	General Design Criteria	Estrella 1	Sonora 2	Lum Wash 3	WR123 4	Mobile 5	Waterman South 6	WR45 7
9.5	Accommodate Juan Bautista de Anza National Historic Trail enhancement and interpretation-linkage from Gila River to State Route 238	Use drainage to create open space buffer adjacent to national historic trail					O		
10	Provide open space		X	X	X	X	X	X	X
10.1	Preserve existing open space value	Incorporate appropriate setback into conveyance and storage designs; use cluster development design criteria	O	O	O	O	O	O	
10.2	Maintain BLM-managed lands as public open space	Use non- or soft structural methods for conveyance and storage facilities where necessary	O	O		(O)	O	O	O
10.3	Development in "MAG Desert Spaces – Retention" areas to comply with MAG *Desert Spaces Design Guidelines*	Include appropriate Desert Spaces sections as appendix in ADMP	O	O	O	O	O	O	O
11	Protect or enhance biological resources		X	X	X	X	X	X	X
11.1	Maintain existing ecological integrity of natural vegetation types	Preserve open space in undisturbed areas/habitats/ vegetation types, control invasive plant and animal species, set priority development of degraded uplands over undisturbed ones	O	O	O	O	O	O	O
11.2	Protect natural and beneficial functions of washes	Exclude development from significant wash corridors, preserve existing vegetation from other forms of disturbance	O	O	O	O	O	O	O
11.3	Preserve the connectivity and permeability of habitats	Maintain open space, preserve movement corridors, create wildlife friendly crossings under roadways and railroads	O	O	O	O	O	O	O

No.	Basic Function Performance Function	General Design Criteria	Estrella 1	Sonora 2	Lum Wash 3	WR123 4	Mobile 5	Waterman South 6	WR45 7
11.4	Restore or enhance vegetation and natural channels in poorly defined or degraded sections of washes	Restore or enhance vegetation along wash channels	O	O	O	O	O	O	O
11.5	Use built structures to create resources for wildlife	Design built structures to co-develop wildlife waters or to create habitat	O	O	O	O	O	O	O
12	Promote appreciation and preservation of significant cultural resources		X	X	X	X	X	X	X
12.1	Historic sites	Preserve identified cultural features within open-space setback of facility - or - provide interpretation of historic character within site design elements	O	O	O	O	O	O	O
12.2	Prehistoric sites	Preserve identified cultural features within open-space setback of facility - or - provide interpretation of historic/prehistoric character within site design elements	O	O	O	O	O	O	O

3.3.1 Restrict Increases in Storm Water Runoff Volume (1)[4]

Runoff volume is key to the characterization of runoff from piedmont surfaces where flow depths are low and runoff is dispersed over a large area (sheet flow). Due to the flow characteristics, there is a substantial amount of peak discharge attenuation as the runoff makes its way down the piedmont slope toward Waterman Wash, which is the axial stream that collects all the piedmont runoff. The peak flow attenuation results from watershed storage, flood travel time, and infiltration on the piedmont surface. Development practices that add impervious area tend to increase runoff volumes and reduce flood travel time. Increasing the capacity of a small natural wash through channelization to contain the broad shallow overland flow drastically reduces the surface area of contact, which also reduces the opportunity for infiltration as the runoff makes its way down slope. Once the runoff volume is increased, the downstream impacts become cumulative as the extent of development increases and runoff volume is further increased. In addition to impacts on the piedmont resulting from increased runoff volume, peak discharges in Waterman Wash would also be expected to increase, which would impact floodplain limits, propagating flood hazards downstream to the Gila River. The strategy to minimize and mitigate increases in storm water runoff volume is described in the following performance functions.

3.3.1.1 Performance Functions

- Store increased runoff volume resulting from development (1.1)

  Construction of roadways, homes, and other elements of a land development project adds impervious surfaces within the area of disturbance that prevent depression storage, storm water infiltration, and increase runoff volume. The increase in runoff volume resulting from development should be captured and stored within the development in retention areas and then either infiltrated into the ground or released after the storm at low discharge rates.

  A desirable incentive associated with this function is to reduce the required storage volume by minimizing the area of disturbance. This could occur by excluding preservation corridors from needing retention.

- Preserve natural land surface storage and infiltration properties (1.2)

  The natural, undisturbed land surface has evolved over time to interact with storm water runoff in a particular way that is suited to the local environment. This includes an interdependent system of vegetative stands and root systems, surface crusting with small depressions, smooth and uniform slopes that minimize flow concentration. Once this system is disrupted it cannot be artificially restored within a short period of time. As a result, a high

[4] Numbers in parentheses refer to the Basic Functions listed in Table 3-1.

priority is placed on preserving natural land surfaces in an undisturbed state to the greatest extent practical. It is additionally beneficial to arrange these undisturbed areas in a way that provides a continuous and connected flow path for runoff that extends with minimal disruption from the mountain slopes to the downstream receiving wash.

- Maintain adequate baseflow to support native vegetation (1.3)

  The native vegetation on the piedmont surface as well as within and along natural washes serves an important function for stabilizing soils and resisting erosion. With any retention requirement, it is important to provide for adequate baseflow to support the native vegetation. The relatively small amounts of runoff from frequent, but low intensity storm events are the most important for sustaining vegetation. As a result, a first flush retention requirement, if applied across the entire development, would be counter to this baseflow requirement. This requirement supports the preceding performance function of preserving natural land surfaces in an undisturbed state. Runoff from the undisturbed lands will aid in supporting native vegetation.

3.3.1.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Lot sizes may be reduced to maintain the same number of total units for the development in order to preserve lands in a natural and undisturbed state. The sum of the reductions in lot size area may not exceed the area of natural and undisturbed area preserved. The preserved area must be owned by a homeowners association, shown in a surveyable manner on the recorded subdivision plat, and protected by recorded covenants attached with the land. Additionally, the number of lots allowed by the reduction cannot exceed the number of lots allowed without the reduction.
- The project layout shall be developed in such a way as to allow the natural and undisturbed portion of the development to drain directly to natural and undisturbed lands on the downslope portion of the site without draining across improved or disturbed lands. Undisturbed lands shall be aligned with adjacent upstream and downstream developments to provide a continuous and directly connected corridor of undisturbed lands through the piedmont.
- Channel improvements may be allowed in lieu of natural and undisturbed flow corridors if the channel improvements are continuously extended to a channelized outfall having adequate capacity. Additionally, it must be shown through a hydrologic analysis that the channelization will not result in increases to downstream discharges in Waterman Wash.

- The natural and undisturbed sheet flow corridors resulting from this requirement shall be designed to convey the full upstream sheet flow entering the site by "funneling" the sheet flow obstructed by development areas into a natural and undisturbed flow corridor. The reduction in the width of sheet flow in the natural flow direction shall not cause excessive erosion for the new undisturbed flow corridor. The drainage report must account for all sheet flow entering the site by showing the corridor where the sheet flow obstructed by development is funneled and that for each corridor, the encroachment criteria is met.
- On-site retention must be provided to capture and store the runoff generated by the disturbed or improved portions of the development so that the runoff volume for the 100-year, 2-hour storm is retained on site.
- Retention shall not be required, nor provided, for undisturbed, natural corridors within the project that drain directly to the natural and undisturbed downstream lands in accordance with this section.
- U.S. Army Corps of Engineers Jurisdictional Waters of the U.S. shall have a minimum baseflow preserved by allowing natural, undisturbed lands within the development to drain directly and in a natural state to jurisdictional waters without "first flush" retention.

3.3.2 Restrict Increases in Storm Water Peak Discharges (2)

Peak discharge is closely related to, and directly affected by, changes in runoff volume. The flow attenuation just described results from watershed storage, flood travel time, and infiltration on the piedmont surface. Channelization drastically reduces watershed storage and travel time, which increases peak discharges. The downstream impacts of reduced piedmont storage and travel time are also cumulative as the extent of development increases and concentration of flows are further increased. Flow concentration through channelization and surface paving will increase the efficiency of flow accumulation and will reduce the time of concentration, which will result in an increased peak discharge even with the same runoff volume. Increases in peak discharge have adverse impacts to downstream developments through increased flow velocities and stream power. This has a direct impact on sediment transport characteristics of the piedmont. Sediment transport on the piedmont is described later in the document. The strategy to minimize and mitigate increases in storm water peak discharge is described in the following performance functions.

3.3.2.1 Performance Functions

- Limit reduction in time of concentration (2.1)

  Improving the efficiency of flow accumulation and conveyance to the sub-basin outfall results in shortened times of concentration; this shortens the time duration of the runoff hydrograph and increases peak discharge. Incorporating elements into the site layout and design to more closely simulate the natural runoff accumulation characteristics will reduce (mitigate) the increase in peak discharge. This can be done by providing long flow paths in channel and roadway design and providing for unconfined sheet flow as far downslope as practical to minimize the length of channelized or concentrated flow. Utilizing rougher materials and flatter slopes in improved channels and pipes will reduce flow velocities, also mitigating increases in peak discharge.

A desirable incentive associated with this function is to reduce the required storage volume by incorporating design elements that lengthen the time of concentration. This in turn either allows for shallower basins or additional land that can be used for other purposes.

- Provide retention/detention to meter flows (2.2)

  Increases in peak discharge from development should be offset by providing additional detention or retention storage in addition to the storage provided for runoff volume.

3.3.2.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Provide additional on-site retention such that peak discharges leaving the site are not greater than the natural condition peak discharges.

3.3.3 Maintain Flow Continuity to Outfall (3)

Flow continuity from the mountains to the watershed outlet at the Gila River is important for both runoff and sediment. Disruptions in flow continuity result in downstream uncertainty and associated risk as well as disruption to the hydrologic and environmental functions and values identified elsewhere in this report. Diversions of runoff into adjacent sub-basins disrupt the runoff and sediment supply to the downstream channel. Flow splits in natural, distributary drainage networks create flow path uncertainty due to the variable nature of the flow distribution between the downstream legs of the flow split. Developments downstream from the flow split must often anticipate the entire flow being conveyed within each leg in order to avoid underestimating the discharge reaching their site.

Broad shallow sheet flow can mask the true amount of runoff that is perceived by an observer. This is due to the lack of landform features such as washes that would normally be associated with large amounts of runoff. Although the natural system conveyance down slope may be relatively low on a flow per foot of width basis, the cumulative conveyance across a large area, such as the flow at a boundary of a subdivision, can be as high as a large wash. Therefore, it is critical that the natural piedmont conveyance be maintained or entirely replaced from the subdivision boundary all the way to a receiving stream or water body. If the conveyance is replaced by a channel, the linear extent of the channelized conveyance must be extended to a suitable receiving stream, wash, or river and not simply be allowed to discharge onto the piedmont surface downstream of the development. The strategy to preserve and provide flow continuity is described in the following performance functions.

3.3.3.1 Performance Functions

- Manage flow split uncertainty by "fixing" or regulating flow split potential (3.1)

  Existing flow splits within the study area were evaluated as part of the geomorphology study. Fourteen significant flow splits were identified in the Sonora Planning Unit that could be diverted into the dominant leg of the split. This would significantly reduce downstream uncertainty.

- Once concentrated, flows to be conveyed to suitable outfall (3.2)

  Due to the shallow sheet flow condition throughout much of the Rainbow Valley ADMP study area, concentrated flow presents a significant erosion hazard to downstream properties. If a development concentrates runoff through channelization or other means, the channel should be continuous to a suitable downstream outfall. Attempts to re-distribute concentrated flow at the downstream property limit back into a sheet flow condition have not been successful.

- Maintain sub-basin continuity (3.3)

  The hydrology modeling has identified numerous drainage sub-basins that extend from the mountains to Waterman Wash. Diversions from one sub-basin to an adjacent sub-basin would "starve" the downstream natural channel and should be restricted. Diversions would also change the discharges for downstream properties. Except for areas designated for diversion into SWCs, inter-basin transfers of runoff should be restricted.

- Coordinate road alignments with drainage patterns (3.4)

  Road crossings of natural washes have a potential to cause flow diversions along the roadway alignment, potentially into an adjacent sub-basin. When runoff ponds at a culvert inlet or a low water "dip" crossing and the water rises to a certain level, it may be diverted along the upstream roadway shoulder, potentially into an adjacent sub-basin. This is a particular concern when road crossings are at an angle, skewed to the channel. As a result road crossings of natural washes should be minimized. When road crossings are needed, they should be oriented perpendicular to the wash. Additionally, road alignments parallel to washes, situated near the divide between two washes is desirable. This function suggests a unique transportation plan approach that is very different than the traditional grid pattern which is oriented to the compass.

3.3.3.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Regulated flow splits, shown as significant splits on **Figure 3-1**, shall be designed according to the specified discharges for each leg of the split.
- If runoff is concentrated as part of the development design, the confined/channelized flow must be conveyed to a suitable outfall. Continuity to an approved outfall must be demonstrated in the drainage report.
- Inter-basin transfers of runoff shall be restricted unless the following conditions are met:
  - the contiguous sub-basins are owned by the same property owner, and
  - the approved outfall(s) lies within the owner's property limit,
  - or if the sub-basin is identified as a basin that can be diverted into a designated SWC
- Site layout shall consider the natural drainage paths by aligning roads parallel or perpendicular to drainage paths and minimizing the number of wash crossings within the development.

3.3.4 Preserve Wash Storage for Peak Flow Attenuation (4)

Natural washes typically have a low flow channel that is formed and maintained by regularly recurring and somewhat frequent storms. The low flow channel cross-section supports the transport of sediment through the system. When larger, less frequent storms occur, the low flow channel section capacity is exceeded and the excess runoff spills onto the overbank floodplain area. On the piedmont surfaces in the Rainbow Valley area, the defined washes have a floodplain area that has been formed by whatever extreme or large storm events that have historically occurred. The small, braided washes that are very shallow interact with the piedmont itself, which functions as the floodplain area. The important functions of the overbank floodplain are to store excess runoff, provide additional conveyance, and due to the added storage volume, attenuate downstream peak discharges. The current FEMA regulations for development within floodplains allow encroachment up to the floodway limit. This encroachment reduces the available overbank storage, resulting in increases in the peak downstream discharge. These increases are not accounted for in the FEMA floodway delineation methodology. The strategy to minimize and mitigate loss of wash storage is described in the following performance functions.

3.3.4.1 Performance Functions

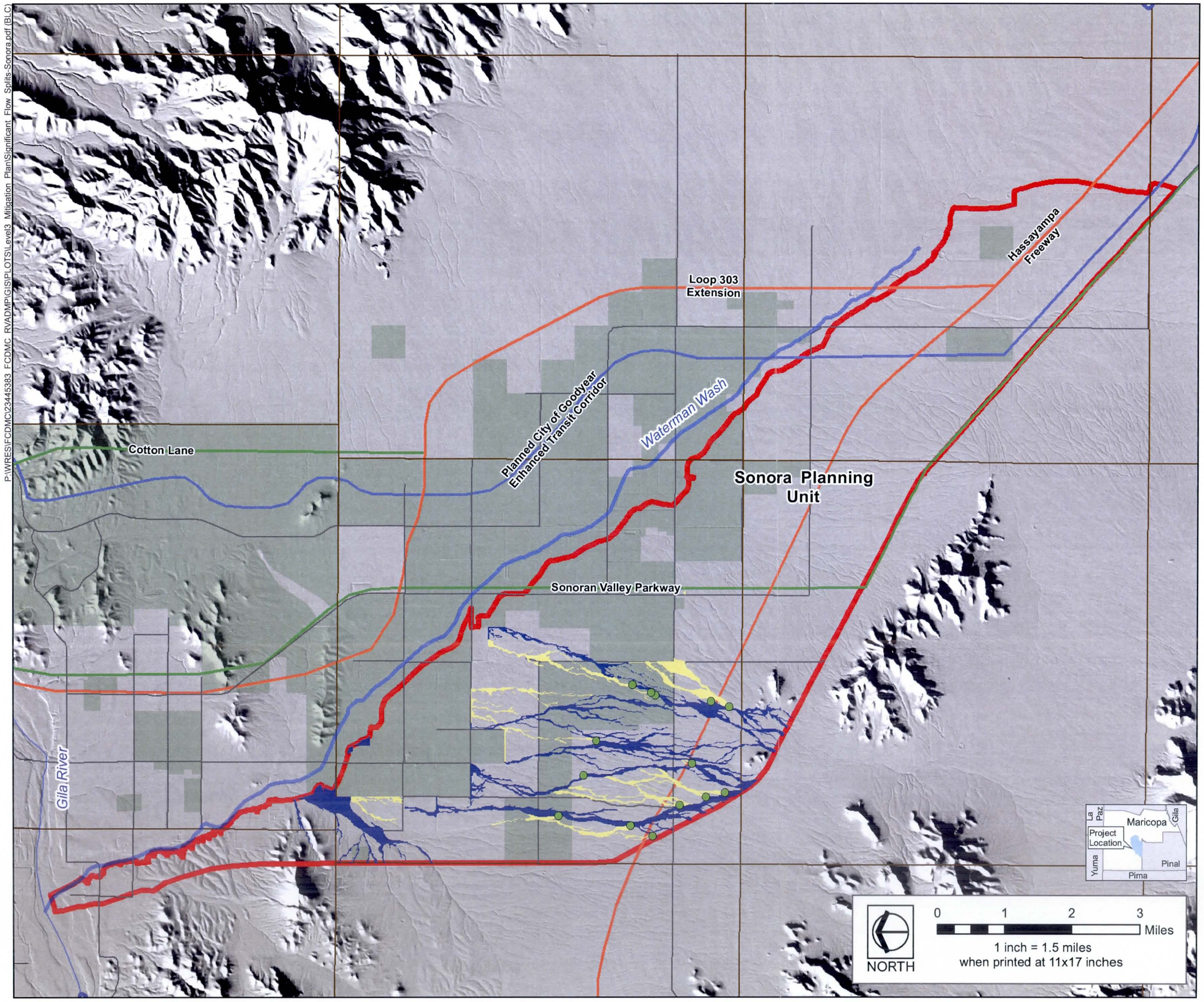
- Mitigate loss of floodplain storage from encroachment (4.1)

  A modified floodway delineation methodology is proposed that utilizes the following iterative approach to develop the floodway. Starting with the natural floodplain delineation:

  1. Develop the floodway limits using the equal conveyance reduction methodology with a 1-foot target for the rise in water surface.
  2. Re-run the hydrology model with the new encroached floodway cross-section substituted for the natural cross-section in the subject routing reach. Due to loss of overbank storage, this is expected to result in a higher computed peak discharge.
  3. Re-analyze the floodway limits by relaxing the limits computed from step 1 to meet the equal conveyance reduction, 1-foot rise criteria using the higher peak discharge from step 2.
  4. Repeat steps 2 and 3 until there is only a small change in discharge and small change in floodway limits from one iteration step to the next. This is the new, encroached 100-year discharge and floodway limit. This is expected to be a wider floodway and a higher discharge than the original floodway developed in step 1.

Rainbow Valley
Area Drainage Master Plan
Significant Flow Splits -
Sonora Planning Unit

Figure 3-1



Project Features

- RVADMP Sonora Planning Unit
- Flow Paths Cutoff By Diversions
- Major Identified Flow Corridors
- Future Master Planned Communities
- Waterman Wash
- Gila River
- Potential Diversions

Future Corridor Type

- Freeway
- Parkway
- Transit Corridor

Reference Features

- Township and Range Boundary
- Major Road

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Master Planned Communities, 2008
JE Fuller
Flow Paths Cutoff By Diversions, 2010
Major Identified Flow Corridors, 2010
Potential Diversions, 2010

5. The standard FEMA floodway delineation methodology does not provide for a change in discharge resulting from encroachment. Therefore, if the floodway is to be submitted for FEMA approval the original, FEMA-approved discharge should be run with the new, wider floodway limits for the FEMA submittal. This will result in an acceptable floodway, with a less than 1-foot rise.

3.3.4.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Utilize the modified floodway delineation methodology to determine the limits of encroachment on all washes with 100-year peak discharges of 500 cubic feet per second or greater. A new floodway analysis shall be performed using the modified methodology for undelineated washes and for washes that already have FEMA-approved delineations.

3.3.5 Preserve Cross-Section Conveyance Capacity (5)

Flood storage and flow conveyance are inter-related in the overbank area of natural washes and must be preserved or replaced when constructing improved open channels or encroaching with development. The conveyance capacity of a wash's cross section defines the amount of floodplain flow capacity that is available when the flow is greater than the bankfull discharge. Whereas overbank storage has the effect of attenuating peak discharges, conveyance is needed to limit the spread of the flow. If overbank storage that is lost due to floodplain encroachment is replaced by storage basins without maintaining the original channel and overbank conveyance capacity, the channel flow will expand by raising the water surface and/or overtopping the banks. The strategy to minimize and mitigate loss of cross-section conveyance capacity is described in the following performance functions.

3.3.5.1 Performance Functions

- Maintain floodplain storage volume (5.1)

  Leaving the natural wash undisturbed and utilizing the modified floodway methodology described in Section 3.3.4.1 will mitigate the loss of conveyance capacity in the floodplain as well as the loss of overbank storage capacity. If modifications to the wash are permitted, they should be designed to maintain the natural conveyance capacity for a combination of the low flow "dominant discharge" channel and the 100-year floodplain channel sections.

3.3.5.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Utilize the modified floodway delineation methodology to determine the limits of encroachment on all washes with 100-year peak discharges of 500 cubic feet per second or greater. A new floodway analysis shall be performed using the modified methodology for undelineated washes and for washes that already have FEMA-approved delineations.

3.3.6 Preserve Sediment Transport Capacity of Washes to Minimize Erosion and Deposition (6)

Sediment transport and erosion are important processes that are heavily influenced by the flow hydraulics, which has been described in Sections 3.3.1 to 3.3.5. The broad, shallow sheet flow on the piedmont combined with the natural channel bank full discharge are in balance with the sediment supplied from the upstream watershed. The sediment transport characteristics of these fluvial systems are very sensitive to changes in the flow hydraulics resulting from natural or man-induced watershed modifications.

> *"...man's activities will modify fluvial system response by influencing the governing physical processes. Perhaps the most important concept to realize about fluvial systems is that they are dynamic systems attempting to achieve a state of balance or equilibrium. Consequently, the fluvial system is either adjusting to altered conditions or is in a state of dynamic equilibrium with present conditions. In either case, natural and man-induced changes can initiate responses that may be propagated through long periods of time or large areas. This dynamic nature requires that the analysis of problems (even on a small, localized scale) and development of solutions be considered in terms of the entire system." (Arizona Department of Water Resources [ADWR] 1985)*

In addition to the effects of increases in peak discharge and floodplain limits previously described, the potential for erosion and deposition exacerbates these flood hazards in the piedmont areas. Sediment transport within these desert washes is highly influenced by the bed sediment characteristics of unit weight and size, the flow depth, and the bed slope. If the sediment transport capacity is raised by increasing the channel flow depth through channelization or encroachment or by increases in peak discharge, significant erosion can occur. Once flows are concentrated and flow depths increased, erosion can become widespread. If sediment transport capacity of the wash is decreased, the sediment that is being delivered to the wash by the upstream watershed will be dropped and problems of deposition will result. The cumulative impacts of changes in sediment transport capacity across the study area can be extensive and include the following:

> *"The combination of large sediment yield, large transport capacity, and "flashy" runoff can cause rapid changes in the configuration of sandy-soil channels. These changes include lateral migration, scour, degradation and aggradation, and can cause changes in stream form, bedform, flow resistance, and other geometric and hydraulic characteristics." (ADWR 1985)*

Natural desert washes are formed by frequent storm events in order to provide capacity for the dominant discharge and the incoming sediment. The dominant discharge is the channel forming discharge, which is much less than the 100-year discharge. Channel forming discharges typically have recurrence intervals of less than 2 years (Moody 2003). The dominant discharge low flow channel is also the section that conveys the incoming sediment through the system. Discharges in excess of the channel bankfull capacity, such as the 100-year discharge, will spill into the overbank. In the case of the piedmonts in the Estrella and Sonora planning units these overbank areas can be very wide.

Within undisturbed areas and within designated SWCs, the sediment transport function will be preserved by virtue of the fact that the wash is being left alone in its natural and undisturbed state. In disturbed areas and other areas where channelization is permitted, the strategy for channel design is to develop a compound channel section that contains a low flow channel sized for the dominant discharge, nested within a larger trapezoidal channel section that is sized for the 100-year discharge. This strategy is further described in the following performance functions.

3.3.6.1 Performance Functions

- Preserve dominant discharge low flow channel (6.1)

  The historic low flow channel was naturally formed over time to the size and shape necessary to carry the incoming sediment load. To maintain sediment continuity it is therefore necessary to preserve the bankfull channel section or else mimic its sediment transport properties within an improved low flow channel.

- Limit increase in maximum tractive shear at design discharge (6.2)

  Maximum tractive shear stresses in a channel cross-section are proportional to the channel flow depth and slope. Encroachment or channelization typically increases channel depth in order to provide a more efficient section that requires less width. This results in increases in tractive shear stresses at the wash flow boundary, which in turn increases sediment transport capacity, resulting in scour. To limit increases in tractive shear stresses, flow width to depth ratios should be limited within the 100-year channel section when the main channel section is to remain in a natural state.

- Design for potential changes in sediment supply from upstream development (6.3)

  Decreases in sediment supply are expected when upstream development reduces the exposed land area. A decrease in sediment supply will result in an adaptive channel response to the change in sediment supply. The change will typically result in erosion and a general flattening of the channel profile. The equilibrium slope for the sediment supply rate anticipated for the fully developed watershed condition should be used to estimate the channel profile change. Grade control structures should be constructed to limit the depth of erosion as the upstream watershed develops and the channel profile flattens in response to the reduced sediment supply.

3.3.6.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described within disturbed areas or other areas where channel improvements are permitted.

- Channel improvements shall utilize a soft or semi-soft structural method in accordance with the criteria of Section 3.4.8 and be designed to convey sediment with a compound channel section that includes a dominant discharge low flow channel nested within a 100-year discharge main channel section.
- In the case of clear water discharge, the channel shall be designed with a stable, non-movable bed and banks based on the allowable tractive shear design approach.
- Channel profile design shall be based on the equilibrium slope utilizing the sediment supply rate for the fully developed watershed condition. Grade control structures shall be included in the design as needed to accommodate the channel adjustment to the equilibrium slope.

3.3.7 Maintain Sediment Continuity (7)

Once sediment is in the system and is being transported through the system, continuity must be maintained to ensure that the sediment can be carried all the way through the system to the outlet. Discontinuities in sediment transport capacity will result in erosion or deposition, which can be a maintenance concern and can cause loss of conveyance capacity. This can result in flooding of the adjacent properties.

The sediment continuity principle applied to a given channel reach states that the sediment inflow minus the sediment outflow equals the time rate of change in sediment storage. So, at any point along a wash, the inflowing sediment must be passed downstream to avoid accumulation of sediment as deposition. Conversely, if the downstream reach has a sediment carrying capacity that is greater than the amount of inflowing sediment, scour will occur in order to satisfy the sediment deficit. As with flow continuity, sediment continuity should be maintained throughout a watershed in order to prevent adverse impacts to downstream property owners and receiving bodies of water, e.g., Waterman Wash. Sediment continuity is often disrupted at:

- Changes in channel cross-section or slope as may result at the upstream or downstream limit of man-made channel improvements
- Road crossings with "dip" sections or culverts
- Washes with interrupted sediment source resulting from land development activities
- Washes with added sediment supply from fires or vegetation clearing or grading of the contributing watershed

The strategy to maintain sediment continuity is described in the following performance functions.

3.3.7.1 Performance Functions

- Minimize concentration of existing sheet flow (7.1)
- Maintain sediment yield from individual development and overall watershed (7.2)
- Maintain sediment delivery to Waterman Wash (7.3)

3.3.7.2 Design Criteria

No additional criteria are identified for this function. Criteria cited in other sections will achieve the performance functions just described.

3.3.8 Complement Planned Future Scenery Resources (8)

Scenery resources describe the visual elements and their arrangement or composition within the watershed. These elements and their arrangement comprise the physical appearance and cultural context of a given landscape, which gives it an identity and sense of place. Flood hazard mitigation facilities and measures should retain this sense of place by using similar compositions of the forms, colors, textures, and materials typically found within the planned future setting. This will minimize potential negative impacts to the visual aesthetic value of a site and its surroundings or enhance the perceived visual quality of the setting, which in turn increases the value to the landscape. This can translate into greater market values for adjacent lands, as well as indirect benefits for improvements in public well-being and health, greater frequency of use for associated recreation, and other multi-use activities.

The existing scenic character and integrity of the watershed should be preserved or enhanced through the design and implementation of flood hazard mitigation facilities and measures. This will help minimize potential negative impacts to the existing, natural visual aesthetic of the watershed that can be associated with development or even enhance the perceived visual quality of the setting, which in turn preserves or increases the value to the community

3.3.8.1 Performance Functions

- Design to be compatible with planned cultural and physical setting (natural, rural, suburban, or urban). (8.1)

  Flood hazard mitigation facilities that are designed to visually integrate into the planned setting increase public acceptance of the structures and add value to the community.

- Flood hazard mitigation to be compatible with natural Sonoran desert wash in floodway (8.2)

  The riparian zone of natural washes entails many elements that define the expected visual character of a natural desert wash. These elements include the sandy wash bottom and its tributary branches, the stands of native vegetation that typically line the banks of the channel, and the U-shaped, cross-sectional form. Preserving this riparian zone can prevent negative impacts to the visual character of existing natural washes including the identified SWCs.

- Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves. (8.3)

  The flood hazard mitigation facilities should be developed in a manner that preserves continuous linear "green spaces" within the valley and elements of the existing viewshed from the mountain preserves into the Rainbow Valley.

  Figure 3-2 shows the existing visual character of the area as seen from the Sonoran Desert National Monument, including the open panoramic distant views to the Sierra Estrella Mountains, interspersed by the green "fingers" of vegetation along the small washes that feed Waterman Wash.

Figure 3-2 Rainbow Valley Viewshed

3.3.8.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Design regional scale conveyance channels and storage basins using a soft or semi-soft structural method. Table 3-2 shows representative examples of soft, semi-soft, and enhanced hard structures with appropriate design themes. Soft and semi-soft structures are considered compatible with all settings in all planning units. In urban areas, enhanced hard structures may be considered appropriate provided that the aesthetic treatment enhances the ability of the structure to complement the built setting using similar materials, colors, and forms in an aesthetically pleasing manner. While the actual application of these criteria needs to be determined on a project-by-project basis, the following specific guidelines have been identified as compatible with the observed setting in the Rainbow Valley study area and serve as the basis for project design:
    - Semi-soft structures should include varied side slope conditions to create an undulated form. Side slopes should vary from 4:1 to 8:1, with an average of 6:1 used to determine the needed right-of-way required for individual projects.

- o Channels should be designed with a composite Manning's 'n'-value at or near 0.055 overall. This 'n'-value should allow for both shrubs as well as trees to be planted within the 100-year floodplain cross-section of the channel.
- o Structures should be designed in accordance with the associated structural methods, as indicated in Table 3-2.

- Apply an appropriate and publicly desirable design theme to drainage and storage facilities. Table 3-2 includes a range of archetypical design themes that are appropriate for the Recommended Plan area. Compatible structural methods as well as key plant species that should be used in project design are also provided. Public feedback should be sought to determine the most acceptable and desirable theme.

Table 3-2 Landscape Design Themes

<table>
<tr><th rowspan="2">Design Theme</th><th colspan="4">Setting</th></tr>
<tr><th>Natural Undeveloped</th><th>Rural Large Lot Residential</th><th>Suburban Parks</th><th>Urban</th></tr>
<tr><td rowspan="2">
Natural Sonoran Desert Uplands</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="4">**Structural Methods:** Soft, Semi-Soft

Key Plant Species:
<u>Succulents</u>
Saguaro, ocotillo, prickly pear, barrel sp., cholla sp., agave, yucca

<u>Trees</u>
Blue palo verde, foothills palo verde, ironwood

<u>Shrubs</u>
Jojoba, brittlebush, bursage, creosote, white ratany</td></tr>
<tr><td rowspan="2">
Natural Sonoran Desert Uplands Riparian</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="4">**Structural Methods:** Soft, Semi-Soft

Key Plant Species:
<u>Cacti</u>
Saguaro, ocotillo, prickly pear, barrel sp., cholla sp.

<u>Trees</u>
Mesquite, desert willow, blue palo verde, ironwood, desert hackberry

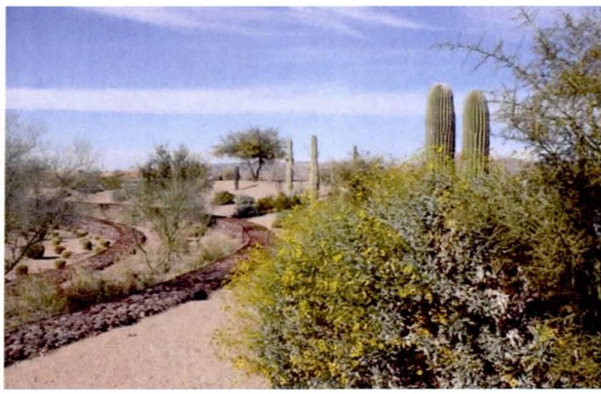
<u>Shrubs</u>
Cat-claw acacia, desert hackberry, desert globemallow</td></tr>
</table>

Design Theme	Setting: Natural Undeveloped	Setting: Rural Large Lot Residential	Setting: Suburban Parks	Setting: Urban
 **Natural Lower Sonoran Desert**	X	X	X	X
	Structural Methods: Soft, Semi-Soft **Key Plant Species:** *Cacti* Prickly pear, cholla sp., low densities of saguaro *Trees* Foothills palo verde, blue palo verde, ironwood *Shrubs* Creosote, bursage, brittlebush, hopbush			
 **Natural Lower Sonoran Desert Riparian**	X	X	X	X
	Structural Methods: Soft, Semi-Soft **Key Plant Species:** *Cacti* Prickly pear, cholla sp., low densities of saguaro *Trees* Mesquite, foothills palo verde, blue palo verde, ironwood, desert willow *Shrubs* Cat-claw acacia, desert hackberry, hop bush, brittlebush, giant bursage, desert holly, four-wing salt bush, wolfberry			
 **Natural Sonoran Desert Hydro Riparian**	X	X	X	X
	Structural Methods: Soft, Semi-Soft **Key Plant Species:** *Trees* Cottonwood, mesquite, desert willow, palo verde, seep willow Baccaris *Shrubs* Cat-claw acacia, desert broom, desert hackberry, hop bush, wolfberry			

<table>
<tr><th rowspan="2">Design Theme</th><th colspan="4">Setting</th></tr>
<tr><th>Natural Undeveloped</th><th>Rural Large Lot Residential</th><th>Suburban Parks</th><th>Urban</th></tr>
<tr><td rowspan="2">
Semi-Natural Sonoran Desert</td><td></td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="4">**Structural Methods:** Semi-Soft

Key Plant Species:
<u>*Succulents*</u>
Saguaro, ocotillo, prickly pear, barrel sp., agave, cholla sp., hedgehog cactus, yucca

<u>*Trees*</u>
Mesquite, desert willow, palo verde, acacia, Texas mountain laurel

<u>*Shrubs*</u>
Brittlebush, bursage, chuparosa , creosote, desert hackberry, fairy duster, hop bush, jojoba, salt bush, wolfberry</td></tr>
<tr><td rowspan="2">
Enhanced Desert</td><td></td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="4">**Structural Methods:** Semi-Soft

Key Plant Species:
<u>*Succulents*</u>
Saguaro, ocotillo, prickly pear, barrel cactus, agave, aloe, cholla sp., hedgehog cactus, yucca

<u>*Trees*</u>
Mesquite, desert willow, palo verde, acacia, Texas mountain laurel

<u>*Shrubs*</u>
Brittlebush, bursage, chuparosa , creosote, desert hackberry, fairy duster, hop bush, jojoba, lantana, sage sp., saltbush, wolfberry, Texas sage

Supplemental irrigation should be included with landscape for this theme.</td></tr>
<tr><td rowspan="2">
Desert Park</td><td></td><td></td><td>X</td><td>X</td></tr>
<tr><td colspan="4">**Structural Methods:** Semi-Soft, Enhanced Hard

Key Plant Species:
<u>*Succulents*</u>
Saguaro, ocotillo, prickly pear, barrel cactus, agave, aloe, cholla sp., hedgehog cactus, yucca

<u>*Trees*</u>
Ash, elm, mesquite, palo verde, acacia, Texas mountain laurel

<u>*Shrubs*</u>
Brittlebush, bursage, butterfly bush, chuparosa, hackberry, fairy duster, jojoba, lantana, ruellia, sage sp.

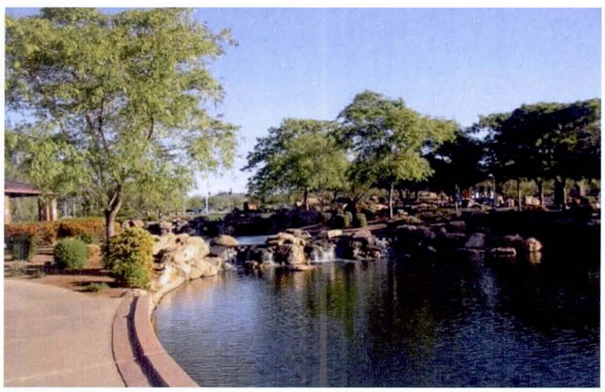
Supplemental irrigation is required with landscape for this theme.</td></tr>
</table>

<table>
<tr><th rowspan="2">Design Theme</th><th colspan="4">Setting</th></tr>
<tr><th>Natural Undeveloped</th><th>Rural Large Lot Residential</th><th>Suburban Parks</th><th>Urban</th></tr>
<tr><td rowspan="2">
Desert Oasis</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td colspan="4">Structural Methods: Enhanced Hard

Key Plant Species:
<u>Cacti</u>
Saguaro, ocotillo, prickly pear, barrel sp., agave, aloe, cholla sp., hedgehog cactus

<u>Trees</u>
Ash, elm, mesquite, palo verde, acacia, Texas mountain laurel, desert palm (also non-native palms)

<u>Shrubs</u>
Brittlebush, bursage, butterfly bush, chuparosa, hackberry, fairy duster, jojoba, lantana, ruellia, sage sp.

Supplemental irrigation is required with landscape for this theme.</td></tr>
<tr><td rowspan="2">
Desert Plaza</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td colspan="4">Structural Methods: Enhanced Hard

Key Plant Species:
<u>Cacti</u>
Saguaro, ocotillo, prickly pear, barrel sp., agave, aloe, cholla sp., hedgehog cactus

<u>Trees</u>
Ash, elm, mesquite, palo verde, acacia, Texas mountain laurel, palms

<u>Shrubs</u>
Brittlebush, bursage, butterfly bush, chuparosa, hackberry, fairy duster, jojoba, lantana, ruellia, sage sp.

Supplemental irrigation is required with landscape for this theme.</td></tr>
</table>

- Select plant species that are appropriate to the design theme as indicated in the matrix above. Additional species should be used provided they are included on the most recent version of the ADWR *Phoenix Active Management Area Low Water Use Drought Tolerant Plant List*. Plant selection and sizing shall comply with applicable zoning codes and ordinances.
- Riparian areas of the wash, including designated floodways, identified 404 limits, or other areas of visual significance recognizable as a natural wash, shall be retained and preserved in a natural state with their natural visual character.
- Preserve the natural form of the wash, except as required for minimal structural improvements as described below.

- Limit utilities to necessary wash crossings only. No utilities shall be located along the linear wash alignment, which would have negative visual impacts on the scenic quality of the wash.
- Aesthetic treatment of roadway and bridge crossings shall be integrated with the selected design theme. Roadway and bridge design shall be coordinated with the biological and recreation multi-use functions described below to maintain function continuity across the wash.

- Retention and maintenance of the existing riparian and overbank vegetation is required. Removal of vegetation will require a state and local permit and be limited to those areas required to construct utilities, crossings, and minimal required flood control structures. Revegetation for functional improvements shall be permitted provided revegetation efforts make use of native plant materials typical of the existing wash.
- No fill or excavation of material within the limits of the designated SWC and associated erosion hazard setbacks will be permitted except as minimally necessary to construct improvements. Allowed grading should be shaped to create smooth, natural transitions into the existing natural grades that replicate the existing topography.
- Configure flood hazard mitigation facilities to preserve natural open space. Open space buffers along conveyance channels should be continuous and extend from the mountain and hillside open spaces to Waterman Wash. Preserve or develop connectivity of open space areas within and between adjacent developments to preserve elements of the rural and natural mosaic of the existing viewshed.

3.3.9 Accommodate Regional and Local Multi-Use (9)

While essential to protect life and property, most flood control facilities in the Sonoran Desert seldom perform their primary flood storage or conveyance functions, except during infrequent periods of rainfall and local flooding. Also, most facilities are designed to protect from larger storm events than typically occur most years. This requires large areas of seldom-used land for their primary function. Incorporating multi-use facilities such as trails, parks, scientific research and learning areas, or other recreational and educational opportunities into flood hazard mitigation or protection sites assists in achieving higher levels of year-round value and use. This function tiers directly to the District's philosophy, which states, *"Constructed facilities should be combined, where feasible, with open space, parks, and trails to create focal points for the community and increased recreational opportunities"* (FCDMC 2009). The following performance functions are intended to serve as benchmarks for preserving open space and creating recreation functions within the community that are integrated with flood hazard mitigation design.

3.3.9.1 Performance Functions

- Accommodate City of Goodyear parks (9.1)

  Integrating City of Goodyear parks and other recreation multi-uses within flood control facilities creates more value-dense units within the watershed.

- Accommodate other local parks (9.2)

  Integrating other parks and recreation multi-uses within flood control facilities to complement City of Goodyear recreation planning goals also creates more value-dense units within the watershed.

- Establish Maricopa Regional Trail Segment(s) (9.3)

  Segment 85

  This 26-mile-long segment of planned trail is intended to follow an existing power line route from the Gila River west of Cotton Lane near the Lum Wash Planning Unit, cross Waterman Wash near the Estrella-North SWC, and crossing the Maricopa Mountains between the Sonoran Desert National Monument and the Buckeye Hills Regional Park through the Sonora Planning Unit.

  Segment 86

  This planned trail will follow Waterman Wash and connect the Gila River on the north with the Juan Bautista de Anza National Historic Trail on the south. This segment of trail is identified as an equestrian multi-use trail in both the Maricopa Regional Trail Master Plan and in the City of Goodyear General Plan.

  Segments 87 and 88

  Segments 87 and 88 are access trails designated to connect Waterman Wash with the Sierra Estrella Wilderness Area. Segment 87 is a potential alignment that follows an existing dirt road while Segment 88 is intended as an alternative trail segment along the wash within the Sevenmile Mountain Planning Unit. The Maricopa Regional Trail identified Segment 88 as an alternative to Segment 87 in the event that the unpaved road became a major traffic route.

  Segments 89 and 90

  Segments 89 and 90 are designated to connect Waterman Wash and the Juan Bautista de Anza National Historic Trail with Vekol Wash and the Table Top Wilderness Area located in Pinal County. These segments lie within the Waterman Reaches 4 and 5, as well as the Waterman South planning units.

Segment 91

Segment 91 is designated as a short trail identified to connect Waterman Wash with the Sonoran Desert National Monument. This trail alignment is located very near the West Prong of Waterman Wash and was identified to follow a gas line route.

Segment 94

Segment 94 is the designation given to the Juan Bautista de Anza National Historic Trail in the Maricopa Regional Trail Master Plan.

- Accommodate other local trails (9.4)
- Accommodate Juan Bautista de Anza National Historic Trail enhancement and interpretation – linkage from Gila River to State Route 238 (9.5)

3.3.9.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Co-locate facilities shown on the City of Goodyear Parks and Trails Master Plan with flood hazard mitigation design. Refer to the most recent approved City of Goodyear Parks and Trails Master Plan.
- When designing recreational uses within flood mitigation facilities, limit locating fields and other uses within storm water retention areas to the percentages of allowable inundation described in Table 3-3.
- Design drainage conveyance channels and washes with sufficient right-of-way to include a multi-use trail on at least one side of the channel. Channel designs should include a minimum of 20 feet of additional right-of-way per planned trail beyond that required for conveyance and aesthetic purposes to allow for a meandered 10-foot-wide trail.
- Trails should be designed to connect to other pedestrian nodes, destination uses such as active use areas or economic centers, or open space patches. Trails located along washes should include sufficient buffering to allow wildlife to travel the wash alignment without extensive human encroachment. Trails should not meander into and out of the washes so that bank erosion is exacerbated. Consideration should be given to lateral migration of the wash when locating the trail.

Table 3-3 City of Goodyear Recreation Matrix

			Developed Channels			Retention Basins		
			Compatibility w/ Channel Components			Compatibility w/ Inundation Level		
Activity	**Inundated**	**Average Minimum Required Dimensions**	**Low-Flow**	**Channel Bottom (Non-Low Flow)**	**Channel Overbank - Above 10 Year**	**<10 year**	**10 year<**	**City of Goodyear** Target Maximum Percentage of Inundated Use per Park/Site
Outdoor Facilities								
Amphitheater	O	50' x 50'	F	F	F	F	F	80%
Basketball Court	O	114' x 70'	N	F	F	N	F	75%
BMX Course	O	2 ac.	P	F	F	F	F	80%
Golf Course	O	140 ac.	P	P	F	P	F	95%
Disc Golf Course	F	1 ac. per hole	P	F	F	F	F	95%
Off-Leash Dog Park	O	1/2 ac.	P	F	F	F	F	80%
X Park	L	n/a	P	P	P	P	P	80%
The following facilities may not be located within a retention area, channel, or wash without specific City of Goodyear approval:								
Concessions	N		N	N	N	N	N	0%
Maintenance Yards	N		N	N	N	N	N	0%
Outdoor Swimming Pool	N		N	N	N	N	N	0%
Outdoor Aquatics	N		N	N	N	N	N	0%
Parking	N		N	N	N	N	N	0%
Picnic Areas/ Ramada	N		N	N	N	N	N	0%
Playgrounds	N		N	N	N	N	N	0%
Restroom Facilities	N		N	N	N	N	N	0%
Sand Volleyball	N		N	N	N	N	N	0%
Skate Park	N		N	N	N	N	N	0%
Tennis Courts	N		N	N	N	N	N	0%
Volleyball Courts	N		N	N	N	N	N	0%
Water/Splash Pads	N		N	N	N	N	N	0%
Sports/Athletic Fields								
Little League/Baseball	L	450' x 450'	N	F	F	F	F	75%
Softball Field	L	450' x 450'	N	F	F	F	F	75%
Soccer Field	L	225' x 360'	N	F	F	F	F	95%
Multi-Use Playing Fields	O	175' x 375'	N	F	F	F	F	95%

			Developed Channels			Retention Basins		
			Compatibility w/ Channel Components			Compatibility w/ Inundation Level		
Activity	Inundated	Average Minimum Required Dimensions	Low-Flow	Channel Bottom (Non-Low Flow)	Channel Overbank - Above 10 Year	<10 year	10 year<	**City of Goodyear** Target Maximum Percentage of Inundated Use per Park/Site
Ranges								
Firing Range	L	1/2 mile	N	F	F	F	F	80%
Archery Range	O	800 meters	N	F	F	F	F	80%
Trails and Courses								
ATV Trail	F	Trail	N	F	F	F	F	95%
Equestrian Trail	F	Trail	F*	F	F	F*	F	95%
Motocross Course	O	100' x 200'	N	N	F	F	F	80%
Mountain Biking Course	O	Trail	N	F	F	P	F	95%
Soft-Surface/Hiking Trail	L	Trail	N	N	F	P	F	95%
Tour Bike Course	L	Trail	N	N	F	P	F	80%
* Equestrian trail routes may be aligned within the bottoms of natural washes or constructed earthen channels provided the route incorporates planned ingress and egress points to minimize bank erosion								
The following trails and courses may not be located within a retention area, channel, or wash without specific City of Goodyear approval:								
Go-kart Course	N	n/a	N	N	N	N	N	0%
Hard-Surface Multi-Use Trails (e.g., Inline Skating)	N	Trail	N	N	N	N	N	0%
Natural Recreation and Open Space Recreation								
Birding (constructed blinds, etc.)	F	n/a	N	F	F	F	F	95%
The following nature-based recreation facilities may not be located within a retention area, channel, or wash without specific City of Goodyear approval:								
Camping** – With No Amenities	O	15' x 15' per site	N	N	N	N	N	0%
Camping** – With Amenities	L	35 ac. for 75 units	N	N	N	N	N	0%
Nature/Interpretive Center	N	n/a	N	N	N	N	N	0%
Outdoor Concert Facilities	N	20 ac. min.	N	N	N	N	N	0%
Equestrian Stables	N	n/a	N	N	N	N	N	0%
** Camping sites may be approved in conditions where partial inundation will occur provided adequate public safety measures are in place (i.e., seasonal closing, flood warning systems, etc.)								

			Developed Channels				Retention Basins		
			Compatibility w/ Channel Components				Compatibility w/ Inundation Level		
Activity	Inundated	Average Minimum Required Dimensions	Low-Flow	Channel Bottom (Non-Low Flow)	Channel Overbank - Above 10 Year		<10 year	10 year<	**City of Goodyear** Target Maximum Percentage of Inundated Use per Park/Site
Other Active Recreation Facilities									
Model Airplane Field	F	n/a	N	F	F		F	F	95%
Paintball Field	F	n/a	P	F	F		F	F	95%
Ropes Course	O	n/a	P	F	F		F	F	80%
The following recreation facilities may not be located within a retention area, channel, or wash without specific City of Goodyear approval:									
Equestrian Arena	N	n/a	N	P	P		P	F	0%
Rock Climbing Wall	N	n/a	N	N	N		N	N	0%
Civic Facilities									
Botanical Garden***	L	n/a	L	L	L		L	L	0%***
Fair Grounds	L	n/a	P	P	P		P	P	95%
Community Gardens	L	n/a	P	P	P		P	P	80%
*** Botanical gardens should be designed so that only those plant materials that benefit from inundation are located within areas that may be inundated. Special design and approval of these facilities are required									
Historic Facilities									
Native American/Living Historical Site	L	n/a	P	P	P		P	P	Based on Specific Site
Historic Mining Site	L	n/a	P	P	P		P	P	Based on Specific Site

Inundated

N = Not Suitable for Inundation
L = Limited Inundation of Facilities Acceptable
O = Occasional Inundation of Full Facilities Acceptable
F = Frequent Inundation Acceptable

Compatibility with Flood Control Facilities

F = Recreation use is fully compatible with this area of the facilities
P = Recreation facilities associated with this use are partially compatible with this area of the facilities
N = Recreation use is not compatible with this area of the facilities

- Trail uses should be based on the City of Goodyear Parks, Trails, and Open Space (PTOS) Master Plan, or on the Maricopa Regional Trail Master Plan. Where local trails are intended to augment the City PTOS, designations and uses should be determined based on trailhead conditions and adjacent land uses. Washes should be planned and facilities should be designed to create a separated multi-use path within the overbank area and access to the trail bottom for use as an equestrian trail.
- Trail designs should include appropriate levels of wayfinding signage, visibility, and lighting where required by the City of Goodyear based on the setting. For example, natural trails along washes that connect to large areas of open space may require little in the form of wayfinding and no lighting while a developed multi-use path within a suburban setting would have greater wayfinding needs and lighting requirements.
- Incorporate the following segments of the Maricopa Regional Trail using the guidelines outlined below:

Segment 85

No segment of this trail was planned to be integrated into flood hazard mitigation facilities. However, some opportunity exists to re-route the trail in order to take advantage of the open space within the Estrella-North SWC as well as other potential SWCs in the Sonora Planning Unit. Use of the erosion hazard setback within the SWCs as an open space trail corridor would provide sufficient open space to accomplish this function within the limits of the SWCs. Coordination would be required to continue the trail beyond the SWC to connect to the original planned alignment within the power line corridor.

Segment 86

A 100-foot open space buffer was included in early conceptual planning for the Waterman Wash corridor, with a multi-use trail on both sides of the wash. Development of the trail system along Waterman Wash should be included within this buffer zone, or within the proposed erosion hazard setback for Waterman Wash as identified within this planning report.

Segments 87 and 88

Segment 87 lies near the Estrella-South SWC. Use of the open space within the erosion hazard setback of the protected wash could be used as an alternative route, which would provide a suitable trail experience that complements the desired goals of the County trails planning group.

The unnamed wash identified to serve as the alignment for Segment 88 lies within the wildlife corridor identified within the Sevenmile Mountain Planning Unit. No recommendations are made in this report to develop an improved trail alignment at this location as current plans for this area are to leave it undeveloped for wildlife permeability. Use of the wash as a primitive trail for non-motorized users should not be prohibited or discouraged. Protection of the wash from off-highway vehicle use will be required as part of the planning and management of the wildlife linkage functions of this area.

Segments 89 and 90

Planning for Waterman Reaches 4 and 5 includes the implementation of a trail within the erosion hazard setback. Portions of the Maricopa Regional Trail segments should be aligned with trails within this buffer area.

Segment 91

The realignment of this trail segment within the West Prong erosion hazard setback would create a complementary trail experience and should be considered as an alternative to the gas line route.

- Flood hazard mitigation projects designated within the alignment of the national historic trail should provide a 100-foot easement for the trail alignment. Project design should be coordinated with the National Park Service and the Maricopa County Parks and Recreation Department to achieve certification. There are seven criteria on the National Park Service website that must be met in order for a trail to qualify as a certified segment of the Juan Bautista de Anza National Historic Trail (National Park Service 1996).
- The Maricopa Regional Trail System alignment for Segment 94 should be used for determining the Juan Bautista de Anza National Historic Trail alignment in order to achieve the criteria referenced above. Coordination with Maricopa County Parks and Recreation Department should include integration of any proposed trail segments within this area into the overall master trail plan.
- To the extent possible, drainage channels and storage basins located within the national historic trail alignment should be themed to meet the criteria referenced above. This requires that the Juan Bautista de Anza National Historic Trail segments may not be co-located with operation and maintenance roads unless otherwise approved by the National Park Service.
- Partnering and stakeholder involvement with projects along the national historic trail alignment should determine trail maintenance responsibilities and establish appropriate

agreements prior to developing final design documents in order to prevent late disagreements or other misunderstandings that might jeopardize certification as required by the National Park Service.

3.3.10 Provide Open Space (10)

The demand for open space preservation has continued to grow throughout Maricopa County. Many local municipalities, such as the cities of Phoenix and Scottsdale, have voter-supported sales tax and bond funding for purchasing and managing open space preserves within their boundaries. The preservation of open space along natural washes used for flood hazard mitigation, as well as open space along constructed channels, can serve as vital linear links between larger preserved open spaces that serve as large habitat patches. In the case of the Waterman Wash watershed, the many existing open space resources, such as the Sierra Estrella Wilderness, Sonoran Desert National Monument, Estrella Mountain Regional Park, and the Buckeye Hills Regional Park, form a significant ring of preserved open spaces around the Rainbow Valley area, each with a variety of associated uses. These range from preservation areas with limited or no motorized access to highly developed active-use facilities. Potential open space linkages that will connect to the larger open space mosaic can preserve value and access to these areas. The benefits and values include market value increases, such as higher premiums for developed lots adjacent to open space areas and indirect market value for residents within the community. For example, in a recent study published in *The Journal of Epidemiology and Community Health* (Maus et al. 2009), researchers reported decreased levels of morbidity, and increased levels in mental as well as physical health associated with living close to green spaces (within 1 kilometer [km] to 3 km). The following performance functions are intended to serve as benchmarks for maintaining or creating open space functions within the community that are integrated with flood hazard mitigation design

3.3.10.1 Performance Functions

- Preserve existing open space value (10.1)
- Maintain BLM-managed lands as public open space (10.2)

  BLM lands and their associated natural resources are managed in accordance with their approved Resource Management Plans (RMP). The RMP for the Phoenix South and Sonoran Desert National Monument areas are under development at the time of writing this report. However, goals identified during the development process that are directly related to the primary functions of the Waterman Wash watershed include the following:

- Watersheds
  - Manage watersheds to maintain or enhance healthy ecosystems, water quality, and water quantity.
- Watersheds (Soils)
  - Manage the public lands such that erosion and sedimentation rates are appropriate to soil types and landforms.
  - Conserve sensitive soils such as desert pavement and cryptogamic soils.
- Watersheds (Water)
  - Manage surface and groundwater resources to protect, maintain, and improve water quality in accordance with water quality standards.
  - Protect water supply to provide for the needs of the biota and other natural resources.
- Cultural
  - Protect and conserve cultural resources including the full range of site types.
  - Conserve, protect, and manage cultural landscapes, sites, and the historic/prehistoric context.
- Biological Resources
  - Maintain or restore ecosystem health and native biodiversity.
  - Conserve and recover threatened and endangered species and their habitat and manage to prevent the listing of additional species.
  - Conserve, restore, or enhance native wildlife populations and their habitats.
  - Maintain, restore, or enhance wildlife corridors.
  - Maintain habitat connectivity and limit habitat fragmentation.
  - Restore, protect, or enhance the diversity and distribution of natural vegetation communities.
  - Manage invasive species to limit their impact on natural resources and processes.
- Visual
  - Conserve visual and aesthetic integrity and diversity.
  - Manage public lands to protect scenic quality, especially to maintain predominantly natural landscapes.

- Grazing
  - Manage livestock grazing consistent with maintaining healthy ecosystems and the concepts of multiple use and sustained yield.
  - Grazing allotments will be reclassified, including the designation of ephemeral range, for management of vegetation and ecological processes as determined through the BLM Arizona Land Health Standards allotment evaluation process.

Flood hazard mitigation projects and uses planned in accordance with the watershed management-based recommendations of the ADMP should accomplish these preliminary goals. BLM projects or allowed uses that vary from the recommendations of the ADMP should be reviewed for their impacts on the watershed functions as a whole rather than on a site-by-site basis.

- Development in "MAG Desert Spaces – Retention" areas to comply with MAG *Desert Spaces Design Guidelines* (10.3)

  Environmentally Sensitive Development Areas (ESDA) are those areas designated as suitable for development in the plan, but that "have landscape characteristics that should be retained" (MAG 2000). This is achieved through the use of environmentally sensitive development.

3.3.10.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Maintain open space within the erosion hazard setbacks designated in association with the SWCs identified in the Recommended Plan. The undeveloped areas within the setback should be left in a natural state adjacent to the wash in order to provide open space value. Where limited disturbance is required for wash crossings or other allowed uses, the disturbance area should be restored or revegetated to maintain scenic, biological, and passive recreation functions as described in other sections of this report.
- Development within Rainbow Valley should use clustering and other watershed functional approaches to preserve open space as well as mitigate sheet flow flood risk.
  - Development plats shall include developed lots and all other information required by the underlying municipality as well as the associated open space areas to be preserved that show compliance with the criteria below.
  - Density of the development shall comply with the following:
    - For areas with slopes between 15 percent and 20 percent, the development shall comply with all hillside ordinances.

        - Where development is adjacent to secured open space areas, no more than 50 percent of the entire development should be disturbed from its natural state to a distance of 300 feet from the edge of the protected open space area. This is based on the recommendations of the *MAG Sonoran Desert Spaces Design Guidelines*.
    - The minimum lot sizes, setbacks, and maximum percentage of lot coverage required by the underlying zoning code do not apply to the development when a minimum of 30 percent of the development is retained as natural open space. Building height restrictions shall comply with the underlying zoning. Minimum building setbacks, maximum lot coverage, and densities shall be provided to the reviewing municipality for approval.
    - A narrative description of the connections between the preserved open space areas to the adjacent lands shall be included for approval. Open space areas shall meet all continuity requires described elsewhere in this report.
    - Open space areas shall be located adjacent to the greatest number of lots possible. Non-adjacent lots shall be provided safe access to open space. Include a diagram showing routes to open space from all non-adjacent lots and public spaces.
    - Perimeter areas shall include open space buffers as part of the 30 percent minimum open space area. Perimeter areas shall be a minimum of 75 feet in depth from adjacent land uses. Where two cluster developments are planned adjacent to one another, the combined buffer may be a combined 80 feet total. Downstream open space buffers shall be 150 feet to allow for sheet flow redistribution. Downstream cluster developments that maintain continuity of open space areas may use a combined 80-foot buffer where the drainage report shows no adverse impacts from flows from the upstream development occur.
- BLM lands located within the Sevenmile Mountain Planning Unit have been identified as the most probable location for establishing an important wildlife linkage. While the complete management of these lands for this purpose are outside of the scope of the Rainbow Valley Recommended Plan, flood hazard mitigation measures can be developed in a manner that complement this function. The Recommended Plan considers the best management for the proposed corridor area as being consistent with the RMP for the Sonoran Desert National Monument as a special use area within the Phoenix South Resource Management Area. Specific design criteria for flood hazard mitigation within this area include the following:
    - Non-structural or soft-structural flood hazard mitigation methods only should be used within the proposed corridor. This includes prohibiting development within 100-year

floodplains and managing BLM-permitted resource uses within the entire wildlife corridor to not encroach within the floodplain in order to reduce negative impacts to wildlife use of the floodplain and wash corridor for habitat and movement.

  - All road crossings should include culverts or bridge structures at any 404 washes or where a delineated floodplain exists and be sized appropriately for wildlife permeability. Proposed structural designs should be developed in consultation with and submitted to Arizona Game and Fish Department (AGFD) for review and acceptance. A suitable monitoring plan should be developed in conjunction with AGFD that evaluates the effectiveness of the roadway crossings following construction, and long-term planning and funding should be set aside to ensure the effectiveness of the structural permeability.

- Flood hazard mitigation projects and development that overlays floodplains and other ESDAs shall incorporate the MAG *Desert Spaces Design Guidelines* identified as "Retention" in the MAG *Desert Spaces Design Guidelines*. The primary areas designated as "Retention" within the Waterman Wash watershed are associated with the 100-year floodplains of the many primary washes. These areas lie within the Lower Sonoran Valley Floor (or LCC-1) and the Lower Sonoran Bajada (LCC-2) of the *Desert Spaces Design Guidelines*. These sections of the MAG Desert Spaces ESDA policy and planning guidelines should be referred to for further design guidelines when planning development or flood hazard mitigation projects in these areas.

3.3.11 Protect or Enhance Biological Resources (11)

Non-xeroriparian habitats have been developed to the greatest extent in the Sonoran Desert in Arizona. Upland habitats, Upper Sonoran Palo Verde mixed-cacti habitats, have received less development and greater preservation by municipal, state, and federal entities. However, lowland desert habitats, creosote desert scrub and salt scrub desert habitats have received the greatest development and greatest loss of local populations of organisms. These lowland areas typically have deep fine-textured soils and a unique array of plant and animal species that are specifically adapted to using these resources.

Xeric desert washes are like riparian areas with perennial water when considering the importance of their ecological functions. Although dry most of the year, desert washes are important for harvesting and distributing water, nutrients, and seeds from the watershed. They also serve as movement corridors or primary habitat for wildlife. In some areas, 90 percent of the bird species occur along various desert washes, and some species of birds have adapted to utilizing these types of habitats almost exclusively. The canopy of vegetation typically provides a cooler and slightly more humid microclimate, and a complex structure for a variety of foraging opportunities for different bird species than in other parts of the desert environment. Although desert tortoise in the Sonoran Desert primarily use foothill habitats, desert washes function as dispersal corridors that help to maintain the long-term gene flow between otherwise isolated populations (Berry 2007). Mule deer, javelina, and bobcats have been documented as preferring dry wash habitats as movement corridors rather than open desert environments (Popowski and Krausman 2002).

As is the case with parts of Waterman Wash, the dense borders of vegetation along larger washes can support a greater amount of wildlife than the surrounding desert habitats. Waterman Wash would serve as a natural north-south dispersal corridor for nutrients, water, seeds, and wildlife and would function to provide habitat for a diverse array of bird species. The tributaries of Waterman Wash help to provide east-west connectivity for plants and animals between the Sierra Estrella and Maricopa mountains and habitats protected in preserves in those areas. Preservation of wash corridors in the planning area would help to preserve these important functions performed by xeroriparian washes in the planning area.

Protecting and enhancing these areas in the planning area by utilizing mitigation banking and clustered development that maintain the integrity and connectivity of these habitats can help to preserve local populations of plant and animal species in non-xeroriparian areas. Ultimately, this can help to preserve the regional diversity of species and genetic diversity within populations of a given species.

Traditional flood protection methods that have relied on hard surfaces and structures like channels, levees, and dams have disturbed natural biological patterns and movement of organisms. The methods of flood protection proposed for this plan have taken into consideration the preservation or enhancement of biological processes and patterns as part of its context sensitive solution. A number of performance functions have been developed in the proposed alternative to meet the goal of preserving or enhancing biological resources as the planning area develops in the future. Although described and categorized individually, these performance functions are not mutually exclusive.

3.3.11.1 Performance Functions

- Maintain existing ecological integrity of natural vegetation types (11.1)

  Maintaining existing areas of natural vegetation not only preserves the natural functions of the watershed but also conserves useable habitat for wildlife or could conserve rare resources that would be lost to development. Ways to maintain natural vegetation include clustering development, avoiding development in washes, mitigation banking of land near preserved areas, and limiting the spread of invasive plant species and noxious weeds.

- Protect natural and beneficial functions of washes (11.2)

  Protecting the natural and beneficial functions of washes preserves the functional patterns and processes described in Section 3.3.11. In summary, these include preservation of the distribution of water, seeds, and nutrients within the Waterman Wash watershed and the pattern of habitat resources that are essential for wildlife and areas necessary for wildlife movement within the planning area. Limiting development in wash corridors and protecting and enhancing washes above 500 cubic feet per second can help to maintain these functions.

- Preserve the connectivity and permeability of habitats (11.3)

  Preservation of the connectivity and permeability of habitats conserves areas necessary for wildlife movement and the movement of seeds and nutrients through the Waterman Wash watershed. Methods to preserve connectivity include maintaining wash corridors, preserving known wildlife corridors, clustering development, and habitat banking. Ways to maintain permeability of habitats include preserving wildlife corridors and designing wildlife-friendly crossings in wash corridors that pass underneath roadways or other man-made barriers.

- Restore or enhance vegetation and natural channels in poorly defined or degraded sections of washes (11.4)

  Restoration of vegetation and altered wash channels can help to restore habitat and movement areas for wildlife. Parts of Waterman Wash and other natural channels that are poorly vegetated and that can support more bank-side vegetation can be improved as habitat for wildlife, which would improve in-situ habitat and habitat available for wildlife movement.

- Use built structures to create resources for wildlife (11.5)

  Built structures can be used to provide different types of resources for wildlife. Basins can be designed to provide water catchments that hold water for wildlife. Linear structures that are designed to mimic natural washes can improve or maintain movement areas or corridors for wildlife. The minimal use of hard structures helps to provide opportunities to create useable habitat areas for wildlife.

3.3.11.2 Design Criteria

If implemented, the design criteria described in Sections 3.3.1 through 3.3.10 will assist in maintaining the biological performance functions previously described above. Fencing in the planning area should follow the AGFD guidelines. Fencing should be permeable to wildlife where it crosses open space areas and along Waterman Wash in order to allow wildlife movement. Fencing around housing developments can be designed to limit encounters with wildlife and household pets. Artificial lighting along pathways or roadways should also follow AGFD guidelines to minimize impacts to wildlife.

3.3.12 Promote Appreciation and Preservation of Significant Cultural Resources (12)

An important project objective is to protect and if feasible, interpret the cultural resources (prehistoric and historic sites) within the planning area in conjunction with development of multi-use flood control facilities. The District plans flood protection facilities that are sensitive to their scenic, environmental, and cultural contexts, in addition to their primary flood protection function. Because flood events are relatively rare, the District considers potential multi-uses (particularly outdoor recreation) for flood protection facilities, which could include preservation and public interpretation of cultural resources. That strategy contributes to the objectives of the *Maricopa County Comprehensive Plan: Eye to the Future 2020* for promoting appreciation and preservation of significant archaeological and historical resources within the framework of state and federal laws (Maricopa County 2002). At the same time, construction of flood control facilities has potential to disturb or destroy cultural resources.

The District sponsored a cultural resource overview of the study area during an earlier stage of planning (Rodgers 2008), and provided digitized information about prior cultural resource surveys and recorded archaeological and historical sites in the planning area. That information was used to prepare a cultural resource assessment that was considered in developing the Rainbow Valley ADMP. The cultural resource assessment estimated that there could be approximately 1,000 to 1,500 archaeological and historical resources in the planning area, but more than 90 percent of those have yet to be discovered, recorded, and evaluated. A model of cultural resource sensitivity was developed by evaluating the frequency and types of sites recorded within environmental zones. The analysis indicates that the average site density varies little among the zones, ranging about 3 to 5 sites per square mile. The foothills and upper alluvial fans zone was rated as having moderate sensitivity because it has the highest site density and because about one-fourth of the recorded sites in that zone have petroglyphs. There often is interest in preserving petroglyph sites and they have some potential for public interpretation. The other three zones (mountains, lower alluvial fans and valley plains, and named river and wash corridors along the Gila River, Waterman Wash, Lum Wash, Corgett Wash, and Vekol Wash) were rated as having low sensitivity.

Only one site in the assessment area—the Initial Point of the Gila and Salt River Base Line and Meridian—is listed in the National Register of Historic Places. The significance of most of the archaeological and historical sites recorded in the study area has not been formally evaluated but those that are significant and eligible for the National Register and Arizona Register are likely to be so for their potential to yield important information (Criterion D). If such resources were within areas that would be disturbed by construction of flood protection facilities, those impacts could be mitigated through studies to recover and preserve artifacts and data, and are unlikely to represent major constraints. (At least 28 archaeological sites in the assessment area were studied to recover and preserve information before they were destroyed by residential development.) If archaeological and historical resources are within rights-of-way or easements acquired for flood protection facilities but would not be disturbed, there could be opportunities to preserve in place and perhaps publicly interpret those resources. Any plans to protect and interpret sites should consider the 2009 *Sustainable Sites Initiative: Guidelines and Performance Benchmarks* for protecting and maintaining cultural and historical places.

3.3.12.1 Performance Functions

- Historic sites (12.1)

  The cultural resource assessment identified historic resources and themes that might be protected and interpreted in conjunction with development of flood control facilities. Those themes and resources relate to travel in the Gila Trail corridor, including the Juan Bautista de Anza National Historic Trail, Mormon Battalion/Butterfield Overland Mail Road, and Southern Pacific Railroad (Mobile Planning Unit), as well as SR 84 and I-8 farther to the south. Another historic theme relates to historic settlement, and resources that might be protected or interpreted include (1) the Mobile African-American community (Mobile Planning Unit); (2) the homestead of Colonel Waterman [near the boundary of Waterman Wash Reach 1 and the Lum Wash Planning Unit, which also is the location of the large Hohokam village site AZ T:10:46(ASM)]; (3) the Initial Point of the Gila and Salt River Base Line and Meridian that created a system to facilitate homesteading and privatization of land; and (4) the historic Rainbow Valley community and the twentieth century development of irrigation agriculture based on deep wells.

  Little of the planning area has been surveyed for historical resources and other historic sites could be identified as the plan is implemented. They should be evaluated and treated in accordance with the design criteria stipulated in the following section.

- Prehistoric sites (12.2)

  The cultural resource assessment concluded that over the 12 millennia of documented human occupation of the region, Rainbow Valley seems never to have been a focus of settlement, probably because of sparse natural resources and the lack of surface water. Only two prehistoric habitation sites have been recorded in the assessment area, and they are related to the era when Hohokam farmers built and operated vast irrigation systems along the terraces and valley floors along the Salt and Gila rivers of central Arizona (circa A.D. 500 to 1500). A large Hohokam village site [AZ T:10:46(ASM)] has been recorded near the confluence of the Gila River and Waterman Wash at the northern end of Rainbow Valley (near the boundary of Waterman Wash Reach 1 and the Lum Wash Planning Unit). That village site warrants consideration for protection and/or interpretation. The only other known Hohokam habitation in the planning area is small (probably only three or four rooms) and situated in a pass through the Sierra Estrella Mountains within the Maricopa County Estrella Mountain Regional Park. Numerous archaeological sites indicate that prehistoric populations exploited the natural resources of the study area and perhaps even pursued ak-chin farming in selected areas on alluvial fans. Those people probably resided in adjacent areas with more abundant water supplies (primarily the Gila River) and entered the Rainbow Valley on only a limited, seasonal basis to hunt game and gather indigenous plant foods.

There also are indications that pre-Hohokam sites might be completely buried in the alluvial fans at the margins of Rainbow Valley. These Archaic era sites could provide evidence about hunters and gatherers who occupied the region thousands of years ago before the Hohokam occupation.

Another theme of the prehistoric era relates to travel along short cut routes in lieu of following the big bend of the Gila River around the north end of the Sierra Estrella Mountains. The well-known historic Gila Trail across the south-central part of Rainbow Valley (Mobile Planning Unit) followed a prehistoric trail along this corridor. The Komatke trail is another aboriginal trail along an approximately parallel route about 12 miles north of the Gila Trail (crossing the Estrella and Sonora planning units and secured open space in the Sonoran National Monument and Maricopa County Estrella Mountain Regional Park). The Quartz Peak Trail [AZ T:15:124(ASM)] is another aboriginal trail that was used for access to the high elevations of the Sierra Estrella Mountains. The local O'odham continue to use the trail for ritual purposes and it also is designated as a recreational trail in the Sierra Estrella Wilderness Area (secured open space at the eastern edge of the planning area).

Many other prehistoric archaeological sites could be identified as the plan is implemented. They should be evaluated and treated in accordance with the design criteria stipulated in the following section.

3.3.12.2 Design Criteria

The following design criteria are proposed to achieve the performance functions just described.

- Pre-planning for flood hazard mitigation projects shall include a cultural survey to determine if there are cultural resources present that are eligible for the Arizona Register and National Register. To be eligible for the Arizona Register and National Register, properties must be at least 50 years old (unless they have special significance) and have national, state, or local significance in American history, architecture, archaeology, engineering, or culture. They also must possess integrity of location, design, setting, materials, workmanship, feeling, and association, and meet at least one of four criteria:

Criterion A: Be associated with significant historical events or trends.

Criterion B: Be associated with historically significant people.

Criterion C: Have distinctive characteristics of a style or type, or have artistic value, or represent a significant entity whose components may lack individual distinction.

Criterion D: Have yielded or have potential to yield important information (Arizona Administrative Code, Title 12, Chapter 8, Article 3, R12-8-302; Title 36, Code of Federal Regulations, Part 60).

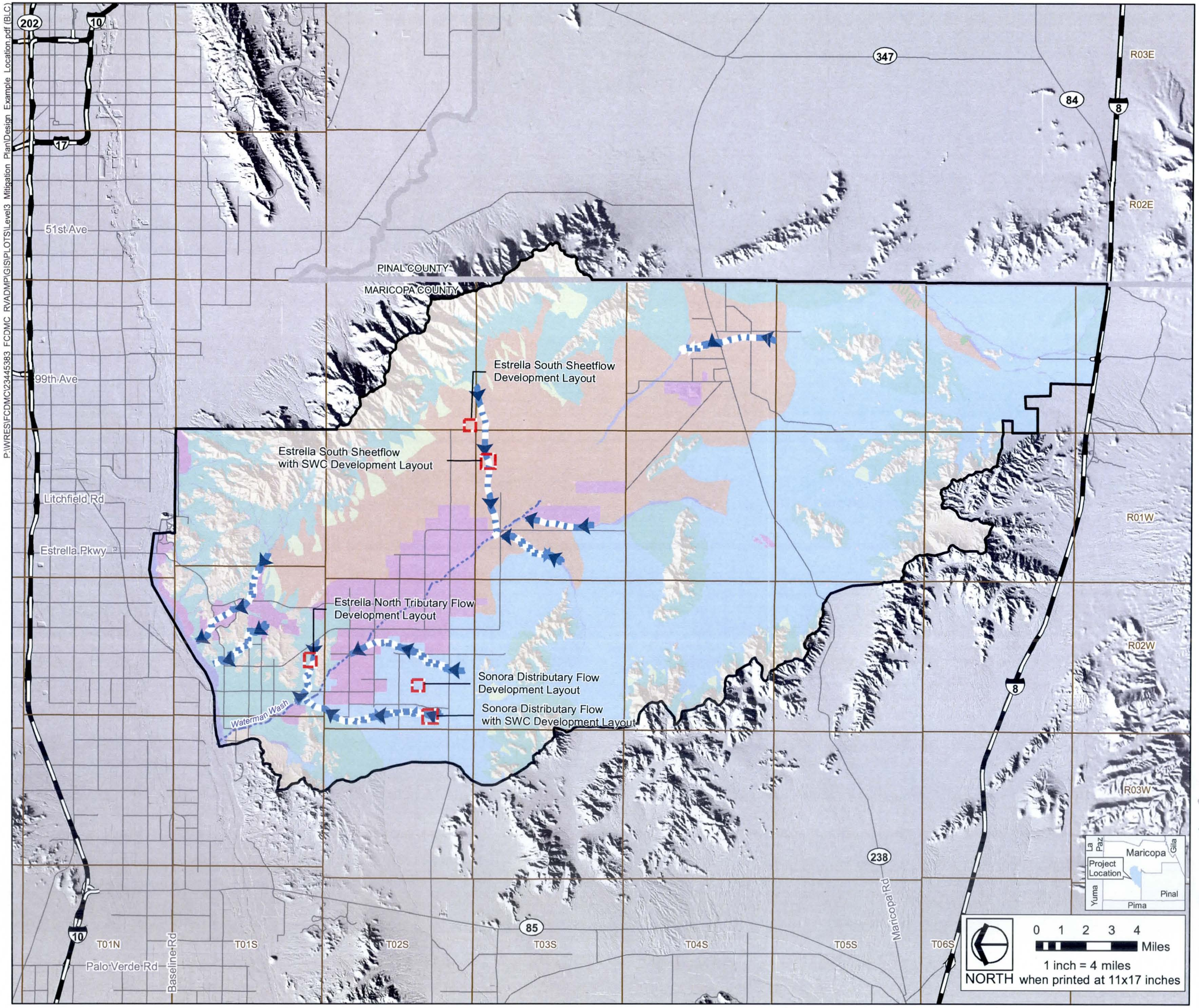
If Register-eligible properties are identified, measures should be implemented to avoid and protect those properties or reduce or mitigate impacts.

3.4 DESIGN GUIDANCE

Representative typical designs were developed for various combinations of flow characteristic and development types within the Rainbow Valley ADMP study area where planned development would introduce higher flood risk. Typical designs are provided for the following flow characteristics:

- Sheet flow
- Sheet flow with an SWC
- Tributary flow
- Distributary flow
- Distributary flow with an SWC

In addition to the above flow characteristic areas, typical designs were developed for Waterman Wash and the existing disturbed areas adjacent to Waterman Wash. The locations for each of the above conditions within the Waterman Wash watershed as well as the corresponding typical design report section are shown on **Figure 3-3**.



Rainbow Valley
Area Drainage Master Plan
Design Example Location

Figure 3-3

Project Features

- Example Location
- SWC Wash Corridor
- Waterman Wash

Flow Characteristics

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

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
JE Fuller/Hydrology & Geomorphology
Alluvial fan identification and flow characteristics assessment, 2008

Actual development layouts and storm water management facilities for any given real parcel must be developed specifically for that particular site. The design criteria for the ADMP are intended to guide the development process based on the unique drainage patterns and site conditions of each individual property. For this reason, the typical design layouts are illustrative in nature, and are not intended to be suitable for duplication on another property even within the same flow characteristic area. Each section is intended to provide reviewing agency staff, developers, homeowners, and their design teams with a representative example demonstrating how the design criteria within the unique conditions of each flow characteristic area can be implemented.

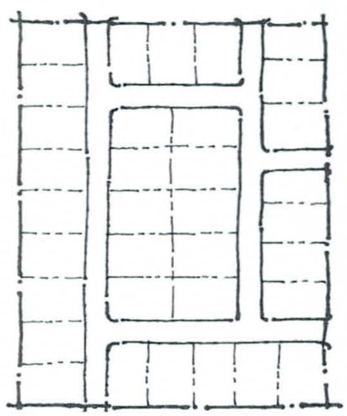
As discussed in Section 2.0, the planned future development in Rainbow Valley will be predominately located on the Piedmont landform where future development can have a significant impact on function continuity for the watershed as a whole. Because of this, each section includes information on the site conditions as they occur in an undeveloped, natural state. Each section also includes preliminary information on how a traditional "lot maximization" approach impacts the watershed functions related to the site. Finally, a typical design is presented that was developed using the design concepts from the ADMP.

A two-dimensional FLO-2D computer model is used to evaluate the runoff under the natural condition and the two developed condition scenarios to illustrate the impacts caused by development. Each typical design includes exhibits showing the FLO-2D results for the natural, traditional, and ADMP condition. The model analyzes runoff using a grid with square cells laid over the terrain to be modeled. Each cell is assigned an average elevation, a roughness factor, rainfall, and loss parameters. The runoff is then routed through the grid for the duration of the design storm. The upstream hydrograph generated in the HEC-1 model is coded in at each upstream grid boundary. The FLO-2D results are depicted using a color ramp to show the maximum flow depth at each cell. The exhibits presented for each typical design show the FLO-2D depth results along with comparative data for runoff, scenery, and multi-use. The darker colors in the exhibit depict the higher flow depths and by observing the paths of darker colors, the predominant flow paths become apparent. The impacts of the traditional and ADMP development approaches are then coded into the model grid and re-run showing the concentration, re-routing, and flow depth changes resulting from the development. The impacts are discussed for each typical design in the following sections.

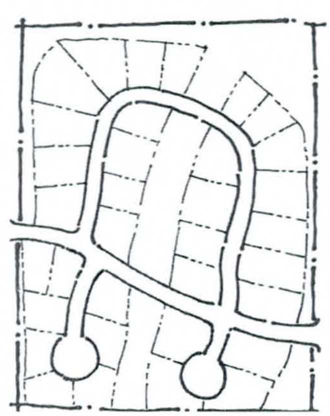
3.4.1 Land Use Planning

Planning information is included with each typical design to demonstrate how the design criteria can be applied within the overlying land use designations and zoning districts. Because this information is municipality-specific, the planning information shown is intended to be illustrative in nature. However, an attempt has been made to use land-use requirements that are based on the City of Goodyear General Plan and reflect common land uses where planned development is expected to occur. In most instances, the land use designations are for lower-density residential development where the natural landscape has been undisturbed. In the disturbed flow characteristics area, the permitted land uses include higher-density residential, commercial, and industrial designations.

As described in the design criteria outlined in Section 3.3, the open space preservation requirements of the ADMP are expected to be achieved through the use of "clustering" development areas within the site boundaries. In order to maintain the number of developable lots, ordinance modifications may be required for municipalities and other reviewing agencies to allow developers to reduce lot sizes, adjust setback requirements, and modify other zoning restrictions within a given area. The purpose of these changes is to maintain the number of lots achievable within the property, as illustrated below.



Traditional: *The 34 lots at left were laid out based on a typical underlying zoning code with standard setbacks, minimum lot sizing requirements, and other restrictions*



***Clustering**: The layout at left shows how the property might be configured with the same number of lots while achieving the ADMP's open-space preservation requirements using smaller lot sizes, but retaining the overall gross density of units per acre*

Traditional and Clustering of Lots

Densities listed in the typical designs are shown as gross density (total units/total site acreage) and are intended to conform generally to the land use designations from the *City of Goodyear General Plan 2003-2013* for both the traditional layout examples as well as the ADMP recommended examples. The following three land use designations are the most common within the natural undisturbed areas where flood risk is likely to increase due to development:

3.4.1.1 Rural Residential (RR: 0.0-2.0 du/ac)

The *City of Goodyear General Plan* describes this designation as "Denot(ing) areas where limited large-lot residential development in natural desert, agricultural production, or livestock grazing areas exist. Locations surrounding open space areas are also ideal for RR land uses. Appropriate locations should offer proximate access to joint-use elementary school/

neighborhood parks, trails, and open space as well as local road vehicular access. **Areas recommended for RR uses shall exhibit a baseline density of 0.2 du/ac (1 du/5 ac)**."

3.4.1.2 Low-Density Residential (LDR: 2.0-4.0 du/ac)

The *City of Goodyear General Plan* describes this designation as "Denot(ing) areas where detached, moderate-sized lot, single–family residential housing is desirable. Transitional uses, such as home offices that do not occupy more than 25 percent of the living area and do not generate additional pedestrian or vehicular traffic, are also allowed in LDR designated areas. LDR parcels should be located with either adjacent or proximate access to joint-use elementary schools/neighborhood parks, trails, open space, and recreational facilities and should use local and collector road access/mobility. Other RR, LDR, or L-MDR parcels should surround appropriate centralized park/school locations. **Areas recommended for LDR uses shall exhibit a baseline density of 2.0 du/ac**."

3.4.1.3 Low-Medium Density Residential (L-MDR: 4.0-6.0 du/ac)

The *City of Goodyear General Plan* describes this designation as, "Denot(ing) areas where small lot, detached and attached single-family residential, townhome and patio home developments are desirable. Transitional uses, such as home offices that do not occupy more than 25 percent of the living area and do not generate additional pedestrian or vehicular traffic, are also allowed. Appropriate centralized locations should surround other LDR, L-MDR, or MDR parcels located with either adjacent or proximate access to joint-use elementary/junior/high schools, neighborhood parks, trails, open space, and recreational facilities. This land use should have direct local and/or collector road access. **Areas recommended for MDR uses shall exhibit a baseline density of 4.0 du/ac.**"

In areas where the land use code permits densities higher than 6.0 units per acre within the undisturbed natural landscape, other mechanisms will be needed to accommodate the requirement for open space preservation as a flood hazard mitigation and function preservation technique. These areas, such as those designated as suitable for medium-density residential (MDR: 6.0-10.0 du/ac), medium-high density residential (M-HDR: 10.0-20.0), and high density residential (HDR: 20.0+ du/ac), may require open space preservation to be balanced with other engineering methods, provided that the developer can effectively demonstrate that the functional continuity is maintained through their site and into the downstream portions of the watershed. This will require addressing the remaining benchmarks and performance functions on a case-by-case basis, to be determined by the governing municipality or agency and approved by the flood plain management group responsible for the area such as the District.

3.4.2 Descriptive Metrics

Each typical design section includes the following descriptive metric that directly relates to the principal functions and design criteria described earlier in this report:

- Runoff volume (1)
- Discharge (2,6)
- Flow Continuity (3,7)
- Storage Preservation (4)
- Landscape character (8)
- Viewshed preservation (8)
- Recreation uses (9)
- Open space resource integrity (10)
- Biological resource integrity (11)
- Cultural resource integrity (12)

3.4.2.1 Runoff Volume

The runoff volume in acre-feet is reported for each typical design to illustrate the change in runoff volume resulting from various development practices. The runoff volume for existing conditions reflects the infiltration and other rainfall losses from the natural piedmont. Traditional development practices tend to drastically increase runoff volume due to adding impervious surfaces such as homes, roads, driveways, parking lots, etc. However, retention requirements are typically used to offset this increase in runoff volume. Since the retention requirements are typically focused on the 100-year storm event, runoff volumes can be drastically reduced in more frequent storm events such as the 2- and 10-year storms. The ADMP development practice of preserving natural and undisturbed open space preserves a portion of the natural piedmont infiltration and runoff characteristics over the full range of storm events. This will ensure that runoff is not eliminated and that runoff volumes aren't increased. The goal is to have a similar runoff volume after development as in the existing, natural piedmont condition.

3.4.2.2 Discharge

Discharge is important for storm water as well as for sediment in the watershed system. The peak discharge for storm water is reported with each typical design in cubic feet per second (cfs). Although not reported, sediment transport rates are important as well to maintain the sediment balance and transport rates from the mountains to Waterman Wash. As with runoff volume, storm water discharges are also impacted by the on-site retention requirements for a traditional development layout. The natural result of development is to increase peak discharge rates leaving the site. The retention will typically offset the increase in discharge and in extreme cases, may almost completely eliminate runoff from leaving the site in frequent storm events because the runoff is fully retained in the basins. The ADMP development practices are intended to preserve a portion of the natural runoff leaving the site for the full range of discharges. Preserving runoff is important to preserve native vegetation as well as to move sediments and the nutrients that they carry through the system. The goal is to have a similar runoff peak discharge after development as in the existing, natural condition.

3.4.2.3 Flow Continuity

Continuity is important for both storm water and sediment extending from the mountains to Waterman Wash. Flow continuity is rated as high for the existing, natural condition, low for traditional development approaches that collect runoff and retain, channelize, or re-route it as part of development. A medium rating is given where practices are incorporated to mitigate the interruption of continuity, such as with SWCs and preserving undisturbed, connected open space within the project.

3.4.2.4 Storage Preservation

Natural watershed storage is an important function for dissipating runoff and limiting peak discharges. This metric considers storage of runoff as sheet flow in shallow swales and on the piedmont surface itself as well as storage within large washes. The natural watershed has a storage preservation rating of high. Development practices that channelize sheet flow or encroach on washes receive a low rating. A medium rating is given when washes are left natural for the dominant discharge channel and portions of their geomorphic floodplain and portions of the development are left as natural sheet flow areas.

3.4.2.5 Landscape Character

The evaluation of landscape character is based on the identified stakeholder goal that flood hazard mitigation solutions, "Preserve and complement the desired visual character of future natural, rural, suburban, and urban cultural settings," as discussed in Section 2.0. These four cultural settings (natural, rural, suburban, and urban) are derived from the District's Landscape Inventory and Analysis (LIA). The LIA has identified planned cultural settings that are derived from the MAG general plan. This information was updated using municipal general plan updates where they were made available and mapped using GIS. **Figure 3-4** shows these cultural settings in relation to the flow characteristic areas. This information is used in the descriptions of the typical designs to identify the desired character for the proposed setting.

Each typical design description identifies the landscape character of the overall site by one of the above cultural settings. Based on the LIA, natural landscapes are considered compatible with all four cultural settings.

The four cultural settings identified were also associated with a selection of preliminary design themes, described in Section 3.4.10. These design guidelines are intended to aid aesthetic design and facility planning for areas where agencies or individual municipalities have not identified unique design criteria and aesthetic treatments. Where such are available, municipal guidelines should be followed provided they do not conflict with maintenance or other flood mitigation functions of the facilities.

3.4.2.6 Viewshed Preservation

Viewshed preservation is identified by the qualitative judgment of two criteria: how well the proposed development preserves views to the mountains that surround the piedmont, and how intact the proposed changes will leave the natural, undeveloped character of the valley as seen from the mountain recreation areas and open space preserves. In most cases, this is directly related to the amount of undisturbed open space preserved within the development or its surroundings. These qualitative determinations range from "High" (fully intact viewshed) to "Low" (views to mountains are severely limited, and the open space "mosaic" of the valley is highly modified.) This is highly related to the "mosaic" concept illustrated below in relation to the open space resource integrity assessment.

This can also refer to impacts to major visual features such as the SWCs or Waterman Wash, where a "High" rating refers to the character of the wash being preserved to "Low" where the character of the wash has been highly modified.

3.4.2.7 Recreation Uses

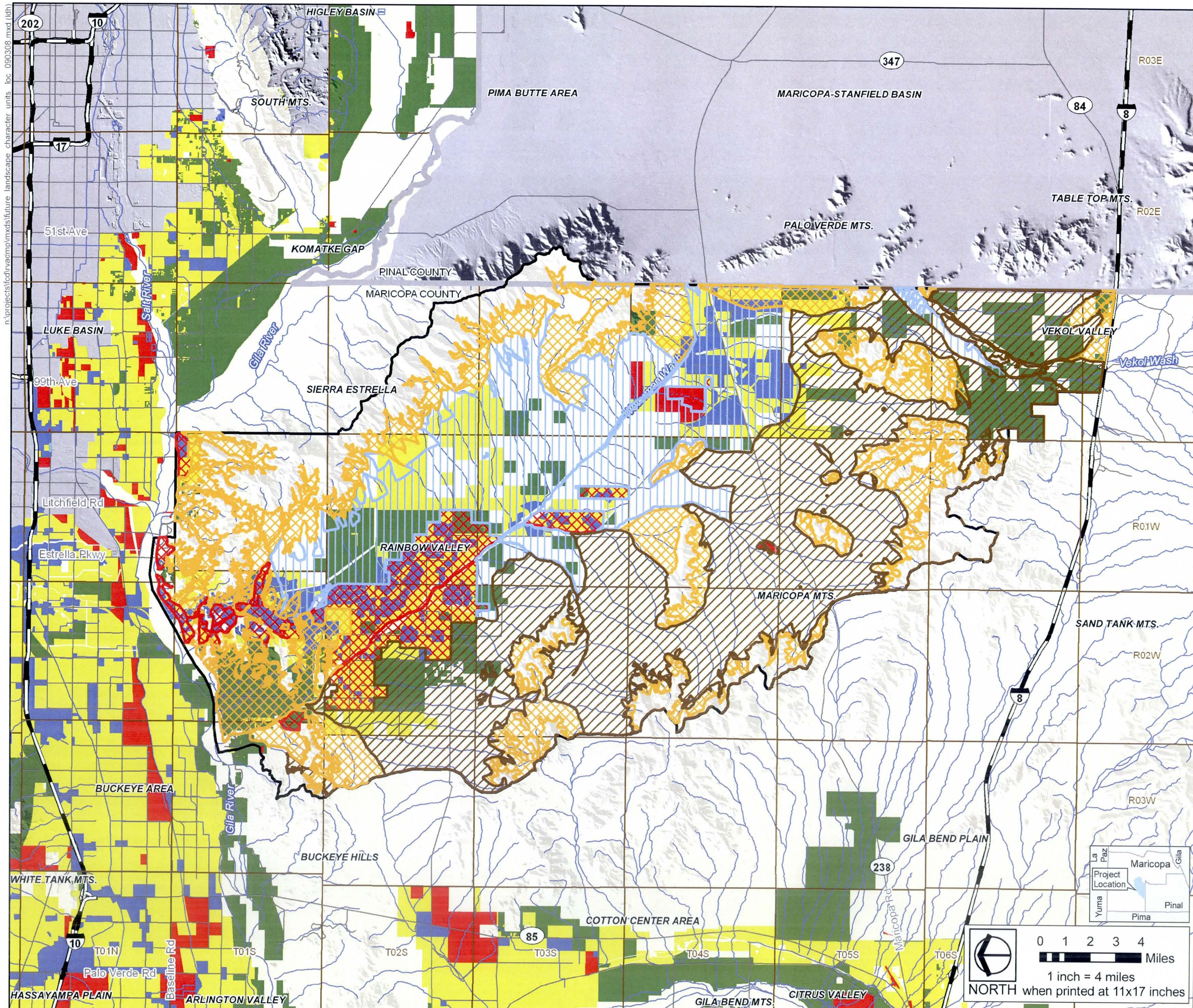
Recreational uses are evaluated based on one of two methods. For the natural undeveloped existing condition the likely un-programmed recreation uses have been identified. For both the more traditional development and the ADMP guided development, recreation is evaluated on the basis of acres of open space per 1,000 residents, or the level-of-service (LOS), provided.

The method used to establish the LOS is based on common recreation planning methodologies, with assumptions being used similar to those identified by the City of Goodyear. These include the following:

- Assuming 2.84 residents per unit or parcel shown in the typical design
- Assuming that the target LOS is 10.3 ac/1,000 residents
- Assuming that preserved natural open spaces, both in protected SWCs as well as within open space buffer areas, are considered high quality open space and contribute to the development's LOS provided. This is in addition to developed active-use park features. This assumption is guided by the City of Goodyear General Plan 2003-2013, *Chapter 4.2 – Open Space Goal, Objectives, and Policies.*

Rainbow Valley
Area Drainage Master Plan
Future Cultural Settings and Flow
Characteristics

Figure 3-4



Project Features

Cultural Setting

- Natural
- Rural
- Suburban
- Urban
- Industrial

Flow Charateristics

- Sheet Flow - Sections 3.4.1 and 3.4.2
- Tributary Flow - Section 3.4.3
- Distributary Flow - Sections 3.4.4 and 3.4.5
- Distrubed Areas - Section 3.4.6

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream

Data Sources

Flood Control District of Maricopa County
Landscape Inventory & Analysis (LIA), 2008
Future Landscape Character Cultural Settings Map, 2008
URS, Corp., 2009
Flow Characteristics

LOS information is provided showing the ratio of active open space to passive/natural open space provided by the typical design. Criteria for balancing the amount of active and passive, undisturbed open space is not specifically addressed in the ADMP design criteria or representative examples. While the LOS measurement is related to the quality-of-life value of preserving open space, the open space preservation guidelines in the ADMP are tied to the public safety-related flood hazard mitigation benefits these resources provide. Municipalities should consider the public safety functions of these areas, as well as their significance in maintaining other quality-of-life functions, when establishing LOS guidance for accepting preserved open space buffers as quality open space areas.

Park and trail master plans are updated on a regular basis, underlying municipal or agency recreation plan updates should be referenced prior to development planning to identify new opportunities for co-locating needed parks and trails with any needed storm-water management facilities. The matrix included as Table 3-3 in Section 3.3.9.2 provides guidelines for incorporating active recreation facilities within storage basins and conveyance channels.

3.4.2.8 Open Space Resource Integrity

Similar to viewshed preservation, these criteria refer to the qualitative judgment of how intact the proposed changes will leave the natural, undeveloped character of the valley. In addition to preservation, this category considers the level of connectivity that the open spaces maintain, both internally as well as to off-site open spaces. These adjacent open spaces include other local open space areas as well as the large, protected open spaces associated with the Sierra-Estrella and Maricopa Mountains.

For the Waterman Wash flow characteristic area, the wash and its floodplain are also considered a significant open space resource as it exists in its natural state. Proposed development in the wash are considered in accordance to the likelihood the wash will continue to sustain multiple functions across the spectrum. For example, the removal of the vegetation and introduction of active recreation may maintain a high overall area of open space, but the heavy modification of the natural wash would inhibit many more natural functions than are introduced. Any single disruption of the continuity of a function in a linear feature such as a wash can prevent the ability of the function to be reintroduced downstream.

While this criterion is considered qualitative, the illustration below helps demonstrate the value judgments involved in assessing how well a particular design maintains open space integrity (**Figure 3-5**).

This value judgment makes use of conceptualizing the functions of the natural landscape as a "mosaic," similar to a stain glass window. Modification to the landscape that replaces the natural functions with human uses reduces the mosaic of the natural landscape functions, much as replacing the pieces of a stain glass window with large, single colored panes reduces the variation one sees. By treating development as new pieces to be integrated into the existing mosaic, rather than replacing it, open space continuity and their related functions can be maintained.

Intact Mosaic (Natural) *Replaced Mosaic (Traditional)* *Integrated Mosaic (ADMP)*

Figure 3-5 Preservation of Open Space Integrity

As with viewsheds, open space intactness is determined based on a range from "High" (open spaces are fully intact and contiguous, as in the natural landscape) to "Low" (the mosaic of open spaces has been completely replaced and fragmented). Based on the design criteria of the ADMP, a minimum of 30 percent of the site's existing natural mosaic should be retained intact. These open spaces should also be contiguous with one another and the adjacent open spaces in order to achieve the performance functions identified in the ADMP. Achieving this benchmark results in a "Moderately-High" rating.

3.4.2.9 Biological Resource Integrity

The impacts to biological resources are closely related to the impacts on natural open space preservation. Consideration of the open space "mosaic" concept is also used to rate the biological resource integrity, ranging from "High" to "Low." Unlike open space continuity, however, active recreation areas are not considered to be as part of the intact mosaic. This is due to the replacement of natural habitat and native plant species with a habitat type that is more conducive to urbanized animal species. While recreation areas can provide habitat for urban-acclimated species, these landscapes still fragment the continuity of the natural biological resources, lowering overall intactness.

Washes are rated as having "High" biological integrity when the existing natural vegetation is preserved. Preserving the majority of the existing vegetation, with restoration of minimally impacted areas (such as near road crossings and utilities) is considered "Moderately-High" in terms of biological intactness. Because native trees and shrubs are difficult to re-establish fully, the large-scale removal and replacement of the existing vegetation with native plant material is rated as "Moderately-Low." A "Low" rating was given for landscapes in which the existing native vegetation was removed and replaced with either non-native species such as turf or ornamental shrubs, or hardened structures such as concrete channels.

3.4.2.10 Cultural Resource Integrity

The impacts to cultural resources are directly related to the amount of disturbance that a development may cause. The impacts to the landscape associated with development make it more likely that cultural resources will be disturbed or destroyed during construction activities. For this reason, consideration of the open space "mosaic" concept is also used to rate the cultural resource integrity, ranging from "High" to "Low," determined by the amount of existing landscape left undisturbed by development. This rating also applies to washes, where the cultural significance of the wash itself as well as any cultural resources along it are modified when the natural vegetation and form is replaced with built structures and introduced vegetative species.

3.4.3 Sheet Flow

The sheet flow example (**Figure 3-6**) is developed for an area in the Estrella Planning Unit (Figure 1-2) where the landform causes this type of flow characteristic. The selected location presently is not developed, but will be in the future. Development has not yet occurred up or down stream of the site so there are no special conditions that could affect the results. The watershed is narrow perpendicular to the direction of flow which will influence the edge effects caused by a development though it is assumed that there is no interflow from adjacent basins. This is done to specifically show the impacts of development practices on flow patterns. Cultural, biological, scenery, open space, and recreational impacts are qualitatively evaluated and compared for undeveloped and developed conditions by reviewing the specifics of the area and knowledge obtained for Rainbow Valley during the ADMP process. Table 3-4 summarizes the applicable functions that occur in sheet flow areas.

Table 3-4 Performance Functions Associated with Sheet Flow Areas

3.4.1.1	Store increases in runoff volume resulting from development Preserve natural land surface storage and infiltration properties Maintain adequate baseflow to support native vegetation
3.4.2.1	Minimize reduction in time of concentration Provide retention/detention to offset increases in peak discharge
3.4.3.1	Maintain sub-basin continuity Coordinate road alignments with drainage patterns
3.4.7.1	Minimize concentration of existing sheet flow Maintain sediment yield from individual development and the overall watershed Maintain sediment delivery to Waterman Wash
3.4.8.1	Design to be compatible with the future cultural and physical setting Design flood hazard mitigation facilities to maintain views toward the mountain preserve areas and preserve existing views from the mountains to the valley
3.4.9.1	Accommodate City of Goodyear parks and trails within flood hazard mitigation projects Accommodate other local parks within flood hazard mitigation projects Accommodate other local trails Accommodate the Juan Bautista de Anza National Historic Trail enhancement and interpretation
3.4.10.1	Preserve existing open space value Maintain BLM-managed lands as public open space Development should comply with MAG Desert Spaces *Environmentally Sensitive Development Areas Policy and Planning Guidelines*
3.4.11.1	Maintain existing ecological integrity of natural vegetation types Preserve the connectivity and permeability of habitats Use built structures to create resources for wildlife
3.4.12.1	Protect and interpret historic sites Protect and interpret prehistoric sites

The lack of defined flow paths makes it particularly difficult to develop and maintain continuity through a development. As shown on **Figure 3-6**, in the natural condition there is shallow flooding that varies in depth along a cross- section perpendicular to the direction of flow. Runoff storage occurs because the overland flow contact area is large so velocities are low and infiltration is prevalent because of the large contact area between the runoff and the ground. There are dry island areas caused by a variation in topography but flow paths recombine downstream.

The traditional development example assumes a 100-acre development will occur in the basin (**Figure 3-7**). Present development practices in the City of Goodyear and other jurisdictions in Rainbow Valley allow collection of off-site sheet flow runoff at the upstream face of the development and conveyance of the runoff using channelized flow around and/or through the developed area. Then downstream spreader swales are utilized to attempt to return the runoff to a sheet flow condition. On-site runoff is collected and retained in basins with only the largest floods leaving the site. Spreader swales do not provide an adequate means for reinstituting downstream sheet flow. As the example in **Figure 3-7** shows, a shadow is formed downstream of the development that causes a dry area. It is more likely that downstream flows will concentrate leaving the spreader swales; especially since upstream sediment delivery is collected in upstream collector channels and deposited in these channels removing sediments that otherwise would be transported down the piedmont. Retaining on-site runoff, except for extreme events, causes additional loss of flow downstream that exacerbates the impacts to the overall continuity of the sheet flow characteristics of the basin. In turn there is an impact to downstream property from a biological perspective that will change the quality of the environment and downstream compatibility compared to undeveloped conditions. Viewsheds will change because the development replaces the natural scenery, impedes views, and disrupts open space.

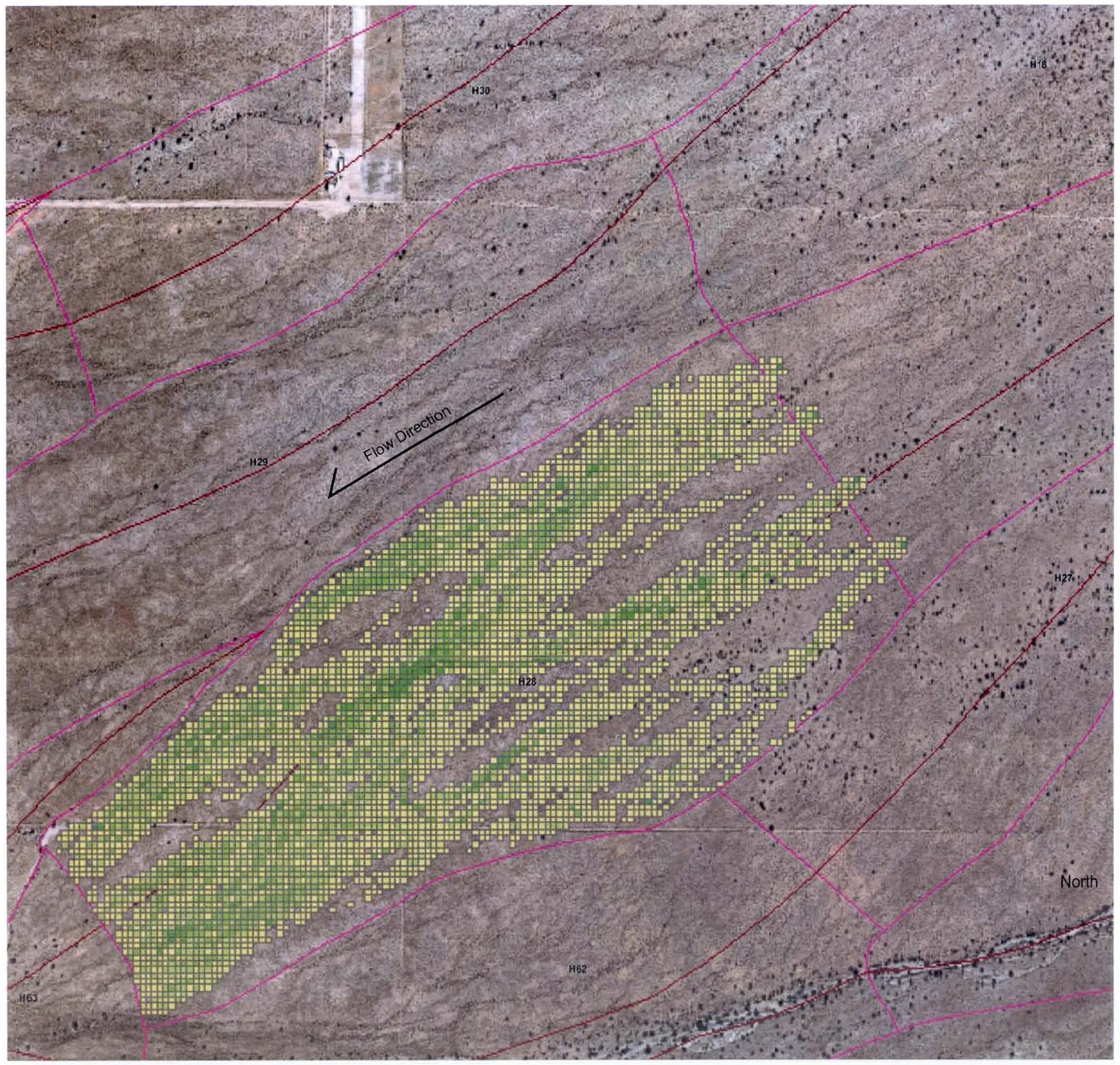
Clustering development patterns (**Figure 3-8**) and development of unimpeded flow paths through the development reduce the shadow effects. The flow through open space should maintain sheet flow patterns so that flow and sediment continuity can be maintained downstream. These paths need to be wide enough to create adequate open space, maintain viewsheds and allow for appropriate biological diversity. These developments will still require stormwater management as flood control for developed areas, but the preserved sheet flow sections will not need controls because they are not being modified except for some road crossings. There may still be some reduction of runoff from the developed areas where retention of stormwater occurs. A portion of the retention balances the increased runoff from impervious areas. The overall impacts to runoff volume from the site are less than for traditional development. Locating the sheet flow areas will require understanding of upstream and downstream flow patterns and coordination with adjacent property owners to maintain continuity. The idea is to maintain continuity of flow and sediment as much as possible to retain the natural processes from the mountains to Waterman Wash while retaining sheet flow patterns through the piedmont. The velocity patterns downstream from development can be compared for the three scenarios (Figure 3-9). Velocities increase where the collected and channelized flows from upstream discharge downstream of the traditional layout development. The concentrated discharge (higher velocities) causes erosion, rills, and gullies. Washes may form where sheet flow patterns existed prior to development. The ADMP layout tends to maintain and preserve sheet flow paths within and through the development reducing the downstream erosion potential of the runoff. The downstream flow area is greater than for the ADMP layout reducing velocities and erosion potential. Table 3-5 shows the results of the three design scenarios and their impacts on the 12 watershed functions described in Section 3.3.

Table 3-5 Sheet Flow Metrics Evaluation

Metric	Undeveloped Condition	Traditional Development	Clustering Development Pattern
Volume (ac-ft)	42 ac-ft - losses due to natural processes.	30 ac-ft - On-site storage impacts	42 ac-ft - balance neutralize effects of developed land only
Peak Discharge (cfs)	677 cfs - Cumulative flow downstream	514 cfs - Reduced flow due to retention storage	624 cfs - Reduce retention - preserved flow paths
Flow Paths/Continuity	High Unmodified	Low Collecting, channelizing and re-routing flow	Medium to High Flow corridor improve continuity and reduce re-routing and retention
Flow Depth	High Unmodified - less than 1 foot	Low Concentrated flow > 1 foot, shadow areas - dry	Medium Some concentrated flows > 1 foot in some areas , reduced downstream shading
Velocities	High Low velocities - 2.0 fps-100 year event, no impediments or capture of sediments	Medium Low velocities - 2.0 fps, but increased shadowing and clear water	Medium Low velocities - less shadowing and improved downstream sediment delivery
Storage Preservation	High Shallow - Large aerial extent	Low Use of localized retention facilities, retention greater than natural condition	Medium Increased use of natural storage and reduced retention requirements
Landscape Character	Natural Creosote flats of the natural piedmont	Rural Large lot residential (1 ac/du)	Rural Large lot residential (0.4 ac/du) laid-out to allow for contiguous undisturbed open spaces
Viewshed Preservation	High Views uninterrupted by development. Natural open space maintained from valley to mountains	Moderately-Low Views somewhat impeded due to continuous development. Suburban or urban settings would result in greater impacts	Moderately-High Narrowed views from valley to mountains along preserved natural flow paths. Undisturbed areas provide some mitigation for change in setting from natural to rural
Recreation Uses	Unprogrammed Potential activities include off-trail hiking, off-roading, and target shooting	LOS: 21.7 ac./1000 residents Active recreation in programmed areas	LOS: 63.0 ac./1000 residents 36.4 acres of total open space. Provides active and preserved open space. Passive recreation such as trails may occur along fringes of preserved areas
Open Space Resource Integrity	High Open space intact, connectivity unimpeded	Moderately-Low Fragmented. Approximately 19% of site retained open space for storm water basins, active recreation, and other amenities	Moderately-High Integrated, contiguous preserved open space. Preserves approximately 30 percent of development with addition active open space for storm water and other uses
Biological Resource Integrity	High Vegetative cover intact and undisturbed allowing uninterrupted native wildlife use	Low Extensive impacts due to removal of native vegetation and displacement of wildlife. Edge condition impacts to adjacent property	Moderate Preserved open space provides corridors for existing vegetative cover and native wildlife. Biodiversity will likely be negatively impacted due to edge effects
Cultural Resource Integrity	High Resources remain intact and undisturbed, though vulnerable to vandalism	Low Extensive impacts to the site	Moderate Preserved areas reduce likely impacts. Extensive impacts where development occurs, increased vandalism potential in preserved areas due to improved access
Planning	Rural residential (RR:0-2 du/ac)	0.8 du/ac. 81 lots included over 100 acres	2.0 units/acre 198 lots included over the 100 acres with reduced lot sizes

Rainbow Valley
Area Drainage Master Plan
Sheet Flow - Undeveloped Conditions

Figure 3-6

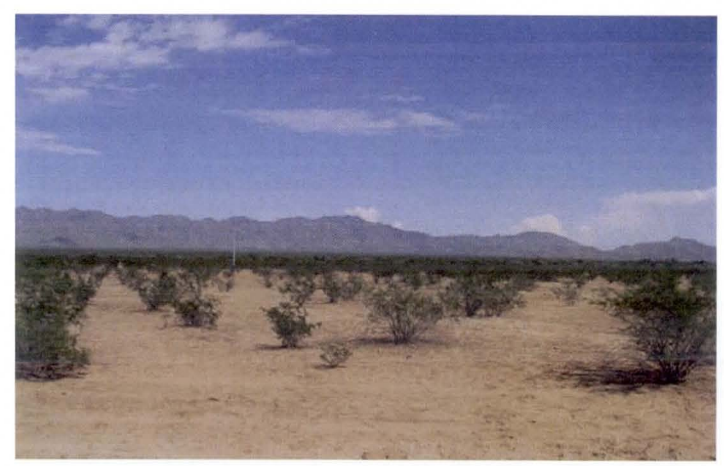


Scale: 1" = 1/4 Mile

Flow Depths

COMPARATIVE DATA

Run Off Volume	42 ac-ft
Peak Q	677 cfs
Flow Continuity	High
Storage Preservation	High
Scenery Resources	
Dominant Cultural Setting	Natural
Viewshed Preservation	High
Regional Multi-Use	
LOS	NA
Preserved Open-Space	100%
Units	0
Density	0
Land Use	RR (0-2 units/ac)



Sheet Flow Area in an Undisturbed Condition

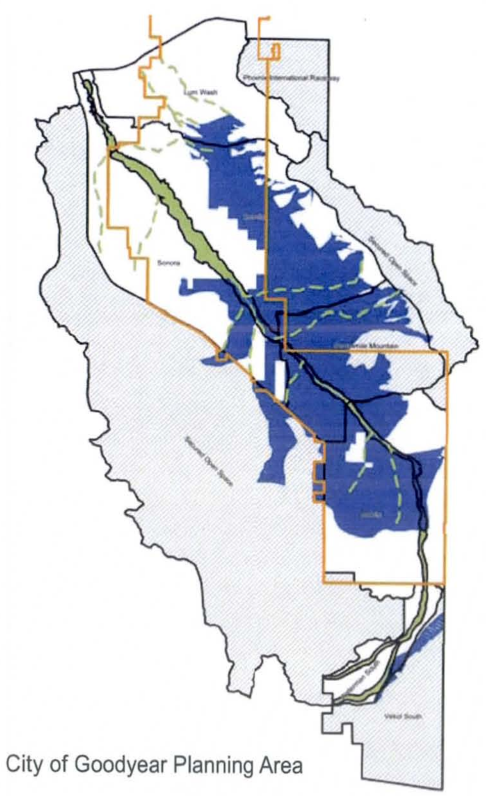
LEGEND

Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Drainage Sub-Basin
Drainage Flowpath

KEYMAP

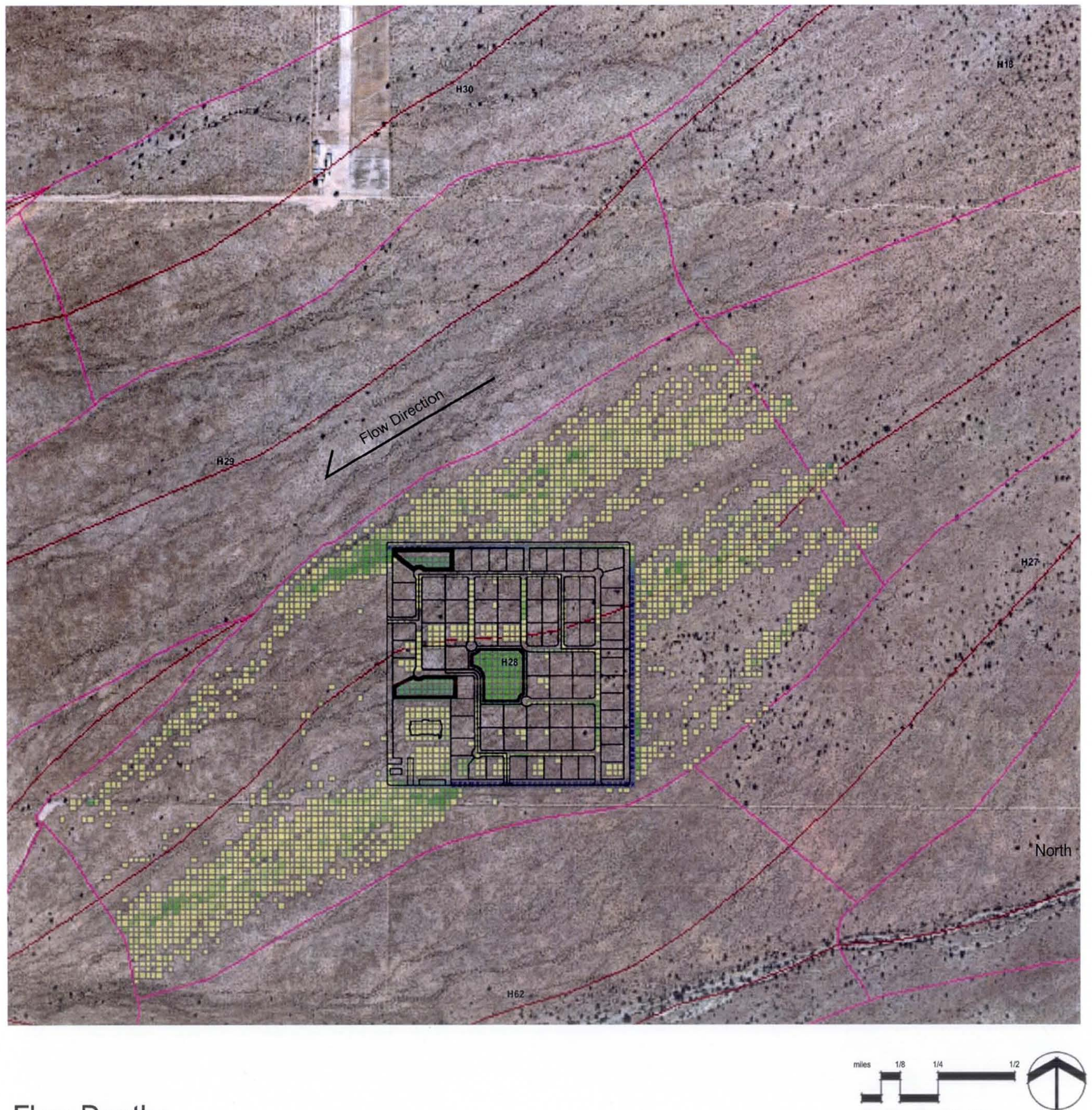


City of Goodyear Planning Area
Sheet Flow Areas
Secured Open Space or Non-Evaluated Planning Units
Significant Wash Corridors and Waterman Wash

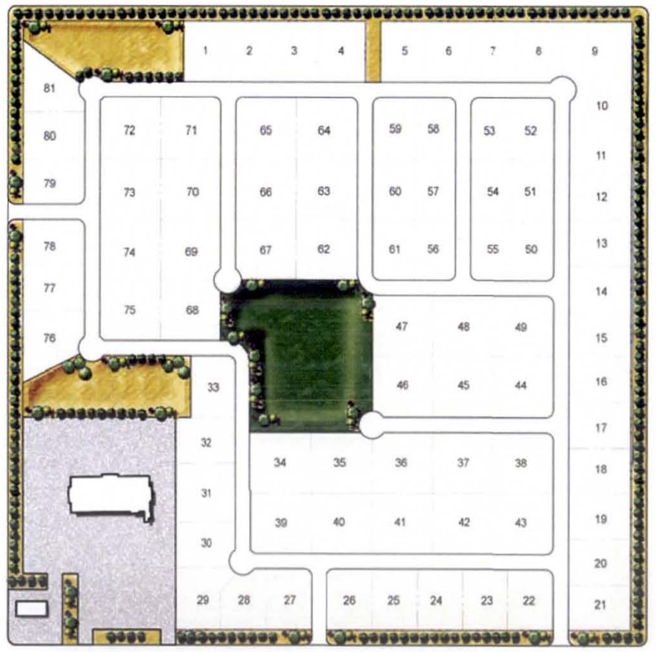
Rainbow Valley
Area Drainage Master Plan
Sheet Flow - Traditional Development Pattern

Figure 3-7

COMPARATIVE DATA	Existing	Traditional
Run Off Volume	42 ac-ft	30 ac-ft
Peak Q	677 cfs	514 cfs
Flow Continuity	High	Low
Storage Preservation	High	Low
Scenery Resources		
Dominant Cultural Setting	Natural	Rural
Viewshed Preservation	High	Moderate-Low
Regional Multi-Use		
LOS	NA	21.7 ac/1000
Preserved Open-Space	100%	0%
Units	0	81
Density	0	0.8 units/acre
Land Use	RR (0-2 units/ac)	



Flow Depths



Traditional Development Layout

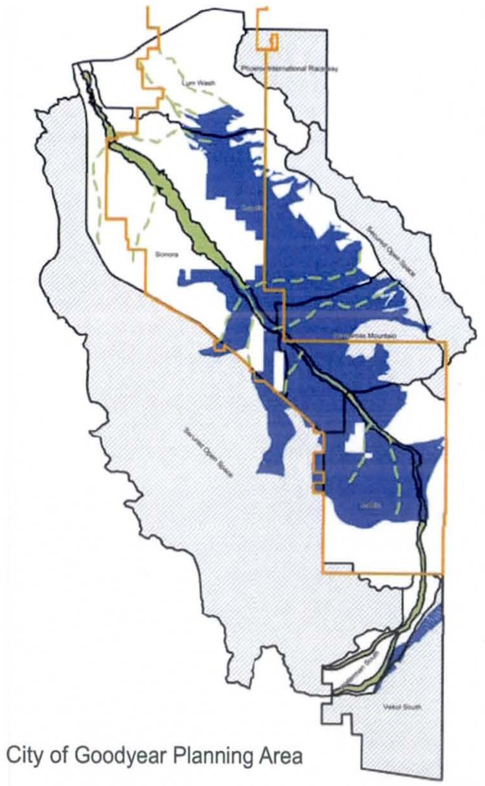
LEGEND

Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Drainage Sub-Basin
Drainage Flowpath

KEYMAP

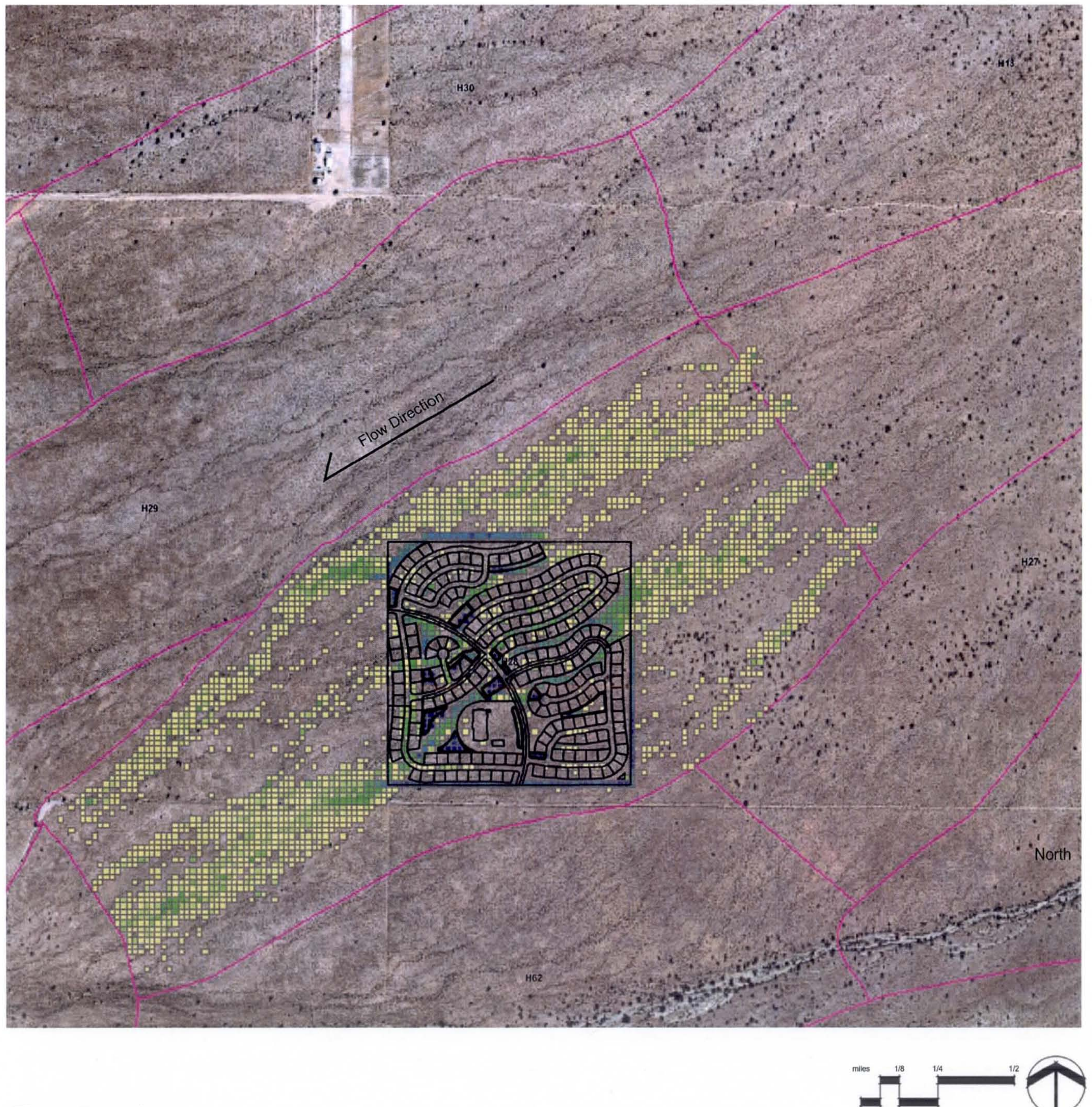


City of Goodyear Planning Area
Sheet Flow Areas
Secured Open Space or Non-Evaluated Planning Units
Significant Wash Corridors and Waterman Wash

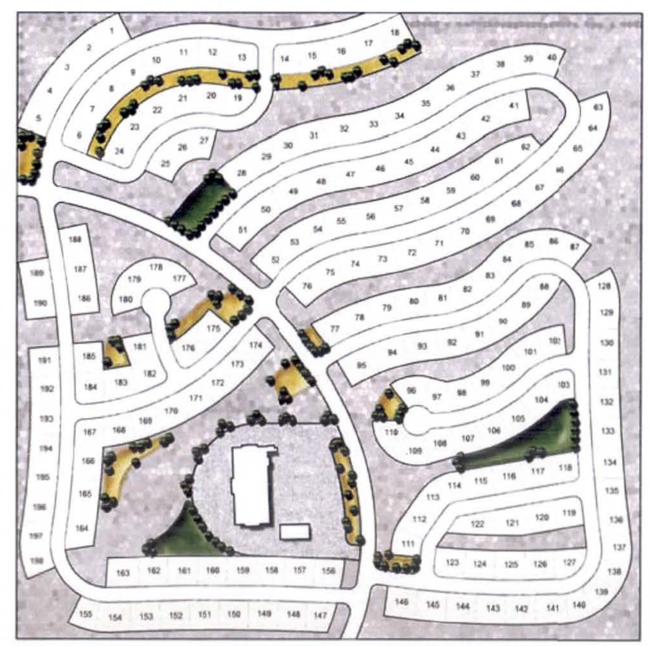
Rainbow Valley
Area Drainage Master Plan
Sheet Flow - Cluster Development
Pattern

Figure 3-8

COMPARATIVE DATA	Existing	Traditional	ADMP
Run Off Volume	42 ac-ft	30 ac-ft	42 ac-ft
Peak Q	677 cfs	514 cfs	624 cfs
Flow Continuity	High	Low	Med-high
Storage Preservation	High	Low	Medium
Scenery Resources			
Dominant Cultural Setting	Natural	Rural	Rural
Viewshed Preservation	High	Mod-Low	Mod-High
Regional Multi-Use			
LOS (ac/1000)	NA	21.7 ac	63.0 ac
Preserved Open-Space	100%	0%	31.0%
Units	0	81	198
Density	0	0.8 u/ac	2.0 u/ac
Land Use	RR (0-2 units/ac)		



Flow Depths



ADMP Development Layout

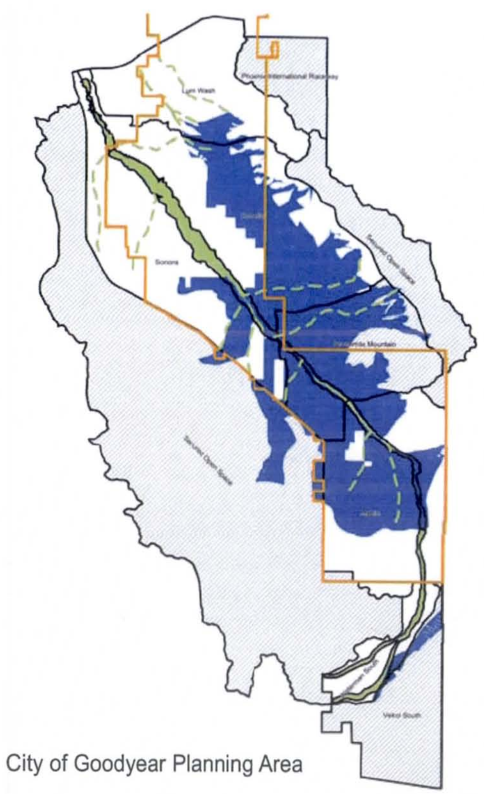
LEGEND

Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Drainage Sub-Basin
Drainage Flowpath

KEYMAP

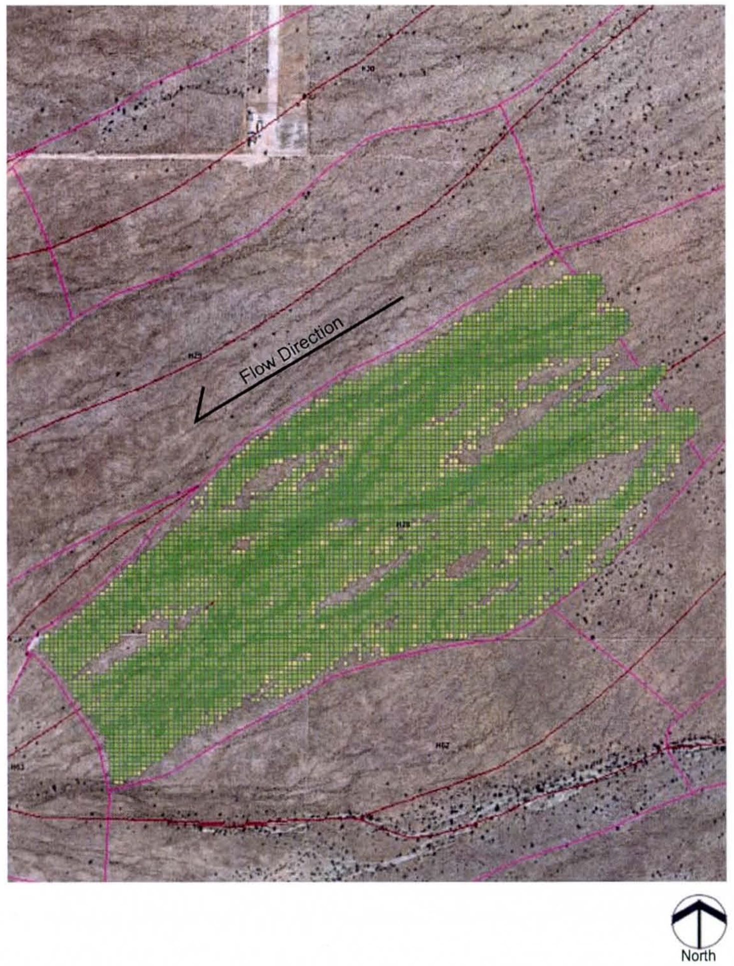


City of Goodyear Planning Area
Sheet Flow Areas
Secured Open Space or Non-Evaluated Planning Units
Significant Wash Corridors and Waterman Wash

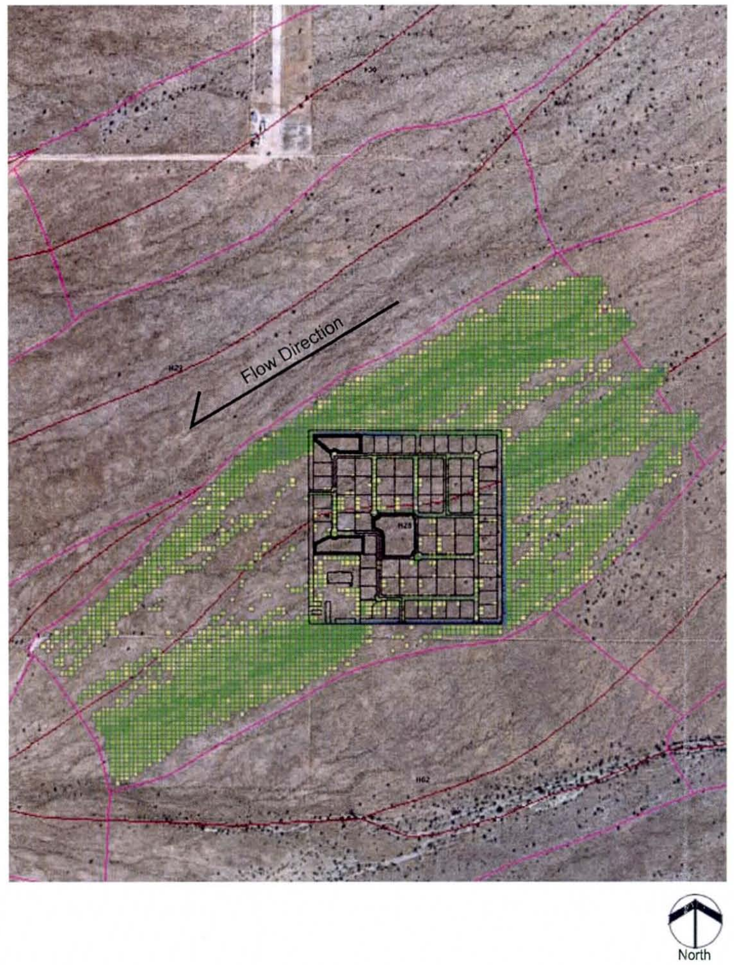
Rainbow Valley
Area Drainage Master Plan
Sheet Flow - Velocities

Figure 3-9

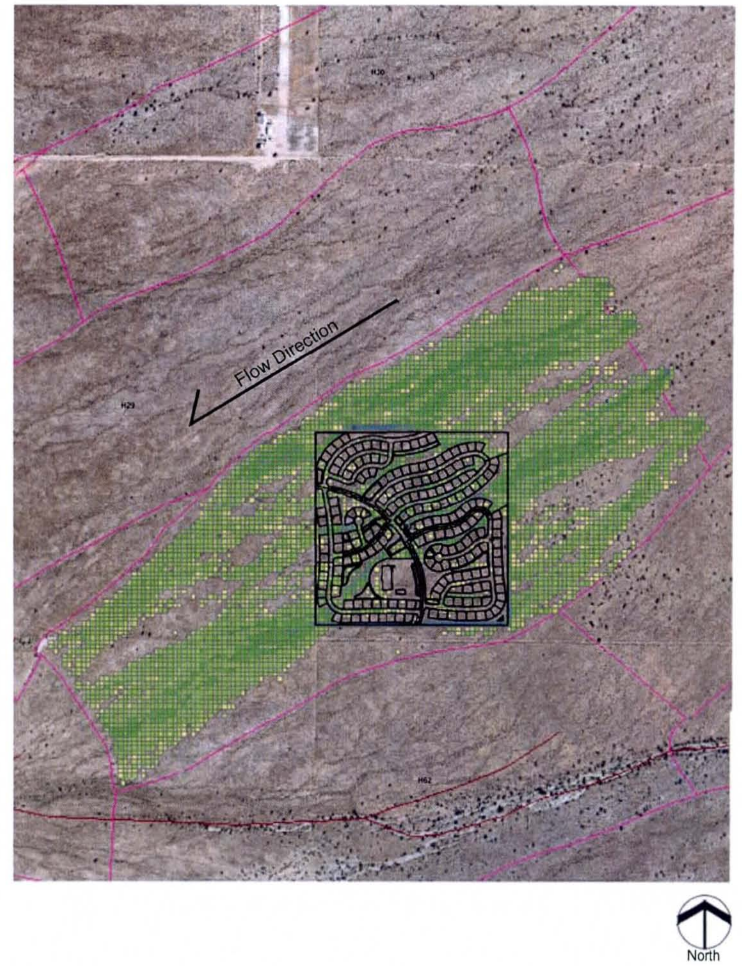
Existing Velocities



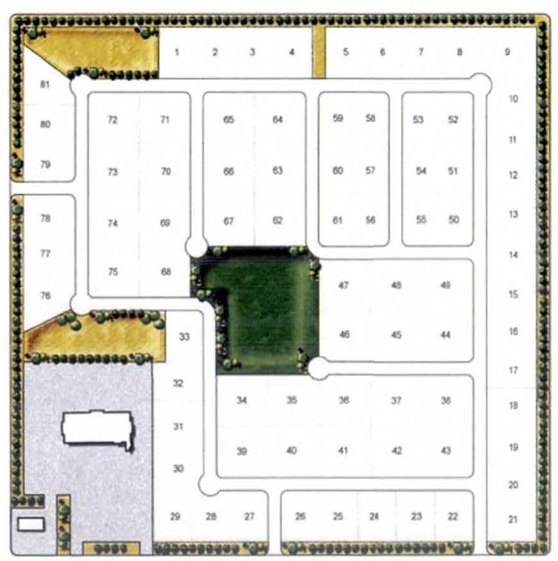
Traditional Layout- Velocities



ADMP Layout- Velocities



Undisturbed Sheet Flow Area



Traditional Development Layout

ADMP "Clustering" Development Layout

LEGEND

Flow Velocity at Cell (ft/s)

- 0.500 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 5.000
- 5.001 - 6.000
- 6.001 - 10.000
- Drainage Sub-Basin
- Drainage Flowpath

3.4.4 Sheet Flow with SWC

This design example is a special case where a SWC is located in a sheet flow area. The site is in the southern portion of the Estrella Planning Unit (Figure 1-2). The area is not yet developed so shallow flooding occurs along the piedmont unimpeded and only concentrates in the wash at the low point of the sub-basin. The SWC flows split between two sub-basins with the southern split being the dominant flow path. The wash meandering through this area is well-defined in some locations (depth greater than 2 feet) but can revert to sheet flow depending on the slope of the piedmont. In the wash velocities for the 100-year flood event are about 2 feet per second (fps). In the sheet flow areas flow depth is approximately 1 foot and velocities are 1 fps (**Figure 3-10**). The sub-basins are narrow and contiguous with the SWC flowing through the southern-most area. Shallow storage and infiltration occur in sheet flow areas, while the wash provides a means to convey flow to Waterman Wash in a more direct fashion. Riparian communities occur along the wash and it provides a corridor for wildlife movement between the mountains and Waterman Wash. Cultural, biological, scenery, open space, and recreational impacts are qualitatively evaluated and compared for the undeveloped and developed conditions. Table 3-6 summarizes the applicable functions associated with sheet flow and SWCs.

A traditional development is modeled as 100 acres of gross development and a housing density of 2 du/acre, rural residential. The development is situated so that it covers both sub-basins (**Figure 3-11**). A wall is used to block and segregate flow from co-mingling with runoff from developed areas except that a channel bisects the property to provide a concentrated flow path for off-site runoff. The channel is man-made to accept flow depths and velocities greater than occur in the existing wash prior to development. The velocities and shear stresses in the channel during the flood event require stabilization to prevent excessive scour and lateral migration that would create a flood hazard to the adjacent properties. A stormwater management system is in-place to remediate increased flow volume that runs off of impervious areas. The system also controls stormwater pollution from development. This in-turn causes a reduction in downstream runoff volume and flow, as well as blocking flow continuity and natural storage in the piedmont. Spreader swales are used to distribute the flow downstream back to existing conditions. However, concentrated flow is prevalent in the corridor downstream of the channel outlet and significantly reduced in the northern sub-basin. The lack of flow in the northern downstream wash will have a negative and cumulative effect to the hydrologic and environmental character of the downstream landform and Waterman Wash. Velocities are increased downstream that can lead to erosion of the piedmont and increase sediment delivery to Waterman Wash.

Table 3-6 Performance Functions Associated with Sheet Flow Areas and Associated SWCs

3.4.1.1	Store increases in runoff volume resulting from development Preserve natural land surface storage and infiltration properties Maintain adequate baseflow to support native vegetation
3.4.2.1	Minimize reduction in time of concentration Provide retention/detention to offset increases in peak discharge
3.4.3.1	Manage flow split uncertainty by fixing or regulating flow split potential Once concentrated, flows should be conveyed to a suitable outfall (i.e. – SWC) Coordinate road alignments with drainage patterns
3.4.4.1	Utilize floodway delineation methodology that accounts for and mitigated impacts of lost overbank flood storage
3.4.5.1	Maintain floodplain storage volume
3.4.6.1	Preserve dominant discharge low flow channel Limit increases in maximum design tractive sheer stress at design discharge Design for potential changes in sediment supply resulting from upstream development
3.4.7.1	Minimize concentration of existing sheet flow Maintain sediment yield from individual development and the overall watershed Maintain sediment delivery to Waterman Wash
3.4.8.1	Design to be compatible with the future cultural and physical setting Design flood hazard mitigation to be compatible with the natural Sonoran desert washes within floodways Design flood hazard mitigation facilities to maintain views toward the mountain preserve areas and preserve existing views from the mountains to the valley
3.4.9.1	Accommodate City of Goodyear parks and trails within flood hazard mitigation projects Accommodate other local parks within flood hazard mitigation projects Establish appropriate segments of the Maricopa Regional Trail along SWCs (Segments 85, 87/88, and 91) Accommodate other local trails
3.4.10.1	Preserve existing open space value Maintain BLM-managed lands as public open space Development should comply with MAG Desert Spaces *Environmentally Sensitive Development Areas Policy and Planning Guidelines*
3.4.11.1	Maintain existing ecological integrity of natural vegetation types Protect natural and beneficial functions of washes Preserve the connectivity and permeability of habitats Restore or enhance vegetation and natural channels in degraded areas Use built structures to create resources for wildlife
3.4.12.1	Protect and interpret historic sites Protect and interpret prehistoric sites

The development is a barrier to both wildlife movement and viewsheds. It creates a gap in open space. In many cases, connectivity for passive recreation is lost because of lack of corridor width, man-made features, and homeowner perception of allowing public access to their property. For the most part the functionality of the SWC is lost.

A key component of clustering the development is maintaining the SWC. To do so a denser land use is utilized (LDR (2-4 units/ac – Goodyear) that would need to be approved by the city or county. Preserving the functionality of the southern wash corridor is prioritized in this example (**Figure 3-12**). There are some impacts to the northern wash though less than for the traditional development. The southern wash segment is designated as a SWC in the ADMP so an emphasis has been placed on maintaining it in its existing state. Velocities are maintained though the depth of flow increases in an attempt to maintain a natural flow corridor through the development. The flow corridor is wide enough to provide natural functions for both public safety and quality of environment. In doing so viewsheds are maintained in both directions from the valley to the mountains, the open space path is wide to allow for both passive and active uses. The SWC remains in a natural state with floodplain limits and an erosion hazard setback delineated. This provides the opportunity to maintain the wash for wildlife migration and habitat though the largest mammals may be reluctant to use it because of the proximity to the developed property.

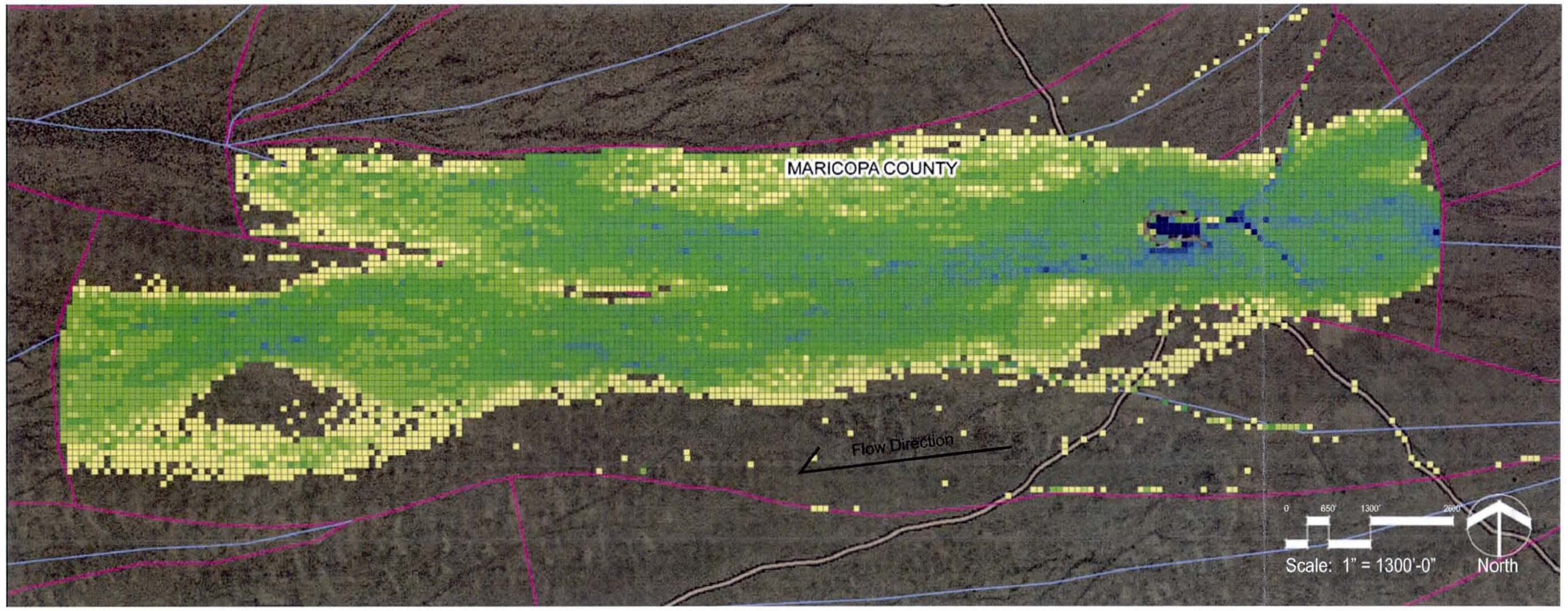
The downstream runoff volume is greater than for the traditional development because the SWC is not subject to retention and stormwater quality requirements. There is a reduction in existing runoff volume because the developed areas are still required to retain runoff. The peak discharge is greater than for the traditional development because the natural flow path (SWC) is maintained and a flow path is provided through the development. Flow continuity is improved and natural storage is maintained in SWC corridor through the development.

Table 3-7 Sheet Flow with SWC Metrics Evaluation

Metric	Undeveloped Condition	Traditional Development	Clustering Development Pattern
Volume (ac-ft)	385 acre-ft -Losses due to natural processes.	186 acre-ft - On-site storage impacts.	264 acre-ft - increase in volume resulting from increase in undisturbed area and reduced retention.
Peak Discharge (cfs)	1,313 cfs - Cumulative flow downstream.	1,062 cfs - Reduced flow due to retention.	1,306 cfs - Reduced retention - preserved flow paths.
Flow Paths/Continuity	High Unmodified	Low Collecting, channelizing and re-routing flow	Medium to High Flow corridor improve continuity and reduce re-routing and retention
Flow Depth	High Unmodified - wash depths < 2 feet less in adjacent sheet flow areas	Low Concentrated flow and zero in some shaded areas.	Medium Some concentrated flows in 2 foot range in downstream wash, some shading water in downstream
Velocities	High Low velocities - 2.0 fps-100 year event, no impediments or capture of sediments	Medium Low velocities - 2.0 fps, but increased shadowing and clear water	Medium Low velocities - less shadowing and improved downstream sediment delivery
Storage Preservation	High Shallow - Large aerial extent	Low Use of localized retention facilities, retention greater than natural condition	Medium Increased use of natural storage and reduced retention requirements
Landscape Character	Natural Natural wash located within the creosote flats of the natural piedmont	Suburban Moderate-sized, single-family residential lots (0.25 ac/du)	Rural Moderate-sized suburban lots (0.18 ac/du) laid-out as clusters between areas of contiguous undisturbed open space and the preserved wash corridor
Viewshed Preservation	High Wash provides visual interest to outside viewers while focusing views	Moderately-Low Channelized wash can focus views towards the mountains. Suburban settings impacts views from the mountains	Moderately-High The preserved wash and other natural drainage ways help maintain existing views and mitigate change in setting
Recreation Uses	Unprogrammed Potential activities include equestrian and hiking within wash, OHV's, and wildlife viewing	LOS: 16.5 ac./1000 residents 17.5 areas of active recreation in programmed areas	Non-SWC Passive: 34.2 ac./1000 residents Active: 4.2 ac./1000 residents 50.8 acres of preserved wash corridor with passive recreation such as trails combine with other open space and active recreation co-located in storm water retention facilities providing a broad spectrum of recreation uses
Open Space Resource Integrity	High Open space intact, connectivity unimpeded	Moderate Approximately 21% of site retained as open space for active recreation, storm water basins and other amenities. Channelized wash aids in preserving continuity	Moderately-High Preserves approximately 52.3 percent of site. Wash and other drainage way preservation preserve large open space areas that are highly contiguous with adjacent open spaces.
Biological Resource Integrity	High Vegetative cover intact and undisturbed allowing uninterrupted native wildlife use	Low Extensive impacts due to removal of riparian vegetation and displacement of wildlife. Edge condition impacts to adjacent property	Moderate Preserved wash and other open spaces provide corridors of vegetative cover for native wildlife. Biodiversity will likely be impacted by edge effects
Cultural Resource Integrity	High Remain intact and undisturbed, but vulnerable to vandalism	Low Extensive impacts to the site	Moderate Preserved areas reduce likely impacts. Extensive impacts where development occurs, increased vandalism potential in preserved areas due to improved access
Planning	Low-Density Residential (LDR:2-4 du/ac)	2.3 units/acre 373 units/160 acres	1.9 units/acre 301 units/160 acres

Rainbow Valley
Area Drainage Master Plan
Sheet Flow with SWC - Existing Conditions

Figure 3-10



FLOW DEPTHS

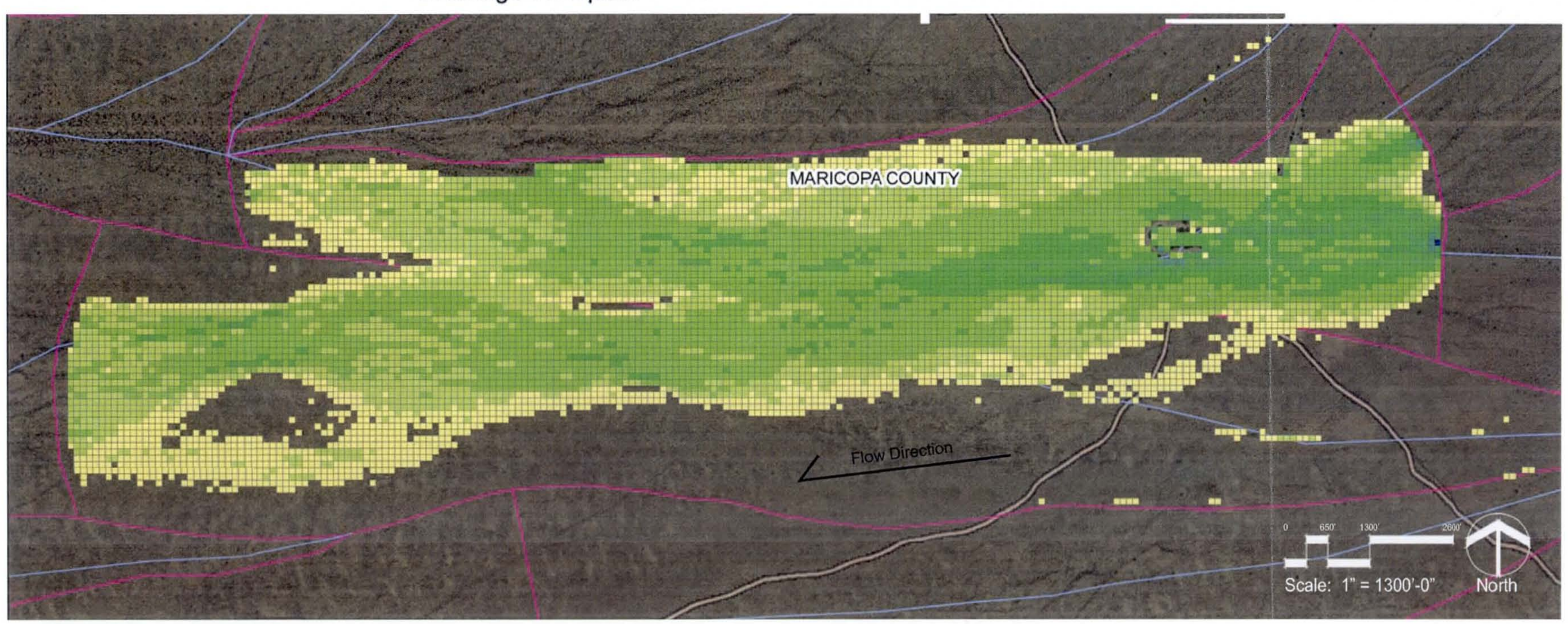
Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Flow Velocity at Cell (ft/s)

- 0.500 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 5.000
- 5.001 - 6.000
- 6.001 - 10.000

Drainage Sub-Basin
Drainage Flowpath



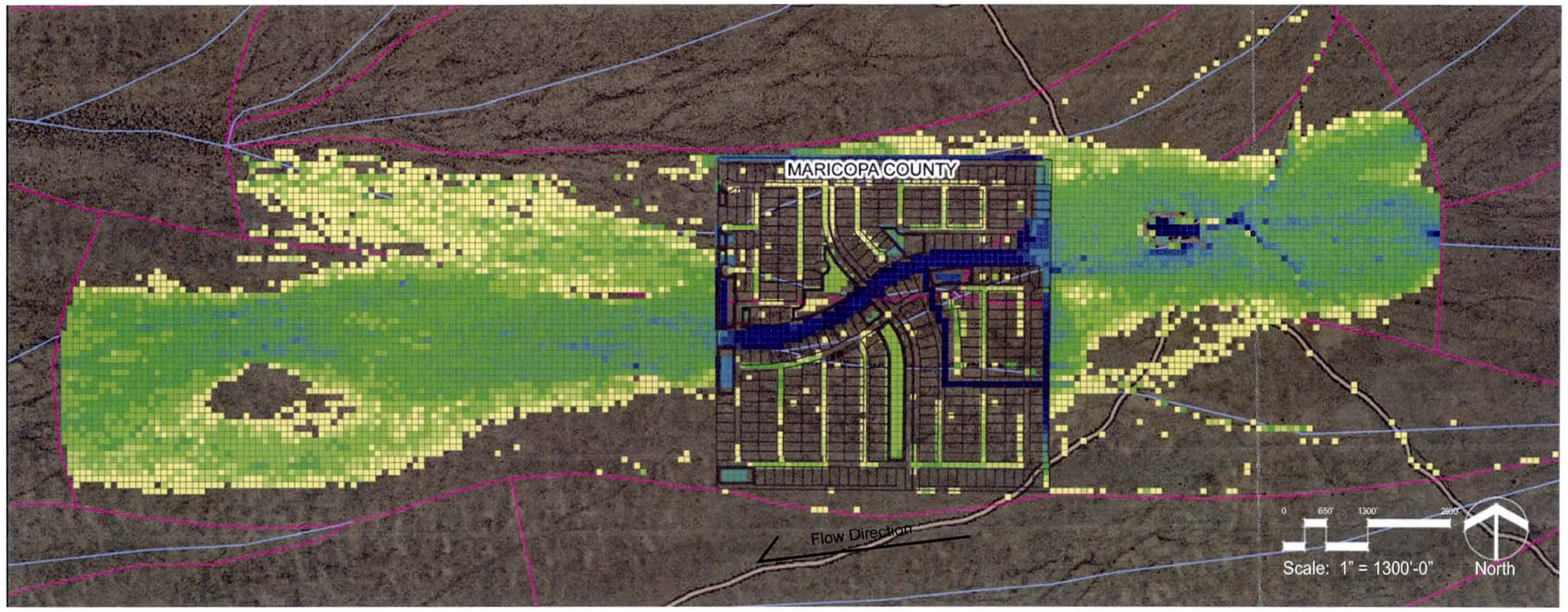
FLOW VELOCITIES

COMPARATIVE DATA

Run Off Volume	385 ac-ft
Peak Q	1313 cfs
Flow Continuity	High
Storage Preservation	High
Scenery Resources	
Dominant Cultural Setting	Natural
Viewshed Preservation	High
Regional Multi-Use	
LOS	NA
Preserved Open-Space	100%
Units	0
Density	0
Land Use	LDR (2-4 units/ac)

Rainbow Valley
Area Drainage Master Plan
Sheet Flow with SWC - Traditional
Development Pattern

Figure 3-11



FLOW DEPTHS

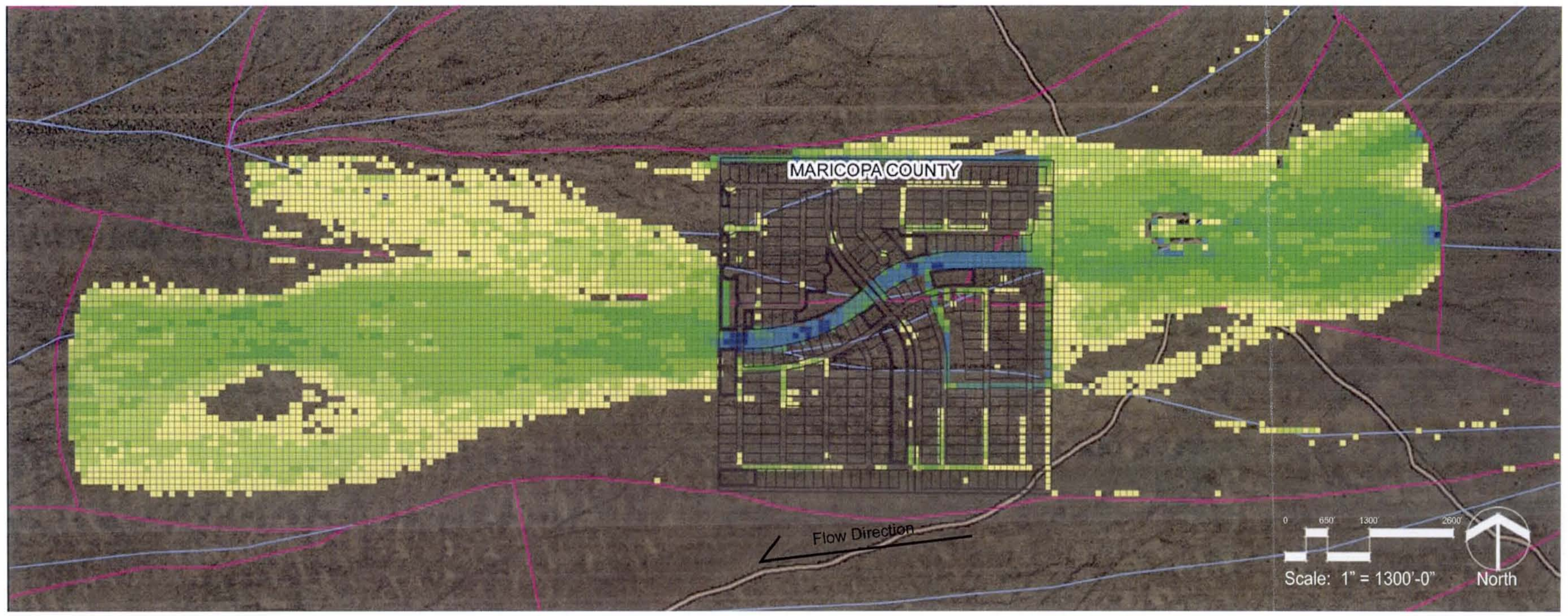
Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Flow Velocity at Cell (ft/s)

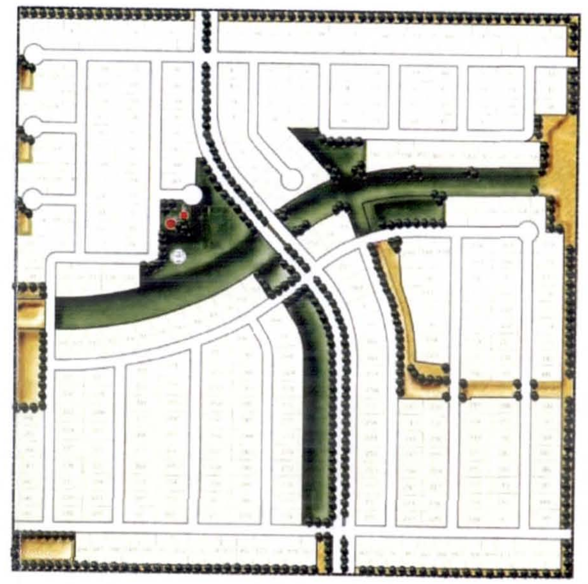
- 0.500 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 5.000
- 5.001 - 6.000
- 6.001 - 10.000

Drainage Sub-Basin
Drainage Flowpath



FLOW VELOCITIES

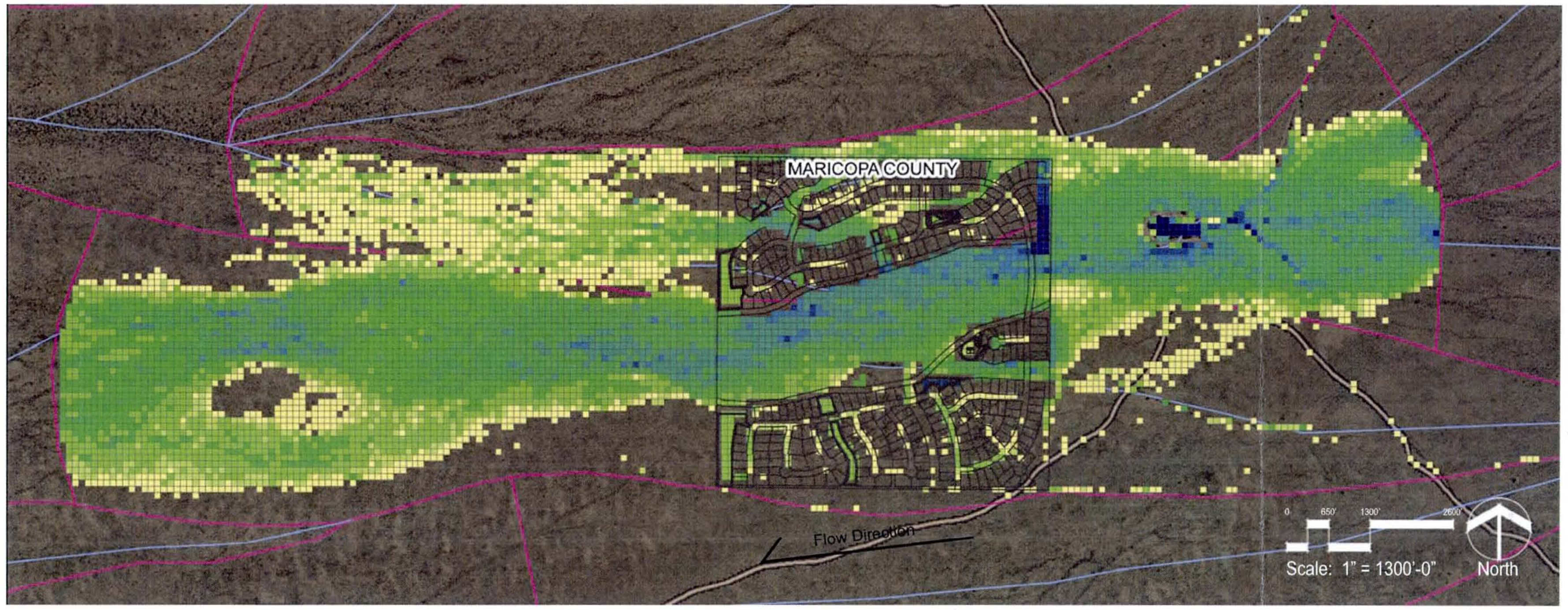
COMPARATIVE DATA	Existing	Traditional
Run Off Volume	385 ac-ft	186 ac-ft
Peak Q	1313 cfs	1062 cfs
Flow Continuity	High	Low
Storage Preservation	High	Low
Scenery Resources		
Dominant Cultural Setting	Natural	Suburban
Viewshed Preservation	High	Moderately-Low
Regional Multi-Use		
LOS	NA	16.5 ac/1000
Preserved Open-Space	100%	0%
Units	0	373
Density	0	2.3 units/acre
Land Use	LDR (2-4 units/ac)	



Traditional Development Layout

Rainbow Valley
Area Drainage Master Plan
Sheet Flow with SWC - Cluster
Development Pattern

Figure 3-12



FLOW DEPTHS

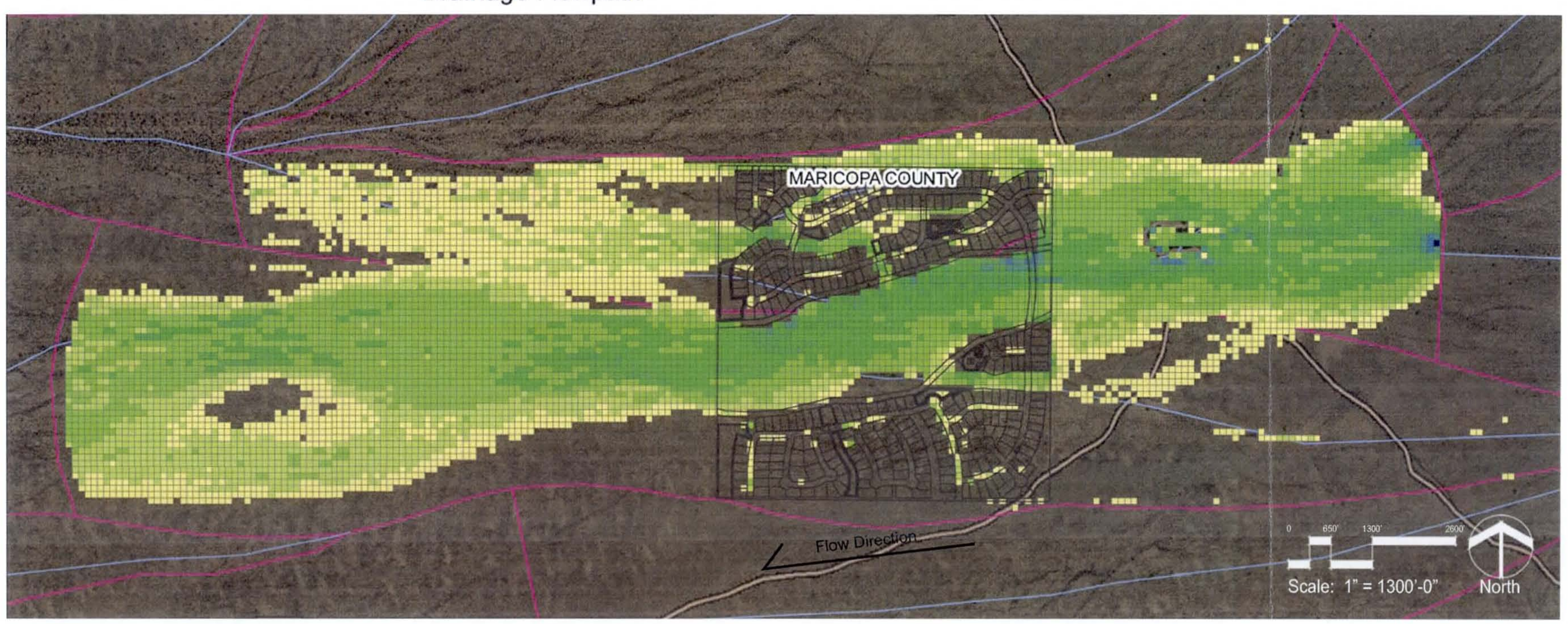
Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Drainage Sub-Basin
Drainage Flowpath

Flow Velocity at Cell (ft/s)

- 0.500 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 5.000
- 5.001 - 6.000
- 6.001 - 10.000



FLOW VELOCITIES

COMPARATIVE DATA	Existing	Traditional	ADMP
Run Off Volume	385 ac-ft	186 ac-ft	264 ac-ft
Peak Q	1313 cfs	1062 cfs	1306 cfs
Flow Continuity	High	Low	Med-high
Storage Preservation	High	Low	Medium
Scenery Resources			
Dominant Cultural Setting	Natural	Suburban	Rural
Viewshed Preservation	High	Mod-Low	Mod-High
Regional Multi-Use			
LOS (acres/1000)	NA	16.5	97.0
Preserved Open-Space	100%	0%	47.3%
Units	0	373	301
Density	0	2.3 u/ac	1.9 u/ac
Land Use		LDR (2-4 units/ac)	

ADMP Development Layout

3.4.5 Tributary Flow

Tributary flow characteristics are prevalent in the mountain and foothill areas of the watershed (Figure 1-2). The flow follows a dendritic form beginning as sheet flow and as it moves down slope, converging into rivulets, and then forming larger and larger washes (**Figure 3-13**). In the steeper slope upstream areas velocities are high and washes incised. As slopes reduce the washes become wider and shallower with reduced velocities. The flood hazard for tributary flow areas is similar in Rainbow valley to other parts of Maricopa County. Existing regulations are adequate for mitigating flood hazards, though retention and other flood control practices will disturb and disrupt the natural hydrologic, environmental, and aesthetic integrity of the area. The location selected for evaluating development for the tributary flow characteristic includes the Estrella North SWC.

Figure 3-13 Typical Tributary Flow – Undeveloped Conditions

Flow rate and runoff volume increase in the downstream direction for tributary flow. In the Rainbow Valley area this requires larger wash channels with lower velocities. An incised dominant discharge channel is formed with vegetation along the slopes with the floodplain extending to overbank areas. During in-frequent flood events channel migration can occur that shifts the dominant discharge channel though the overall width of the floodplain will not vary significantly in size. The channel will degrade during the flood event carrying sediments as wash, suspended, and bed load, with suspended and bed load re-depositing as the hydrograph recedes.

Viewsheds vary with location from mountain views to valley views. Views from larger washes including Waterman Wash are obstructed by the channel and vegetation to form their own unique views. Wildlife and vegetation is undisturbed as is the natural cultural setting of the area. There is open space connectivity that provides passive and active recreational opportunities. Performance functions attributed to tributary flow characteristics and landforms including SWC locations are listed in Table 3-8.

Table 3-8 Performance Functions Associated with Tributary Flow Areas (SWCs included)

3.4.1.1	Store increases in runoff volume resulting from development Preserve natural land surface storage and infiltration properties Maintain adequate baseflow to support native vegetation
3.4.2.1	Minimize reduction in time of concentration Provide retention/detention to offset increases in peak discharge
3.4.3.1	Maintain sub-basin continuity Once concentrated, flows should be conveyed to a suitable outfall (i.e. – SWC) Coordinate road alignments with drainage patterns
3.4.4.1	Utilize floodway delineation methodology that accounts for and mitigated impacts of lost overbank flood storage
3.4.5.1	Maintain floodplain storage volume
3.4.6.1	Preserve dominant discharge low flow channel Limit increases in maximum design tractive sheer stress at design discharge Design for potential changes in sediment supply resulting from upstream development
3.4.7.1	Minimize concentration of existing sheet flow Maintain sediment yield from individual development and the overall watershed Maintain sediment delivery to Waterman Wash
3.4.8.1	Design to be compatible with the future cultural and physical setting Design flood hazard mitigation to be compatible with the natural Sonoran desert washes within floodways Design flood hazard mitigation facilities to maintain views toward the mountain preserve areas and preserve existing views from the mountains to the valley
3.4.9.1	Accommodate City of Goodyear parks and trails within flood hazard mitigation projects Accommodate other local parks within flood hazard mitigation projects Establish appropriate segments of the Maricopa Regional Trail along SWCs (Segments 85, 87/88, and 91) Accommodate other local trails
3.4.10.1	Preserve existing open space value Maintain BLM-managed lands as public open space Development should comply with MAG Desert Spaces *Environmentally Sensitive Development Areas Policy and Planning Guidelines*
3.4.11.1	Maintain existing ecological integrity of natural vegetation types Protect natural and beneficial functions of washes Preserve the connectivity and permeability of habitats Restore or enhance vegetation and natural channels in degraded areas Use built structures to create resources for wildlife
3.4.12.1	Protect and interpret historic sites Protect and interpret prehistoric sites

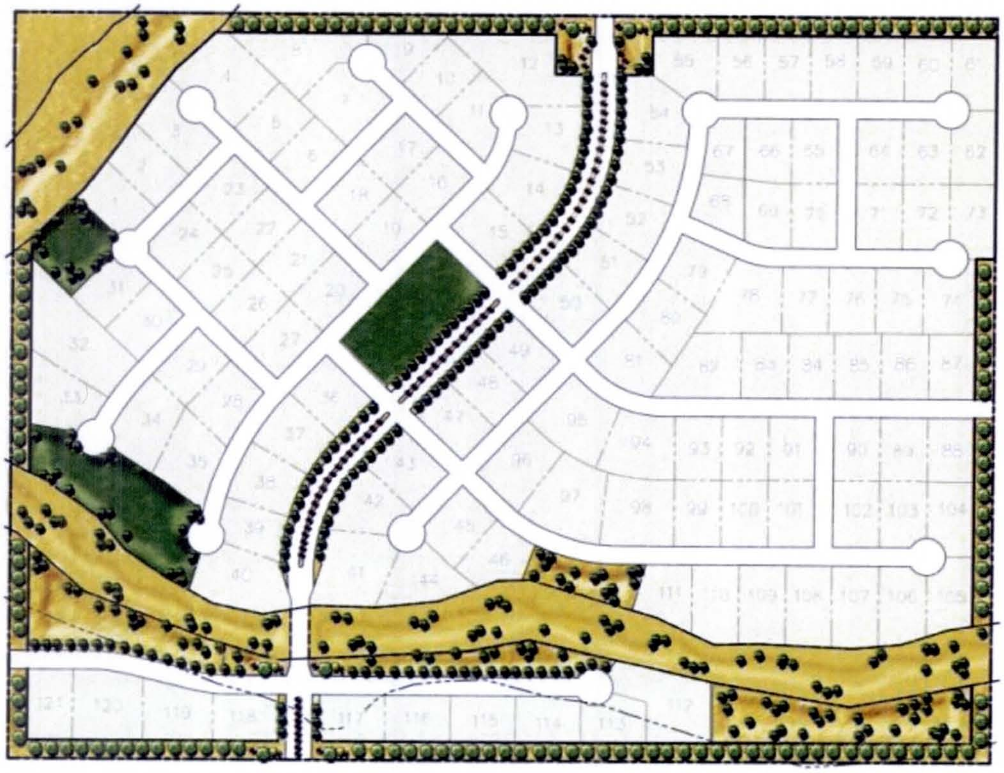


Figure 3-14 Tributary Flow – Traditional Development Pattern

Traditional development practices (**Figure 3-14**) have been developed specifically to address flood hazards and tributary flow landforms. Standard practices address development in the floodplain and mitigating stormwater runoff through retention of on-site flows and maintaining off-site flow patterns or mitigating for same. Off-site runoff is normally collected from both overland flow and channelized flow and then conveyed either through or around a development in the most efficient way so as to minimize significant adverse flood impacts to other properties. Wash corridors are preserved when they are designated as wetlands or if they provide enhanced value to the development. Floodplain and floodway impacts are mitigated. In many cases the natural washes are replaced by manmade conveyances. Jurisdictional wetlands are a special case where they may be preserved and even enhanced.

The landscape in these areas changes from natural to rural with impeded views of the mountains and valleys. Wash corridors can improve the viewshed for the development. There can be both passive and active recreational function with connectivity park nodes depending on the specific government jurisdiction. Stormwater retention takes up a significant percentage of the open space requirements. There are extensive impacts to cultural and biological resources.

Figure 3-15 Tributary Flow – Cluster Development Pattern

The recommended plan guidance for tributary flow areas is to provide a natural corridor for the SWC. This includes a broader width so that the wash can maintain a dominant discharge channel, floodway limit, and erosion hazard zone that accounts for some migration. The corridor is larger than required for a manmade system. Development is clustered to allow for adequate development density while providing open spaces that can also maintain a natural identity. Retention requirements are reduced because natural areas are not impacting downstream flow or quality. Therefore the footprint for retention basins as open space is less.

Viewsheds are still impeded but through preserving the natural function and continuity of the SWC both panoramic (mountain and valley) and specific (wash) views still occur. The SWC is a corridor for wildlife and natural vegetation though larger mammals may not be willing to utilize. Passive and active uses are available in the SWCs as long as specific uses are designated for various locations. Connectivity for flow, wildlife, open space and recreation are accounted for as part of the SWC.

Table 3-9 Tributary Flow with SWC Metrics Evaluation

Metric	Undeveloped Condition	Traditional Development	Clustering Development Pattern
Volume (ac-ft)	No data available scenario not modeled	No data available scenario not modeled	No data available scenario not modeled
Peak Discharge (cfs)	No data available scenario not modeled	No data available scenario not modeled	No data available scenario not modeled
Flow Paths/Continuity	High Unmodified	Low Collecting, channelizing and re-routing flow	Medium to Low Flow corridor improves continuity and reduces re-routing and retention
Flow Depth	Low Unmodified - wash depths expected 1ft or less	Medium Concentrated flows, increased shadowing with decreased flow depths downstream	Medium Flow concentrated along preserved flow path
Velocities	Medium Low velocities expected	Medium Low velocities with increased shadowing expected	Medium Low velocities, minimal shadowing, improved downstream sediment delivery
Storage Preservation	High Shallow - Large aerial extent	Low Use of localized retention facilities, retention greater than natural condition	Medium Reduced use of localized retention facilities, increased use of natural storage
Landscape Character	Natural Natural wash located within the lower bajada of the piedmont landform	Rural Large lot residential (0.65 ac/du)	Rural Moderate-sized suburban lots (0.20 ac/du) laid-out as clusters between areas of contiguous undisturbed open spaces and the preserved wash corridor
Viewshed Preservation	High Wash provides visual interest to outside viewers while focusing views. Proximity to hills and mountains increases value of views	Moderate Channelized wash can focus views towards the mountains. Rural setting has moderate impact on the views from the mountains	Moderately-High The preserved wash and other natural drainage way help maintain existing views and mitigate change in setting
Recreation Uses	Unprogrammed Potential activities include equestrian and hiking within wash, OHV's, and target shooting.	LOS: 13.1 ac./1000 residents 4.5 areas of active recreation in programmed areas	Non-SWC Passive: 63.0 ac./1000 residents Active: 2.8 acres/1000 residents 23.2 acres of preserved wash corridor with passive recreation such as trails combine with other open space and active recreation co-located in storm water retention facilities that provide a broad spectrum of recreation uses
Open Space Resource Integrity	High Open space intact, connectivity unimpeded	Moderate Approximately 25.0% of site retained as open space primarily as a result of storm water conveyance areas and storm water basins. Channelized wash aids in preserving continuity, but change in setting and vegetative cover lowers integrity.	Moderately-High Preserves approximately 52.3 percent of site. Wash and other open spaces are highly contiguous and residential development is integrated into the existing open space mosaic
Biological Resource Integrity	High Vegetative cover intact and undisturbed allowing uninterrupted native wildlife use	Low Extensive impacts due to removal of riparian vegetation and displacement of wildlife. Edge condition impacts to adjacent property	Moderately-High Preserved wash and other open spaces provide corridors of vegetative cover for native wildlife. Biodiversity will likely be impacted by edge effects
Cultural Resource Integrity	High Remain intact and undisturbed, but vulnerable to vandalism	Low Extensive impacts to the site	Moderately-High Preserved areas reduce likely impacts. Extensive impacts where development occurs, increased vandalism potential in preserved areas due to improved access.
Planning	Rural Residential (RR: 0-2.0 du/ac)	1 unit/acre 121 units/120.7 acres	1.3 units/acre 162 units/120.7 acres

3.4.6 Distributary Flow

The distributary flow example (**Figure 3-16**) is developed for the Sonora Planning Unit (Figure 1-2) where the landform caused this type of flow characteristic. The selected location is presently undeveloped, but will be in the future. Up and downstream development will occur to the upstream boundary with the Sonoran Desert National Monument. Flow paths follow small washes with breakouts being prevalent. Interflow between sub-basins can occur as does reconnections of flow paths downstream from where they bifurcate. Many of the bifurcated washes are small though there are some large washes in the planning unit that have dominant and minor flow paths. The example shows a large flow path with flow depths less than 1.5 feet and velocities in the 2 to 2.5 fps range (**Figure 3-16**). The flow rate is large at approximately 900 cfs so many of the smaller washes are connected. At lower flow rates the smaller washes would be separated and separating and reconnecting in the downslope direction. As the flow moves downslope the flow splits (bifurcates) into two distinct paths with the right path containing more flow than the left. It can also be seen that there is a tendency for the flow to reconnect. The flow velocities and large contact area between the flow and the ground provide both natural storage and infiltration. Lack of man-made obstructions preserve the natural viewshed from the Maricopa Mountains to Waterman Wash and the Estrella Mountains in the far background. There are no obstructions to wildlife movement and natural vegetation dominates the landscape. Cultural settings are not disturbed. **Figure 3-16** is characteristic of distributary flow in a natural condition. Table 3-10 lists the performance functions associated with distributary flow areas.

When a 100-acre traditional development is constructed in the Sonoran Planning Unit flow patterns are changed. Upstream flow is blocked and collected by a channel, then rerouted around the development. A shadow occurs downstream of the development and flow paths are concentrated causing greater wash depths and velocities. Downstream erosion occurs and natural dominant bifurcations can be lost unless planned for in advance through regulations by the permitting jurisdiction(s). In the example, the dominant bifurcation is maintained but is narrower and flow depths deeper. Basically, flow continuity in the secondary bifurcation is cutoff (**Figure 3-17**). Runoff volumes and peak flows are significantly reduced because the development follows standard stormwater practices where the 100-year 6-hour rainfall event is retained. Viewsheds, wildlife access and open space are discontinuous and the cultural setting is changed from natural to rural.

Table 3-10 Performance Functions Associated with Distributary Flow Areas

3.4.1.1	Store increases in runoff volume resulting from development Preserve natural land surface storage and infiltration properties Maintain adequate baseflow to support native vegetation
3.4.2.1	Minimize reduction in time of concentration Provide retention/detention to offset increases in peak discharge
3.4.3.1	Manage flow split uncertainty by fixing or regulating flow split potential Maintain sub-basin continuity Coordinate road alignments with drainage patterns
3.4.7.1	Maintain sediment yield from individual development and the overall watershed Maintain sediment delivery to Waterman Wash
3.4.8.1	Design to be compatible with the future cultural and physical setting Design flood hazard mitigation facilities to maintain views toward the mountain preserve areas and preserve existing views from the mountains to the valley
3.4.9.1	Accommodate City of Goodyear parks and trails within flood hazard mitigation projects Accommodate other local parks within flood hazard mitigation projects Accommodate other local trails Accommodate the Juan Bautista de Anza National Historic Trail enhancement and interpretation
3.4.10.1	Preserve existing open space value Maintain BLM-managed lands as public open space Development should comply with MAG Desert Spaces *Environmentally Sensitive Development Areas Policy and Planning Guidelines*
3.4.11.1	Maintain existing ecological integrity of natural vegetation types Preserve the connectivity and permeability of habitats Use built structures to create resources for wildlife
3.4.12.1	Protect and interpret historic sites Protect and interpret prehistoric sites

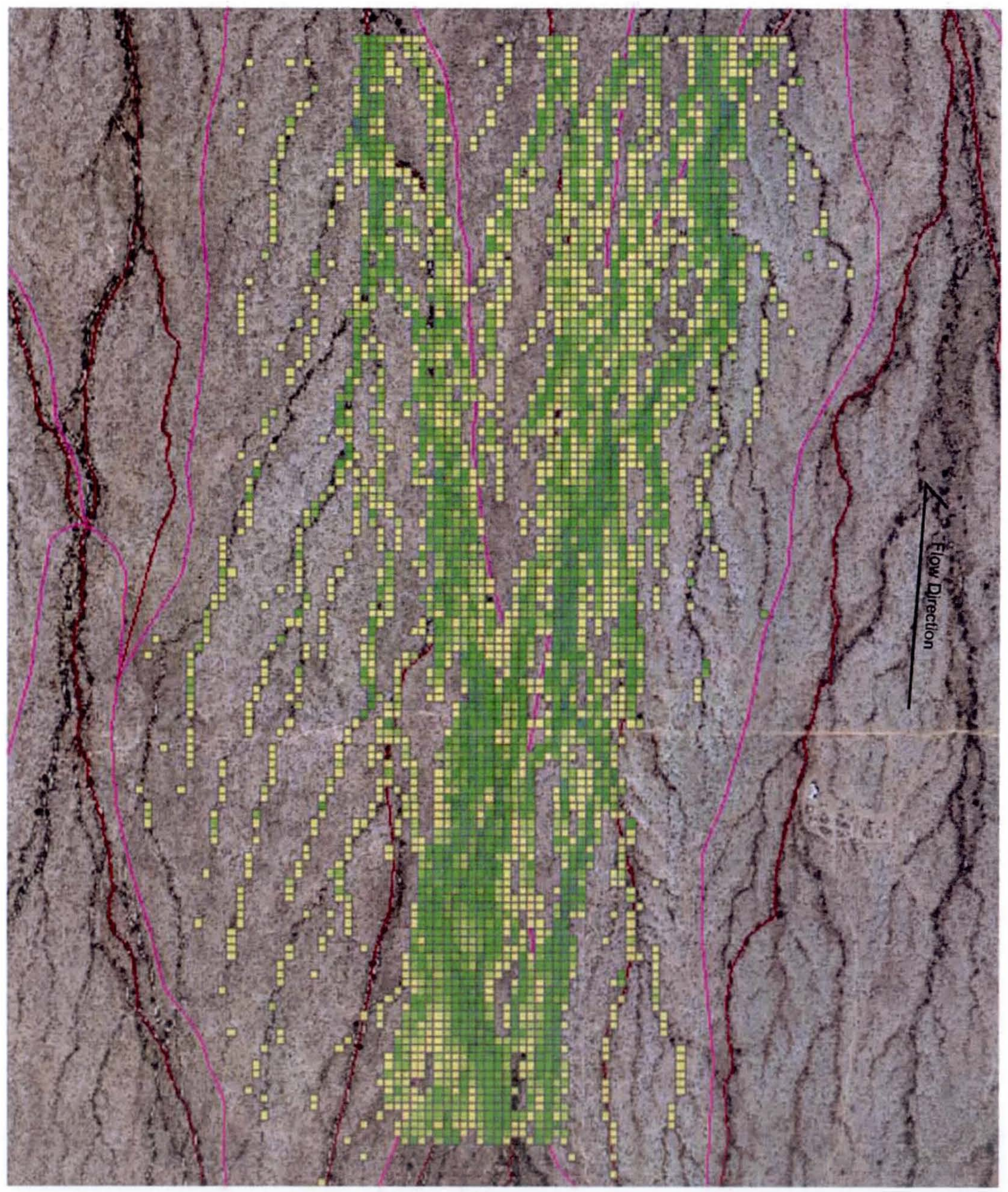
Through clustering of developed areas and maintaining some flow paths through the development the downstream distributary flow characteristic is maintained. The shadow effect is mitigated through strategic placing of open space flow corridors. Downstream flow depths and velocities are similar to natural conditions though there will be some variation. Providing natural flow paths through the development will allow for sediment to move downstream and maintain sediment delivery to Waterman Wash. Reduced stormwater retention will increase the volume of flow downstream and as it is moving through a more natural landform, natural storage and infiltration can occur. **Figure 3-18** shows the flow patterns and depth of flow for the clustering of development. The velocity patterns downstream from development can be compared for the three scenarios (**Figure 3-19**). There will be some blockage of viewsheds though corridors occur in the preserved areas. There are open space and wildlife corridor opportunities, though the width of the preserved areas may not be adequate to accommodate large mammals. If there are large dominant bifurcations that are preserved as part of the development more opportunities occur for open space and recreation.

Table 3-11 Distributary Flow Metrics Evaluation

Metric	Undeveloped Condition	Traditional Development	Clustering Development Pattern
Volume (ac-ft)	162 ac-ft - losses due to natural processes	149 ac-ft - On-site storage impacts	162 ac-ft - balance neutralize effects of developed land only
Peak Discharge (cfs)	909 cfs - Cumulative flow downstream	641 cfs - Reduced flow due to retention storage	905 cfs - Reduced retention - preserved flowpaths
Flow Paths/Continuity	<u>High</u> Unmodified	<u>Low</u> Collecting, channelizing and re-routing flow	<u>Medium to High</u> Flow corridor improves continuity and reduce re-routing and retention
Flow Depth	<u>Low</u> Unmodified - wash depths < 1ft	<u>Medium</u> Concetrated flow > 1.5 ft, shadow areas dry	<u>Medium</u> Some concentrated flow in 2ft range, reduced downstream shading
Velocities	<u>Medium</u> Low velocities 2.0 fps-100year event, no impedence or capture of sediment	<u>Medium</u> Low velocities - 2.0 fps, increased shadowing and clear water	<u>Medium</u> Low velocities - 2.0 fps, decreased shadowing, improved downstream sediment delivery
Storage Preservation	<u>High</u> Shallow - Large aerial extent	<u>Low</u> Use of localized retention facilities, retention greater than natural condition	<u>Medium</u> Reduced use of localized retention facilities, increased use of natural storage
Landscape Character	<u>Natural</u> Undisturbed piedmont with flow splits and shallow overland flows	<u>Rural</u> Large lot residential (1 ac/du)	<u>Rural</u> Large lot residential (0.5 ac/du) laid-out to allow for contiguous undisturbed open spaces
Viewshed Preservation	<u>High</u> Views uninterrupted by development. Sites maintained from valley to mountains.	<u>Moderately-Low</u> Views somewhat impeded due to continuous development. Suburban or urban settings would result in greater impacts	<u>Moderately-High</u> Narrowed views from valley to mountains along preserved natural drainage ways. Undisturbed areas provide some mitigation for change in setting from natural to rural
Recreation Uses	<u>Unprogrammed</u> Potential activities include off-trail hiking, off-roading, and target shooting.	<u>21.7 ac./1000 residents</u> Active recreation in programmed areas	<u>103.4 ac./1000 residents</u> 36.4 acres of total open space. Provides active and preserved open space. Passive recreation such as trails may occur along fringes of preserved areas.
Open Space Resource Integrity	<u>High</u> Open space intact, connectivity unimpeded	<u>Moderately-Low</u> Approximately 19% of site retained open space for active recreation, storm water basins and other amenities. Fragmented	<u>Moderately-High</u> Preserves approximately 31 percent of natural piedmont with an addition 5.3 ac. active open space for storm water and other uses. Layout should integrate development into existing mosaic
Biological Resource Integrity	<u>High</u> Vegetative cover intact and undisturbed allowing uninterrupted native wildlife use	<u>Low</u> Extensive impacts due to removal of native vegetation and displacement of wildlife. Edge condition impacts to adjacent property	<u>Moderate</u> Preserved open space provides corridors for existing vegetative cover and native wildlife. Biodiversity will likely be negatively impacted due to edge effects
Cultural Resource Integrity	<u>High</u> Remain intact and undisturbed, but vulnerable to vandalism	<u>Low</u> Extensive impacts to the site	<u>Moderate</u> Preserved areas reduce likely impacts. Extensive impacts where development occurs, increased vandalism potential in preserved areas due to improved access.
Planning	Rural Residential (RR:0-2 du/ac)	0.8 du/ac. 81 lots included over 100 acres	1.2 units/acre 124 lots included over the 100 acres with reduced lot sizes

Rainbow Valley
Area Drainage Master Plan
Distributary Flow - Undeveloped Conditions

Figure 3-16



Scale: 1" = 1/4 Mile

Flow Depths

COMPARATIVE DATA

Run Off Volume	122 ac-ft
Peak Q	1099 cfs
Flow Continuity	High
Storage Preservation	High
Scenery Resources	
Dominant Cultural Setting	Natural
Viewshed Preservation	High
Regional Multi-Use	
LOS	NA
Preserved Open-Space	100%
Units	0
Density	0
Land Use	LDR (2-4 units/ac)

Split Flow Area in an Undisturbed Condition

LEGEND

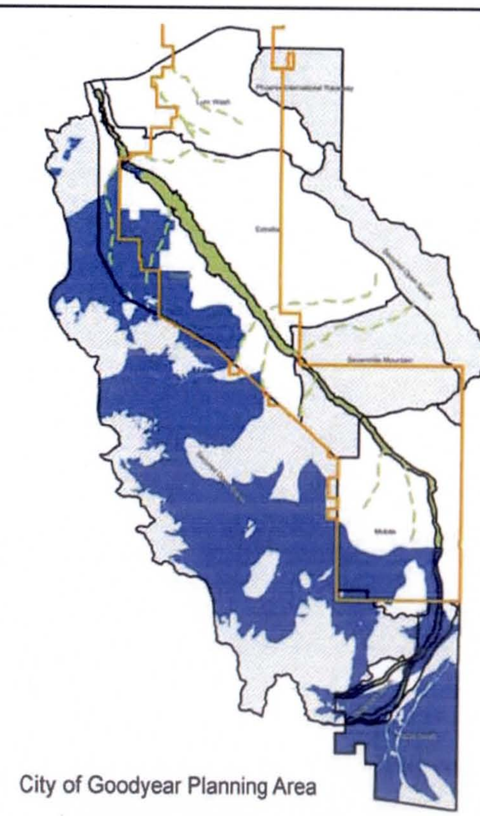
Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Drainage Sub-Basin

Drainage Flowpath

KEYMAP



City of Goodyear Planning Area

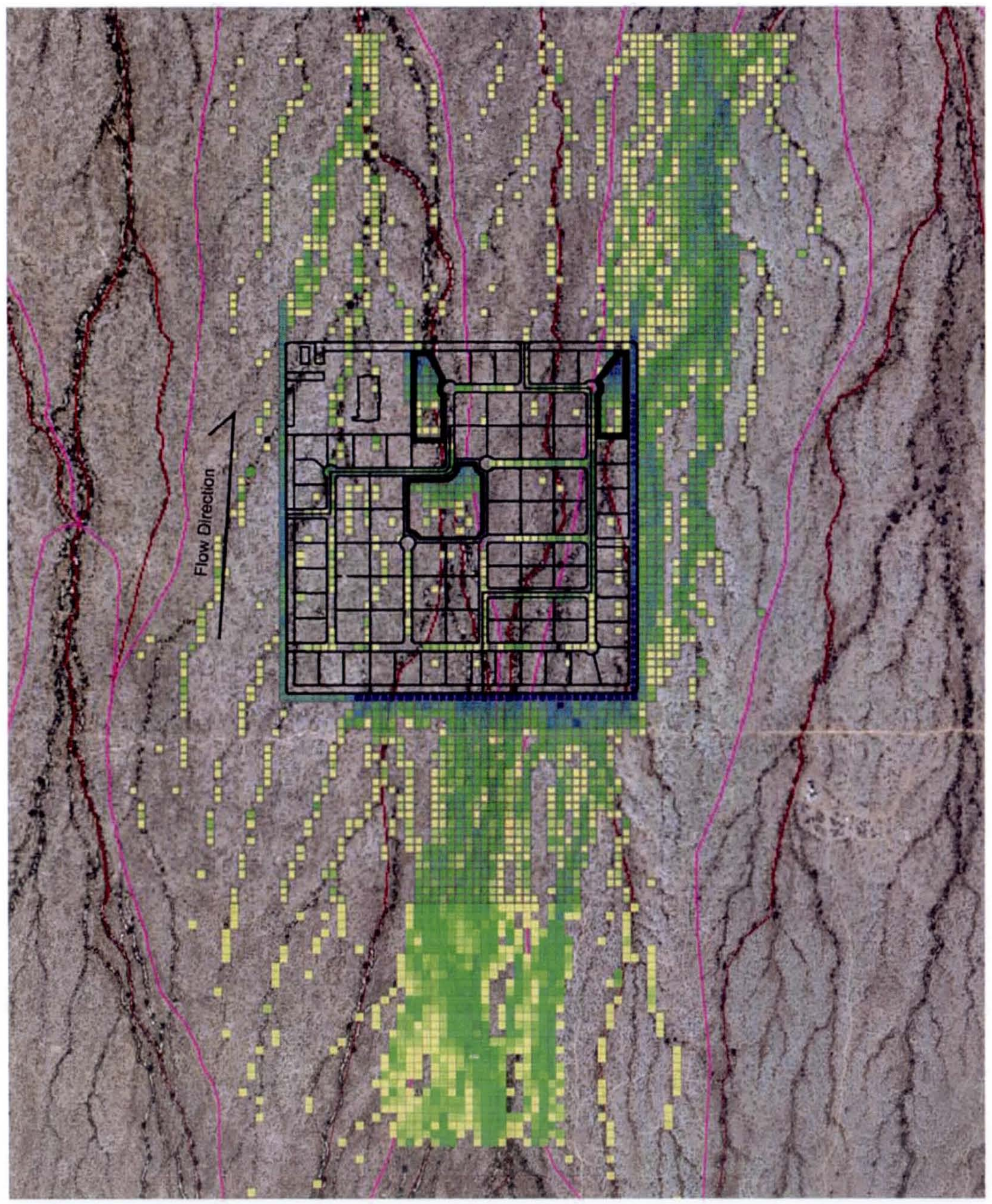
Distributary Flow Areas

Secured Open Space or Non-Evaluated Planning Units

Significant Wash Corridors and Waterman Wash

Rainbow Valley
Area Drainage Master Plan
Distributary Flow - Traditional
Development Pattern

Figure 3-17

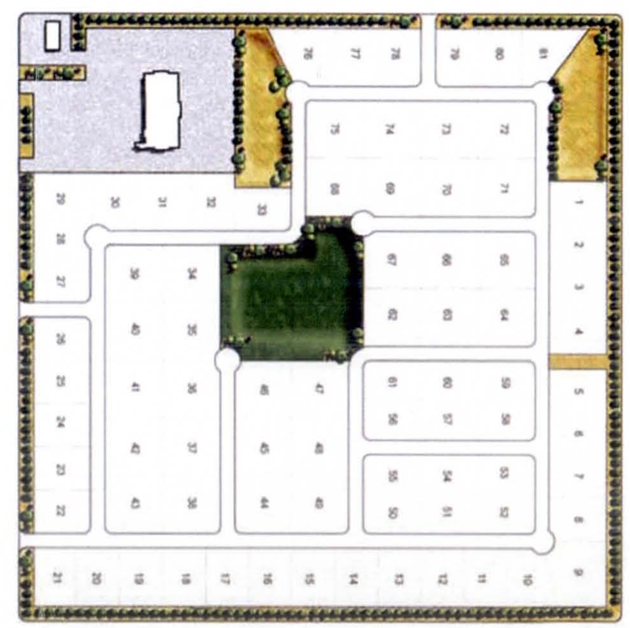


Flow Depths

Scale: 1" = 1/4 Mile

COMPARATIVE DATA

	Existing	Traditional
Run Off Volume	122 ac-ft	57 ac-ft
Peak Q	1099 cfs	514 cfs
Flow Continuity	High	Low
Storage Preservation	High	Low
Scenery Resources		
Dominant Cultural Setting	Natural	Rural
Viewshed Preservation	High	Moderately-Low
Regional Multi-Use LOS	NA	21.7 ac/1000
Preserved Open-Space	100%	0%
Units	0	81
Density	0	0.8 units/acre
Land Use		LDR (2-4 units/ac)



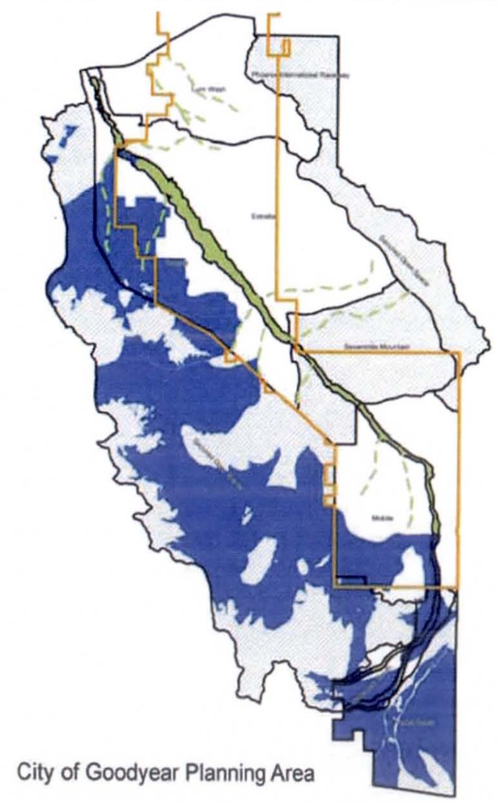
Traditional Development Layout

LEGEND

Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000
- Drainage Sub-Basin
- Drainage Flowpath

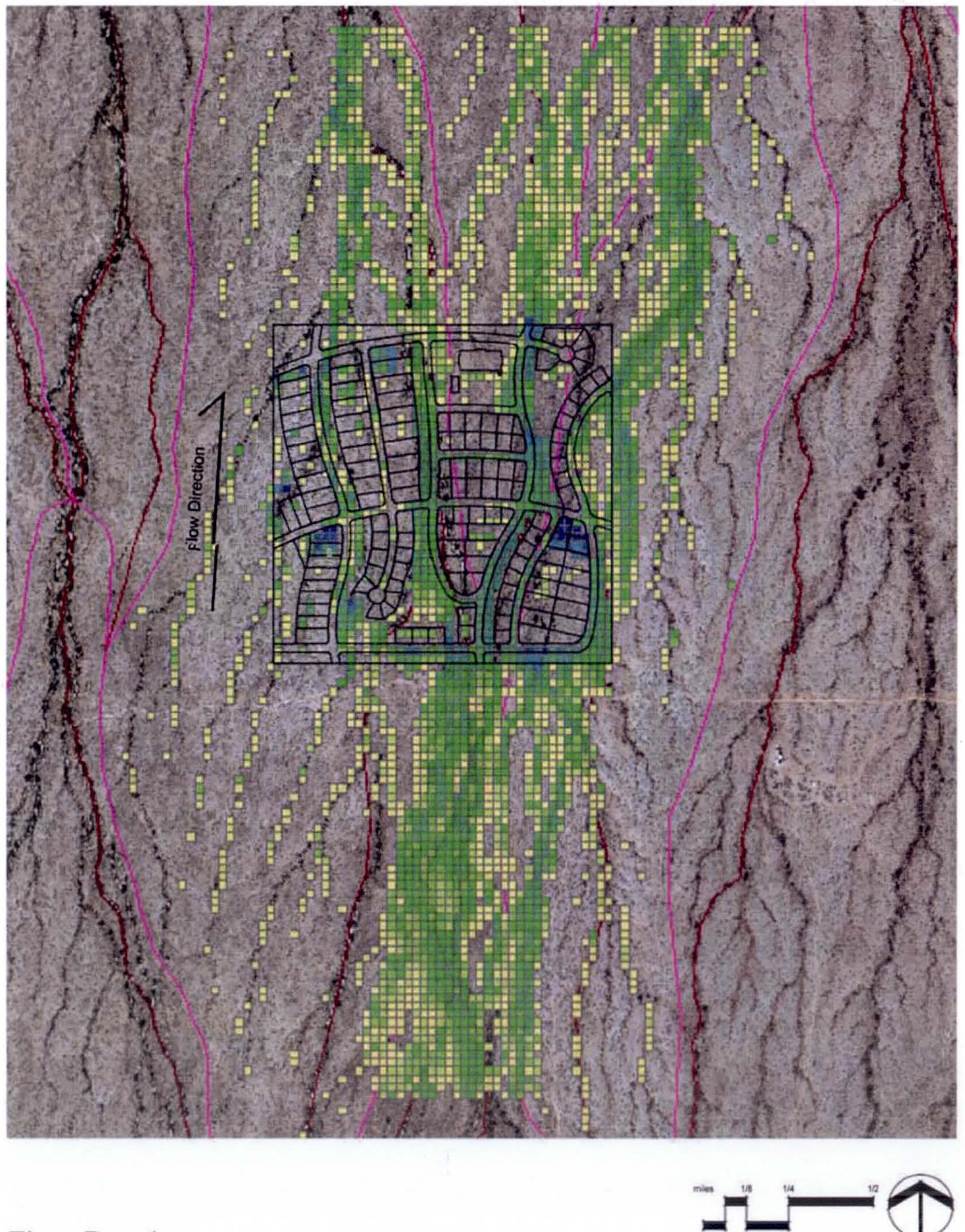
KEYMAP



- City of Goodyear Planning Area
- Distributary Flow Areas
- Secured Open Space or Non-Evaluated Planning Units
- Significant Wash Corridors and Waterman Wash

Rainbow Valley
Area Drainage Master Plan
Distributary Flow - ADMP
Development Pattern

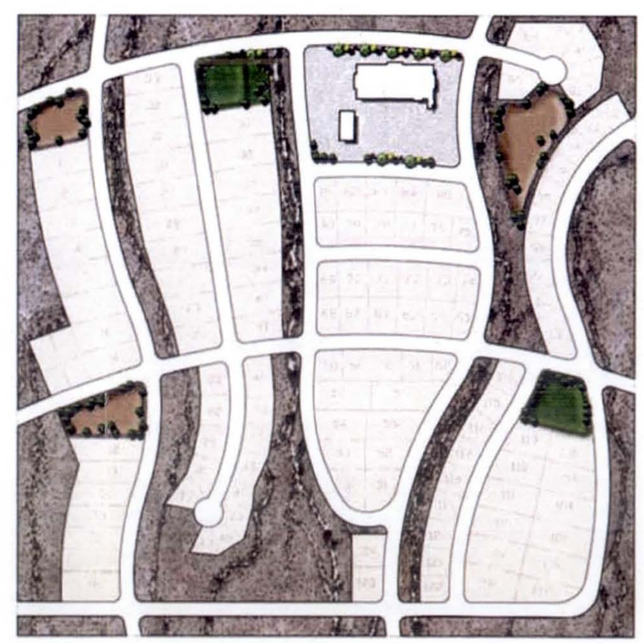
Figure 3-18



Flow Depths

COMPARATIVE DATA

	Existing	Traditional	ADMP
Run Off Volume	122 ac-ft	57 ac-ft	76 ac-ft
Peak Q	1099 cfs	514 cfs	1088 cfs
Flow Continuity	High	Low	Med-high
Storage Preservation	High	Low	Medium
Scenery Resources			
Dominant Cultural Setting	Natural	Rural	Rural
Viewshed Preservation	High	Mod-Low	Mod-High
Regional Multi-Use			
LOS (acres/1000)	NA	21.7	103.4
Preserved Open-Space	100%	0%	31.1%
Units	0	81	124
Density	0	0.8 u/ac	1.2 u/ac
Land Use		LDR (2-4 units/ac)	



ADMP Development Layout

LEGEND

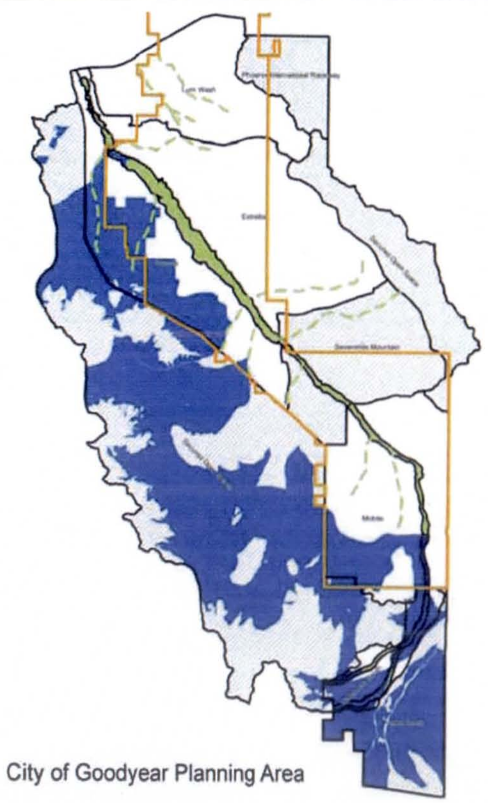
Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Drainage Sub-Basin

Drainage Flowpath

KEYMAP



City of Goodyear Planning Area

Distributary Flow Areas

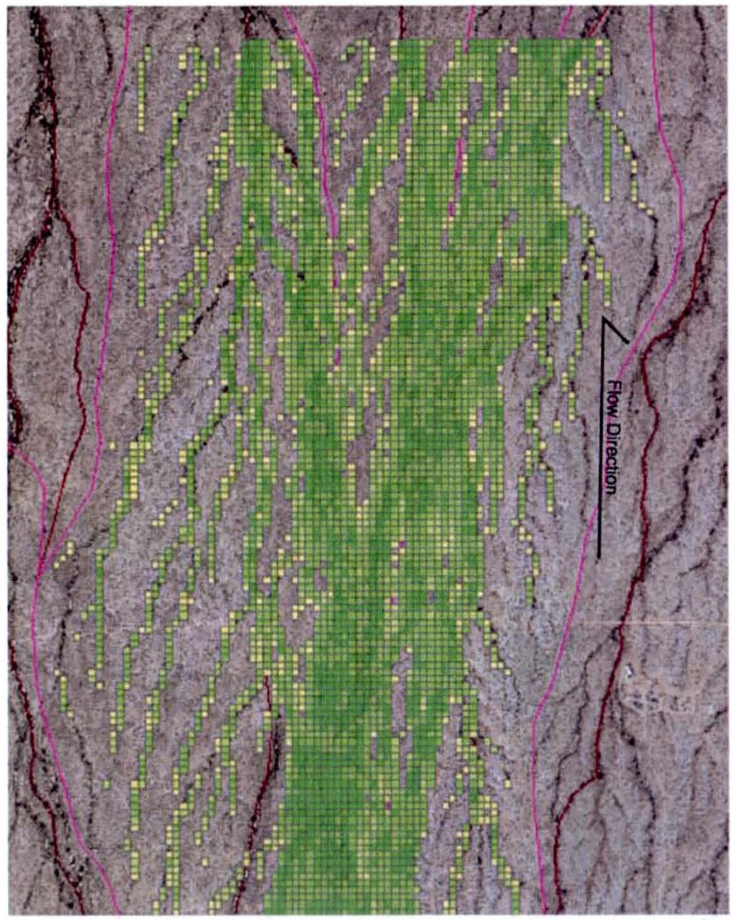
Secured Open Space or Non-Evaluated Planning Units

Significant Wash Corridors and Waterman Wash

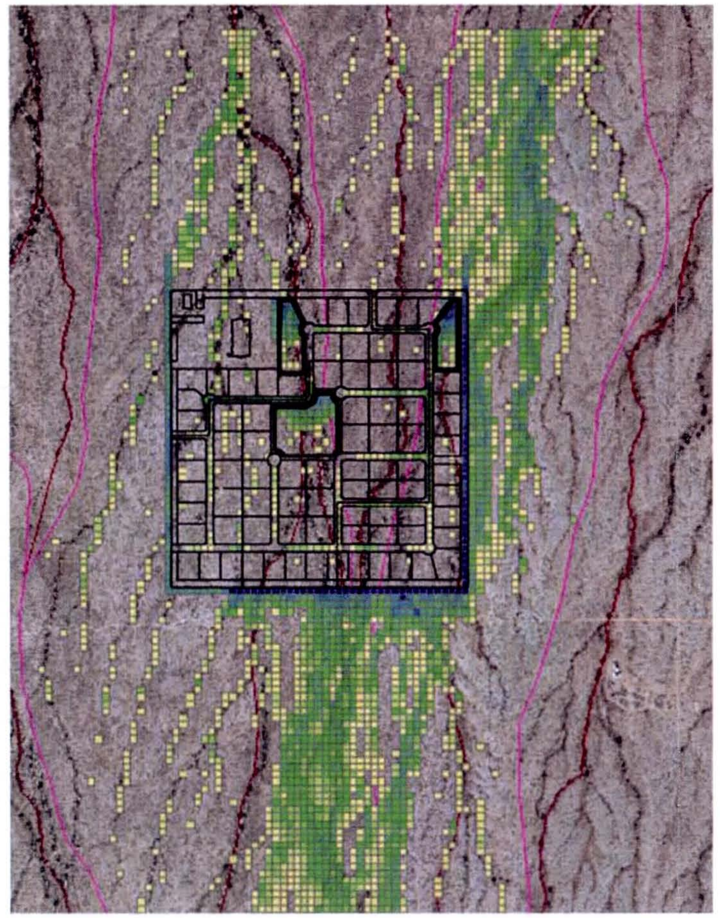
Rainbow Valley
Area Drainage Master Plan
Distributary Flow - Velocities

Figure 3-19

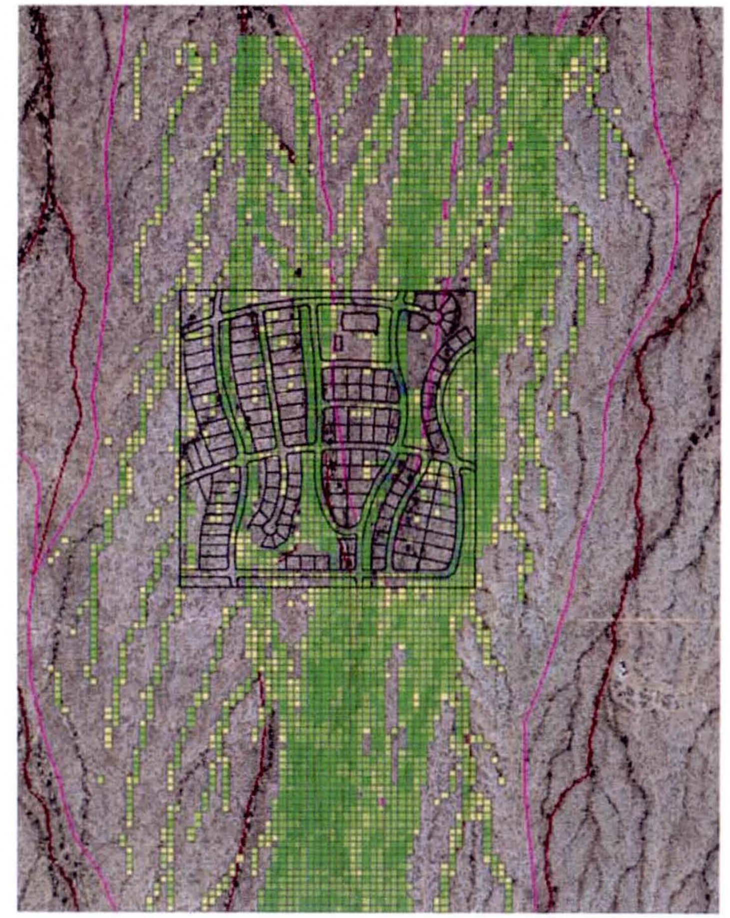
Existing Velocities



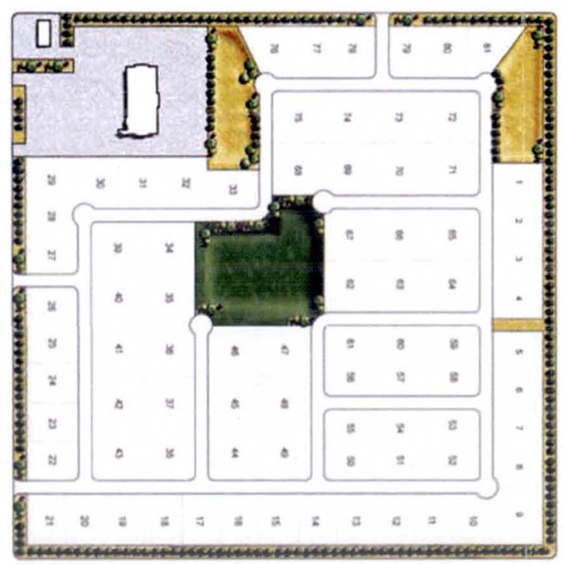
Traditional Layout- Velocities



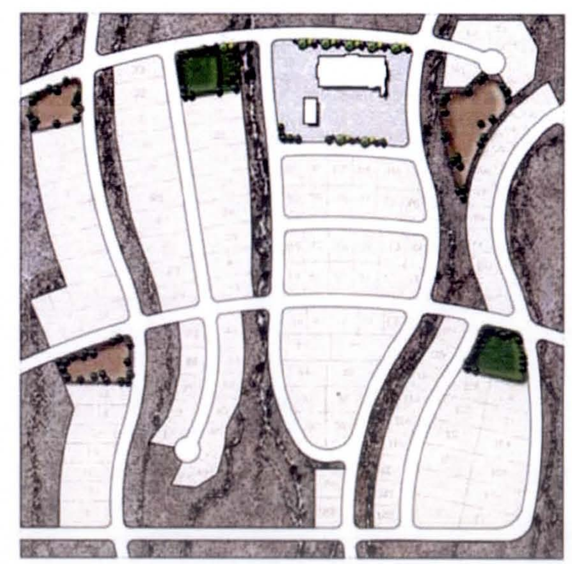
ADMP Layout- Velocities



Undisturbed Distributary Flow Area



Traditional Development Layout



ADMP "Clustering" Development Layout

LEGEND

Flow Velocity at Cell (ft/s)

0.500 - 0.750	2.501 - 3.000
0.751 - 1.000	3.001 - 4.000
1.001 - 1.500	4.001 - 5.000
1.501 - 2.000	5.001 - 6.000
2.001 - 2.500	6.001 - 10.000

Drainage Sub-Basin

Drainage Flowpath

3.4.7 Distributary Flow with SWC

This design example is a special case where a SWC is designated in the Sonoran Planning Unit where distributary flow patterns are prevalent (Figure 1-2). The idea is to preserve the SWC as a continuity corridor between the Maricopa Mountains and Sonoran Desert National Monument with Waterman Wash. The SWC provides a natural flow path, cultural and environmental continuity as well as open space, scenic and recreation opportunities in Rainbow Valley. In a distributary flow landform there could be many paths with potential for hydrologic continuity as the flow divides and re-connects, therefore a dominant bifurcation conveyance was selected for the SWC. **Figure 3-20** shows the flow patterns for the specific example. The main flow corridor divides into major paths. The ADMP chose the right bifurcation as the dominant path for the SWC. In this case both the width and depth of flows are greater and the maximum velocities are similar in each leg of the bifurcated wash. Table 3-12 shows the performance functions that are to be considered when developing the area.

A 100-acre traditional development is superposed on the drainage (**Figure 3-21**). It is determined that providing detention storage for off-site flow and metering it through the development will be less disturbing to adjacent property owners than diverting off-site flow around the development, because routing flows may create excessive flow and volume of runoff where it does not presently occur, such as east of the development. Off-site downstream discharge is released to the secondary bifurcation corridor in this example. Other downstream areas including the primary corridor are in the shadow of the development and do not receive upstream flow. Though the volume of runoff in the secondary corridor is increased there is a significant overall reduction in the downstream volume and peak flows. Flow continuity is low and so is storage preservation when compared to the existing condition. Sediment movement downstream is significantly reduced as a result of the upstream detention and metering and on–site retention. This will cause additional erosion and modifications to downstream flow patterns. The channelized flow through the development will need stabilization because of the higher velocities which in turn will remove natural vegetation and make it less desirable as a corridor for wildlife.

Table 3-12 Performance Functions Associated with Distributary Flow Areas and Associated SWCs

3.4.1.1	Store increases in runoff volume resulting from development Preserve natural land surface storage and infiltration properties Maintain adequate baseflow to support native vegetation
3.4.2.1	Minimize reduction in time of concentration Provide retention/detention to offset increases in peak discharge
3.4.3.1	Manage flow split uncertainty by fixing or regulating flow split potential Once concentrated, flows should be conveyed to a suitable outfall (i.e. – SWC) Coordinate road alignments with drainage patterns
3.4.4.1	Utilize floodway delineation methodology that accounts for and mitigated impacts of lost overbank flood storage
3.4.5.1	Maintain floodplain storage volume
3.4.6.1	Preserve dominant discharge low flow channel Limit increases in maximum design tractive sheer stress at design discharge Design for potential changes in sediment supply resulting from upstream development
3.4.7.1	Maintain sediment yield from individual development and the overall watershed Maintain sediment delivery to Waterman Wash
3.4.8.1	Design to be compatible with the future cultural and physical setting Design flood hazard mitigation to be compatible with the natural Sonoran desert washes within floodways Design flood hazard mitigation facilities to maintain views toward the mountain preserve areas and preserve existing views from the mountains to the valley
3.4.9.1	Accommodate City of Goodyear parks and trails within flood hazard mitigation projects Accommodate other local parks within flood hazard mitigation projects Establish appropriate segments of the Maricopa Regional Trail along SWCs (Segments 85, 87/88, and 91) Accommodate other local trails
3.4.10.1	Preserve existing open space value Maintain BLM-managed lands as public open space Development should comply with MAG Desert Spaces *Environmentally Sensitive Development Areas Policy and Planning Guidelines*
3.4.11.1	Maintain existing ecological integrity of natural vegetation types Protect natural and beneficial functions of washes Preserve the connectivity and permeability of habitats Restore or enhance vegetation and natural channels in degraded areas Use built structures to create resources for wildlife
3.4.12.1	Protect and interpret historic sites Protect and interpret prehistoric sites

The flow path preservation development pattern (**Figure 3-22**) emphasizes the preservation of the dominant leg of the bifurcation and provides a wide corridor for the wash in the same location as in existing conditions. The SWC landform and flow characteristics are left in the natural condition and include erosion hazard setbacks and floodplain limits as buffers to development. Removal of conveyance of the secondary leg concentrates off site runoff and causes the design flow to be deeper, especially where the wash channel is incised. Water surface elevations are approximately 0.5 to 1.0 feet higher. However, velocities (**Figure 3-23**) remain in the 1.0 to 2.0 fps range in both cases. There is some ponding on the upstream face of the development because a split to the northeast has been blocked. Smaller manmade flow paths are included in the developed areas to provide downstream continuity and flow along the downstream (north) face of the development though the SWC is the prime conveyance path. On-site retention occurs only for developed areas and not the SWC which is approximately 29 percent of the 100-acre area. This increases the runoff volume although not to the amount in the existing conditions. Flow continuity is preserved in the SWC footprint but there is disruption to the downstream distributary flow patterns where washes are blocked by development.

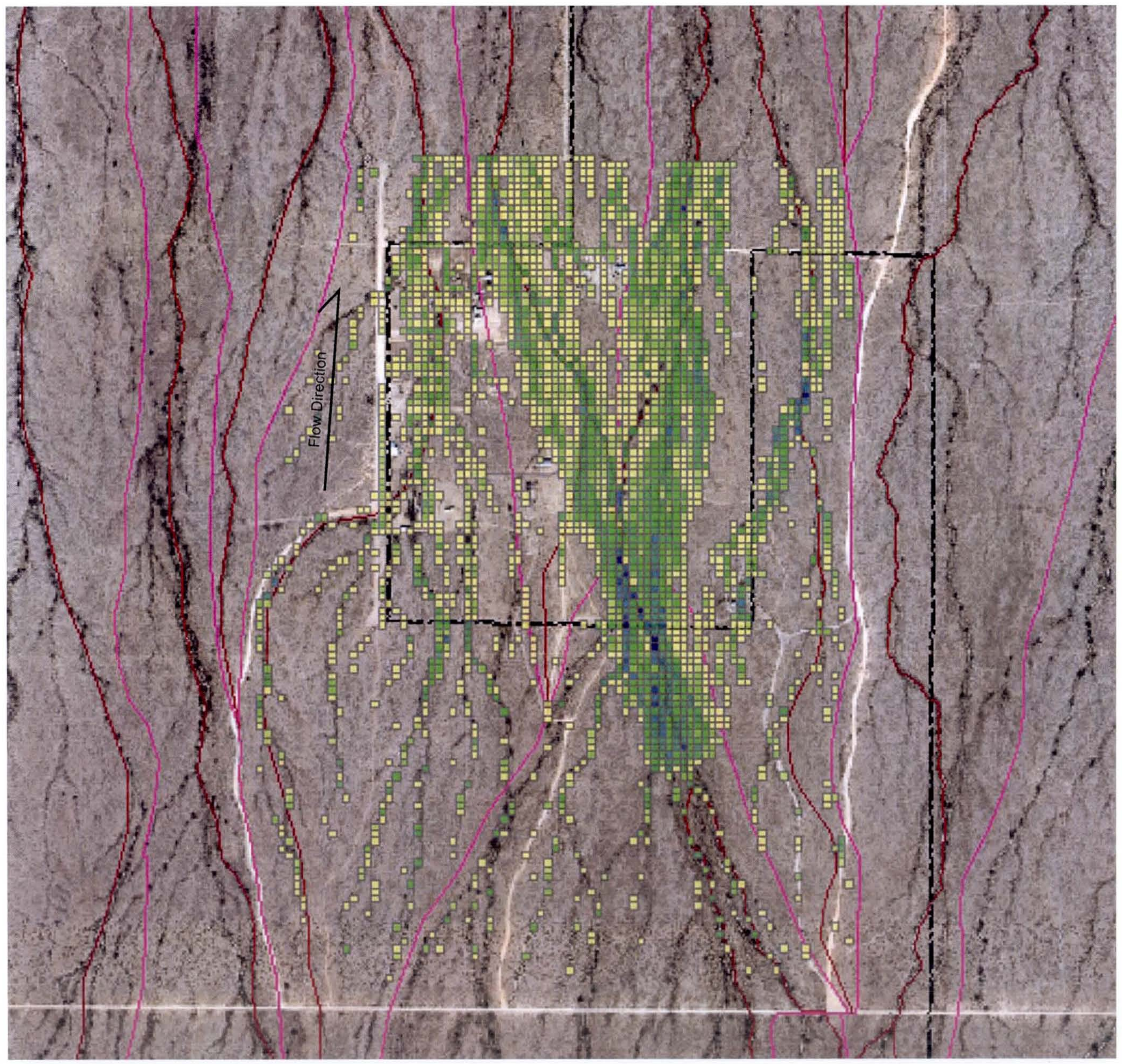
The SWC maintains its natural characteristics as a viewshed from the mountains to Waterman Wash. A natural cultural setting is maintained by not imposing engineering features to the corridor. Strategic perpendicular roadway crossings are an exception. The SWC provides a wildlife migration corridor, though larger mammals may be reluctant to use it because of the proximity to development. The width of the SWC is large enough to accommodate passive recreation with some active recreation on the fringes. The SWC should be used as a passive link between active recreational nodes.

Table 3-13 Distributary Flow with SWC Metrics Evaluation

Metric	Undeveloped Condition	Traditional Development	Clustering Development Pattern
Volume (ac-ft)	122 ac-ft - losses due to natural processes	57 ac-ft - On site storage impacts	76 ac-ft - Reduced on-site storage impacts
Peak Discharge (cfs)	1099 cfs - Cumulative flow downstream	514 cfs - Reduced due to retention storage	1088 cfs - Reduced retention, flow concentration within preserved flow path
Flow Paths/Continuity	High Unmodified	Low Collecting, channelizing and re-routing flow	Medium to Low Flow corridor improves continuity and reduce re-routing and retention
Flow Depth	High Unmodified wash depths as high as 4ft along major wash, lower in adjacent areas	Medium Concentrated flow < 2ft, less than 1ft in shadow areas	Medium Some concentrated flow in 2ft range along preserved flow path, as high as 4ft in some locations
Velocities	Medium Low velocities 2.0 fps-100year event, no impediments or capture of sediment	Medium Low velocities - 2.0 fps, increased shadowing, small areas of higher velocities, and clear water	Medium Low velocities - 2.0 fps or less, minimal shadowing, improved downstream sediment delivery
Storage Preservation	High Shallow - Large aerial extent	Low Use of localized retention facilities, retention greater than natural condition	Medium Reduced use of localized retention facilities, increased use of natural storage
Landscape Character	Natural Natural braided wash located within the natural piedmont	Suburban Moderate sized single family residential lots (0.25 ac/du)	Rural Moderate-sized suburban lots (0.17 ac/du) laid-out as clusters between areas of contiguous undisturbed open spaces and the preserved wash corridor
Viewshed Preservation	High Wash provides visual interest to outside viewers while focusing views.	Moderately-Low Channelized wash can focus views towards the mountains. Suburban settings impacts views from the mountains	Moderately-High The preserved wash and other natural drainage way help maintain existing views and mitigate change in setting
Recreation Uses	Unprogrammed Potential activities include equestrian and hiking within wash, OHV's, and target shooting.	15.7 ac./1000 residents 16.2 areas of active recreation in programmed areas	Non-SWC Passive: 27.5 ac./1000 residents Active: 6.2 ac/1000 residents 27.6 acres of preserved wash corridor with passive recreation such as trails combine with other open space and active recreation co-located in storm water retention facilities to provide a broad spectrum of recreation uses
Open Space Resource Integrity	High Open space intact, connectivity unimpeded	Moderate 25.4 percent of the site is retained as open space, largely as a result of storm water management needs. The channelized wash provides an opportunity for connecting the majority of open spaces	Moderately-High Preserves approximately 39.3 percent of site. Wash and other drainage way preservation preserve large open space areas that are highly contiguous with adjacent open spaces.
Biological Resource Integrity	High Vegetative cover intact and undisturbed allowing uninterrupted native wildlife use	Low Extensive impacts due to removal of riparian vegetation and displacement of wildlife. Edge condition impacts to adjacent property	Moderately-High Preserved wash and other open spaces provide corridors of vegetative cover for native wildlife. Biodiversity will likely be impacted by edge effects
Cultural Resource Integrity	High Remain intact and undisturbed, but vulnerable to vandalism	Low Extensive impacts to the site	Moderately-High Preserved areas reduce likely impacts. Extensive impacts where development occurs, increased vandalism potential in preserved areas due to improved access.
Planning	Low-Density Residential (LDR:2-4 du/ac)	2.2 units/acre 363 units/163.9 acres	2.7 units/acre 446 units/163.9 acres

Rainbow Valley
Area Drainage Master Plan
Distributary Flow with SWC -
Undeveloped Conditions

Figure 3-20



Flow Depths

Scale: 1" = 1/4 Mile

COMPARATIVE DATA

Run Off Volume	162 ac-ft
Peak Q	909 cfs
Flow Continuity	High
Storage Preservation	High
Scenery Resources	
Dominant Cultural Setting	Natural
Viewshed Preservation	High
Regional Multi-Use	
LOS	NA
Preserved Open-Space	100%
Units	0
Density	0
Land Use	LDR (2-4 units/ac)

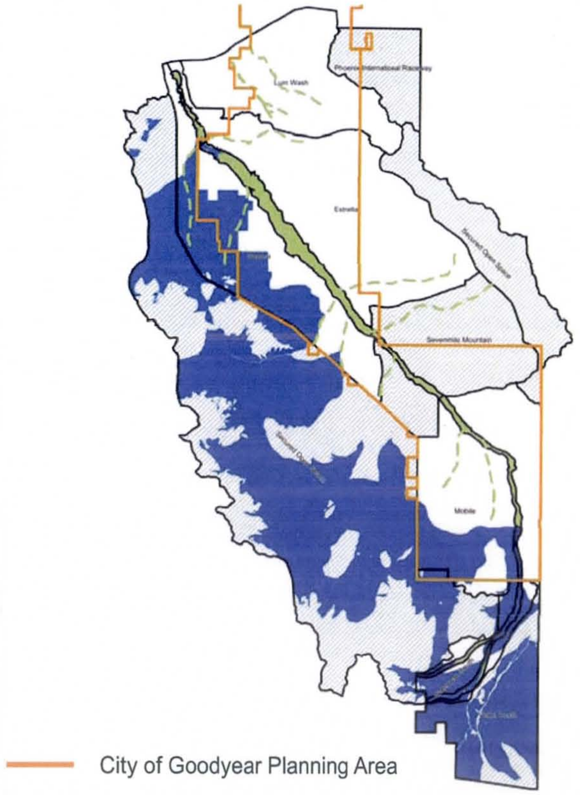
Split Flow Area in an Undisturbed Condition

LEGEND

Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000
- Drainage Sub-Basin
- Drainage Flowpath

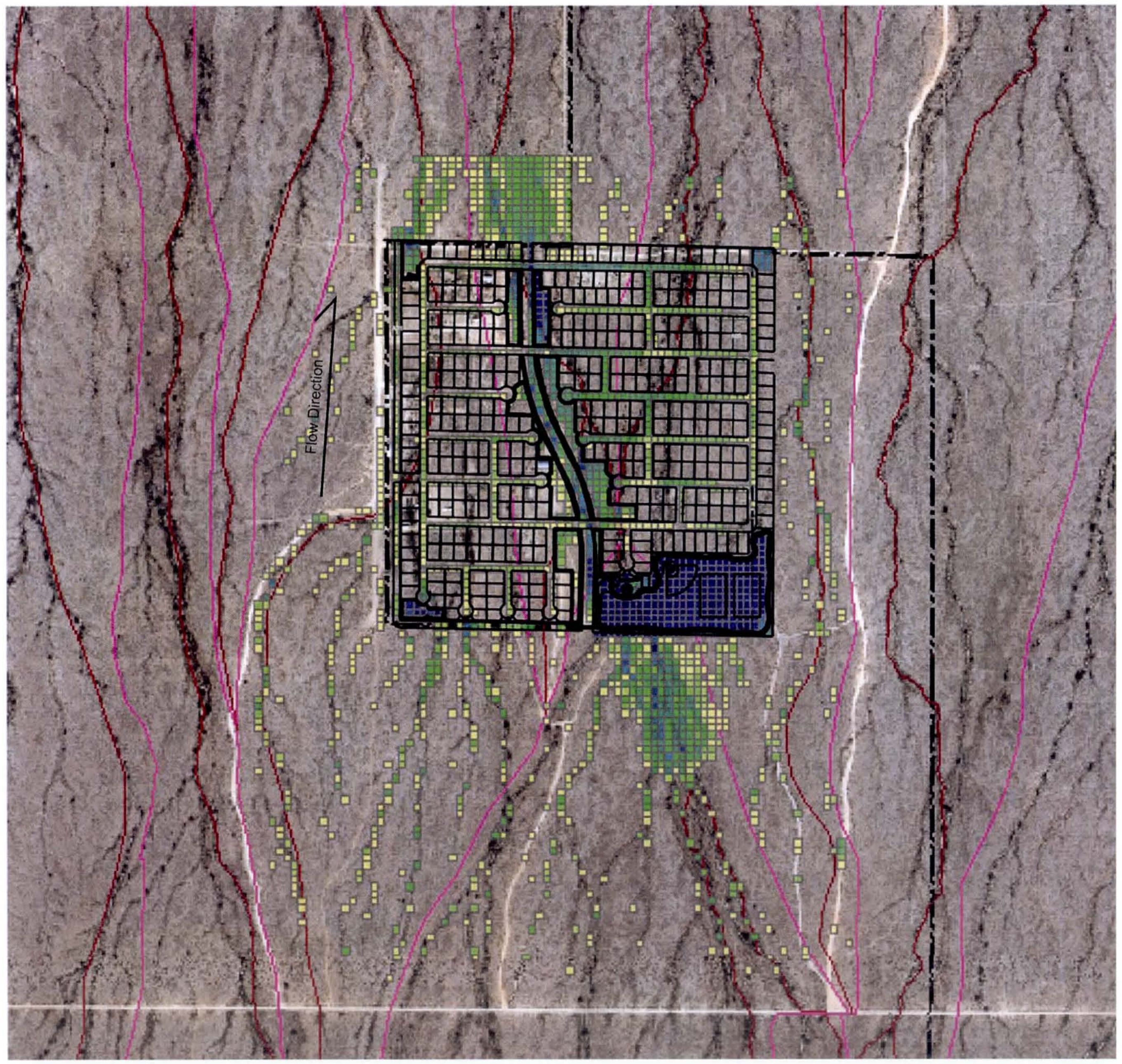
KEYMAP



- City of Goodyear Planning Area
- Distributary Flow Areas
- Secured Open Space or Non-Evaluated Planning Units
- Significant Wash Corridors and Waterman Wash

Rainbow Valley
Area Drainage Master Plan
Distributary Flow with SWC -
Traditional Development Pattern

Figure 3-21



Flow Depths

miles 1/8 1/4 1/2

Scale: 1" = 1/4 Mile

COMPARATIVE DATA

	Existing	Traditional
Run Off Volume	162 ac-ft	57 ac-ft
Peak Q	909 cfs	631 cfs
Flow Continuity	High	Low
Storage Preservation	High	Low
Scenery Resources		
Dominant Cultural Setting	Natural	Suburban
Viewshed Preservation	High	Moderate-Low
Regional Multi-Use		
LOS	NA	15.7 ac/1000
Preserved Open-Space	100%	0%
Units	0	363
Density	0	2.2 units/ac
Land Use	LDR (2-4 units/ac)	

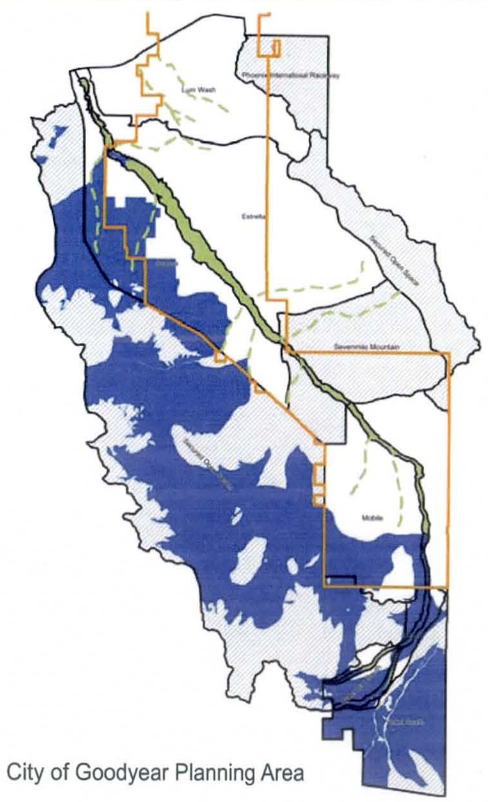
Split Flow Area in an Undisturbed Condition

LEGEND

Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000
- Drainage Sub-Basin
- Drainage Flowpath

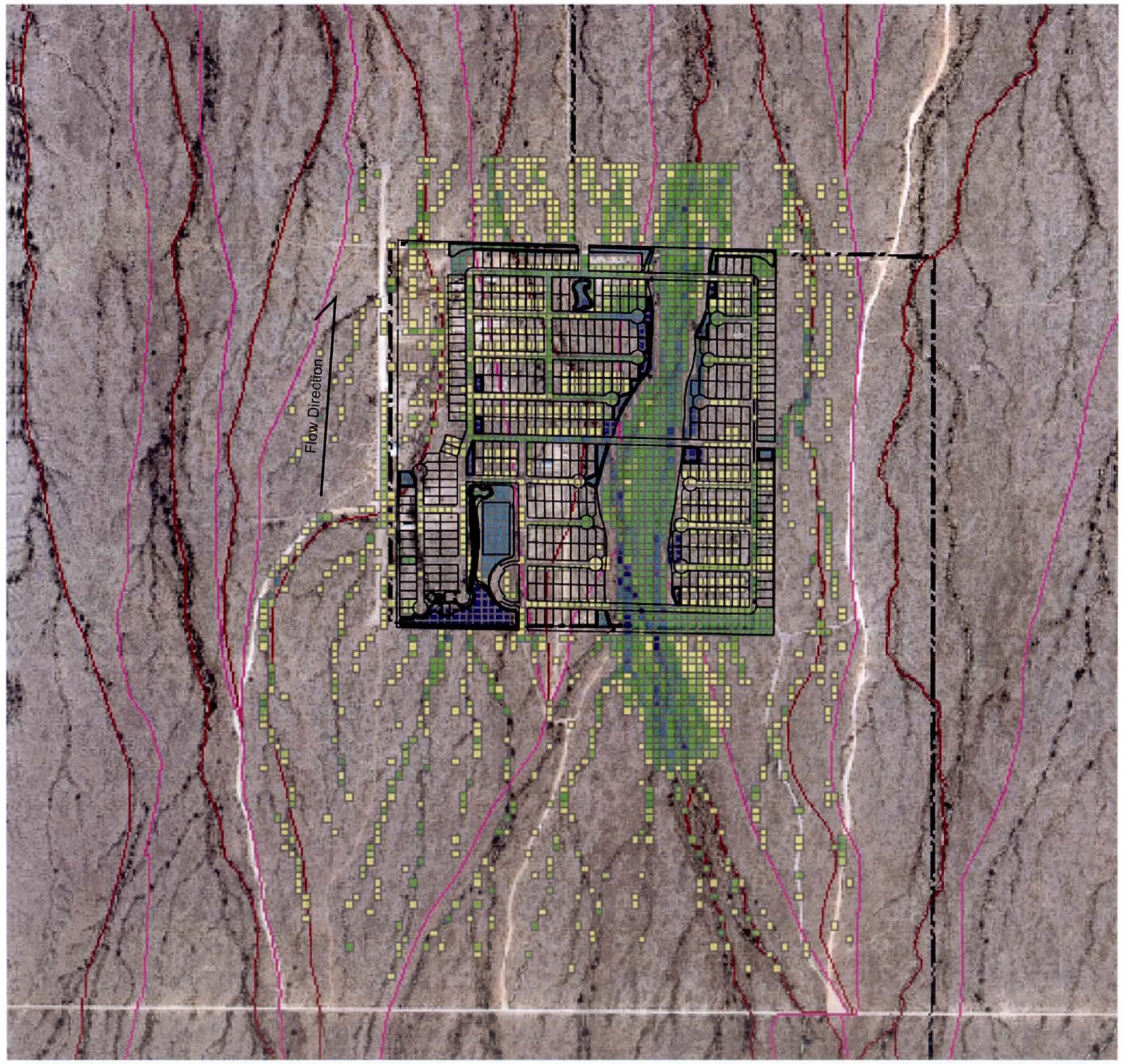
KEYMAP



- City of Goodyear Planning Area
- Distributary Flow Areas
- Secured Open Space or Non-Evaluated Planning Units
- Significant Wash Corridors and Waterman Wash

Rainbow Valley
Area Drainage Master Plan
Distributary Flow with SWC -
Flowpath Preservation
Development Pattern

Figure 3-22



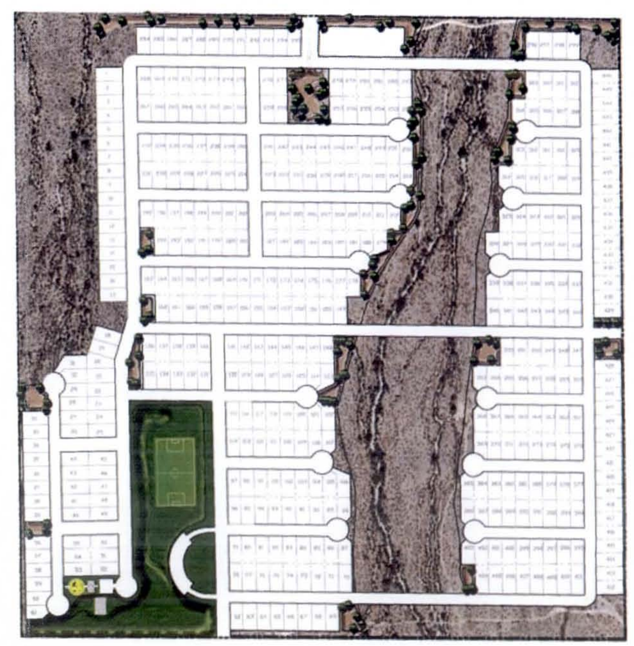
Flow Depths

miles 1/8 1/4 1/2

Scale: 1" = 1/4 Mile

COMPARATIVE DATA

	Existing	Traditional	ADMP
Run Off Volume	162 ac-ft	57 ac-ft	76 ac-ft
Peak Q	909 cfs	631 cfs	1088 cfs
Flow Continuity	High	Low	Med-Low
Storage Preservation	High	Low	Medium
Scenery Resources			
Dominant Cultural Setting	Natural	Suburban	Suburban
Viewshed Preservation	High	Mod-Low	Mod
Regional Multi-Use			
LOS (acres/1000)	NA	15.7	27.5
Preserved Open-Space	100%	0%	28.8%
Units	0	363	446
Density	0	2.2 u/ac	2.7 u/ac
Land Use		LDR (2-4 units/ac)	



Traditional Development Pattern

LEGEND

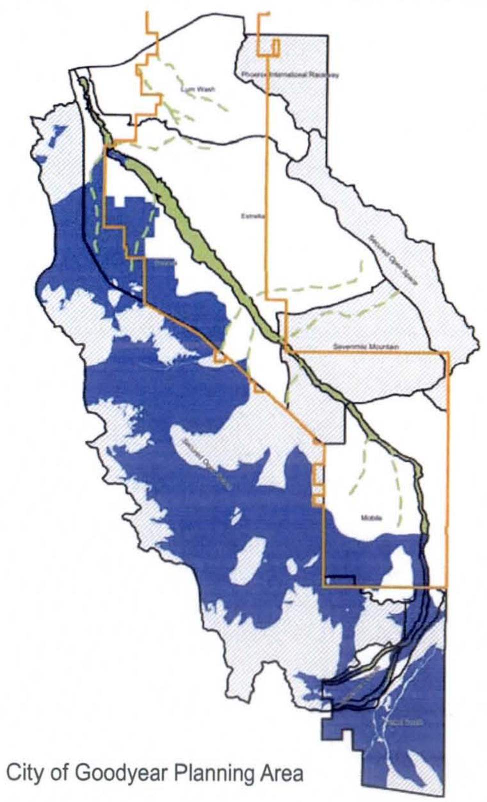
Flow Depth at Cell (ft)

- 0.250 - 0.400
- 0.401 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 4.000
- 4.001 - 10.000

Drainage Sub-Basin

Drainage Flowpath

KEYMAP



City of Goodyear Planning Area

Distributary Flow Areas

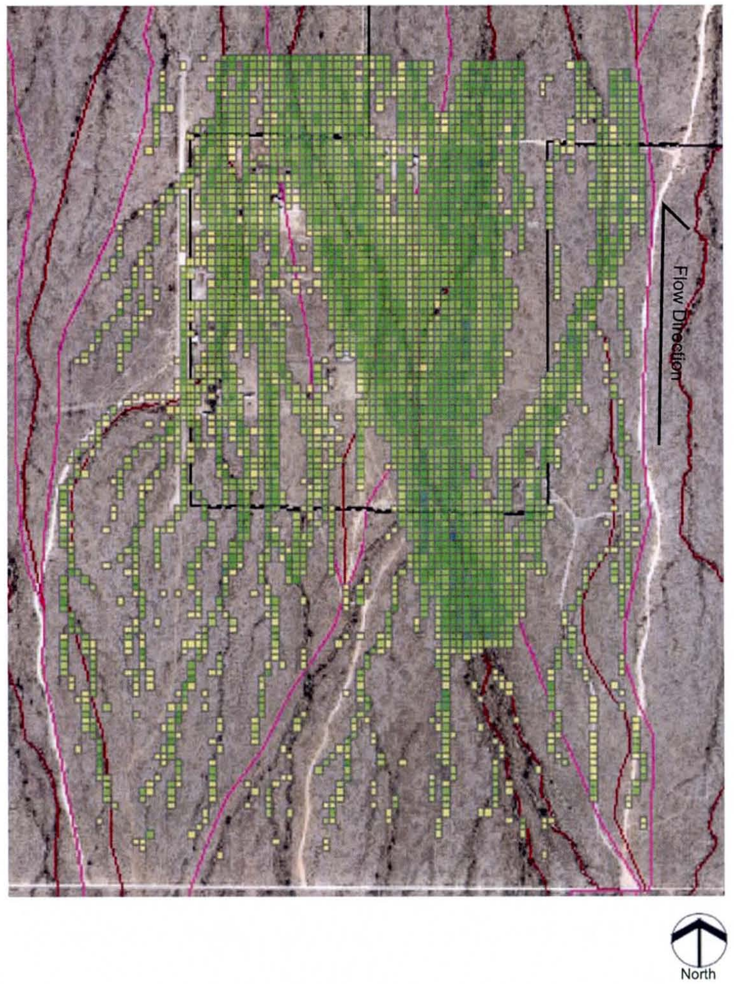
Secured Open Space or Non-Evaluated Planning Units

Significant Wash Corridors and Waterman Wash

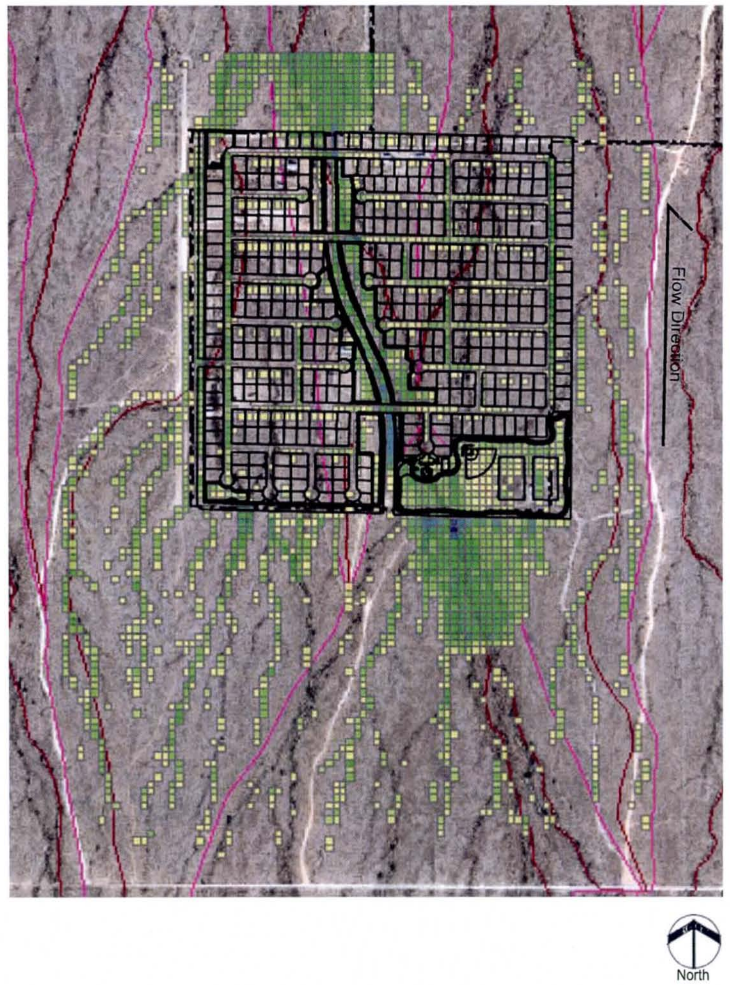
Rainbow Valley
Area Drainage Master Plan
Distributary Flow with SWC - Velocities

Figure 3-23

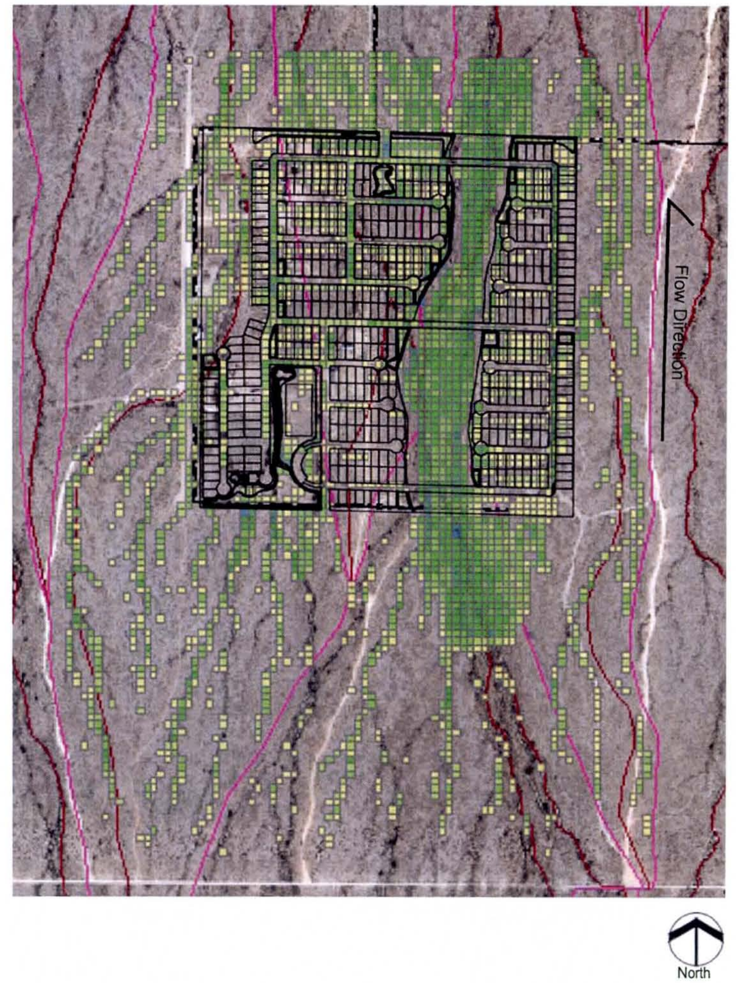
Existing Velocities



Traditional Layout- Velocities



ADMP Layout- Velocities



Split Flow in Undisturbed Distributary Flow Area

Traditional Development Layout

ADMP "Flow Path Preservation" Development Layout

LEGEND

Flow Velocity at Cell (ft/s)

0.500 - 0.750	2.501 - 3.000
0.751 - 1.000	3.001 - 4.000
1.001 - 1.500	4.001 - 5.000
1.501 - 2.000	5.001 - 6.000
2.001 - 2.500	6.001 - 10.000

Drainage Sub-Basin

Drainage Flowpath

3.4.8 Disturbed Areas

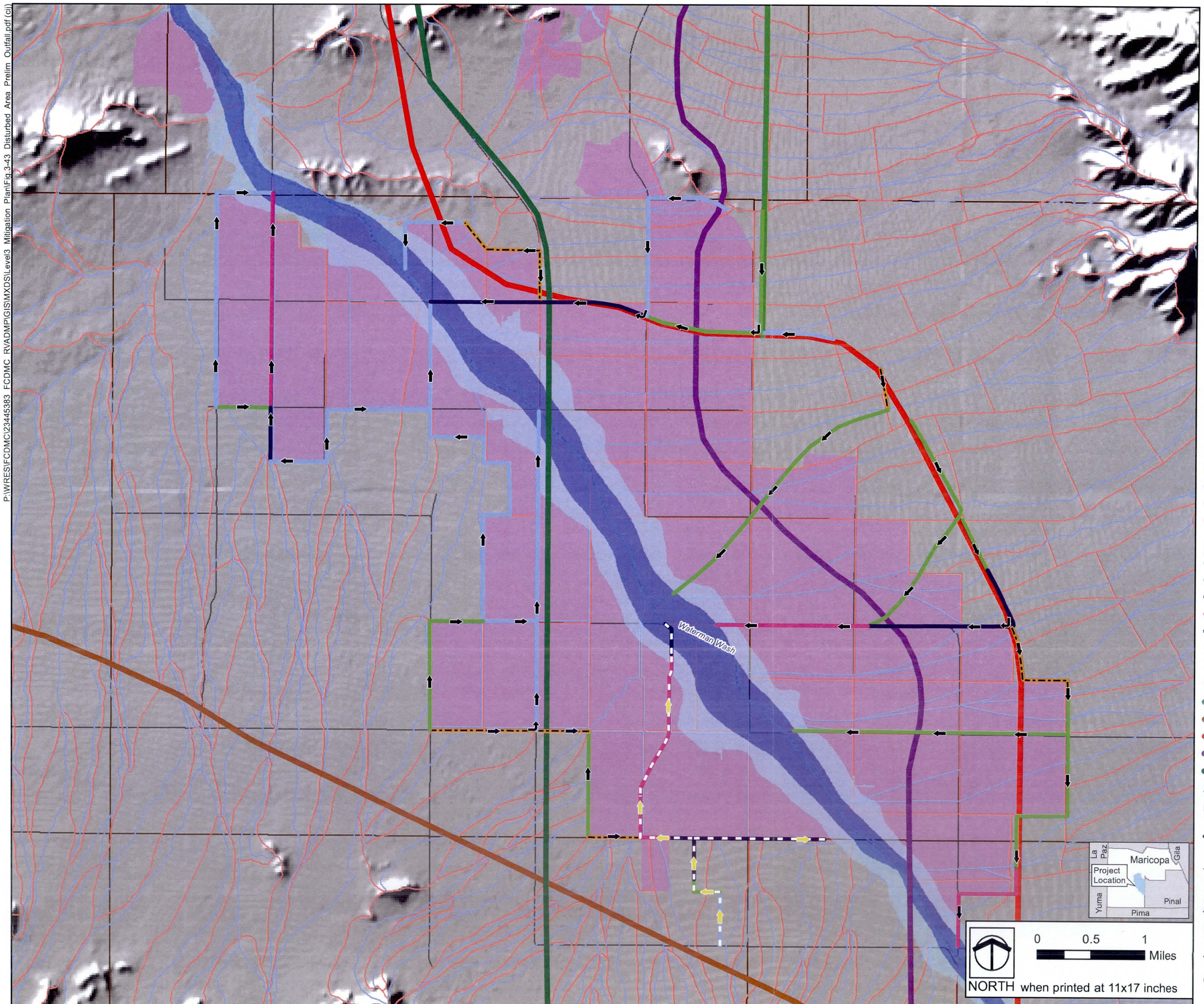
The watershed function analysis and the associated development of design criteria have focused almost exclusively on development within the natural and relatively undisturbed areas of the piedmont. The subject piedmont is very prominent within Rainbow Valley. The criteria are intended to minimize the adverse flooding impacts resulting from development. The foregoing discussion of representative typical designs has also been focused on natural and undisturbed areas. This focus on preservation of existing natural watershed functions is the essence of the Recommended Plan. However, there is a flow characteristic area within the study area that has been designated as "Disturbed Area" to describe areas that have been modified by agricultural practices of clearing, leveling, tilling, and irrigating for production of crops. The natural watershed functions in these areas have already been modified and cannot realistically be restored. Therefore, a different approach is warranted.

The disturbed areas are generally situated along Waterman Wash near the watershed outlet at the Gila River. As a result, almost all of the runoff generated within the piedmont must flow through the disturbed area before reaching the Gila River. The ADMP proposed strategy for this area is distinctly different than the rest of the watershed. Since the area is already disturbed, a structural conveyance approach is recommended. The application of the development criteria developed throughout this report will only be applied to the upstream natural and undisturbed portions of the watershed. At the upstream boundary of the disturbed areas, the runoff will be collected and directed into channels which will convey the sediment and runoff through the agricultural areas to Waterman Wash. Although a conceptual design for the recommended channels has not been developed as part of this plan, a preliminary outfall location map (**Figure 3-24**) is provided to show a set of potential channel alignments with design discharges to illustrate the concept.

The proposed alignment for the Loop 303 extension is shown on **Figure 3-24**. The proximity of the Loop 303 extension to the disturbed area boundary along the east side of Waterman Wash represents an opportunity to use the freeway alignment as the boundary between the watershed function preservation approach recommended for the upstream areas and the conveyance approach recommended for the disturbed areas downstream of the freeway. A collection system could be constructed in conjunction with the freeway drainage system to direct runoff into planned outlet channels, potentially located as shown in **Figure 3-24**. Implementation of this concept would reduce flow path uncertainty in the downstream area and would facilitate development.

The proposed Hassayampa Freeway alignment, situated on the west side of Waterman Wash could conceivably be used in the same way, however, the planned Hassayampa Freeway alignment is 3 miles upstream from the disturbed area boundary in some places which would significantly increase the implementation cost. For purposes of illustrating this concept, the outfall channels shown on **Figure 3-24** for the area west of Waterman Wash start at the disturbed area boundary instead of at the proposed Hassayampa Freeway alignment. It is recommended that a more detailed local area drainage plan be developed for the disturbed area based on the general concepts presented herein.

P:\WRES\FCDMC\23445383 FCDMC RVADMP\GIS\MXDS\Level3 Mitigation Plan\Fig.3-43 Disturbed Area Prelim Outfall.pdf (cil)



Rainbow Valley
Area Drainage Master Plan
Disturbed Area - Preliminary Outfall Location

Figure 3-24

Project Features

- 1% Annual Chance Floodplain
- Floodway; AFW
- Disturbed Area
- Subbasin Boundary
- Drain Path
- Waterman Wash
- Flow Direction
- Aread Flow Direction*

Channel Flow (cfs)

- 0 - 100
- 100 - 300
- 300 - 500
- 500 - 750
- 750 - 1500

Aread Channel Flows*

- 100 - 300
- 300 - 500
- 500 - 750; 695
- 750 - 1500
- > 2000

*Aread channel flows are consistant with flow data provided in Drainage Map Exhibit 2 by Project Design Consultants dated 10/15/10, but do not necessarily represent flow paths in the URS corp. existing condition model.

Hidden Valley Framework

- Cotton Lane
- Hassayampa Freeway
- Loop 303 Extension
- Planned City of Goodyear Enhanced Transit Corridor
- Sonoran Valley Parkway

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
JE Fuller/Hydrology & Geomorphology
Alluvial fan identification and flow characteristics assessment, 2008
City of Goodyear
Aread Channel Flow Data

3.4.9 Waterman Wash

Waterman Wash is the backbone of the watershed and the varied, interconnected functions the watershed provides. Waterman Wash serves as the axial stream at the base of the piedmont landform, making the wash critical to fully achieving context-sensitive flood hazard mitigation as part of a comprehensive watershed management plan. Performance functions directly associated with Waterman Wash are outlined in Table 3-14:

Table 3-14 Performance Functions Associated with Waterman Wash

3.4.1.1	Store increases in runoff volume resulting from development Preserve natural land surface storage and infiltration properties Maintain adequate baseflow to support native vegetation
3.4.2.1	Minimize reduction in time of concentration Provide retention/detention to offset increases in peak discharge
3.4.3.1	Coordinate road alignments with drainage patterns
3.4.4.1	Utilize floodway delineation methodology that accounts for and mitigated impacts of lost overbank flood storage
3.4.5.1	Maintain floodplain storage volume
3.4.6.1	Preserve dominant discharge low flow channel Limit increases in maximum design tractive sheer stress at design discharge Design for potential changes in sediment supply resulting from upstream development
3.4.7.1	Maintain sediment yield from individual development and the overall watershed
3.4.8.1	Design to be compatible with the future cultural and physical setting Design flood hazard mitigation to be compatible with the natural Sonoran desert washes within floodways Design flood hazard mitigation facilities to maintain views toward the mountain preserve areas and preserve existing views from the mountains to the valley
3.4.9.1	Accommodate City of Goodyear trails within flood hazard mitigation projects Establish appropriate segments of the Maricopa Regional Trail along Waterman Wash (Segments 86 and 89/90) Accommodate other local trails
3.4.10.1	Preserve existing open space value Maintain BLM-managed lands as public open space Development should comply with MAG Desert Spaces *Environmentally Sensitive Development Areas Policy and Planning Guidelines*
3.4.11.1	Maintain existing ecological integrity of natural vegetation types Protect natural and beneficial functions of washes Preserve the connectivity and permeability of habitats Restore or enhance vegetation and natural channels in degraded areas Use built structures to create resources for wildlife
3.4.12.1	Protect and interpret historic sites Protect and interpret prehistoric sites

The design criteria related to the natural watershed functions served within Waterman Wash have been divided into two groups: those that apply to all reaches of Waterman Wash (General Design Criteria – Section 3.4.9.1), and reach-specific criteria (Section 3.4.9.2).

3.4.9.1 General Design Criteria

General design criteria for Waterman Wash have been developed in order to preserve watershed function continuity from the headwaters of the wash to its outfall at the Gila River. Modifications to these general criteria may be permitted in the reach-specific criteria developed for all five reaches of Waterman Wash, but in no case should watershed functionality, as defined in the performance functions of the ADMP, be impeded by permitted activities or modifications to the wash.

Erosion Hazard Zone

Erosion hazard setbacks have been identified for Waterman Wash as the primary tool to accomplish local flood hazard mitigation while assisting in preserving watershed functional continuity. These setbacks are intended to minimize potential adverse impacts to public health, safety, and general welfare, while also accounting for potential hazards associated with the natural migration of the wash. The area within the erosion hazard setbacks including the floodway, jurisdictional 404 areas, and portions of the floodplain fringe have been identified as the Erosion Hazard Zone (EHZ). The Waterman Wash EHZ should be maintained as natural open space to the greatest extent possible.

The floodway of Waterman Wash should remain in a natural undisturbed state, except as needed for limited structural improvements such as roadway crossings as deemed necessary by the responsible floodplain management agency including the District and/or the City of Goodyear.

Impacts within the EHZ between the floodway and the EHZ extents should be limited to non-motorized recreational activities including hiking/riding trails and other passive recreation or open space-related activities which will not impede stormwater conveyance. Additional improvements within this zone may be permitted within a given reach, as described below in Section 3.4.9.2.

Utilities

Utilities within the EHZ should be limited to wash crossings only. All installations should be protected against scouring in a manner that is visually compatible with a natural setting. The width of utility corridor should be the minimum necessary. Following construction the corridor should be revegetated using native vegetation as approved by the reviewing municipality.

Roadway Crossings

Properly designed and constructed roadway crossings are a critical component of preserving watershed continuity through Waterman Wash. The City of Goodyear concept plan for

Waterman Wash recommends the use of bridge crossings for major roads but allows for interim crossings to include either at-grade or culvert-crossings. In order to maintain functional continuity through the wash, the ADMP recommends that no new at-grade crossings of Waterman Wash should be permitted.

Minimum Culvert Size Standards

- For equestrians, a minimum of 10-foot vertical clearance is required.
- For large mammals, the culvert should provide clearly visible, suitable habitat at each opening and achieve an openness ratio of 0.9, suitable for large mammal crossing.
- Openness should be determined by using the formula:

  Openness Ratio = (Culvert Height* Culvert Width)/Culvert Length

Example: The City of Goodyear standard for a scenic arterial road is 150 feet of right-of-way. Based on the above guidelines, in order to achieve an openness ratio of 0.9 a 150-foot wide road crossing should have a culvert face area of 135 square feet.

$$(0.9 = x/150') = (x = 135')$$

By using 10-foot high culverts, passable by pedestrians and the minimum height required for equestrian use, the minimum culvert size of 13.5' x 10' is derived.

While bridge-crossings are preferred, open bottom culverts with a minimum 10-foot vertical clearance may be used as a minimum standard for all Waterman Wash crossings. This is based on multiple criteria, including minimum pedestrian and equestrian trail requirements as well as AGFD recommendations for wildlife crossings under roadways. The actual dimensions of the culvert should be determined based on the width of the road right-of-way required using the following methodology shown in the box at left.

No roads smaller than arterial roads should cross Waterman Wash to minimize impacts to the Wash. Where possible, existing at-grade crossings for minor roads and utility access should be abandoned and rehabilitated unless deemed necessary by the local municipality for fire or other public safety purposes. These considerations should balance the risks caused by allowing public roads to cross a major wash at grade.

In addition to the openness requirements, roadways should incorporate open medians whenever possible to encourage large mammal crossing.

Grading

There should be no fill or excavation of material within the EHZ except as minimally necessary to construct utility and roadway/bridge crossings, flood control structures, trail improvements and vegetative restoration. Exceptions to this restriction are noted in the specific reach guidelines.

In cases where grading is required and permitted by the overlying municipality, the impacted areas of the wash should be revegetated and graded to a natural form.

Non-Levee Embankments

Agriculture started in portions of Rainbow Valley adjacent to Waterman Wash after World War II. The best practices the land owner utilized at the time was to construct berms parallel to Waterman Wash that obstructed flows from flooding their fields during large storm events. The berms were also used to retain irrigation water. These berms are interspersed along Waterman Wash, and are concentrated between river miles 8 and 14 in WR3 Planning Unit adjacent to the Sonora and Estrella planning units where the agricultural fields are located (**Figure 3-25**). Presently, most agriculture has stopped and the properties along Waterman Wash are planned for residential, commercial and industrial development. The berms are still in-place and are a potential flood hazard because they could breach during large rainfall events and flood adjacent property.

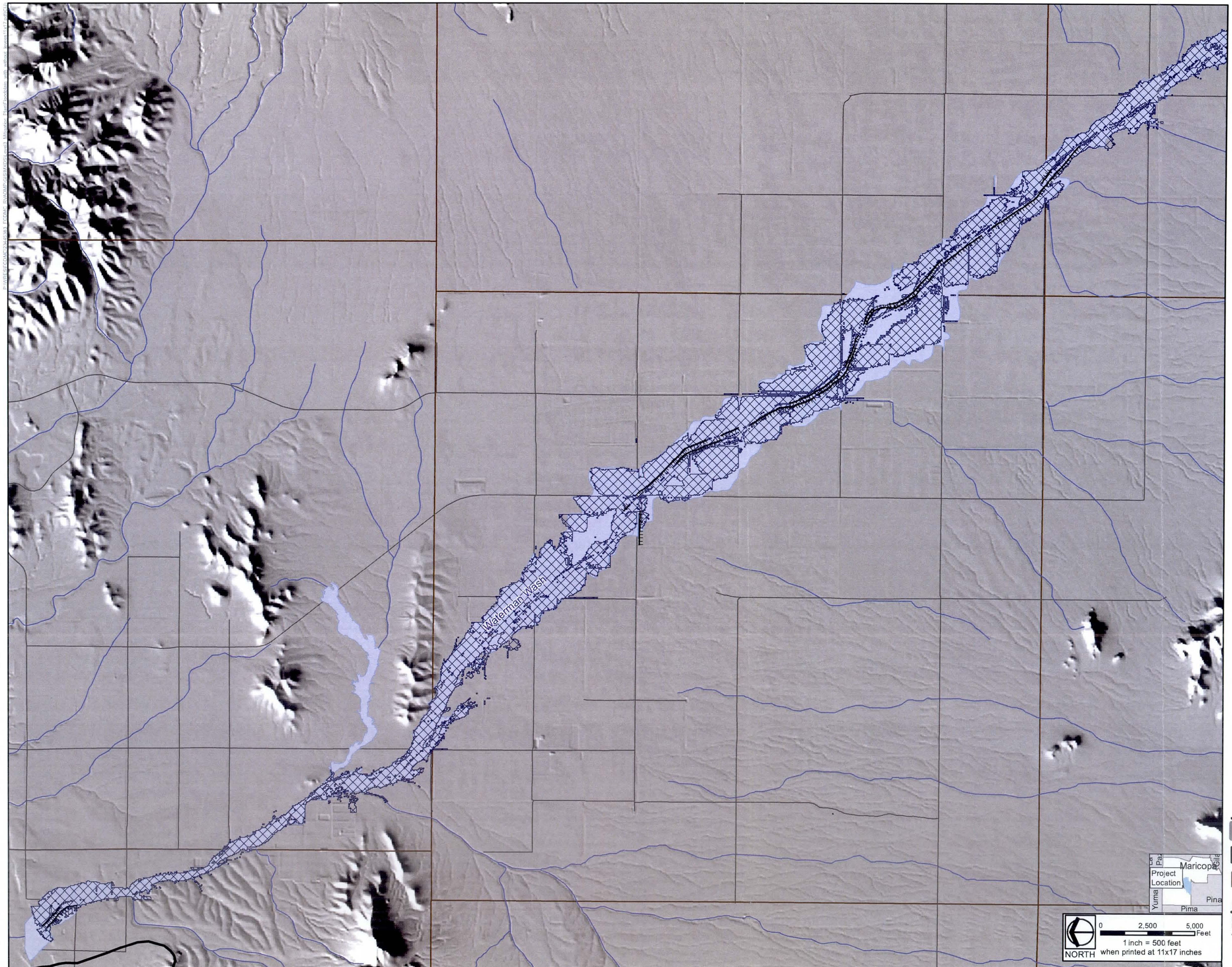
The berms are large enough to be considered non-levee embankments when determining the floodplain and floodway limits associated with Waterman Wash. The berms are evaluated as if they do not block flow to the adjacent contiguous property to Waterman Wash. Therefore, floodplain delineations are developed assuming the highest water surface elevation for the 100-year (base) flood in accordance with FEMA 65.10, City of Goodyear and unincorporated Maricopa County floodplain ordinances. In doing so the floodplain was delineated for the highest base flood elevation assuming the 4 analysis scenarios:

- without both non-levee embankments
- with left non-levee embankment in place
- with right non-levee embankment in place
- with both non-levee embankments in place

The base flood elevation for each of these scenarios was determined using the HEC-RAS model developed by the USACE. Corollary to the ADMP, new studies were done to determine the floodplain for Waterman Wash. In this area the floodplains were delineated as described above. The new floodplain limits are wider because it accounts for the non-levee embankments. The narrowest floodplain calculated would be without non-levee embankments. A recommendation would be to remove the berms. This would reduce the flood hazard that could occur as a result of a breach and base flood elevations would decrease because the berm barriers that block the water from spreading are removed. As such, the removal of the berms would reduce the areal footprint and floodplain width. The process to do this entails:

Rainbow Valley
Area Drainage Master Plan
Existing Floodplain Limits
and Proposed Without
Non-Levee Embankment Conditions

Figure 3-25



Project Features

- Non-Levee Embankment
- Floodplain Without Non-Levee Embankment
- Floodplain With Non-Levee Embankment

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream
- Railroad

Data Sources

Existing Flood Hazard, Base Map Data: Flood Control District of Maricopa County
Proposed Flood Control Data: URS Corporation 2010
Aerial Imagery: Bing 2011

- Submitting a design that includes the removal of the berms and appropriate hydraulic analysis of the revised floodplain limits.
- Receiving an approval from FEMA through a Conditional Letter of Map Revision.
- Constructing the project that includes the removal of the berms.
- Submitting the as-built plans, hydraulic analysis, and revised mapping to FEMA.
- Approval by FEMA of the new base flood elevations and floodplain limits.

The process includes the local jurisdiction that is responsible for administering and enforcing through ordinance FEMA's program, which in this case is the City of Goodyear.

The property affected by the berms has a number of owners. The most effective way to remove the flood hazard risk would be to request the City of Goodyear to schedule a berm removal project and partner with the Flood Control District of Maricopa County and other affected jurisdictions.

Revegetation Requirements

Vegetation within Waterman Wash plays a critical role in supporting the full spectrum of watershed functions. For this reason, the removal or other disturbance of existing vegetation should be minimized within the EHZ. Where disturbance is required, the following species should be re-established through appropriate revegetation means with a mature canopy cover of up to 76 percent and a plant composition that is similar to nearby undisturbed parts of Waterman Wash.

Table 3-15 Waterman Wash Function-Based Vegetation Species

Common Name	*Scientific Name*	Disposition	Revegetation Method					
			Tall-Pot	Seeding	Salvage w/ Irrigation	Container w/ Irrigation	Salvage w/o Irrigation	Container w/o Irrigation
Blue Palo Verde	*Parkinsonia florida*	Common	X	X*	X	X	X**	X**
Foothills Palo Verde	*Parkinsonia microphyllum*	Uncommon	X	X*	X	X	X**	X**
Velvet Mesquite	*Prosopis velutina*	Common in more mesic areas	X	X*	X	X	X**	X**
Ironwood	*Olneya tesota*	Common	X	X*	X	X	X**	X**
Cat Claw Acacia	*Acacia greggii*	Infrequent		X*	X	X	X**	X**
White Thorn Acacia	*Acacia constricta*	Infrequent		X*	X	X	X**	X**
Canyon Ragweed	*Ambrosia ambrosioides*	Common		X		X		X**
Wolfberry	*Lycium andersoni or berlanderi*	Infrequent		X	X	X	X**	X**
White Ratany	*Krameria grayi*	Common		X		X		X**
Chuparosa	*Justicia californica*	Common		X		X		X**
Desert lavender	*Hyptis emoryi*	Common		X		X		X**
Sweetbush	*Bebbia juncea*	Infrequent		X		X		X**
Desert Globemallow	*Sphaeralcea ambigua*	Common		X		X		X**

* *For this species, seeding is considered an appropriate secondary means of revegetation provided it is used in combination with other methods.*

** *Salvage and/or container plantings of this species are acceptable to use for revegetation without supplemental irrigation provided the plant location makes use of water-harvesting techniques.*

Multi-Use Trails

A 20-foot minimum multi-use trail easement should be dedicated along both sides of Waterman Wash within the EHZ, but outside of the floodway. The physical edge of the trail, including shoulders, should be buffered 5-feet from adjacent built structures such as walls, view fencing, abrupt changes in grade, or buildings. Trail design should comply with Section 3.3.9.2 of the ADMP, including the design criteria for the Maricopa Trail Segment 86. Trail design should also conform to the design requirements of the local municipality. Where trail segments occupy lands within unincorporated Maricopa County, or lands where no trail design standards have been established, the following criteria should apply to both trails designated adjacent to Waterman Wash:

- All trail segments should be designed to create a continuous system that extends from the Gila River to the south, upstream to the headwaters of Waterman Wash. Where an existing trail segment exists either upstream or downstream from the new segment to be constructed, the new trail should meet the existing trails grade and alignment. Additional trail connections, such as to other segments of the Maricopa Regional Trail and City of

Goodyear trails described previously in this report, should be coordinated with the trail design and meet the Waterman Wash trail system at-grade.

- Where possible, Waterman Wash trail segments should meet the Maricopa County Parks and Recreation Department's specifications for a Barrier-Free Trail. Where a Barrier-Free Trail is not achievable due to physical constraints, the trail system adjacent to Waterman Wash should meet the specifications for a Primary Trail and be signed to warn users that these segments of the trail are not ADA accessible. These minimum standards include the following:
    - Maximum Grade: 5 percent maximum (Barrier-Free); 10 percent maximum (Primary Trail). For barrier-Free trails – Dips and ramps may be a maximum of 8 percent for a distance not to exceed 30 feet. Where the trail requires a ramp condition, level grade landings are required at intervals of 30 feet. Landings should be no less than 5 feet in length and the full width of the trail. Rest areas at landings are recommended but not required.
    - Width (all conditions): 10 feet, with 2 feet clear shoulders for a total of 14 feet.
    - Surface: Crushed or decomposed granite. Barrier-Free trails should be stabilized. Stabilization using a cementatious hardening process is preferred. Asphalt is not desirable for the Waterman Wash trail system.
    - Rest Areas: At intersections with other trail segments, and at intervals of between 300 feet to 0.25-mile minimum.
    - Lighting: No lighting is recommended for the Waterman Wash trail system in order to minimize conflicts with other functions such as wildlife use of the wash. Where municipal ordinances require lighting, the trail easement should be located as close to the edge of the EHZ as possible to provide a buffer from light pollution into the wash for wildlife purposes. Lighting fixtures should be oriented away from the wash. Security lighting required in urbanized reaches should use low-scale bollard lights or similar methods.
    - Shoulders: As noted above, 2-foot trail shoulders are required on each side of the trail. These shoulders may be unstabilized granite and should be cleared of vegetation.

Equestrian Trail

The sandy bottom low-flow of Waterman Wash should serve as an equestrian "highway" through the center of Rainbow Valley. The minimum roadway crossing culvert size noted above also provides for the minimum vertical clearance required by equestrian users. Where larger culverts or bridge structures are proposed, 12 feet of vertical clearance is preferred.

Equestrian activity may discourage certain wildlife use within Waterman Wash. The ADMP recognizes that human users will have the priority of use within Waterman Wash in Reaches 1-2 and Reach 4. These impacts may be partially mitigated by the Sevenmile Mountain wildlife corridor that crosses Waterman Wash in Reach 3.

3.4.9.2 Reach-Specific Design Criteria

Future development along Waterman Wash is likely to vary in intensity and setting as indicated by current planning information. Major large-scale transitions between governmental jurisdiction oversight (i.e., City of Goodyear, BLM, or Town of Buckeye) as well as differences in planned development land use type and intensity correspond generally with the five Waterman Wash Reaches originally identified during the alternatives development phase of the ADMP. Reach-specific design criteria as well as the appropriate general criteria are outlined below. These reach-specific and general design criteria are also illustrated in the typical cross-sections included in the report sections, below.

Reach 1

Reach 1 of Waterman Wash is primarily within unincorporated Maricopa County, extending from the Gila River to 187th Avenue. In this reach, Waterman Wash is a relatively deep, well-defined natural wash lined with mature stands of riparian desert vegetation. The wash has a relatively flat adjacent floodplain that covers both natural as well as developed lands. Small, disconnected segments of this reach have been degraded by human activity including rural development such as occurs in the vicinity of Eagle Mountain Road as well as at-grade road crossings, wildcat trash dumps and off-road vehicle impacts. Encroachment of rural development into the floodplain is common in this reach.

Reach 1 EHZ Modification

The EHZ within Reach 1 may be reduced up to the floodway in addition to a 20-foot trail easement (both sides) provided that appropriate bank protection is constructed to mitigate for the loss of the erosion hazard setback. Bank protection should meet the following criteria:

- Bank-protection materials should be natural (i.e., rock riprap or cemented native soil) and include design by a professional engineer and landscape architect experienced in the visual mitigation of structural features in order to be compatible with the desired natural character of the wash.
- Bank-protection design, including toe-downs and other structural requirements, should be approved by the District.

Additional activities are permitted within the EHZ up to the floodway within this Reach. These include minimal, non-residential, or commercial-built structures such as fencing, pasture facilities (i.e., troughs, livestock shelters, etc.) as well as trails that do not create a significant risk to human life or property destruction in the event of a flood or change in the wash alignment. These facilities should be installed in a manner that minimizes disturbance of existing vegetation and the soil integrity within the erosion hazard setback to the greatest extent possible. Revegetation and soil integrity restoration is required where construction activities have impacted the natural soil outside of the built envelop.

Reach 1 Additional Trail Considerations

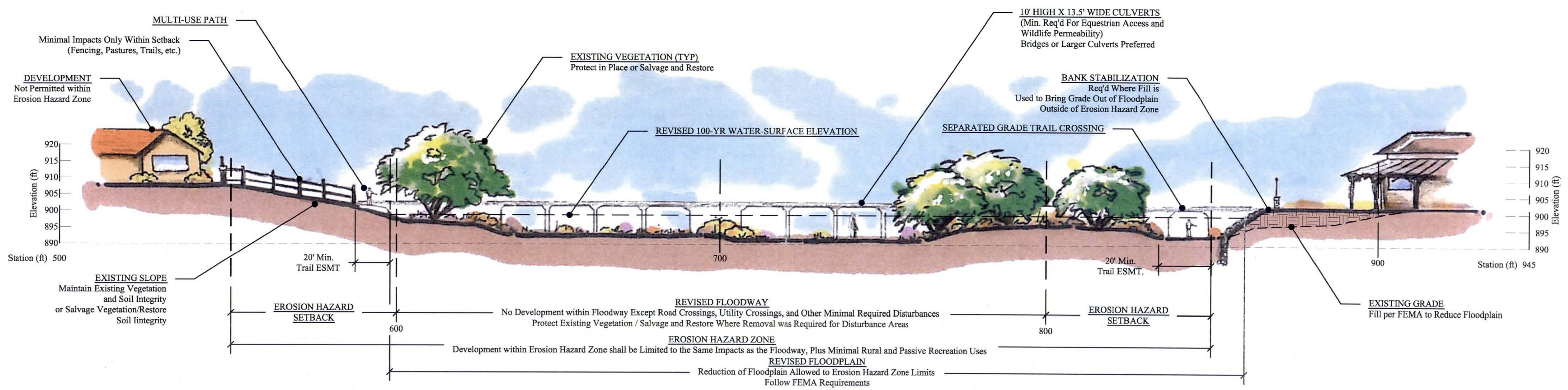
Waterman Wash in Reach 1 includes varied braided flow-paths besides the dominant thalwag of the wash within the floodway. Culverted road-crossings of these flow-paths create opportunities for designing a single culvert for dual use as a separated-grade crossing for at least one of the multi-use trails. Where this is feasible, the encroachment of the trail into the floodway is permitted, provided the following criteria are met:

- Trail grade should remain higher than the dominant discharge elevation as determined by an engineer and documented in the design drainage report.
- Trail surface should be a cementitious stabilized granite. Appropriate toe-downs should be included in trail design.

Figure 3-26 illustrates the general and Reach 1-specific design criteria.

Rainbow Valley
Area Drainage Master Plan
Significant Wash Corridors - Typical Sections

Figure 3-26



Waterman Wash Reach 1 - Typical Section (Sta. 1.69)
(Town of Buckeye / Maricopa County)

Reach 2

Reach 2 is located within the limits of the City of Goodyear, and extends from 187th Avenue to approximately the intersection of Bullard and Patterson Roads. Existing development in this reach is limited with extensive agriculture on either side of the wash. However, extensive development is planned for this area ranging from rural residential and open-space areas to intensive commercial and higher-density residential land-uses. Because planned development intensity adjacent to Waterman Wash will vary in this reach, two typical sections have been developed. Section 2A is intended for areas where low density residential development will predominately border the wash, while 2B shows the permissible impacts to Waterman Wash for higher intensity development areas.

Reach 2 Additional Trail Considerations

Reach 2 includes a number of existing dirt roads associated with the agricultural lands that are located within the EHZ. Where possible, these roads may be repurposed to serve as the multi-use trail, provided the following criteria are met:

- A minimum 20-foot easement must be designated over the roadway for the full length of the trail segment and meet trail design at both ends.
- Trail grade should remain higher than the dominant discharge elevation as determined by an engineer and documented in the design drainage report.
- Trail surface, grades, and tread width should meet the criteria provided in this report.

Reach 2A EHZ Modification

In keeping with the Waterman Wash concept report developed by the City of Goodyear, the EHZ within Reach 2A is intended to serve as part of the 100-foot buffer required in the report. For this reason, reduction of the EHZ is not allowed.

Additional activities are permitted within the EHZ up to the floodway within Reach 2B, including minimal, non-residential or commercial built structures such as fencing, pasture facilities (i.e., troughs, livestock shelters, etc.) as well as trails that do not create a significant risk to human life or property destruction in the event of a flood or change in the wash alignment. These facilities should be installed in a manner that minimizes disturbance of existing vegetation and the soil integrity within the erosion hazard setback to the greatest extent possible. Revegetation and soil integrity restoration is required where construction activities have impacted the natural soil outside of the built envelop.

Existing Disturbed Lands within the EHZ

In many areas, agriculture has replaced the native desert within the EHZ of Reach 2. Where adjacent future proposed land-use is rural residential and the recommendations for Reach 2A apply, these areas should remain in some form as either productive agriculture areas in order to preserve the historic character of the region or be rehabilitated to serve as natural open space. In all cases, the riparian vegetation immediately adjacent to the wash should be restored where it has been removed in order to buffer and improve the functional value of the wash for biological and scenic resources.

Figure 3-27 illustrates the general and Reach 2A specific design criteria.

Reach 2B EHZ Modification

The EHZ within Reach 2B may be reduced up to the floodway provided that appropriate bank protection is constructed to mitigate for the loss of the erosion hazard setback. The combined existing floodway and trail easements in this area should meet the intended purposes for the 100-foot buffer identified in the Goodyear Waterman Wash Concept Report while allowing for EHZ-reduction creates a context-sensitive approach in high-intensity development areas. Bank protection should meet the following criteria:

- Bank-protection materials should be natural (i.e., rock riprap or soil cement) and include design by a professional engineer or landscape architect experienced in the visual mitigation of structural features in order to be compatible with the desired natural character of the wash.

Bank-protection design, including toe-downs and other structural requirements, should be approved by the City of Goodyear.

The 20-foot trail easement should be relocated above the erosion protection within this reach to protect the trail from flood damage. This may require that the trail easement be located adjacent to the modified EHZ as illustrated in the figure below.

Additional activities are permitted within the undisturbed EHZ up to the floodway within Reach 2B. These include:

- Stormwater Management Structures: Water quality and retention basins may be located within the EHZ provided they are designed to prevent co-mingling with wash flows. These facilities should be revegetated to serve other functional needs such as natural open space with wildlife habitat value or active recreation.
- Passive Recreation and Restored Open Space Areas

Existing Disturbed Lands within the EHZ

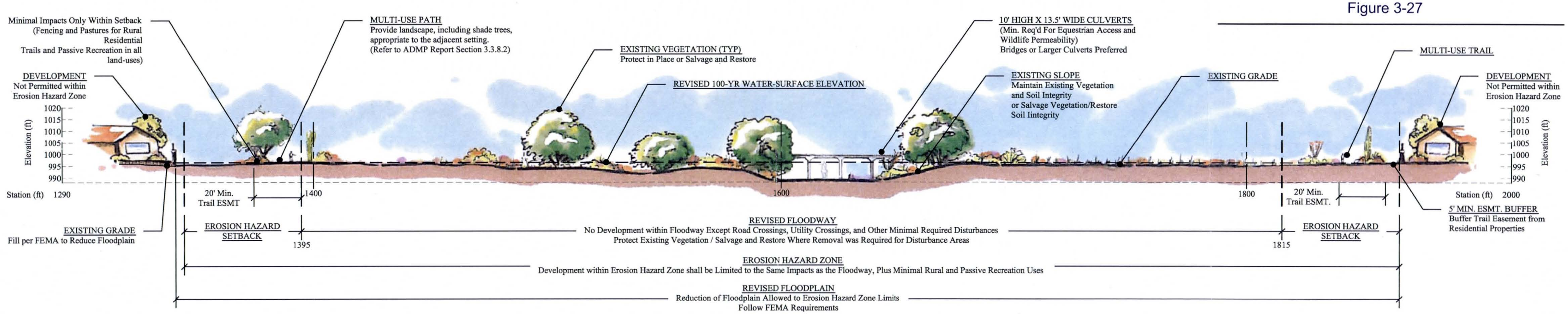
As described previously, agriculture has replaced the native desert within areas of the EHZ of Reach 2B. In addition to the permitted modifications to these disturbed areas described for Reach 2A, in Reach 2B these areas may also be developed for active recreation provided the facilities placed in this area are suited to inundation and damage to the facilities due to channel migration would not represent a significant threat to human health or loss of property. The ADMP recommends limiting these uses to turf and other non-structural uses.

In all cases, the riparian vegetation immediately adjacent to the wash should be restored in order to buffer and improve the functional value of the wash for biological and scenic resources.

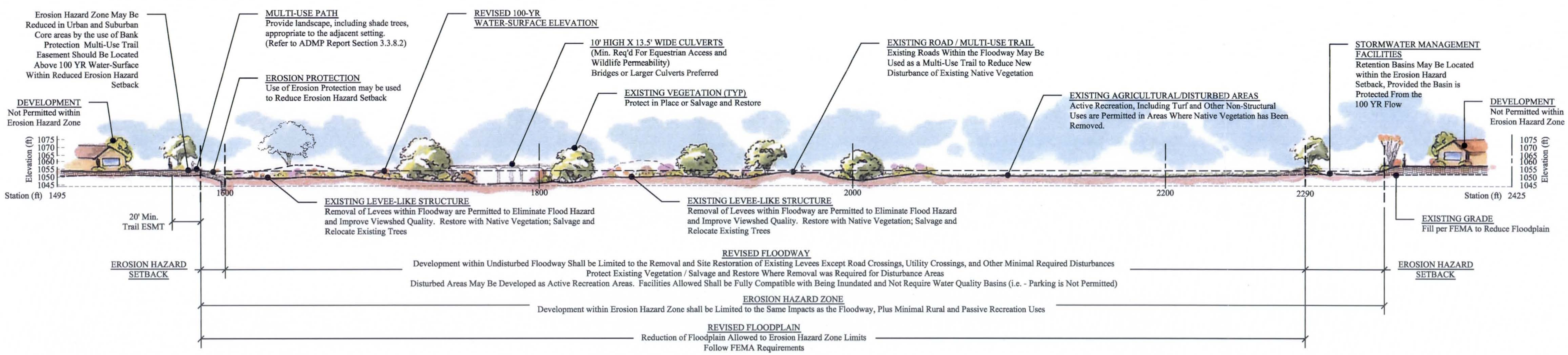
Figure 3-27 illustrates the general and Reach 2B-specific design criteria.

Rainbow Valley
Area Drainage Master Plan
Significant Wash Corridors - Typical Sections

Figure 3-27



Waterman Wash Reach 2A - Typical Section (Sta. 6.75)
(City of Goodyear - Rural Residential and Low to Low-Medium Density Residential Areas)



Waterman Wash Reach 2B - Typical Section (Sta. 10.10)
(City of Goodyear - Urban and Suburban Core)

Reaches 3 and 5

Figure 3-28 shows the proposed treatment for Waterman Wash within Reach 3 and 5. Reach 3 is primarily within BLM-managed lands and is within the Sevenmile Mountain Planning Unit where a potential wildlife corridor has been identified by AGFD. Reach 5, which includes the headwaters of Waterman Wash, lies in an area where development is unlikely to occur in the near future and planned land uses at the County-level include low-density or rural residential development.

Provided that these land-use conditions remain, no impacts or reductions to the floodplain should occur in these Reaches other than as required for the construction of planned transportation facilities.

In the event that future development does occur in Reach 5, the design criteria identified for Reach 1 should be applied. Detailed flood plan and floodway analysis is recommended for Reach 5, including more detailed EHZ analysis, as only approximate floodplains are currently identified for this reach.

Figure 3-28 shows the proposed treatment for Waterman Wash within Reaches 3 and 5.

Because no actual flood control improvements are included in these areas, multi-use facilities such as the multi-use path will need to be developed by other stakeholders such as the City of Goodyear or Maricopa Parks and Recreation. It is likely that the development of a trail on BLM land would necessitate National Environmental Policy Act review and possibly an Environmental Assessment.

Reach 4

Reach 4 is primarily within the City of Goodyear in an area where Waterman Wash is shallow and lacks significant continuous stands of vegetation. The typical section provides guidance for developing Waterman Wash in those areas where the wash is poorly defined. Channelization and establishment of a stronger riparian character is intended to augment the watershed functions associated with Waterman Wash. Recommendations for channelizing the wash alignment in this reach include the following:

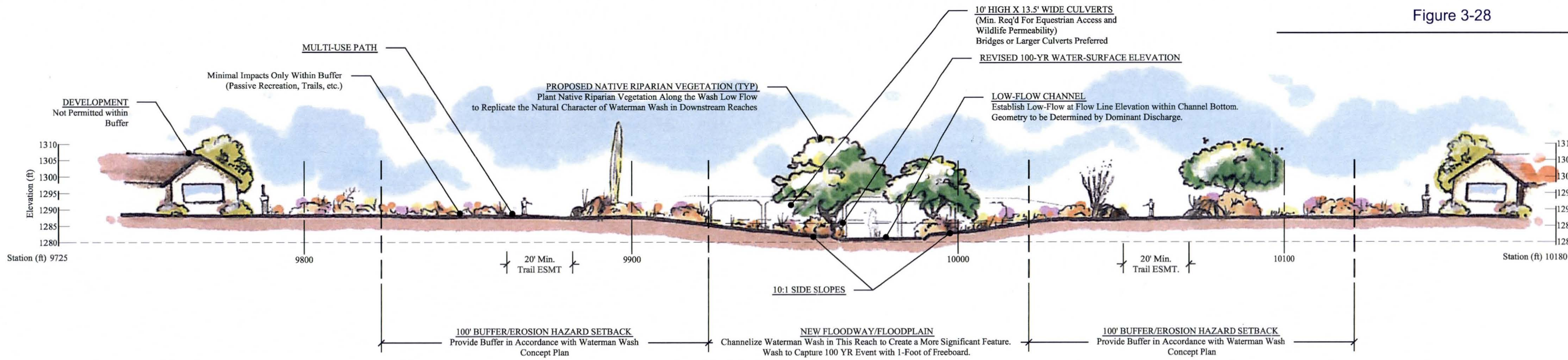
- The channel geometry should be designed to accommodate 10:1 side slopes, 1-foot of freeboard above the 100-year return event, a low-flow channel to accommodate the dominant discharge event, and appropriate Manning's 'n'-values for the revegetation of the channel.

- 100-foot buffers/EHZ's should be established from the channel high-water elevation.
- Include a 20-foot trail easement within the buffer/EHZ.
- Incorporate riparian vegetation along the edge of the low-flow channel, within the 100-year channel cross-section to replicate the form and vegetation patterning of a natural desert wash and tie into the downstream reaches of Waterman Wash.

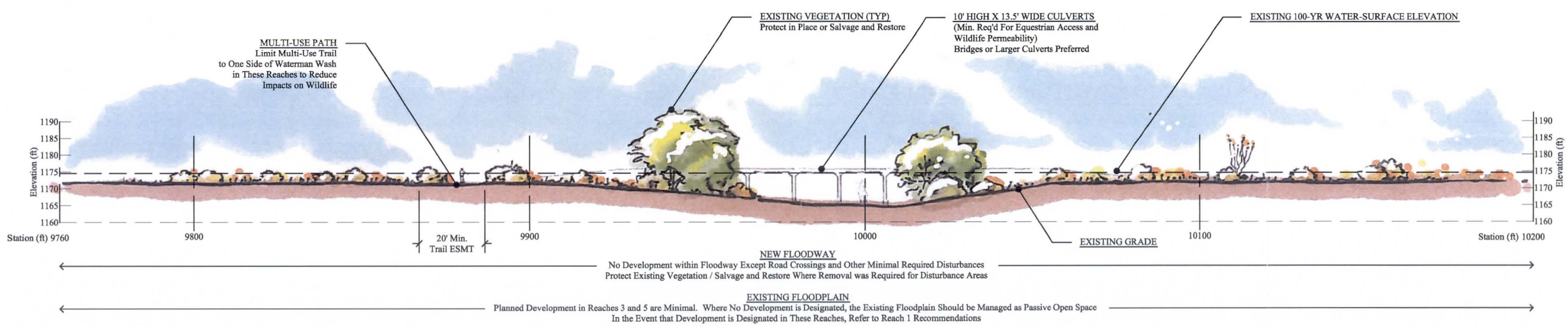
Figure 3-28 shows the proposed treatment for Waterman Wash within Reach 4.

Rainbow Valley
Area Drainage Master Plan
Significant Wash Corridors - Typical Sections

Figure 3-28



Waterman Wash Reach 4 - Typical Section (Sta. 26.756)
(City of Goodyear - Constructed Conveyance)



Waterman Wash Reach 3 & 5 - Typical Section (Sta. 18.319)
(Seven Mile Mountain and Waterman Headwaters)

3.4.9.3 Waterman Wash – Additional Considerations and Concerns

The above design criteria for the five reaches of Waterman Wash have been identified to preserve the continuity of watershed functions from the headwaters of the wash to the greater Gila River watershed. These design criteria focus on adjacent development and mitigating the impacts of development if allowed to encroach into the wash. However, the success of the watershed management plan relies on successfully preserving the continuity of watershed functions from the tributaries feeding into Waterman Wash as well as the extended floodplains that surrounds the wash. Although preserving Waterman Wash and its associated functional value is critical to the success of maintaining sustainable watershed functions, a failure to maintain functional continuity from the piedmont and other landforms above Waterman Wash is likely to create functional loss with various impacts downstream because these functions primarily originate outside of Waterman Wash itself.

While design criteria have been identified for planned road crossings of Waterman Wash that will serve to preserve functional continuity in the wash, major existing crossings of Waterman Wash are places where watershed functionality may be impeded. Watershed function loss in these areas should be identified and mitigated. Two of these are located in Reach 4 and include the UPRR crossing as well as the SR 238 crossing. The UPRR has recently replaced the older bridge crossings with pipe culverts. While there are benefits to this upgrade, the railroad and highway represent significant barriers to watershed functional continuity from Reach 5 to Reach 4. Because there are no flooding-specific issues known to exist at these locations, no recommendations have been made in the ADMP that could also serve to improve this condition.

3.4.10 Alternative Methods

While the recommended plan has focused on the use of open space preservation as one of the main flood hazard mitigation methods, circumstances and costs may require developers and reviewing agencies to consider alternative methods for mitigating flood risk within the Waterman Wash watershed. The recommended plan recognizes that the broadest objectives for successful implementation of the ADMP are: (1) to effectively mitigate future flood risk as development intensity increases while (2) maintaining the full suite of watershed functions identified in the Waterman Wash watershed. Creative, economically viable approaches that involve a combination of structures, open space buffers, and responses to unforeseen unique site conditions should be allowed by floodplain managers provided they meet these objectives. In order to provide flexibility in achieving these objectives, the following alternatives are included to show that, while open space preservation is the preferred solution the ADMP recognizes it is not the only solution.

Each of the examples below has been developed to a conceptual level. Validation of the concept did not include engineering calculations. However, two of the three solutions reflect common engineering approaches with only slight modification to their configuration in order to maximize the number of watershed functions preserved, and the third represents a combination of open space preservation with other ordinances as described in other sections of this document.

Each of the alternative methods is illustrated on **Figure 3-29** and is described in more detail in the sections below. Common requirements for each include:

- A recommendation that watershed functional analysis be included in required drainage reports that demonstrate how the watershed functions are being maintained in the proposed design along a flow conveyance corridor or improved channel.
- The inclusion of multi-use facilities within constructed storm water retention basins and the location of any remaining required open space acreage in a passive or natural open space buffer around the development.
- The reconfiguration of internal road alignments to run parallel to natural storm water flow paths.

3.4.10.1 Alternative Method 1.1 – Flow Path Preservation

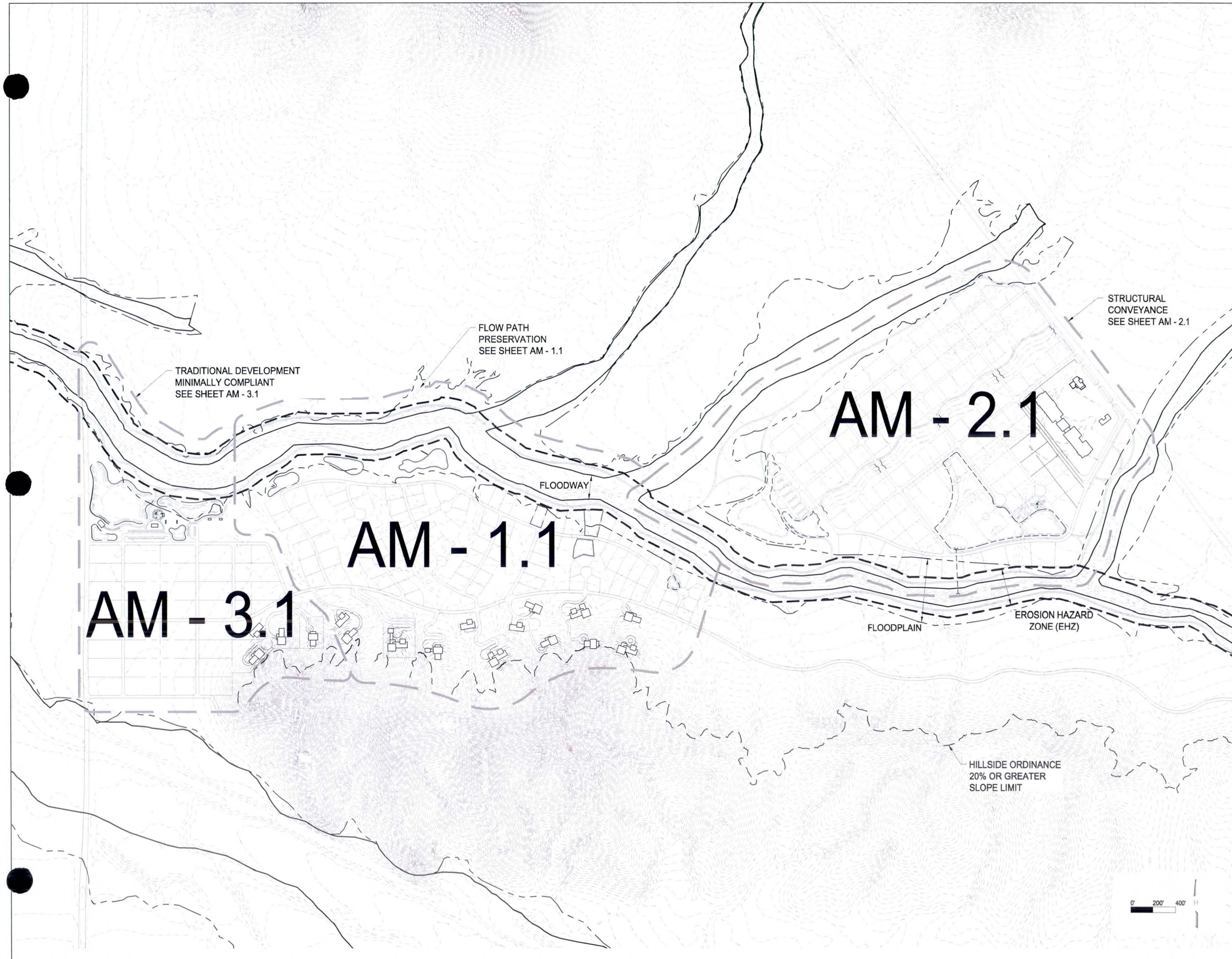
This alternative reflects the implementation of the design criteria provided in the other sections of the ADMP, independent of the flow characteristic area. Shown in **Figure 3-30**, this method illustrates how combining the various design criteria of the recommended plan, such as lot reduction and prudent site design based on hillside ordinances, result in watershed function continuity. The notes for this figure outline many of the design criteria illustrated.

3.4.10.2 Alternative Method 2.1 – Structural Conveyance in Undisturbed Piedmont

Structural conveyance may be used to channelize flows in the undisturbed piedmont area, as illustrated in **Figure 3-31**, provided that the watershed functions are incorporated into the design of the structure and the development overall. Having a suitable outfall is critical to the success of this alternative method in order to maintain functional continuity between the undisturbed areas through the development to Waterman Wash. Suitable outfalls are defined by the ADMP as protected natural conveyances such as the SWCs or Waterman Wash, as well as larger structural conveyance and storage systems that are also multi-functional provided these systems also outfall to Waterman Wash. Specific criteria for these structures are listed in the notes on the figure.

3.4.10.3 Alternative Method 3.1 – Existing Developments

Under certain conditions it is expected that new developments may be constructed that were either approved prior to the adoption of the ADMP or for other reasons make implementation of the ADMP's recommendations unachievable. The alternative demonstrated in **Figure 3-32** is intended to illustrate how minimally compliant areas may be integrated into the watershed functional matrix. In the illustrated example, it was assumed that existing standards and flood mitigation were used whereby flood risk is mitigated through local storm water conveyance into storage basins that meeting both the active open space requirements of the municipality as well as the retention requirements. Because these are understood to negatively impact watershed functions, the minimum recommendations shown focus on the inclusion of the common requirements outlined above.



DISCLAIMER: THE TYPICAL PLANS SHOWN ON THESE SHEETS ARE SCHEMATIC IN NATURE AND ARE FOR REFERENCE PURPOSES ONLY. THE LAYOUTS AND RELATIONSHIP TO ADJACENT SURFACE FEATURES IS INTENDED TO SERVE AS DESIGN AIDS FOR THE DEVELOPMENT OF FLOOD HAZARD MITIGATION PLANS THAT INTEGRATE MULTI-CONTEXTUAL FUNCTIONS. WHILE THE PHYSICAL LOCATION OF THE TYPICAL PLANS ARE LOCATED WITHIN THE RAINBOW VALLEY AREA, THE LOCATION, LAYOUT, AND OTHER INFORMATION PROVIDED IS NOT INTENDED TO REPRESENT ACTUAL DEVELOPMENTS, EITHER EXISTING OR PLANNED. ANY RESEMBLANCE TO AN ACTUAL DEVELOPMENT IS PURELY COINCIDENTAL.

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACK
- PARCEL LINES
- TYPICAL DESIGN LIMITS

epg

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029

PRELIMINARY NOT FOR CONSTRUCTION

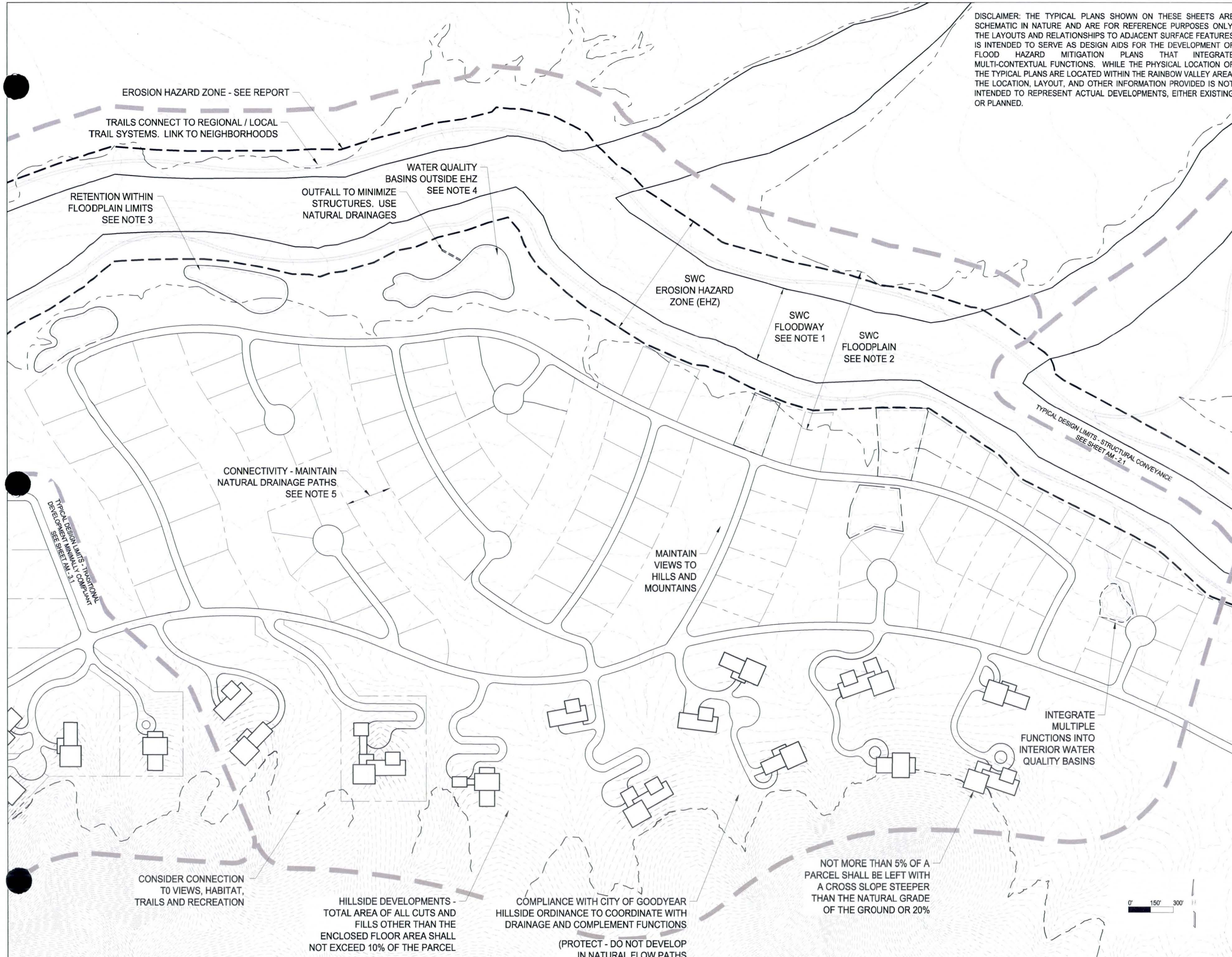
	BY	DATE
DESIGNED	J. GRIFFIN	5/2010
DRAWN	C. DAVIDSON	5/2010
CHECKED	M. PARK	6/2010

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
AM 0.0	FIGURE 3-29: ALTERNATIVE METHODS KEYMAP	1 OF 4-

S:\EPG\projects\FCD\Rainbow Valley ADMP\D-CAD\Level III\Typical Designs\ Alternative_Designs.dwg

DISCLAIMER: THE TYPICAL PLANS SHOWN ON THESE SHEETS ARE SCHEMATIC IN NATURE AND ARE FOR REFERENCE PURPOSES ONLY. THE LAYOUTS AND RELATIONSHIPS TO ADJACENT SURFACE FEATURES IS INTENDED TO SERVE AS DESIGN AIDS FOR THE DEVELOPMENT OF FLOOD HAZARD MITIGATION PLANS THAT INTEGRATE MULTI-CONTEXTUAL FUNCTIONS. WHILE THE PHYSICAL LOCATION OF THE TYPICAL PLANS ARE LOCATED WITHIN THE RAINBOW VALLEY AREA, THE LOCATION, LAYOUT, AND OTHER INFORMATION PROVIDED IS NOT INTENDED TO REPRESENT ACTUAL DEVELOPMENTS, EITHER EXISTING OR PLANNED.



NOTES:

1. PROTECT EROSION HAZARD ZONE (EHZ) FROM DISTURBANCE, TO INCLUDE RIPARIAN VEGETATION, EXISTING FORM, SOILS, AND WASH OVER BANK CHARACTER. SEE REPORT FOR PERMITTED DISTURBANCE AND USES.
2. ENCROACHMENT INTO FLOODPLAIN UNDER STANDARD FEMA GUIDELINES IS PERMITTED UNDER THE FOLLOWING CONDITIONS:
   - 2.1. PROVIDE COMPENSATORY STORAGE IN THE FLOODPLAIN OVER BANK AREA OF EROSION HAZARD ZONE.
   - 2.2. DRAINAGE REPORT MUST DEMONSTRATE THAT COMPENSATORY STORAGE BASINS OR OTHER FACILITIES PROVIDE COMPARABLE INFILTRATION TO THAT OF DISPLACED FLOODPLAIN.
   - 2.3. COMPENSATORY STORAGE BASINS WITHIN SWC'S SHOULD BE REVEGETATED AND DESIGNED TO PROVIDE MULTI-USE FUNCTIONS SUCH AS OPEN SPACE, PASSIVE RECREATION, AND/OR WILDLIFE HABITAT.
   - 2.4. ACTIVE RECREATION IS NOT A PREFERRED MULTI-USE WITHIN COMPENSATORY STORAGE FACILITIES. MINIMAL ACTIVE RECREATION MAY BE APPROVED AS A MULTI-USE FUNCTION PROVIDED FACILITIES DO NOT REQUIRE THE FOLLOWING FACILITIES THAT WOULD CREATE A NEGATIVE IMPACT ON THE BIOLOGICAL FUNCTIONS OF THE WASH:
     - 2.4.1. BALLFIELD LIGHTING
     - 2.4.2. TURF
     - 2.4.3. PARKING OR OTHER IMPERVIOUS SURFACING
3. STORM WATER STORAGE BASINS ARE PERMITTED WITHIN THE FLOODPLAIN UNDER THE FOLLOWING CONDITIONS:
   - 3.1. WATER QUALITY BASINS MUST BE SEPARATED FROM ATTENUATION BASINS AND LOCATED OUTSIDE OF THE FLOODPLAIN LIMITS. SEE NOTE 4 FOR FURTHER DIRECTION.
   - 3.2. DRAINAGE REPORT MUST DEMONSTRATE THAT FLOOD TIMING WILL NOT RESULT IN STORAGE BASIN BEING FILLED BY WASH FLOWS PRIOR TO DESIGN FLOWS ENTERING FROM THE ADJACENT SITE.
   - 3.3. STORAGE BASINS SHALL BE MULTI-FUNCTIONAL
4. WATER QUALITY BASINS LOCATED WITHIN EHZ MUST BE LOCATED SO THAT THERE IS NO CO-MINGLING OF FLOWS DURING THE 100 YEAR, 2 HOUR STORM EVENT.
   - 4.1. WQ BASINS SHOULD BE DESIGNED TO IMPLEMENT OTHER MULTI-USE FUNCTIONS.
5. MULTI-USE TRAILS
   - 5.1. DEVELOP MULTI-USE TRAILS WITHIN THE LIMITS OF THE EROSION HAZARD SETBACK AND THE FLOODWAY.
   - 5.2. COORDINATE DEVELOPMENT OF THE MULTI-USE TRAIL ALONG THE ESTRELLA NORTH SWC WITH MARICOPA COUNTY PARKS AND RECREATION - TRAILS GROUP FOR USE AS A PORTION OF THE MARICOPA REGIONAL TRAIL.

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACK
- PARCEL LINES
- TYPICAL DESIGN LIMITS

epg

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029

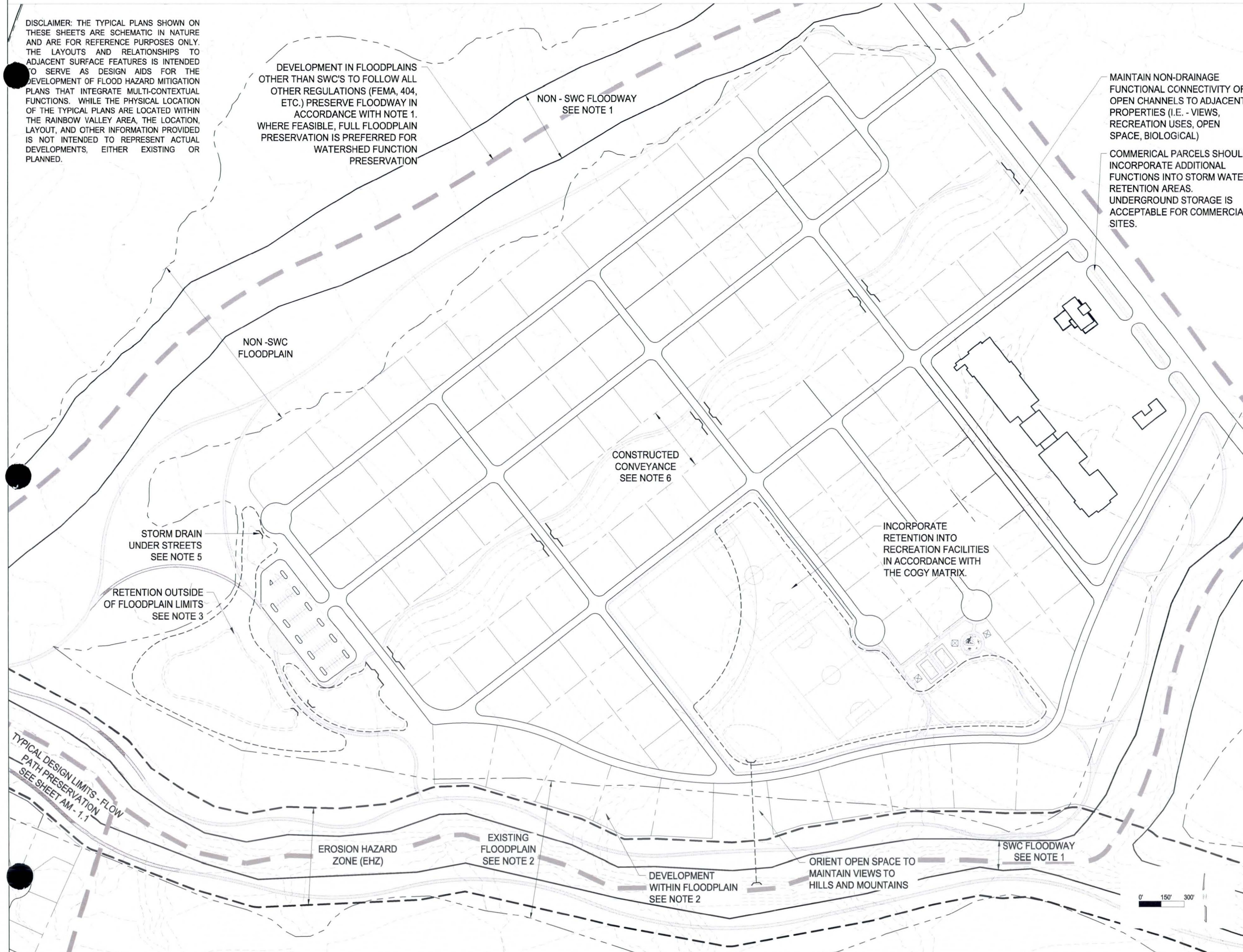
PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	J. GRIFFIN	5/2010
	DRAWN	C. DAVIDSON	5/2010
	CHECKED	M. PARK	6/2010

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
AM 1.1	FIGURE 3-30: ALT. METHODS FLOW PATH PRESERVATION	2 OF 4-

S:\EPG\projects\FCD\Rainbow Valley ADMP\D-CAD\Level III\Typical Designs\ Alternative_Designs.dwg

DISCLAIMER: THE TYPICAL PLANS SHOWN ON THESE SHEETS ARE SCHEMATIC IN NATURE AND ARE FOR REFERENCE PURPOSES ONLY. THE LAYOUTS AND RELATIONSHIPS TO ADJACENT SURFACE FEATURES IS INTENDED TO SERVE AS DESIGN AIDS FOR THE DEVELOPMENT OF FLOOD HAZARD MITIGATION PLANS THAT INTEGRATE MULTI-CONTEXTUAL FUNCTIONS. WHILE THE PHYSICAL LOCATION OF THE TYPICAL PLANS ARE LOCATED WITHIN THE RAINBOW VALLEY AREA, THE LOCATION, LAYOUT, AND OTHER INFORMATION PROVIDED IS NOT INTENDED TO REPRESENT ACTUAL DEVELOPMENTS, EITHER EXISTING OR PLANNED.



NOTES:

1. PROTECT FLOODWAY FROM DISTURBANCE, TO INCLUDE RIPARIAN VEGETATION, EXISTING FORM, SOILS, AND WASH OVER BANK CHARACTER. SEE REPORT FOR PERMITTED DISTURBANCE AND USES.
2. ENCROACHMENT INTO FLOODPLAIN UNDER STANDARD FEMA GUIDELINES IS PERMITTED UNDER THE FOLLOWING CONDITIONS:
   - 2.1. PROVIDE COMPENSATORY STORAGE IN THE FLOODPLAIN OVER BANK AREA OF EROSION HAZARD SETBACK.
   - 2.2. DRAINAGE REPORT MUST DEMONSTRATE THAT COMPENSATORY STORAGE BASINS OR OTHER FACILITIES PROVIDE COMPARABLE INFILTRATION TO THAT OF DISPLACED FLOODPLAIN.
   - 2.3. COMPENSATORY STORAGE BASINS WITHIN SWC'S SHOULD BE REVEGETATED AND DESIGNED TO PROVIDE MULTI-USE FUNCTIONS SUCH AS OPEN SPACE, PASSIVE RECREATION, AND/OR WILDLIFE HABITAT.
   - 2.4. ACTIVE RECREATION IS NOT A PREFERRED MULTI-USE WITHIN COMPENSATORY STORAGE FACILITIES. MINIMAL ACTIVE RECREATION MAY BE APPROVED AS A MULTI-USE FUNCTION PROVIDED FACILITIES DO NOT REQUIRE THE FOLLOWING FACILITIES THAT WOULD CREATE A NEGATIVE IMPACT ON THE BIOLOGICAL FUNCTIONS OF THE WASH:
     - 2.4.1. BALLFIELD LIGHTING
     - 2.4.2. TURF
     - 2.4.3. PARKING OR OTHER IMPERVIOUS SURFACING
3. STORM WATER STORAGE BASINS ARE PERMITTED WITHIN THE FLOODPLAIN UNDER THE FOLLOWING CONDITIONS:
   - 3.1. WATER QUALITY BASINS MUST BE SEPARATED FROM ATTENUATION BASINS AND LOCATED OUTSIDE OF THE FLOODPLAIN LIMITS. SEE NOTE 4 FOR FURTHER DIRECTION.
   - 3.2. DRAINAGE REPORT MUST DEMONSTRATE THAT FLOOD TIMING WILL NOT RESULT IN STORAGE BASIN BEING FILLED BY WASH FLOWS PRIOR TO DESIGN FLOWS ENTERING FROM THE ADJACENT SITE.
   - 3.3. STORAGE BASINS SHALL BE MULTI-FUNCTIONAL
4. WATER QUALITY BASINS SHOULD BE DESIGNED TO IMPLEMENT OTHER MULTI-USE FUNCTIONS.
5. STORM DRAIN SYSTEMS ARE PERMITTED UNDER STREETS FOR DRAINAGE FUNCTIONS PROVIDED THE FOLLOWING CRITERIA ARE MET:
   - 5.1. A DRAINAGE REPORT IS SUBMITTED THAT DOCUMENTS ALL DRAINAGE FUNCTIONS ARE MAINTAINED BY THE PROPOSED SYSTEM INCLUDING SEDIMENT FUNCTIONS.
   - 5.2. NON-DRAINAGE WATERSHED FUNCTIONS ARE MAINTAINED WITHIN THE DEVELOPMENT OR THROUGH ADJACENT OPEN SPACE EASEMENTS AND BUFFERS. APPROPRIATE PLANS AND REPORTS SHALL BE REFERENCED IN THE FINAL DRAINAGE REPORT FOR SUPPORT DOCUMENTATION FOR NON DRAINAGE FUNCTIONAL CONTINUITY PRIOR TO APPROVALS OR PERMITTING.
6. CONVEYANCE CHANNELS SHALL BE DESIGNED IN ACCORDANCE WITH THE RECOMMEND PLAN REPORT. OPEN CHANNELS MAY BE USED IN CONJUNCTION WITH STORM DRAIN SYSTEMS TO INCLUDE ADDITIONAL FUNCTIONAL CONTINUITY WITHIN THE OVERALL DEVELOPMENT AND TO MEET OPEN SPACE REQUIREMENTS.

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACK
- PARCEL LINES
- TYPICAL DESIGN LIMITS

epg

TWO WORKING DAYS BEFORE YOU DIG, CALL 263–1100 BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029

PRELIMINARY NOT FOR CONSTRUCTION

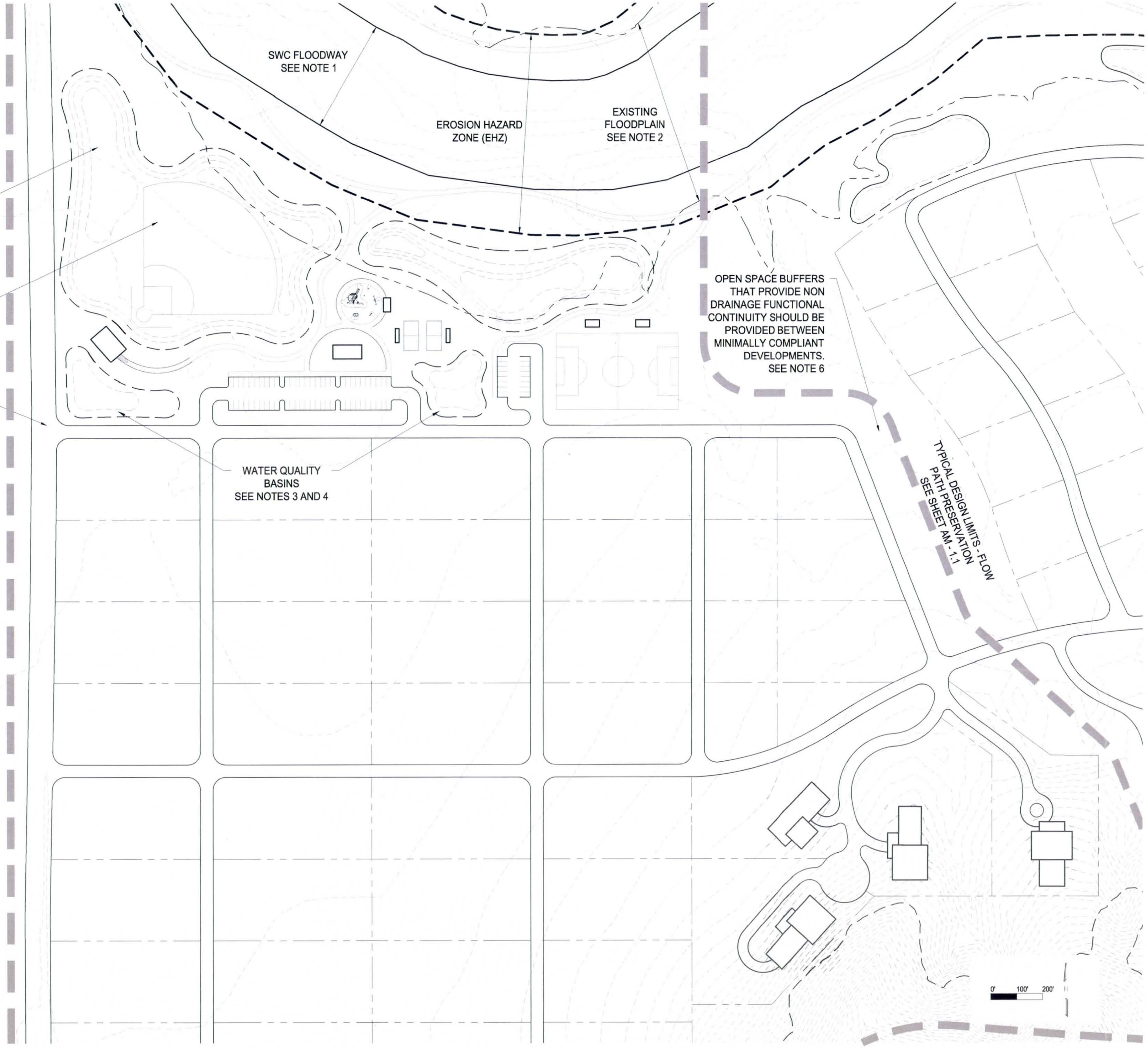
	BY	DATE
DESIGNED	J. GRIFFIN	5/2010
DRAWN	C. DAVIDSON	5/2010
CHECKED	M. PARK	6/2010

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
AM 2.1	FIGURE 3-31: ALT. METHODS STRUCTURAL ALTERNATIVE	3 OF 4-

S:\EPG\projects\FCD\Rainbow Valley ADMP\D-CAD\Level III\Typical Designs\ Alternative_Designs.dwg

DISCLAIMER: WHILE THE EXAMPLE DEVELOPMENT SHOWN ON THIS SHEET OVERLAYS THE SITE OF A KNOWN FUTURE DEVELOPMENT, THE EXAMPLE LAYOUT IS FOR REFERENCE ONLY AND DOES NOT REPRESENT THE ACTUAL PLANS FOR THIS LOCATION. NOR SHOULD THIS PLAN BE CONSTRUED AS APPLYING TO THIS SPECIFIC LOCATION IN ANY MANNER OTHER THAN AS A REPRESENTATION OF HOW THE PERFORMANCE FUNCTIONS COULD BE IMPLEMENTED BY AN OWNER AT ANY LOCATION WITHIN THE WATERSHED. THE EXAMPLE LAYOUT DEMONSTRATES A MINIMAL LEVEL OF COMPLIANCE WITH THE WATERSHED FUNCTION CONTINUITY OBJECTIVES OF THE RECOMMENDED PLAN.



NOTES:

1. MINIMALLY COMPLAINT DEVELOPMENT SHALL STILL SWC FROM DISTURBANCE. SEE REPORT FOR PERMITTED DISTURBANCE AND USES.
2. ENCROACHMENT INTO FLOODPLAIN OF NON-SWC WASHES UNDER STANDARD FEMA GUIDELINES IS PERMITTED UNDER THE FOLLOWING CONDITIONS:
   - 2.1. PROVIDE COMPENSATORY STORAGE IN THE FLOODPLAIN OVER BANK AREA OF EROSION HAZARD SETBACK.
   - 2.2. DRAINAGE REPORT MUST DEMONSTRATE THAT COMPENSATORY STORAGE BASINS OR OTHER FACILITIES PROVIDE COMPARABLE INFILTRATION TO THAT OF DISPLACED FLOODPLAIN.
   - 2.3. COMPENSATORY STORAGE BASINS WITHIN SWC'S SHOULD BE REVEGETATED AND DESIGNED TO PROVIDE MULTI-USE FUNCTIONS SUCH AS OPEN SPACE, PASSIVE RECREATION, AND/OR WILDLIFE HABITAT.
   - 2.4. ACTIVE RECREATION IS NOT A PREFERRED MULTI-USE WITHIN COMPENSATORY STORAGE FACILITIES. MINIMAL ACTIVE RECREATION MAY BE APPROVED AS A MULTI-USE FUNCTION PROVIDED FACILITIES DO NOT REQUIRE THE FOLLOWING FACILITIES THAT WOULD CREATE A NEGATIVE IMPACT ON THE BIOLOGICAL FUNCTIONS OF THE WASH:
     - 2.4.1. BALLFIELD LIGHTING
     - 2.4.2. TURF
     - 2.4.3. PARKING OR OTHER IMPERVIOUS SURFACING
3. STORM WATER STORAGE BASINS ARE PERMITTED WITHIN THE EROSION HAZARD ZONE UNDER THE FOLLOWING CONDITIONS:
   - 3.1. WATER QUALITY BASINS MUST BE SEPARATED FROM ATTENUATION BASINS AND LOCATED OUTSIDE OF THE FLOODPLAIN LIMITS. SEE NOTE 4 FOR FURTHER DIRECTION.
   - 3.2. DRAINAGE REPORT MUST DEMONSTRATE THAT FLOOD TIMING WILL NOT RESULT IN STORAGE BASIN BEING FILLED BY WASH FLOWS PRIOR TO DESIGN FLOWS ENTERING FROM THE ADJACENT SITE.
   - 3.3. STORAGE BASINS SHALL BE MULTI-FUNCTIONAL
4. WATER QUALITY BASINS SHOULD BE DESIGNED TO IMPLEMENT OTHER MULTI-USE FUNCTIONS.
5. STORM DRAIN SYSTEMS ARE PERMITTED UNDER STREETS FOR DRAINAGE FUNCTIONS PROVIDED THE FOLLOWING CRITERIA ARE MET:
   - 5.1. A DRAINAGE REPORT IS SUBMITTED THAT DOCUMENTS ALL DRAINAGE FUNCTIONS ARE MAINTAINED BY THE PROPOSED SYSTEM INCLUDING SEDIMENT FUNCTIONS.
   - 5.2. NON-DRAINAGE WATERSHED FUNCTIONS ARE MAINTAINED WITHIN THE DEVELOPMENT OR THROUGH ADJACENT OPEN SPACE EASEMENTS AND BUFFERS. APPROPRIATE PLANS AND REPORTS SHALL BE REFERENCED IN THE FINAL DRAINAGE REPORT FOR SUPPORT DOCUMENTATION FOR NON DRAINAGE FUNCTIONAL CONTINUITY PRIOR TO APPROVALS OR PERMITTING.
6. WHERE NON-DRAINAGE FUNCTIONS CAN NOT BE MAINTAINED WITHIN A DEVELOPMENT, ADJACENT BUFFER AREAS THAT PROVIDE THE FULL SUITE OF FUNCTIONS MAY BE USED PROVIDED THE CRITERIA OUTLINED IN THE RECOMMEND PLAN REPORT ARE MET.

LEGEND

FLOODPLAIN LIMITS
FLOODWAY LIMITS
EROSION HAZARD SETBACK
PARCEL LINES
TYPICAL DESIGN LIMITS

epg

TWO WORKING DAYS BEFORE YOU DIG, CALL 263–1100 BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029

PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	J. GRIFFIN	5/2010
	DRAWN	C. DAVIDSON	5/2010
	CHECKED	M. PARK	6/2010

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
AM 3.1	FIGURE 3-32: ALTERNATIVE METHODS MINIMAL COMPLIANCE	4 OF 4 -

S:\EPG\projects\FCD\Rainbow Valley ADMP\D-CAD\Level III\Typical Designs\ Alternative_Designs.dwg

3.5 SIGNIFICANT WASH CORRIDORS

SWCs play a vital role in preserving the overall functionality of the Waterman Wash watershed. All SWCs are some of the primary tributaries contributing flow to Waterman Wash. Performance functions directly associated with SWCs are outlined in Table 3-16 below:

Table 3-16 Performance Functions Associated with SWCs

3.4.1.1	Store increases in runoff volume resulting from development Preserve natural land surface storage and infiltration properties Maintain adequate baseflow to support native vegetation
3.4.2.1	Minimize reduction in time of concentration Provide retention/detention to offset increases in peak discharge
3.4.3.1	Coordinate road alignments with drainage patterns
3.4.4.1	Utilize floodway delineation methodology that accounts for and mitigated impacts of lost overbank flood storage
3.4.5.1	Maintain floodplain storage volume
3.4.6.1	Preserve dominant discharge low flow channel Limit increases in maximum design tractive sheer stress at design discharge Design for potential changes in sediment supply resulting from upstream development
3.4.7.1	Maintain sediment yield from individual development and the overall watershed
3.4.8.1	Design to be compatible with the future cultural and physical setting Design flood hazard mitigation to be compatible with the natural Sonoran desert washes within floodways Design flood hazard mitigation facilities to maintain views toward the mountain preserve areas and preserve existing views from the mountains to the valley
3.4.9.1	Accommodate City of Goodyear trails within flood hazard mitigation projects Establish appropriate segments of the Maricopa Regional Trail Accommodate other local trails
3.4.10.1	Preserve existing open space value Maintain BLM-managed lands as public open space Development should comply with MAG Desert Spaces *Environmentally Sensitive Development Areas Policy and Planning Guidelines*
3.4.11.1	Maintain existing ecological integrity of natural vegetation types Protect natural and beneficial functions of washes Preserve the connectivity and permeability of habitats Restore or enhance vegetation and natural channels in degraded areas Use built structures to create resources for wildlife
3.4.12.1	Protect and interpret historic sites Protect and interpret prehistoric sites

3.5.1 Flow Characteristics and SWCs

SWCs have been identified throughout the watershed in areas that will be developed in the future but are currently under natural conditions. Areas that will be developed lie within landforms that produce various types of flooding that have different flow characteristics. Through preservation of the flood functions mentioned above, SWCs will also mitigate flood hazards for the various flow characteristics in the watershed. The flow characteristics that affect the SWCs are:

- Sheet flow
- Distributary flow
- Tributary flow

There are differences in how SWCs will be implemented in the different flow characteristic areas. Existing flow characteristics will generally remain the same for an SWC that is in a tributary flow area. However, flow characteristics will be somewhat altered for the SWCs in distributary and sheet flow areas.

Sheet Flow

The SWCs are intended to preserve the sheet flow characteristics which are generally defined by shallow flow depths and low flow velocities. However, development in the sheet flow areas will impact the characteristics of the flood hazards which will in turn impact the flow characteristics within the SWC. Because flows will be concentrated into the corridor up to the limits of the erosion hazard setbacks discussed below as a result of development, increases to flow depths and velocities within the SWC are expected to occur.

Distributary Flow

The same can be said for changes to distributary flow areas. There are two main differences between sheet and distributary flow areas, which are the presence of flow splits and defined flow paths. Distributary flows in the Sonoran Planning Unit have been evaluated to determine which of the flow paths have been historically the dominant flow path. The SWCs in this area have been aligned with the dominant flow path. However, by selecting one flow path over another will require that a flow split be eliminated and thus the secondary flow path will be eliminated. Although, this approach impacts continuity of one flow path, continuity is still maintained for the dominant flow path while achieving flood hazard mitigation. By eliminating a flow split and conveying all the floodwaters through one flow path, flow depths and velocities will increase similar to the changes seen in the sheet flow SWCs.

Affected Planning Units

The Estrella, Sonora and Mobile planning units are currently undeveloped but are slated for development by master planned communities. SWCs in the Estrella Planning Unit contain sheet and tributary flow characteristics. The Sonora and Mobile planning units have SWCs that are influenced by distributary flow and sheet flow. The sheet flow areas are primarily found in the Estrella Planning Unit, but can also be found in the Sonora Planning Unit.

3.5.2 General Design Criteria

Several regulatory features have been identified that will help preserve watershed functionality associated with the SWCs while also serving to protect adjacent development from flood risk. These items are explained in the design criteria sections below.

Plan and profile drawings have been developed for each SWC and can be found in Appendix C. The plan view of the drawings shows the existing topography and flowline for each SWC. Floodplain boundaries and erosion hazard setbacks for each SWC are also shown on the plan view. It should be noted that not every SWC has a detailed floodplain/floodway delineation. Only Estrella SWC 1 and Sonora SWC 4 have detailed floodplain/floodway delineations, the floodplains for the remaining SWCs were determined under a previous study using approximate methods. Erosion hazard setbacks were calculated using ADWR's SS-5-96 Level I methodology and based on existing condition peak discharges. The erosion hazard setbacks show the allowable limits for encroachment into the SWC. The profiles show the flowline and 100-year water surface elevation for each SWC.

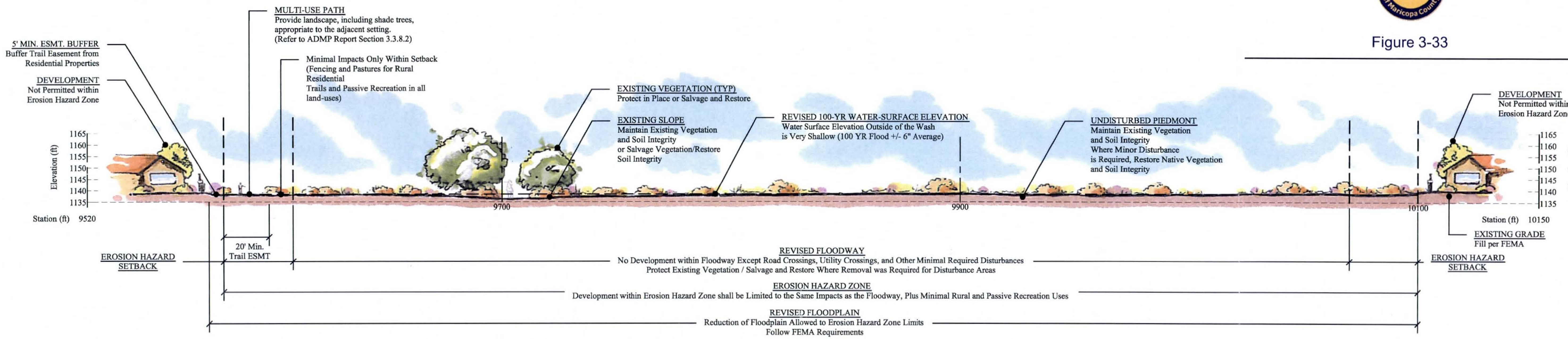
The drawings should be referred to in combination with the typical sections (**Figure 3-33**) depicting the land and resource functions when planning a development that is affected by an SWC. Using the plan and profiles along with the typical sections viable areas for encroachment can be determined for each SWC.

Erosion Hazard Zone

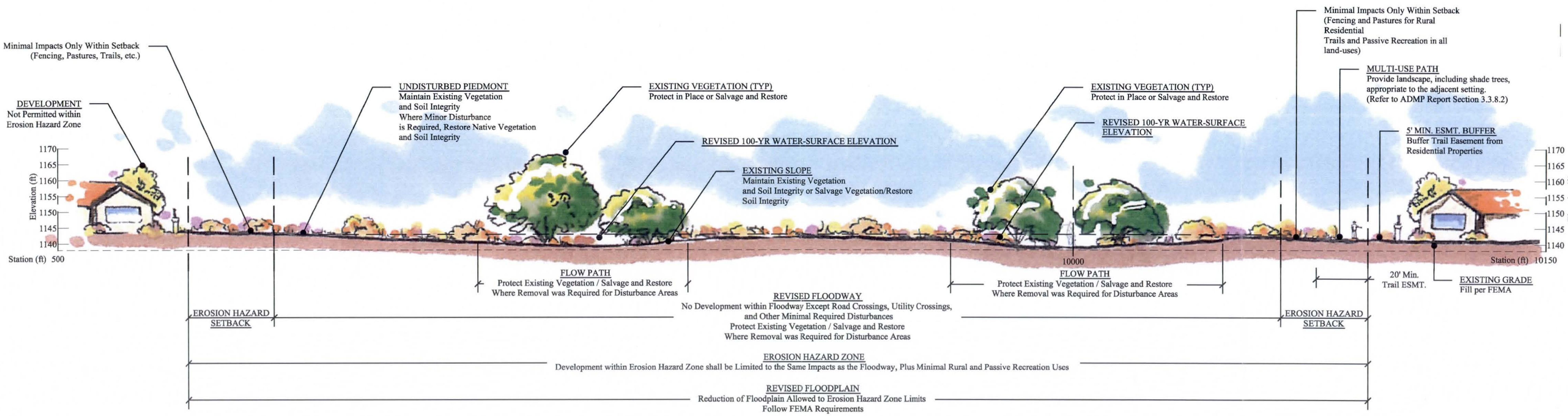
Existing regulatory features common to all of the SWCs are the effective floodplains and the potential for being considered jurisdictional Waters of the US. An additional feature that should be used for development regulation is erosion hazard setbacks. Erosion hazard setbacks have been delineated for each SWC to prevent encroachment into areas that may erode due to the additional flow in the corridor as shown in the drawings. These erosion hazard setbacks serve as the primary tool to accomplish local flood hazard mitigation while assisting in preserving watershed functional continuity. As with Waterman Wash, they are intended to minimize potential adverse impacts to public health, safety, and general welfare, while also accounting for potential hazards associated with the natural migration of the wash. The erosion hazard setback for the SWCs serves as the limits of the EHZ for the SWC and should be maintained as natural open space to the greatest extent possible except as needed for limited structural improvements such as roadway or utility crossings.

Rainbow Valley
Area Drainage Master Plan
Significant Wash Corridors - Typical Sections

Figure 3-33



Significant Wash Corridors Within Sheet Flow And Tributary Flow Areas - Typical Section



Significant Wash Corridors Within Distributary Flow Areas - Typical Section

Additional improvements permitted within the EHZ should be limited to non-motorized recreational activities including hiking/riding trails and other passive recreation or open space-related activities which will not impede stormwater conveyance. These improvements should be kept out of the existing vegetated portions of the wash.

Utilities

Utilities within the EHZ should be limited to wash crossings only. All installations should be protected against scouring in a manner that is visually compatible with a natural setting. The width of utility corridor should be the minimum necessary. Following construction the corridor should be revegetated using native vegetation as approved by the reviewing municipality.

Roadway Crossings

At-grade crossings of the SWCs are discouraged. Roadway crossings of the SWCs shall maintain natural channel geometry, encourage the conveyance of the incoming sediment load; and avoid or minimize disturbance of riparian habitat.

Culvert crossings of the wash must be designed to allow sediment to travel under the road. Culvert inside diameters shall be designed a minimum of 6 inches below the channel low-flow grade to ensure sediment transport within the wash.

Grading

There should be no fill or excavation of material within the EHZ except as minimally necessary to construct utility and roadway/bridge crossings, flood control structures, trail improvements and vegetative restoration. In cases where grading is required and permitted by the overlying municipality, the impacted areas of the wash should be revegetated and graded to a natural form.

Revegetation Requirements

Vegetation within the SWCs plays a critical role in supporting the full spectrum of watershed functions. Where disturbance is required, the species described above in Table 3-15 for Waterman Wash should also be used to re-established vegetation with a plant and canopy cover composition that is similar to nearby undisturbed areas of the SWC.

Multi-Use Trails

A 20-foot minimum multi-use trail easement should be dedicated along one side of each SWC within the EHZ, but outside of the riparian habitat. The physical edge of the trail, including shoulders, should be buffered 5-feet from adjacent built structures such as walls, view fencing, abrupt changes in grade, or buildings. Trail design should comply with Section 3.3.9.2 of the

ADMP. Trail design should also conform to the design requirements of the local municipality. Where trail segments occupy lands within unincorporated Maricopa County, or lands where no trail design standards have been established, the following criteria should apply:

- All trail segments should be designed to create a continuous system within the SWC. Where an existing trail segment exists either upstream or downstream from the new segment to be constructed, the new trail should meet the existing trails grade and alignment. Additional trail connections, such as to other segments of the Maricopa Regional Trail and City of Goodyear trails described previously in this report, should be coordinated with the trail design and meet the SWC trail at-grade.
- Where possible, trail segments should meet the Maricopa County Parks and Recreation Department's specifications for a Barrier-Free Trail. Where a Barrier-Free Trail is not achievable due to physical constraints, the trail system should meet the specifications for a Primary Trail and be signed to warn users that these segments of the trail are not ADA accessible. These minimum standards include the following:
    - Maximum Grade: 5 percent maximum (Barrier-Free); 10 percent maximum (Primary Trail). For barrier-Free trails – Dips and ramps may be a maximum of 8 percent for a distance not to exceed 30 feet. Where the trail requires a ramp condition, level grade landings are required at intervals of 30 feet. Landings should be no less than 5 feet in length and the full width of the trail. Rest areas at landings are recommended but not required.
    - Width (all conditions): 10 feet, with 2 feet clear shoulders for a total of 14 feet.
    - Surface: Crushed or decomposed granite.
    - Lighting: Security lighting as required in urbanized reaches. Use low-scale bollard lights or similar methods.
    - Shoulders: As noted above, 2-foot trail shoulders are required on each side of the trail. These shoulders may be unstabilized granite and should be cleared of vegetation.

4.0 PROPOSED REGULATIONS

4.1 INTRODUCTION

From discussions with agency stakeholders, review of city and town General Plans, the selection of the recommended plan for each planning unit and the knowledge of flood risks in the study area led to the Team focusing on the Estrella and Sonora planning units for developing policies, ordinances, and guidelines (PGOs). The City of Goodyear is the prominent jurisdiction in these two study areas and the Estrella and Sonoran planning units contain some of Goodyear's larger master planned communities whereby future development is most viable in the short term and long term.

4.2 CITY OF GOODYEAR POLICIES, GUIDELINES, AND ORDINANCES

Implementation of the regulatory approach for flood hazard mitigation described in Section 3.0 of this report was evaluated to determine where and how it could be addressed by the City of Goodyear. A "road map" of sorts was developed to provide a means to systematically identify, evaluate or "map" where the various functions and criteria would be most suitable for inclusion or amendment to existing Goodyear goals, policies, objectives and design guidelines that together define the City's existing regulatory framework. To simplify the process, specific Goodyear PGOs were identified as suitable "targets" for possible implementation. These existing City of Goodyear regulatory framework includes:

- General Plan
- Zoning Ordinance
- Engineering Design Standards and Policy Manual
- Design Guidelines
- Subdivision Ordinance
- Flood Damage Prevention Code

The "PGO Road Map" is provided in Appendix B. The PGO Tools road map identified what section or reference point of each Goodyear regulatory document could or should be a logical and/or plausible target for amendment with respect to each of the performance functions/design criteria identified. Each citation provides an evaluation of how that particular performance function/design criteria relates (or not) to each Goodyear regulatory document section – citing specific sections by which the document would be suitable for amendment to accommodate the newly defined PGO. Supplemental policy notes provided offered commentary on some of the refinements suggested to certain performance functions/design criteria as well as noting concerns or relationships to other code provisions that should be considered prior to moving forward with any formal development of PGOs in Goodyear.

In instances where a performance function or design criterion is identified for multiple entries within one City of Goodyear document or across multiple City of Goodyear documents, each entry reflects a potential range of existing City of Goodyear policy/code "amendment targets" that could occur if so desired by City of Goodyear. Additional evaluation and review with City of Goodyear planning and engineering staff is necessary to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired. This has been referred to as the "multi-pronged approach" in Project Team discussions.

A White Paper (Appendix A) was also prepared to accompany the PGO road map. The White Paper describes the intent of Task 12.8.3 and to define ways to achieve the goals and objectives of the regulatory flood mitigation plan in Goodyear. It describes the initial PGO vision and why it is important for the approach to be mutually beneficial to Goodyear, the development community, and the District. The process began in April 2010 and will likely continue beyond the completion of the Rainbow Valley Area Drainage Master Plan process through the adoption of select PGOs by Goodyear.

The White Paper discusses how the PGO can be successfully and effectively achieved by developing a nexus that includes the following components:

- Understanding Goodyear's objectives and expectations
- Achieving effective flood hazard mitigation options
- Respecting developer stakeholder expectations and concerns
- Accounting for planning unit land and resource and community context objectives

As the White Paper notes, the PGO process included a data investigation and collection process of existing City of Goodyear and Maricopa County ordinances and policies as well as a multitude of other local, regional, and national documents providing a greater perspective in PGO and Low Impact Development (LID) techniques that could be drawn from to assist the PGO effort. The types of documents collected represented a broad spectrum of documents that ranged from specific LID site planning and design techniques, to the creation of storm water utility districts, transfer of development rights (TDRs), zoning overlay districts, and a host of other technical design and modeling components. This data collection effort includes over 50 entries.

Meetings occurred early in the project with developers where the Team listened to and recorded their needs, wants, and concerns. More recent meetings with Goodyear staff provided input as to a course that they want the project to proceed which largely focused on utilizing their existing regulatory framework as opposed to the creation of new tools or codes. Further meetings are planned with the ultimate goal in selecting the best course of action to follow in implementing the watershed and approach and criteria in their PGOs. These could include updating or amending the General Plan, Zoning Ordinances, Engineering Design Standards and Policy Manual and/or Design Guidelines through LID site planning and design techniques, and engineer reporting/modeling requirements. Other PGO implementation tools such as the creation of storm water utility districts, transfer of development rights, or use of zoning overlay districts were not desired by Goodyear staff at this time but could be further evaluated as a component of future implementation efforts.

The White Paper specifically discusses how it will be difficult to include all of the ideas developed in Sections 2.0 and 3.0 so it is important to work with Goodyear to prioritize the approaches that will provide the best "bang for the buck." Collaboration in achieving a positive result should lead to a positive implementation result. A likely first means for achieving this goal is to move forward with updating any stormwater reporting, modeling and retention requirements and design guidelines associated with SWCs including Waterman Wash where Goodyear is interested in complementing their existing Waterman Wash guidelines.

The White Paper describes a framework for implementing portions or all of the performance functions and design criteria into Goodyear's existing regulatory framework. **Figure 4-1** illustrates the implementation procedure that begins with identifying the watershed functions and design criteria, dividing them between public safety and quality of life elements, prioritizing which are most likely to be supported in the short term by Goodyear staff, linking them to the appropriate PGO document and then vetting them to determine their implementation through:

- Development of draft PGO language with respect to Goodyear Planning and Engineering staff
- Benefits versus costs to the development community
- Legal staff evaluation
- Meets ADMP intent
- Equitability
- Proposition 207 issues
- Adoptability and enforcement

Once these steps are synthesized and completed through internal vetting with Goodyear staff, the process can proceed to obtaining buy-in from developer property owners and approval from the Planning Commission and finally City Council adoption.

Additional work beyond the purview of this ADMP is still needed to develop, prioritize, and amend desirable PGOs to implement and update Goodyear's regulatory framework for mitigating flood hazards.

4.3 OTHER JURISDICTIONS AND SURFACE MANAGEMENT AGENCIES

Though Goodyear at this time is the focus for coordinating the regulatory and SWC alternatives for the Rainbow Valley ADMP, there are other government jurisdictions and land management stakeholders in the study area (refer to Figure 2-1). A formal process occurred that included these stakeholders in both individual and group meetings. Four stakeholder meetings were conducted in determining goals and objectives for the study through selecting the recommended alternative. The meetings provided the study team an excellent forum to obtain knowledge and understand the perspectives of each stakeholder. It also provided guidance in developing the watershed approach and design criteria describe in Sections 2.0 and 3.0. By listening to the stakeholders, it solidified the planning unit approach in selecting alternatives and a preferred plan. For example, designating the Sonoran Desert National Monument and Sierra Estrella Wilderness as secured open space where no additional flood hazard mitigation is necessary became apparent as was designating Sevenmile Mountain Planning Unit the same. Future use of the Sevenmile Mountain Planning Unit as a wildlife corridor connecting the Sierra Estrella and Maricopa mountains was especially preferred because approximately 92 percent of the land in this planning unit is presently owned by BLM. Table 4-1 shows the percent of each government jurisdiction by planning unit, and Table 4-2 shows the percent by surface ownership. Specific discussions regarding each group or agency is found in the next few subsections.

Figure 4-1 PGO Implementation Procedures

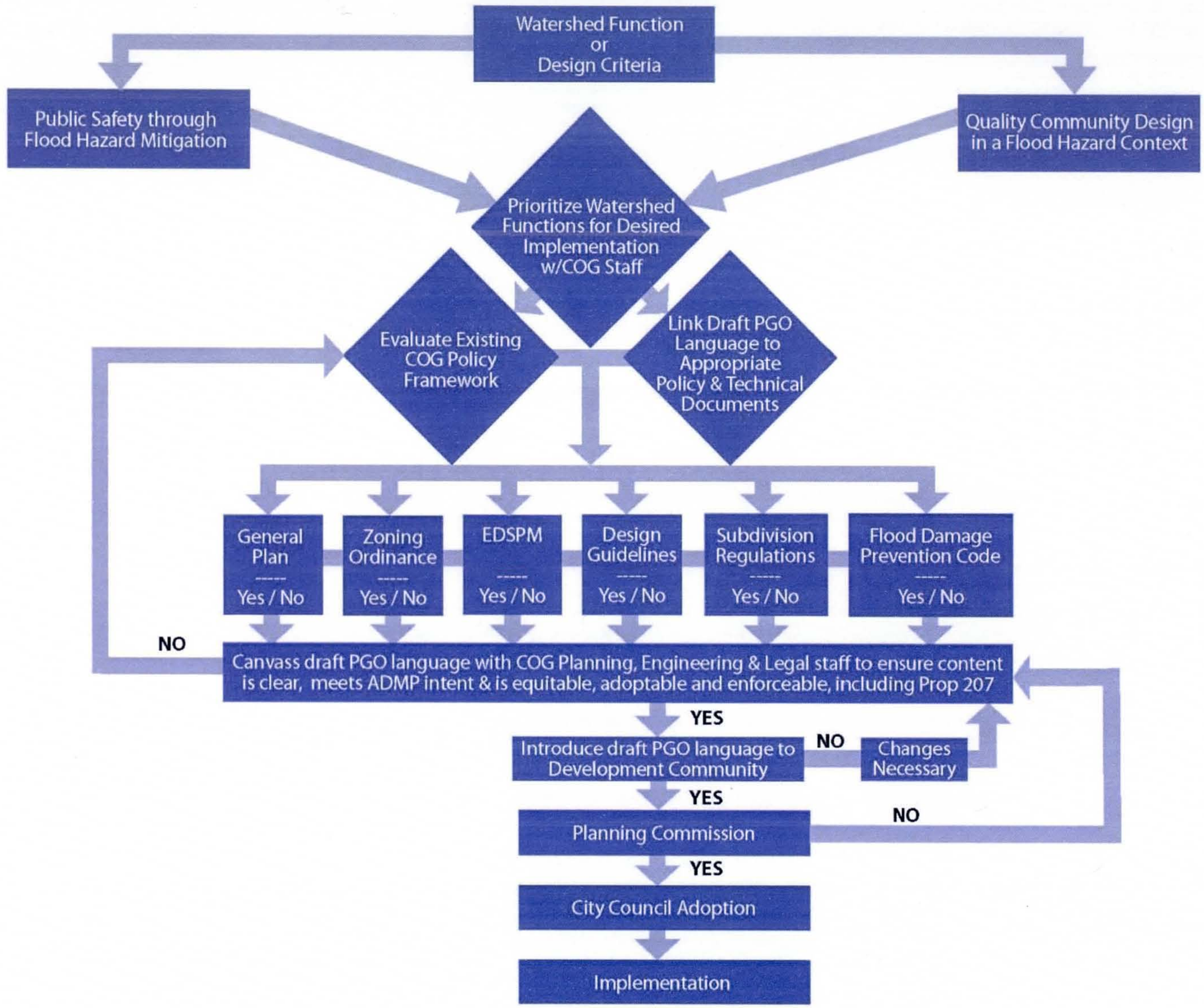


Table 4-1 Acres of Jurisdiction within the Alternatives as a Percentage

	A	B	C	D	E	F	G	LW	SOS	WR1	WR2	WR3	WR4	WR5	TOTAL
	Phoenix International Raceway	Estrella	Sonora	Sevemile Mountain	Mobile	Waterman South	Vekol South	Lum Wash	Secured Open Space						
Avondale	71%	5%	0%	0%	0%	0%	0%	11%	2%	0%	0%	0%	0%	0%	4%
Buckeye	0%	0%	2%	0%	0%	0%	0%	0%	10%	0%	0%	0%	0%	0%	4%
Goodyear	20%	46%	40%	51%	64%	0%	0%	71%	1%	0%	79%	73%	77%	0%	28%
Unincorporated Maricopa County	8%	49%	58%	49%	36%	100%	100%	18%	87%	100%	21%	27%	23%	100%	64%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 4-2 Acres of Surface Ownership within the Alternatives as a Percentage

	A	B	C	D	E	F	G	LW	SOS	WR1	WR2	WR3	WR4	WR5	TOTAL
	Phoenix International Raceway	Estrella	Sonora	Sevemile Mountain	Mobile	Waterman South	Vekol South	Lum Wash	Secured Open Space						
BLM	0%	18%	38%	92%	33%	48%	46%	4%	94%	16%	4%	86%	22%	39%	58%
Indian Reservations	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	1%
Local or State Parks	76%	3%	0%	0%	0%	0%	0%	34%	1%	0%	0%	0%	0%	0%	5%
Other	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Private	20%	42%	49%	5%	59%	47%	50%	57%	2%	80%	85%	10%	76%	50%	27%
State Trust	4%	37%	13%	3%	7%	5%	4%	6%	1%	3%	11%	4%	2%	10%	8%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

4.3.1 Town of Buckeye

The Rainbow Valley study area coincides with the Town of Buckeye south of the Gila River and east of Watson Road. The area is within their Municipal Planning Area as updated on January 18, 2008. In meeting with the Town staff in 2008, it was determined that the area is designated as open space with some potential low-density residential use. There will likely be a component of the Town's comprehensive trail system in the study area. The existing regulatory requirements should be sufficient in response to the proposed land use designations, discussions with the Town, and its location within the study area. The Town did not request any new or revised floodplain or floodway designations.

4.3.2 City of Avondale

The City of Avondale is located in the northeastern portion of the study area in the PIR, Lum Wash, and Estrella planning units. Most of the developable property drains to the Gila River. Other areas encompass mainly the Estrella Mountain Regional Park and BLM managed lands. A small portion of private land is located in the Estrella Planning unit in the foothill area of the Sierra Estrella Mountains. The City of Avondale is largely focused on establishing and maintaining connectivity and their parks and trails program in these areas. The City of Avondale requested two floodplain delineations as part of the ADMP with both flowing to the Gila River. Otherwise, existing regulations should be adequate for flood hazard mitigation.

4.3.3 Maricopa County Planning and Development

Unincorporated Maricopa County is the largest jurisdictional area in the Estrella and Sonora planning units. Their participation will be required to implement an integrated flood hazard mitigation plan as describe in Sections 2.0 and 3.0. While the City of Goodyear planning and incorporated areas are centered on Waterman Wash and contain the largest active master planned communities most viable for future development, the unincorporated area can be found more toward the higher elevation of the planning unit though not entirely. Approximately 21 percent of the W2 Planning Unit (Waterman Wash) is in the unincorporated County; however, most of Waterman Wash is in the Goodyear Planning Area. The present strategy is to initially work with Goodyear in developing a PGO implementation plan crafted for Goodyear's needs and then move forward with discussions with Maricopa County Planning and Development. This approach will offer the benefit of added guidance and leverage in those conversations. A process similar to that shown in **Figure 4-1** will be used to adopt PGOs in the unincorporated County.

To date, in the study area, the County has been most active in regulating lot splits with very few large subdivisions (Liberty Park) where the proposed revisions to the regulatory framework are most effective. However, it is necessary to ensure consistency in the regulatory process and enforcement for the success of the flood mitigation plan in the Estrella and Sonora planning units. Largely in response to statutory limitations placed upon them, the County presently only recommends open space land use designations and does not establish an open space land use per se. Also, the present County retention criterion for flood mitigation is the 100-year 2-hour storm event which is different than Goodyear's 100-year 6-hour retention criteria for development.

4.3.4 Federally Owned Lands

The BLM owns approximately 58 percent of the total land in the study area making them the largest property owner. Approximately 77 percent (146,600 acres) is located in the Secured Open Space and Sevenmile Mountain planning units that are planned for preservation. However, 18,750 acres or 26 percent of the Estrella and Sonora planning units where the proposed regulation revisions are to occur are owned by the BLM. Most of this land is in unincorporated Maricopa County but some is located in the Estrella Planning Unit within the City of Goodyear. The BLM participated as a member of our stakeholder group and had a positive position for the non-structural solutions proposed. These potentially include land swaps because it is more qualitatively valuable to have large continuous properties for preserving vegetation and wildlife then scattered non-contiguous parcels. Connectivity is also tantamount to maintaining a healthy ecological climate. They supported the idea of continuous SWCs including Waterman Wash. Wildlife corridors, vegetative corridors, and pockets for avian flight paths were considered by the BLM to be positive elements of the ADMP. Multi-use opportunities with trails and other passive recreation were supported. The results of the discussions with BLM led to the conclusion that the organization would take a positive view of land swaps that make sense meeting their agency goals. Preservation of both wetland and upland habitats and flow ways will provide a positive result related to the desert community. However, specific actions would need to be evaluated as they occur.

There are no other large federal land management holdings in the study area.

4.3.5 Arizona State Land Department

The ASLD holds in trust for the state approximately 8 percent of the study area (26,400 acres). A significant portion of this land is in the Estrella (15,300 acres) and Sonora (3,800 acres) planning units. The land is both within the City of Goodyear and in unincorporated Maricopa County with continuous land parcels covering both jurisdictions. ASLD does not develop the land per se but does prepare preliminary zoning documents and master drainage plans that are in compliance with local, state, and federal drainage, floodplain, and wetland (404 permitting) requirements. In fact, the ASLD is currently in the process of collaborating with the City of Goodyear to establish Preliminary Planned Area Development (PAD) zoning entitlements and associated potable water rights on over 10,000 acres of ASLD held lands, the majority of which are situated in the Rainbow Valley ADMP Study Area. This information is included in the infrastructure assessment of the property that they will be considering for disposition and future development. ASLD and the City of Goodyear together can collaborate to effectively stipulate that when a parcel is purchased and developed, it needs to conform to the drainage and permit requirements. As such, ASLD's concerns related to new regulations should be addressed in part by the City of Goodyear as a part of the ongoing Preliminary Planned Area Development zoning process much in the same manner as the City negotiates with other developers in the Estrella and Sonora planning units regarding revising regulations and designating SWC.

The ASLD is interested in how the ADMP and regulations will benefit the state. They would prefer that the plan assist in minimizing impacts to Waters of the United States by avoiding these areas. The preservation concept of the new regulations is complementary to this ASLD goal. It is important that ASLD be a proponent of the implementation of the ADMP because they have a significant role in pre-planning their sites and requiring purchasers of the sites to comply with planned floodplain and drainage requirements developed for the property.

Planning through implementation of the watershed approach and design criteria should remediate flood hazards to property owned by ASLD in the Estrella (sheet flow) and Sonora (distributary flow) planning units. Development of State Trust Land will need to follow any new regulations; however, it will also benefit from implementation by other property owners in the watershed. Early planning efforts that establish an understanding and awareness of these watershed planning objectives will provide the ASLD with a conduit for smoother implementation and could provide a means of coordination between Goodyear and unincorporated Maricopa County where a parcel is in both jurisdictions.

4.3.6 Maricopa County Owned Lands

Maricopa County as a land management agency owns property in the northeastern portion of the study area which is basically included as the Estrella Mountain Regional Park. It is mainly in mountain and foothill areas where existing regulations should be adequate for flood hazard mitigation.

5.0 HYDROLOGY

5.1 INTRODUCTION

The process being used to validate the effectiveness of maintaining hydrologic and hydraulic functionality relies on testing proposed regulations with a watershed approach. The design examples in Section 4.0 only consider localized impacts. Three development conditions are compared in the evaluation of the watershed:

- Existing (baseline) land use and hydrology that has development without flood mitigation measures
- Future land use and hydrology assuming implementation of existing regulations
- Future land use and hydrology that accounts for adopting preservation corridors for residential development and balancing the densities by lot size reduction (ADMP condition). Modified drainage criteria are also implemented for this alternative.

The Waterman Wash HEC-1 hydrology model was used as a tool in comparing hydrologic functionality. The existing condition and developed condition HEC-1 models were created for the watershed under preceding tasks for the RVADMP project. Then the performance functions and design criteria identified in Section 3.0 were applied to the developed condition HEC-1 model for the Waterman Wash watershed. All three models used for the comparison were based on the 100-year 24-hour with Railroad HEC-1 model.

The developed condition hydrologic analysis incorporated the future condition land use and the 100-year 2-hour retention volume for unincorporated Maricopa County and the City of Avondale, or 100-year 6-hour volume for the City of Goodyear. An 80-percent efficiency factor was applied to all retention in the watershed.

5.2 FLOOD HAZARD MITIGATION PLAN MODELING ASSUMPTIONS

Changes were made to the land use designations and retention volume requirements in order to simulate the flood hazard mitigation plan criteria. The primary factors that were modeled include preservation of undisturbed areas for residential development and increased runoff in developed areas. The modeling assumptions include:

- Only single family residential land use zoned parcels were changed.
- Land use parameters were modified (weighted Green and Ampt infiltration loss parameters) to reflect the revised lot density (du/Ac) of the land use code.

- Runoff coefficient 'C' associated with revised lot density (du/Ac) of the land use code were modified for the retention volume calculations.
- Thirty percent of the overall residential land use area was considered undisturbed, and applied to the Green and Ampt infiltration and runoff coefficient parameters.
- Rainfall depth for all retention volume calculations was based on the 100-year 2-hour rainfall event and 80 percent effectiveness.

The parameters in the DDMSW land use look-up table were modified for single family residential land use codes to account for the 30 percent undisturbed area. Given that 30 percent of a single family parcel will be left undisturbed, the remaining 70 percent of the parcel used a higher density in order to increase the lot count (lot size reduction). The modified land use parameters are shown in Table 5-1. Areas used to calculate required retention volumes of the residential land use codes were reduced by 30 percent to account for the undisturbed area.

Table 5-1 Modified Land Use

Veg Cover	rtimp	ia	kn	Classification
22	5	0.32	0.04	Rural Residential
22	6	0.32	0.04	Estate Residential
43	16	0.31	0.04	Large Lot Residential
43	24	0.28	0.04	Medium Lot Residential
43	28	0.28	0.02	Small Lot Residential

In order to determine the impacts of the flood hazard mitigation plan criteria on the hydrologic and hydraulic functionality on a smaller scale, one SWC (Sonora SWC-3) was evaluated. The sub-basins contributing to Sonora SWC-3 that had single family residential as its future land use were sub-divided. The sub-basins were split into either developed areas with modified residential land use or undisturbed areas that included the thirty percent open space as part of the flood hazard mitigation criteria.

The hydrologic parameters were calculated for each sub-basin and then updated in the HEC-1 model. Five different HEC-1 models were created for five different retention volume requirements. The retention requirements modeled were the first flush (0.5 inch of runoff volume), 100-year 2-hour, 50-year 2-hour, 25-year 2-hour and 10-year 2-hour retention volumes. The runoff volume and peak discharges for each of the five conditions were compared with existing conditions and developed conditions.

5.3 CUMULATIVE IMPACTS OF RECOMMENDED PLAN

The overall analysis of the ADMP using the methodology described in Section 5.2 shows that flood hazard mitigation is achieved. More importantly, the results show that using the ADMP methodology, when compared to current regulations, will have less of an impact to watershed functionality with respect to runoff volume and peak discharge. Table 5-2 compares the peak discharges and volumes from the ADMP condition to the existing and developed conditions for select concentration points in the watershed and along Waterman Wash.

The refined analysis for Sonora SWC-3 is tabulated in Table 5-3. The table provides a comparison of runoff volume, peak discharge, and retention volume requirements for five retention requirement scenarios. The analysis showed that the 50-year 2-hour retention criteria yielded runoff volumes that are closer to existing condition volumes than the other retention scenarios. However, the peak discharges are slightly higher for some of the sub-basins due to several factors. By further sub-dividing the sub-basins to account for the undisturbed areas and developed areas the peak discharge increased due to change in time of concentration calculations. In addition, the combination of hydrographs from the sub-divided sub-basins also changes the peak discharges.

The cumulative runoff volume at the downstream end of the SWC is less than the existing conditions for all scenarios except the first flush requirement condition. The cumulative results show that the first-flush volume is the same as the existing volume and that the next closest retention scenario is the 10-year 2-hour. However, when reviewing the results for the individual sub-basins the runoff volumes are higher than existing conditions thereby failing to achieve flood hazard mitigation. This shows that the ADMP methodology must be evaluated at both the overall watershed scale and the smaller scale applicable to individual developments in order to satisfy flood hazard mitigation and watershed functionality.

Results of this evaluation suggest that the runoff volume retention for 100-year and 50-year 2-hour and the 30-percent undisturbed area preservation satisfy pre-vs-post development requirement for controlling runoff volume for both individual sub-basins and for the overall SWC watershed. A more refined analysis should be carried out to determine the most appropriate retention requirements and undisturbed area percentage that will achieve flood mitigation in concert with preservation of watershed function. This should be done by expanding the more refined analysis to a larger part of the Waterman Wash watershed. It should be noted that the assumption of preserving 30-percent of a development as undisturbed area may not be the ideal percentage and was selected to help demonstrate the impacts of preserving undisturbed areas.

Table 5-2 Peak Discharge and Volume Comparison Table
Existing, Future, and ADMP Conditions

Existing Conditions 100-Year, 24 Hour Storm Modeled with Railroad				
HEC-1 Identifier	Peak Flow (cfs)	Time of Peak (hr)	Volume (ac-ft)	Contributing Area (sq.mi.)
D39RIV	5782	14.5	3767	172
CPB12	4617	16.0	1503	68
CPH72	882	15.7	284	5
A42RIV	10943	17.7	7331	341
CPA45	939	13.2	208	5
CPA56	1795	14.0	535	18
CPI63	1448	12.5	487	9
A62RIV	11286	20.2	9162	422

Future Conditions 100-Year, 24 Hour Storm Modeled with Railroad				
HEC-1 Identifier	Peak Flow (cfs)	Time of Peak (hr)	Volume (ac-ft)	Contributing Area (sq.mi.)
D39RIV	3907	14.7	2717	172
CPB12	4960	16.0	1597	68
CPH72	600	16.2	163	5
A42RIV	8609	18.3	5088	341
CPA45	254	15.0	109	5
CPA56	1239	14.3	430	18
CPI63	615	14.8	316	9
A62RIV	8793	20.7	5638	422

ADMP Conditions 100-Year, 24 Hour Storm Modeled with Railroad				
HEC-1 Identifier	Peak Flow (cfs)	Time of Peak (hr)	Volume (ac-ft)	Contributing Area (sq.mi.)
D39RIV	4221	14.7	3004	172
CPB12	4637	16.0	1478	68
CPH72	690	16.0	208	5
A42RIV	8907	18.0	5551	341
CPA45	384	14.2	151	5
CPA56	1526	14.2	471	18
CPI63	992	14.2	420	9
A62RIV	9364	20.5	6559	422

Peak Flow Difference Between Existing, Future and ADMP Conditions				
HEC-1 Identifier	Peak Flow Diff (Existing vs Future) cfs	Peak Flow Diff (Existing vs Future) %	Peak Flow Diff (Existing vs ADMP) cfs	Peak Flow Diff (Existing vs ADMP) %
D39RIV	1875	32	1561	27
CPB12	-343	-7	-20	0
CPH72	282	32	192	22
A42RIV	2334	21	2036	19
CPA45	685	73	555	59
CPA56	556	31	269	15
CPI63	833	58	456	31
A62RIV	2493	22	1922	17

Runoff Volume Difference Between Existing, Future and ADMP Conditions				
HEC-1 Identifier	Runoff Volume (Existing vs Future) cfs	Runoff Volume (Existing vs Future) %	Volume Diff (Existing vs ADMP) cfs	Volume Diff (Existing vs ADMP) %
D39RIV	-287	-11	763	20
CPB12	119	7	25	2
CPH72	-45	-28	76	27
A42RIV	-463	-9	1780	24
CPA45	-42	-39	57	27
CPA56	-41	-10	64	12
CPI63	-104	-33	67	14
A62RIV	-921	-16	2603	28

Notes:
The values w ere based of the ADMP condition HEC-1 model

Table 5-3 Sonora SWC-3 Condition Peak Discharge and Runoff Volume Comparison Table

Hec-1 ID	Peak Discharge (cfs)							Time to Peak								Runoff Volume (ac-ft)							Retention Volume (ac-ft)				
	Existing Condition	Future Condition - ADMP condition split Basin First Flush	Future Condition ADMP condition split Basin 100-yr 2-hr	Future Condition ADMP condition split Basin 50-yr 2-hr	Future Condition ADMP condition split Basin 25-yr 2-hr	Future Condition ADMP condition split Basin 10-yr 2-hr	Future Conditions - Current Regulations	Existing Condition	Future Condition ADMP condition split Basin First Flush	Future Condition ADMP condition split Basin 100-yr 2-hr	Future Condition ADMP condition split Basin 50-yr 2-hr	Future Condition ADMP condition split Basin 25-yr 2-hr	Future Condition ADMP condition split Basin 10 yr 2-hr	Future Conditions - Current Regulations	Future Condition ADMP condition Composite Basin	Existing Condition	Future Condition ADMP condition split Basin First Flush	Future Condition ADMP condition split Basin 100-yr 2-hr	Future Condition ADMP condition split Basin 50-yr 2-hr	Future Condition ADMP condition split Basin 25-yr 2-hr	Future Condition ADMP condition split Basin 10 yr 2-hr	Future Conditions - Current Regulations	Future Condition ADMP condition split Basin First Flush	Future Condition ADMP condition split Basin 100-yr 2-hr	Future Condition ADMP condition split Basin 50-yr 2-hr	Future Condition ADMP condition split Basin 25-yr 2-hr	Future Condition ADMP condition split Basin 10-yr 2-hr
B12	244						257	12.5						12.5	12.5	13						21					
B12FA		184	184	184	184	184			12.17	12.17	12.17	12.17	12.17				10	10	10	10	10						
B12E		226	226	226	226	226			12.33	12.33	12.33	12.33	12.33				9	9	9	9	9						
CPB12P		352	250	309	352	352	185		12.33	12.33	12.33	12.33	12.33	12.5	12.5		15	11	12	13	14	10	3.19	7.17	6.36	5.59	4.57
C36	1614						1541	12.67						12.67	12.67	99						99					
C36AF		106	106	106	106	106			12.33	12.33	12.33	12.33	12.33				4	4	4	4	4						
C36E		1562	1562	1562	1562	1562			12.67	12.67	12.67	12.67	12.67				96	96	96	96	96						
CPC36A		1575	1562	1562	1562	1564	1541		12.67	12.67	12.67	12.67	12.67	12.67	12.67		97	96	96	96	96	90	2.62	5.89	5.23	4.59	3.76
C51	97						361	13.17						12.33	12.33	14						36					
C51AF		326	326	326	326	326			12.33	12.33	12.33	12.33	12.33				26	26	26	26	26						
C51E		44	44	44	44	44			12.5	12.5	12.5	12.5	12.5				3	3	3	3	3						
CPC51A		357	114	202	255	318	95		12.33	12.83	12.67	12.5	12.5	12.33	12.33		21	10	12	15	18	11	7.73	18.88	16.48	14.09	11.26
C52	90						339	13.17						12.33	12.33	13						35					
C52AF		381	381	381	381	381			12.33	12.33	12.33	12.33	12.33				27	27	27	27	27						
C52E		49	49	49	49	49			12.5	12.5	12.5	12.5	12.5				3	3	3	3	3						
CPC52A		427	48	145	286	307	61		12.33	12.5	12.67	12.5	12.33	12.33	12.33		21	8	11	14	17	9	8.39	21.92	18.90	15.83	12.41
C53	91						330	13.17						12.5	12.5	13						35					
C53AF		299	299	299	299	299			12.33	12.33	12.33	12.33	12.33				26	26	26	26	26						
C53E		43	43	43	43	43			12.5	12.5	12.5	12.5	12.5				3	3	3	3	3						
CPC53A		324	55	127	223	324	124		12.5	13	12.83	12.67	12.5	12.67	12.67		21	8	11	14	17	11	8.25	20.22	17.64	15.07	12.03
B05	415						382	12.5						12.67		21						23					
B05FA		212	212	212	212	212			12.17	12.17	12.17	12.17	12.17				7	7	7	7	7						
B05E		374	374	374	374	374			12.5	12.5	12.5	12.5	12.5				17	17	17	17	17						
CPB05P		398	374	374	378	398			12.33	12.5	12.5	12.33	12.33				21	17	18	19	20		3.21	7.21	6.40	5.62	4.60
B10	504						433	12.5						12.67		23						29					
B10FA		316	316	316	316	316			12.17	12.17	12.17	12.17	12.17				13	13	13	13	13						
B10E		364	364	364	364	364			12.33	12.33	12.33	12.33	12.33				14	14	14	14	14						
CPB10P		648	364	364	364	467			12.33	12.33	12.33	12.33	12.33				19	14	14	14	16		6.94	15.59	13.83	12.14	9.94
B11	220						217	12.5						12.5		10						13					
B11FA		73	73	73	73	73			12.33	12.33	12.33	12.33	12.33				3	3	3	3	3						
B11E		170	170	170	170	170			12.5	12.5	12.5	12.5	12.5				8	8	8	8	8						
CPB11P		201	170	170	170	170			12.5	12.5	12.5	12.5	12.5				9	8	8	8	8		2.16	4.84	4.30	3.77	3.09
C47	671						638	12.67						12.67		41						42					
C47FA		95	95	95	95	95			12.17	12.17	12.17	12.17	12.17				3	3	3	3	3						
C47E		663	663	663	663	663			12.67	12.67	12.67	12.67	12.67				39	39	39	39	39						
CPC47P		664	663	663	664	664			12.67	12.67	12.67	12.67	12.67				40	39	39	39	39		1.43	3.22	2.86	2.51	2.05
CPB12	4617	4678	4627	4645	4657	4657	4960	16	16	16	16	16	16	16	16	1503	1511	1482	1488	1494	1496	1597					

Notes:
1. The table includes only sub-basins that contribute to Sonora SWC-3.
2. The ADMP condition analysis was applied only to sub-basins with single family residential land use.
3. The ADMP future condition developments were assumed to occur at the downstream portion of the sub-basins to determine the hydrologic input,parameters. in cases where development was identified in the middle of the basin.

6.0 PLAN VALIDATION

6.1 INTRODUCTION

The ADMP validation process examines the impacts to the watershed, whether negative or positive, by the recommendations contained in the previous sections of this report assuming the recommendations are fully implemented for the area studied. Validation descriptions focus on a determination of how well the recommendations achieve the preservation of important watershed functions needed to mitigate flood hazards as the watershed develops.

6.2 NON-IMPLEMENTATION SCENARIO

In order to consider the effectiveness of the ADMP in accomplishing the identified goals and objectives, it is valuable to consider the potential consequences to the watershed if the ADMP recommendations are not implemented.

Under the current regulatory framework, the accomplishment of context sensitive solutions to mitigate flooding hazards and preserve existing beneficial watershed functions will be largely dependent on individual developers or underlying municipal oversight, resulting in a variety of solutions that will likely range from being highly context-sensitive to areas where flooding solutions focus only on meeting the immediate on-site flooding risks but do not address the overall watershed functions as they relate to other resources. This may result in areas that do not accomplish the stakeholder goals and objectives identified during the ADMP's development and potentially pass flooding on to adjacent owners in the attempt to mitigate on-site flood hazards. Compatibility of flood protection methods, structure types, or design themes will be the result of individual owners' discretions and local municipal requirements, which will increase the probability that incompatible flood hazard mitigation methods will be used. Visually discordant, single use projects will likely result that may also lower the biological or cultural resource value of a given area resulting in the loss of beneficial watershed functions and the value-added opportunities that could have been provided by these facilities.

6.2.1 Flooding Context

Existing floodplain regulations and ordinances have been largely effective in mitigating flooding in the study area at current levels of development. In areas where future flood hazard risks have been identified as being low, for example in areas protected from development such as in the Sonoran Desert National Monument, existing floodplain regulations and ordinances may represent appropriate solutions that respond to both the existing and future flooding context. However, as development in the area continues to expand, flood hazard mitigation may become more difficult through existing regulations and result in impacts to adjacent and downstream land owners. During the ADMP evaluation process, it has become apparent that standard flood mitigation methods, at the individual property owner level, in alluvial fan, sheet flow, and distributary flow areas do not adequately address flood risk and its compounding effects as development intensity increases (see Section 2.8). In the event that the ADMP recommendations are not implemented, it appears likely that the communities within the study area will continue to require additional modifications to their flood protection planning in order to adapt to the changing socio-economic context as new development occurs. CIP-funded projects are likely to be required as a reaction to flooding that does occur.

6.2.2 Land and Resource Context

Current storm water management practices in the area focus on the retention of flooding in lieu of regional storm water conveyance. A possible consequence of this practice as it relates to the land and resource context is the potential for the permanent loss of sustaining flows and their associated functions from the watershed mountains and piedmont into the washes and axial stream as development levels increase significantly above those presently found in the study area. Current practices allow for a reduction in the on-site storage requirements, as determined on a case-by-case basis. This practice is beneficial to the watershed land and resource functions and, in the event that the ADMP is not implemented, should be formalized by the underlying municipalities in a manner that ensures beneficial functions in the washes and other natural conveyances of the watershed are maintained.

Current floodplain regulations allow for development within the flood fringe of the identified SWCs, including Waterman Wash. In addition, removal of the existing riparian vegetation, permitted under existing guidelines especially where the washes do not qualify as jurisdictional waters of the United States, will have negative impacts on the functions these washes serve within the watershed. Development under these regulations will result in a decrease in the beneficial functions served by these floodplains. Open space preservation, regional trail development and other active recreation development, biological diversity preservation and enhancement, cultural resource protection and interpretation, as well as other resource goals are likely to require local municipalities and county and state agencies to act as the lone facilitator. This may result in fewer multi-use goals being accomplished and/or the loss of resources in some areas.

6.2.3 Community Context

The accomplishment of the goals and objectives identified by the project stakeholders and the public is likely to be fully decoupled from flood hazard mitigation. In the event that the ADMP is not implemented, planning for the watershed as a whole is likely to become less feasible as implementation takes place at smaller, politically defined units. The next largest unit for identifying and implementing community goals will be the individual municipality whose focus will define the accomplishment and implementation of the applicable goals and objectives. The planning for multi-use facilities will require the coordination of the various stakeholders on a project-by-project basis, decreasing the likelihood that the goals identified for the ADMP, and synthesized into the watershed performance functions, will be accomplished. Regional goals and objectives will require the City of Goodyear, Town of Buckeye, City of Avondale, and county and state agencies to be more heavily involved and to actively coordinate with one another for watershed-wide goals and objectives to be accomplished.

6.3 STORM WATER RUNOFF

6.3.1 Runoff Volume

Future development increases the impervious surface area in a watershed which in turn increases the runoff volume occurring due to a storm event. To mitigate the increase in runoff volumes, current drainage regulations require the retention of runoff when developments occur to remediate downstream flood hazards. The City of Goodyear requires a retention storage volume for the 100-year 6-hour storm event. Unincorporated Maricopa County, the City of Avondale, and the Town of Buckeye require retention for the 100-year 2-hour storm event. Within a fully developed watershed area, this may capture all of the runoff generated by a small, frequent storm event, leaving no runoff to feed downstream systems thereby disrupting watershed functionality.

The ADMP methodology of reduced retention and preservation of undisturbed areas is validated by the results shown in Table 5-2 which illustrates the runoff volume comparison between existing, developed, and ADMP recommended conditions at certain prominent locations along SWCs and Waterman Wash. The results show that ADMP condition runoff volumes are higher than those generated using current regulations. The cumulative impacts of the ADMP regulations show that the runoff volume that flows into Waterman Wash shows a decrease of approximately 28 percent when compared to the existing conditions at the confluence with the Gila River. Current regulations would have a decrease in runoff volume of approximately 38 percent. The percentage increase in runoff volumes due to recommended regulations when compared to current regulations is less in certain areas when compared to others. This is attributed to the fact that certain areas have a smaller area slated for single family residential development than other areas.

The validation analysis shows that preserving undisturbed areas and reducing the amount of retention helps maintain runoff volume needed to support watershed functionality while mitigating flood hazards.

6.3.2 Peak Discharge

Peak discharge will be reduced downstream of new development due to existing retention requirements. The development approach recommended in the ADMP is predicated on providing natural flow paths, concentrating development to the land and reducing retention requirements. The results of the validation analysis support this conclusion because peak discharges in the washes and in Waterman Wash (see Table 5-2) are greater than when present development practices are applied. The cumulative impacts of the ADMP regulations show that the peak discharge that flows into Waterman Wash shows a decrease of approximately 17 percent when compared to the existing conditions at the confluence with the Gila River. Current regulations would have a decrease in peak discharge of approximately 22 percent. The increase in peak flow of the ADMP results versus the current regulations is not substantial partly because hydrographs are flattened because the developments are concentrated closer to Waterman Wash. These areas impact peaks more than the upper portions of these basins.

The dominant discharge is a more important factor in the health of a wash and Waterman Wash. The ADMP provides more opportunity for washes to receive runoff to help maintain a dominant discharge while also mitigating flood hazards during severe storm events (100-year flood) by reducing peak flows.

6.3.3 Flow Continuity

Maintaining flow continuity within the watershed is vital to achieving watershed functionality. Current regulations focus on mitigating flood hazards but do not provide a means for maintaining flow continuity from the mountains to Waterman Wash. Continuity is disrupted by retention of runoff to existing flow paths.

Currently much of the watershed is undeveloped, which provides a good opportunity to provide flood control measures that will minimize the impact to flow continuity in its natural state. Preserving continuous undisturbed areas and SWCs provides drainageways for the flow. Preservation of tributary, distributary, and sheet flow paths to Waterman Wash and the Gila River is an important factor in achieving flow continuity. Otherwise, flood impacts from individual developments could result as is discussed in Section 2.8.

Flow continuity through sheet flow areas is currently provided from the mountains through the piedmont via overland flow (sheet flow) and small existing wash corridors to Waterman Wash and the disturbed areas. Typical development practices in this portion of the watershed will eliminate existing small washes and sheet flow corridors by intercepting, diverting, and concentrating flows. In addition, runoff from within a development is captured by retention, which does not allow the runoff from smaller storms to contribute flows to the watershed system.

The ADMP will provide a way for regulating and maintaining flow paths through the agency review process and the development of modified policies, guidelines, and ordinances. This will ensure that coordination of flow paths through the system will occur to achieve flow continuity to SWCs, Waterman Wash, or specific wash corridors in the disturbed areas.

Through distributary flow areas continuity occurs even though flow paths bifurcate that distributes flow among multiple flow path corridors to Waterman Wash, the West Prong of Waterman Wash, or the disturbed areas. New development under current regulations may cut off flows to random flow paths by capturing, diverting, channelization, or detaining flow and forcing the flow to a desired flow path. In doing so, primary flow corridors could be depleted so that the functionality of a distributary flow corridor is compromised. As part of the ADMP, primary distributary flow corridors have been identified that have historically conveyed flow from the mountains to Waterman Wash. Undisturbed areas will also provide means for some of the more minor distributary flow corridors to receive seasonal flows that would otherwise be cut off from development and/or retention. The continuity provided by these corridors will be maintained through the regulatory review process and modification of the policies, guidelines, and ordinances.

Using the ADMP to regulate development in the sheet flow and distributary flow areas will help simulate the flow characteristics of the landform rather than allow them to be changed completely by current development practices.

6.3.4 Stream Storage

In Rainbow Valley stream storage occurs in the floodplains in the undisturbed areas associated with the washes and their adjacent floodplains. The washes traverse three very different types of areas with distinctive flow characteristics as described in Section 2.5. The flow characteristics for these landforms are:

- Tributary Flow
- Sheet Flow
- Distributary Flow

A fourth distinctive flow feature of the study area is Waterman Wash that represents the axial watercourse that collects and conveys the flow from the south to the north where it confluences with the Gila River.

Tributary Flow

Natural floodplain storage attenuates flows, reduces peak discharges, and mitigates flood hazards to downstream properties. Where detailed studies have been prepared, floodplains and floodways have been delineated and the limits of the flood hazard have been established. In other areas only approximate floodplain limits have been delineated. Existing regulations mitigate for the increase in runoff from development by providing storage of excess runoff that in many cases actually reduces flows to the washes because current regulations require on-site retention of the 100-year, 2-hour duration runoff or 100-year, 6-hour duration runoff (City of Goodyear). The reduction of runoff in many cases also balances the loss of floodplain storage due to development encroaching into the floodplain. However, there can be cases where this does not occur and the downstream flood hazard risk increases. The ADMP recommends, where viable, for the loss of floodplain storage to be accounted for when determining the discharge used for delineating the floodway. In this way the impact of development that occurs within the floodplain fringe but outside of the floodway limits is accounted for as lost stream storage. The base flood elevation and floodway width both increase as a result of the lost floodplain storage. It should be noted, where washes are well incised and the floodplain is shallow and narrow, that stream storage may be minimal. The developed condition model analysis done for the watershed shows that flows are reduced as a result of the existing retention requirement imposed on new development. A detailed study of Waterman Wash shows that allowing development to encroach to the floodway limits increases discharge. The proposed floodway limits for Waterman Wash account for this loss in storage.

Sheet Flow

Sheet flow areas in the study area lack defined washes that would provide stream storage. There are a few washes in these areas that have been designated as SWCs that include Estrella SWC-2 in the southern portion of the Estrella Planning Unit and Mobile SWC-1 in the Mobile Planning Unit. To preserve floodplain storage the ADMP is recommending floodplains and floodways be delineated and remain in their natural condition. Erosion Hazard Zones have been developed to account for natural erosion processes to occur unimpeded while not causing increased flood hazards to adjacent development. Preservation of the floodplain in the SWC maintains stream storage and does not increase flows to Waterman Wash. In addition to floodplain storage associated with SWCs, preservation of undisturbed areas also provides overland flow storage attributed to sheet flow.

Distributary Flow

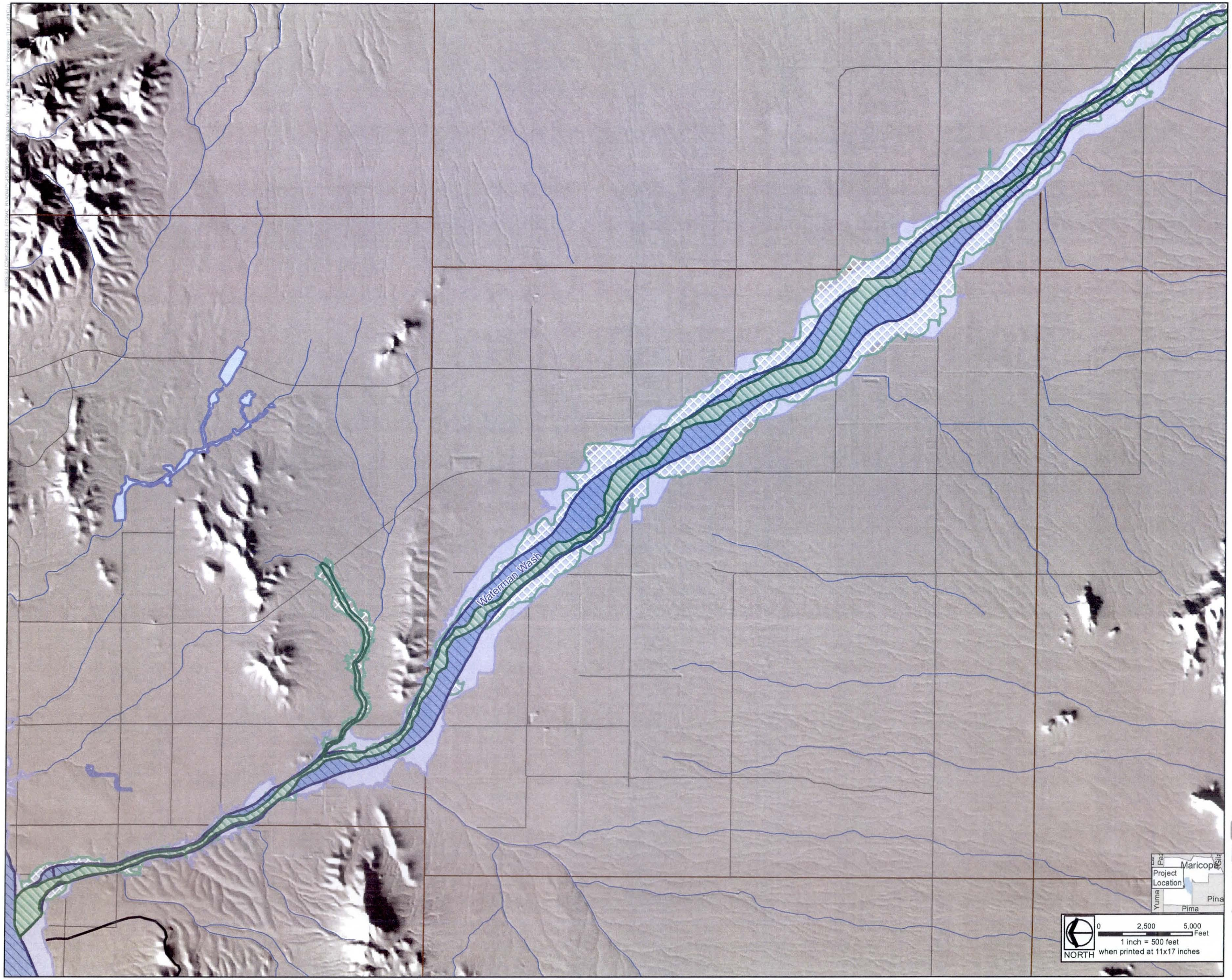
The geomorphic landform of distributary flow in the piedmont changes over time as a result of rainfall-runoff events. Many of the small washes change in time and do not necessarily provide stream flow storage. Only some significant bifurcations as identified in Figure 3-1 are somewhat stable and could provide attenuation to downstream flows. Four such washes were identified in the ADMP as SWCs in the Sonora Planning Unit (Figure 1-2). Typical cross sections for these washes are shown in Figure 3-28 where floodplains and floodways are preserved. Erosion hazard zone setbacks are also recommended that may provide additional storage. Otherwise storage through retention is required when development occurs to mitigate any loss of storage when smaller washes are removed when the property is developed. Increased on-site storage is also needed to mitigate for increased impervious area caused by development. Another way stream storage is accounted for in a SWC is through delineating the floodway and calculating the base flood elevation as if the land adjacent to the floodway is filled and the 100-year peak discharge (base flood) increases because of the loss of floodplain storage.

Waterman Wash

Waterman Wash is the major stream storage feature in the watershed. The effective floodplain of Waterman Wash ranges from less than one-tenth of a mile to approximately one-mile in width. The dominant discharge channel is smaller in most areas but still provides significant stream storage along the watercourse. As part of the ADMP the hydrologic model of the watershed was updated to reflect recent rainfall data with the results showing a significant reduction in the 100-year peak discharge (over 50 percent) as well as a significant reduction in the floodplain (in review by the District and FEMA). Although the stream storage width has been reduced, there is still significant storage capacity that reduces the peak discharges in the downstream flow direction. As part of the detailed floodplain and floodway analysis of Waterman Wash an assumption was made that development could encroach and fill to the floodway limits removing stream storage volume and the capacity of the floodplain to attenuate flows and reduce the downstream flood risk. To capture this condition (presently allowed in Goodyear and unincorporated Maricopa County floodplain ordinances), the new Waterman Wash watershed was modeled assuming the floodplain storage was lost. The loss of floodplain storage increased the flows by approximately 10 percent in Waterman Wash and increased the risk of flooding along the wash. To account for and mitigate for the lost storage and subsequent increased flows, the floodway was delineated assuming the flows are greater than in the existing hydrologic model results. The results are a wider floodway with more storage and higher base flood elevations along Waterman Wash. **Figure 6-1** shows an example of the effective and proposed floodplain and floodway limits for Waterman Wash.

Rainbow Valley
Area Drainage Master Plan
Existing and Proposed
Floodplain and Floodway Limits

Figure 6-1



Project Features

- Proposed Floodway
- Proposed Zone AE
- Existing Floodway
- Existing Zone AE
- Existing Zone A

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream
- Railroad

Data Sources

Existing Flood Hazard, Base Map Data, Hillshade:
Flood Control District of Maricopa County
Proposed Flood Control Data: URS Corporation 2010

6.3.5 Watercourse Conveyance

In Rainbow Valley watercourse conveyance occurs in the floodplains in the undisturbed areas associated with the washes and their floodplains. As in the discussion on stream storage, the washes traverse 3 very different types of areas with distinctive flow characteristics as described in Section 2.5. The flow characteristics for these forms are:

- Tributary Flow
- Sheet Flow
- Distributary Flow

The fourth distinctive flow feature of the study area is Waterman Wash that represents the axial watercourse that collects and conveys the flow from the south to the north where it confluences with the Gila River.

The validation approach considered for conveyance on a watershed basis is similar to that of storage so the discussions related to loss of floodplain storage and preservation of the floodway and floodplain for Waterman Wash and the SWCs is the same. The discussion regarding increased flows in washes as a result of floodplain encroachment is also the same. Implementation of floodplains, floodways, SWCs and the typical SWC and Waterman Wash cross-sections should mitigate for increases in flows. Where this is not the case existing and proposed retention criteria should be used to effectively maintain existing flow rates.

Where there are no specific watercourses, preservation areas are used to convey flows. These preservation areas convey flows downstream under natural condition and should be aligned/ inter-connected providing continuous paths from the mountain areas to Waterman Wash.

Tributary Flow

Development occurs where runoff is collected in smaller washes and combines in a dendritic pattern in the downstream (down slope) direction. Preservation of the wash systems from the mountain foothills to the Gila River and Waterman Wash is needed to maintain flow conveyance. Maintaining adequate wash capacity is achieved through determining adequate wash cross-section for the 100-year flood. Larger developments such as Estrella Mountain Ranch provide the means achieving conveyance and do so. Smaller developments and multiple landowners along a watercourse are required to obtain USACE 404 permits and local floodplain ordinances that protect or require mitigation for impacts to watercourses. The permits normally provide continuous flow paths and require that conveyance capacity be maintained even if altered. Many of the major watercourses such as Lum Wash and Corgett Wash have delineated floodplains and floodways. Therefore watercourse conveyance should be achieved in tributary flow areas without requiring additional or modified regulations.

Sheet Flow

In sheet flow areas watercourse conveyance is achieved by designating two SWCs to collect and convey runoff to Waterman Wash. These SWCs are located in the following locations (Figures 2-3 and 2-6):

- South Estrella Planning Unit (Estrella SWC-2)
- Mobile Planning Unit (Mobile SWC-1)

Other sheet flow areas are located in Secure Open Space and should not be significantly impacted by development or flow to disturbed areas as in the Estella Planning Unit where flow watercourse conveyance is presently non-existent except by irrigation ditches. As discussed in Section 3.4.8 (Disturbed Areas) the recommendation is to develop drainage corridors in the disturbed areas that will provide flow paths to convey flows to Waterman Wash. To do so agreement between property owners and agencies will be required. In the sheet flow areas preservation corridors are recommended as part of developments that provide shallow runoff conveyance through the development as shown in the FLO-2D models described in Sections 3.4.3 and 3.4.4.

Distributary Flow

The ADMP has identified four SWCs in the Sonora Planning Unit to provide watercourse from the Maricopa Mountains to Waterman Wash. In doing so major bifurcations were reviewed and the dominant wash corridor was selected for the flow path. This process eliminates other flow paths when development occurs though there should be adequate spacing that allows flows to enter Waterman Wash. Two SWCs are located in the north portion of the planning unit and two in the south. The southernmost SWC is the West Prong of Waterman Wash. The SWCs as stated earlier will include floodplains and floodways that provide adequate conveyance to Waterman Wash. As in the case of sheet flow areas, a discontinuity occurs in the central Sonora Planning Unit from disturbed agricultural lands. The only conveyance in the disturbed areas occurs in agricultural ditches. As discussed in Section 3.4.8 of the report, providing conveyance corridors in the disturbed areas is recommended. Other distributary flow areas are located on public lands such as the Sonora Desert National Monument so flow patterns and natural conveyance should be maintained. In the distributary flow areas preservation corridors are recommended as part of developments that provide runoff conveyance paths through the development as shown in the FLO-2D models described in Section 3.4.6 and 3.4.7.

Waterman Wash

The floodway delineation methodology described in Section 3.3.4.1 and in Section 6.2.4 (Waterman Wash) describes how conveyance is maintained in the floodway even when development encroaches to its limits. The floodway conveyance and width is determined using the discharges for the full floodplain encroachment and the base flood elevation determined using the higher discharge. Therefore adequate conveyance is achieved in Waterman Wash.

6.4 PIEDMONT STABILITY

Current stormwater and floodplain regulations largely depend on the use of retention and structural solutions to maintaining runoff and flood control solutions. The ADMP goal of preserving SWCs in a natural and undisturbed state provides a source of sediment and means of transport from the upper piedmont to the axial washes, e.g., Waterman Wash. Through this natural corridor sediment is able to be supplied to the ephemeral and axial washes thereby accomplishing the goal of piedmont stability by attempting to limit and control the amount of erosion that would take place and require other structural methods to be implemented.

6.4.1 Sediment Transport Capacity

A goal of the ADMP is to maintain sediment transport capacity in washes as development occurs. As development expands transport capacity is negatively impacted through the removal of sediment sources from runoff. Through the preservation of the SWCs as undisturbed and natural washes the natural capacity would be maintained in portions of the watershed to the outlet into Waterman Wash. In areas where significant development occurs, by providing the undisturbed open space, a source of sediment for the SWCs is provided which under the current regulations would not be available. The undisturbed areas within the SWCs include the buffer area set aside as part of the erosion hazard setback. The setbacks based on the ADWR SS 5-96 Lateral Migration Setback Allowance for Riverine Floodplains in Arizona provide a buffer to the 100-year floodplain and another source of sediment for runoff.

As development occurs runoff will decrease due to retention, which could be construed as a benefit by reducing scour potential from reduced peak discharges. However, sediment supply will also decrease due to increased impervious area. The watercourses that convey water and transport sediment will have to re-adjust to satisfy the sediment transport capacity, but if the area develops under current regulations, detrimental impacts could result from sediment transport capacities not being satisfied. Detrimental impacts could include not only scour but deposition if the transport capacities are not allowed to adjust naturally or prevented from adjusting due to road crossings or channelization.

Undisturbed open space also serves as a source for sediment for areas that are not directly connected to the SWCs but ultimately outfall into Waterman Wash or the Gila River. The ADMP strategy of providing a low flow channel sized for the dominant discharge carries the sediment fed to it from the undisturbed open space within a development to downstream locations. The low flow channel within a larger trapezoidal shape section allows for sediment capacity and continuity to be maintained.

6.4.2 Sediment Continuity

Current storm water management practices require the retention of either the 100-year 6-hour or the 100-year 2-hour storm event. A consequence of these regulations is the removal of sediment loads from ephemeral washes which outfall into the axial streams such as Waterman Wash. Through the development and detainment of run-off the sediment continuity within the watershed is interrupted which leads to adverse impacts to downstream property owners and receiving bodies of water, e.g., SWCs, Waterman Wash, and Gila River. Adverse impacts can include scour/lateral erosion and head cutting that could all lead to costly repairs and maintenance of infrastructure. A goal identified for the ADMP is the preservation of open space to prevent the complete removal of sediment from the ephemeral streams and axial washes in the watershed. The ADMP considered the use of undisturbed open space and protecting conveyance in the SWCs along with erosion hazard setback requirements. The preservation corridor and sediment transport SWCs serve as sources of sediment for the washes for the purpose of maintaining some level of sediment continuity throughout the watershed.

A DDMSW model was created to estimate the sediment yield for the existing, future, and ADMP conditions. The DDMSW model used the MUSLE method to determine the wash load, and the total bed material load is calculated with the Zeller-Fullerton equation. Sediment yield was calculated for the 2-, 5-, 10-, 25-, 50-, and 100-year 24-hour events. The modifications made to the land use data to model future development only affect the results of the wash load calculation; the bed load calculation remains independent of land use changes. To determine the total sediment yield at a downstream point the bed load is added to the wash load which has been reduced by the Sediment Delivery Ratio.

The ADMP condition land use requirements were integrated into the future land use data to simulate the ADMP plan's regulation assuming 30 percent undisturbed open space within a residential development. Additional modeling assumptions made include:

- Removing residential land use from the SWC drainage area to reflect the current regulation requirements of runoff detainment and a developed area of land's inability to contribute sediment.
- Only the wash load was changed to reflect residential areas.
- Adding 30 percent of the removed residential land area back into the SWC as open space in the sediment yield analysis.
- Flows and volumes from the existing conditions hydrology for both the ADMP model and the developed conditions using current regulations model were used to so that the comparison is based only on the areas that could contribute sediment.

The results for the sediment yield analysis are detailed in Table 6-1 and Table 6-2. The SWC watersheds in the Sonora Planning Unit were discarded from the comparison due to the fact that the percentage of land that was open space far outweighed the land that was designated for development. As such, only the SWC watersheds in the Estrella Planning Unit were used for the comparison.

The sediment yield results suggest that the effect of preserving 30 percent of the undisturbed area as open space within a residential development is minor when compared to the sediment yield for developed conditions under current regulations. The results also show that the majority of the sediment is being generated by the bed load when compared to the wash load. This is further justification for preservation of SWCs in their natural state. The preservation of open space in the SWC watersheds and in other watershed areas helps provide a supply of sediment, although at a reduced level, but more importantly provides a path to the system outlet. Thus, through the combination of preserving undisturbed areas and SWCs, the sediment functions contributing to the overall watershed functionality are achieved.

Table 6-1 Estrella SWC-1 Total Yield Summary

	Estrella SWC-1	Wash Load	
	Existing	Future	ADMP
2-year	1.849	0.01	0.025
5-year	3.495	0.052	0.198
10-year	5.365	0.213	0.663
25-year	8.601	0.715	2.085
50-year	11.332	1.557	3.234
100-year	14.546	2.708	4.64
Annual	2.6	0.124	0.304

	Estrella SWC-1	Bed Load	
	Existing	Future	ADMP
2-year	0.073	-	0.001
5-year	0.156	0.002	0.014
10-year	0.255	0.017	0.067
25-year	0.12	0.084	0.237
50-year	0.118	0.206	0.394
100-year	0.156	0.378	0.125
Annual	0.09	0.014	0.026

	Estrella SWC-1	Total Yield	
	Existing	Future	ADMP
2-year	1.922	0.01	0.026
5-year	3.651	0.054	0.212
10-year	5.62	0.23	0.73
25-year	8.721	0.799	2.322
50-year	11.45	1.763	3.628
100-year	14.702	3.086	4.765
Annual	2.69	0.138	0.33

Table 6-2 Estrella SWC-2 Total Yield Summary

Estrella SWC-2	Wash Load Existing	Future	ADMP
2-year	3.093	0.517	0.667
5-year	5.276	0.841	1.06
10-year	7.704	1.176	1.502
25-year	12.096	1.807	2.411
50-year	14.948	2.352	3.549
100-year	20.24	3.198	4.946
Annual	3.92	0.625	0.823

Estrella SWC-2	Bed Load Existing	Future	ADMP
2-year	0.31	0.187	0.183
5-year	0.518	0.301	0.307
10-year	0.895	0.403	0.403
25-year	1.794	0.707	0.839
50-year	2.391	1.086	1.438
100-year	3.69	1.687	2.396
Annual	0.462	0.237	0.258

Estrella SWC-2	Total Yield Existing	Future	ADMP
2-year	3.403	0.704	0.85
5-year	5.794	1.142	1.367
10-year	8.599	1.579	1.905
25-year	13.89	2.514	3.25
50-year	17.339	3.438	4.987
100-year	23.93	4.885	7.342
Annual	4.382	0.862	1.081

6.5 SCENERY, RECREATION, AND OPEN SPACE RESOURCES

Early inventory and evaluation of the scenery, recreation, and open space resources within the study area was based on the District's CSFHMPD, and in particular the evaluation of the compatibility of potential flood protection structures and methods with these three resource groups. This information was synthesized into two maps: the Combined Resource Structure Types Compatibility Map (**Figure 6-2**), and the Combined Resource Flood Protection Methods Compatibility Map (**Figure 6-3**). These two figures identify areas where the three resource groups are best benefited by the use of non-structural flood hazard mitigation techniques compared to areas where structural solutions may be compatible provided they are design using the correct flood protection methods. The implementation of the ADMP, by the inclusion of the recommendations into municipal policies, guidelines, and ordinances (PGOs), will result in flood hazard mitigation that is generally compatible with the information mapped on these figures. This will be accomplished through:

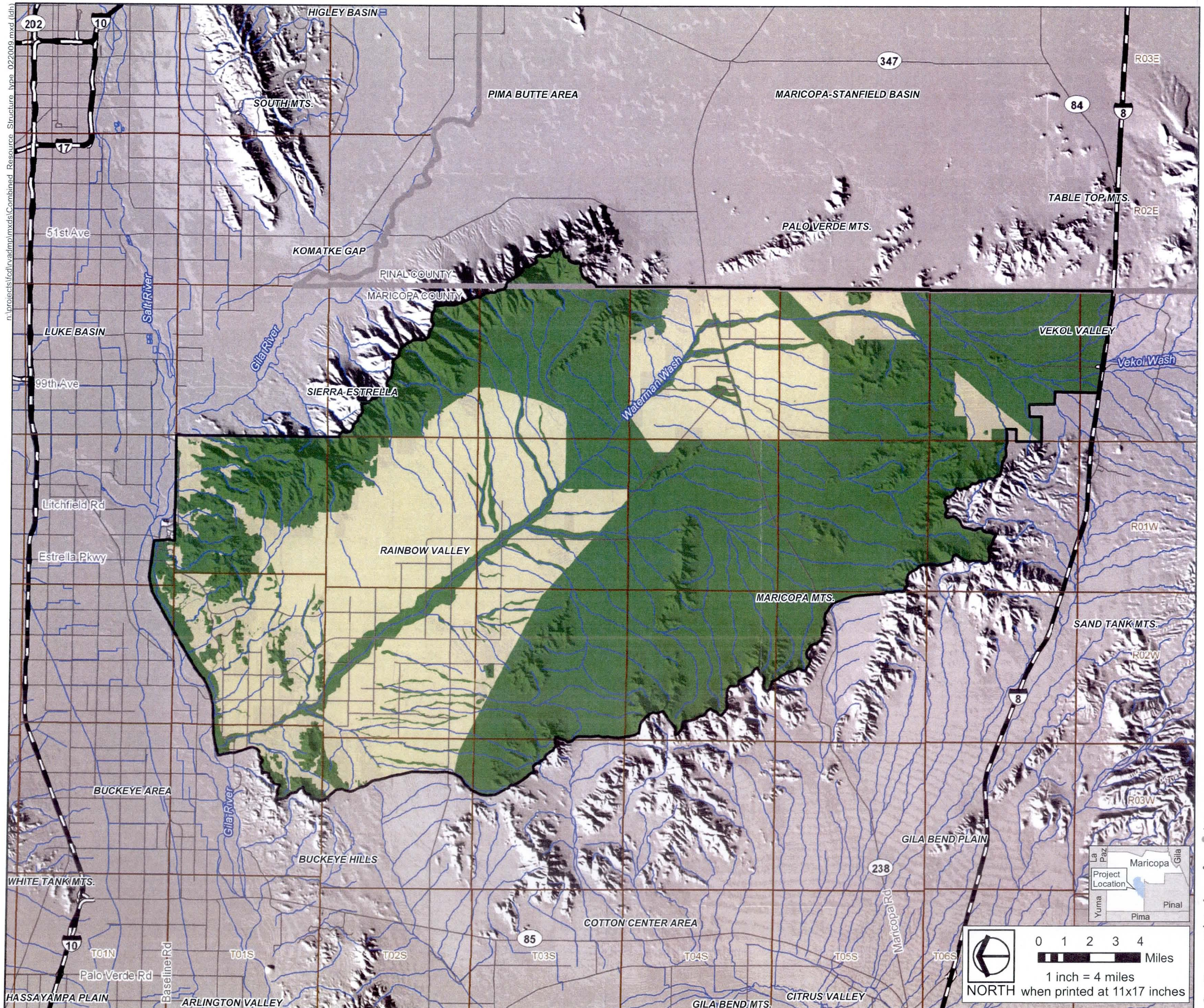
- Protection of the SWCs including Waterman Wash
- Implementing open-space preservation as part of the overall flood hazard mitigation strategy within the undisturbed piedmont
- Designing constructed facilities in the disturbed areas as well as those required for future transportation corridors using design guidelines identified to facilitate multiple-resource objectives

Details of how each of these recommendations impact the scenery, recreation, and open space resources of the watershed are outlined in the sections below.

Validation of the success of the ADMP includes comparing the ADMP with the City of Goodyear's General Plan 2003-2013, Chapter 4.0 – Open Space Element. This chapter serves as the most current, adopted resource for evaluating the effectiveness of recreation and open space resource implementation within the City limits and is reference throughout the sections below. It is hereafter referred to simply as the Open Space Element.

Rainbow Valley
Area Drainage Master Plan
Combined Resource
Structure Types Compatibility

Figure 6-2



Project Features

Combined Structure Types Compatibility

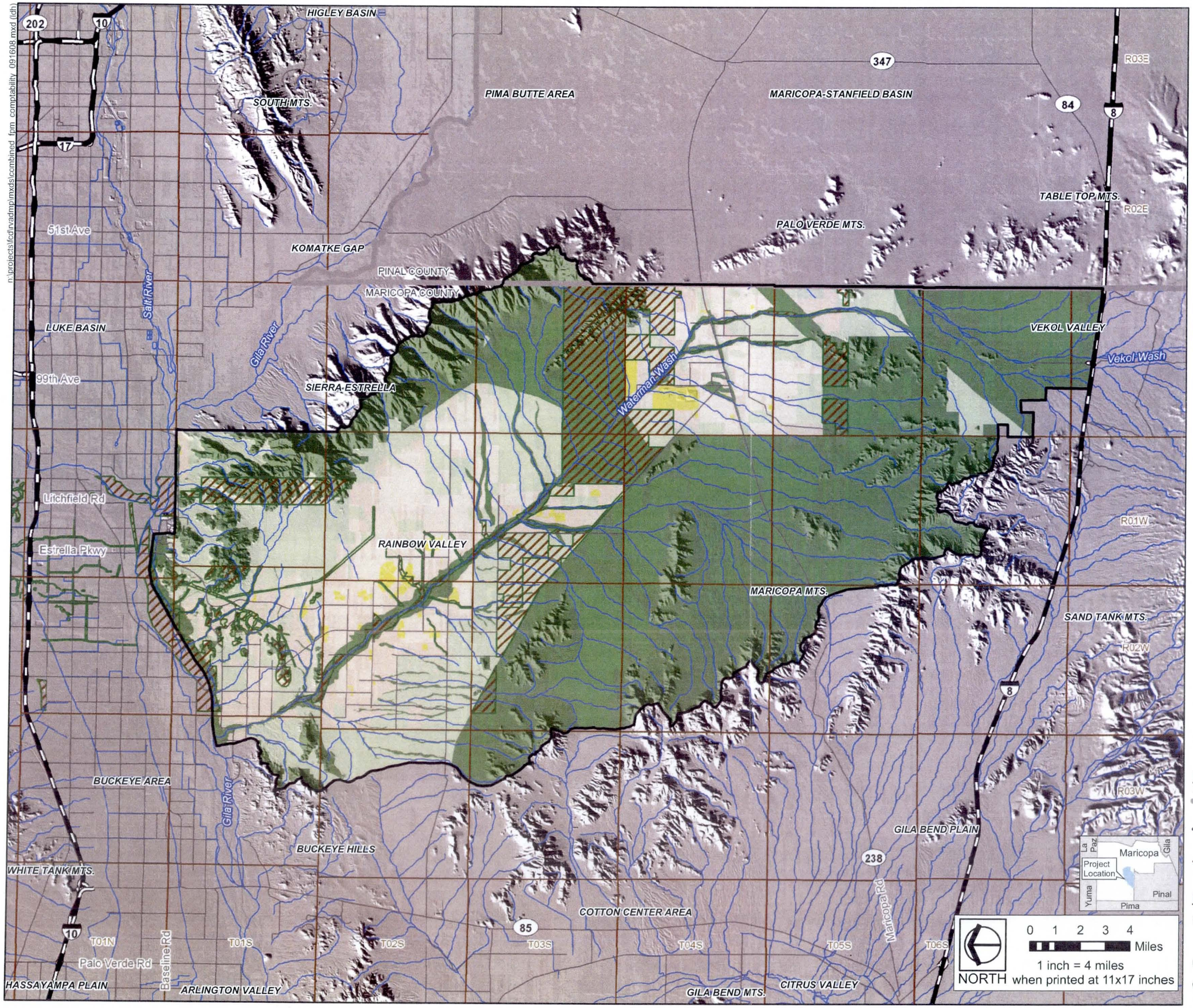
- Compatibility Class 1
- Other - Refer to individual resource flood protection structure type compatibilty maps for flood protection planning

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream

Data Sources

Flood Control District of Maricopa County Landscape Inventory & Analysis (LIA), 2008
Landscape Character Units Structure Types Compatibility Map, 2008
Parks & Recreation Resources Structure Types Compatibility Map, 2008
Open Space Resources Structure Types Compatibility Map, 2008
URS Corporation
Flood Protection Structure Types Compatibility, 2009
City of Goodyear Land Use Plan, 2008



Rainbow Valley
Area Drainage Master Plan
Combined Resource
Flood Protection Methods Compatibility

Flood Control District of Maricopa County

Figure 6-3

Project Features

Combined Flood Protection Methods Compatibility

- Compatibility Class 1
- Compatibility Class 2
- Compatibility Class 3
- Compatibility Class 4

Other Designations

- City of Goodyear Open Space

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- River/Stream

Data Sources

Flood Control District of Maricopa County Landscape Inventory & Analysis (LIA), 2008
Landscape Character Units Flood Protection Methods Map, 2008
Parks & Recreation Resources Flood Protection Methods Map, 2008
Open Space Resources Flood Protection Methods Map, 2008
URS Corporation
Flood Protection Methods Compatibility, 2009
City of Goodyear Land Use Plan, 2008

6.5.1 Protection of Significant Wash Corridors

The recommendation to protect identified SWCs as a non-structural flood hazard mitigation approach is consistent with the resource compatibility mapping previously completed for the ADMP.

Scenery Resources

Protecting the existing riparian vegetation maintains the existing desirable natural scenic character of these features. This existing vegetation also contributes to the scenic value of the washes as trail corridors, especially for equestrian users who prefer to travel in the sandy low-flows of the wash over riding on constructed surfaces.

Recreation Resources

As described in the report, these SWCs provide opportunities to co-locate segments of the Maricopa Regional Trail system within the protected areas of the SWC. These trail segments would create the multiple "east-west" connections that stakeholders indicated were desirable at the outset of the ADMP.

Open Space Resources

Floodplains associated with the SWCs are considered environmentally sensitive lands in the MAG *Desert Spaces Plan* and protection of a portion of these areas within the erosion hazard zones (EHZ) of the SWCs helps protect the open space resources associated with the washes.

This recommendation of the ADMP facilitates multiple goals and objectives identified in Chapter 4.2 Open Space Goals, Objectives and Policies of the Open Space Element, including:

> **Objective C-2:** Utilize natural and man-made corridors for land use buffers and open space connections.
>
> > **Policy C-2a:** The City shall utilize … Corgett, and Lum Washes … as land use **buffers and multi-use trails.**
> >
> > **Policy C-2c:** The City shall utilize proposed regional drainage corridors as defined in the Flood Control District of Maricopa County's … Area Drainage Master Plans as land use buffers, multi-use trails, and open spaces.

By identifying the areas within the SWCs as "natural open spaces" as defined in the General Plan Section 4.3.1, the portions of the SWCs within the City of Goodyear would assist in meeting multiple General Plan objectives.

6.5.2 Waterman Wash Design Guidelines

By identifying Waterman Wash as a SWC and augmenting the City of Goodyear's *Waterman Wash Concept Plan* to emphasize preservation of the existing natural wash (as compared to modification and restoration of the conveyance as a soft-structural channel intended to replicate a natural wash), the ADMP designates Waterman Wash as a non-structural flood hazard conveyance system which is consistent with the resource compatibility mapping previously completed for the ADMP.

Scenery Resources

As with the SWCs, protecting the existing riparian vegetation maintains the existing desirable natural scenic character of the wash. Modifications and allowable uses within the EHZ are intended to respond to varied adjacent land-uses. The ADMP recommendations result in a compatible solution overall by maintaining the natural wash low-flow and vegetation throughout the watershed, and establishing the flood fringe areas as a visual transition zone between this natural area and the adjacent development. The visual character of this transition area varies based on the specific reach and adjacent development intensity.

Channelizing the wash in accordance with the ADMP design guidelines through Reach 4, or in the area around SR 238, will also help achieve the desired goal of extending the visual character of downstream Waterman Wash further upstream to the south.

Recreation Resources

The dual trails along the wash identified by the City of Goodyear and represented in the Maricopa County Regional Trail System are facilitated by the ADMP recommendations.

Open Space Resources

As with the tributary SWCs, protection of the floodplain within the EHZ of Waterman Wash is consistent with the identified open space goals for the ADMP. Also, the ADMP recommendation to treat Waterman Wash as a SWC facilitates the same goals and objectives identified in the Open Space Element. Preservation or restoration of the agriculture areas within the EHZs of Reach 2A and 2B may also benefit farmland and desert preservation goals that were referenced but not specifically identified in the Open Space Element.

6.5.3 Lot-Reduction/Open Space Preservation for Flood Hazard Mitigation

The combined resource compatibility maps demonstrate that certain structural as well as non-structural flood hazard mitigation methods and structure-types are compatible with the scenery, recreation, and open space resources in the undeveloped piedmont areas of the ADMP. The use of lot reduction to preserve open space areas (a non-structural method) within the piedmont is consistent with the compatibility mapping.

Scenery Resources

Stakeholder goals identifying the desire to preserve the natural and rural character of the area are better met through this mitigation technique than through structural methods, contributing to the success of the ADMP in accomplishing scenery and open space resource preservation objectives. In particular, the preservation of natural flow paths in sheet flow and distributary flow areas of the watershed influence the quality of the view of the valley from the adjacent protected mountain areas.

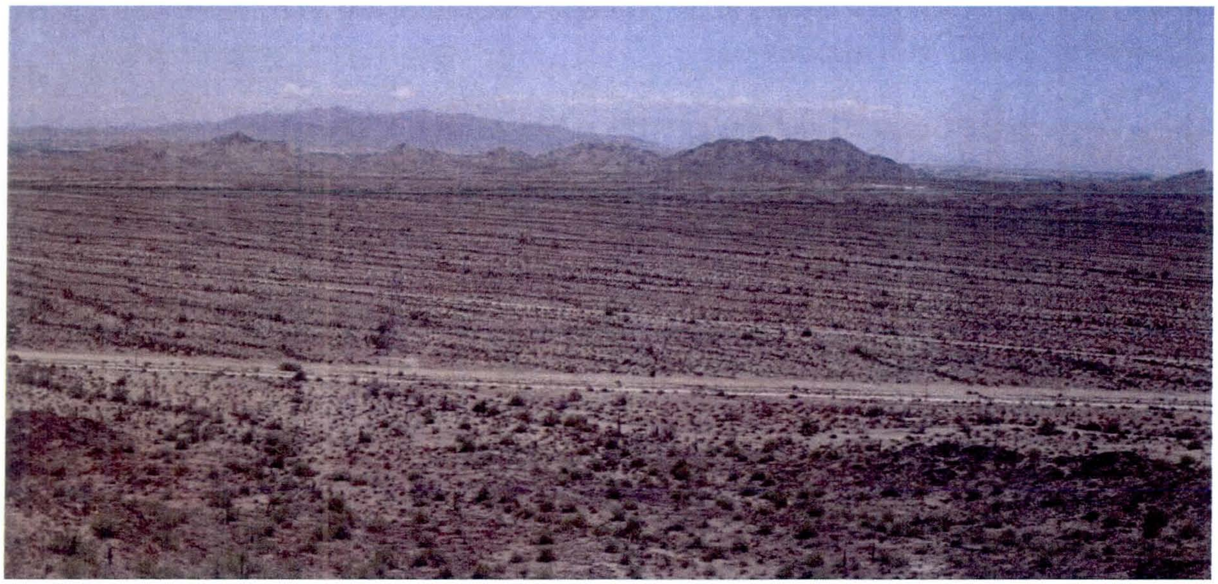


Figure 6-4 Rainbow Valley Study Area

View from the Sonoron Desert National Monument Looking Northeast to Waterman Wash Showing Existing Distributary Flow Patterns in the Sonora Planning Unit

Recreation Resources

Recreation resources impacts vary. The preservation of open space areas within individual developments sufficient to mitigate flood risk will result in an overall increase in natural open space and passive recreation beyond the minimum required by existing municipal PGOs. This results in greater access to trails, wildlife viewing, and connectivity to the larger protected open spaces found that bound the watershed. All of these are identified in the Open Space Element as desirable outcomes. However, active recreation uses are not benefited by this flood hazard mitigation approach.

Open Space Resources

The recommendations of the ADMP will result in a significant increase in passive or natural open space within the study area. The City of Goodyear defines passive open space as, "open space that has had minor, if any, improvements and is set aside, dedicated, designated or reserved for public or private use." The ADMP does not make recommendations regarding the balance between passive and natural open space areas that would be most beneficial in maintaining watershed function, and leaves this decision to the underlying municipality. Access levels to preserved open space areas should consider the impacts that activities such as "picnicking, hiking, bicycling, equestrian, walking, dog park or 'off-leash' running areas, neighborhood electric vehicles, gardening, agriculture, … trail corridors, (and) linear pathways" might have on the other existing or desired functions of the watershed and ensure that no function is completely lost within the overall open space mosaic.

6.5.4 Constructed Channels and Basins – Disturbed Areas

Constructed channels designed as semi-soft structures with appropriate landscape design themes, adequate right-of-way, and integrated multi-use will be compatible with the scenery, recreation, and open space resources identified by the Flood Protection Methods Compatibility Maps for the disturbed areas within the City of Goodyear adjacent to Waterman Wash. Constructed storm water management facilities will also be compatible with the piedmont landform where water quality and attenuation basins are required provided these facilities are also designed in accordance with the ADMP recommendations. Constructed channels in the undisturbed piedmont would only be considered compatible with the recreation and open space resources provided they are designed to maintain continuity between other recreation and open space areas and integrate adequate right-of-way to allow for open space buffering within the project limits.

Scenery Resources

Channels and basins that are constructed in accordance with the ADMP recommendations will be visually compatible with the more intense development levels identified by the City of Goodyear in the disturbed lands. Landscape design themes outlined in the ADMP need to be further developed by the adopting agencies such as the City of Goodyear within the appropriate PGO mechanisms such as zoning codes or specific neighborhood development plans in order to provide a more specific level of context-sensitive design.

Recreation Resources

Constructed basins and channels that integrate active recreation and trails are advantageous to developers and municipalities by maximizing the value that these landscapes provide. The Open Space Element specifically recommends that this opportunity be considered. Because the ADMP does not specify project locations with corresponding planned recreation facilities, local municipalities and developers will be required to integrate this recommendation into planned basins and channels on a project-by-project basis. The identified probable channel locations in the disturbed areas present opportunities for additional planning efforts by the City of Goodyear and subsequent drainage designers and recreation planners to more fully integrate a trail system into the drainage network.

Open Space Resources

As noted above, constructed channels and basins best achieve the project open space goals provided they are designed to maintain continuity between other recreation and open space areas and integrate adequate right-of-way to allow for open space buffering within the project limits. Because the level of design detail for these facilities is preliminary at the completion of the ADMP, the success of this recommendation is reliant on additional planning efforts and implementation.

6.5.5 Other Related Goals and Objectives

The following stakeholder goals and objectives related to scenery, recreation, and open space resources are not directly associated with the above recommendations.

The Juan Bautista de Anza National Historic Trail

The project stakeholders identified the interpretation of the Juan Bautista de Anza Historic Trail in flood hazard mitigation project(s) as a goal for the ADMP. No specific flood hazard mitigation facilities were identified in the area around the potential trail alignment as part of the ADMP, consistent with the recommended plan's focus on identifying regulatory mechanisms for flood mitigation over CIP projects. However, the ADMP has sought to facilitate the interpretation of the trail by including the following:

- Identifying the requirements for having any segments of the trail within the watershed recognized as part of the national historic trail system
- Identifying potential opportunities as well as issues that may arise with including the trail alignment in any flood hazard mitigation facilities
- Recommending that the Maricopa County Regional Trail System's alignment for Segment 94 be recognized as the location for the trail in this area for the purposes of defining the trail corridor through the Waterman Wash watershed

The Sevenmile Mountain Wildlife Corridor

The protection of the identified potential wildlife corridor that encompasses the Sevenmile Mountain Planning Unit was also identified as a stakeholder goal for the ADMP. The ADMP makes no recommendations for impacting this area. Existing landownership (BLM) and management of this area (City of Goodyear land use plans show this area as "Open Space") indicate that future flood risk will remain low, resulting in no needed action on the part of the ADMP.

Confluence of Waterman Wash and the Gila River

The project stakeholders identified the confluence of Waterman Wash with the Gila River as representing a potentially valuable resource that could include scenic, recreation, and open space functions. Outside of the general design guidelines for Waterman Wash, and the specific design guidelines for Reach 1, no specific recommendations were made for this area in the ADMP. This is, in part, due to the lack of CIP projects in the ADMP in general. Also, this area is outside of the incorporated boundaries of the local municipalities and owned by multiple landowners. While this area remains a potentially valuable location for future recreation and open space resources, the accomplishment of this goal will ultimately have to be accomplished by later planning efforts.

6.6 BIOLOGICAL RESOURCES

Under the current regulatory framework, impacts of flood protection projects on biological resources are addressed to varying degrees, depending on which state or federal regulations need to be addressed. Those requirements stem from several factors including land ownership, sources of funding, and permitting requirements.

If a project requires federal land or rights-of-way or easements across federal land, or uses federal funds, or requires federal permits (such as permits to disturb jurisdictional waters of the United States pursuant to Section 404 of the Clean Water Act), the project must comply with the Endangered Species Act (ESA). The responsible federal agency would work with project proponents to conduct a Section 7 consultation if one or more species listed under the ESA were impacted. If a project would not impact any listed species, then the project proponent should document as such in its administrative record, particularly if listed species are present in the general vicinity of a project. If a project were to disturb jurisdictional waters, a Section 404 permit would be required. The extent of the federal purview varies, and can be limited to only parts of a project on federal land, or extend to entire projects if they are supported by federal funds.

For projects that have no federal involvement, the extent of consideration of impacts on biological resources depends on the use of state land and involvement of state agencies or state funding sources. Projects that involve state land or oversight or funding by a state agency are required to salvage protected native plants according to the Arizona Native Plant Laws, which are administered by the Arizona Department of Agriculture. Private landowners have the right to destroy or remove plants growing on their land, but 20 to 60 days prior to the destruction of any protected native plants; landowners are required to file a notice of intent with the Arizona Department of Agriculture. The landowner also has the right to sell or give away any plant growing on the land. However, protected native plants may not be legally possessed, taken or transported from the growing site without a permit from the Arizona Department of Agriculture.

Implementation of the recommended plan would not modify the current biological resource regulatory framework for planning units A (Phoenix International Raceway), D (Sevenmile Mountain), and G (Vekol South), as well as secured open space within the planning area because no flood hazard mitigation projects are proposed in those areas. The recommended plan also would not change the regulatory framework for planning units E (Mobile) and LW (Lum Wash). The proposed nonstructural approach for reducing flood hazards by protecting SWCs helps to preserve habitat in situ in focal areas of high biodiversity and also provides movement areas for wildlife that could be lost if implementing structural flood control methods. Revitalizing parts of Waterman wash under this plan would help to restore or enhance the biological value in parts of the wash that currently have low value habitat.

Implementation of the recommended plan would involve development of new regulations to reduce flood hazards in planning units F (Waterman South), Waterman Wash Reaches 1, 2, and 3, and Waterman Wash Reaches 4 and 5, as well as a combination of new regulations and protection of SWCs in planning units B (Estrella) and C (Sonora). Because the plan does not propose any structural flood protection projects, it preserves native vegetation and wildlife use areas by avoiding ground disturbing construction or introducing structures into the landscape that could otherwise prevent wildlife movement. The effect of the new regulations would be to protect more open space to preserve the functions of natural drainages, which could provide opportunities to preserve biological resources and the ecological fabric of the planning area by conserving the connections between uplands, lowlands, and wash corridors. Also including provisions to retain a major wildlife corridor that was identified between the Estrella Mountains and Maricopa Mountains (connecting the Secured Open Space planning units through the Sevenmile Mountain and WR3 planning units) would help to conserve historical movements of bobcat, desert bighorn sheep, desert tortoise, Gila monster, javelina, and mule deer. Wildlife movement would be aided further by providing wildlife friendly crossings where future major transportation projects intersect major washes. Because the new regulations would designate easements between clusters of development and for trail systems, particularly along the length of Waterman Wash, there would be recreational opportunities for viewing wildlife and native plants that are usually lost when regional areas are developed. However, some recreational pursuits such as horseback riding through washes could be at cross-purposes to preserving or enhancing biological resources in the planning area. The preservation of biological resources within the planning area is a major improvement over the current regulatory framework. The new regulations also could provide consistent planning for biological resources across a large natural area that would be extraordinary in the desert southwest if stakeholders adopt the recommended design criteria that incorporates biological into the flood protection process.

6.7 CULTURAL RESOURCES

Under the current regulatory framework, impacts of flood protection projects on cultural (archaeological and historical) resources are addressed to varying degrees, depending on which state or federal regulations need to be addressed. Those requirements stem from several factors including land ownership, sources of funding, and permitting requirements.

If a project requires federal land or rights-of-way or easements across federal land, or uses federal funds, or requires federal permits (such as permits to disturb jurisdictional waters of the United States pursuant to Section 404 of the Clean Water Act), the project must comply with Section 106 of the National Historic Preservation Act. The responsible federal agency requires project proponents to conduct cultural resource inventories, evaluations, and assessments of effects, and to develop and implement measures to avoid, reduce, or mitigate any identified adverse effects on properties listed in or eligible for the National Register of Historic Places in accordance with Section 106. The extent of the federal purview varies, and can be limited to only parts of a project on federal land, or extend to entire projects if they are supported by federal funds. The extent of Section 106 review for Section 404 permits can be limited to from small setbacks from normal high water marks along jurisdictional washes or extend to entire developments, depending on the density and distribution of jurisdictional waters.

For projects that have no federal involvement, the extent of consideration of impacts on cultural resources hinges on the use of state land and involvement of state agencies. The Arizona Antiquities Act requires some consideration of archaeological and historical resources for projects that use state land, which is defined to include not only State Trust land, but any land owned or controlled by a state agency, or county, city, or town. The Arizona Antiquities Act requires discoveries of cultural resources on state land are to be reported to the Arizona State Museum, and cultural resource investigations on state land to be conducted in accordance with permits issued by the museum. The State Historic Preservation Act requires state agencies to consider the impacts of any flood protection project they undertake or assist on properties listed in or eligible for the Arizona Register of Historic Places and to appropriately document any such properties that cannot be avoided. (The criteria for the State Register and National Register are identical.) The State Burial Law also protects historic or prehistoric human remains (that are sometimes associated with archaeological and historical sites) on private land.

Implementation of the recommended plan would not modify the current cultural resource regulatory framework for planning units A (Phoenix International Raceway), D (Sevenmile Mountain), and G (Vekol South), as well as secured open space within the planning area because no flood hazard mitigation projects are proposed in those areas. The recommended plan also would not change the regulatory framework for planning units E (Mobile) and LW (Lum Wash), but the proposed nonstructural approach for reducing flood hazards by protecting SWCs reduces threats to cultural resources by avoiding ground disturbing construction activities. That plan also could protect any cultural resources that might be present within the SWCs and could provide opportunities to publicly interpret cultural resources in conjunction with any recreational trail development along those corridors.

Implementation of the recommended plan would involve development of new regulations to reduce flood hazards in planning units F (Waterman South), Waterman Wash Reaches 1, 2, and 3, and Waterman Wash Reaches 4 and 5, as well as a combination of new regulations and protection of SWCs in planning units B (Estrella) and C (Sonora). Because the plan does not propose any structural flood protection projects, it reduces threats to cultural resources by avoiding ground disturbing construction activities. The effect of the new regulations would be to protect more open space to preserve the functions of natural drainages, which could provide opportunities to protect any cultural resources that might be present within those protected areas, as well as in the designated SWCs. Because the new regulations would designate easements for trail systems, particularly along the length of Waterman Wash, there would be opportunities to publicly interpret the themes of prehistoric and historic use and occupation of Rainbow Valley identified by the cultural resources assessment in conjunction with any recreational trail development. That opportunity to coherently promote appreciation and preservation of significant cultural resources within the planning area is a major advantage over the current regulatory framework. The new regulations also could result in more consistent consideration of impacts on cultural resources if they adopt the recommended design criteria of requiring cultural resource surveys and measures to avoid, reduce, or mitigate adverse impacts for all flood protection projects.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The following general conclusions result from the data collection, analysis, and stakeholder involvement activities conducted as part of this Rainbow Valley ADMP. The conclusions are supported by the documentation presented in the ADMP Report.

1. There are significant portions of the Waterman Wash watershed that exhibit landforms associated with unique flood hazards that are not adequately addressed by conventional land development regulations. These include the alluvial fan, sheet flow, and distributary flow areas.
2. While the Waterman Wash watershed is relatively natural and undeveloped at the present time, existing land use plans indicate the potential for extensive land development activities within portions of these unique landform areas over the next 10 to 20 years.
3. Conventional approaches to flood control characterized by diverting, concentrating, and storing runoff are expected to result in excessive flood risk to residents and property when development expands in these unique flood hazard areas. These risks result from the impacts of development on important natural watershed functions.
4. Although these risks may be partially mitigated on an individual project basis, they are compounded when considered cumulatively throughout the watershed. As a result, comprehensive development practices are needed that will mitigate the loss of watershed functions that are important for stability of the piedmont surface and preservation of the quality of life.
5. The Waterman Wash watershed contains a near pristine natural Sonoran desert ecosystem that covers multiple landforms, from the protected mountain areas that form the watershed headwaters to the vulnerable but significant riparian washes. This ecosystem includes a variety of native vegetation that supports a varied population of desert wildlife species. This ecosystem also provides the opportunity for multiple recreation activities for residents and visitors. The natural desert environment has been identified as a valuable resource to be preserved to enhance the quality of life by future residents.
6. Since the watershed is still relatively natural and undisturbed, an opportunity exists to guide development practices in order to maintain the important natural watershed functions to a significant extent. This could occur by integrating new development into the natural watershed functional matrix rather than replacing it.

7. The plan presented in this report, if implemented, would partially mitigate the adverse flood risk associated with conventional development practices in unique flood hazard areas and would preserve watershed functions needed to support native vegetation and wildlife.
8. Changes to existing policies, guidelines, and ordinances will be required to implement the plan presented in this report.
9. Acceptance of the plan has not yet been clearly established by the City of Goodyear or the development community.

7.2 RECOMMENDATIONS

Based on the foregoing conclusions, the following recommendations are made for implementation of the plan.

1. The District should follow up with project stakeholders to review the plan and seek acceptance and adoption of the plan.
2. Upon plan acceptance and adoption, the District should develop Intergovernmental Agreements between stakeholder groups to establish the means for implementation.
3. Ideas that have been identified as possible means for implementation that should be explored include:
    a. Formation of Drainage Districts to enable coordination between developments within a sub watershed.
    b. Inter-Agency discussions to coordinate improvements between the Loop 303 and potential outfall alignments through the disturbed areas.
    c. Development of a CIP project for removal of the Waterman Wash levees
    d. Development of a conservancy advocate group to promote watershed-based planning and design
4. The District should work with regulatory jurisdictions to develop ordinances to establish Erosion Hazard Zones and SWCs as well as other regulatory tools needed to fully implement the plan.
5. The floodplain administrator should prepare detailed floodplain and floodway studies for all identified SWCs.
6. The transportation circulation portion of general plans should be updated to identify road alignments that are coordinated with drainage patterns and minimize crossings of drainageways.

8.0 REFERENCES

Arizona Department of Water Resources. *Low Water Use Drought Tolerant Plant List – Official Regulatory List for the Arizona Department of Water Resources, Phoenix Active Management Area*. Available online at: hppt://www.azwater.gov/AzDWR/WaterManagement/AMAs/LowWaterUsePlantList.htm.

Berry, K. 2007. Ecology and population dynamics of desert tortoise. Desert Tortoise Survey and Handling Seminar, Desert Tortoise Council, Ridgecrest, California.

Black, P.E. 1997. *Watershed Functions, Journal of the American Water Resources Association*, June, 33:10:1-11.

Chapin III, F.S., M.S. Torn, and Masaki Tateno. 1996. *Principles of Ecosystem Sustainability. The American Naturalist*. December, 148:6:1016-1037.

Federal Interagency Floodplain Management Task Force. 1996. *Protecting Floodplain Resources, A Guidebook for Communities*, 2nd Edition. June.

Flood Control District of Maricopa County. 2010. *Context Sensitive Flood Hazard Mitigation Planning and Design Approach.*

Flood Control District of Maricopa County. 2009. *Comprehensive Flood Management Plan and Program.*

Goodyear, City of, Development Trends Committee. 2010. *City of Goodyear Development Trends FY 10-14*.

Levick, L. et al. 2008. *The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-Arid American Southwest*, U.S. Environmental Protection Agency and USDA/ARS Southwest Watershed Research Center, EPA/600/R-08/134, ARS/233046.

Maricopa County. 2002. *Maricopa County Comprehensive Plan: Eye to the Future 2020.* Planning and Zoning Commission, Phoenix, Arizona. Adopted October 20, 1997; revised August 7, 2002.

Maus, J., et al. 2009. *The Journal of Epidemiology and Community Health, "Morbidity is related to a green living environment,"* October, 63:12:967.

Miller, Mark E. 2005. *The Structure and Functioning of Dryland Ecosystems – Conceptual Models to Inform Long-Term Ecological Monitoring: U.S. Geological Survey Scientific Investigations Report 2005-5197*; prepared in conjunction with the National Park Service.

Moody. 2003.

Popowski, R.J., and P.R. Krausman. 2002. Use of crossings over the Tucson Aqueduct by selected mammals. Southwestern Naturalist, 47:363-371.

Rodgers, James B. 2008. *An Archeological Resource Overview of the Rainbow Valley Area Drainage Master Plan Region of South-Central Maricopa County, Arizona*. Contract Archeological Series 08-3. Scientific Archeological Services, Phoenix, Arizona. June 25.

Simons, Li & Associates, Inc. 1985. *Design Manual for Engineering Analysis of Fluvial Systems*, prepared for Arizona Department of Water Resources. Project Number AZ-DWR-05, RDF162, 166, 232/R522. March.

Wright, James M. 2008. *Floodplain Management – Principles and Current Practices*. University of Tennessee – Knoxville. Available online at: http://training.fema.gov/emiweb/edu/fmpcp.asp.

United States National Park Service. 1996. Juan Bautista de Anza National Historic Trail Comprehensive Management and Use Plan Final Environmental Impact Statement, Appendix I: Site/Segment Certification Guide. Available online at: http://www.nps.gov/juba/parkmgmt/upload/JUBA-CMP_App-I_Site-SegmentCertGuide.pdf.

Data Collection Report

Preliminary Alternatives Formulation Report

APPENDIX A

POLICIES, GUIDELINES & ORDINANCES WHITE PAPER

Policies, Guidelines & Ordinances White Paper
Task 12.8.3
Rainbow Valley ADMP
June 2011

I. Review of the Policies, Goals & Ordinances Process and Task Objectives

Introduction

The Flood Hazard Mitigation Report completed for the Rainbow Valley Area Drainage Master Plan (Rainbow Valley ADMP) describes the process to further develop the Recommended Plan. The Recommended Plan embodies the results of the alternatives analysis, stakeholder guidance, recommendations from the Value Analysis exercise, and detailed hydrologic and hydraulic analyses to support the creation and implementation of the Recommended Plan.

Through the creation and culmination of these extensive processes, it has been recommended that a series of context sensitive criteria be developed as a desired approach to the development of flood mitigation hazards in Rainbow Valley. This approach is somewhat varied from previous ADMP studies where a series of structural solutions are often proposed to meet project objectives.

To enhance the acceptability and compatibility of implementing context sensitive design solutions for the Rainbow Valley ADMP, a regulatory framework consisting of a combination of municipal policies, guidelines and ordinances (PGO's) was recommended by Project Stakeholders for select Planning Units of the Rainbow Valley ADMP watershed. These potential PGO's would be developed to assist and complement City of Goodyear efforts to implement and administer through their existing regulatory framework. This task was identified to complement and enhance the "Waterman Wash Conceptual Corridor Study" completed by the City of Goodyear in 2008. The PGO component of the Rainbow Valley ADMP was then identified as Task 12.8.3 of the Rainbow Valley ADMP.

Initial PGO Vision

The initial vision for the PGO Task consisted of developing a series of PGO's that would be applicable, adoptable and enforceable within the expansive Rainbow Valley ADMP study area. As the Project Team began to evaluate the broad parameters that this potential mission could create, a sharper focus for the development of PGO's specifically for the City of Goodyear seemed the most favorable. Maintaining the focus on the development of PGO's to the City of Goodyear was largely due to the fact that the majority of near term and long term developable property within the Rainbow Valley ADMP study area is located within the City of Goodyear Municipal Limits. The City of Goodyear therefore offers the enhanced likelihood of establishing, adopting, implementing and enforcing PGO's that are mutually beneficial to the District, City and development community.

Steps in the Process

In April of 2010, the Project Team began to investigate and identify a potential "roadmap" of how to integrate Task 12.8.3 into the overall RVADMP work effort. The Project Team first began with developing the definition and preliminary approach to developing a context sensitive approach to PGO's. Rooted in the District's design procedure for context sensitive flood hazard mitigation planning tool, the Project Team defined the steps necessary to create a "roadmap" for the potential creation of context sensitive PGO's for the City of Goodyear. It was determined that an effective, acceptable, compatible and implementable context sensitive PGO could be achieved if there was an intersection of the following four components:

1) City of Goodyear Objectives and Expectations
2) Achieves Effective Flood Hazard Mitigation
3) Developer Stakeholder Expectations and Concerns
4) Planning Unit Land Resource and Community Context Objectives

The intersection of these four components would define the nexus that must be emphasized as guidance in the development of implementable and enforceable PGO's. The data collection process then began and the scheduling of a meeting with the City of Goodyear occurred.

In April of 2010 the "Implementation Tools Kick Off Meeting" was held between the Project Team, District staff and City of Goodyear staff. The focus of this meeting was largely to introduce the City of Goodyear to the PGO element of the RVADMP process, identify their various codes and ordinances (regulatory framework), what elements of those codes and ordinances were worthwhile, which elements were antiquated from a city staff perspective. The meeting also identified what the goals and objectives are for the project and evaluate if those goals and objectives can be achieved under the existing City of Goodyear policies, regulations and ordinances framework.

An important outcome of this meeting, in the context of the PGO process, was that Goodyear City staff felt that a key consideration for a successful adoption and implementation of any PGO should be developed utilizing existing Goodyear codes, policies or ordinances. In other words, Goodyear was not interested in developing an additional regulatory tool, code, ordinance or policy document specifically for the implementation of any PGO for the Rainbow Valley ADMP project Goodyear preferred that any new PGO tool be considered for amendment to their existing codes and ordinances.

A second meeting was conducted with Goodyear staff in June of 2010 – City of Goodyear Implementation Meeting #2. The objective of this meeting was to follow up on the first meeting by delving a little deeper into some more specific policy, ordinance, financial and design guideline tools that Goodyear may or may not wish to evaluate as a component of any potential implementation tools for the Rainbow Valley ADMP.

The PGO process also included a data investigation and collection process of existing City of Goodyear and Maricopa County ordinances and policies as well as a multitude of other local, regional and national documents providing a greater perspective in PGO and Low Impact Development (LID) techniques that could be drawn from to assist this effort. The types of documents collected represented a broad spectrum of documents that ranged from specific LID site planning and design techniques, to stormwater utility districts, transfer of development rights (TDRs) an a host of other technical design and modeling components. This data collection effort was completed in August of 2010 and includes over 50 entries.

II. Two Distinctive Groupings of Performance Functions & Their Responding Policy Framework

The Flood Hazard Mitigation Plan introduces a series of Performance Functions and Design Criteria that contribute towards enhancing the public safety and quality of life in Rainbow Valley. These functions were derived from the Project Team-identified natural and beneficial functions served by floodplains and the stakeholder identified goals for the Rainbow Valley ADMP.

The functions are loosely divided into two groups: those functions that are primarily associated with the hydrologic and hydraulic flood mitigation regimes that are designed to protect people and property and therefore could be encapsulated into a "Public Safety Through Flood Hazard Mitigation" category for PGO implementation purposes. The public safety-related Performance Functions and Design Criteria represent a complex set of tangible and value-added attributes that in many respects are interdependent upon one another.

The second grouping, "Quality Community Design in a Flood Hazard Context", promotes a broad set of enhanced community design principles geared towards preserving the natural character and resources in a flood hazard context that achieves effective subdivision designs in an equitable, cost effective manner. In the future process of developing PGO's, it will be important to be cognizant of the inter-relatedness of these functions and how each performance function or design criteria – if modified – influences the level of benefit or effectiveness of other related functions or criteria.

Group 1 – Public Safety Through Flood Hazard Mitigation

Group 1 – Public Safety Through Flood Hazard Mitigation - includes seven (7) of those Performance Functions. The Group 1 functions are focused specifically on hydrologic/ hydraulic flood mitigation features that are designed to promote public safety. The seven Public Safety Through Flood Hazard Mitigation Base Performance Functions along with a brief summary of each is provided below:

3.3.1 Restrict Increase in Storm Water Runoff Volume

Runoff from piedmont surfaces is sensitive to runoff volume, which is a key determinant of downstream discharges. Urbanization of a watershed will typically cause an increase in runoff volume. Key piedmont characteristics that impact runoff volume and associated discharge are watershed storage from sheet flow, depression storage, and infiltration that occurs where runoff is in contact with the surface. The strategy to minimize and mitigate increases in storm water runoff volume is described in the following performance functions.
This base function is further defined by eight (8) separate Performance Functions and/or Design Criteria.

3.3.2 Restrict Increases in Storm Water Peak Discharge

Storm water runoff volume, as just described, is a key determinant of downstream discharge. However, flow concentration through channelization and surface paving will increase the efficiency of flow accumulation and will reduce the time of concentration, which will result in an increased peak discharge even with the same runoff volume. The strategy to minimize and mitigate increases in storm water peak discharge is described in the following performance functions.
This base function is further defined by three (3) separate Performance Functions and/or Design Criteria.

3.3.3 Maintain Flow Continuity to Outfall

Flow continuity from the mountains to the watershed outlet at the Gila River is important for both runoff and sediment. Disruptions in flow continuity result in downstream uncertainty and associated risk as well as disruption to the hydrologic and environmental functions and values identified elsewhere in the Rainbow Valley ADMP. Diversions of runoff into adjacent sub-basins disrupt the runoff and sediment supply downstream.
This base function is further defined by eight (8) separate Performance Functions and/or Design Criteria.

3.3.4 Preserve Wash Storage for Peak Flow Attenuation

One of the key functions of floodplains is peak flow attenuation that results from overbank storage in the flood fringe areas. The current FEMA regulations for development within floodplains allow encroachment up to the floodway limit. This encroachment reduces the available overbank storage, resulting in increases in the peak discharge. These increases are not accounted for in the FEMA floodway delineation methodology. The strategy to minimize and mitigate loss of wash storage is described in the following performance functions.
This base function is further defined by two (2) separate Performance Functions and/or Design Criteria.

3.3.5 Preserve Cross Section Conveyance Capacity

The conveyance capacity of a wash's cross section defines the amount of floodplain flow capacity that is available when the flow is greater than the bankfull discharge. Similar to preserving a floodplain's function of attenuating peak flows, effort should also be taken to preserve a wash's cross section conveyance capacity. The strategy to minimize and mitigate loss of cross-section conveyance capacity is described in the following performance functions.
This base function is further defined by two (2) separate Performance Functions and/or Design Criteria.

3.3.6 Preserve Sediment Transport Capacity of Washes to Minimize Erosion and Deposition

Natural desert washes are formed by frequent storm events that provide capacity for the dominant discharge. The dominant discharge is the channel forming discharge, which is much less than the 100-year discharge, with recurrence intervals of less than 2-years (Moody 2003). The 100-year discharge is typically the standard for design of flood protection for new developments. The dominant discharge is equivalent to the bankfull discharge for the defined wash section. Discharges in excess of the bankfull discharge spill into the overbank, which in the case of the piedmonts in the Estrella and Sonora Planning Units, can be very wide. The dominant discharge low flow channel is the section that conveys the incoming sediment through the system.
This base function is further defined by six (6) separate Performance Functions and/or Design Criteria.

3.3.7 Maintain Sediment Continuity

The sediment continuity principle, when applied to a given channel, reach states that the sediment inflow minus the sediment outflow equals the time rate of change in sediment storage. So, at any point along a wash, the inflowing sediment must be passed downstream to avoid accumulation of sediment as deposition. Conversely, if the downstream reach has a sediment carrying capacity that is greater than the amount of inflowing sediment, scour will occur in order to satisfy the sediment deficit. As with flow continuity, sediment continuity should also be maintained throughout a watershed in order to prevent adverse impacts to downstream property owners and receiving bodies of water
This base function is further defined by three (3) separate Performance Functions.

The seven hydrology/hydraulic Base Functions described above form the basis for defining the Public Safety Through Flood Hazard Mitigation Performance Functions and Design Criteria. Collectively, there are a total of 32 Performance Functions or Design Criteria that could be considered for future PGO's. The interrelatedness of many of these principals will likely find the need for a combination of these to form suitable municipal PGO's for the City of Goodyear to contemplate for incorporation into some form of PGO's. It will be important to be cognizant of the interrelatedness of these functions and how each performance function or design criteria – if modified – influences the level of benefit or effectiveness of other related functions or criteria.

Group 2 – Quality Community Design in a Flood Hazard Context
There are five (5) quality of life related Base Functions that are designed to complement the H&H functions through the preservation of existing biological and scenic resources and promotion of quality community design principals within a flood hazard context. Group 2 – Quality Community Design in a Flood Hazard Context – recognizes the stewardship and preservation of integral open spaces associated with or adjacent to flood hazard mitigation facilities. Group 2 also is focused on promoting enhanced community design principals that embrace multi-use recreation opportunities and cultural and biological resources in a cost effective manner.

3.3.8 Complement Planned Future Scenery Resources

The existing scenic character and integrity of the watershed should be preserved or enhanced through the design and implementation of flood hazard mitigation facilities and measures. This will help minimize potential negative impacts to the existing, natural visual aesthetic of the watershed that can be associated with development or even enhance the perceived visual quality of the setting, which in turn preserves or increases the value to the community.
This base function is further defined by eleven (11) separate Performance Functions and/or Design Criteria.

3.3.9 Accommodate Regional and Local Multi-Use

Co-locating recreational multi-uses within flood control facilities can create greater value density, making use of land that otherwise may lie unused most of the year and be closed to the public. The following performance functions are intended to serve as benchmarks for preserving open space and creating recreation functions within the community that are integrated with flood hazard mitigation design.
This base function is further defined by ten (10) separate Performance Functions and/or Design Criteria.

3.3.10 Provide Open Space

The preservation of open space along washes used for flood hazard mitigation, as well as open space along constructed channels and storage basins, can serve as vital linear links between larger preserved open spaces that serve as large habitat patches. Potential open space linkages that will connect to the larger open space mosaic of the watershed can preserve value and access to these areas. The benefits of preserved open space include measurable benefits such as higher premiums for developed lots adjacent to open space areas. These open space areas also contribute to the overall well-being of residents within the community. The following performance functions are intended to serve as benchmarks for maintaining or creating open space functions within the community that are integrated with flood hazard mitigation design.
This base function is further defined by six (6) separate Performance Functions and/or Design Criteria.

3.3.11 Protect or Enhance Biological Resources

Traditional flood protection methods that have relied on hard surfaces and structures like channels, levees, and dams have disturbed natural biological patterns and movement of wetlands and upland habitats. The methods of flood protection proposed for this plan have taken into consideration the preservation or enhancement of biological processes and patterns as part of its context sensitive solution. A number of performance functions have been developed in the proposed alternative to meet the goal of preserving or enhancing biological resources as the planning area develops in the future. Although described and categorized individually, these performance functions are not mutually exclusive.
This base function is further defined by five (5) separate Performance Functions and/or Design Criteria.

3.3.12 Promote Appreciation and Preservation of Significant Cultural Resources

The cultural resource assessment estimated that there could be approximately 1,000 to 1,500 archaeological and historical resources in the planning area, but more than 90 percent of those have yet to be discovered, recorded, and evaluated. A model of cultural resource sensitivity was developed by evaluating the frequency and types of sites recorded within environmental zones. The analysis indicates that the average site density varies little among the zones, ranging between 2.8 to 4.5 sites per square mile. The foothills and upper alluvial fans zone was rated as having moderate sensitivity because it has the highest site density and because about one-fourth of the recorded sites in that zone have petroglyphs. The other three zones (mountains, lower alluvial fans and valley plains, and named river and wash corridors along the Gila River, Waterman Wash, Lum Wash, Corgett Wash, and Vekol Wash) were rated as having low sensitivity.
This base function is further defined by three (3) separate Performance Functions and/or Design Criteria.

The five Community Design/Land Resource-related (non-hydrology/hydraulic) Base Functions described above form the basis for defining the Quality Community Design in a Flood Hazard Context Performance Functions and Design Criteria that all together yield a total of 35 individual functions or design criteria for consideration as future PGO's.

Similar to that of Group 1, Group 2 has an interrelatedness and overlapping benefits derived from the implementation of many of these 35 individual Performance Functions and/or Design Criteria. Unlike their Public Safety Through Flood Hazard Mitigation counterparts however, these Quality Community Design in a Flood Hazard Context Performance Functions and Design Criteria have a little more independence and have the ability and discretion to be evaluated and implemented in a more independent setting. In other words, a modification or change to a Cultural Resources Performance Function does not maintain a high level of interdependence on a Multi-Use Performance Function in the same manner as the interdependence of the H&H Performance Functions.

Performance Functions and Design Criteria as the Foundation for Future PGO's
Group 1 and Group 2 of the Rainbow Valley ADMP Flood Hazard Mitigation Plan has identified a total of 67 various "Public Safety Through Flood Hazard Mitigation" and "Quality Community Design in a Flood Hazard Context" Performance Functions and Design Criteria possibilities. The 67 functions/criteria are identified as the foundational PGO concepts that will require some level of synthesizing, refining, combining and/or repackaging for potential consideration as future policies, guidelines and/or ordinances for contemplation by the City of Goodyear. Further review with the City of Goodyear could develop additional Performance Functions and/or Design Criteria developed as a "spin off" of the 67 possibilities introduced above.

It is important to recognize that it is unlikely that each of these 67 Performance Functions/Design Criteria will lead to the creation of 67 independent PGO's. Relative to the future drafting of PGO's, the existing 67 Performance Functions/Design Criteria are in a raw or preliminary state of recognition. Basic ideas and concepts were expressed by the Stakeholders and refined by the Project Team and the District. No other input was received other than from the City of Goodyear relative to the PGO task.

Some of the Performance Function/Design Guideline concepts require minimal refinement to translate into a successful PGO for the City of Goodyear. Others will require additional analysis, transcription, linking of concepts to properly convey an otherwise "raw" concept into complete municipal PGO vernacular that is understandable, equitable and enforceable by the City of Goodyear. Some concepts will be combined into a unified PGO. Close collaboration with Goodyear staff to navigate the process of matching new prospective PGO's with the appropriate combination of existing City regulatory documents will be critical to the success of the future PGO effort. Examples are provided in the forthcoming sections of this paper.

III. Identification and Definition of Possible COG Regulatory Framework

Understanding City of Goodyear Existing Regulatory Framework
In the process of promulgating new regulations for municipalities, it is essential to gain an understanding of that particular municipality's existing regulations – their contents, how they interrelate, what portions of content are particularly important to the City (politically or administratively), which are flawed or give them difficulty in administering, which are antiquated and so forth. Having a working knowledge of staff's sensitivities to issues that are derived from the enforcement or existing regulations/PGO's is essential for defining the stepping stones for success in developing potential PGO's for the Rainbow Valley ADMP process. Developing context sensitive PGO's that achieve project goals and objectives, are enforceable and equitable from a City administration point of view, and are also embraced (at least in large part) by the development community is key to PGO implementation success.

Equally important is to gain an understanding of City staff's insight on what PGO tools and methods or combination of tools and methods of PGO adoption staff would be willing to consider. Factors that influence this consideration can and are usually based on the current economic or political climate, ongoing issues of cooperation or contention with key development community stakeholders and City staff, infrastructure and development agreement-related issues of obligation etc. This is particularly acute in Goodyear where much of the City, including significant land holdings in Rainbow Valley, are zoned Planned Area Development (PAD). Each individual PAD has its own individual prescribed standards for development and are typically linked to a development agreement outlining collaborative infrastructure responsibilities and "development rights". The Estrella project (formerly known as "Estrella Mountain Ranch") by example has multiple PAD's within one master planned community.

Defining Future PGO Implementation Parameters

As part of PGO Task 12.8.3, two meetings with City of Goodyear staff representatives were conducted. Relative to the process of creating future PGO's, a couple of key observations or directives were taken away from those meetings. Through information derived from the Data Collection process, the Project Team introduced a handful of various tools utilized by government agencies elsewhere. Some tools were familiar to Goodyear staff. Some of the concepts were newly introduced and discussed. Perhaps the tool most foreign to Goodyear that peaked their interest most was on the City of Phoenix zoning ordinance overlay and Transfer of Development Rights (TDR) approach to portions of Skunk Creek. There was interest by staff to emulate certain components of that model, but what became a readily important point of emphasis for Goodyear staff was that any PGO's contemplated for moving forward for some form of Goodyear adoption must be done under the existing Goodyear regulatory framework. In other words, any new PGO must be integrated and adopted into one of the existing Goodyear codes, ordinances, guidelines or manuals. This poses limitations on the ability to adopt certain unique PGO's but should not be entirely discarded at this point in the process. This is especially true where Significant Wash Corridors (SWC's) are concerned for the adoption of future floodplain mapping – new ordinances regulating these areas, Waterman Wash in particular, could likely generate the need for additional regulatory oversight.

Existing Goodyear Regulatory Framework

The various existing City of Goodyear regulatory documents identified for consideration and possible vehicle for implementation of PGO's for the Rainbow Valley ADMP include the following. City documents:

General Plan – The City's key policy document that represents the City's desired goals, objectives and vision for land use, circulation, open spaces, housing, economic development, environmental planning and others. All other ordinances and codes are intended to implement the policy direction established in the General Plan.

Zoning Ordinance – The Zoning Ordinance is considered the minimum requirements necessary for the promotion of the General Plan, To promote and protect the health, safety and welfare of the residents of the City of Goodyear and to establish land use classifications; dividing the City into districts; imposing regulations, prohibitions and restrictions for the promotion of health, safety, convenience, aesthetics, and welfare. Further, such regulations are deemed necessary to lessen congestion in the streets; to provide adequate open space for light and air; to conserve property values; to assure orderly growth; to facilitate the adequate provision of transportation, water sewer, schools, parks and other improvements; and to promote public health, safety, and welfare.

Engineering Design Standards & Policies Manual – The purpose of the Engineering Design Standards and Policies Manual is to provide developers and their designers the planning and designing requirements of public and private infrastructure within the City and to provide an enhanced quality of life for Goodyear citizens and visitors. Design concepts and specific technical data (and reporting methods) are outlined, but are not intended to supersede sound engineering judgment. The Manual is divided into sections each for plan review and design of, storm water, water wastewater, roadways, landscape, subdivision and site development.

Design Guidelines – The Design Guidelines are intended to promote a desired level of future development quality in Goodyear that will:

1) Provide diversity in building design as well as improve the character of streetscapes,
2) Provide guidance for the orderly development of the City and promote high quality development;
3) Supplement the contents of the Goodyear Zoning Ordinance on matters of design and aesthetics;
4) Stimulate investment in and strengthen the economic vitality of areas within the City;
5) Implement the goals, objectives, and policies of the General Plan; and
6) Ensure quality building design for residential, commercial and industrial buildings, as well as enhancing the surrounding environment.

Subdivision Regulations – The purpose of this chapter of the City Code is to provide for the orderly growth and harmonious development of the City of Goodyear; to insure adequate traffic circulation through coordinated street systems with relation to major thoroughfares, adjoining subdivisions and public facilities; to achieve individual property lots of reasonable utility and livability; to secure adequate provisions for water supply, drainage, sanitary sewerage and other health requirements; to insure consideration for adequate sites for schools, recreation areas and other public facilities; to promote the conveyance of land by accurate legal description; and to provide logical procedures for the achievement of this purpose.

Flood Damage Prevention Code – Its purpose is to promote the public health, safety and welfare and to minimize public losses due to flood conditions, minimizing the need to rescue and relief from flooding events, insuring that potential landowners are notified of properties in special flood hazard areas, etc. The document prescribes many of the legal compliance, disclaimer and statutory exemptions defining general development floodplain practices. A section on standards of construction is provided and is fairly provincial in its application. Variance procedures and storm water pollution elimination standards are also included.

Developer Stakeholder Expectations and Concerns

As noted previously in this White Paper, it was determined that in order for a set of context sensitive PGO's to be effective, acceptable, and implementable, feedback and support from the development community would be critical to the success of any future PGO efforts. Developer stakeholders shared their respective project goals and objectives with the Project Team early in the Rainbow Valley ADMP process, but it was also important to present concepts of the Draft Recommended Plan as well as proposed floodway/floodplain mapping to select members of the development community.

On June 2, 2011, District staff and some members of the URS Team conducted two separate meetings with representatives of AREAD Inc. and Newland Communities. It was determined that it would be important to review the concepts of the Recommended Plan with these two large landowners because they are the two largest active development parcels in Rainbow Valley – Madeira and Estrella respectively. These two development parcels are also the most likely to develop in the near and long term, both have frontage onto Waterman Wash and both are situated within the City of Goodyear.

At each meeting, the URS Team gave an introduction of the project goals, discussed the watershed systems approach and revisited previously identified stakeholder objectives that were used to guide the URS Team throughout the process. The Recommended Plan was introduced, and a thorough review and comparison of the effective versus proposed floodplain and floodway limits and Q's for Waterman Wash Reach 2 nearest each property were detailed. A review of preliminary development concepts of Waterman Wash and Significant Wash Corridors (SWC's) were also reviewed with each of the developer stakeholders.

The vast majority of the Madeira project is situated within the disturbed areas. As a result, much of the discussion focused on channelization and non-levee embankments within the disturbed areas and the effective versus proposed floodway/floodplain for Waterman Wash. While just a small portion of the Madeira property is subject to distributary flow characteristics, the URS Team sought feedback from AREAD on the concept of providing preservation corridors to preserve distributary flow continuity.

Feedback received from AREAD at this meeting was positive and receptive to the proposed floodplain delineations of Waterman Wash, SWC and Waterman Wash development concepts as well as the concept of preserving distributary flow corridors to the extent practicable. AREAD even noted how they had employed a strategy of preserving a distributary flow corridor on another project in Maricopa County and felt that it was a better way to manage the watershed. AREAD suggested that they would be supportive of a City of Goodyear PGO's that aim to preserve distributary flow corridors.

Feedback received from Newland Communities was generally favorable as well. Much of the dialogue at the Newland meeting focused on the comparison of the effective versus proposed floodway/floodplain for Waterman Wash and the non-levee embankments situated within the disturbed areas adjacent to Waterman Wash. Newland Communities was receptive to the proposed floodway/floodplain delineations and developable acreage gains likely to occur with the proposed floodway/floodplain. They were also interested in continuing further discussions and evaluation of how the removal of the non-levee embankments influences the floodway/floodplain delineation.

The Estrella project is also influenced by considerable areas of sheet flow so time was also spent reviewing typical designs and development concepts associated with sheet flow conditions. The notion of preserving sheet flow corridors and the lot reduction technique were reviewed with the Newland Communities team. Feedback was generally favorable and suggested they were glad to see a paradigm shift of sorts when it comes to a watershed systems approach, including a reduction in the current City retention requirements. Newland Communities expressed a desire to continue to be aware of any future implementation efforts and want to work with the District and Goodyear staff on developing more precise criteria for roadway crossings of Waterman Wash.

Creation of the PGO Tools Roadmap

With the 67 Performance Functions/Design Criteria conceptually defined from the Rainbow Valley ADMP Flood Hazard Mitigation Plan, together with guidance from Goodyear and the regulatory framework for adoption of any PGO's, the building blocks for defining the PGO "roadmap" begin to come together. In November of 2010, a "PGO Tools Roadmap" was created by the Project Team. The PGO Tools Roadmap systematically evaluated each of the 67 Performance Functions/Design Criteria in relation to the contents of the six Goodyear regulatory documents introduced above.

The PGO Tools Roadmap identified what section or reference point of each Goodyear regulatory document could be a logical and/or plausible target for amendment relative to each of the 67 Performance Functions/Design Criteria identified. Each citation provides an evaluation of how that particular Performance Function/Design Criteria relates (or not) to each Goodyear regulatory document section – citing specific sections by which the document would be suitable for amendment to accommodate the newly defined PGO. Supplemental policy notes provide added commentary on some of the refinements, concerns or relationships to other code provisions that should be considered prior to moving forward with the formal development of any PGO's.

In instances where a Performance Function or Design Criteria is identified for multiple entries within one City of Goodyear document or across multiple City of Goodyear documents, each entry reflects a potential range of existing City of Goodyear policy/code "amendment targets" that could occur if so desired by City of Goodyear. Additional evaluation and review with City of Goodyear staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired. This has been referred to as the "multi-pronged approach" in Project Team discussions.

IV. PGO Implementation Structure

Charting the Course

The PGO Tools Roadmap in many respects is like a compass pointing to the direction for the establishment of a formal set of PGO's – each Performance Function/Design Criteria is identified with plausible section(s) of each Goodyear regulatory document targeted for possible amendment. As previously noted, instances where a Performance Function or Design Criteria is identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. This becomes a critical ingredient to defining the potential success in promulgating new regulations – deciphering the mosaic of how the conceptual design guideline can fit under an existing General Plan policy framework and linking that policy framework – existing or proposed – to a more precise ordinance provision, design criteria or development standard. This analysis includes asking the question "is the new PGO concept not really captured under an existing General Plan policy and as a result, a new policy framework must first be established in order to provide for the creation of a new specific guideline to be created?" This is a delicate balance that must be deciphered closely with staff as they are the "daily enforcers" and must weigh the political, legal and development community realities.

The PGO Roadmap analysis was based on existing documents adopted by the City of Goodyear and does not include the review of any documents that may be in the draft stages of update or development. For many of the Performance Functions/Design Criteria, modification to the existing language provided will be necessary for transformation into a refined municipal policy/design standard/code vernacular.

Regulatory Approach – Unifying Elements

There have been a total of 67 different performance Functions/Design Criteria possibilities for consideration in moving forward in the creation of possible PGO's for the City of Goodyear. These 67 Performance Functions/Design Criteria generally fall under two larger groupings – Public Safety Through Flood Hazard Mitigation and Quality Community Design in a Flood Hazard Context. These two broader groupings will have individually defined approaches to potential PGO implementation depending if their focus is more technical in nature or that of a policy-based function. One constant that unifies the PGO process however – the promulgation of new municipal regulations inherently consists of a process or balancing of the inter-relatedness and inter-connection between the policy functions and the technical functions.

That is to say that many of the Performance Functions or Design Criteria will need to be rooted in some form of an existing or newly created policy. By example, the inclusion of technically oriented criteria that will likely take the form of a specific requirement in the Engineering Design and Policies Manual or Flood Damage Prevention Code should be linked to an existing or newly created policy in the General Plan or Design Guidelines that provides City Council vision and guidance in the development of specific criteria to effectively implement the City policy.

A more specific example of this relationship is illustrated with this excerpt from the PGO Tools Roadmap:

Table 1 – Sample Citation from the PGO Roadmap

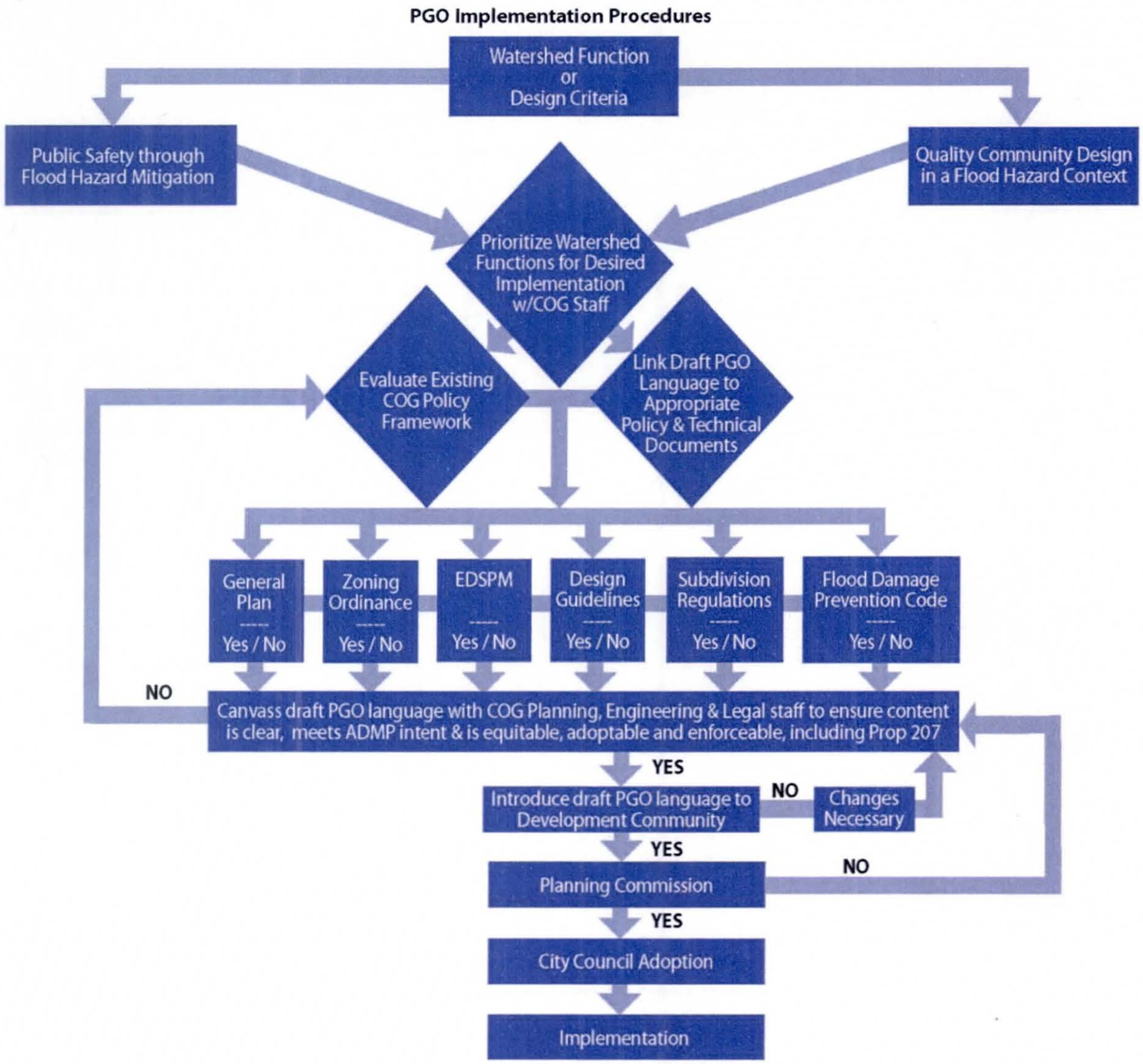
PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
4.1 Mitigate loss of floodplain storage from encroachment	EDSPM	EDSPM	Section 3.2.1 Section 3.2.2 Table 3-3-1	EDSPM	EDSPM	16-1-3 16-5-1	Modification of language may be necessary for inclusion into EDSPM. FDPC reference should be given to methodology in EDSPM. Accompanying flowchart would be useful.

What is evident in the review of this specific Design Criteria is that the contents of this particular criteria is very specific – a new floodplain delineation methodology is introduced and defined. This approach accounts for the loss of overbank storage by permitting a less than one foot rise in the floodway water surface elevation. Design Criteria 3.3.4.1 cites a step-by-step approach to this floodplain delineation methodology that should likely be housed in the City of Goodyear Engineering Design Standards & Policies Manual, with reference to the Flood Damage Prevention Code. These existing regulatory documents would be amended to include this new floodplain delineation design criteria. Moreover, it is also necessary that a broader policy statement in the General Plan or Zoning Ordinance suggesting support and understanding of the impacts of this floodway delineation methodology and why it is in the best interest of Goodyear will be needed in order to amend the Engineering Design Standards and Policies Manual.

In this particular example, Goodyear General Plan Section 9.2, Goal B, "A Community Protected from the Hazards of the Natural and Man Made Environment" could be targeted to add this new floodplain methodology objective for this policy measure. This specific reference portrays how the "multiple prongs" in the PGO approach are necessary for consideration jointly by the Project Team and City of Goodyear staff. Deciphering of these multiple prongs in some form or fashion really defines how the individual PGO citation can be instituted.

In the evaluation of the future PGO process that could ensue, there are a myriad of PGO combinations and possibilities that could come to fruition. This paper has attempted to outline the need and process of individually vetting each of the 67 Performance Functions/Design Criteria – how they interrelate and/or effect one another and so on. Each PGO of sorts will go through its own individual "journey" to establish a proper combination of policy and development standard in a "multi-pronged" approach that is sensible, adoptable, equitable and enforceable for the City of Goodyear. So while each PGO may have its own individual analysis and "journey" through the process, there are some commonalities or considerations that can be expected or be cognizant of as the PGO process moves forward. Some of these considerations hold true universally and others are more dependent upon which "group" the PGO is housed. This is not an all-inclusive list of opportunities and constraints for further consideration, others will develop as the PGO process evolves. A flowchart illustration of the likely steps that each individual and/or combination of policies, guidelines or ordinances would go through is shown on Figure 1.

Figure 1



Universal PGO Implementation Opportunities, Constraints and Observations for Further Consideration

1) Much of the current language is conceptual in nature and will need refinement for municipal PGO application. This would include the translation of select technical language into broader policy statements and crafting PGO's that are more succinct (in some cases) than the existing conceptual Performance Functions and Design Criteria.
2) Many Performance Functions and Design Criteria provide explanations of the concept blended with the concept itself. For municipal policy-level applications, these must be distilled into more concise forms. Existing language for specific design criteria will need less word massaging. (ex., 1.3, 2.1, 6.3)
3) Some of the concepts would be enhanced by the inclusion of a vignette or similar graphic that illustratively portrays the concept.
4) In cases where there is one prescribed standard/metric (i.e., 1.3(a)) being the most prominent example), further consideration should be given to providing a suite of options or sliding scale to index the metric rather than one universal application. Additional examples provided below.
5) To supplement observations made here, the PGO Tools Roadmap outlines additional policy commentary for each of the 67 identified Performance Functions or Design Criteria.
6) Design Guideline references could be lumped together for a unified inclusion of a new Article in the Goodyear Comprehensive Design Guidelines that relates to design provisions relating to the RVADMP study area. This must be further evaluated in the future as an update to the Design Guideline document is scheduled in 2011. Goodyear staff has been drafting the document internally and a public review draft has not yet been released.
7) Depending on document referenced, it may be desirable to institute a new " Rainbow Valley Watershed section" (or similar) of the COG document that houses all RVADMP-related PGO's into one stand alone section rather than scatter about the document.
8) In some instances, primarily policy-related PGO entries, some of the technical language currently provided should be re-written into a non-technical format to the best extent practicable. Examples are referenced in the PGO Roadmap report.
9) In general, the Flood Hazard Mitigation Plan places emphasis on the benefits and values of the Performance Functions and Design Criteria provide to the watershed. Early in the PGO implementation process, a thorough discussion with COG staff will be necessary to weigh and prioritize the interrelationship of the benefits and values derived for the watershed as compared and contrasted with the municipal goals and objectives – does each hold the same priority? An example might include the evaluation and comparison between percentage of open space preserved as undisturbed area compared to suitable residential lot size and segmentation amongst the municipal lot inventory. Avoiding the unintended consequence of doing a good job of preserving undisturbed areas

but inadvertently promoting a proliferation of a certain lot size or residential development style that mayor may not be politically desirable.

10) Once the watershed beneficial functions are aligned with municipal goals and priorities, the next level of vetting should include which statements require a "shall" mandate versus which maintain some flexibility with "should". These issues will be influenced by the City's Proposition 207 "safe harbor" strategy in relation to the proposed PGO's.
11) Future amendments are likely to include new definitions for terms like "dominant discharge low flow" and "bankfull channel section" and others that are not specifically known by future users. It is also suggested that these definitions be vetted with the District and ADWR so that consistent terminology between agencies is used and thus avoid arbitrary usage of the terms.
12) A key and necessary step in the PGO process before earnestly engaging the City of Goodyear will be to provide an in depth overview of the Performance Functions and their inter-relationships to the planning and engineering staff. Explanation of watershed functions and the hierarchy of cause/effect relationships of Performance Functions at a macro level will be needed. Illustrations and graphics to convey the cause and effect of the new floodplain delineation methodology, "30% rule" and clustering by example. It will be important to identify and prioritize functions and values that are deemed a high priority compared to those that are not.
13) Performance Measures and Design Criteria for Groupings 1 & 2 must be further developed for SWC's (3.5.2) and Waterman Wash (3.4.9) as these important project components will be a high priority for COG staff and likely represent the most some of the implementable concepts.
14) Suggest a Planning Commission and/or City Council work session to garner their input and support on key PGO concepts in the developmental stages of the PGO's. Obtaining buy-in from the elected officials on cornerstone PGO concepts in the preliminary stages will reduce the likelihood of interested parties submarining efforts by lobbying Council at the later stages of the PGO development process.

Public Safety Through Flood Hazard Mitigation – Opportunities & Constraints

The PGO Tools Roadmap identified what section/reference point of each Goodyear regulatory document that could be a logical or plausible target for amendment relative to each of the 67 Performance Functions/Design Criteria. In general, the Public Safety Through Flood Hazard Mitigation Performance Functions/Design Criteria are more technically based in hydrologic and hydraulic requirements or reporting methodologies. As a result, the development of potential PGO's under for these principles are often best suited for inclusion in the Engineering Design Standards & Policies Manual (EDSPM) with a policy umbrella citation likely needed in the General Plan or Flood Prevention Code (FPC). Some of these Performance Functions/Design Criteria however are capable for amendment to the EDSPM without the need to consider a new policy per se because it has the ability to link and "be covered" under an existing policy statement. Specific determinations to this effect will need to be further vetted with Goodyear staff.

Public Safety Through Flood Hazard Mitigation – Opportunities, Constraints & Observations for Further Consideration

1) In general, the Design Criteria presented are likely more representative of future potential code requirements, design guidelines or development standards and the Performance Functions lend themselves to General Plan or Flood Damage Prevention Code-level policy statements.
2) Design Guideline 1.3(a), "Maintain Adequate Baseflow for Vegetation", is an important concept, has large ramifications and ripple effects on many other Design Guidelines and existing development practices in Goodyear. The concept on the whole is beneficial and likely desired by Goodyear staff however a one size fits all approach (30% for all properties) is not realistic or implementable in its current form. Policy needs refining by creating a "suite" of choices that could be based on a combination of flood hazard rating, land form, land use, density and flow characteristics. Open space percentage requirements slide up and down depending on combination of above. This should be further refined before moving this important concept forward to the City of Goodyear.
3) Some concepts, such as 2.1, "Limit Reduction in Time of Concentration", should be divided into a more general policy statement and more specific ordinance development standard. By example, "incorporating elements into the site layout that simulates natural runoff" is a good policy level statement. But also bring greater specificity describing what is considered "rougher materials" and "flatter slopes" by more specifically defining that metric of rougher slopes and flatter slopes. 2.2(a), "Provide Retention/Detention to Meter Flows", also is identified as an example needing a specific metric balancing increased peak discharge and amount of retention storage provided – can we quantify a rule of thumb based on percentage of impervious surface?
4) Guidance from Performance Function 3.1, "Manage Flow Split Uncertainty by Fixing or Regulating Flow Split Potential" becomes enhanced and measurable if the flow splits are mapped and adopted by the City to give guidance on where flow split diversions could/should occur. Otherwise, policy has no "teeth" if there is no mapping prioritization of key flow splits. 3.4(a), also relating to flow splits, discusses "significant splits" without quantification and the adoption of a map would illustratively establish the quantification necessary for successful implementation. Policy application of this provision likely to be co-mingled with 3.2, 3.3. Changes to FDPC would consist of streamlined language for refined standards of construction or amended by reference only. Need further Project Team discussion on weighing these potential maps against ACOE and FEMA other regulatory issues. In the alternate, perhaps utilize maps for Goodyear staff as internal guidelines/reference to guide their decision making on community design proposals in the future.
5) Further clarification to define a "suitable outfall" beyond the current practice of downstream spreader basins should be explored to craft an acceptable and functional PGO. In instances where a suitable outfall is not readily available, explore alternative means to accommodate these instances. Assumption that

an outfall must provide downstream connectivity to Waterman Wash is not a realistically implementable provision. If that is not the intent of the "suitable outfall" standard, consider revision to existing text to suggest desired intent.

6) Further evaluation (with map illustrations) of SWC's or washes of 500 cfs or greater (including Waterman Wash) in relation to resulting floodplain footprint based upon the modified floodway delineation methodology is highly suggested as a key tool in demonstrating these concepts to Goodyear staff. Examination of wash locations, a comparison of the before and after effect on developable land area is needed for Goodyear to have a meaningful examination of the opportunities and constraints that are created in the municipal implementation and enforcement of this key concept. The application of erosion hazard setbacks influences this discussion.

   A "before and after" analysis demonstrating the difference in the floodway footprint will likely be necessary to roll out to the development community. The Project Team should identify these locations to be examined. Further, the evaluation of what "trade-offs" (if any) will be necessary to implement this measure without triggering Proposition 207 issues is suggested. Trade offs for potential consideration include transfer of development rights (density), open space requirement contributions and operation and maintenance contributions. With City Attorney oversight, the City may find that no "trade-offs" are necessary. This suggestion touches on the interrelationship of several of the Performance Functions/Design Criteria presented in the Flood Hazard Mitigation Plan.

7) Please see PGO Tools Roadmap for additional observations so as to not be redundant here.

Quality Community Design in a Flood Hazard Context Mitigation – Opportunities, Constraints and Observations for Further Consideration

1) In general, many of the Performance Functions/Design Criteria presented are best positioned for use as policy statements in the existing COG PGO framework. These policy statements will be effective in achieving a "policy umbrella" for community design concepts. A refinement and/or quantification of some of the concepts is needed if they are desired to be included as a Goodyear development standard or design guideline provision. Specific guidance relative to each individual Performance Function/Design Criteria has been identified in the PGO Tools Roadmap document. An example includes 8.1, quantifying the link between riparian zone preservation and size of wash or facility type.
2) General observation that certain vernacular such as "flood hazard mitigation facilities" used extensively throughout this section will need to be modified or subdivided into more specific terms such as "soft structural drainage channels", "retention basins" and the like for use as a municipal PGO.
3) Though there is a relationship to H&H functions, some policies introduced arguably are more appropriate for another venue outside of the Rainbow Valley ADMP process (i.e., protecting groundwater resources, biological resources, preservation of BLM open spaces in general).

4) Landscape palettes and appropriate design themes to be determined with city through independent task. Concepts as presented are broad and should be distilled to match facility type, adjacent land use, existing City of Goodyear approved palette and community design theme. District Context Sensitive approach and LIA for this project should assist (if not already) in guiding future discussions with Goodyear. Useful instruction could be to map design theme locations in watershed for guidance. Key plant matrices are more useful for Goodyear as policy guide when applied in this manner.

5) Identifying segments of the Maricopa Trail linking to SWC's is important. Policy statement regarding trails could be enhanced (for demonstration to Goodyear staff) by illustratively identifying segments of the Maricopa Trail with SWC's or other notable washes. Maricopa Trail segments not associated with SWC's should be considered under a separate trails study with Goodyear unless those Maricopa Trail locations are in relation to outfall channel locations – identify distinction accordingly.

6) Enhanced specificity and guidance is needed relative to co-location of "facilities" with flood hazard mitigation facilities. Suggest development of PGO's that speak to trail head locations, amenities, buffering, prohibited uses, trail tread types, use of turf, how park facilities work or don't work with water quality basins. Rather than determine locations, give parameters for developers to implement.

7) Table 3-3 in the Flood Hazard Mitigation Plan is very instructive and is suggested to be included (in some form) into future PGO's as these issues have historically been administered in a nebulous fashion by the City.

8) Notion of "sufficient buffering" for wildlife travel is a laudable goal but very difficult to implement without more quantifiable data. Extensive buffers always seem to be suggested for larger species. Consider evaluation of corridors for small mammals and reptiles? Otherwise, "sufficient buffering" will not be well received by Goodyear as a value-added tool.

9) Concepts referring to clustering of development need to be more thoroughly defined and articulated to achieve desired purpose. Goodyear does not have a definition of clustering" or a "cluster product". Perhaps "alternative lot design" or "lot size reduction" techniques are supplemental terms that could be evaluated. Suggest stronger corollary between land use type, density and intensity of land use, size of wash (cfs/SWC)..."development" and "cluster" could be defined for each land use and intensity type and provide range or choice of standards/ guidelines. A PGO instrument to achieve the clustering concept should be done in unison with the concepts presented in 1.3(a) as they are inextricably intertwined. The sliding scale approach giving a range of options will define the success of this key implementation tool.

APPENDIX B

PGO ROAD MAP

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.1 – Restrict Increases in Storm Water Runoff Volume

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
1.1 Store increased runoff volume resulting from development	Section 4.2, Obj. A-2 Section 6.2, Goal A Section 9.2, Obj. B-4	Section 3-2-7(B) Section 3-3-6(B) Section 3-5-5	GP, ZO, DG	Article II, Section C Article X, Section B	GP, ZO, DG	16-1-2 16-1-3	Performance Function language best suited for GP and DG with reference to FDPC. GP language needs adjustment to fit GP policy vernacular.
1.2 Preserve natural land storage and storm water infiltration properties	Section 4.2, Goal B Section 5.2, Obj. B-2 Section 9.2, Goal A and Obj. B-4	GP, DG	GP, DG	Article II, Section C Article X, Section B	GP, DG	16-1-2 16-1-3	Performance Function language best suited for GP and DG with reference to FDPC. GP language needs adjustment to fit GP policy vernacular.
1.3 Maintain adequate baseflow for vegetation	Section 5.2, Obj. C-3 Section 9.2, Goal A	Section 5-1-3(C)	GP, ZO, DG	Article II, Section E Article X, Section B	GP, DG	16-1-2 16-1-3	Performance Function language best suited for GP and DG with reference to FDPC. GP language needs adjustment to fit GP policy vernacular.
1.3 (a) Maintain adequate baseflow for vegetation	Section 2.2, Goal E Section 4.2, Obj. A-2 Section 6.2, Goal A Section 9.2, Obj. B-4	Section 3-2-7(B) Section 3-3-6(B) Section 3-5-5	Section 3.2.1 Section 3.2.2 Section 7.8 (future) Section 9.1.2(B) Section 9.1.3	Article II, Section C Article X, Section B, C Article IV, Section B Article VII, Section B	15-2-4(D) 15-2-5(B) 15-2-6(D) 15-3-1(C) 15-3-7(C) 15-4-4(F) 15-4-6	16-1-2 16-1-3 16-3-2 16-5-1 16-5-4 16-5-7 16-5-8	Need to refine definition of "development" as 30% is applicable to all land use types as written. A one size fits all approach is not realistic nor implementable. 30% is more/less double the City's existing open space requirements. Policy needs refining through creation of range of choices based on land use, density and flow characteristics. DG references could be modified to reflect inclusion of new Article exclusively for ADMP study area.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
1.3 (b) Maintain adequate baseflow for vegetation	Section 9.2, Obj. B-4	Section 3-2-7(B) Section 3-3-6(B) Section 3-5-5	Section 3.2.1(A, B) Section 3.3.3(C) Section 9.1.2(B) Section 9.1.3	EDSPM, ZO, SR	15-2-4(D) 15-2-5(B) 15-2-6(D) 15-3-1(C)	16-5-1 16-5-4	
1.3 (c) Maintain adequate baseflow for vegetation	EDSPM, SR	EDSPM, SR	Section 3.2.2(A)	EDSPM, SR	15-2-4(D) 15-2-5(B) 15-2-6(D)	16-5-1 16-5-4	
1.3 (d) Maintain adequate baseflow for vegetation	Section 5.2, Obj. C-3 Section 9.2, Obj. B-4	Section 3-2-7(B) Section 3-3-6(B) Section 3-5-5	Section 3.2.1 Section 3.3.3 (C)	Article II, Section C 10 Article X, Section B, C1, C2, E1	GP, ZO, DG, EDSPM	GP, ZO, DG, EDSPM	This "framework" language needs enhanced specificity for adequate consideration. DG provisions must include region/geographical reference.
1.3 (e) Maintain adequate baseflow for vegetation	Section 5.2, Obj. C-3 Section 9.2, Obj. B-4	Section 3-2-7(B) Section 3-3-6(B) Section 3-5-5	Section 3.2.1 Section 7.5	Article X, Section B, C1, C2, C5, E1	GP, ZO, DG, EDSPM	16-5-1 16-5-4	

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.2 – Restrict Increases in Storm Water Peak Discharges

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
2.1 Limit reduction in time of concentration	Section 5.2, Obj. B-2 Section 9.2, Goal B Section 9.2, Obj. B-4	GP, DG	GP, DG See Notes	Article II, Section C Article IV, Section B Article VII, Section B Article X, Section B	GP, DG See Notes	16-1-2 16-1-3 16-3-2	Existing language needs to be more succinct and less technical for policy application. Specify or quantify rougher materials and flatter slopes for ZO, EDSPM inclusion.
2.2 Provide retention/detention to meter flows	Section 5.2, Obj. B-2 Section 9.2, Goal B Section 9.2, Obj. B-4	GP, DG	GP, DG See Notes	Article II, Section C Article IV, Section B Article VII, Section B Article X, Section B, C1, C2, E1	GP, DG See Notes	16-1-2 16-1-3 16-3-2 16-5-1 16-5-4 16-5-8	Current language needs a more specific metric relating to balance between increased peak discharge and retention storage for adequate DG, ZO or EDSPM guidance. FDPC changes will consist of cross-references throughout the FDPC.
2.2(a) Provide retention/detention to meter flows	Redundant for GP	Section 3-2-7 (B) Section 3-3-6(B) Section 3-5-5 Section 5-1-3(c)	Section 3.2.1 Section 3.2.2(c)3b, c Section 3.3.3(C) Section 3.3.6 Section 9.1.2 (B) Section 9.1.3	Article II, Section C Article IV, Section B Article VII, Section B Article X, Section B, C1, C2, E1	15-2-4(D) 15-2-5(B) 15-2-6(D) 15-3-1 (C)	16-1-2 16-1-3 16-3-2 16-5-1 16-5-4 16-5-7 16-5-8	Current language needs a more specific metric relating to balance between increased peak discharge and retention storage for adequate DG, ZO or EDSPM guidance. FDPC changes will consist of cross-references throughout the FDPC.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.3 – Maintain Flow Continuity to Outfall

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
3.1 Manage flow split uncertainty by "fixing" or regulating flow split potential	Section 4-2, Goal C Section 5.2, Obj. B-2 Section 9.2, Goal A Section 9.2, Goal B Section 9.2, Obj. B-4	GP, EDSPM	Section 3.2.1 Section 3.2.2(C)3b, c Section 9.1.2 (B) Section 9.1.3	GP, EDSPM	GP, EDSPM	16-3-2 16-5-1 16-5-4	Presumes flow splits are mapped and adopted by City to give guidance on where flow split diversions could/should occur. Policy application of this provision likely to be co-mingled with 3.4.3.1 (B, C). Changes to FDPC would consist of streamlined language for refined standards of construction or amended by reference only.
3.2 Once concentrated, flows to be conveyed to suitable outfall	Section 5.2, Obj. B-2 Section 9.2, Goal A Section 9.2, Goal B Section 9.2, Obj. B-4	GP, DG, EDSPM	Section 3.2.1 Section 3.2.2(C)3b, c Section 9.1.2 (B) Section 9.1.3	Article II, Section C Article IV, Section B Article VII, Section B	15-4-4(F)	GP, DG, EDSPM	Changes to FDPC would consist of streamlined language for refined standards of construction or amended by reference only.
3.3 Maintain sub-basin continuity	Section 5.2, Obj. B-2 Section 9.2, Goal A Section 9.2, Goal B Section 9.2, Obj. B-4	GP, EDSPM	Section 3.2.1 Section 3.2.2(C)3b, c Section 9.1.2 (B) Section 9.1.3	GP, EDSPM	GP, EDSPM	GP, EDSPM	Concerned about practical effect and implementation. Suggest range of choices/constraints based on sub-basin size, property size and flow characteristics.
3.4 Coordinate road alignments with drainage patterns	Section 3.2, Goal A Section 5.2, Obj. B-2	GP, DG, EDSPM See 3.4.3.2 (d)	Section 3.2.1 Section 4.1.3(A)	Article II, Section C Article IV, Section B Article VII, Section B Article X, Section C (5), E(3) See 3.4.3.2 (d)	15-3-2 15-4-4(A)	16-5-1 16-5-4	

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
3.4(a) Coordinate road alignments with drainage patterns	ZO, EDSPM	Section 3-2-7 (B) Section 3-3-6(B) Section 3-5-5	Section 3.2.1 Section 3.2.2(C)3b, c Section 9.1.2 (B) Section 9.1.3	ZO, EDSPM, FDPC	ZO, EDSPM	ZO, EDSPM	Adoption of map by reference needed to identify "significant splits" which correlates best to EDSPM or FDPC and cross referenced in ZO.
3.4(b) Coordinate road alignments with drainage patterns	ZO, EDSPM, DG, FDPC	Section 3-2-7 (B) Section 3-3-6(B) Section 3-5-5 EDSPM	Section 3.2.1 Section 3.2.2(C)3b, c Section 9.1.2 (B) Section 9.1.3	Article II, Section C Article IV, Section B Article VII, Section B	ZO, EDSPM, DG, FDPC	16-5-1 16-5-4	Notion of "suitable outfall" needs further definition. Concern on implementability of this provision as written.
3.4(c) Coordinate road alignments with drainage patterns	EDSPM	EDSPM	Section 3.2.1 Section 3.2.2(C)3b, c Section 9.1.2 (B) Section 9.1.3	EDSPM	EDSPM	EDSPM	
3.4(d) Coordinate road alignments with drainage patterns	Section 3.2, Goal A	Section 3-2-7 (B) Section 3-3-6(B) Section 3-5-5	Section 3.2.1 Section 4.1.3(A)	Article II, Section C (6) Article IV, Section B Article VII, Section B	15-3-2 15-4-4(A)	16-5-1 16-5-4	

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.4 – Preserve Wash Storage for Peak Attenuation

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
4.1 Mitigate loss of floodplain storage from encroachment	EDSPM	EDSPM	Section 3.2.1 Section 3.2.2 Table 3-3-1	EDSPM	EDSPM	16-1-3 16-5-1	Modification of language may be necessary for inclusion into EDSPM. FDPC reference should be given to methodology in EDSPM. Accompanying flowchart would be useful.
4.1(a) Mitigate loss of floodplain storage from encroachment	Section 9.2, Goal B Section 9.2, Obj. B-4	Section 3-2-7 (B) Section 3-3-6 (B) Section 3-5-4	GP, ZO, DG, SC	Article II, Section C Article IV, Section B Article VII, Section B Article X, Section B	15-3-1	16-1-3 16-3-2 16-5-1	GP, ZO, DG and SC to provide policy statement and reference to EDSPM for specific delineation methodology.

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

BASE FUNCTION 3.3.5 – Preserve Cross Section Conveyance Capacity

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
5.1 Maintain floodplain storage volume	Redundant or subservient to 3.4.4.1	Redundant or subservient to 3.4.4.1	Section 3.2.1 Section 3.2.2 Table 3-3-1	Redundant or subservient to 3.4.4.1	Redundant or subservient to 3.4.4.1	Redundant or subservient to 3.4.4.1	Redundant or subservient to 3.4.4.1. EDSPM modification denoted for cross-reference.
5.1(a) Maintain floodplain storage volume	Section 9.2, Goal B Section 9.2, Obj. B-4	Section 3-2-7 (B) Section 3-3-6 (B) Section 3-5-4	GP, ZO, DG, SC	Article II, Section C Article IV, Section B Article VII, Section B Article X, Section B	15-3-1	16-1-3 16-3-2 16-5-1	GP, ZO, DG and SC to provide policy statement and reference to EDSPM for specific delineation methodology.

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.6 – Preserve Sediment Transport Capacity of Washes

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
6.1 Preserve dominant discharge low flow channel	Section 9.2, Goal B Section 9.2, Obj. B-4	GP, EDSPM	Section 3.2 Section 3.3	GP, EDSPM	GP, EDSPM	GP, EDSPM	Omit first sentence when modifying language for policy statement. "Bankful channel section" will need new definition introduction.
6.2 Limit increase in maximum tractive shear at design discharge	EDSPM, FDPC	EDSPM, FDPC	Section 3.2 Section 3.3	EDSPM, FDPC	EDSPM, FDPC	16-5-1	Technical concept requiring more simplified language for policy application. Last sentence is primary focus. Other sentences more explanatory in nature.
6.3 Design for potential changes in sediment supply from upstream development	EDSPM, FDPC	EDSPM, FDPC	Section 3.2 Section 3.3	EDSPM, FDPC	EDSPM, FDPC	16-5-1	Technical concept requiring more simplified language for policy application. Last two sentences are primary focus. Other sentences more explanatory in nature.
6.3(a) Design for potential changes in sediment supply from upstream development	Section 9.2, Goal B Section 9.2, Obj. B-4	Section 3-2-7 (B) Section 3-3-6 (B) Section 3-5-4	Section 3.2 Section 3.3.3 Section 3.3.5 (C)	Article II, Section C Article IV, Section B Article VII, Section B Article X, Section B	15-3-1 15-3-7 (C)	16-5-1	Modification to reference citation is necessary upon implementation.
6.3(b) Design for potential changes in sediment supply from upstream development	EDSPM	EDSPM	Section 3.2 Section 3.3.2 (B) Section 3.3.3 Section 3.3.5 (C)	EDSPM	EDSPM	EDSPM	

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
6.3(c) Design for potential changes in sediment supply from upstream development	EDSPM	EDSPM	Section 3.2 Section 3.3.2 (B) Section 3.3.3 Section 3.3.5 (C)	EDSPM	EDSPM	EDSPM	

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.7 – Maintain Sediment Continuity

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION CODE	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
7.1 Minimize concentration of existing sheet flow	Section 5.2, Obj B-2 Section 9.2, Goal B Section 9.2, Obj. B-4	GP, EDSPM	Section 3.2 Section 3.3.2 (B) Section 3.3.4 Section 3.3.5(C)	GP, EDSPM	GP, EDSPM SC Cross Reference	GP, EDSPM FDPC Cross reference	Suggestion that last sentence of opening paragraph of Section 3.4.7 be used as a policy statement. SC and FDPC should provide reference to EDSPM.
7.2 Maintain sediment yield from individual development and overall watershed	Section 5.2, Obj B-2 Section 9.2, Goal B Section 9.2, Obj. B-4	GP, EDSPM	Section 3.2 Section 3.3.2 (B) Section 3.3.4 Section 3.3.5(C)	GP, EDSPM	GP, EDSPM SC Cross Reference	GP, EDSPM FDPC Cross reference	Suggestion that the existing language for the three Performance Functions could be combined into one or two policy statements. SC and FDPC should provide reference to EDSPM.
7.3 Maintain sediment delivery to Waterman Wash	Section 5.2, Obj B-2 Section 9.2, Goal B Section 9.2, Obj. B-4	GP, EDSPM	Section 3.2 Section 3.3.2 (B) Section 3.3.4 Section 3.3.5(C)	GP, EDSPM	GP, EDSPM SC Cross Reference	GP, EDSPM FDPC Cross reference	Suggestion that the existing language for the three Performance Functions could be combined into one or two policy statements. SC and FDPC should provide reference to EDSPM.

GENERAL NOTES:

1) **In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.**
2) **Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.**
3) **All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.**
4) **In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.**
5) **PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.**

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.8 – Compliment Planned Future Scenery Resources

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
8.1 Design to be compatible with planned cultural and physical setting (natural, rural, suburban, or urban)	Section 2.2, Goal E Section 4.2, Obj. B-2 Section 4.2, Obj. C-2 Section 9.2, Goal A Section 9.2, Obj. A-4 Section 9.2, Goal B Section 9.2, Obj. B-4 Section 10.2, Growth Area D Section 11.2, Obj. A-3 Section 11.2, Obj. A-4	GP, DG	GP, DG	Article X, Section B Article X, Section F	GP, DG	GP, DG	"Flood Hazard Mitigation Facilities" vernacular needs to be modified to "soft structure drainage channels, retention basins" and the like for municipal policy jargon. Section 9.2, Obj. A-4 Could be used as a tool in early stages of incremental adoption, use GP first then remaining policies and guidelines to follow.
8.2 Flood hazard mitigation to be compatible with natural Sonoran desert wash in floodway	Section 2.2, Goal E Section 4.2, Obj. B-2 Section 4.2, Obj. C-2 Section 9.2, Goal A Section 9.2, Obj. A-4 Section 9.2, Goal B Section 9.2, Obj. B-4 Section 10.2, Growth Area D Section 11.2, Obj. A-3 Section 11.2, Obj. A-4	GP, DG	GP, DG Section 7.8 (future)	Article X, Section B Article X, Section F	GP, DG	GP, DG	Riparian zone preservation policies should be included in EDSPM Section 7.8 future update. Suggest greater clarity to size of wash by flow characteristics (500 cfs?) and 404 status to give parameters for required preservation to increase likelihood of implementation. DG Article X, Section F to be expanded categorically to include these concepts. See similar comment 3.4.8.2(D) for integration and cross reference.
8.3 Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	Section 2.2, Goal E Section 4.2, Obj. B-2 Section 4.2, Obj. C-2 Section 9.2, Goal A Section 9.2, Obj. A-4 Section 9.2, Goal B Section 9.2, Obj. B-4 Section 10.2, Growth Area D Section 11.2, Obj. A-3 Section 11.2, Obj. A-4	GP, DG	GP, DG	Article X, Section B Article X, Section F	GP, DG	GP, DG	

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
8.3(a) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	(a) Section 9.2, Goal A Section 9.2, Obj. B-4	Section 3.2.7 (B) Section 3.3.6 (B) Section 3-5-5 All by cross reference notation to EDSPM	(i., ii., iii.) Section 3.2 Section 3.2.2 Section 3.3.3 Section 3.3.5 (C)	Article X, Section B Article X, Section F	15-3-1 (content or cross reference)	16-5-1 (content or cross reference)	3.4.8.2(aiii.) is not needed for inclusion into municipal PGO
8.3(b) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Landscape palettes and appropriate design themes to be determined with city through independent task.
8.3(c) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Landscape palettes and appropriate design themes to be determined with city through independent task.
8.3(d) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	See similar comment 3.4.8.1 (B) for integration and cross reference.
8.3(e) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	EDSPM, DG	EDSPM, DG	(i.) Section 3.2 Section3.3.3 Section 3.3.5	(ii.) Article X, Section B Article X, Section F	EDSPM, DG	EDSPM, DG	Suggestion of no utilities in linear wash alignment is flawed by not providing allowance for gravity sewer facilities in a prescribed wash buffer area. Modify language from biological and recreation functions to "wildlife, pedestrian, equestrian" or similar.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
8.3(f) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Concept is vague and conflicts itself. More specific metrics and consistency with other identified Performance Functions and Design Criteria for maintenance of overbank protection being required. Revegetation for "functional improvements" offers little value and could be considered conflicting with above.
8.3(g) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	Section 9.2, Goal A Section 9.2, Obj. A-4 Section 9.2, Goal B Section 9.2, Obj. B-4	Section 3-2-7 (B) Section 3-3-6 (B) Section 3-5-4	Section 3.2 Section3.3.3 Section 3.3.5	Article X, Section B Article X, Section F	GP, ZO, EDSPM, DG	16-5-1 by reference notation	ZO citation if included in new section for SWC's
8.3(h) Design to maintain views toward mountain preserve areas; preserve existing character of views from mountain preserves	Section 3.2, Goal D Section 9.2, Goal A Section 9.2, Obj. A-4 Section 9.2, Goal B Section 9.2, Obj. B-4	Section 3-2-7 (B) Section 3-3-6 (B) Section 3-5-4	Section 3.2 Section3.3.3 Section 3.3.5	Article X, Section B Article X, Section F	GP, ZO, EDSPM, DG	16-5-1 by reference notation	ZO citation if included in new section for SWC's. Bring specificity to "flood hazard mitigation facilities" language. Consider "bajada" and "valley plain"

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.9 – Accommodate Regional & Local Multi-Use

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
9.1 Accommodate City of Goodyear parks	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Policy statement already exists, is utilized by staff and common development practice. Existing supporting policy framework includes GP, Section 4.2, Obj. A-2, Obj. B-2, Goal C, Obj. C-2 and DG Article X, Section B. "More value dense units" is awkward terminology and nebulous in application.
9.2 Accommodate other local parks	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Policy statement already exists, is utilized by staff and common development practice. Existing supporting policy framework includes GP, Section 4.2, Obj. A-2, Obj. B-2, Goal C, Obj. C-2 and DG Article X, Section B. "More value dense units" is awkward terminology and nebulous in application.
9.3 Establish Maricopa Region Trail segment(s)	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Adoption of policy recommendations for various segments of the Maricopa Regional Trail more appropriately housed in update/creation of a COG PTOS/Trails Master Plan with supporting reference and mapping to RVADMP. Guidance on trail character, user types, tread type and amenities would be useful.
9.3(a) Establish Maricopa Region Trail segment(s)	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Policy statement already exists, is utilized by staff and common development practice. Existing supporting policy framework includes GP, Section 4.2, Obj. A-2, Obj. B-2, Goal C, Obj. C-2 and DG Article X, Section B.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
9.3(b) Establish Maricopa Region Trail segment(s)	See Notes	See Notes	Section 3.3 Section 7.6 See Notes	See Notes	See Notes	See Notes	Additional internal team discussion necessary to prescribe various implementation tools. Existing policy PGO could take on many forms for implementation, but is likely rooted in EDSPM. COG may not want to prescribe "required dimensions" for every use identified.
9.3(c) Establish Maricopa Region Trail segment(s)	Section 4.2, Obj. A-2 Section 4.2, Obj. B-2 Section 4.2, Obj. C-2 Section 9.2, Obj. B-4	Section 3-2-7 (B) Section 3-3-6 (B) Section 3-5-5 Section 5-1-3 (C)	Section 3.3.5 (C) Section 7.4	Article X, Section B Article X, Section C (3) Article X, Section D (3) Article X, Section E (2)	15-3-1 by reference	GP, ZO, EDSPM, DG	Policy statement well suited for GP and DG. Additional guidance/metric on tread type and threshold of wash size (500 cfs/width/SWC's) to trigger trails on both sides would be constructive.
9.3(d) Establish Maricopa Region Trail segment(s)	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Policy as written is more of a "framework" as it is too vague and needs modification to become a "design criteria". "Sufficient buffering" for wildlife travel good concept but not implementable. Trails meandering in/out of washes good policy concept that warrants its own separate designation.
9.3(e) Establish Maricopa Region Trail segment(s)	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	This broad trails policy more appropriately housed in update/creation of a COG PTOS/Trails Master Plan with supporting reference to RVADMP. Notion of "overbank area" should translate to a "buffer area" and is better suited and consistent with 3.4.9.2 (C) above.
9.3(f) Establish Maricopa Region Trail segment(s)	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	This broad trails policy more appropriately housed in update/creation of a COG PTOS/Trails Master Plan

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
9.3(g) Establish Maricopa Region Trail segment(s)	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Adoption of policy recommendations for various segments of the Maricopa Regional Trail more appropriately housed in update/creation of a COG PTOS/Trails Master Plan with supporting reference and mapping to RVADMP. In the alternate, select Maricopa Regional Trail segments should be mapped as SWC's in Goodyear and have specific prescribed design standards for each SWC's, Waterman Wash and the Anza National Historic Trail (with annotated reference to Maricopa Trail segment number).

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RBF CONSULTING

BASE FUNCTION 3.3.10 – Provide Open Space

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
10.1 Preserve existing open space value	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Ubiquitous policy framework in need of distilling for value-added municipal policy application prior to inclusion into Goodyear PGO exercise. Concepts are generally favorable, but vague and not implementable in a practical sense. Some policies introduced arguably are more appropriate for another venue outside of the RV ADMP process (i.e., protecting groundwater resources, biological resources, preservation of BLM open spaces in general). Goals intended for Waterman Wash should be housed in a separate Waterman Wash or SWC category.
10.2 Maintain BLM-managed lands as public open space	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Ubiquitous policy framework in need of distilling for value-added municipal policy application prior to inclusion into Goodyear PGO exercise. Concepts are generally favorable, but vague and not implementable in a practical sense. Some policies introduced arguably are more appropriate for another venue outside of the RV ADMP process (i.e., protecting groundwater resources, biological resources, preservation of BLM open spaces in general). Goals intended for Waterman Wash should be housed in a separate Waterman Wash or SWC category.
10.3(a) Development in "MAG Desert Spaces – Retention" areas to comply with MAG *Desert Spaces Design Guidelines*	Section 2.2, Goal E Section 4.2, Goal A, Obj. A-2 Section 9.2, Goal A Section 9.2, Goal B	See Notes	See Notes	See Notes	See Notes	See Notes	Suggest GP level language application only with adjustments and specificity added to the language as presented. Elaborate on resolving conflict between leaving undeveloped portions in a natural state vs. giving guidance on "other allowed uses" so two are not juxtaposed in a municipal enforcement setting. Will erosion hazard/lateral migration areas be mapped for SWC's? Policy should be housed in a SWC section and correlate to others in similar policy objective context.

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
10.3(b) Development in "MAG Desert Spaces – Retention" areas to comply with MAG *Desert Spaces Design Guidelines*	Section 9.2, Goal A Section 9.2, Goal B	See Notes	See Notes	See Notes	See Notes	See Notes	Points and subpoints contained in this section need to be more thoroughly defined and articulated to achieve desired purpose. Need stronger correlaries between land use type, density and intensity of land use, size of wash (cfs/SWC)…"development" and "cluster" need to be defined for each land use and intensity type and provide range or choice of standards/guidelines. Many concepts are laudable and possible in some development types, but a one size fits all approach on a key concept that is the cornerstone to many PGO possibilities/successes needs to be refined to help enhance the likelihood of acceptance and implementation. Suggest better connection between metric and flood mitigation function. Introduce lot reduction technique concept whereby open space is preserved commensurate with area suitable for lot size reductions – 1:1 ratio.
10.3(c) Development in "MAG Desert Spaces – Retention" areas to comply with MAG *Desert Spaces Design Guidelines*	Section 4.2, Goal C Section 9.2, Goal A Section 9.2, Goal B	See Notes	See Notes	See Notes	See Notes	See Notes	BLM will maintain management over these lands and a COG GP policy statement to "compliment" or support the RMP can be summarized in one GP policy statement
10.3(d) Development in "MAG Desert Spaces – Retention" areas to comply with MAG *Desert Spaces Design Guidelines*	Section 4.2, Goal C Section 9.2, Goal A Section 9.2, Goal B	See Notes	See Notes	Article X, Section B-F	See Notes	See Notes	Useful comments to serve as a guide in the preparation of more specific policies and standards that can utilize potions of the MAG Desert Spaces Plan. Most appropriate applications appear to be in GP of DG.

GENERAL NOTES:

1) **In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.**
2) **Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.**
3) **All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.**
4) **In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.**
5) **PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.**

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.11 – Biological Resources

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
11.1 Maintain existing ecological integrity of natural vegetation types	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	Suggest this language be modified and combined with 3.4.11.1(B) to build one targeted policy. One policy sufficient for ecological and natural functions. Pair down language for a value-added policy. Mitigation banking not a concept in Goodyear's current "tool box" and probably not a viable option at this time.
11.2 Protect natural and beneficial functions of washes	Section 2.2, Goal E Section 4.2, Goal A, Obj. A-2 Section 9.2, Goal A Section 9.2, Goal B	GP, EDSPM, DG	Section 3.2 Section 3.3 Section 3.3.5	Article X, Section B	GP, EDSPM, DG	16-5-1 GP, EDSPM, DG	See 3.4.11.1(A) comment above. Also, existing policy language exists in GP and DG so do not replicate/conflict with existing policy structure, but support as needed.
11.3 Preserve the connectivity and permeability of habitats	Section 2.2, Goal E Section 3.2, Goal C-D Section 4.2, Obj. A-2 Section 4.2, Goal C Section 9.2, Goal A Section 9.2, Goal B	GP, DG	GP, DG	Article X, Section B-F	GP, DG	GP, DG	Language as presented must be distilled and crafted into municipal policy vernacular. GP and DG policies are extent of this provision. If known species can be linked to known corridor, perhaps a metric for crossing design could be developed for EDSPM or DG.
11.4 Restore or enhance vegetation and natural channels in poorly defined or degraded sections of washes	Section 9.2, Goal A Section 9.2, Goal B Section 11.2, Obj. A-3	Section 5-1	Section 3.3.5(C) Section 7.8 (future)	Article X, Section B	15-3-1	16-5-1	Language should be refined for targeted policy application. Suggest determination of acceptable plant palette for Waterman Wash and codify.

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
11.5 Use built structures to create resources for wildlife	Section 9.2, Goal A Section 9.2, Goal B	See Others	Section 3.3.5(C) Section 3.3.6 Section 7.8 (future)	Article X, Section B, F	15-3-1	16-5-1 or reference	Eliminate term "built structures" specify "basins" and "man made soft structural channels".

GENERAL NOTES:
1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

RBF CONSULTING

RAINBOW VALLEY ADMP
TASK 12.8.3 – Policies, Guidelines & Ordinances
PGO TOOLS ROADMAP
June 2011

BASE FUNCTION 3.3.12 – Cultural Resources

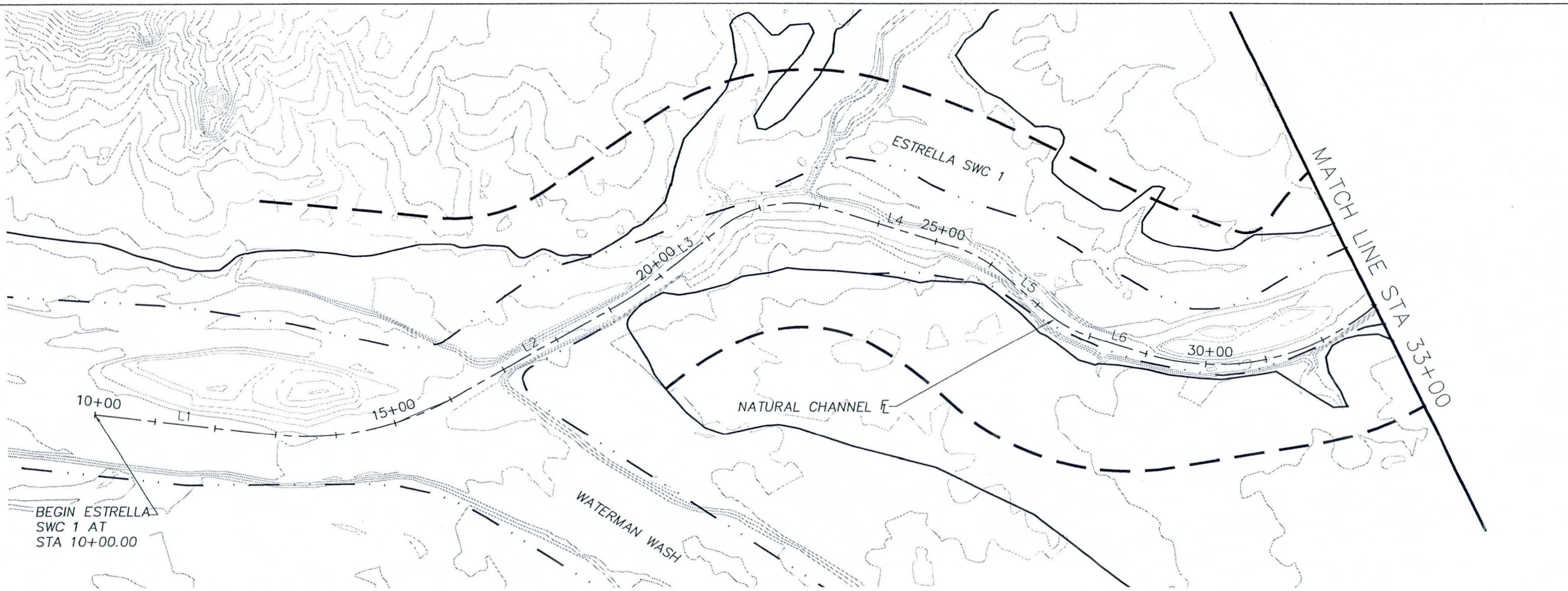
PERFORMANCE FUNCTION/DESIGN CRITERIA	GENERAL PLAN	ZONING ORDINANCE	ENGINEERING DESIGN STANDARDS & POLICY MANUAL	DESIGN GUIDELINES	SUBDIVISION REGULATIONS	FLOOD DAMAGE PREVENTION CODE	POLICY NOTES
12.1 Historic sites	Section 2.2, Goal E Section 4.2, Goal B Section 9.2, Goal B	See Notes	See Notes	See Notes	See Notes	See Notes	Language as provided should be distilled into a succinct GP policy statement identifying each priority resource for protection. Need to review and prioritize with COG staff and coordinated with SHPO procedures. DG provisions could then be built with more specificity to bolster and compliment GP policy.
12.2 Prehistoric sites	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	This "performance function" is more reflective of a factual and informative description of human occupation over 1,200 years in Rainbow Valley. As noted above, any historical preservation sites of value should be prioritized with COG staff, coordinated with SHPO procedures and first codified through a GP policy with more specific DG provisions exclusive to each historic site developed.
12.3(a) Prehistoric sites	Section 2.2, Goal E Section 4.2, Goal B Section 9.2, Goal B	See Notes	See Notes	See Notes	See Notes	See Notes	Language as provided should be distilled into a succinct GP policy statement identifying each priority resource for protection. Need to review and prioritize with COG staff and coordinated with SHPO procedures. DG provisions could then be built with more specificity to bolster and compliment GP policy.

GENERAL NOTES:

1) In instances where a Performance Function or Design Criteria are identified for multiple entries within one COG document or across multiple COG documents, each entry reflects a potential range of existing COG policy/code amendments that could occur if so desired by COG. Additional evaluation and review with COG staff to determine if amendment(s) to one or multiple code section(s) is desirable. In some instances, one amendment with appropriate cross reference citations between various documents may be desired.
2) Where the Flood Damage Prevention Code (FDPC) is identified for plausible amendment (but not denoted as a priority for change, further evaluation with COG staff is necessary to determine instances where a citation by reference is optimal or if the policy/provision should be included in the FDPC.
3) All documents are identified by their formal name but without the "Goodyear" of "City of Goodyear" moniker.
4) In just about every instance, modification to the language provided will be necessary for transformation into municipal policy/design standard/code vernacular.
5) PGO Roadmap analysis was based on existing documents adopted by the COG and does not include the review of any documents that may be in the draft stages of update or development.

APPENDIX C

SIGNIFICANT WASH CORRIDOR PLAN AND PROFILE SHEETS



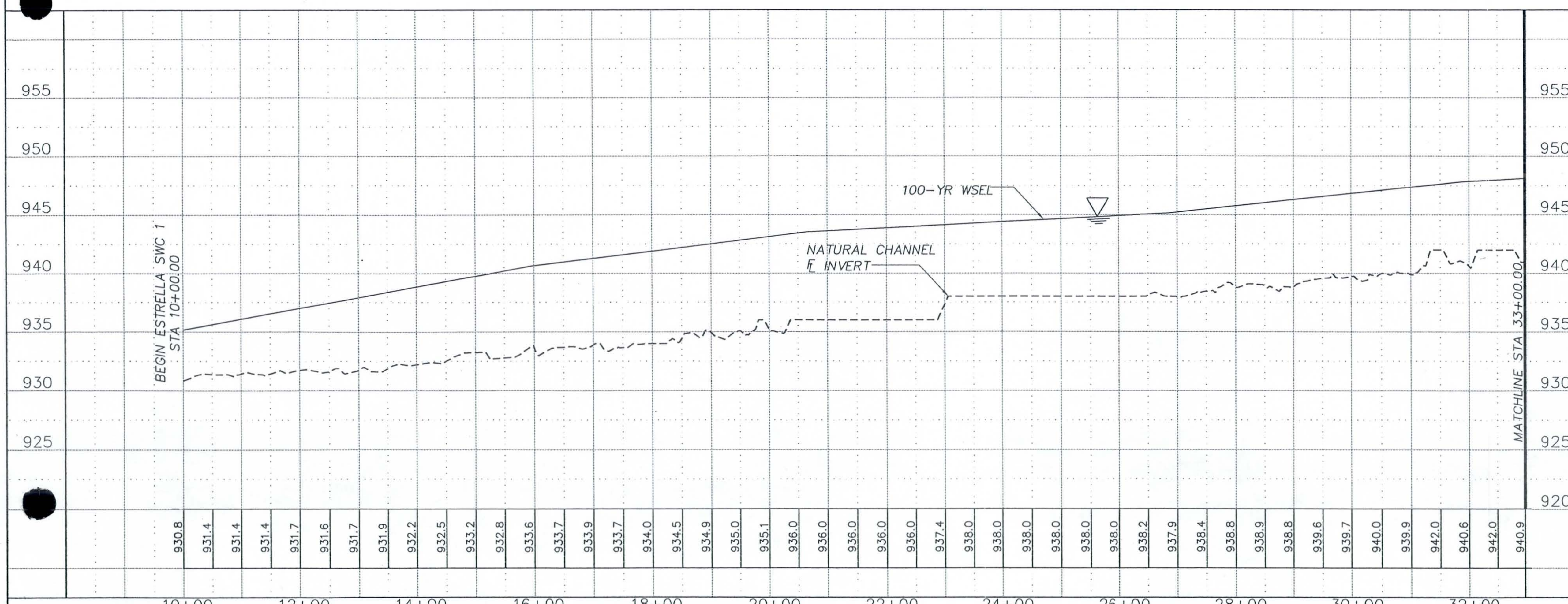
LEGEND

FLOODPLAIN LIMITS

FLOODWAY LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 1

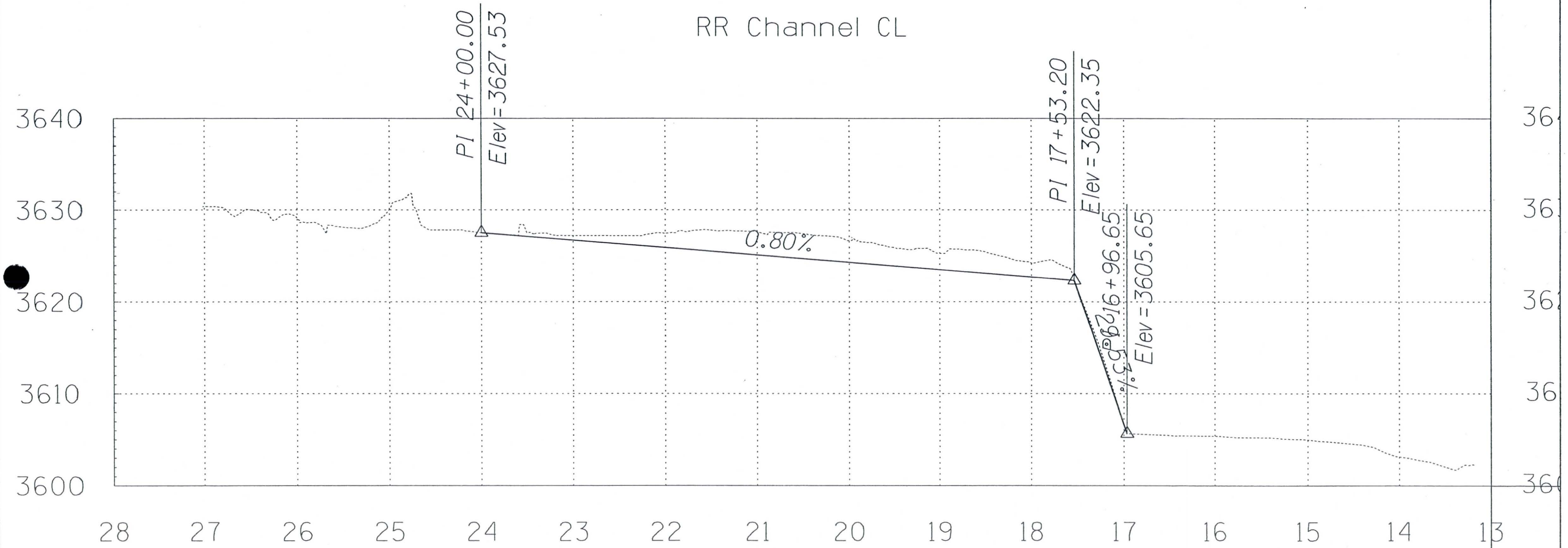
PRELIMINARY NOT FOR CONSTRUCTION

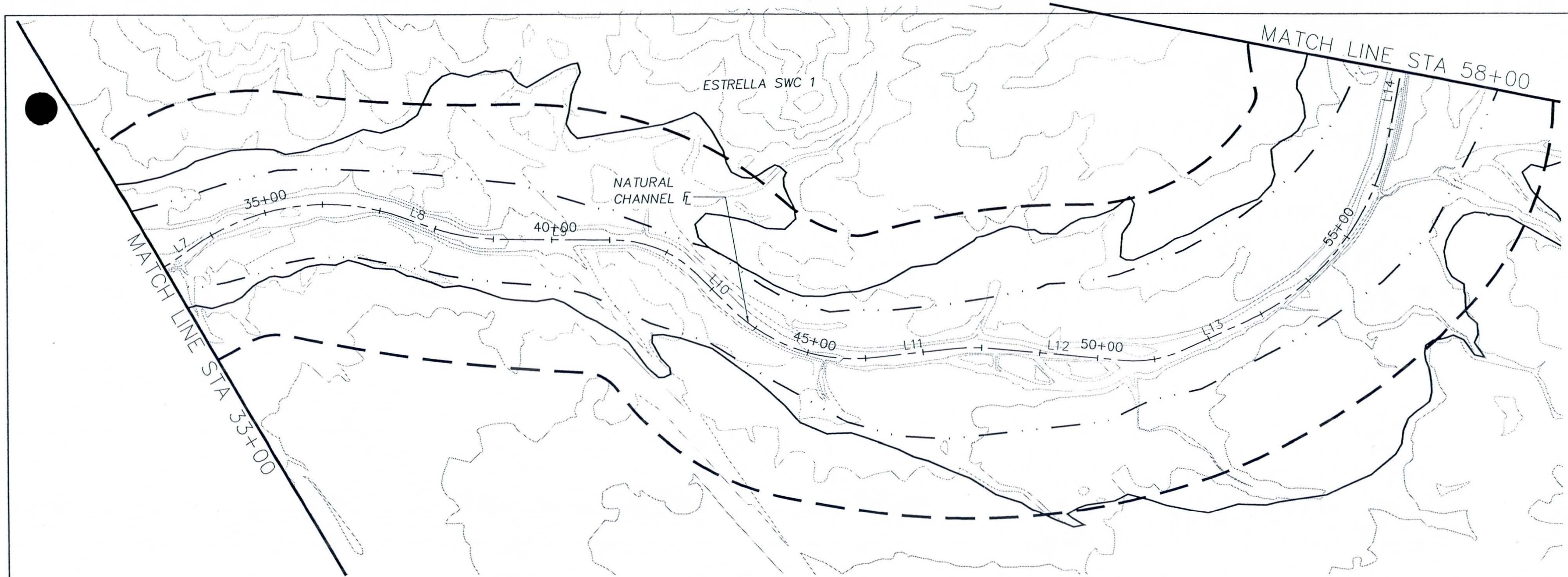
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

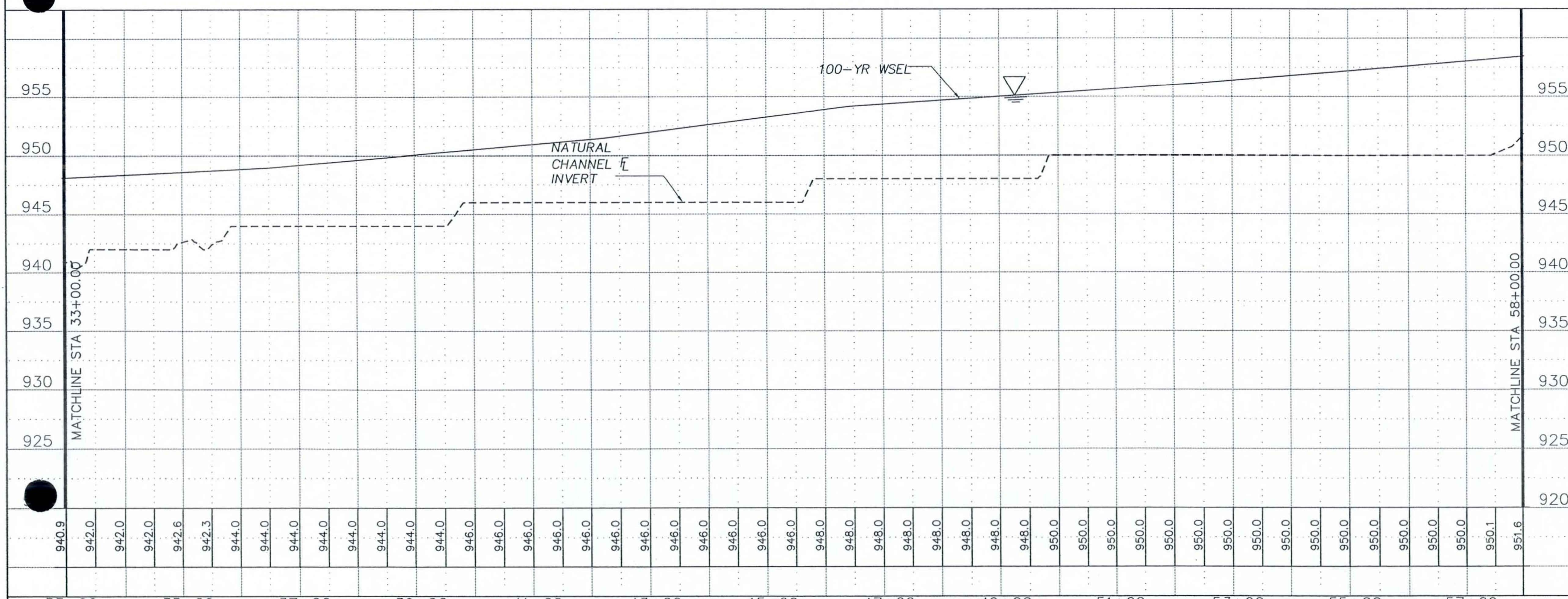
URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP1	STA 10+00.00 TO 33+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-1\ ESTRELLA-SWC-1-PP01-REVA.dwg


RR Channel CL
PI 24+00.00
Elev=3627.53
0.80%
PI 17+53.20
Elev=3622.35
PI 16+96.65
Elev=3605.65
3600
3610
3620
3630
3640
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-1\ ESTRELLA-SWC-1-PP02-REVA.dwg

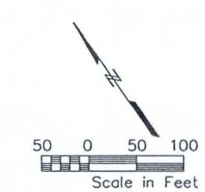
LEGEND

FLOODPLAIN LIMITS

FLOODWAY LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

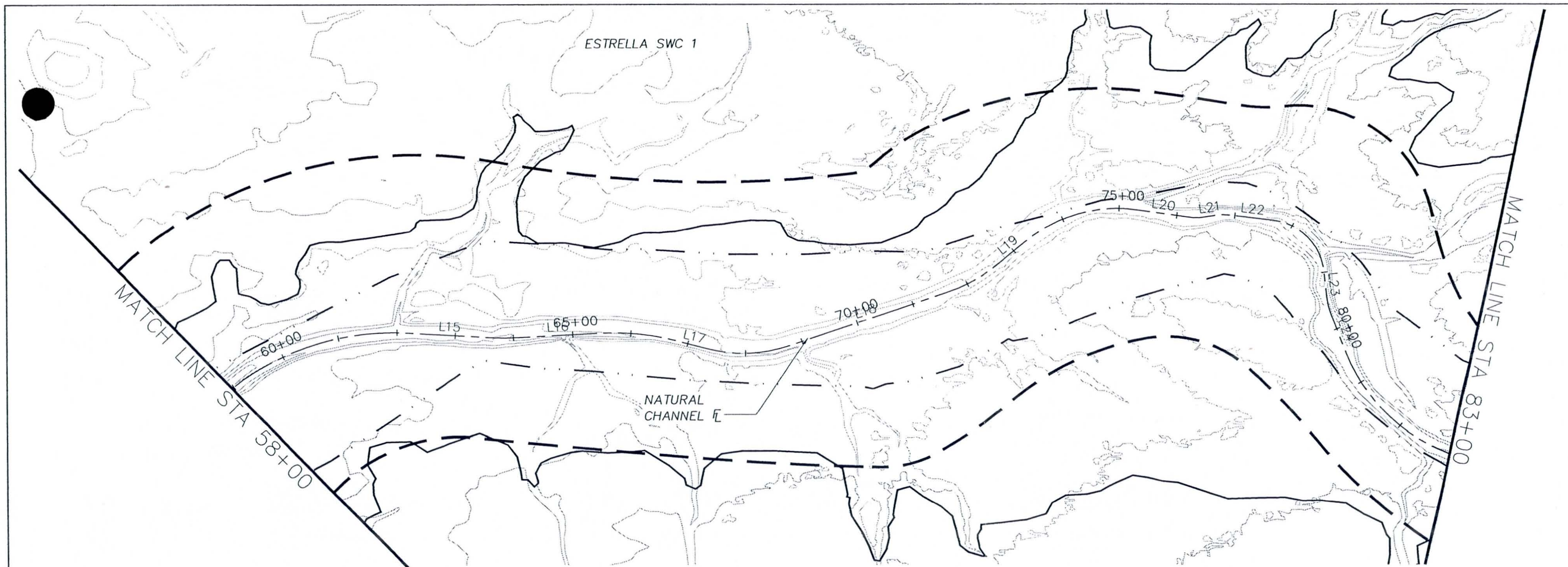
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 1

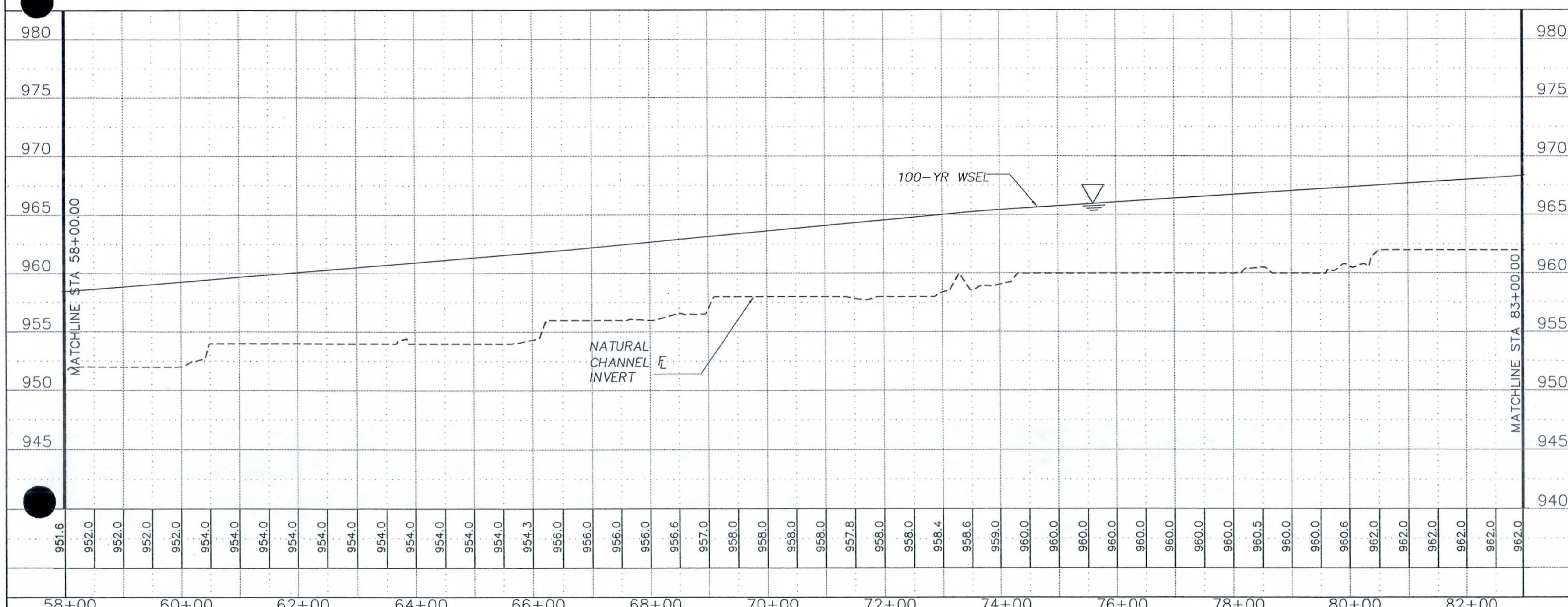
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP2	STA 33+00.00 TO 58+00.00	- -





LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

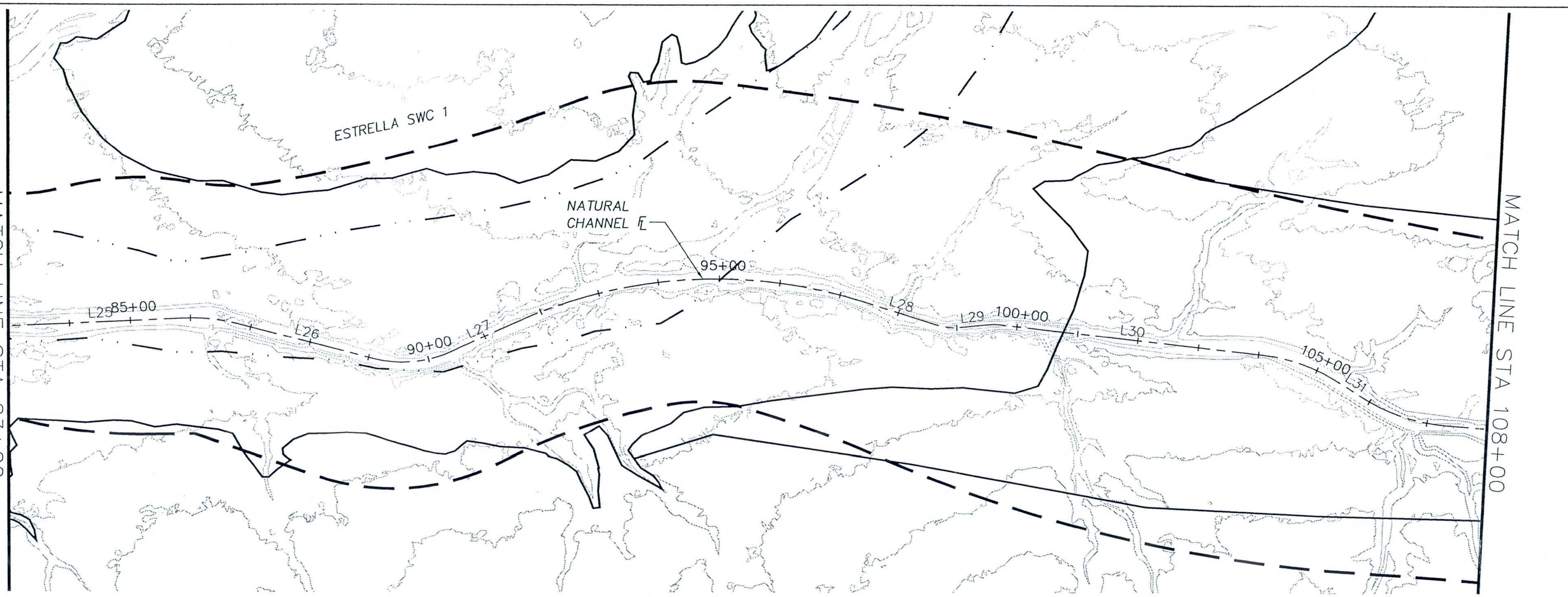
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 1

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

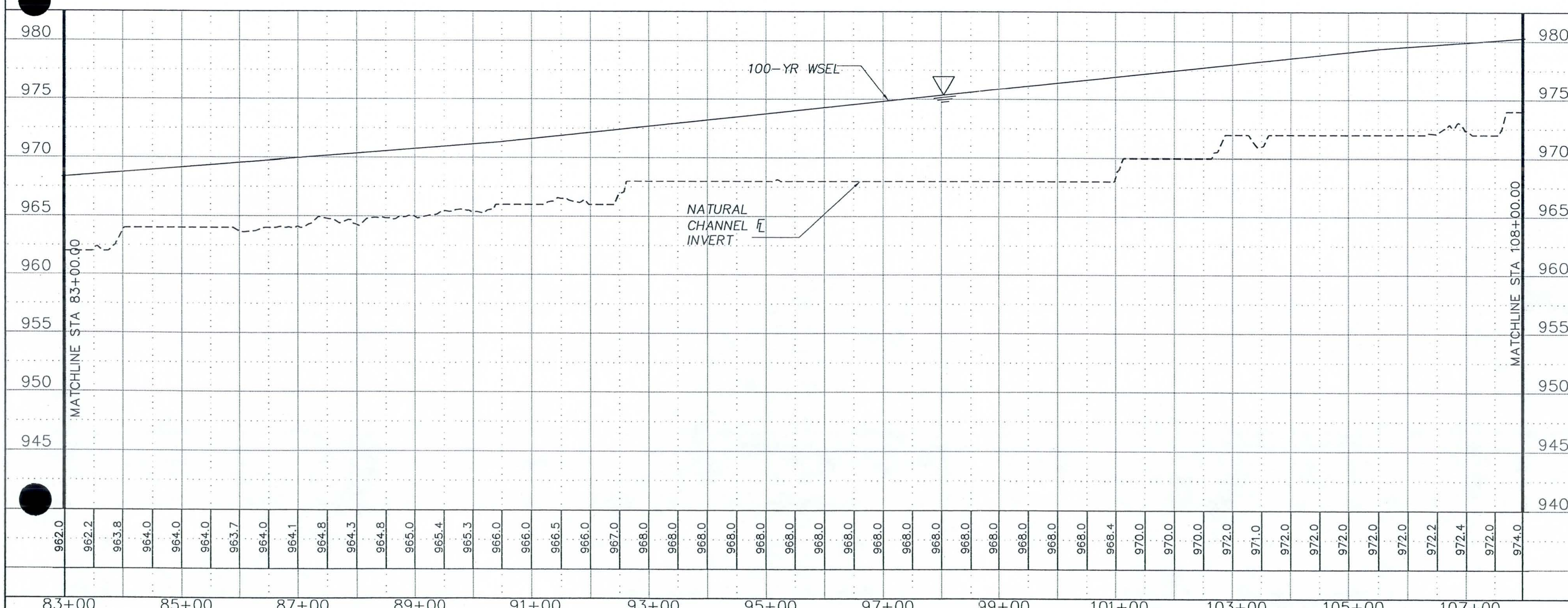
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP3	STA 58+00.00 TO 83+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-1\ ESTRELLA-SWC-1-PP03-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

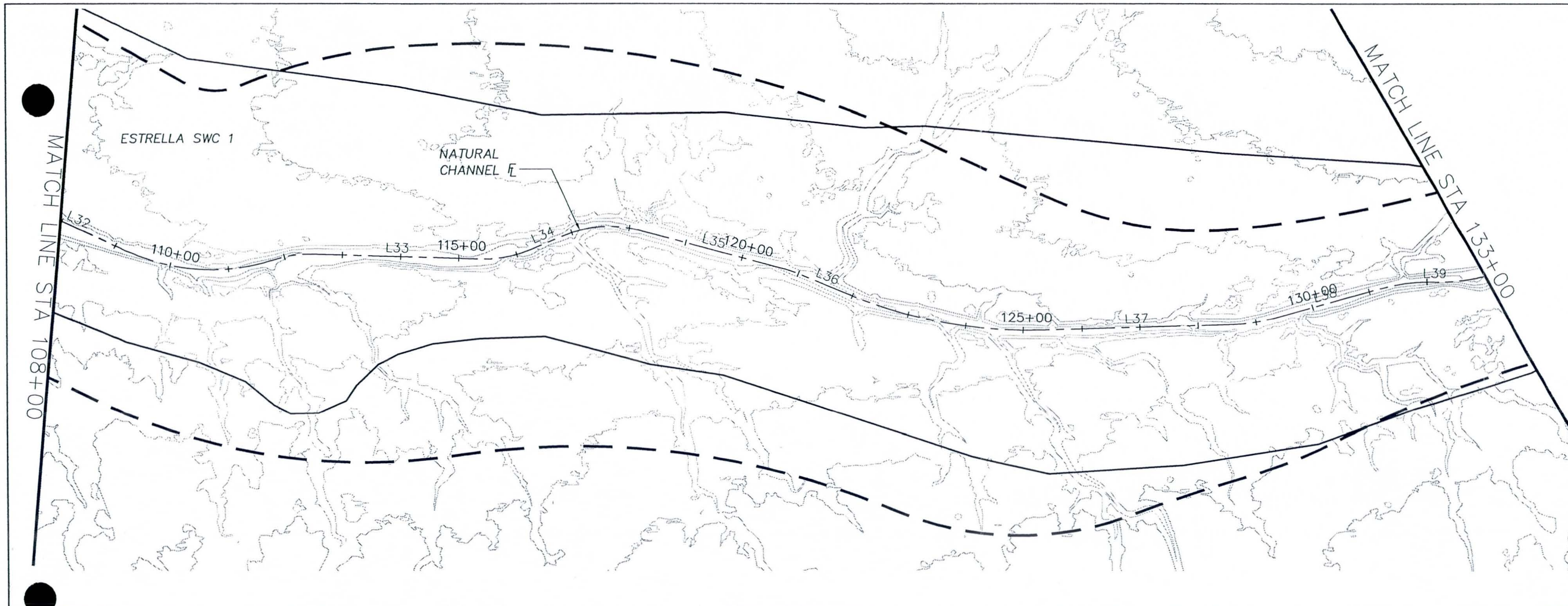
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 1

PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP4	STA 83+00.00 TO 108+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-1\ ESTRELLA-SWC-1-PP04-REVA.dwg



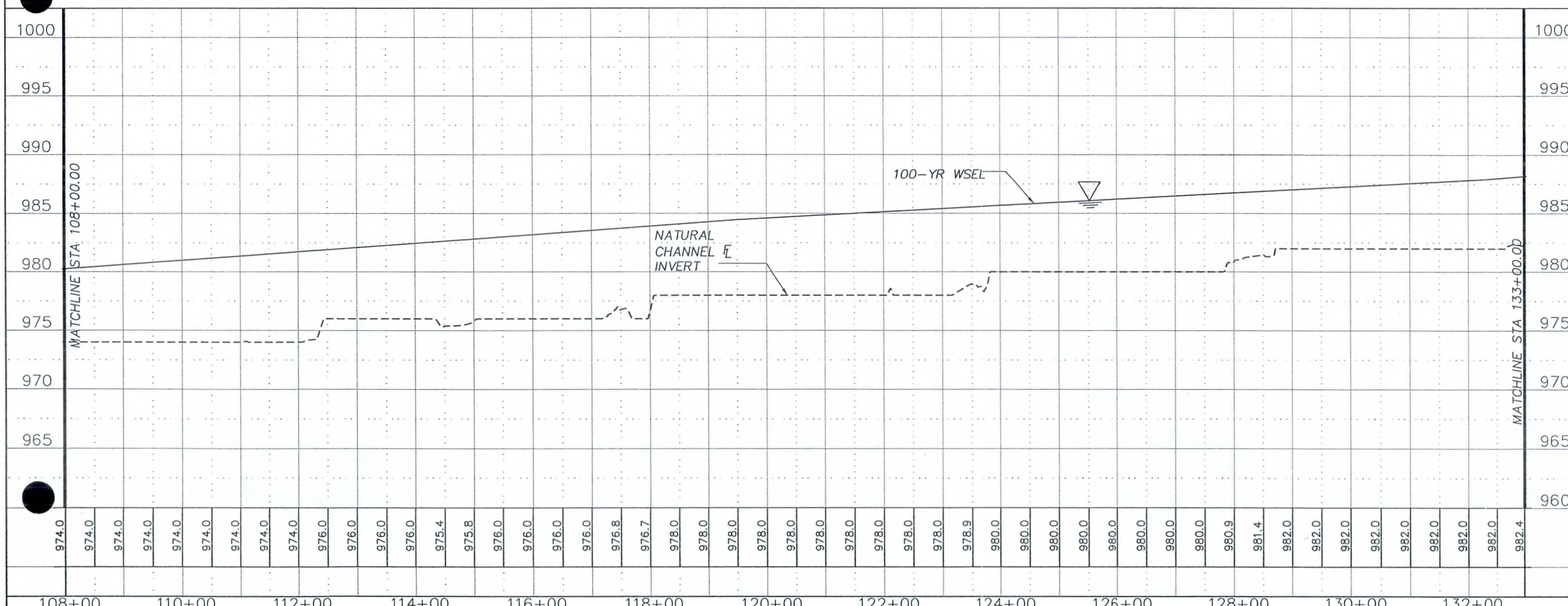
LEGEND

FLOODPLAIN LIMITS

FLOODWAY LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



N

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 1

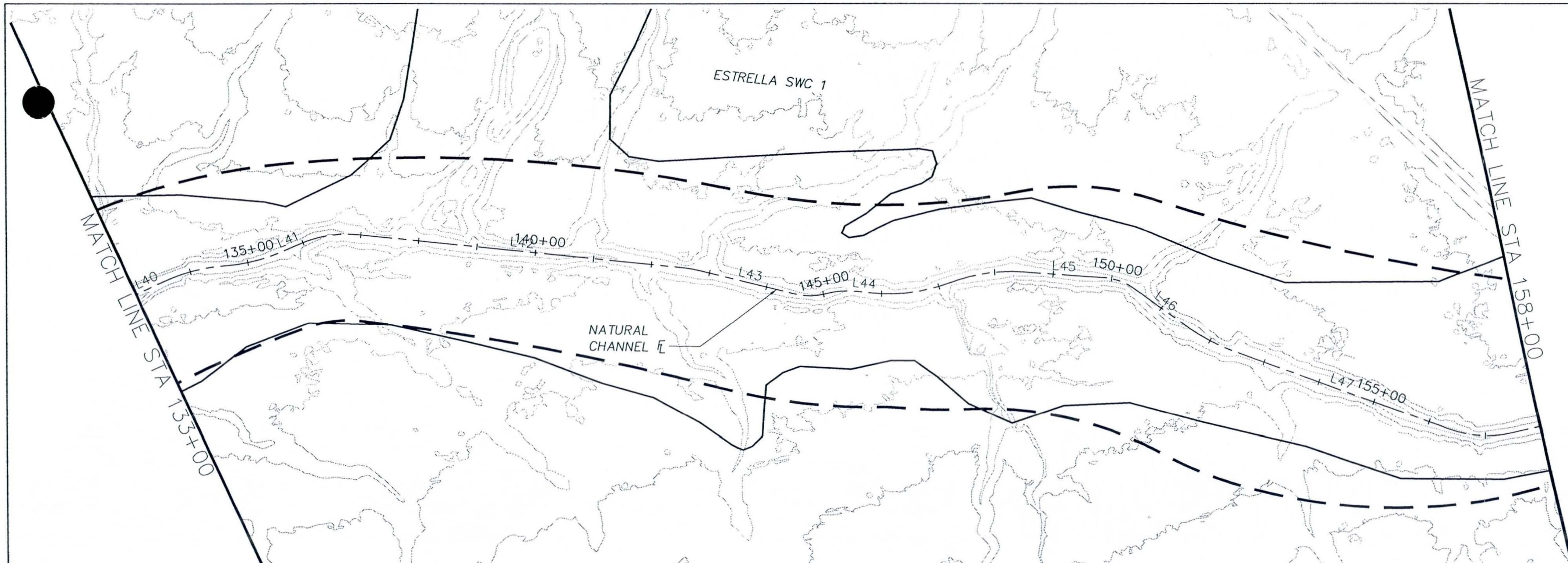
PRELIMINARY NOT FOR CONSTRUCTION

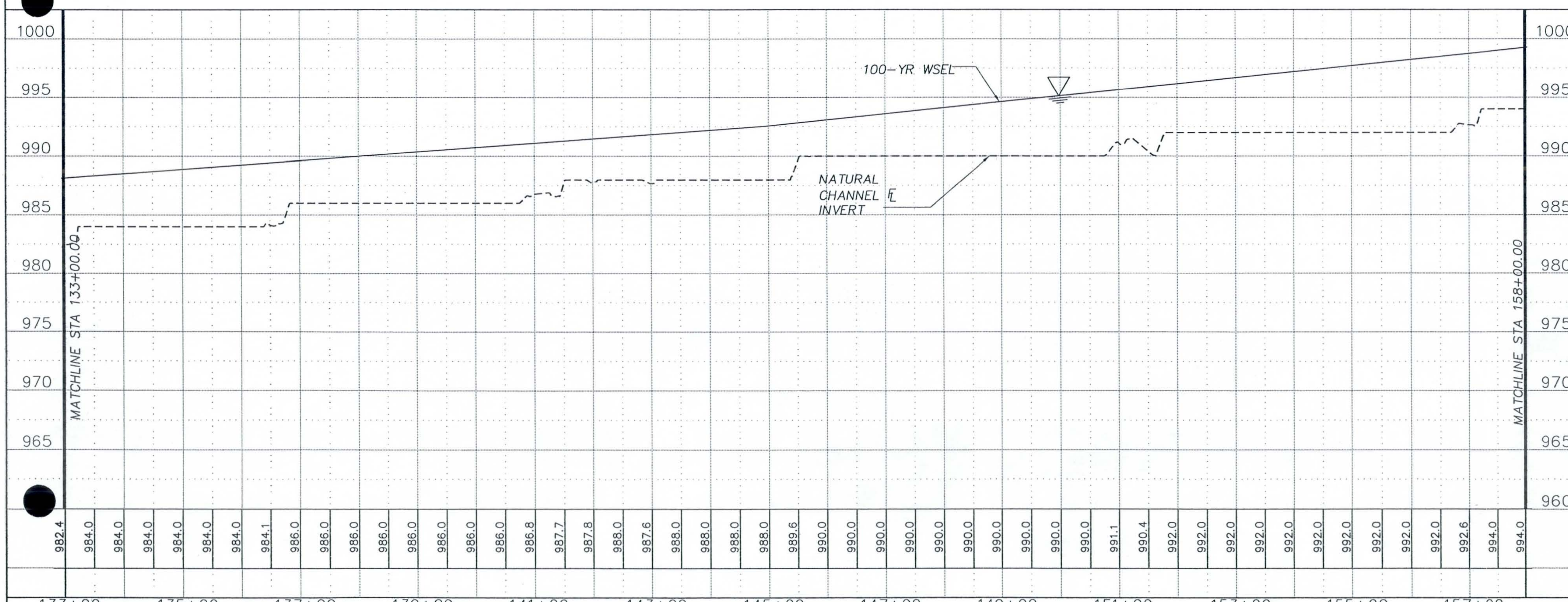
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP5	STA 108+00.00 TO 133+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-1\ ESTRELLA-SWC-1-PP05-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-1\ ESTRELLA-SWC-1-PP06-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
A			

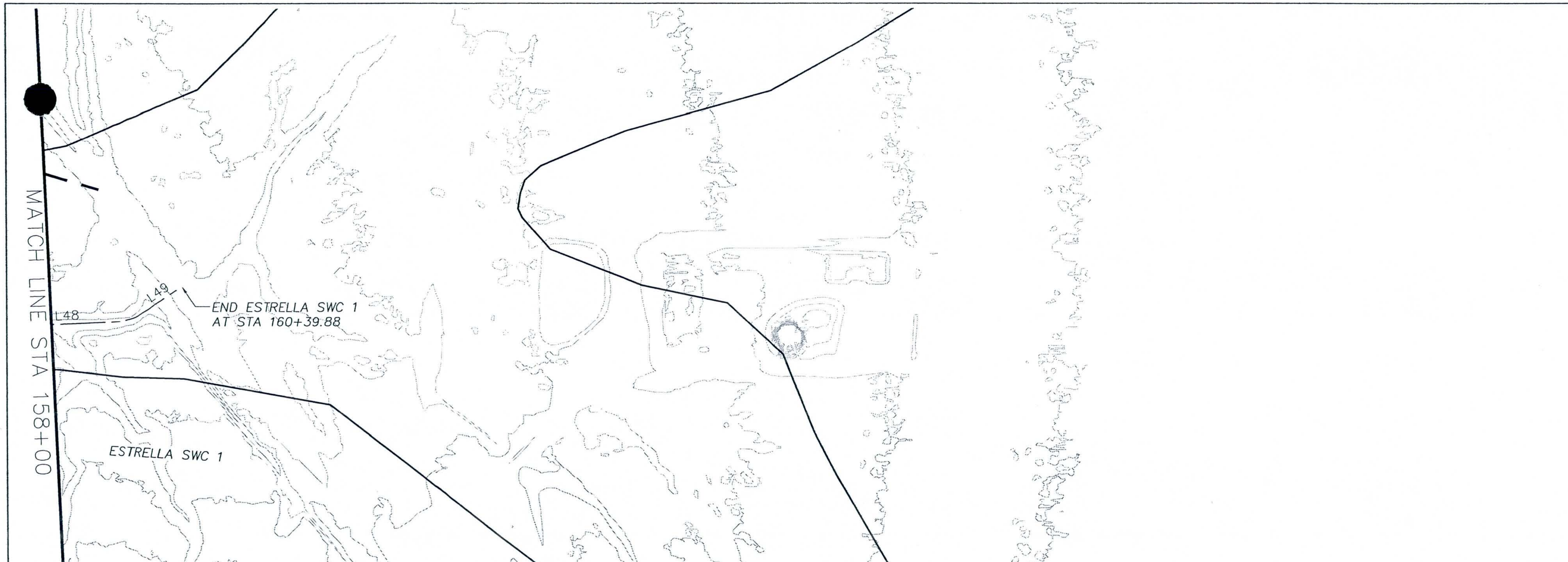
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

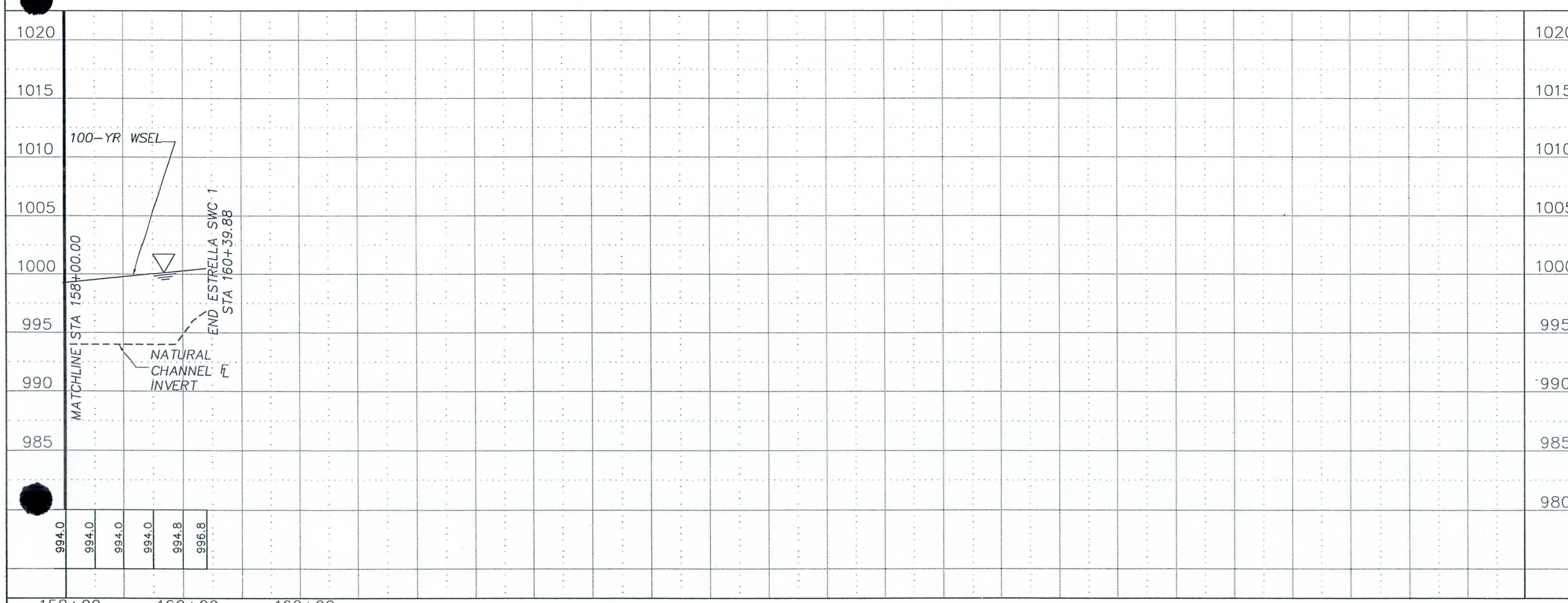
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 1

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP6	PLAN AND PROFILE SHEET STA 133+00.00 TO 158+00.00	- -





LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

N

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

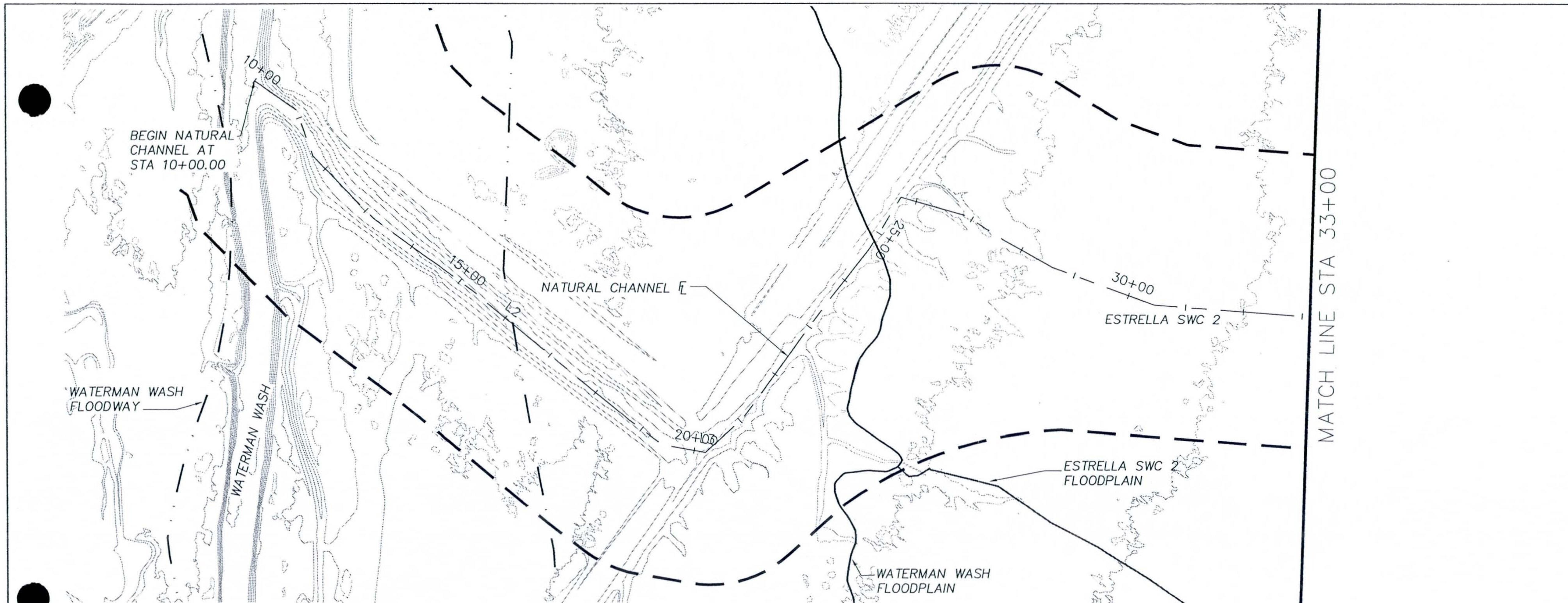
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 1

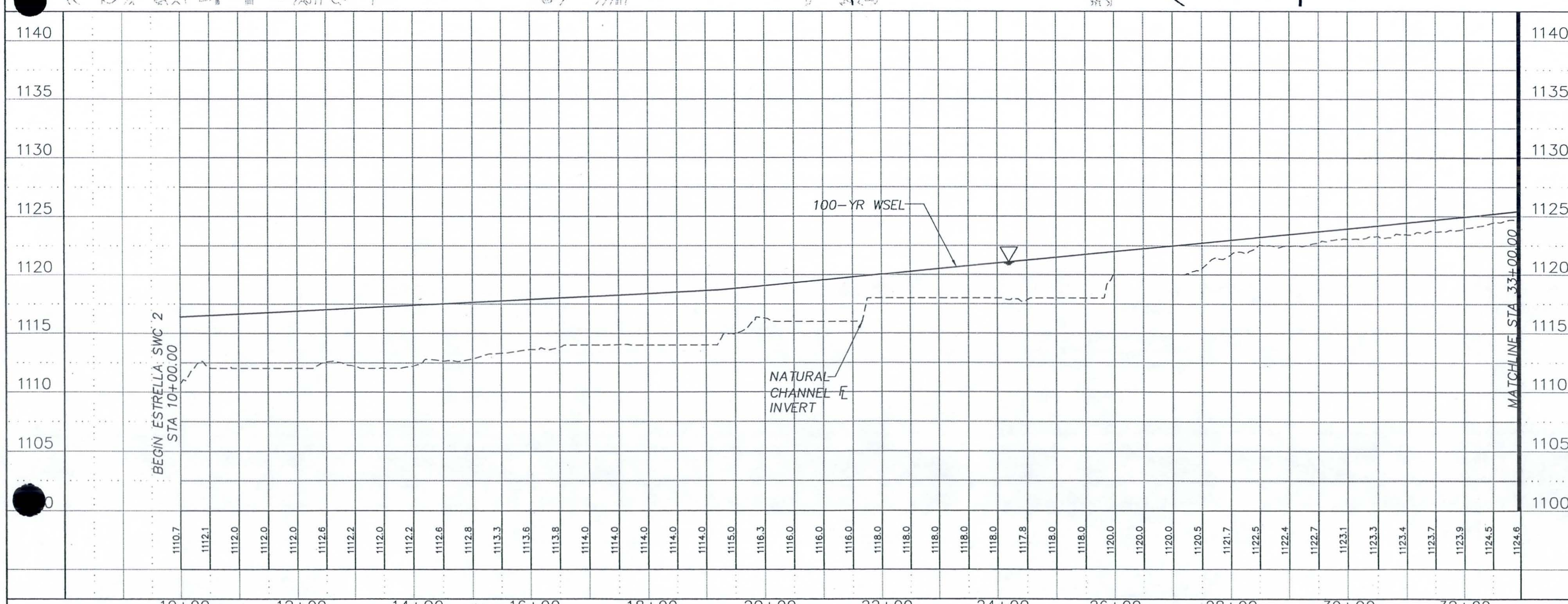
		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP7	PLAN AND PROFILE SHEET STA 158+00.00 TO 160+39.88	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-1\ ESTRELLA-SWC-1-PP07-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP8-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE
- FLOODWAY

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

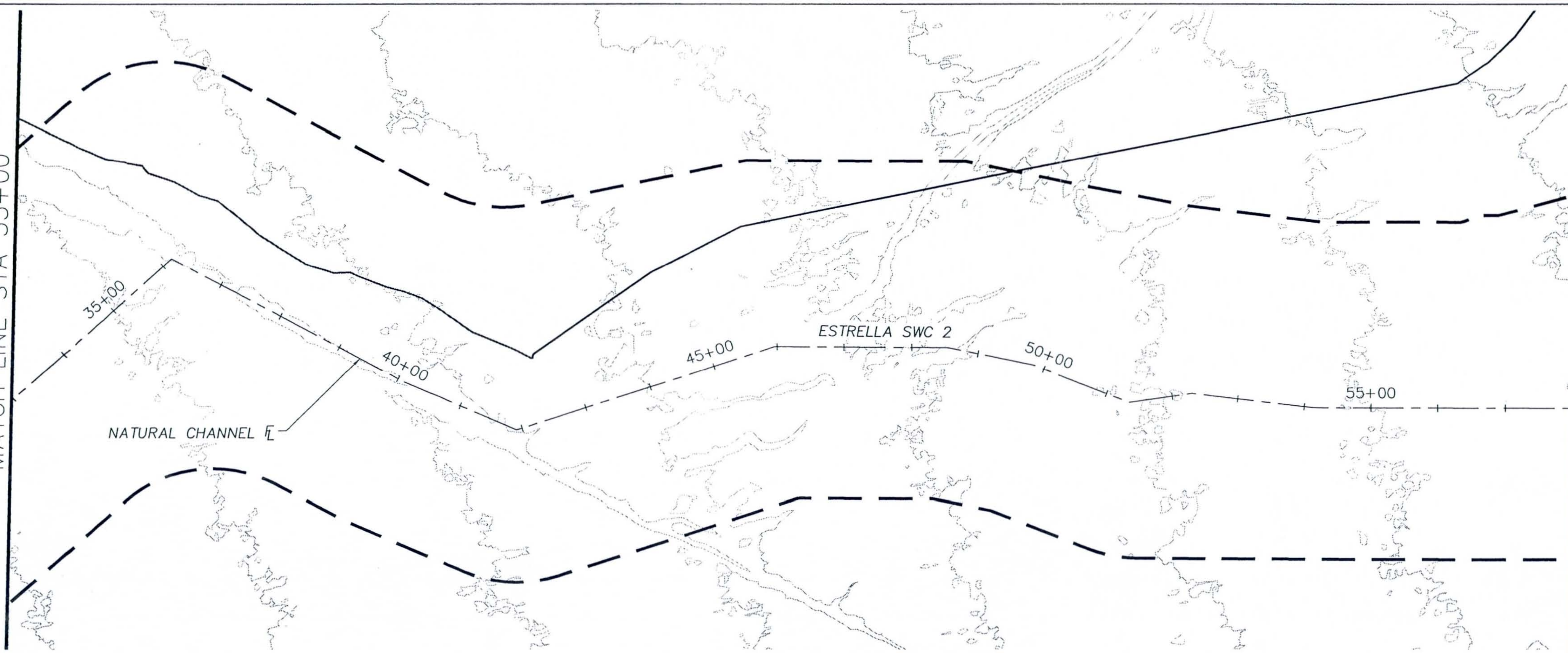
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP8	STA 10+00.00 TO 33+00.00	– –

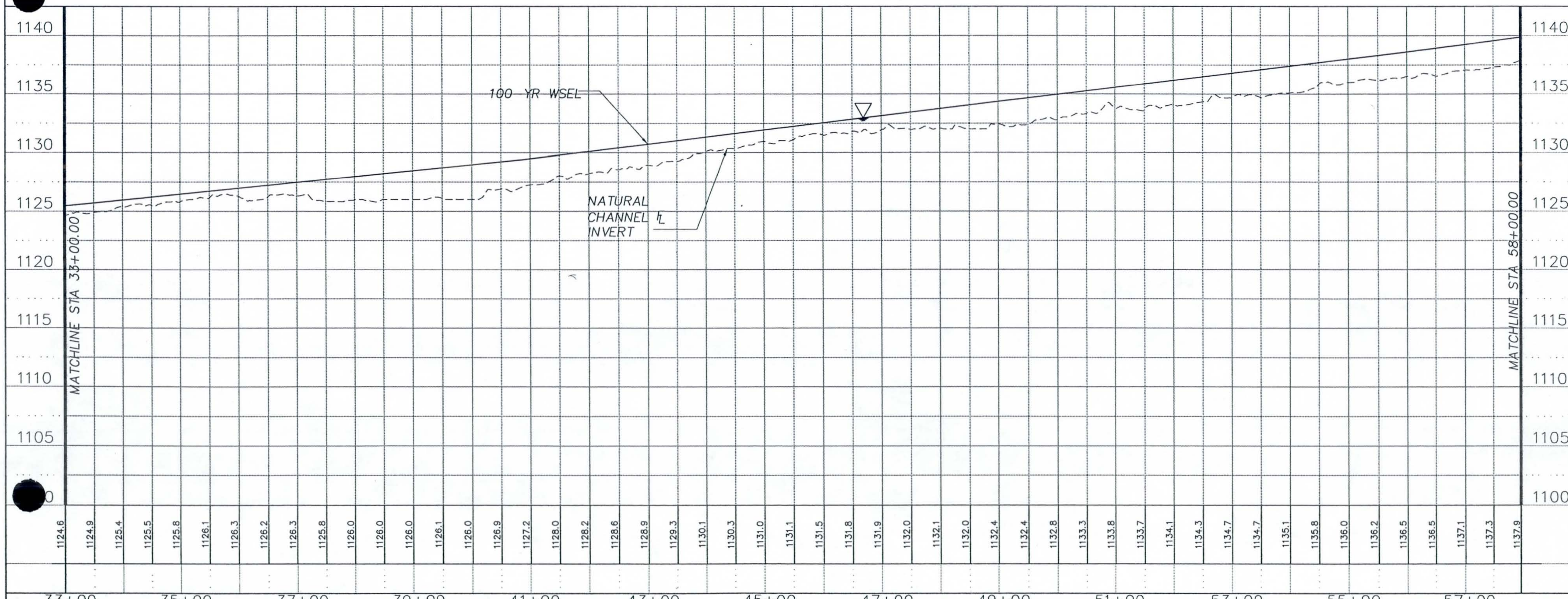


LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

CENTER LINE



N

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

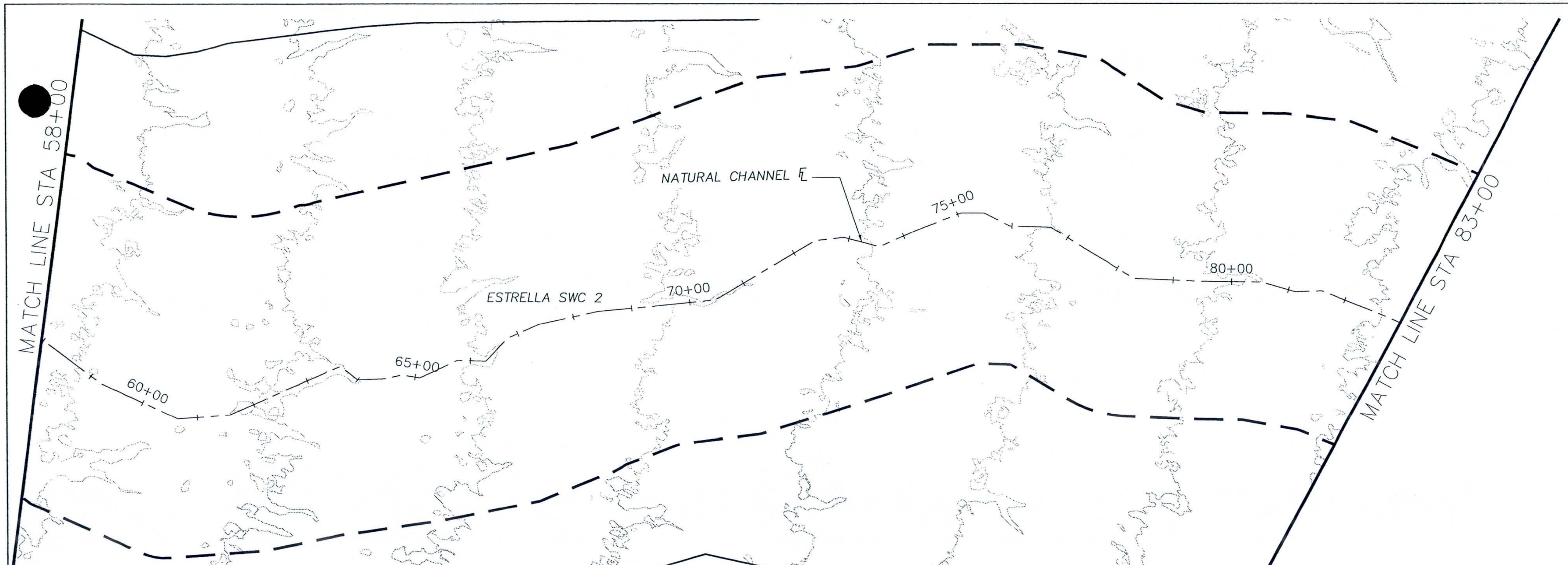
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

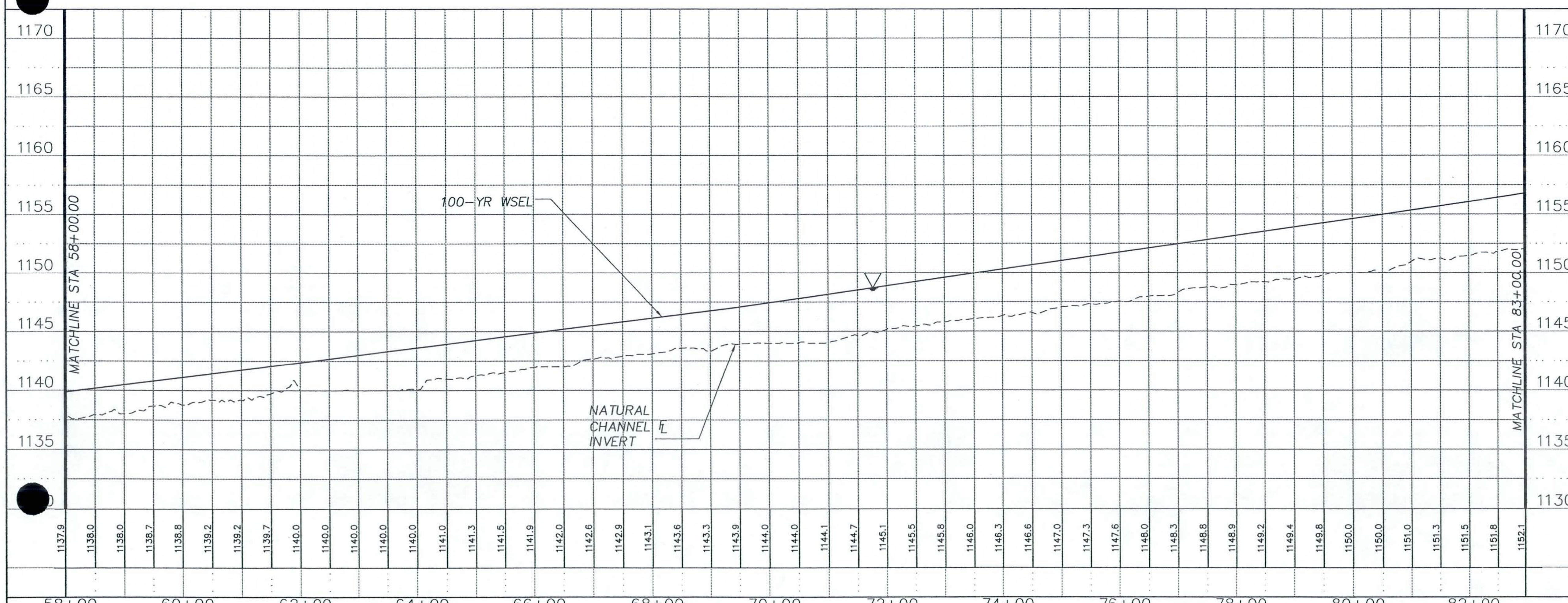
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP9	STA 33+00.00 TO 58+00.00	– -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP9-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP10-REVA.dwg

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

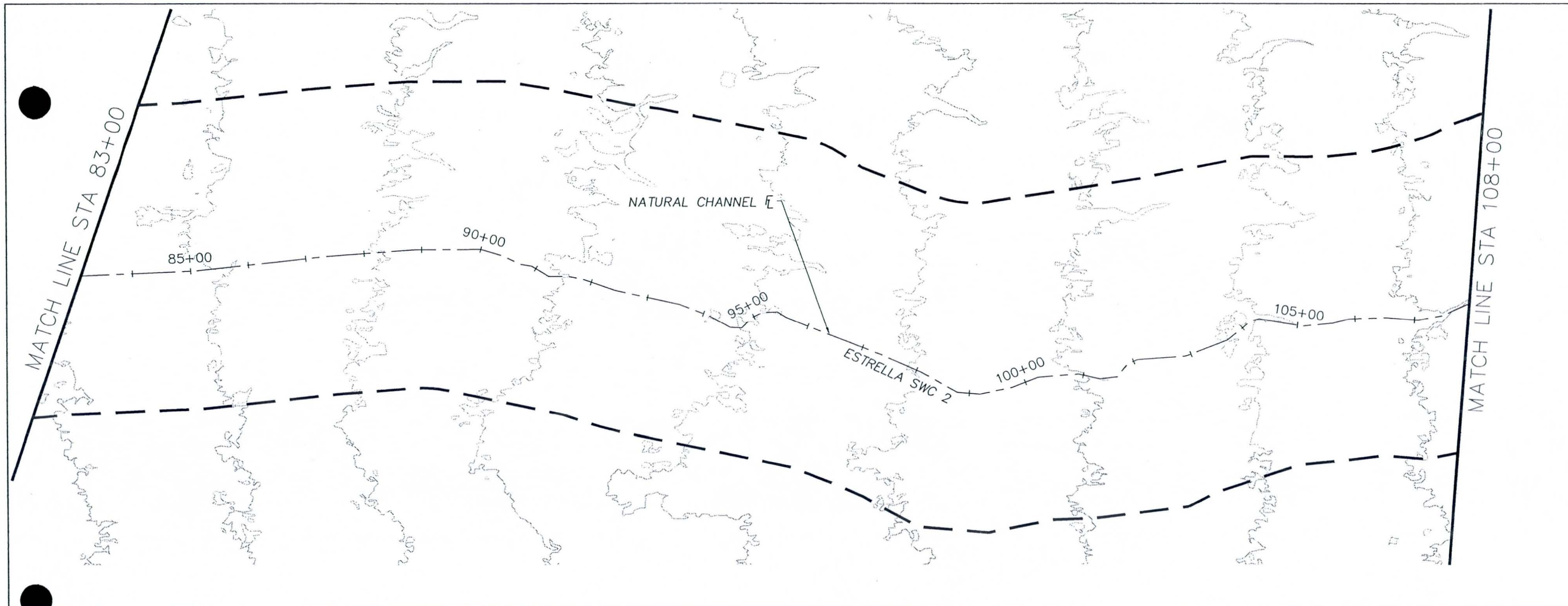
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

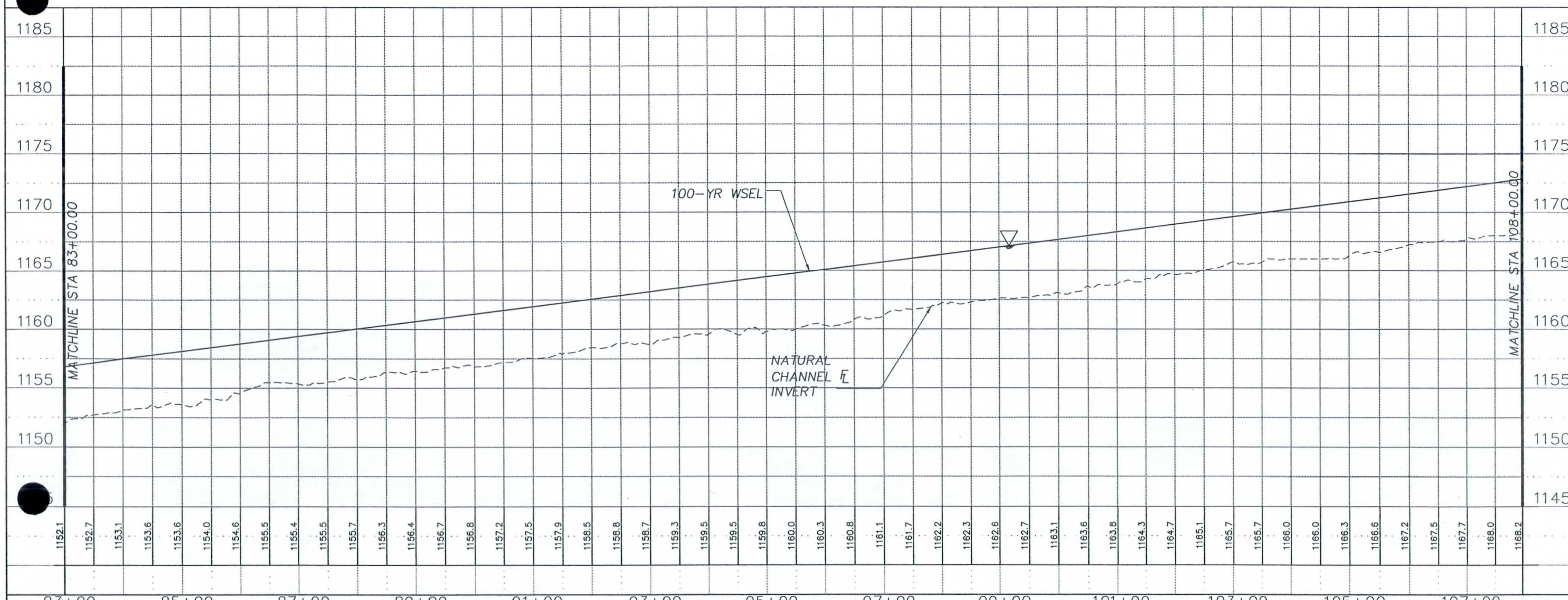
URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP10	STA 58+00.00 TO 83+00.00	- -



LEGEND

FLOODPLAIN LIMITS
EROSION HAZARD SETBACKS
CENTER LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

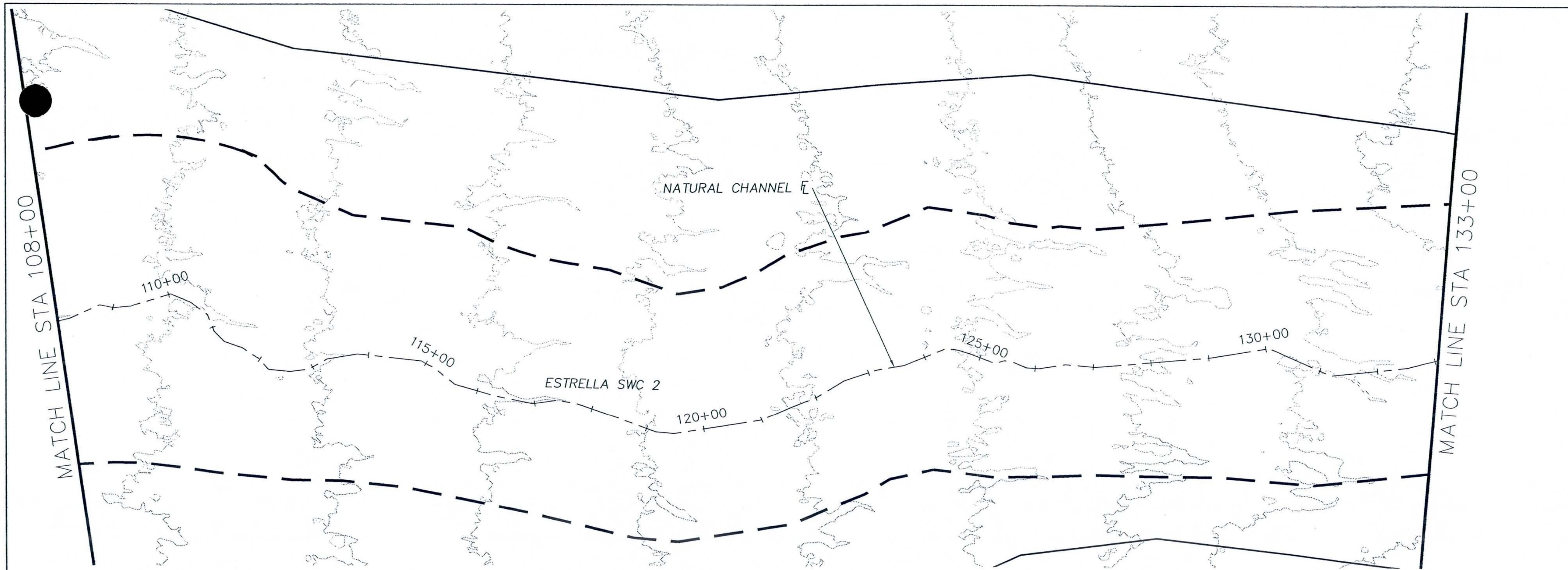
PRELIMINARY NOT FOR CONSTRUCTION

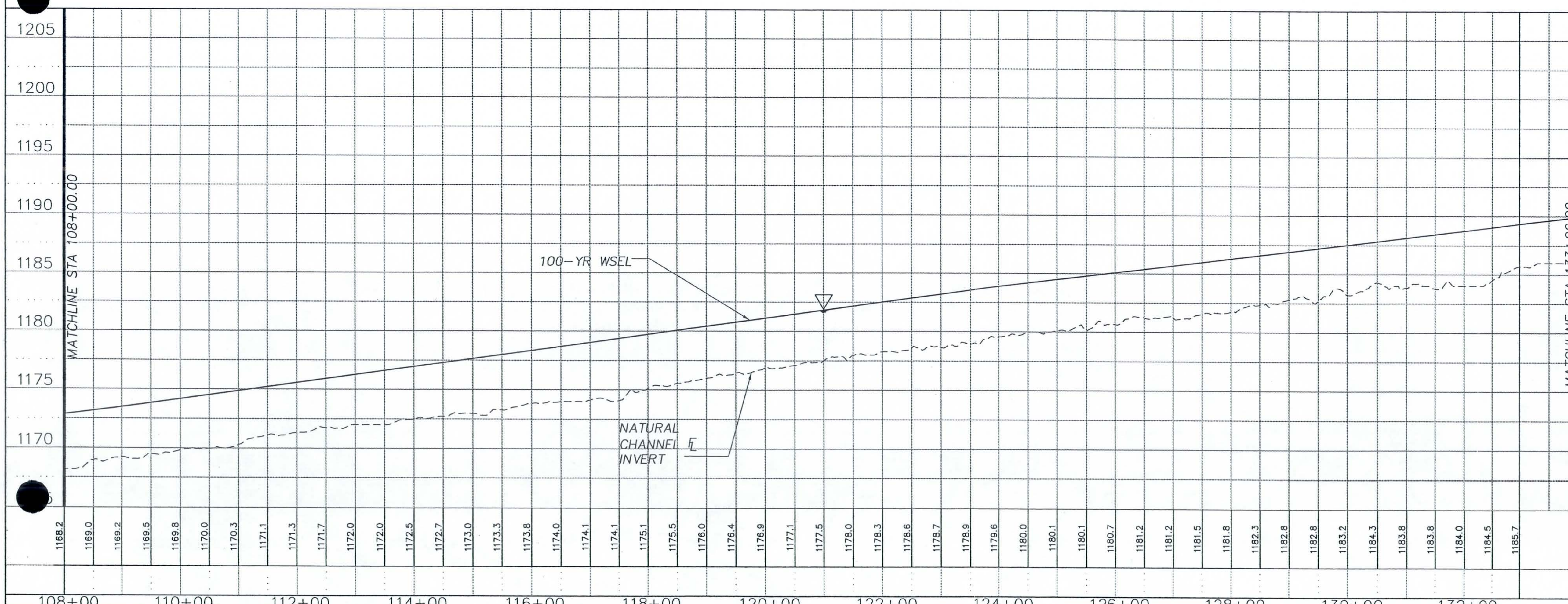
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP11	STA 83+00.00 TO 108+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP11-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP12-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE

N

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

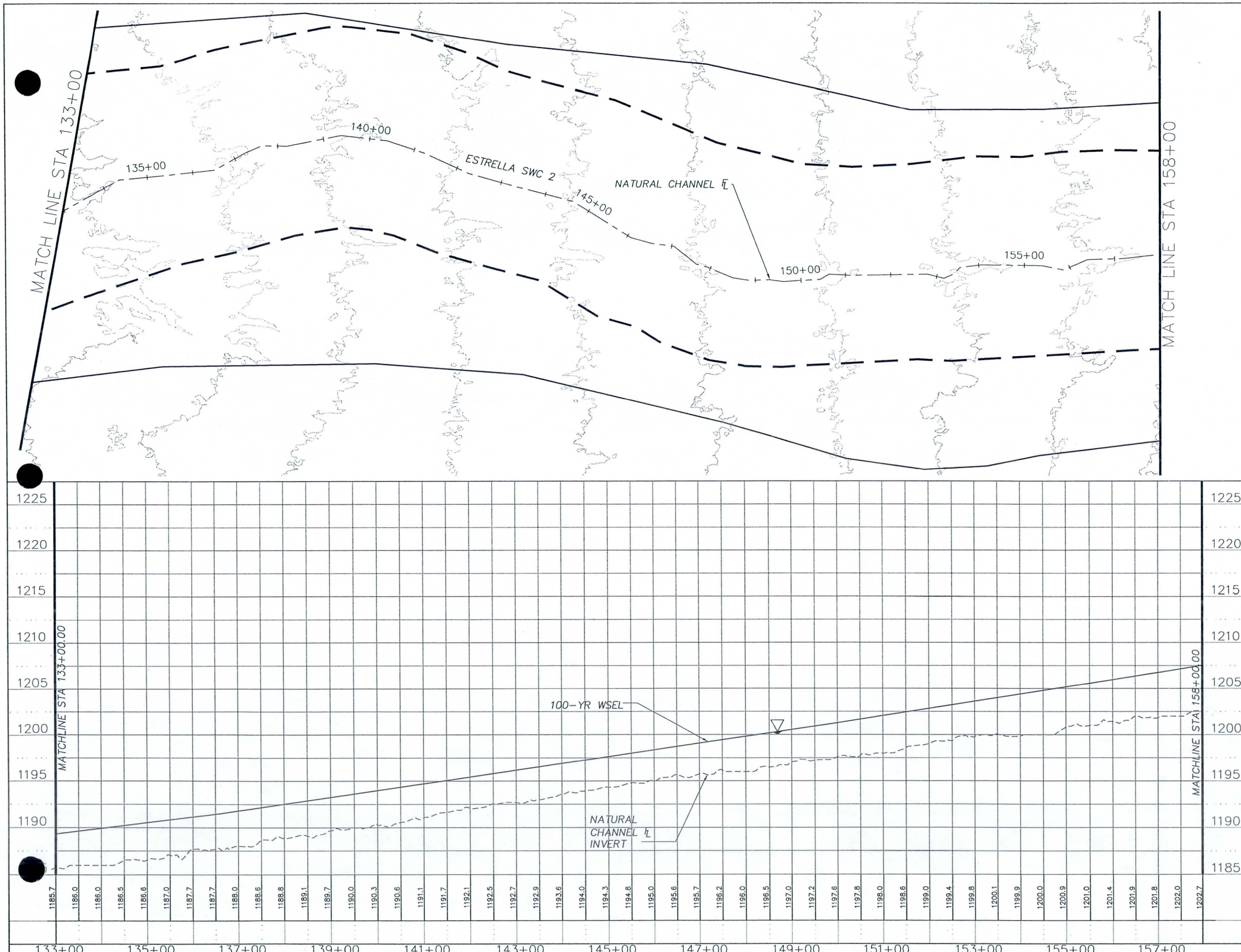
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP12	STA 108+00.00 TO 133+00.00	- -



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP13-REVA.dwg

LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

CENTER LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

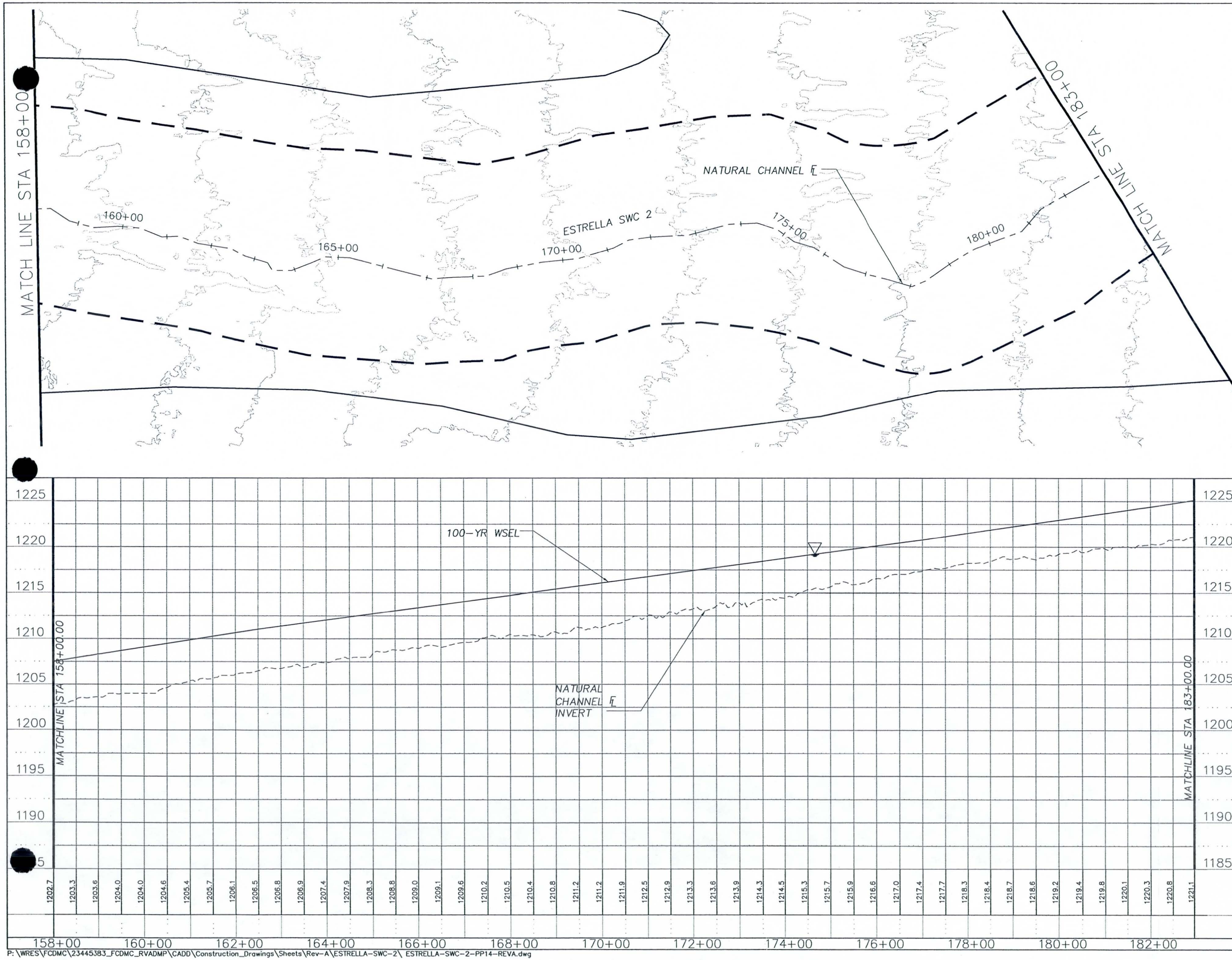
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP13	STA 133+00.00 TO 158+00.00	- -



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP14-REVA.dwg

LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

CENTER LINE

N

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
A			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

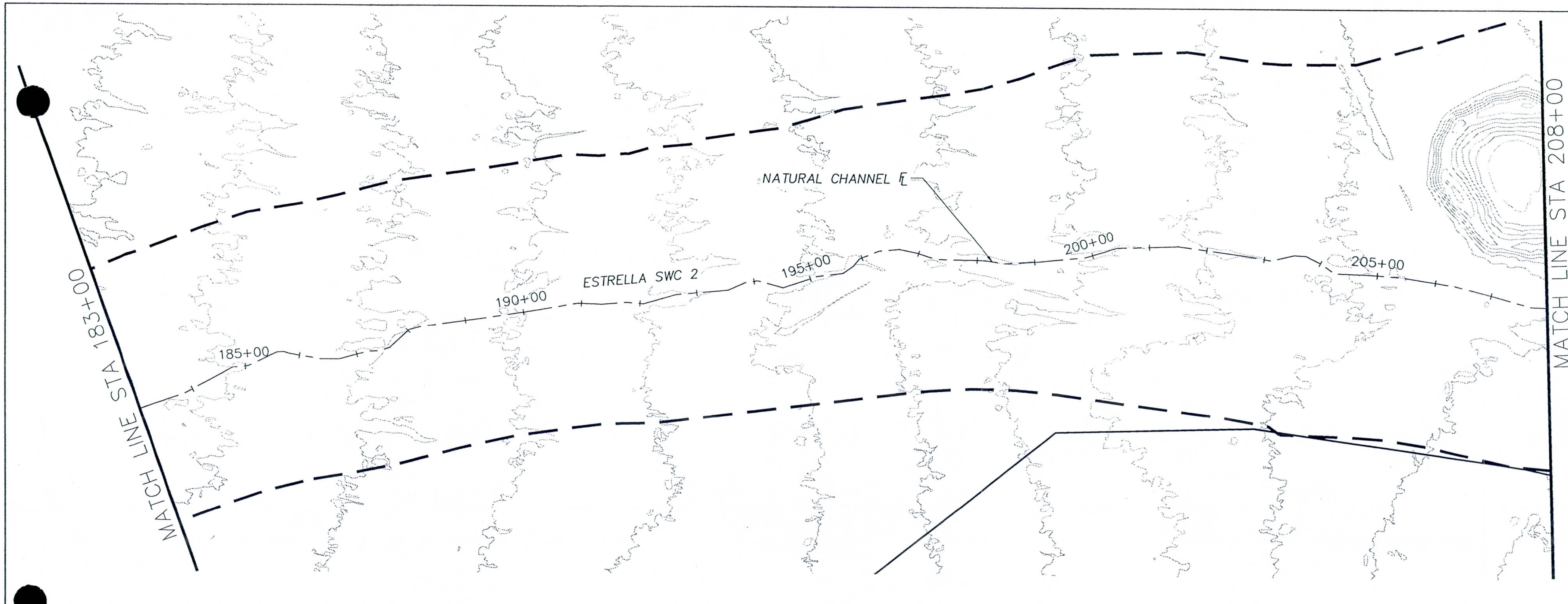
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP14	STA 158+00.00 TO 183+00.00	- -

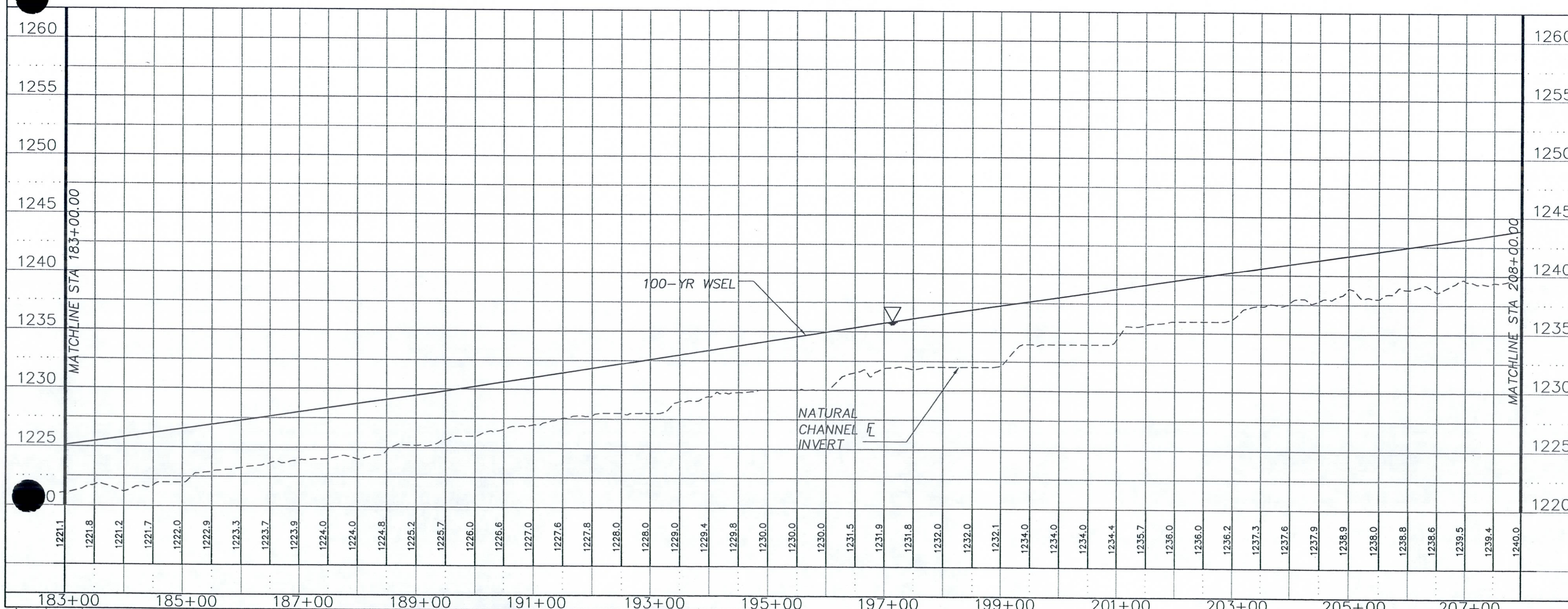


LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

CENTER LINE



N

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
A			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

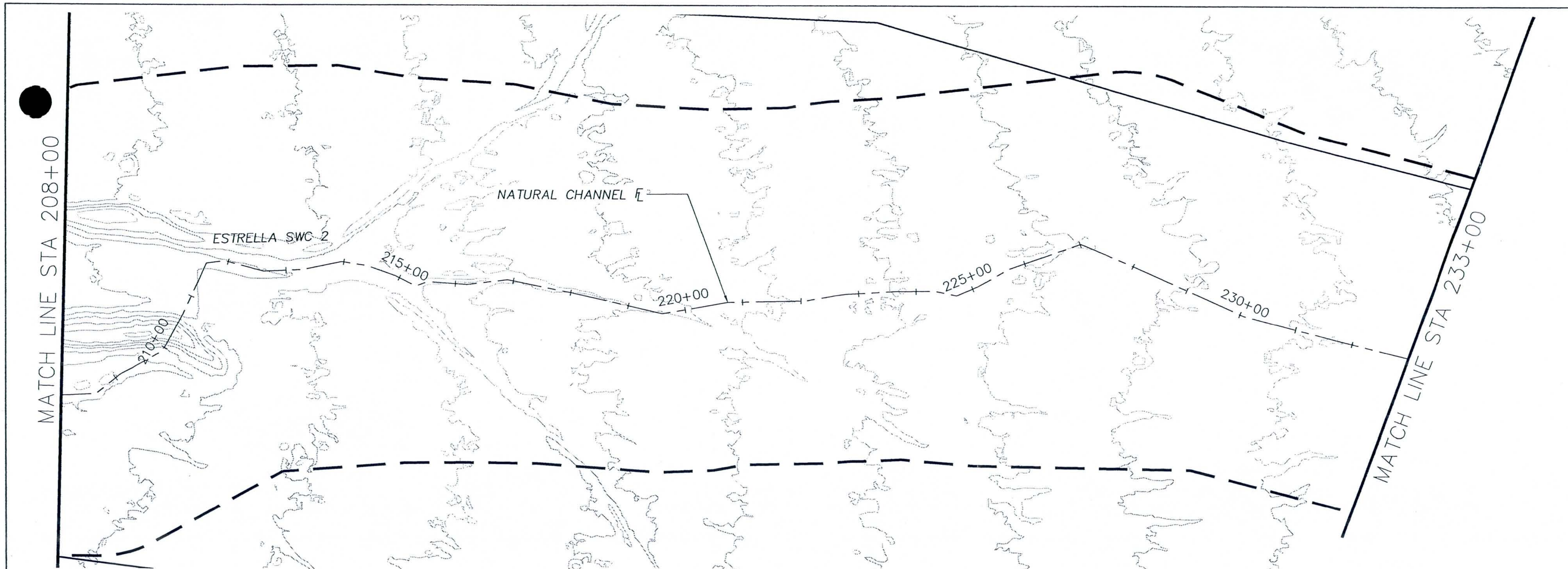
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP15	STA 183+00.00 TO 208+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP15-REVA.dwg

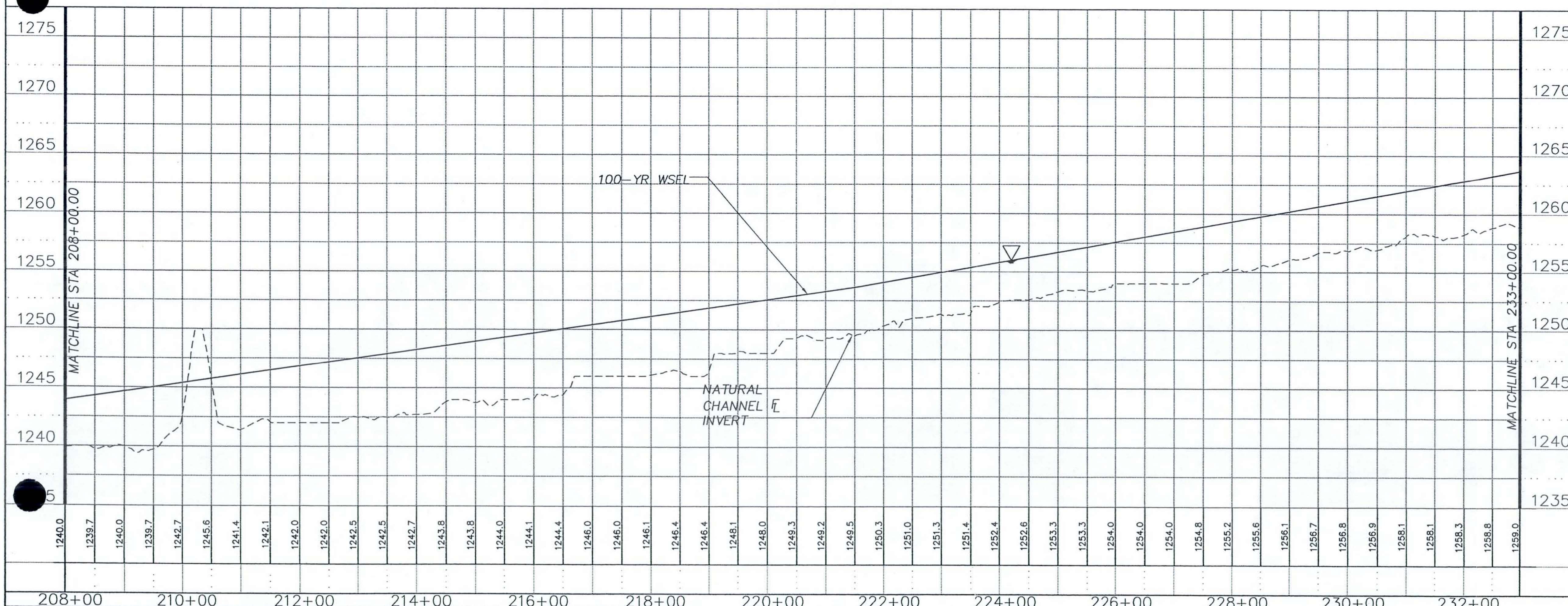


LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

CENTER LINE



N

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

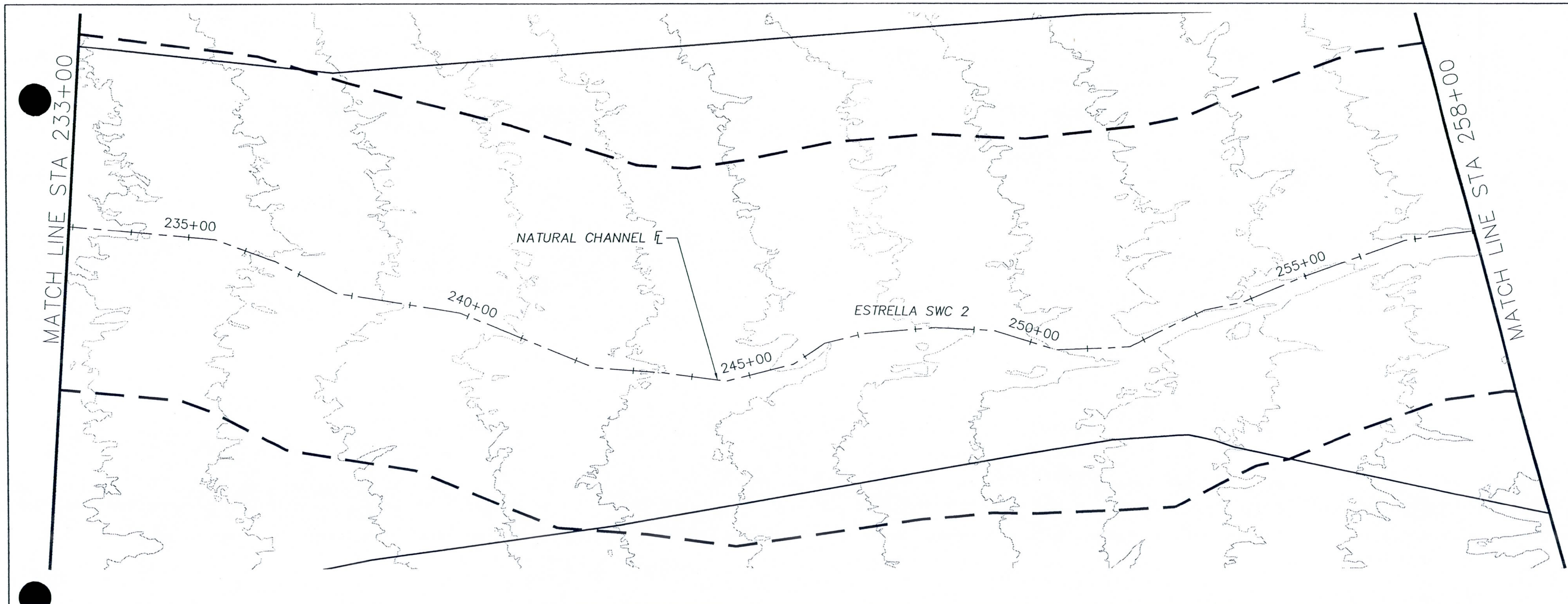
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

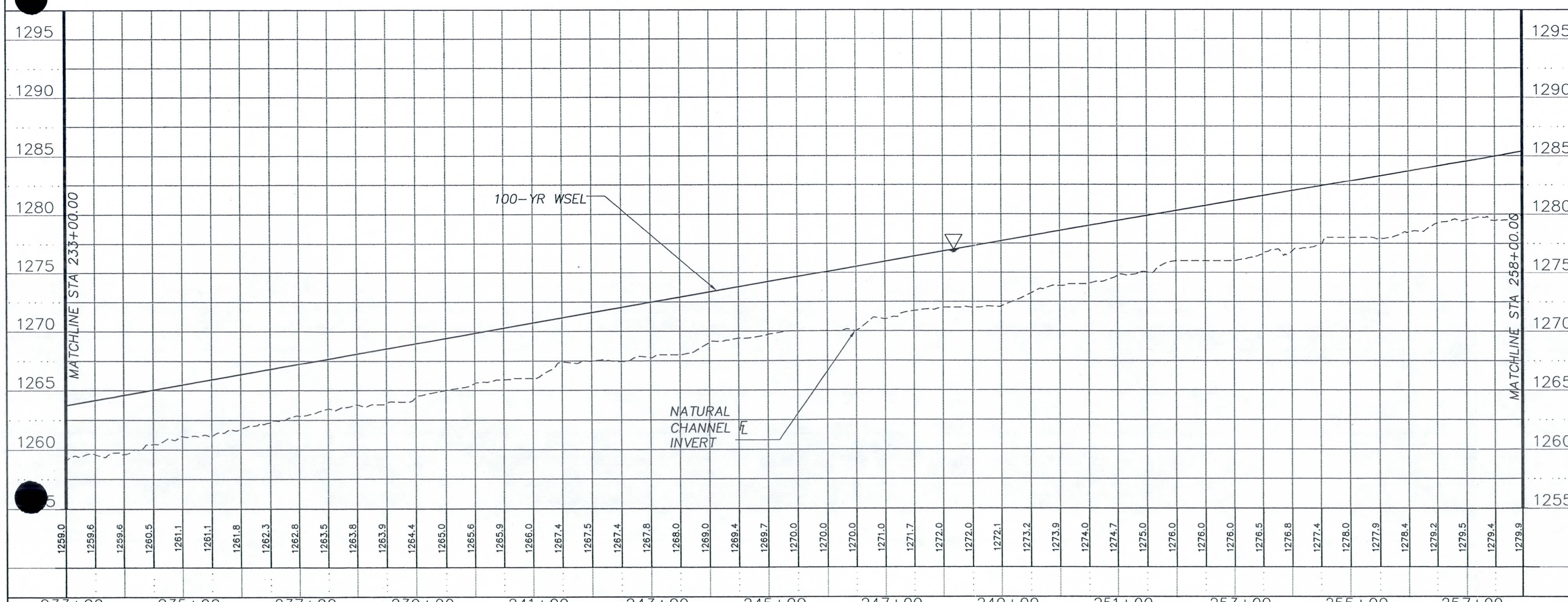
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP16	STA 208+00.00 TO 233+00.00	– –

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP16-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

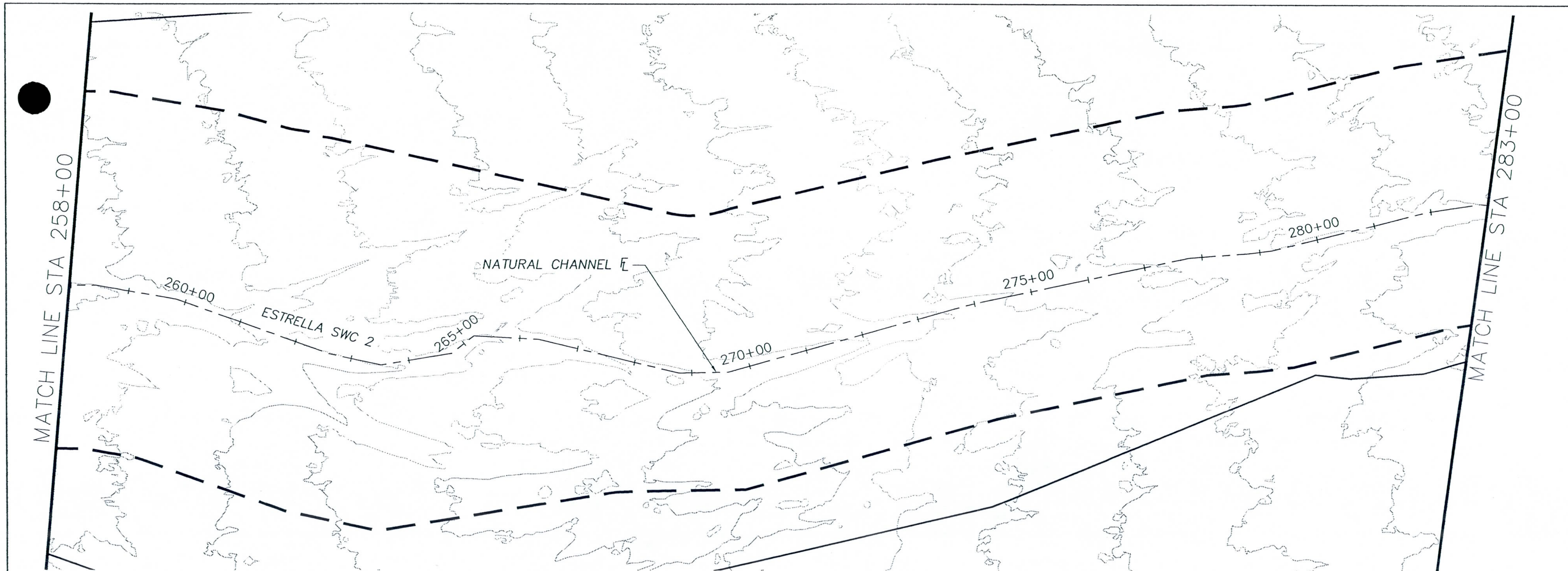
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

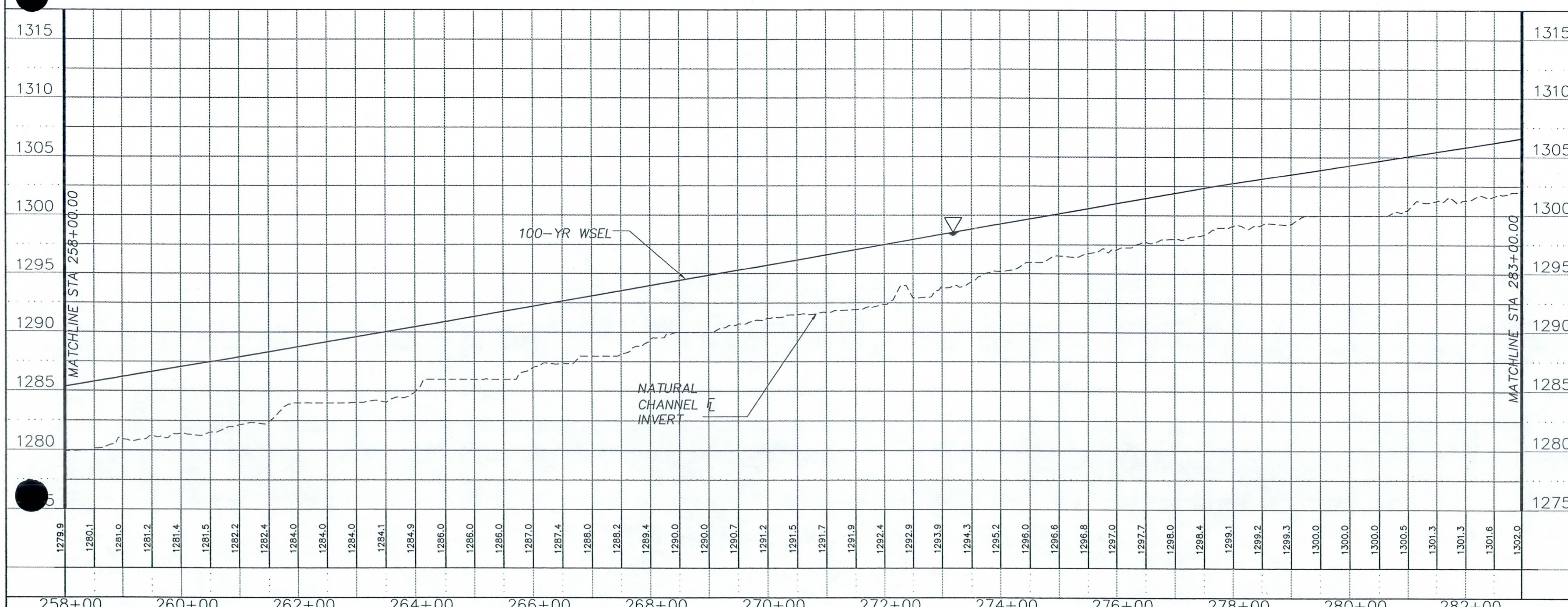
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP17	STA 233+00.00 TO 258+00.00	– –

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP17-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

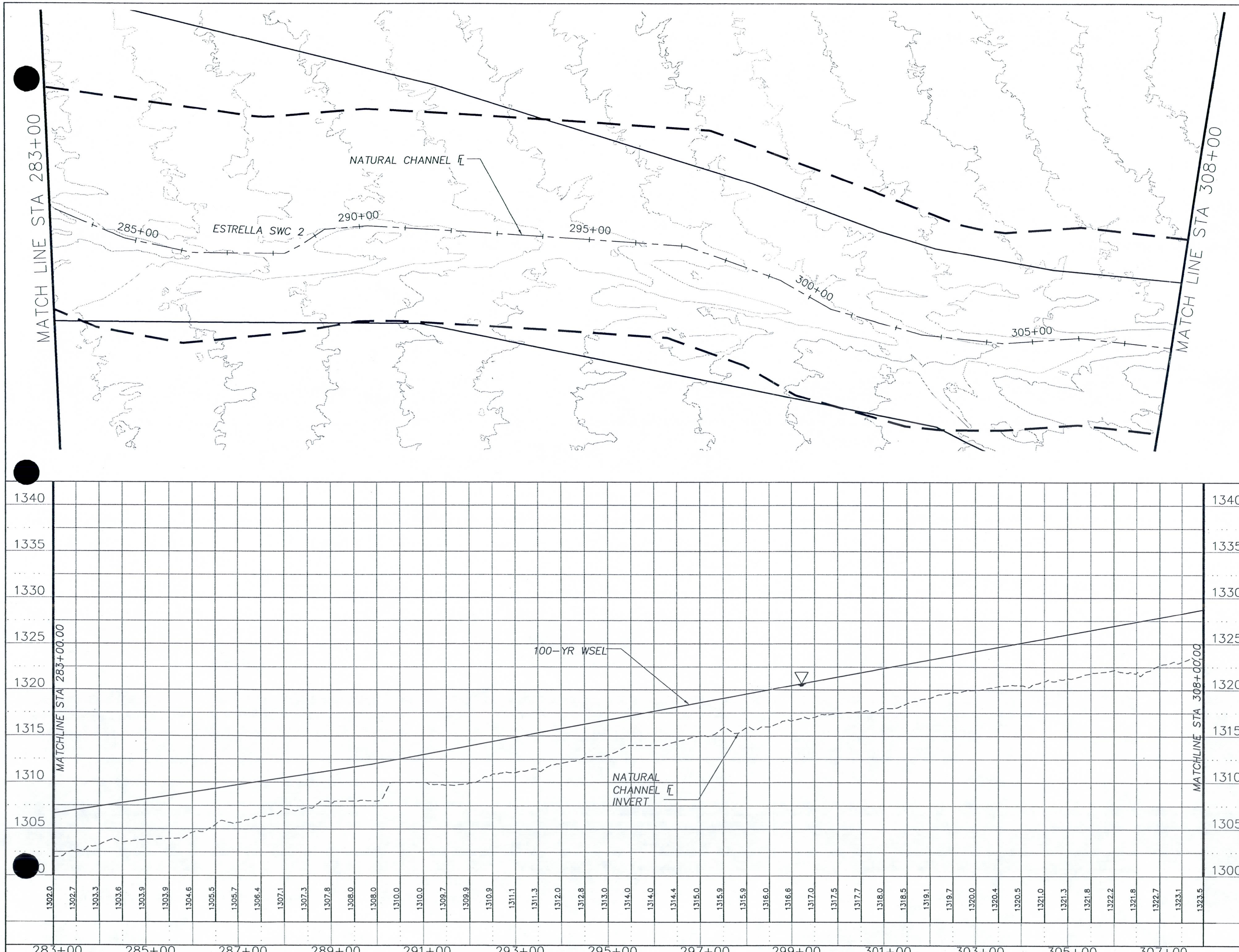
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP18	STA 258+00.00 TO 283+00.00	– -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP18-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

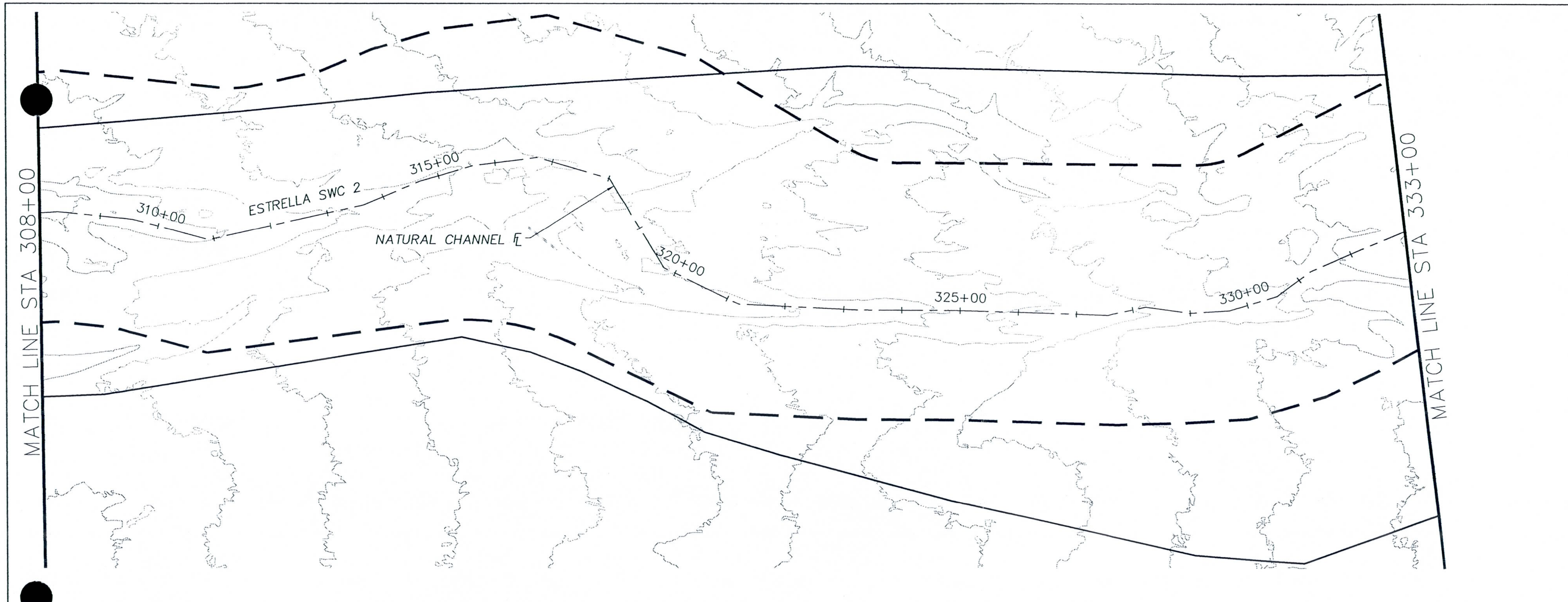
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

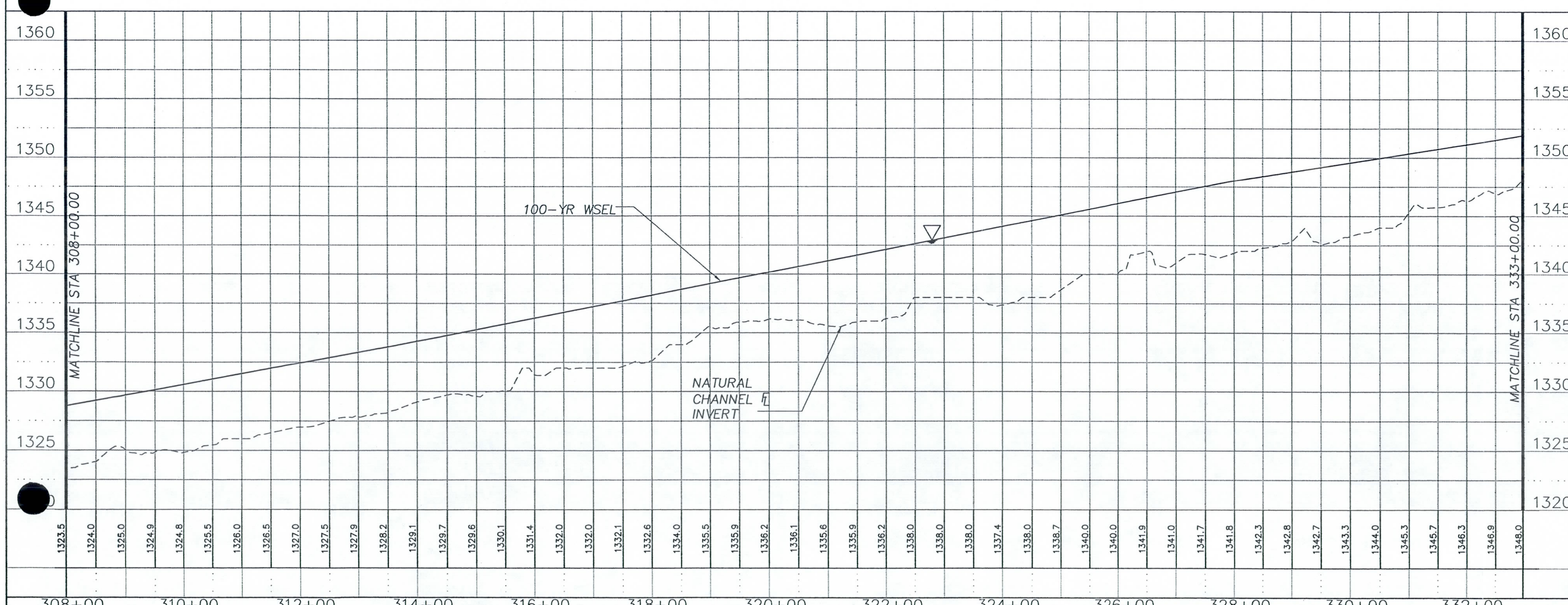
PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP19	PLAN AND PROFILE SHEET STA 283+00.00 TO 308+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP19-REVA.dwg





LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

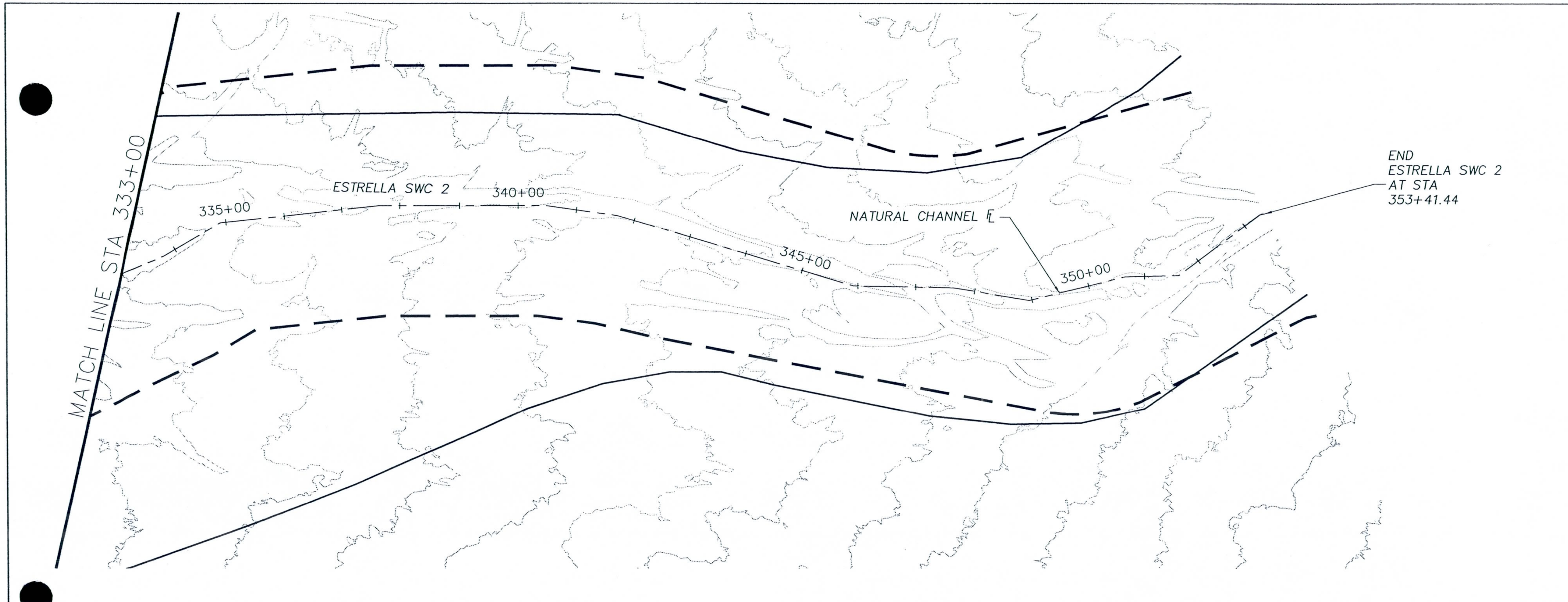
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

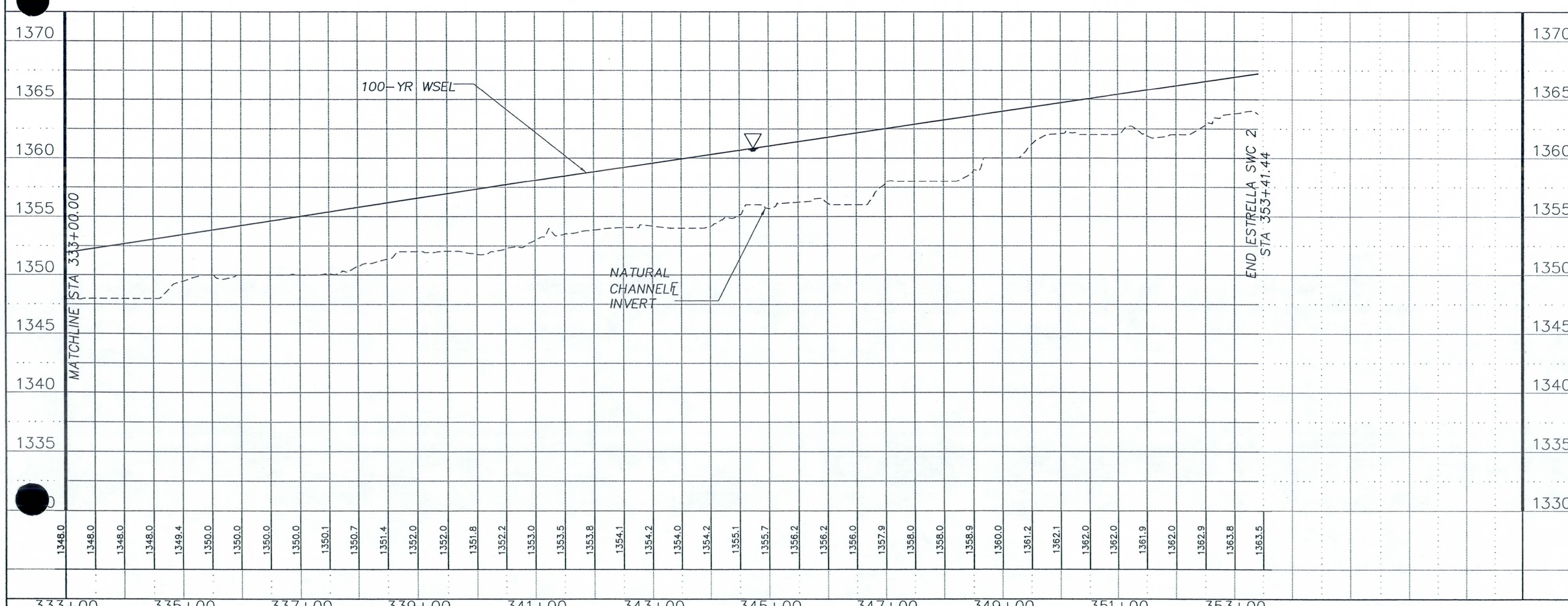
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP20	STA 308+00.00 TO 333+00.00	– -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP20-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
ESTRELLA SWC 2

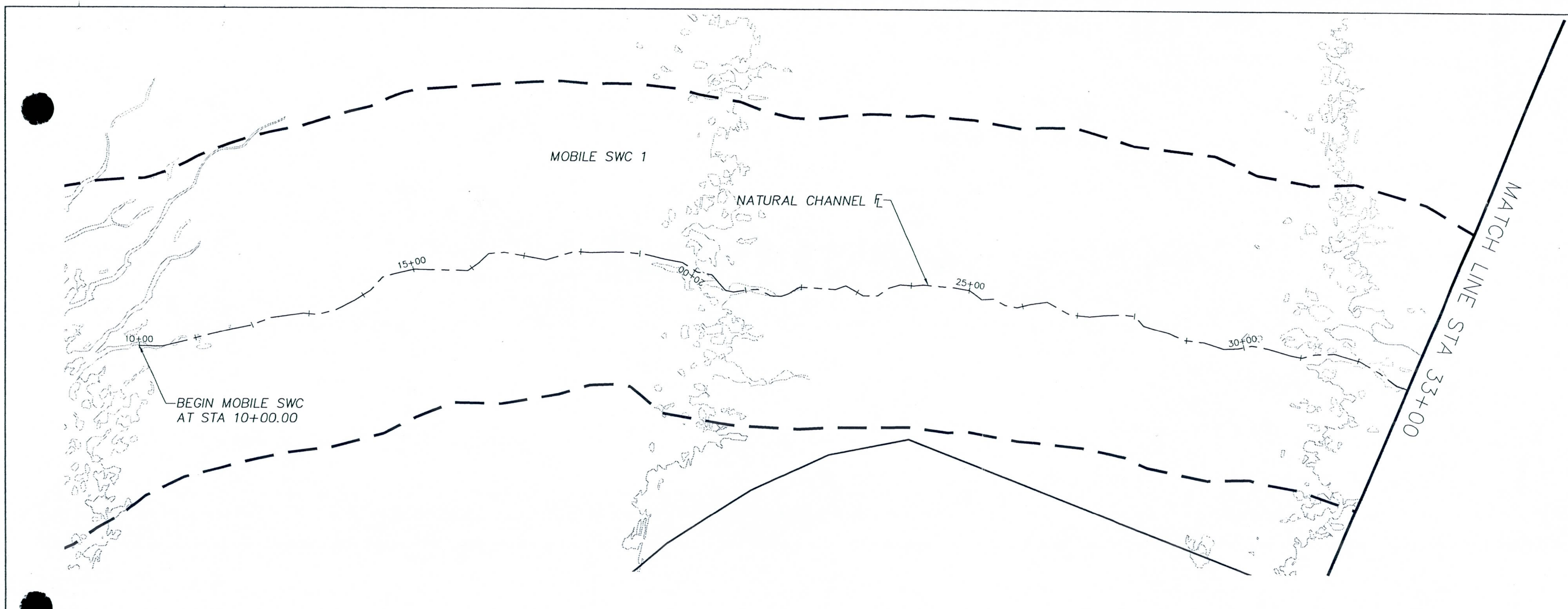
PRELIMINARY NOT FOR CONSTRUCTION

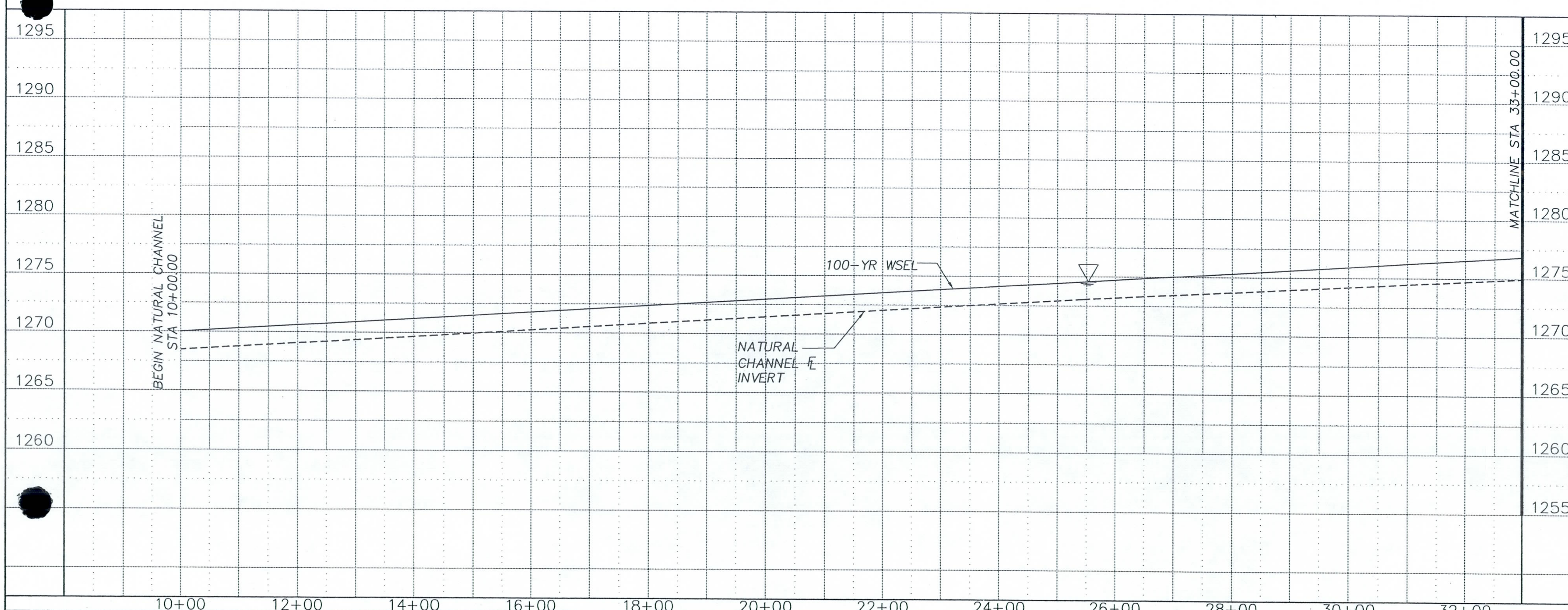
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP21	PLAN AND PROFILE SHEET STA 333+00.00 TO 353+41.44	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\ESTRELLA-SWC-2\ ESTRELLA-SWC-2-PP21-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP01-REVA.dwg

LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

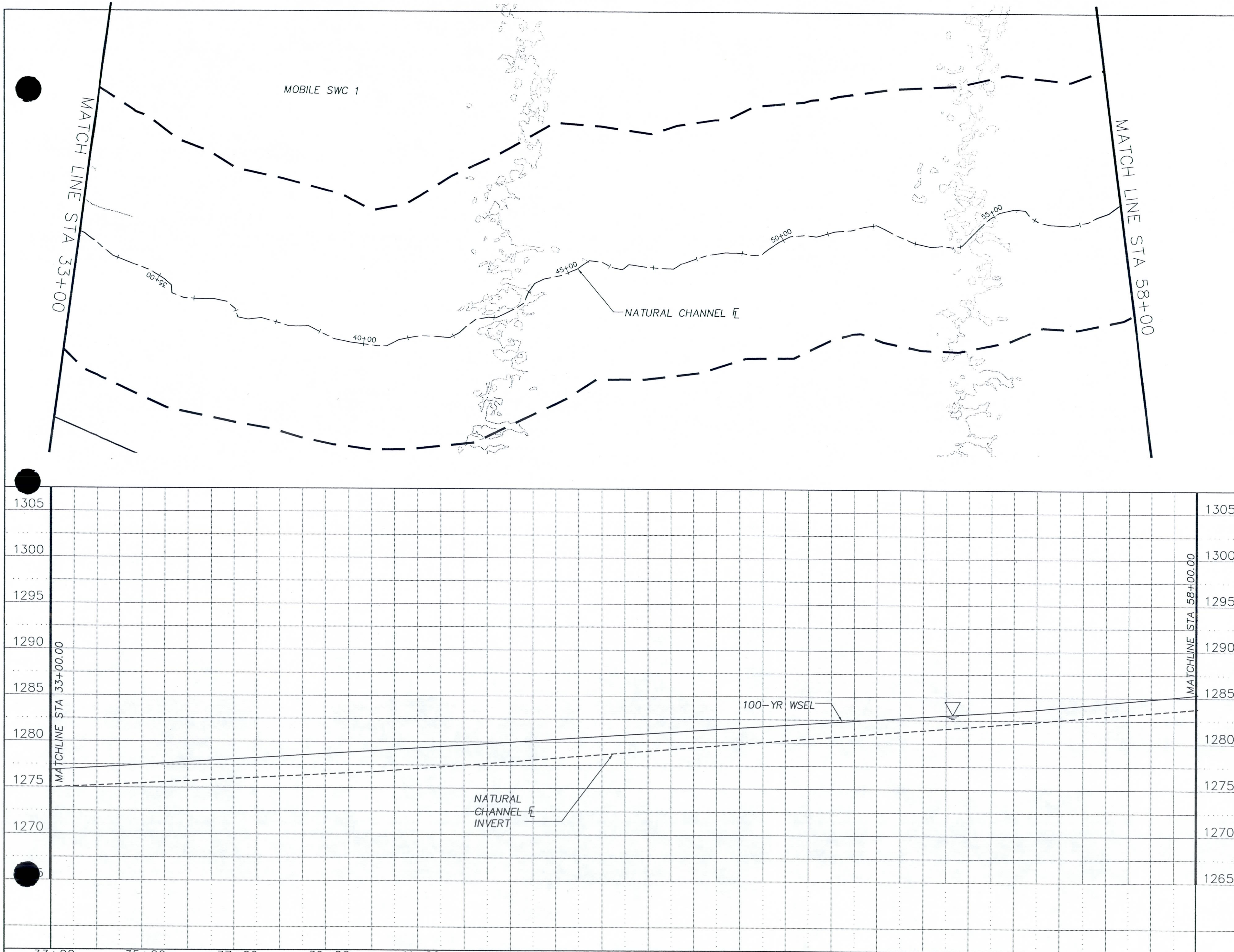
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP1	PLAN AND PROFILE SHEET STA 10+00.00 TO 33+00.00	- -



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP02-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

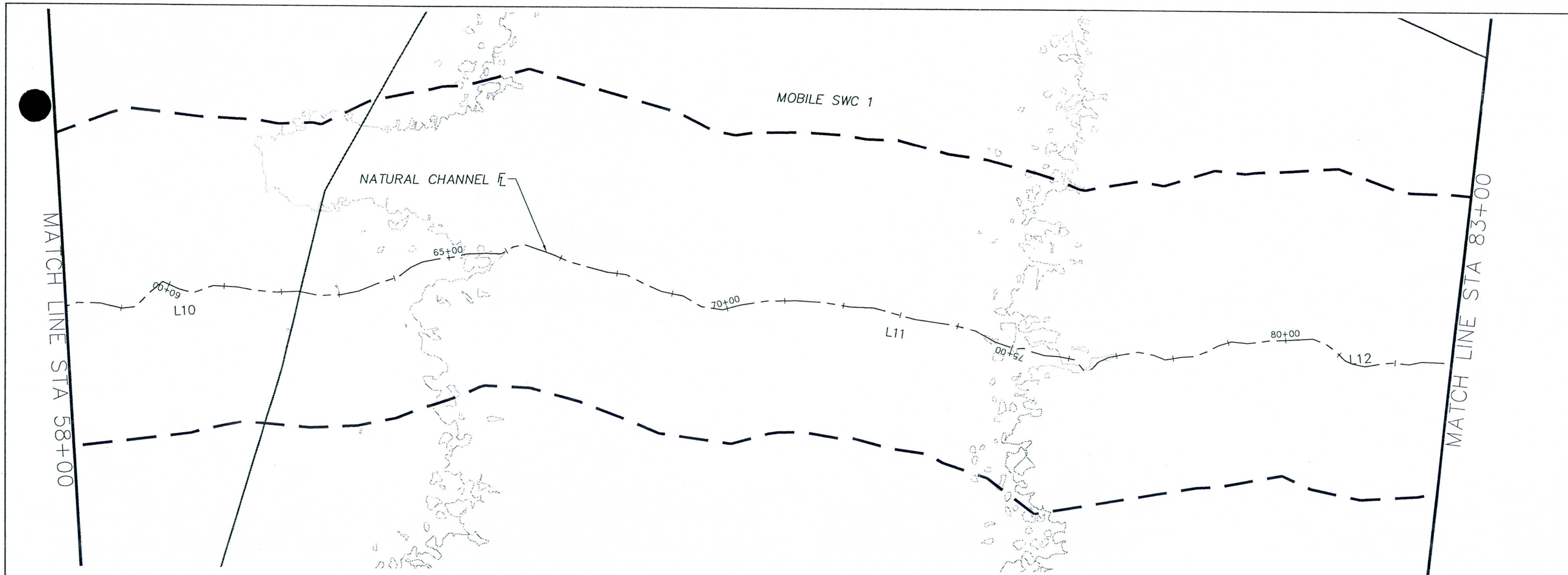
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

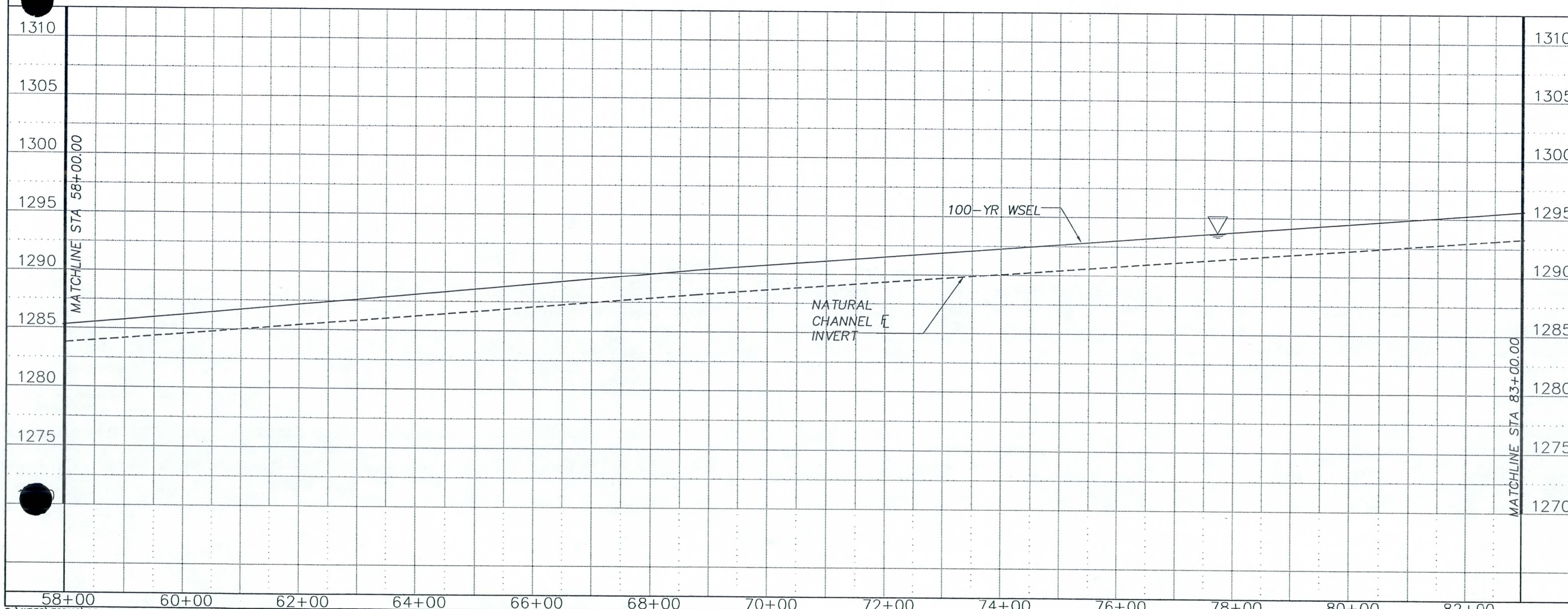
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP2	PLAN AND PROFILE SHEET STA 33+00.00 TO 58+00.00	- -





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP03-REVA.dwg

LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

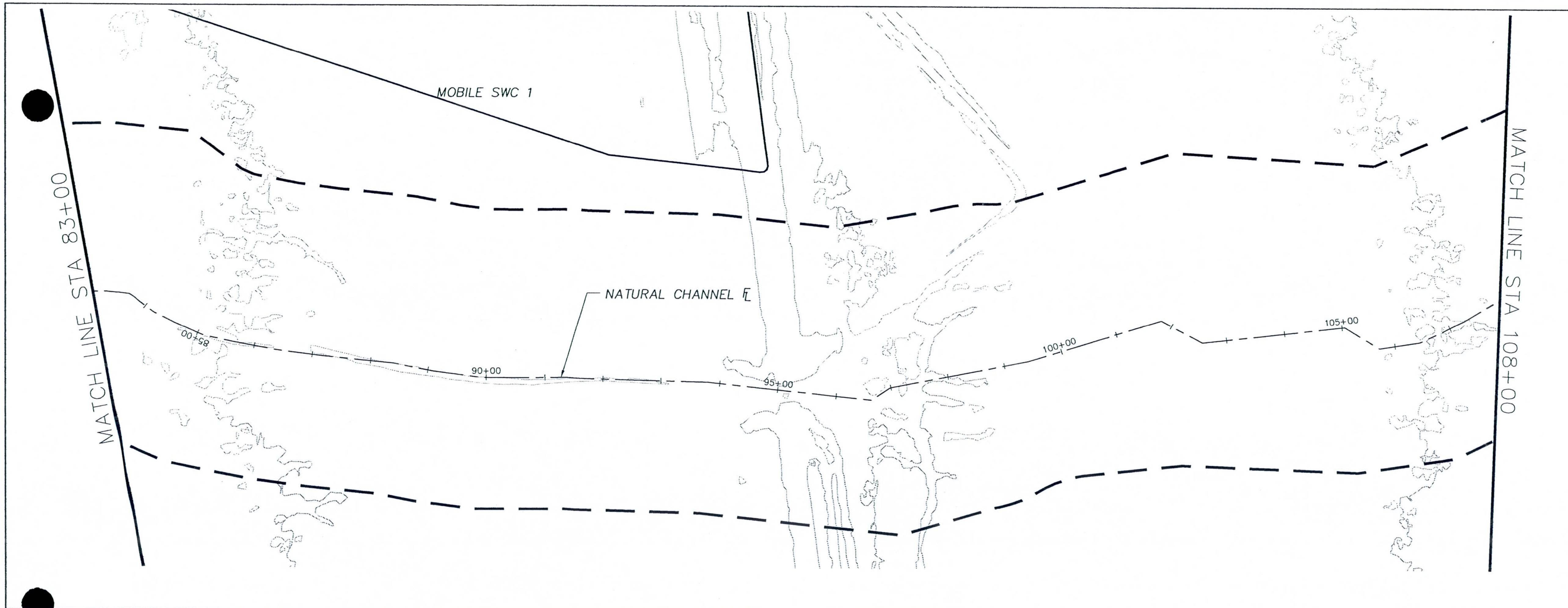
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

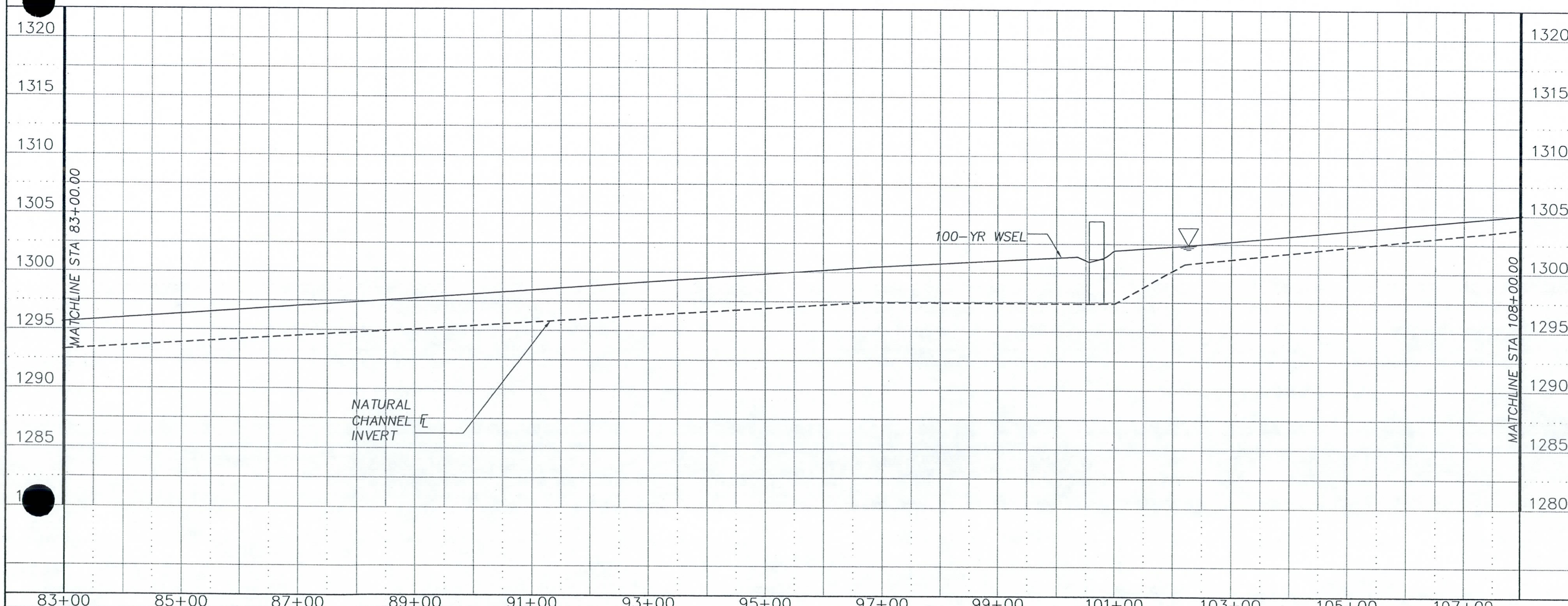
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

PRELIMINARY NOT FOR CONSTRUCTION

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP3	STA 58+00.00 TO 83+00.00	- -





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP04-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

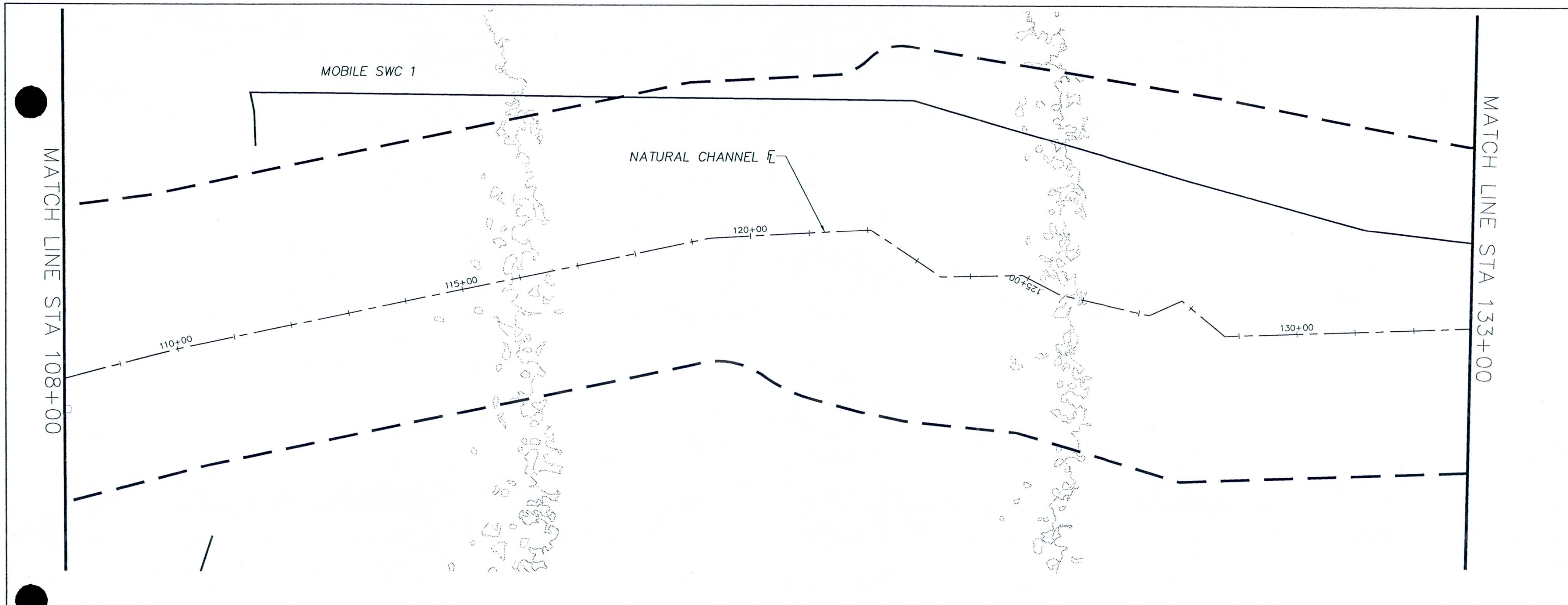
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

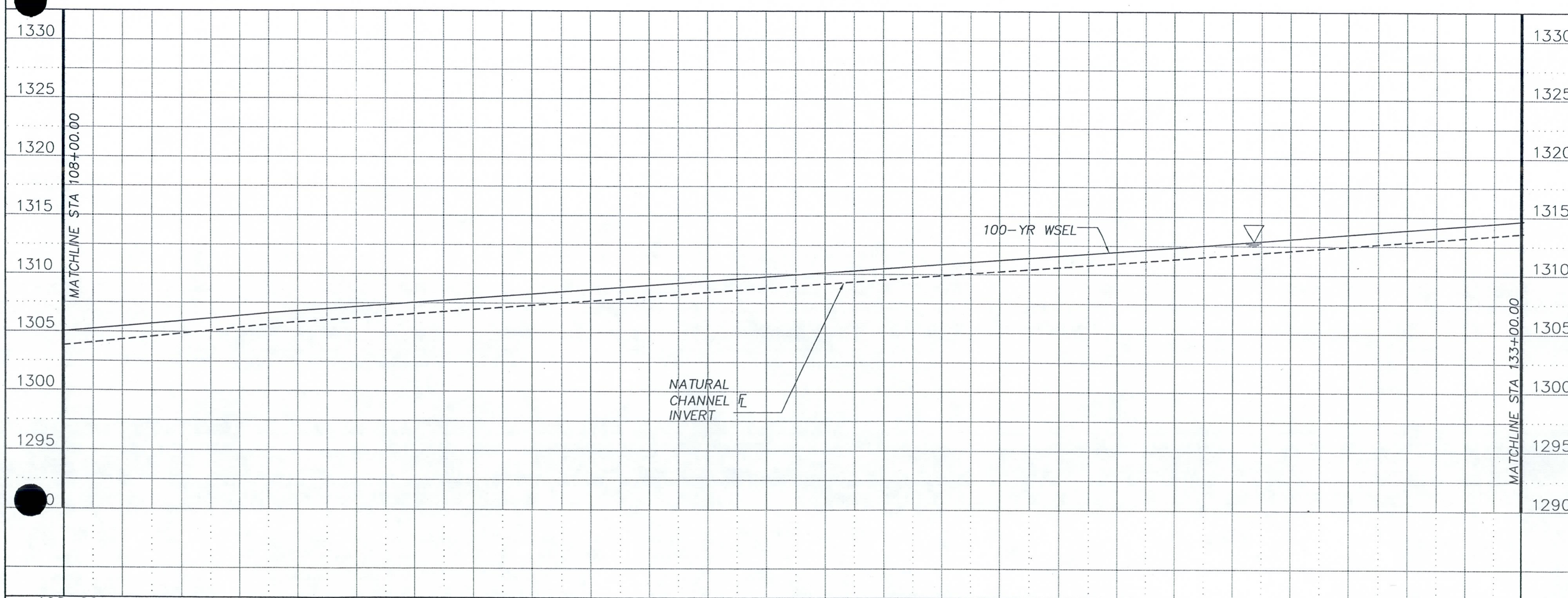
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP4	PLAN AND PROFILE SHEET STA 83+00.00 TO 108+00.00	- -





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP05-REVA.dwg

LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100

Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL

263-1100

BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

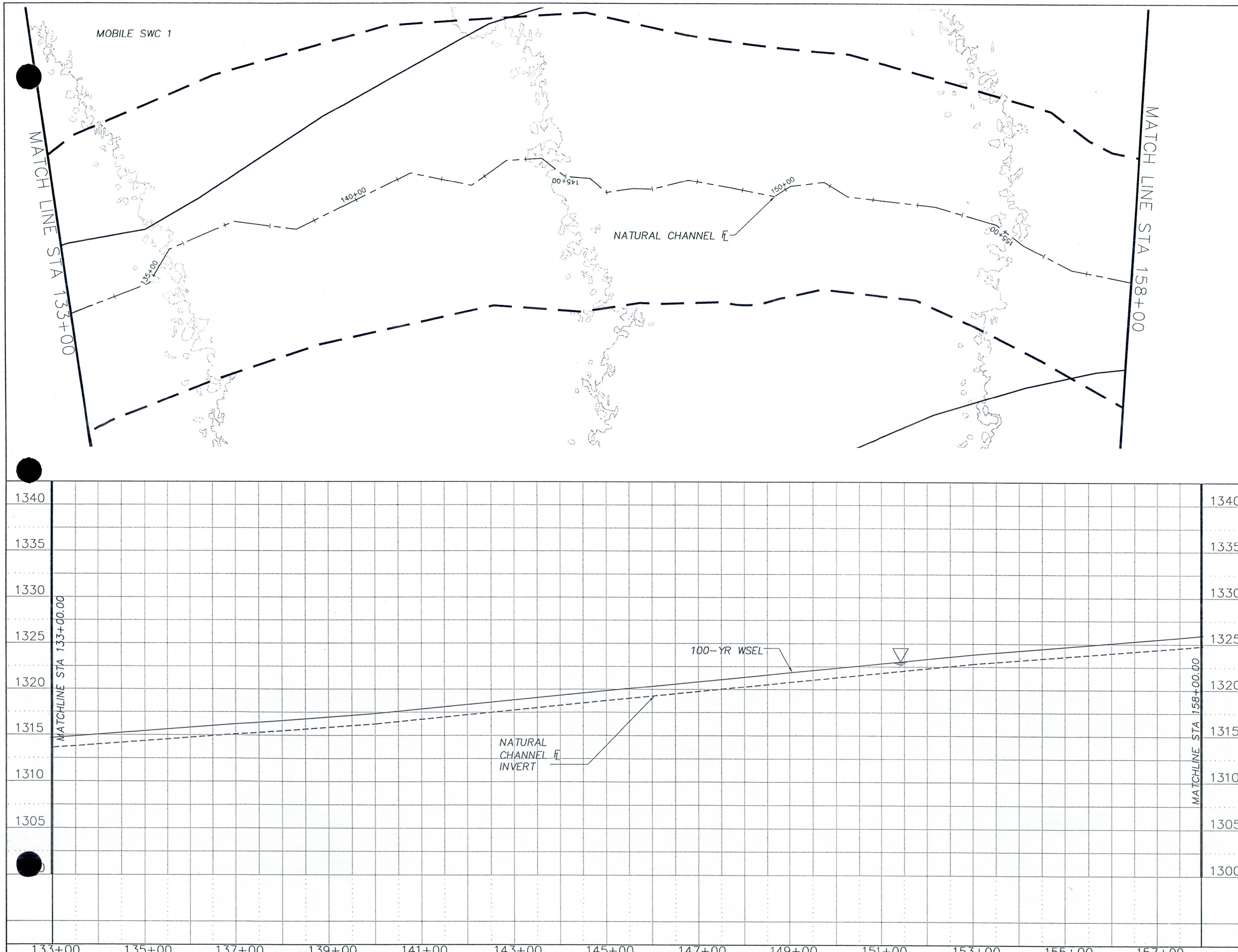
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP5	PLAN AND PROFILE SHEET STA 108+00.00 TO 133+00.00	- -



LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100

Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

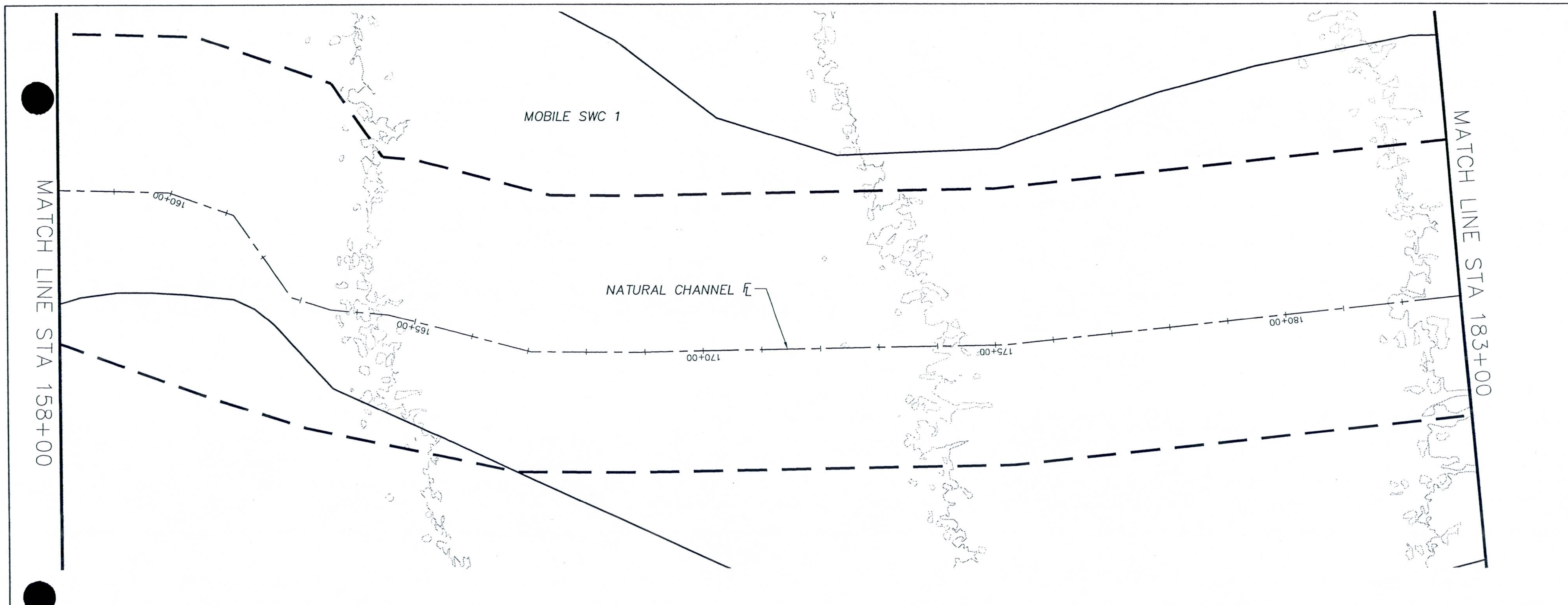
PRELIMINARY NOT FOR CONSTRUCTION

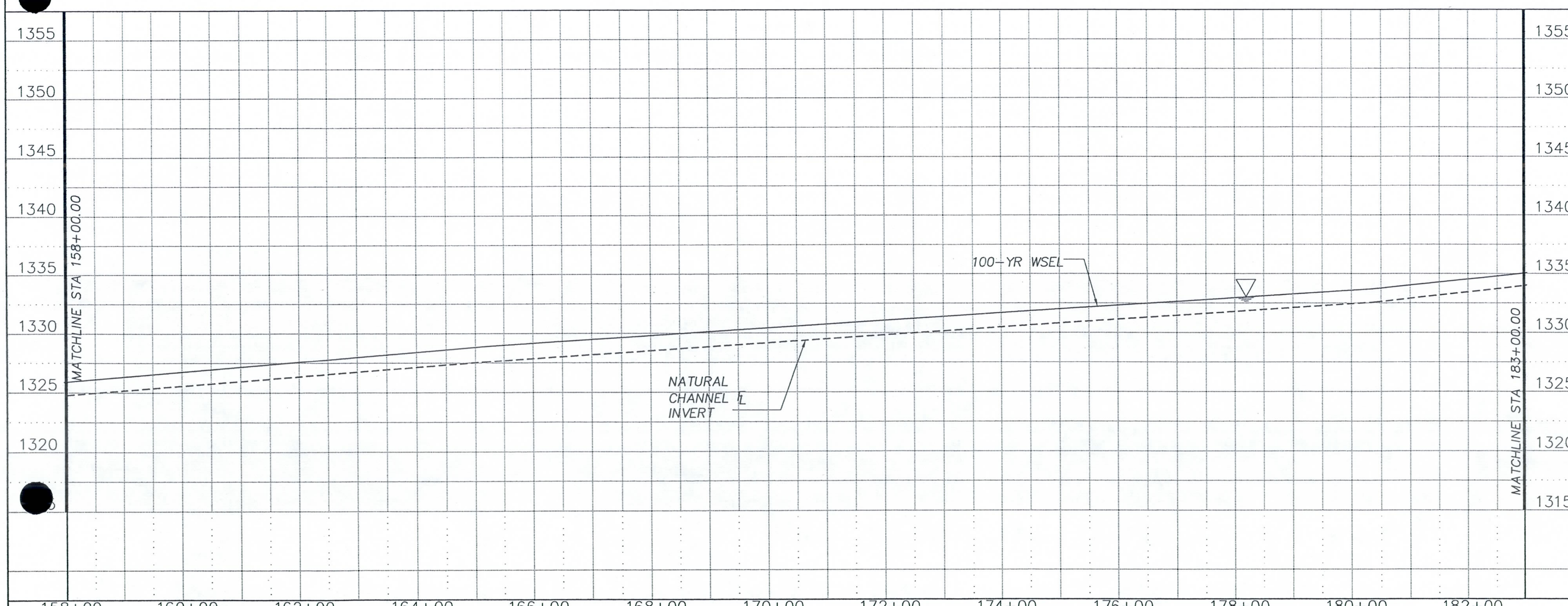
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP6	PLAN AND PROFILE SHEET STA 133+00.00 TO 158+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP06-REVA.dwg





LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

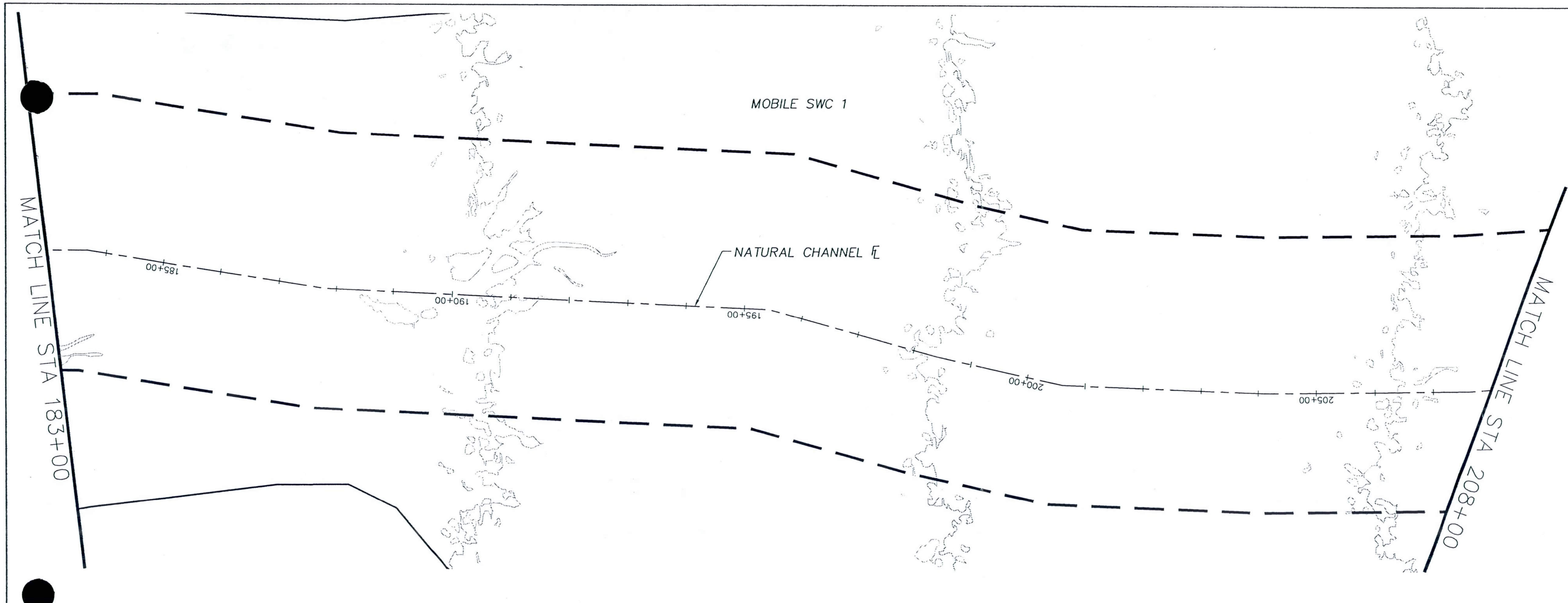
PRELIMINARY NOT FOR CONSTRUCTION

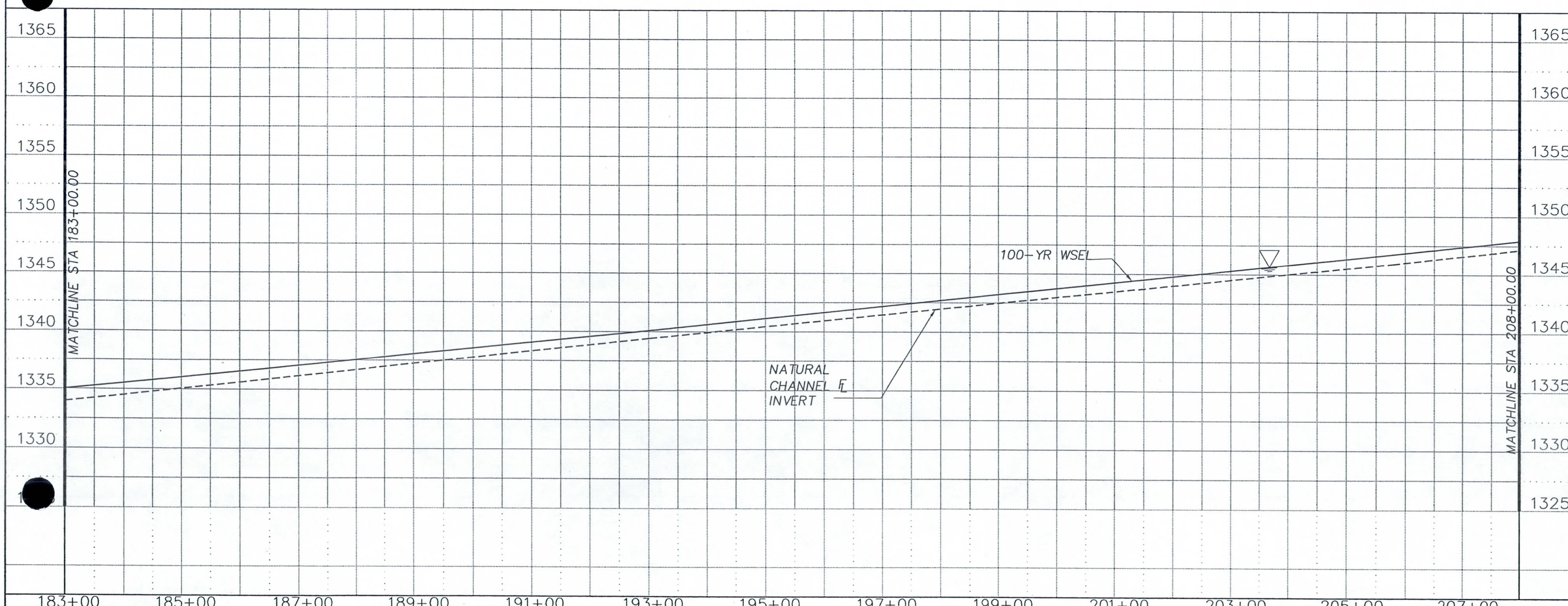
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP7	PLAN AND PROFILE SHEET STA 158+00.00 TO 160+39.88	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP07-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP08-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

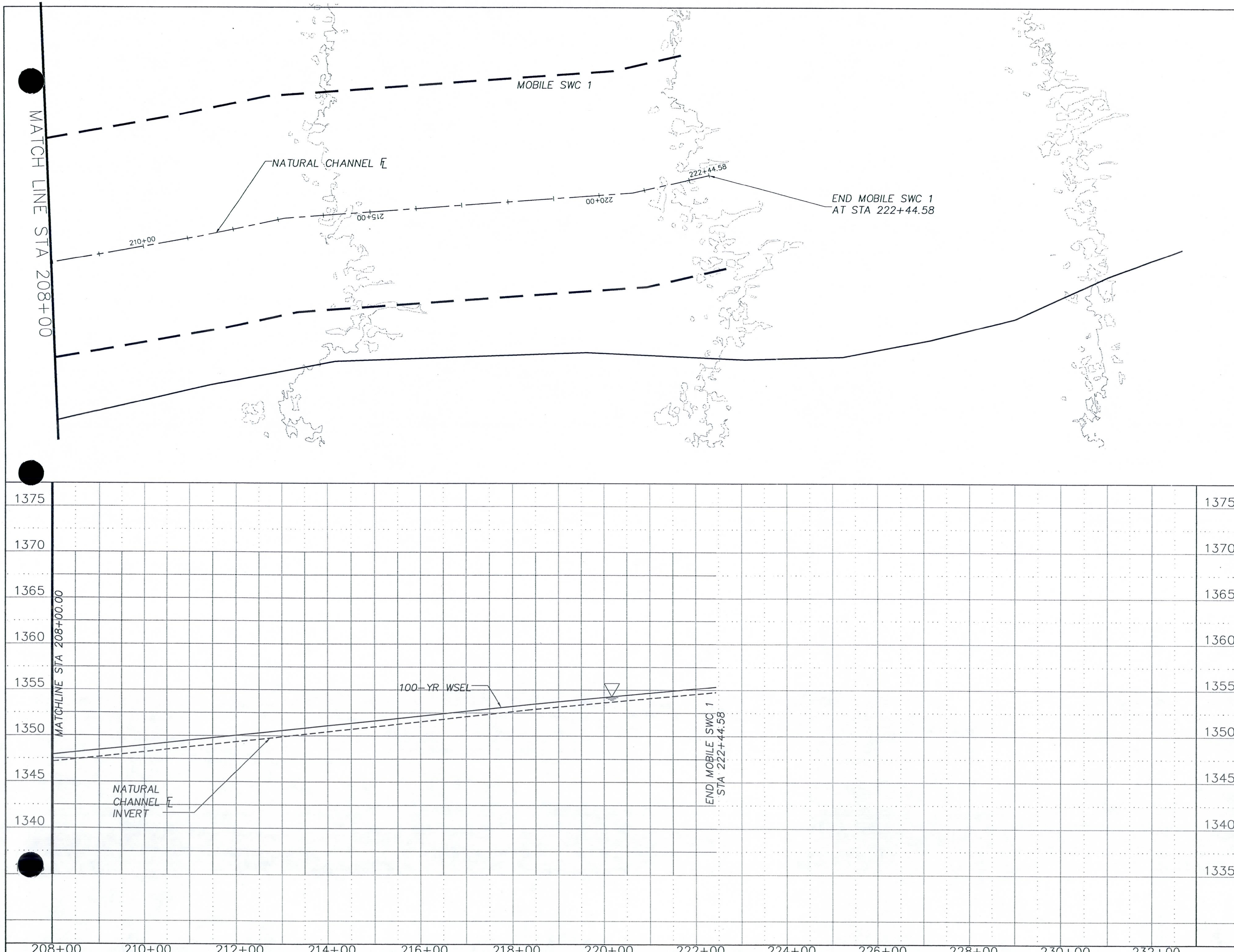
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP8	STA 183+00.00 TO 208+00.00	- -



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\MOBILE-SWC-1\ MOBILE-SWC-1-PP09-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

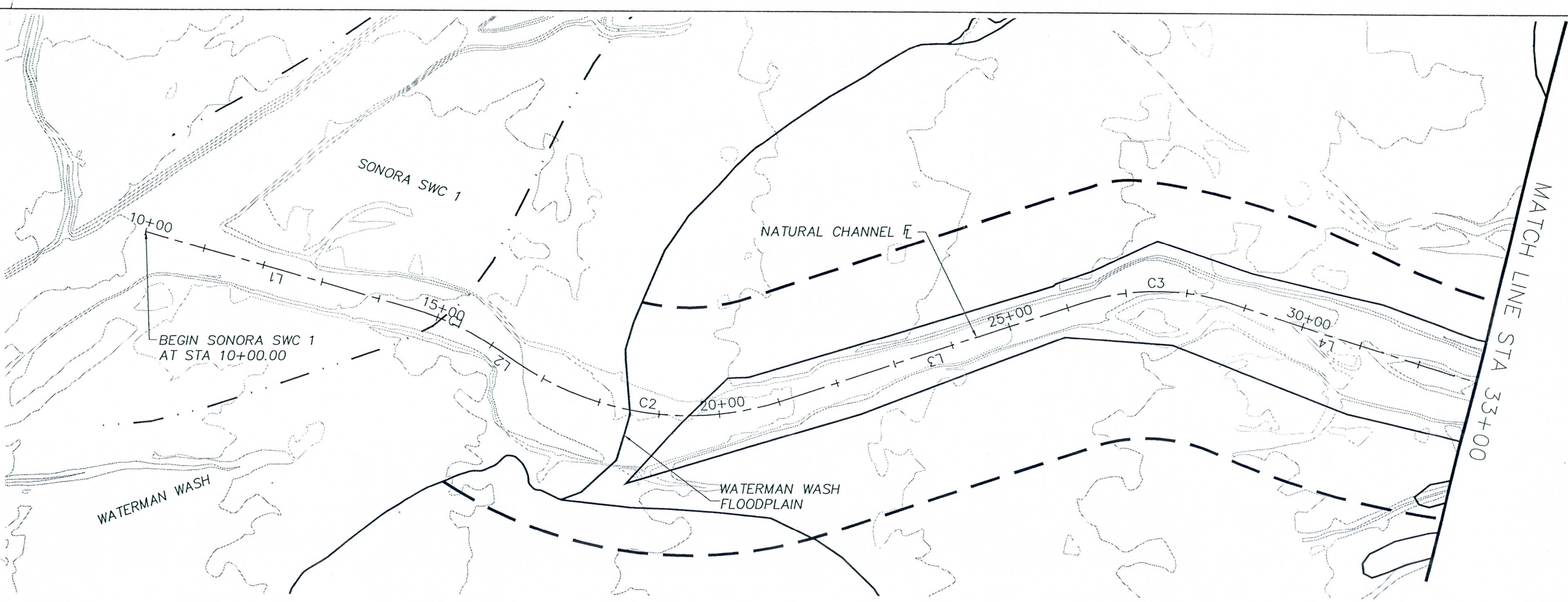
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
MOBILE SWC 1

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

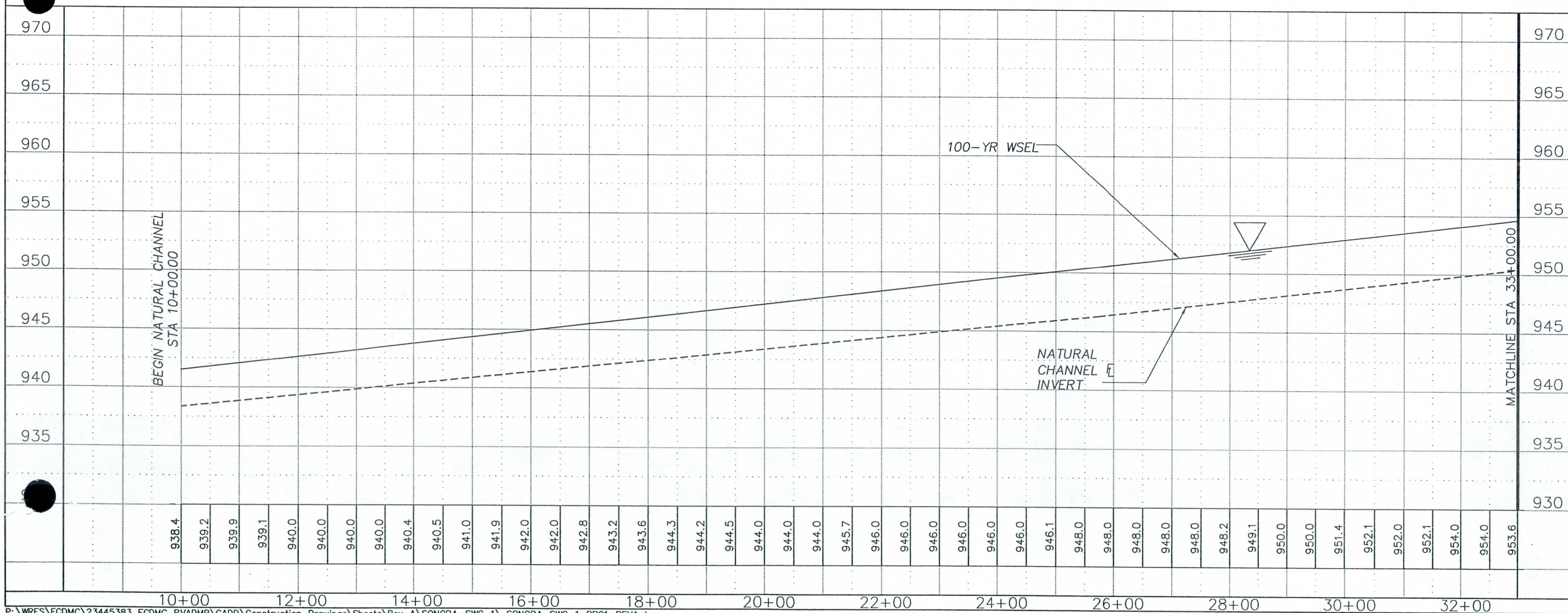
URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP9	STA 208+00.00 TO 222+44.58	– –



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

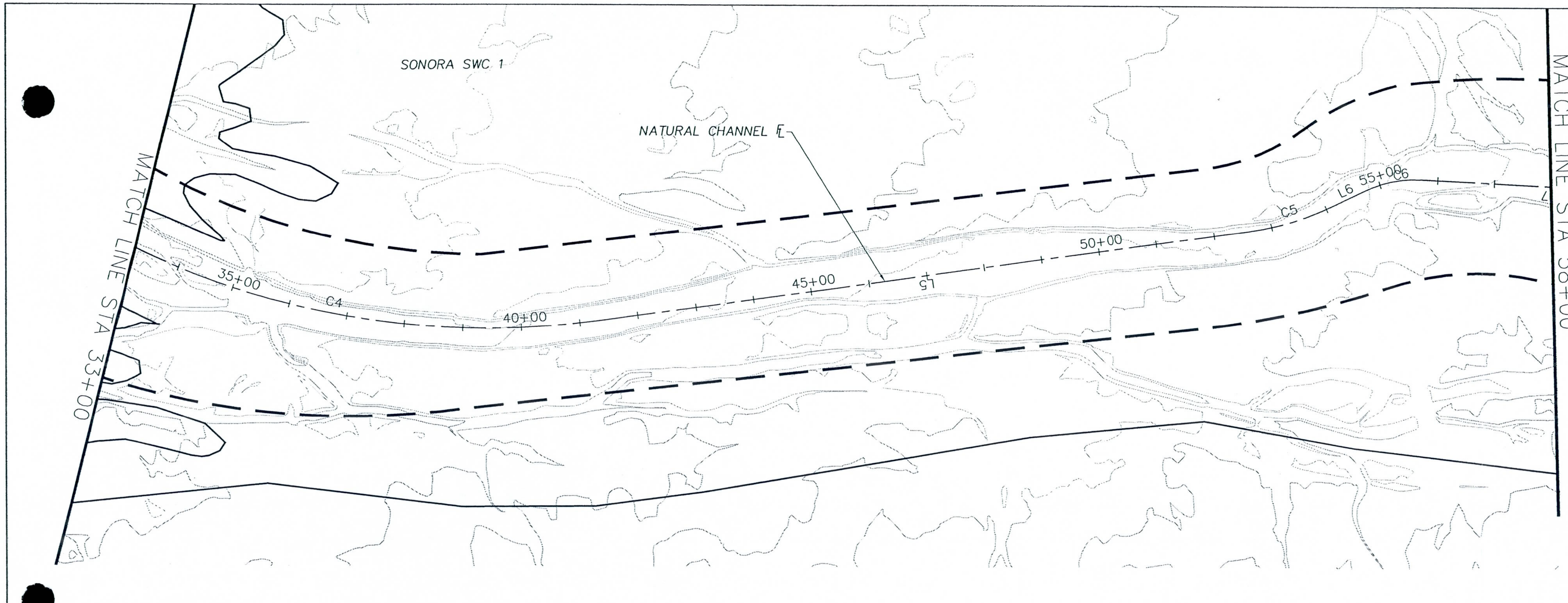
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP1	STA 10+00.00 TO 33+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP01-REVA.dwg

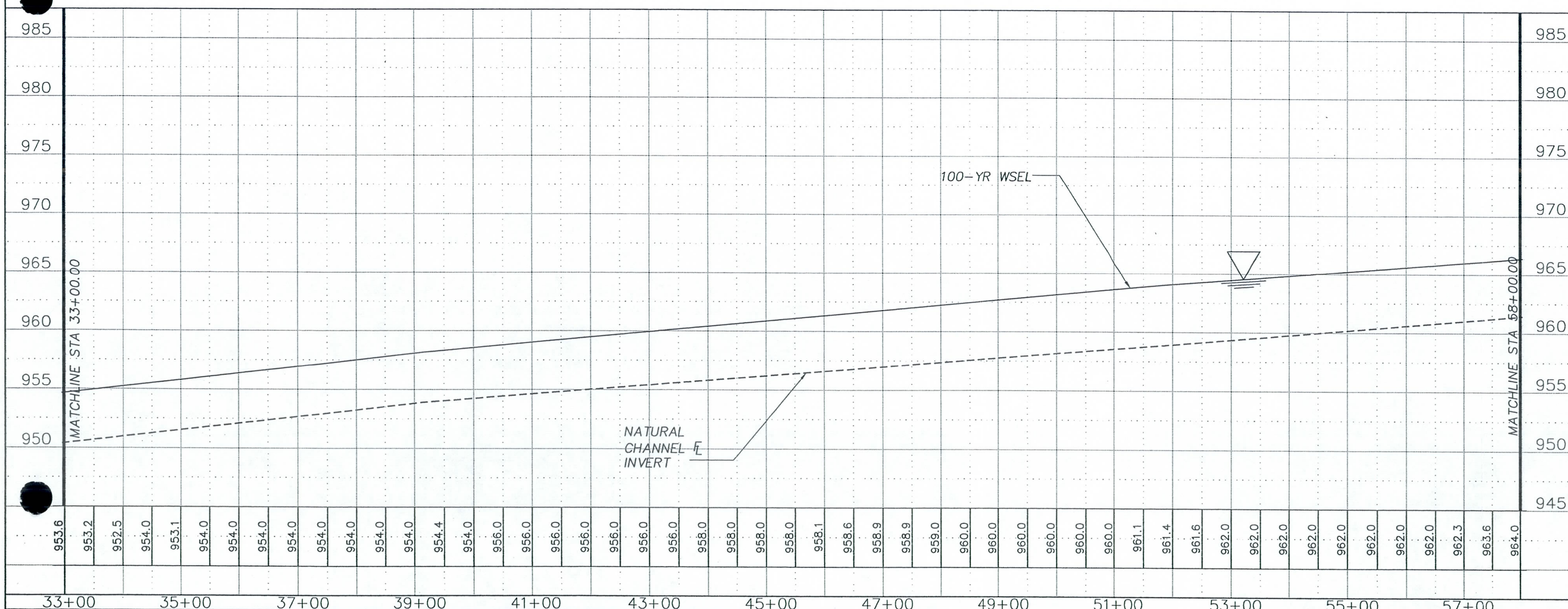


LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

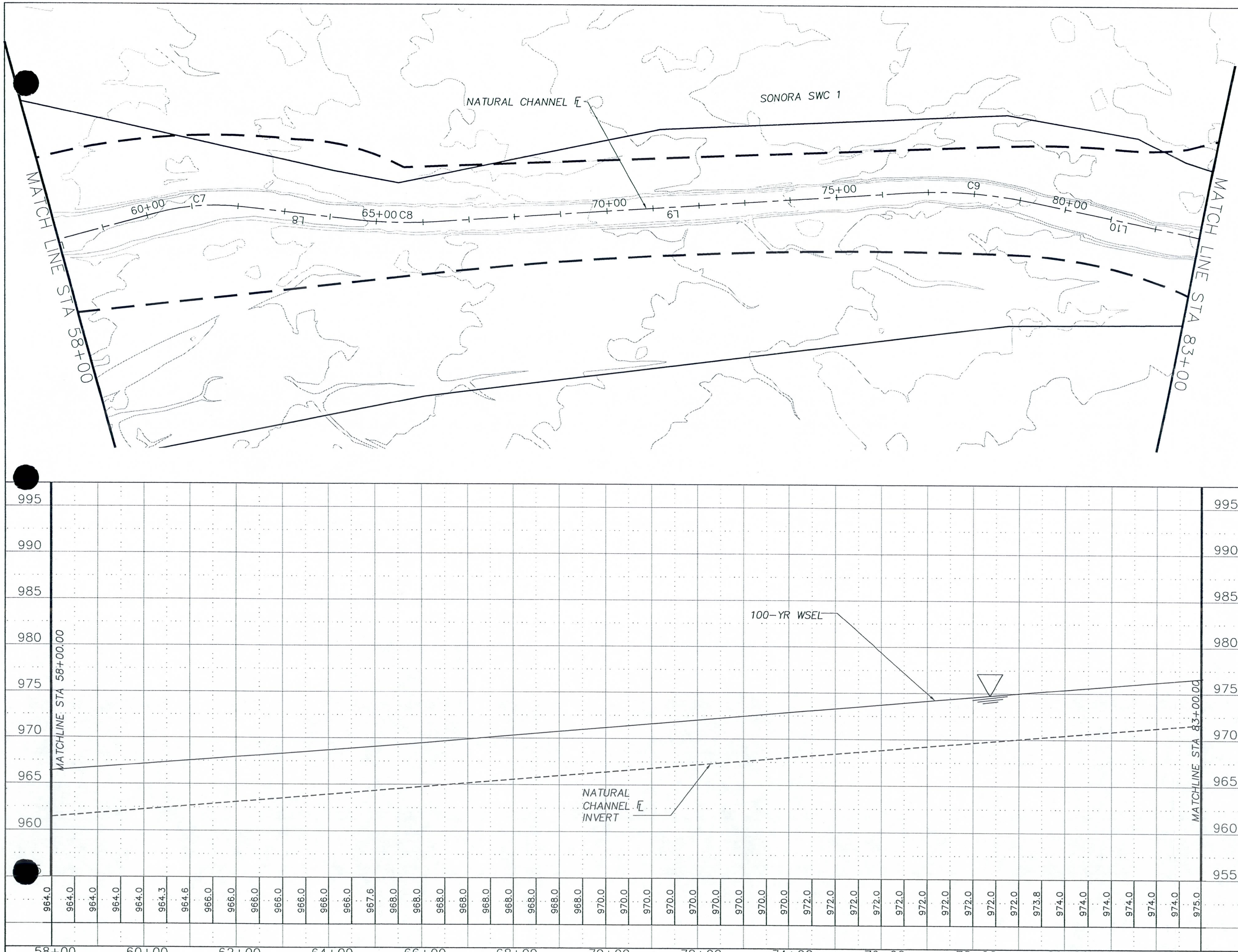
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP2	STA 33+00.00 TO 58+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP02-REVA.dwg



P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP03-REVA.dwg

LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

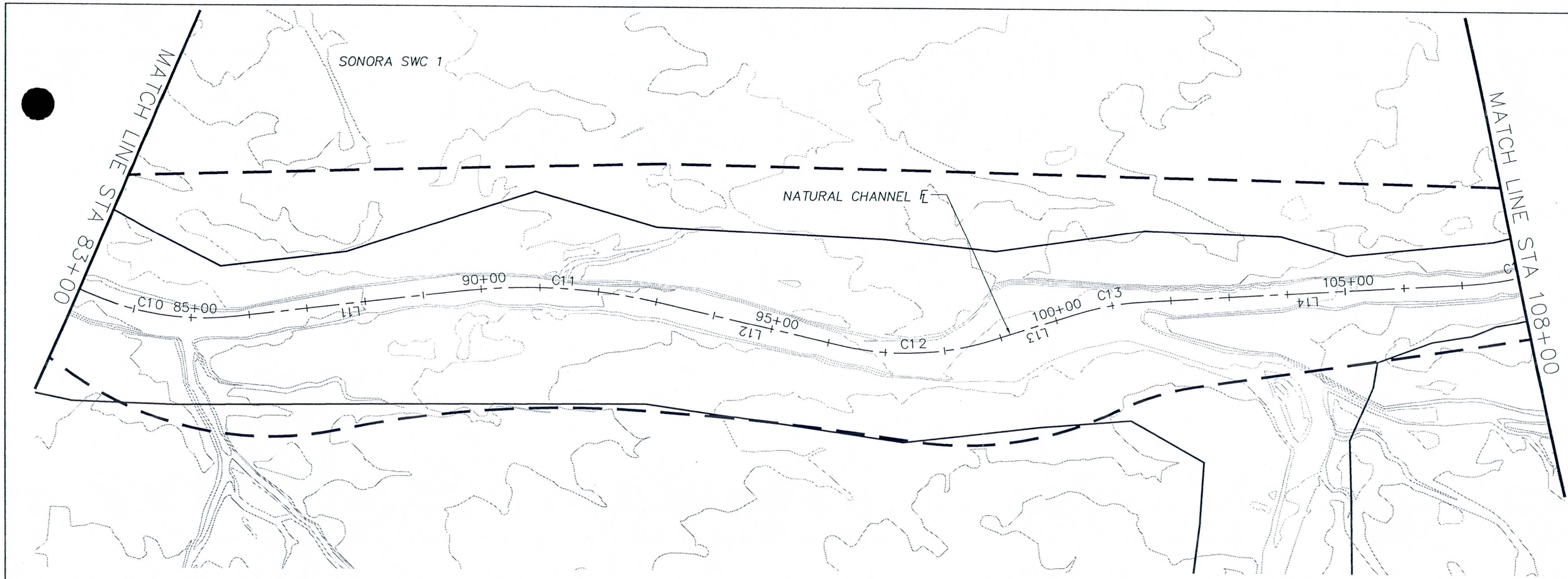
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

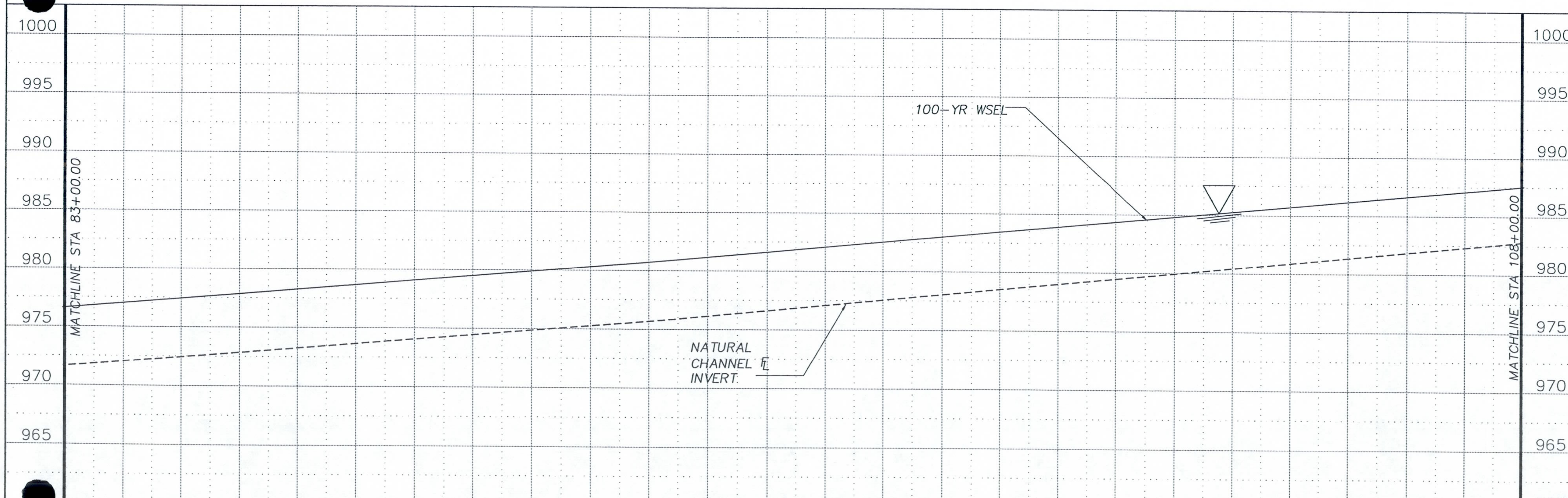
URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP3	STA 58+00.00 TO 83+00.00	- -



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



975.0	974.9	975.1	976.0	976.0	976.0	976.0	976.0	976.0	976.0	976.5	978.0	978.0	978.0	978.0	978.0	978.0	978.0	978.0	978.4	978.9	980.0	980.0	980.0	980.0	980.0	980.0	980.0	980.8	982.0	982.0	982.1	982.5	982.6	982.4	982.6	982.5	984.0	984.0	984.0	984.0	984.0	984.0	984.0	984.0	986.0	986.0	986.0	986.0	986.0	986.0

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

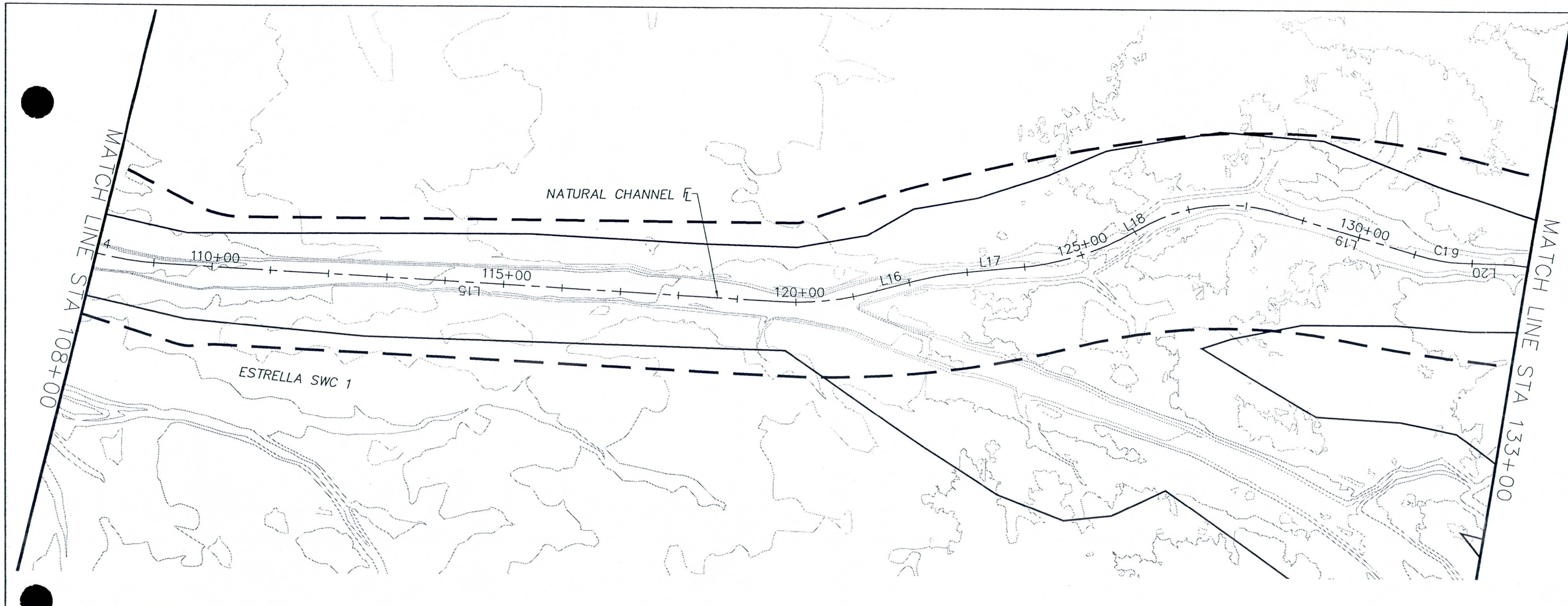
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

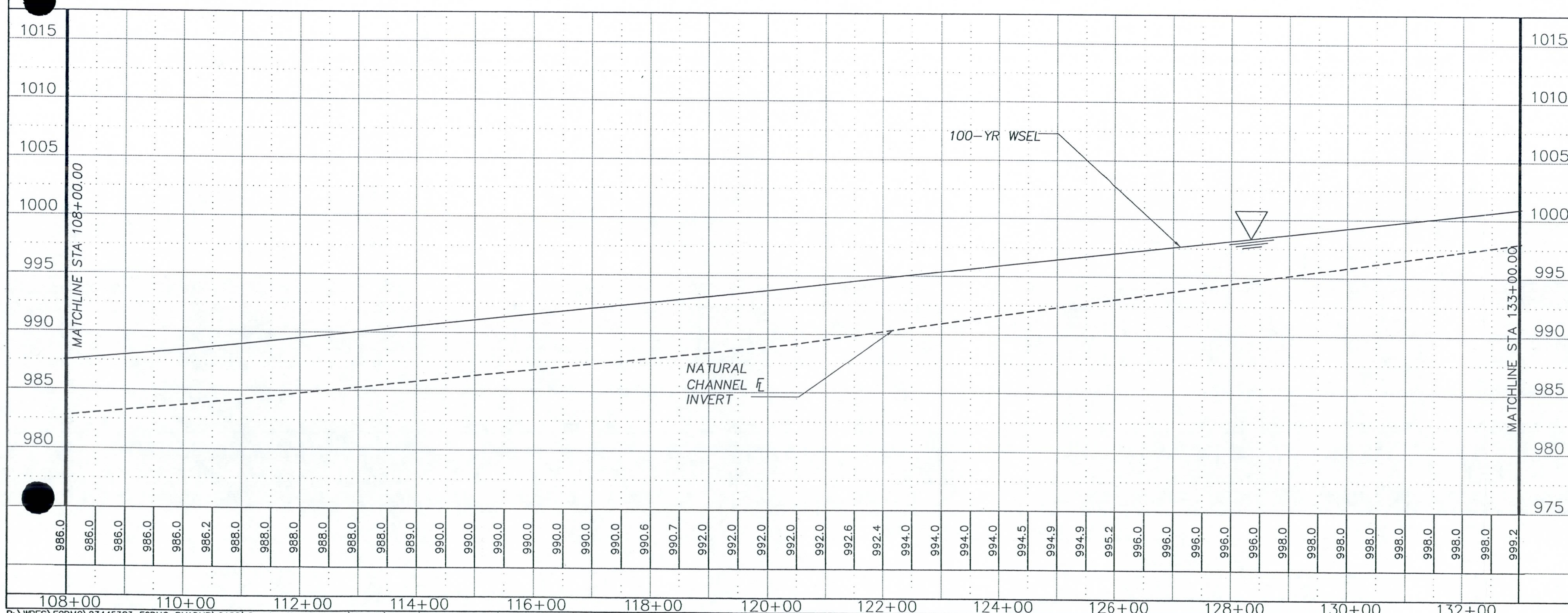
DRAWING NO.		SHEET OF
PP4	PLAN AND PROFILE SHEET STA 83+00.00 TO 108+00.00	– -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP04-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

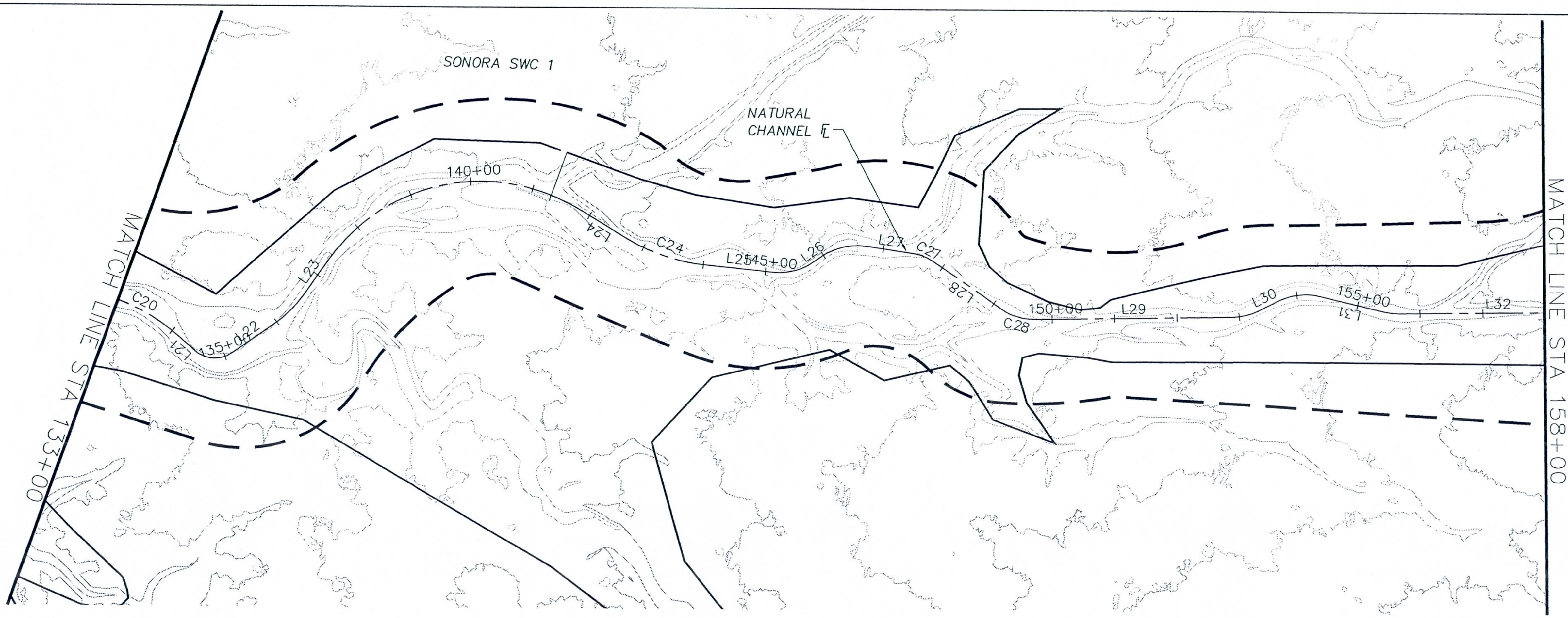
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

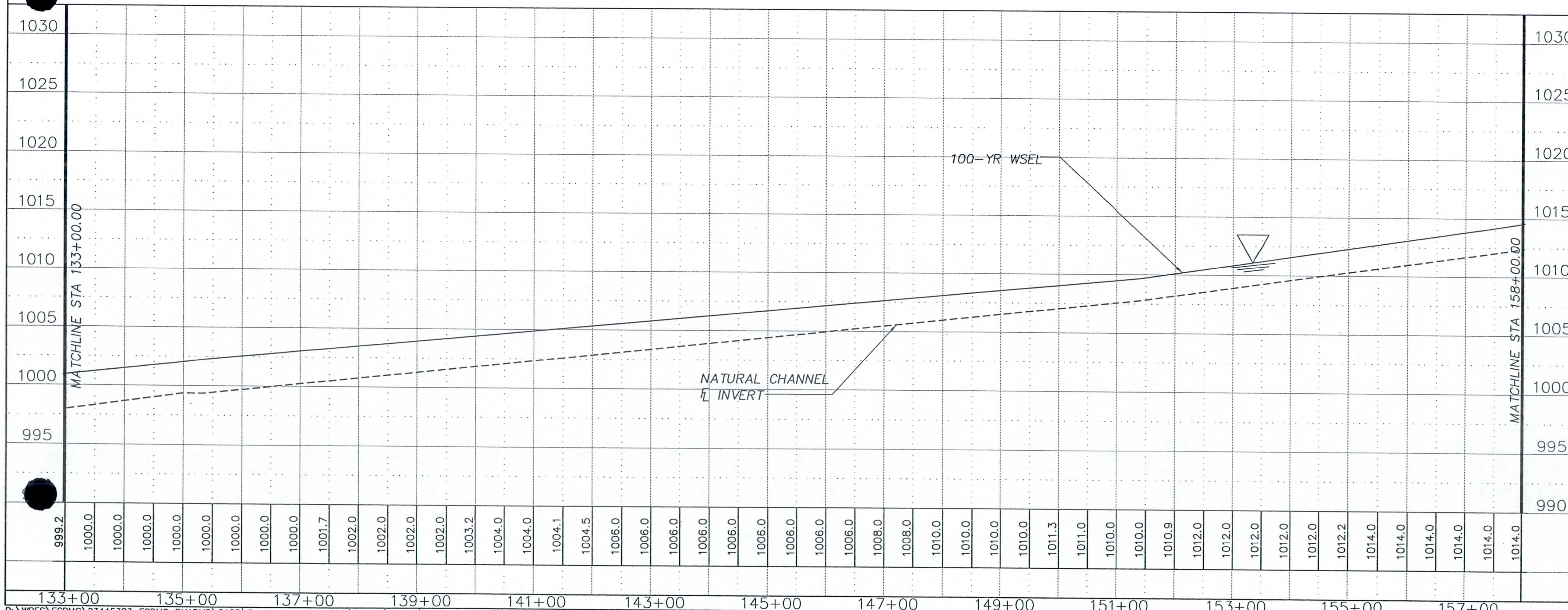
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP5	STA 108+00.00 TO 133+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP05-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

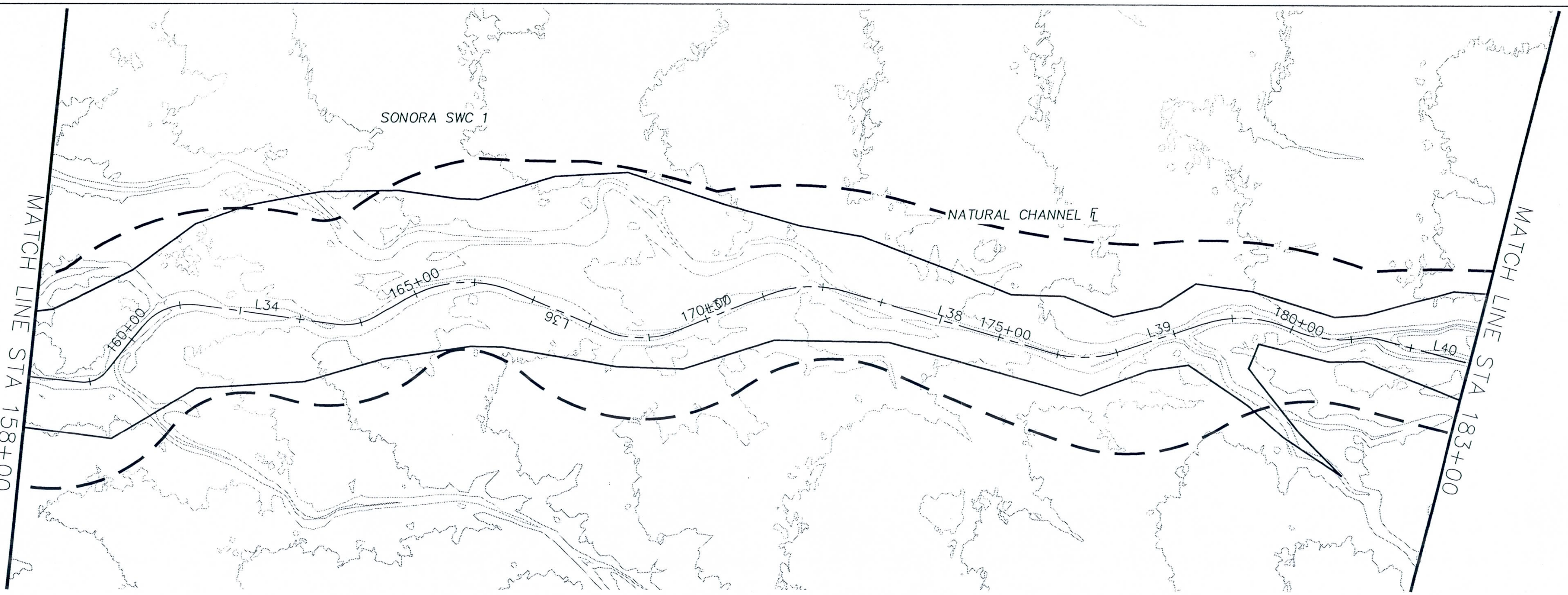
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

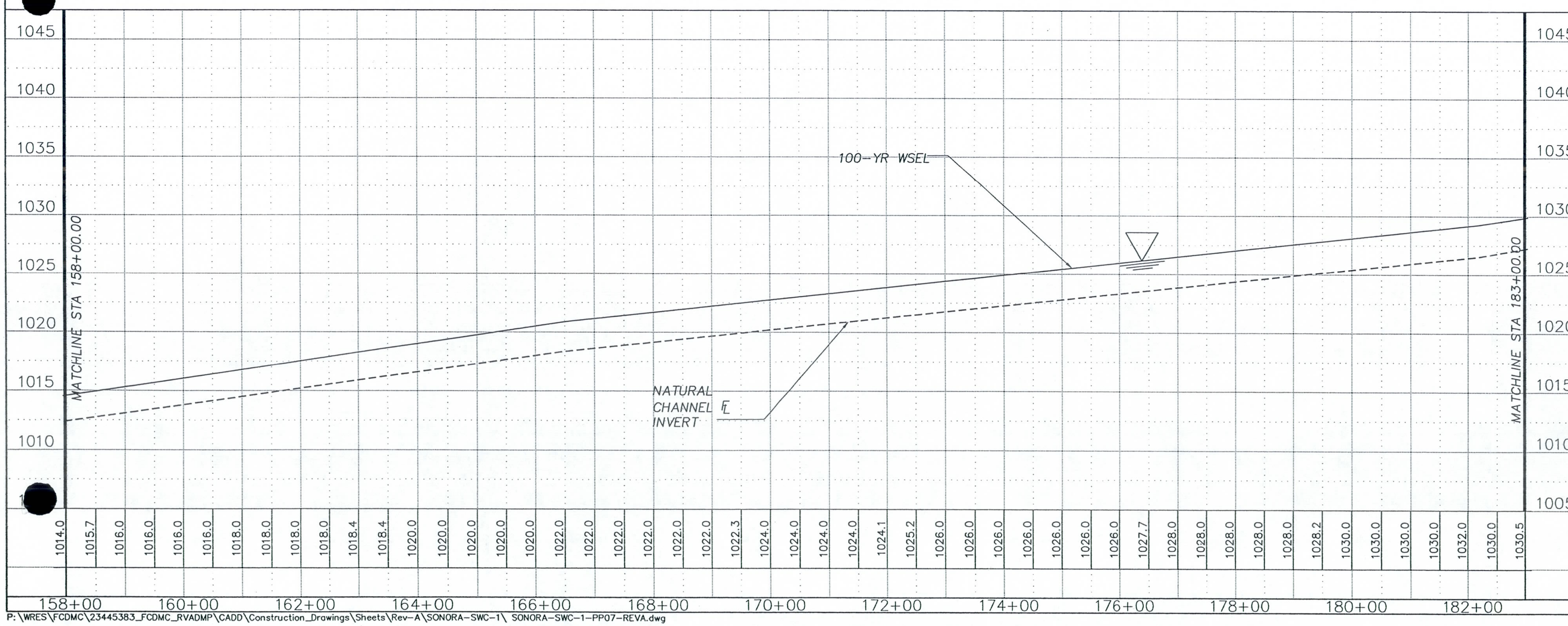
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP6	STA 133+00.00 TO 158+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP06-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

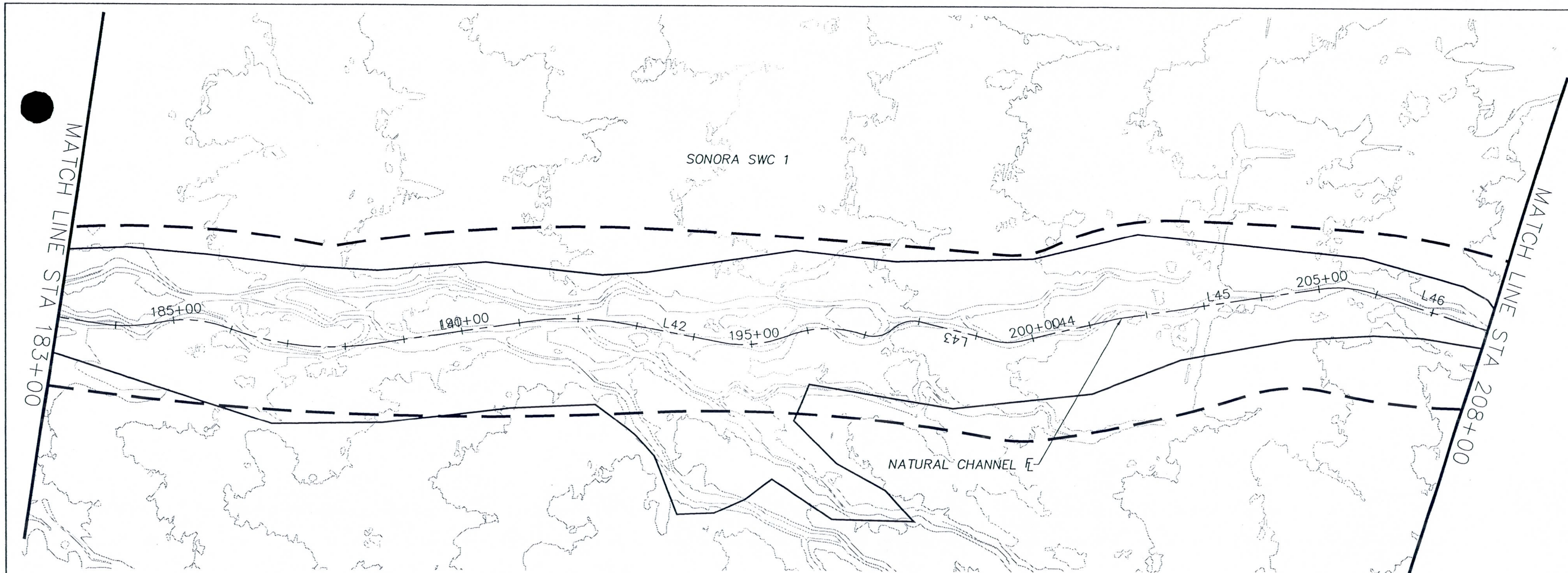
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP7	PLAN AND PROFILE SHEET STA 158+00.00 TO 160+39.88	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP07-REVA.dwg

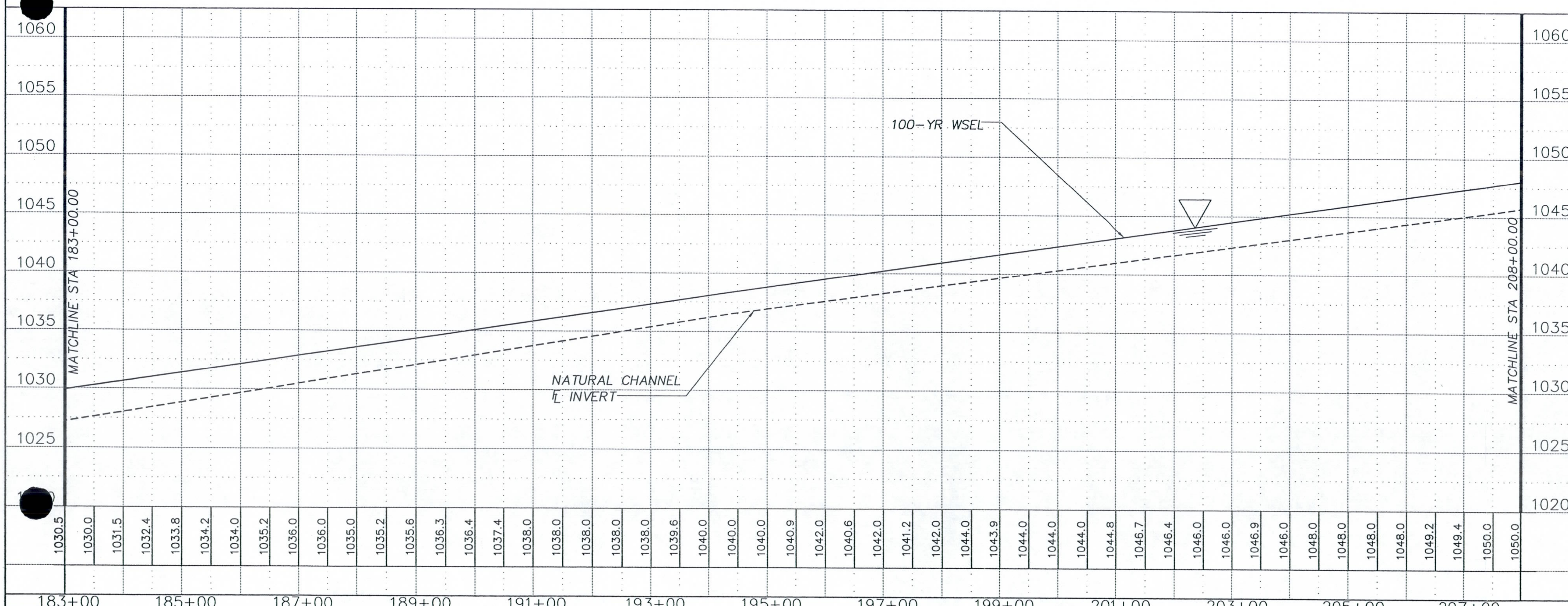


LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

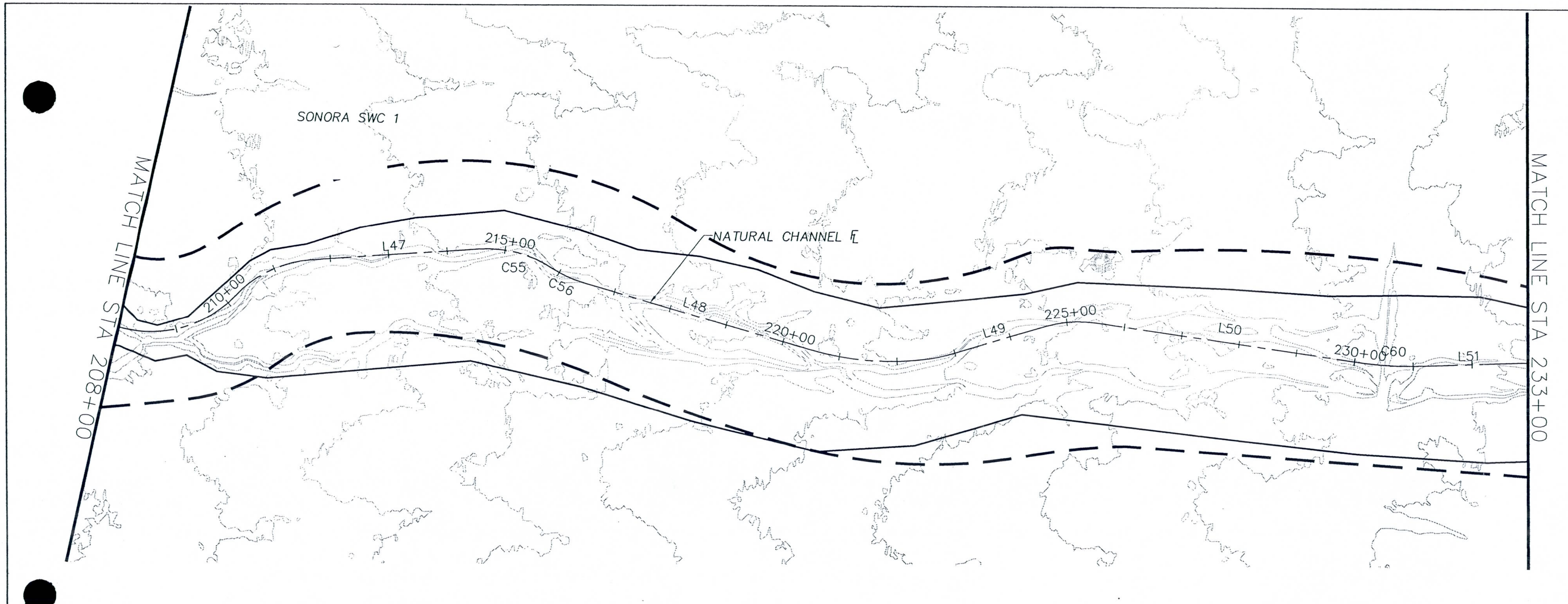
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

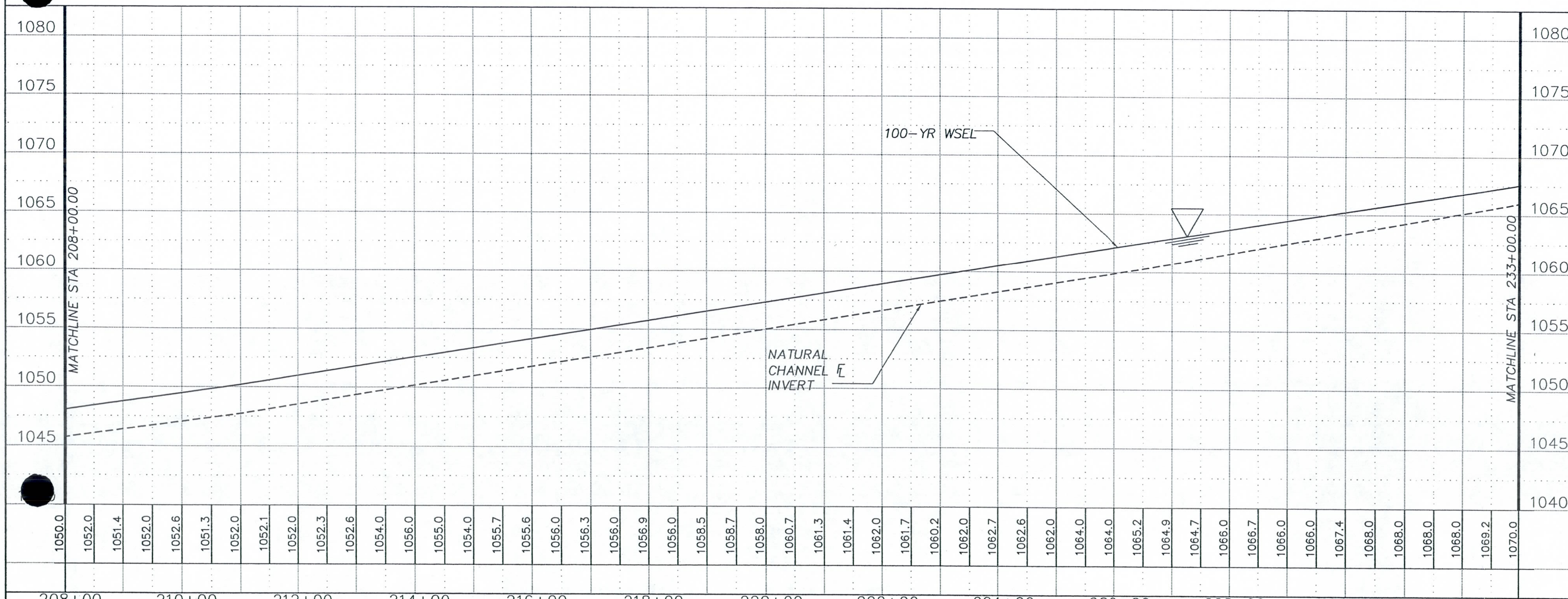
URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP8	STA 183+00.00 TO 208+00.00	- -



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

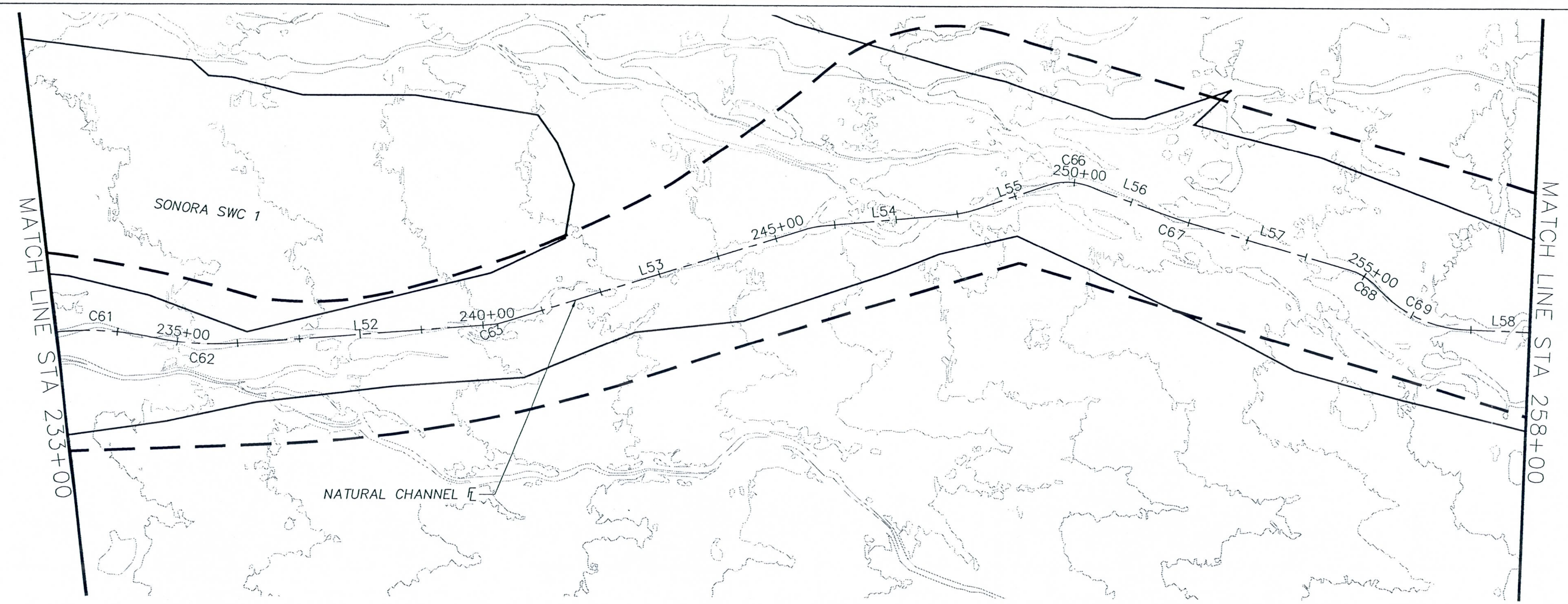
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

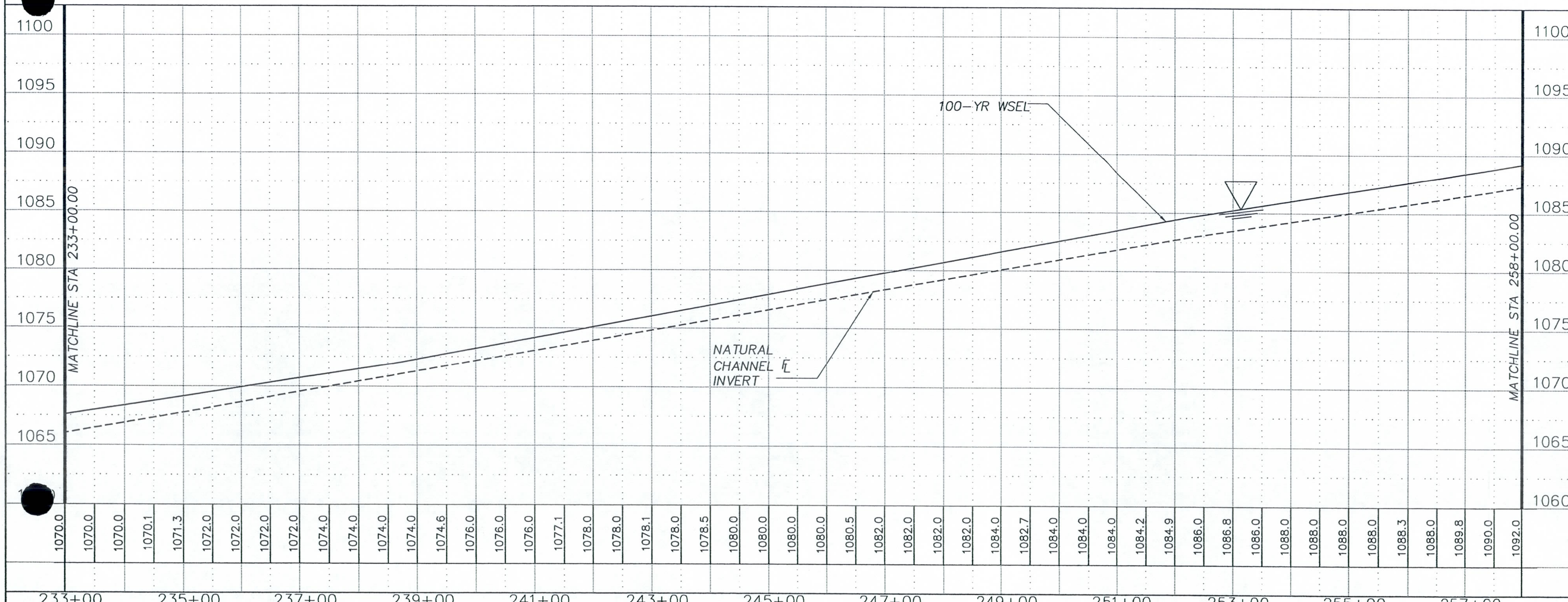
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP9	STA 208+00.00 TO 233+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP09-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

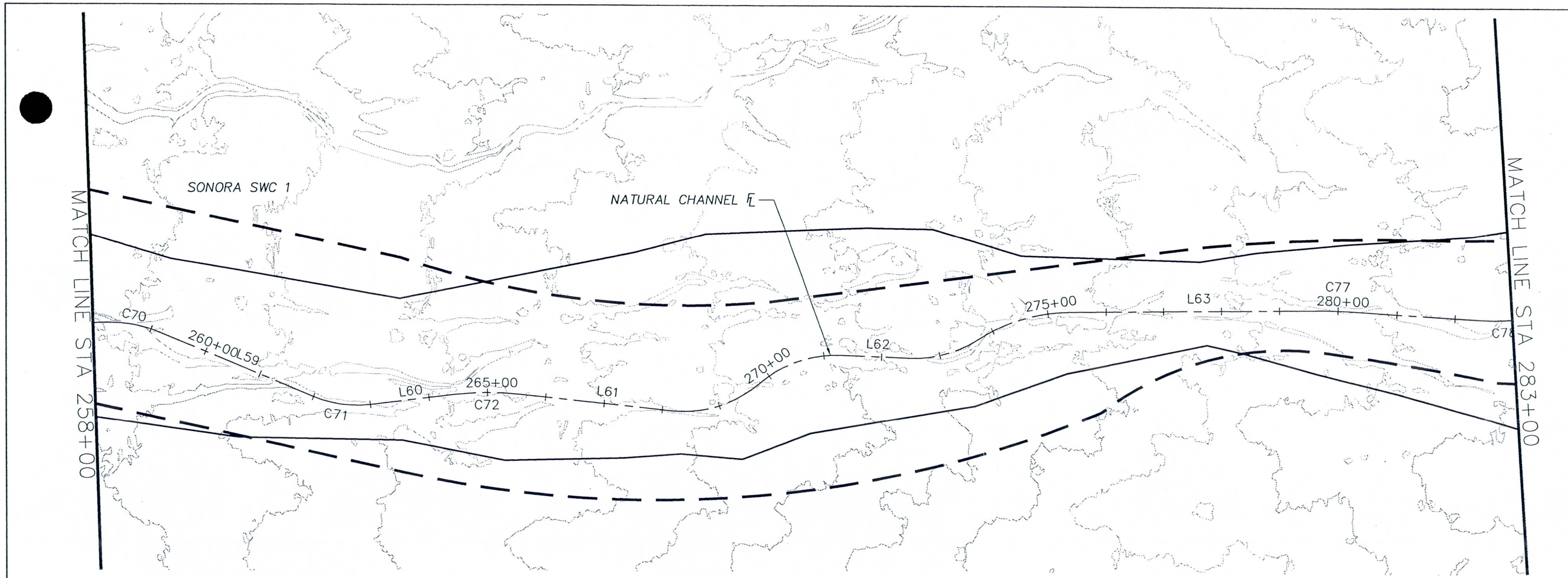
PRELIMINARY NOT FOR CONSTRUCTION

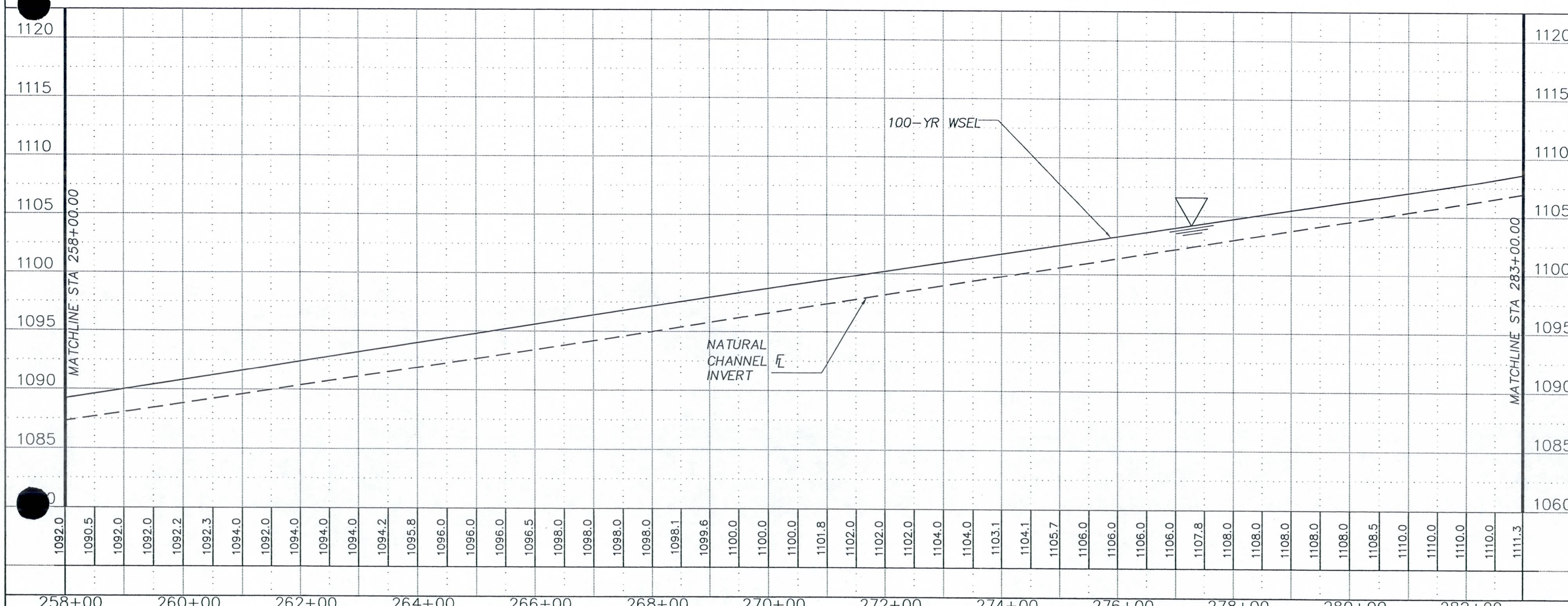
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP10	STA 233+00.00 TO 258+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP10-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP11-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

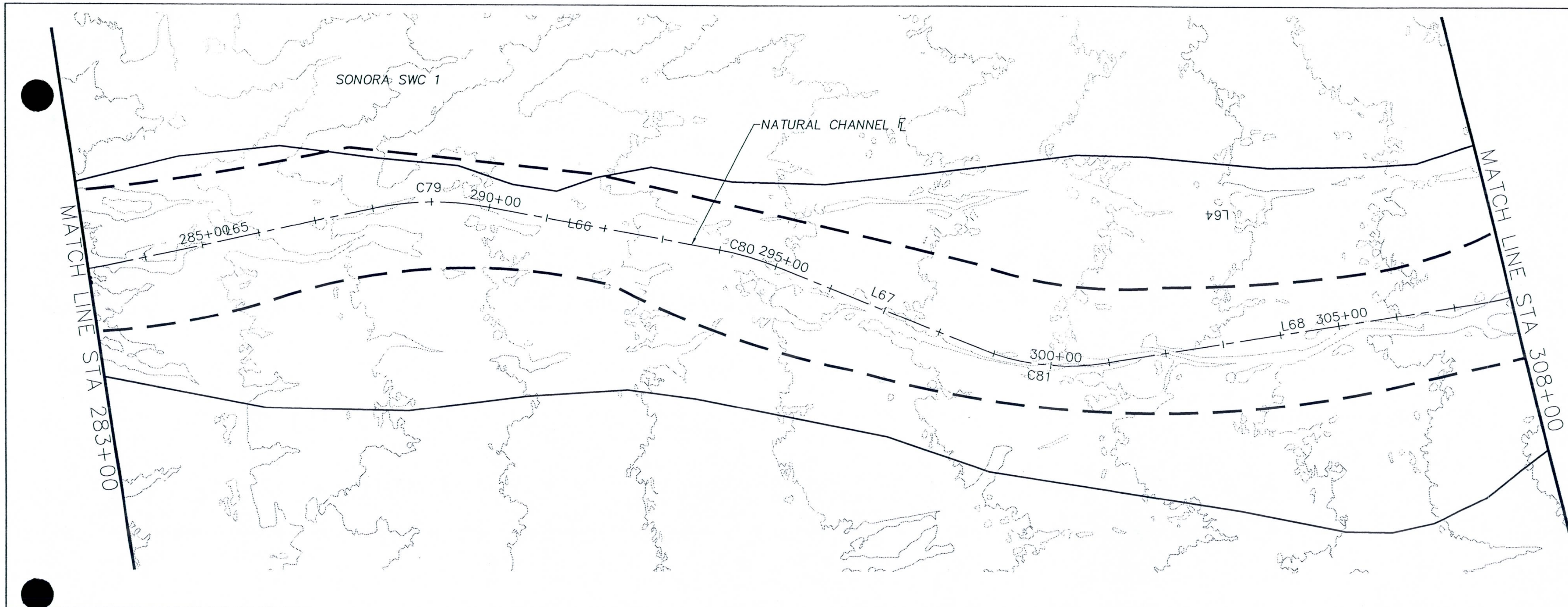
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

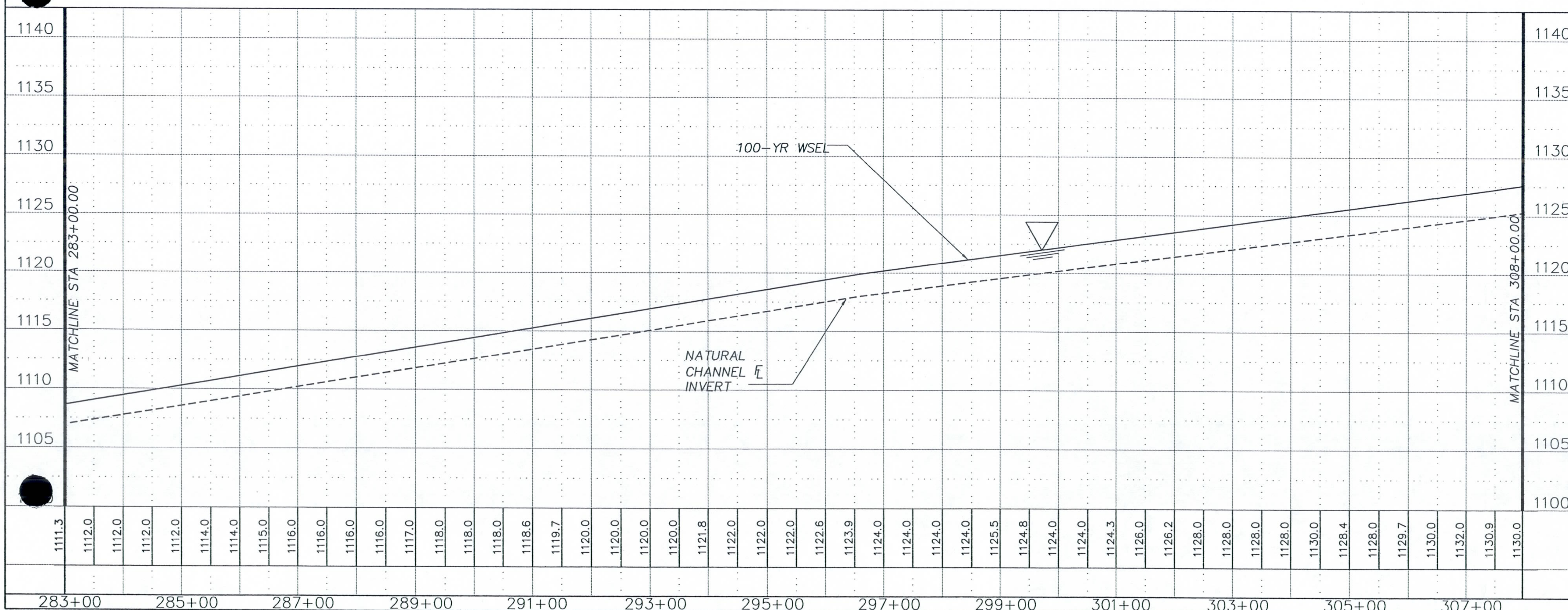
URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP11	PLAN AND PROFILE SHEET STA 258+00.00 TO 283+00.00	- -



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

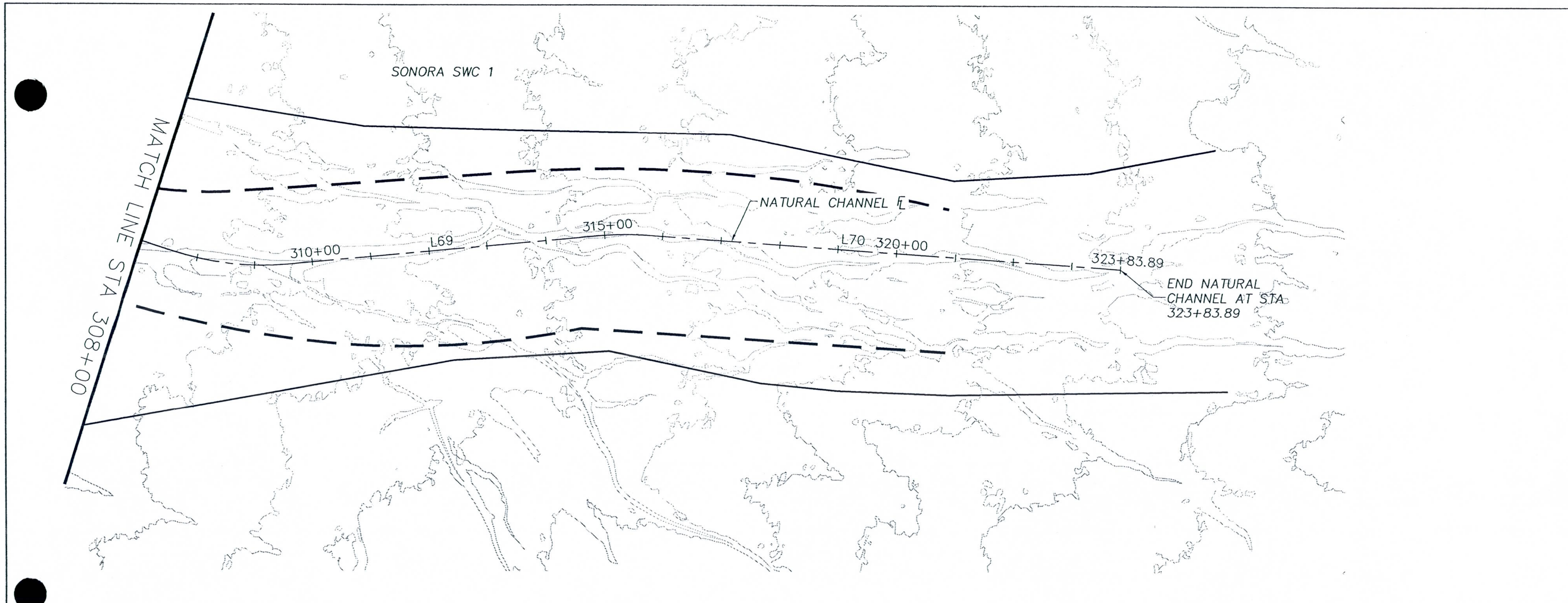
PRELIMINARY NOT FOR CONSTRUCTION

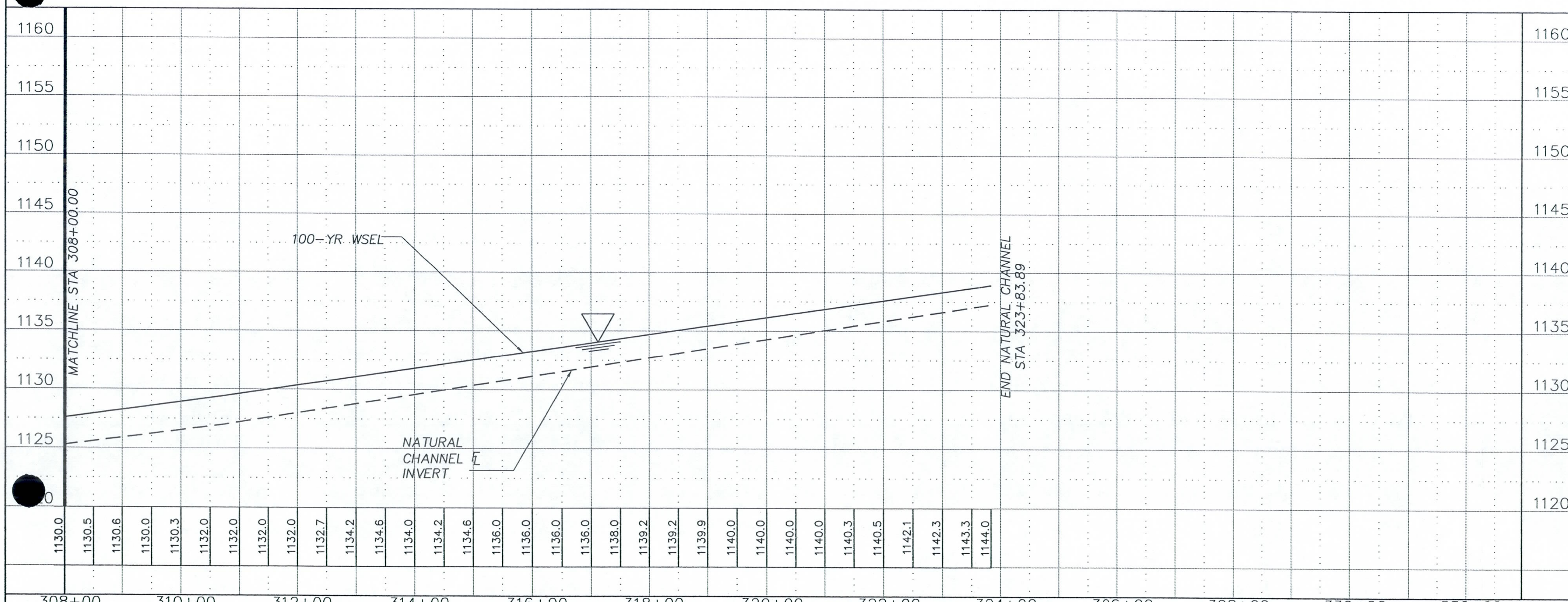
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP12	PLAN AND PROFILE SHEET STA 283+00.00 TO 308+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP12-REVA.dwg





LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

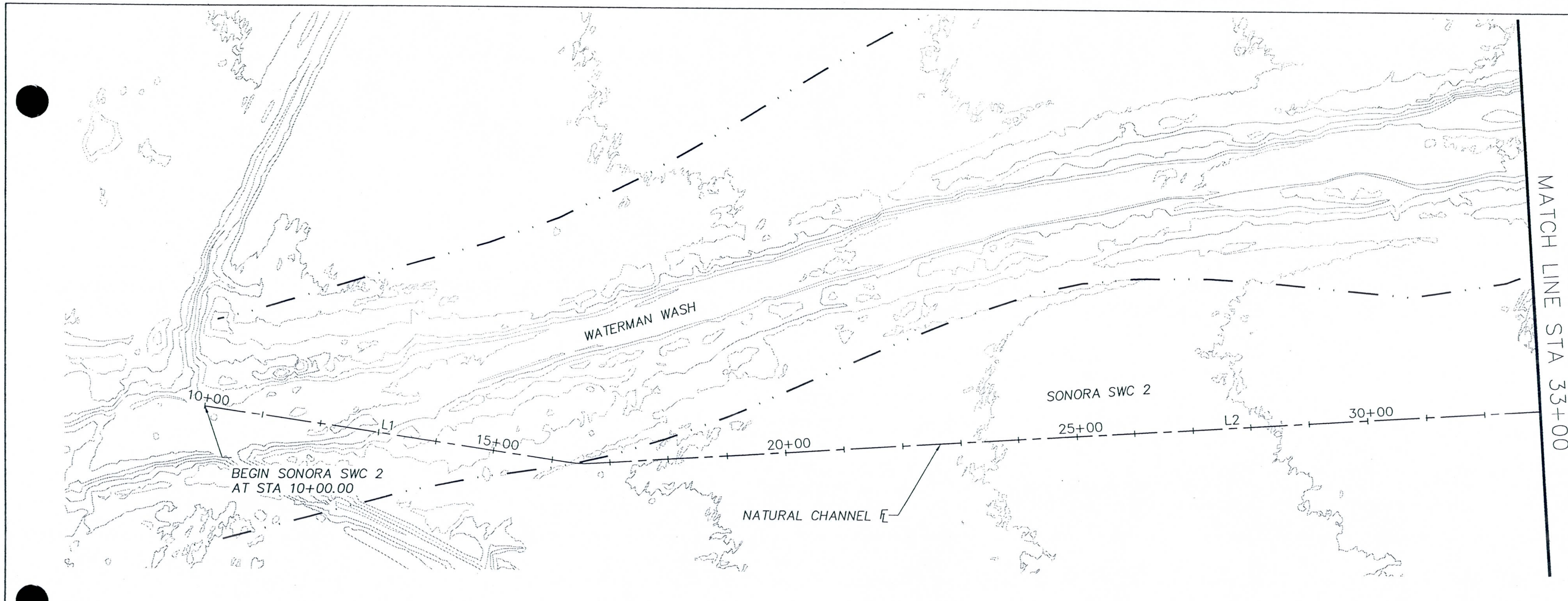
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 1

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04–2011
	DRAWN	JT	04–2011
	CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

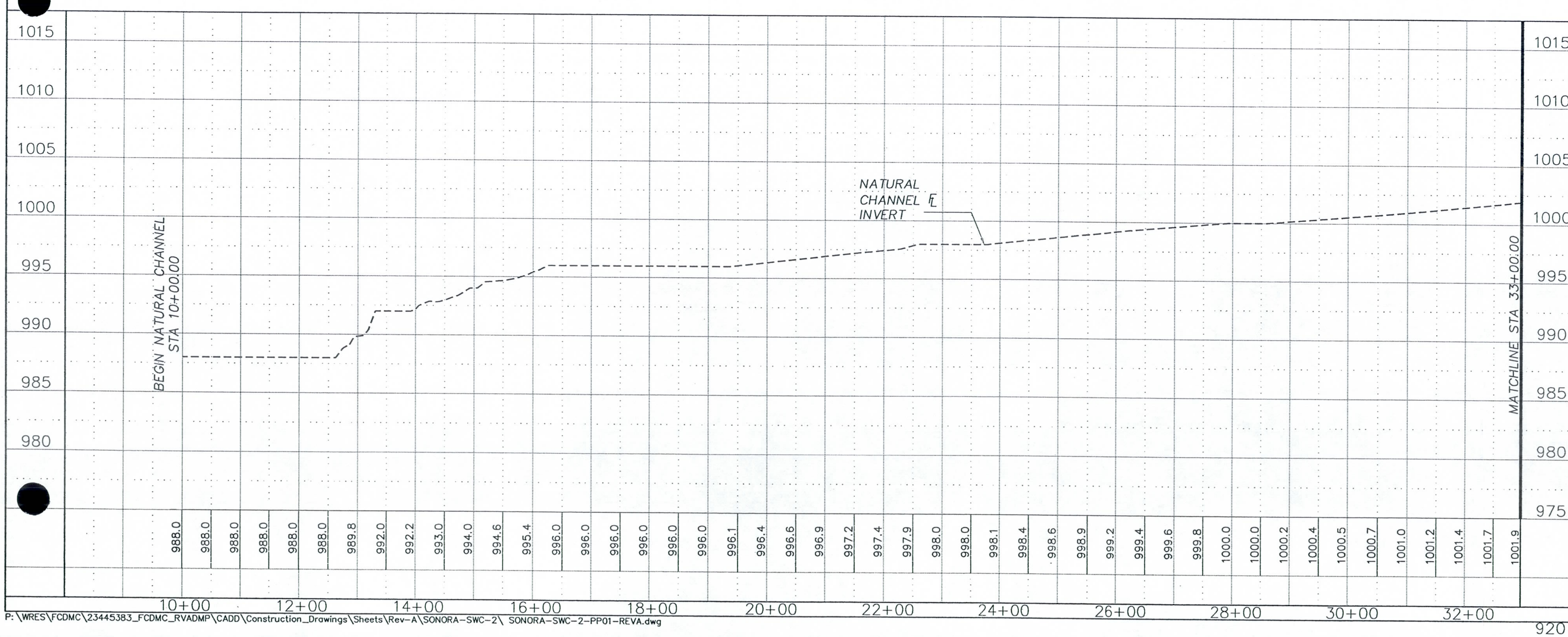
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP13	STA 308+00.00 TO 333+00.00	– –

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-1\ SONORA-SWC-1-PP13-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

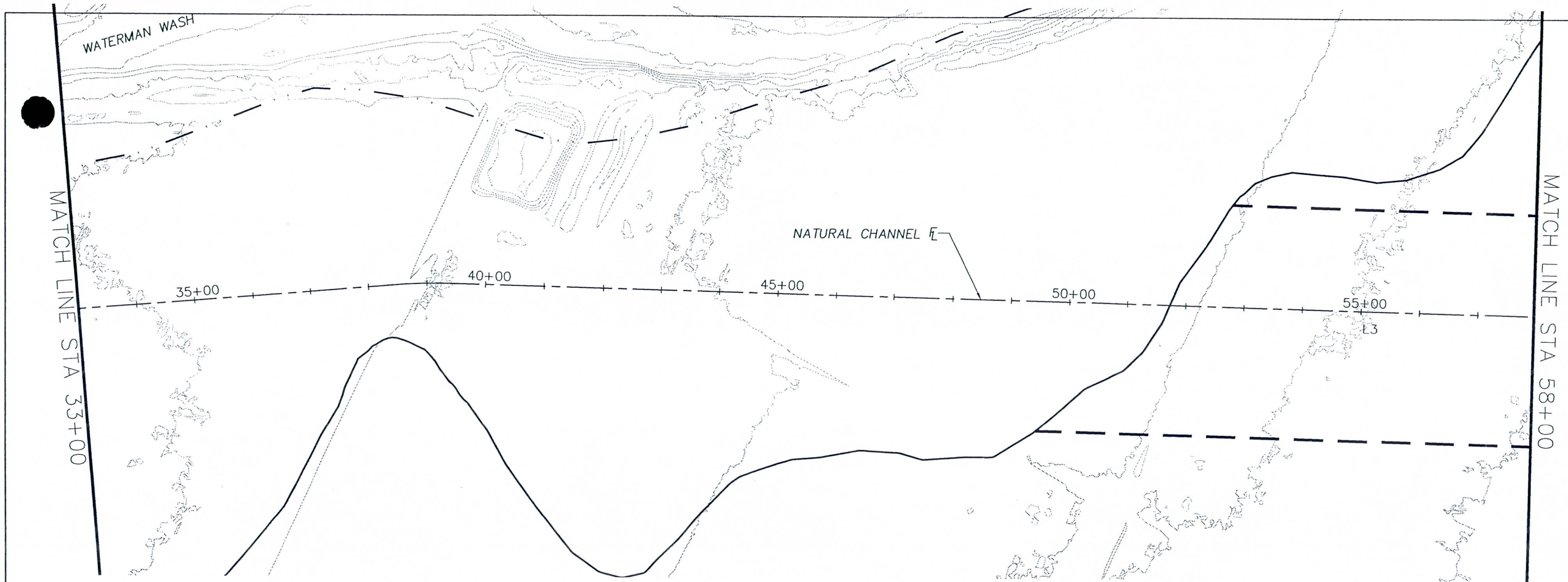
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

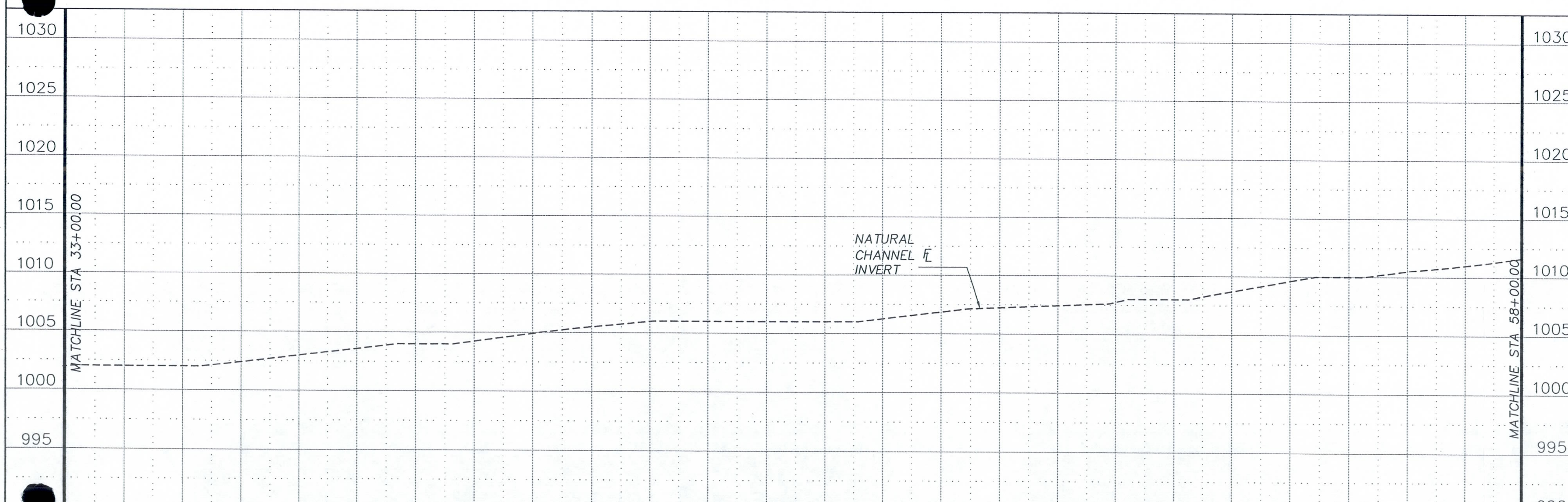
DRAWING NO.		SHEET OF
PP1	PLAN AND PROFILE SHEET STA 10+00.00 TO 33+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP01-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



1001.9 | 1002.0 | 1002.0 | 1002.0 | 1002.0 | 1002.1 | 1002.4 | 1002.7 | 1003.0 | 1003.3 | 1003.6 | 1003.9 | 1004.0 | 1004.0 | 1004.2 | 1004.6 | 1004.9 | 1005.2 | 1005.5 | 1005.7 | 1006.0 | 1006.0 | 1006.0 | 1006.0 | 1006.0 | 1006.0 | 1006.0 | 1006.0 | 1006.3 | 1006.6 | 1006.9 | 1007.1 | 1007.2 | 1007.3 | 1007.4 | 1007.5 | 1007.7 | 1008.0 | 1008.0 | 1008.2 | 1008.7 | 1009.2 | 1009.6 | 1010.0 | 1010.0 | 1010.2 | 1010.5 | 1010.7 | 1011.0 | 1011.3 | 1011.6

33+00 35+00 37+00 39+00 41+00 43+00 45+00 47+00 49+00 51+00 53+00 55+00 57+00

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

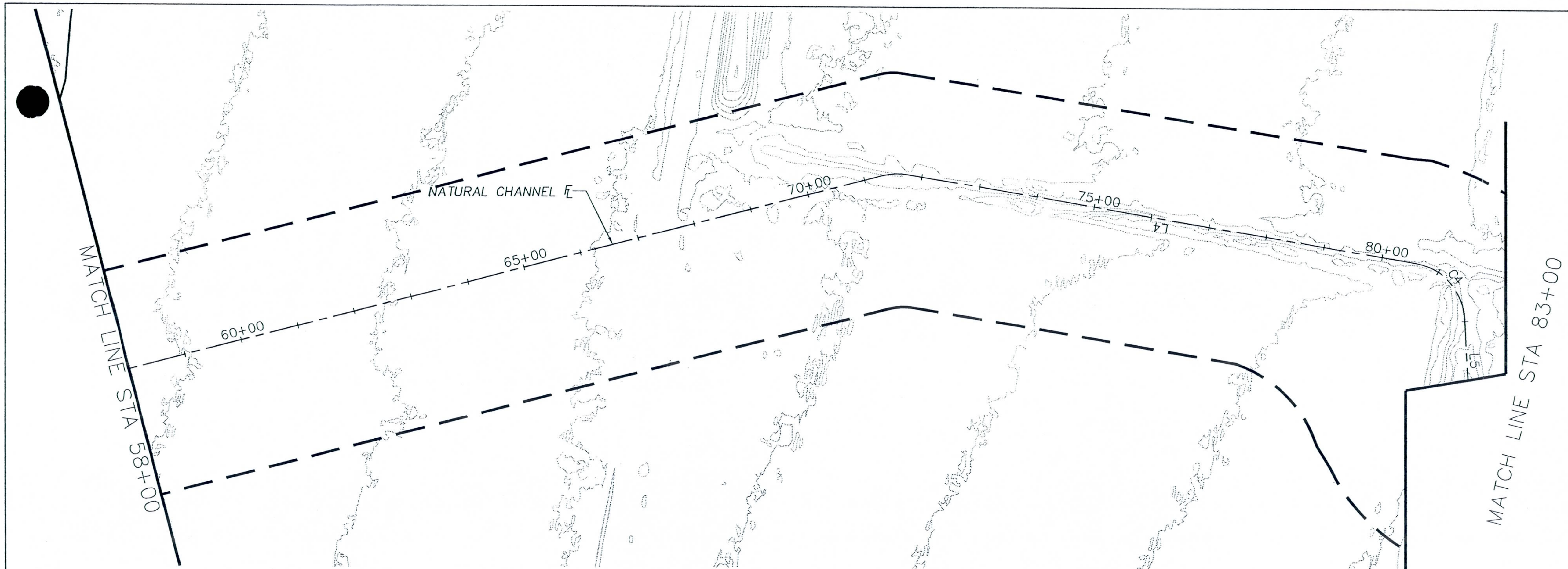
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP2	STA 33+00.00 TO 58+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP02-REVA.dwg

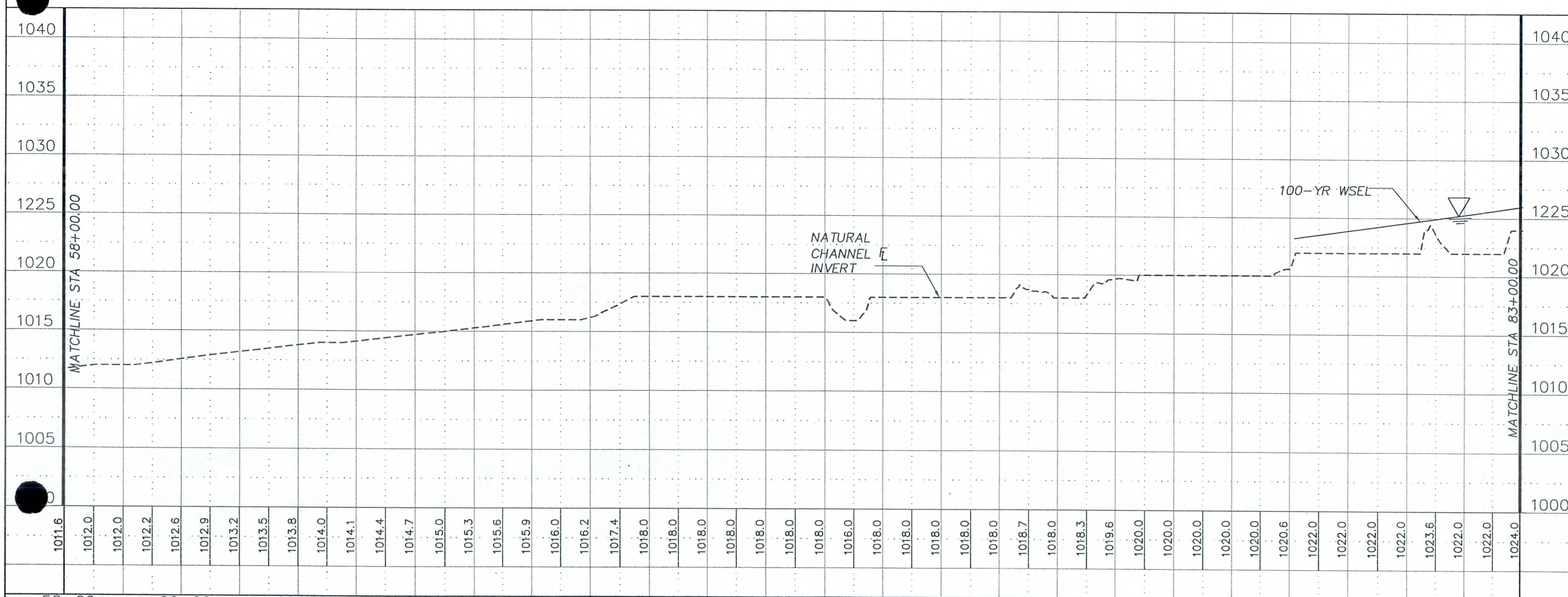


LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
A	15% CONCEPTUAL DESIGN SUBMITTAL	MM	07-2010

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

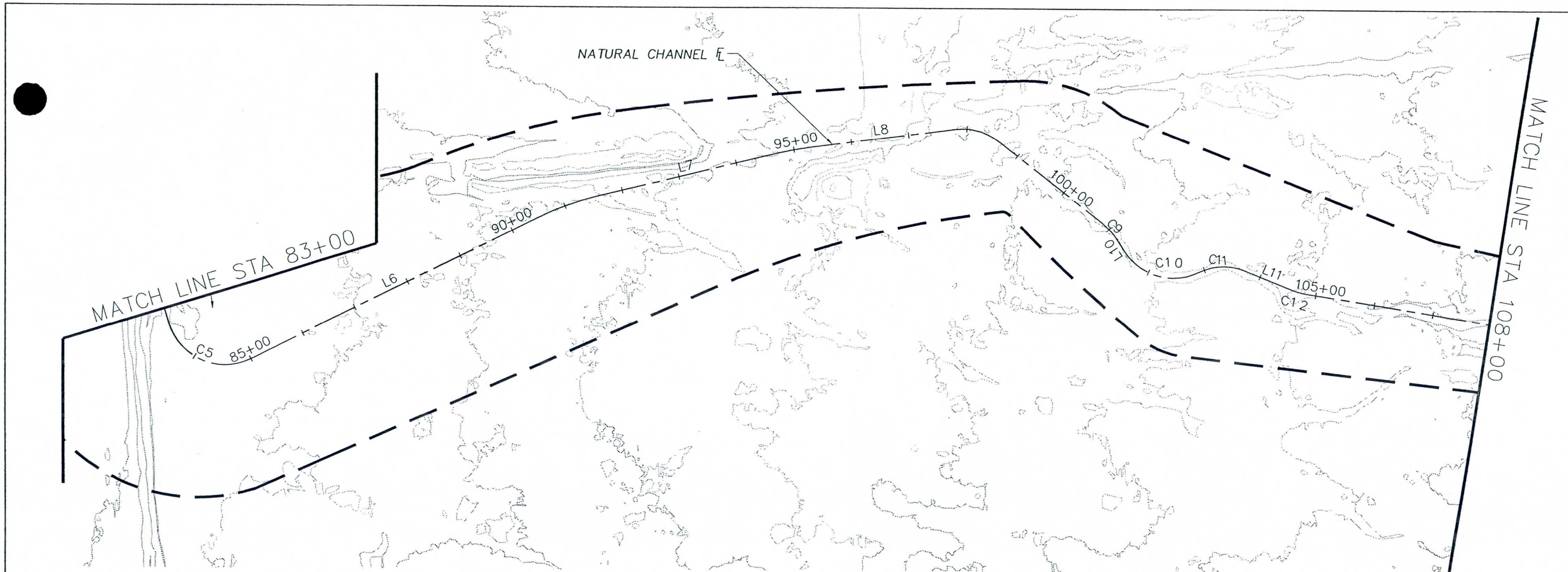
PRELIMINARY NOT FOR CONSTRUCTION

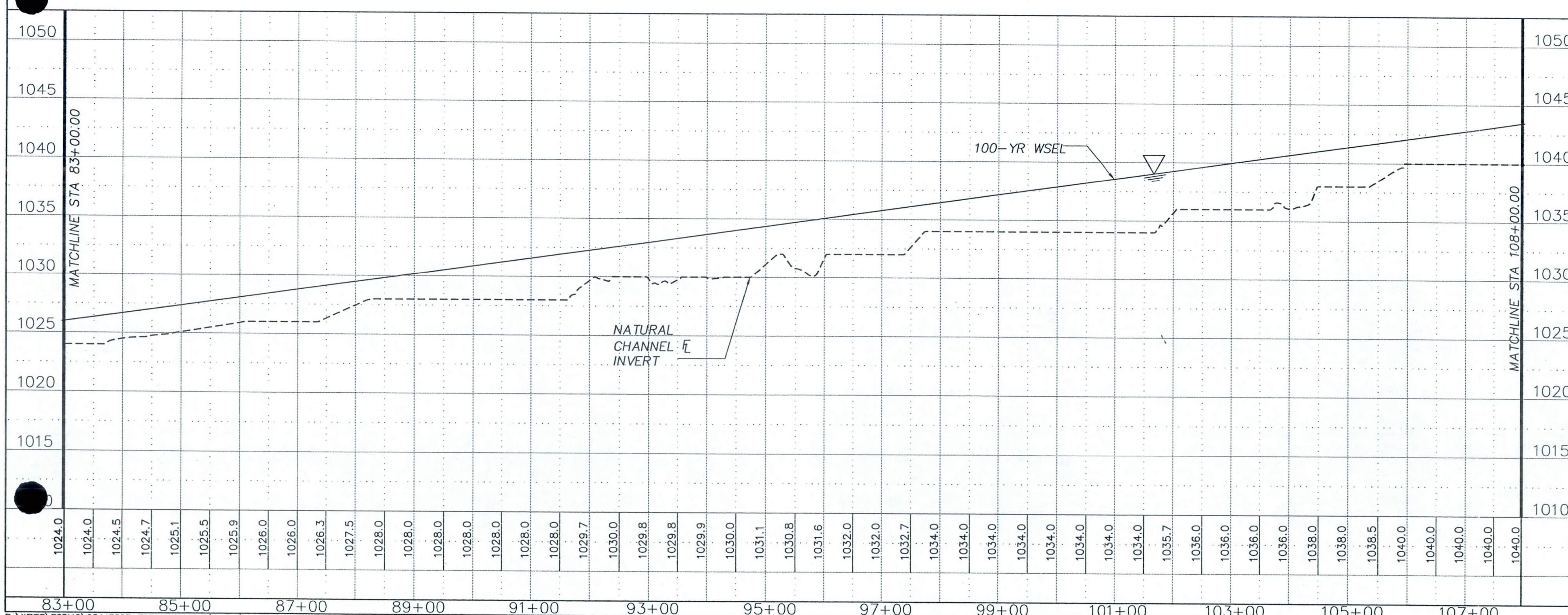
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP3	STA 58+00.00 TO 83+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP03-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP04-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

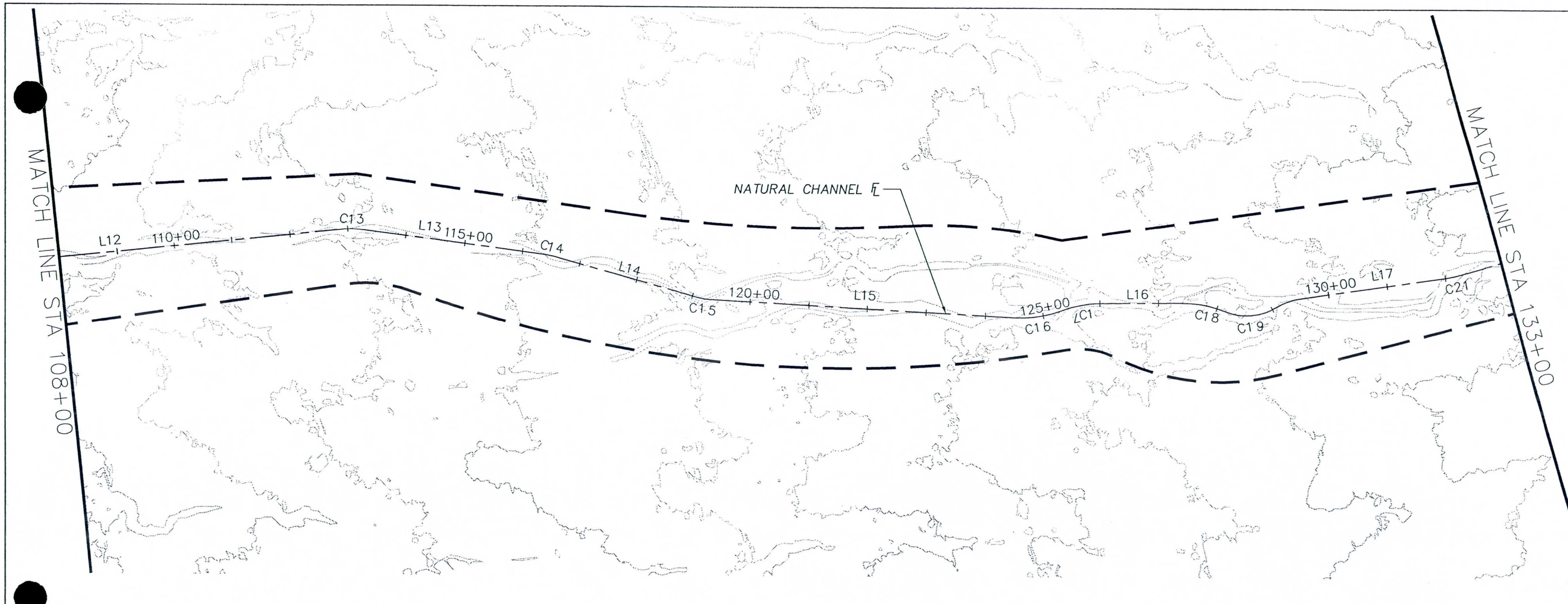
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

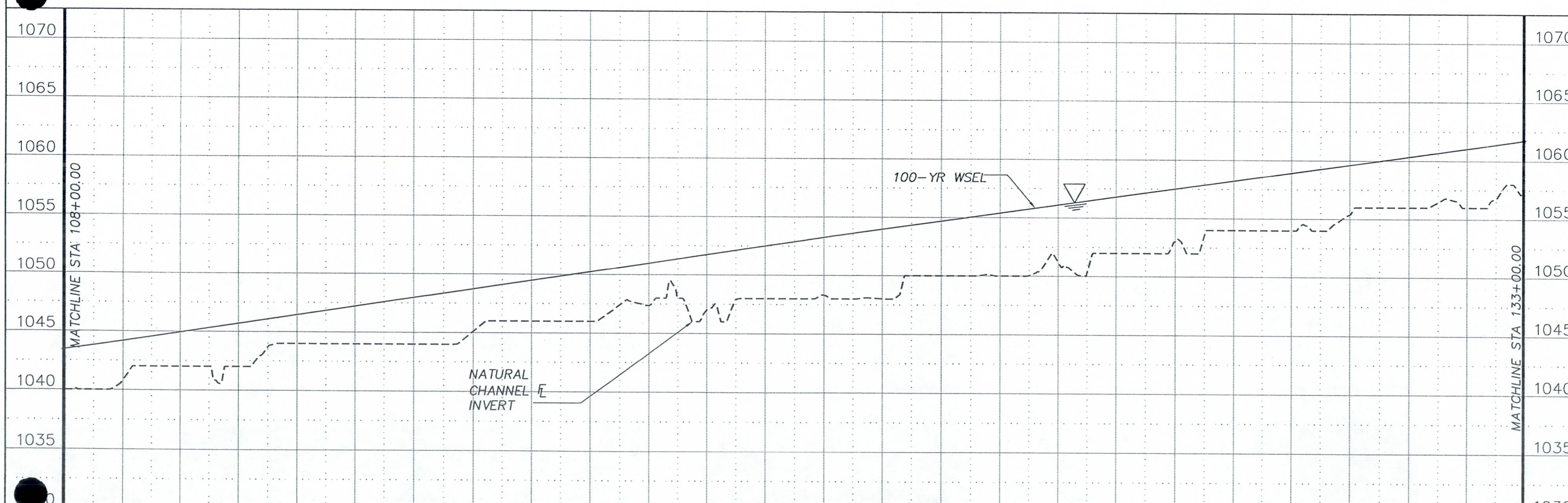
URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP4	PLAN AND PROFILE SHEET STA 83+00.00 TO 108+00.00	- -



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



1040.0	1040.0	1040.8	1042.0	1042.0	1042.0	1042.0	1043.7	1044.0	1044.0	1044.0	1044.0	1044.0	1044.0	1045.1	1046.0	1046.0	1046.0	1046.0	1047.4	1047.4	1048.0	1047.0	1047.9	1048.0	1048.0	1048.3	1048.0	1048.0	1050.0	1050.0	1050.0	1050.0	1050.0	1051.2	1050.4	1052.0	1052.0	1053.0	1053.6	1054.0	1054.0	1054.0	1054.0	1055.4	1056.0	1056.0	1056.5	1056.0	1056.7	1057.9

108+00 110+00 112+00 114+00 116+00 118+00 120+00 122+00 124+00 126+00 128+00 130+00 132+00

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP05-REVA.dwg

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

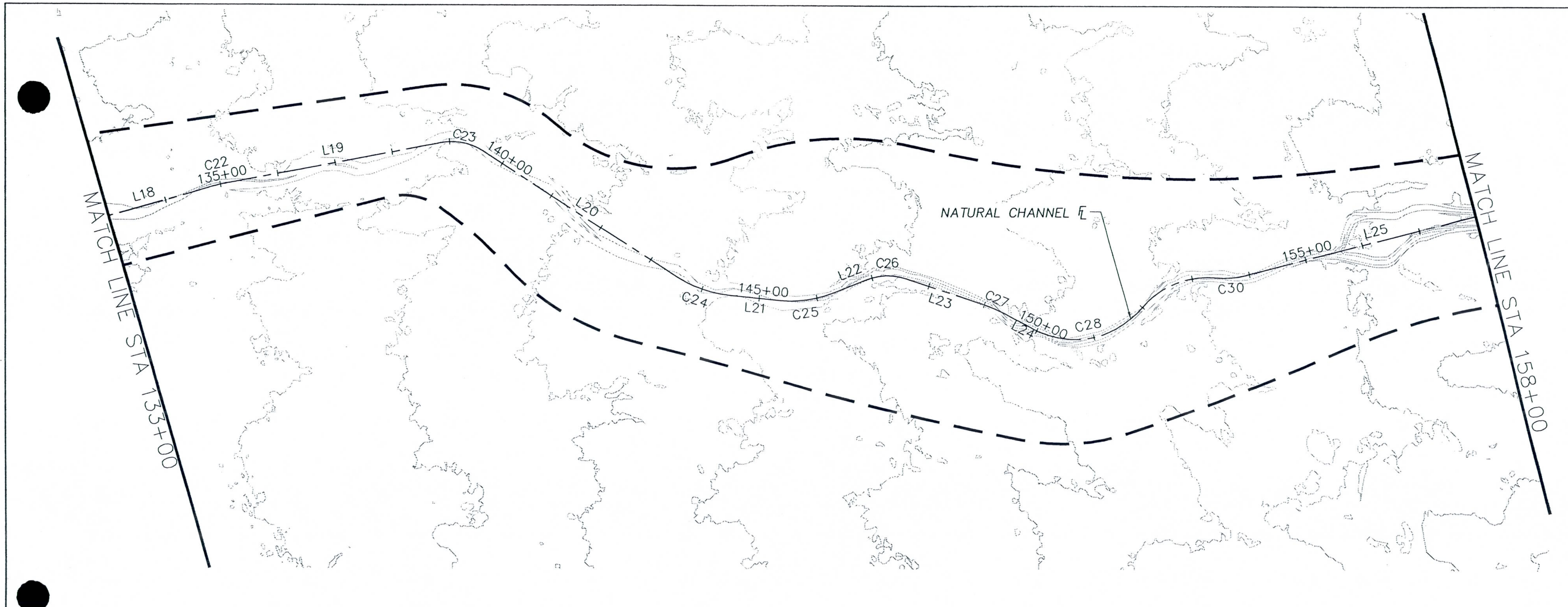
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

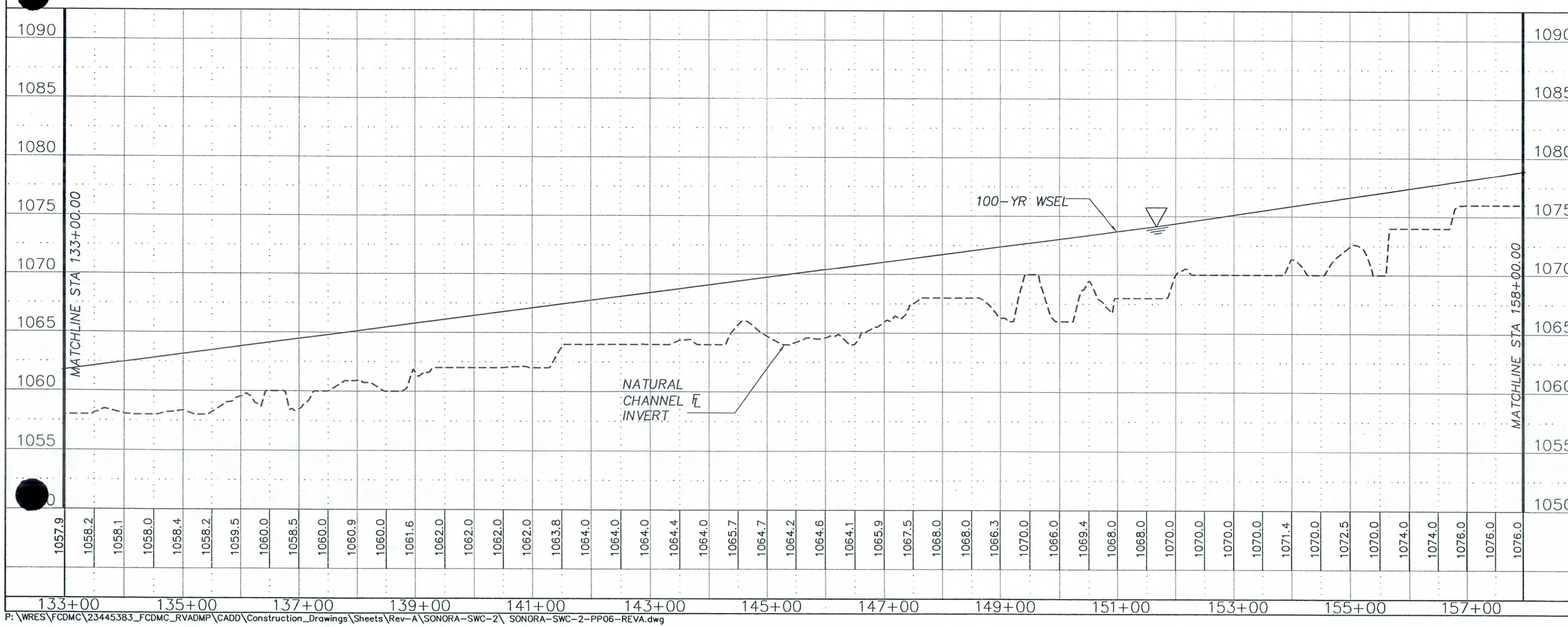
URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP5	PLAN AND PROFILE SHEET STA 108+00.00 TO 133+00.00	- -



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

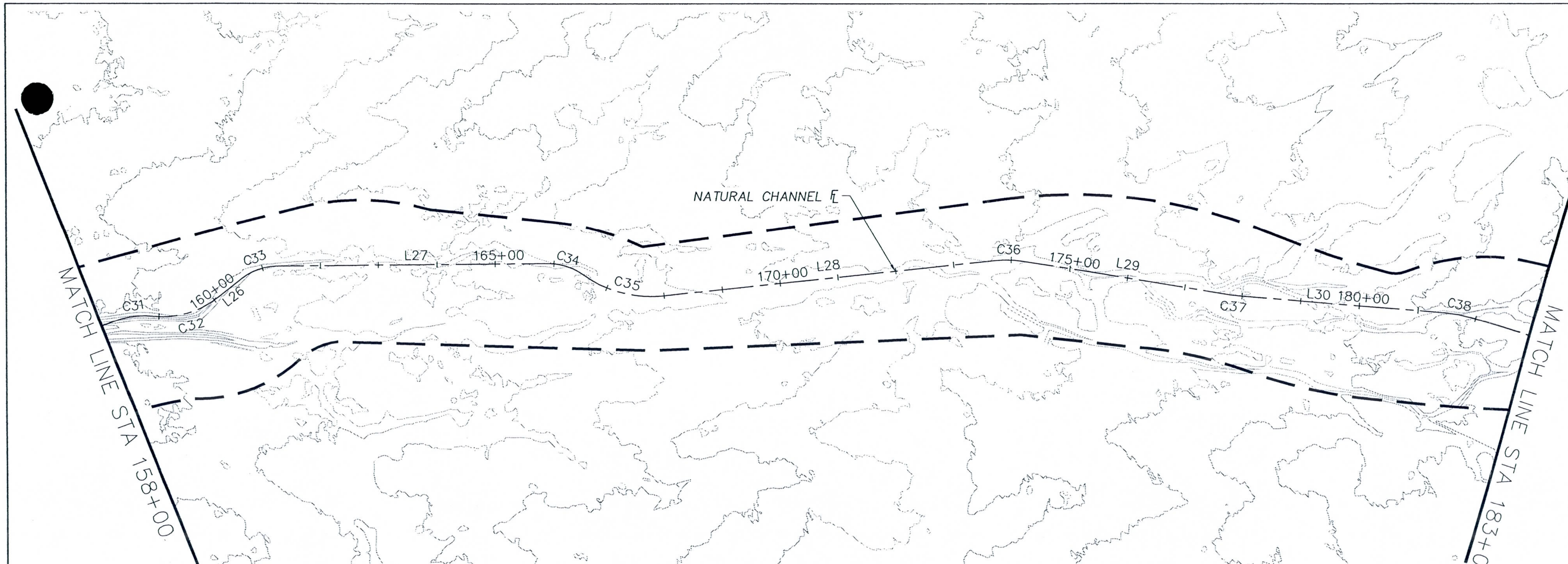
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

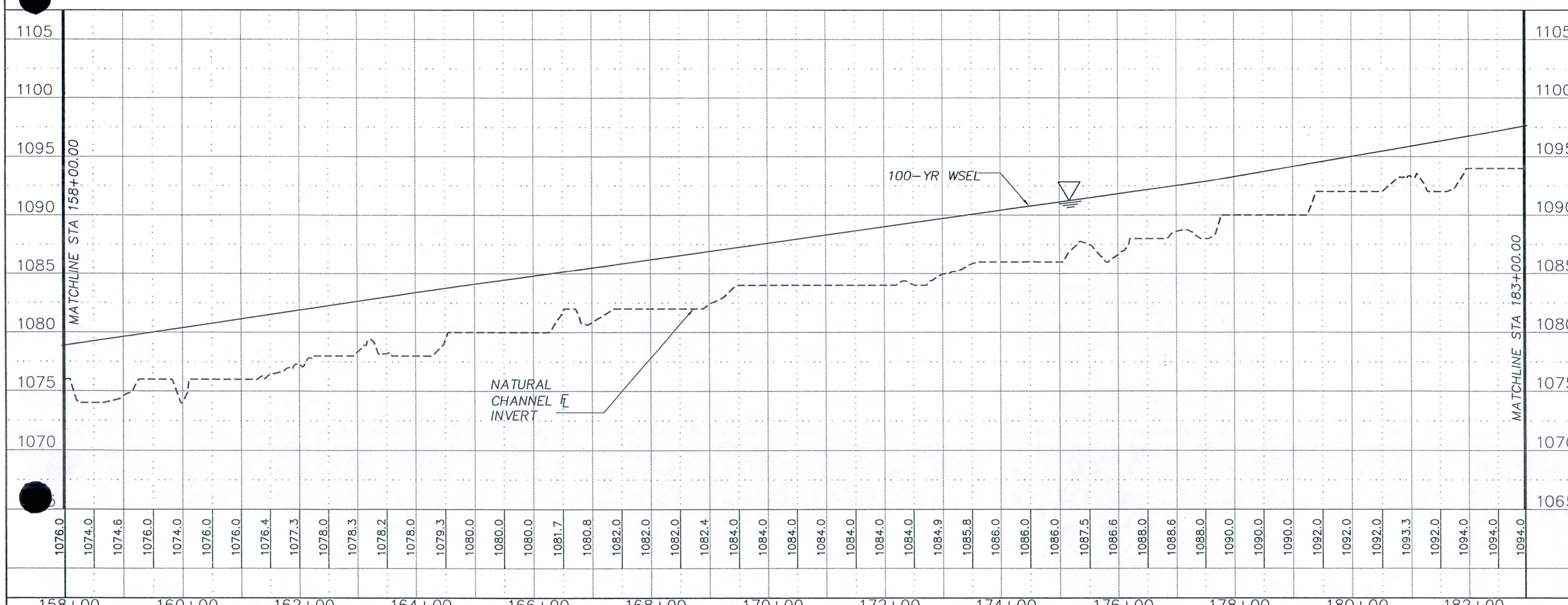
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP6	STA 133+00.00 TO 158+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP06-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

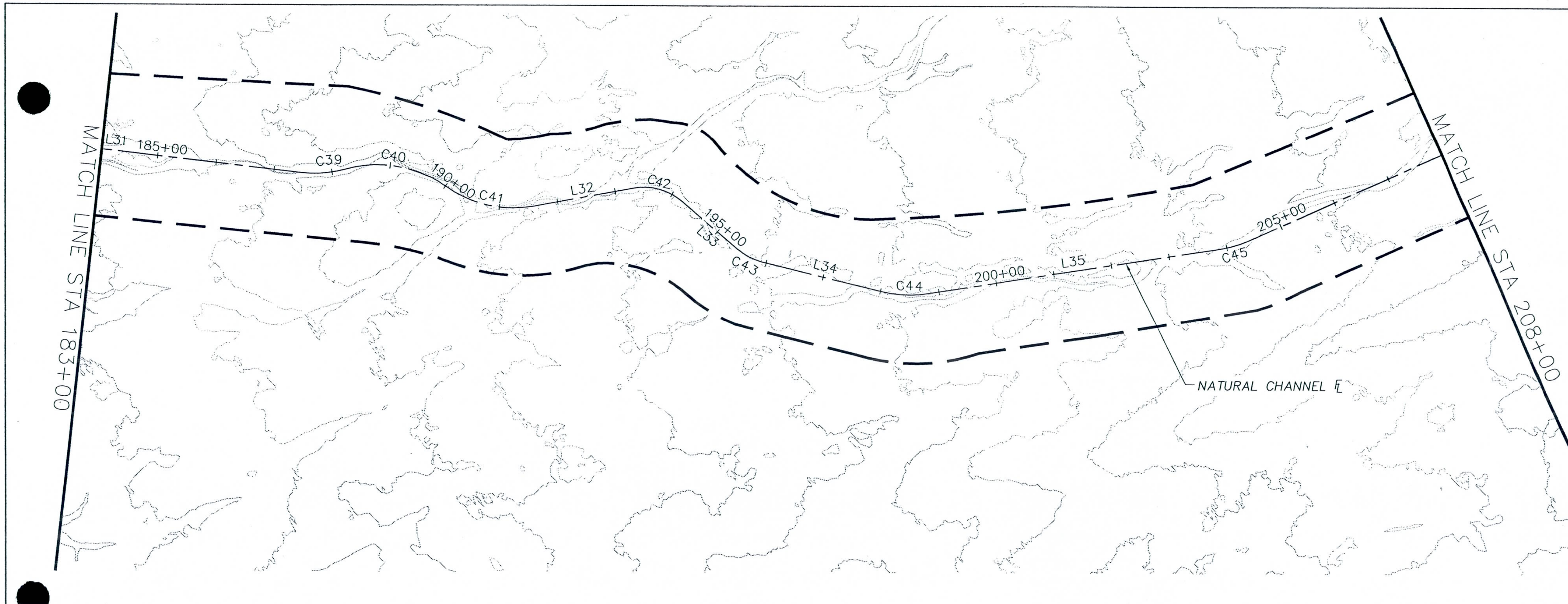
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04–2011
	DRAWN	JT	04–2011
	CHECKED	ES	04–2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

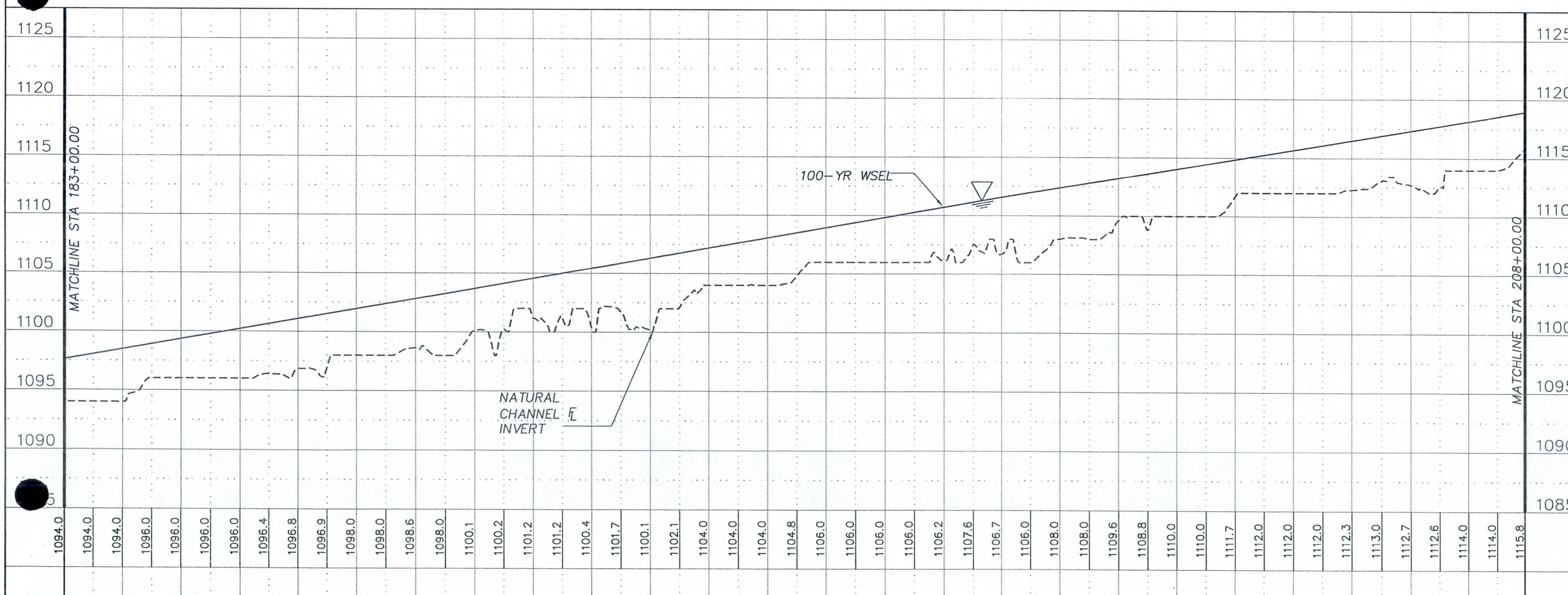
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP7	STA 158+00.00 TO 160+39.88	– -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP07-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

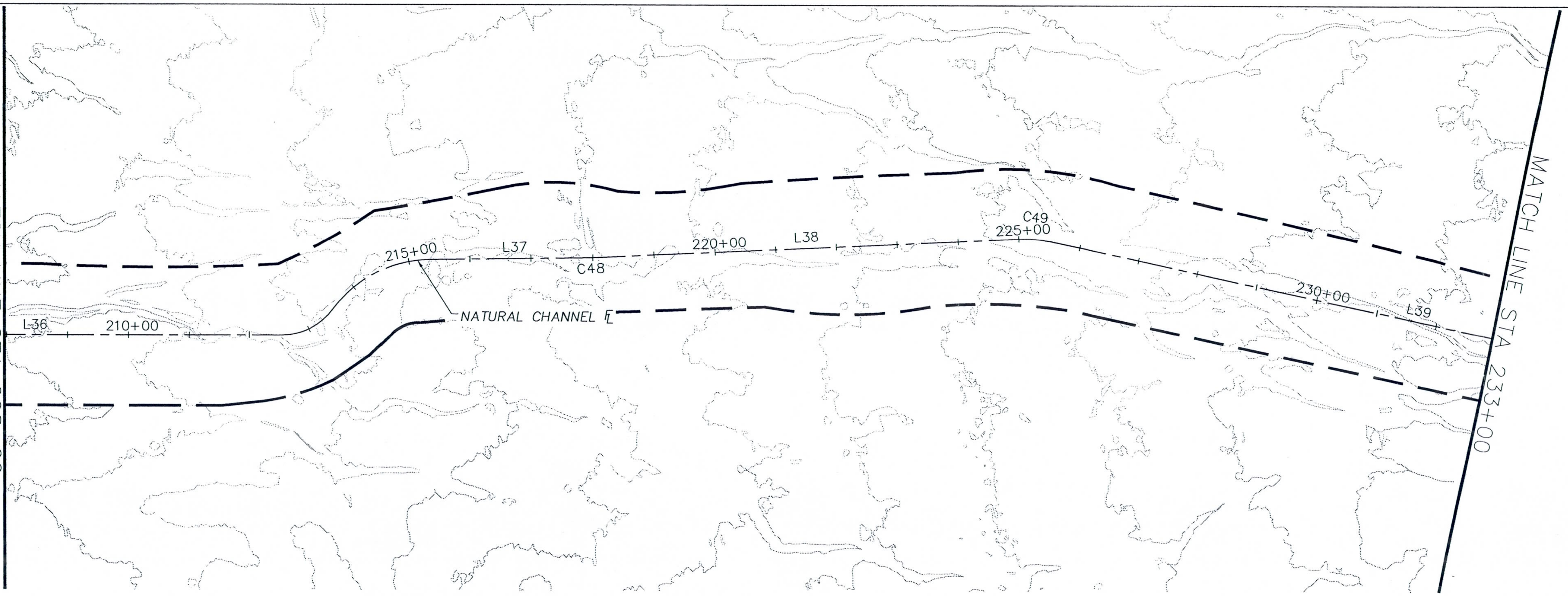
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

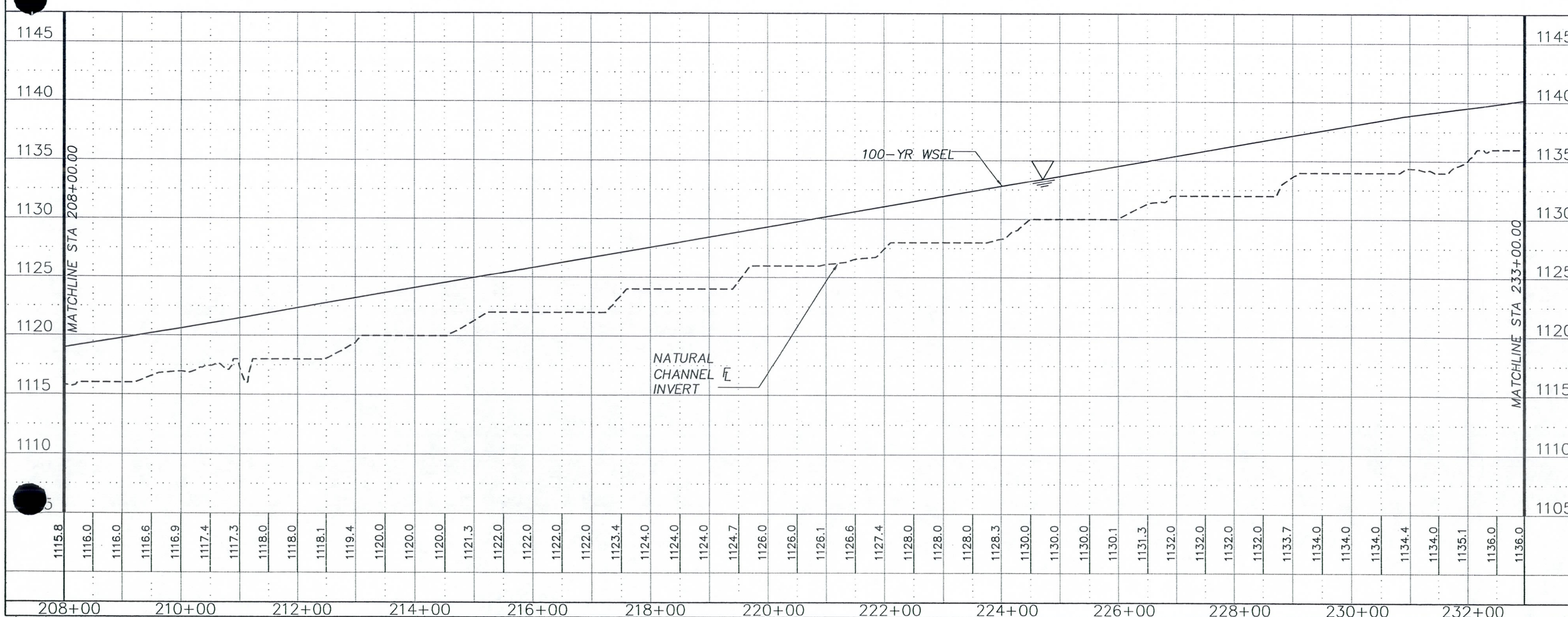
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP8	PLAN AND PROFILE SHEET STA 183+00.00 TO 208+00.00	- -





LEGEND

FLOODPLAIN LIMITS

FLOODWAY LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

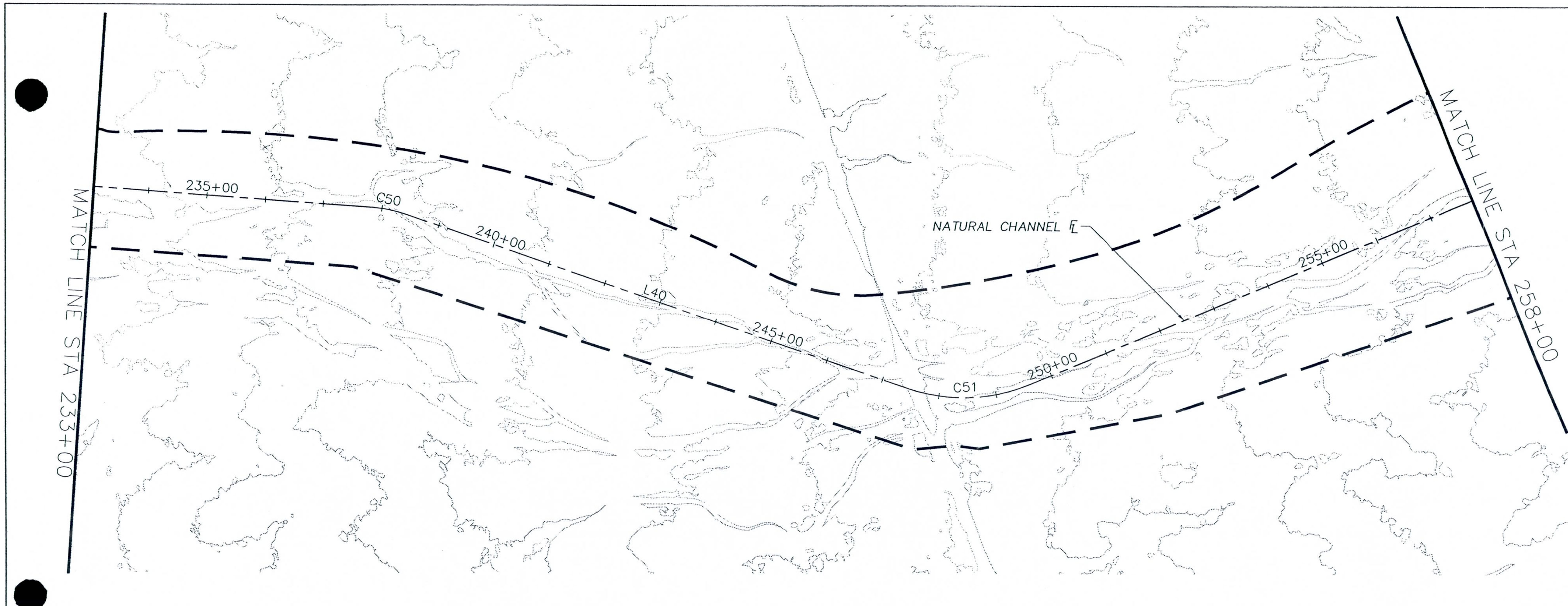
PRELIMINARY NOT FOR CONSTRUCTION

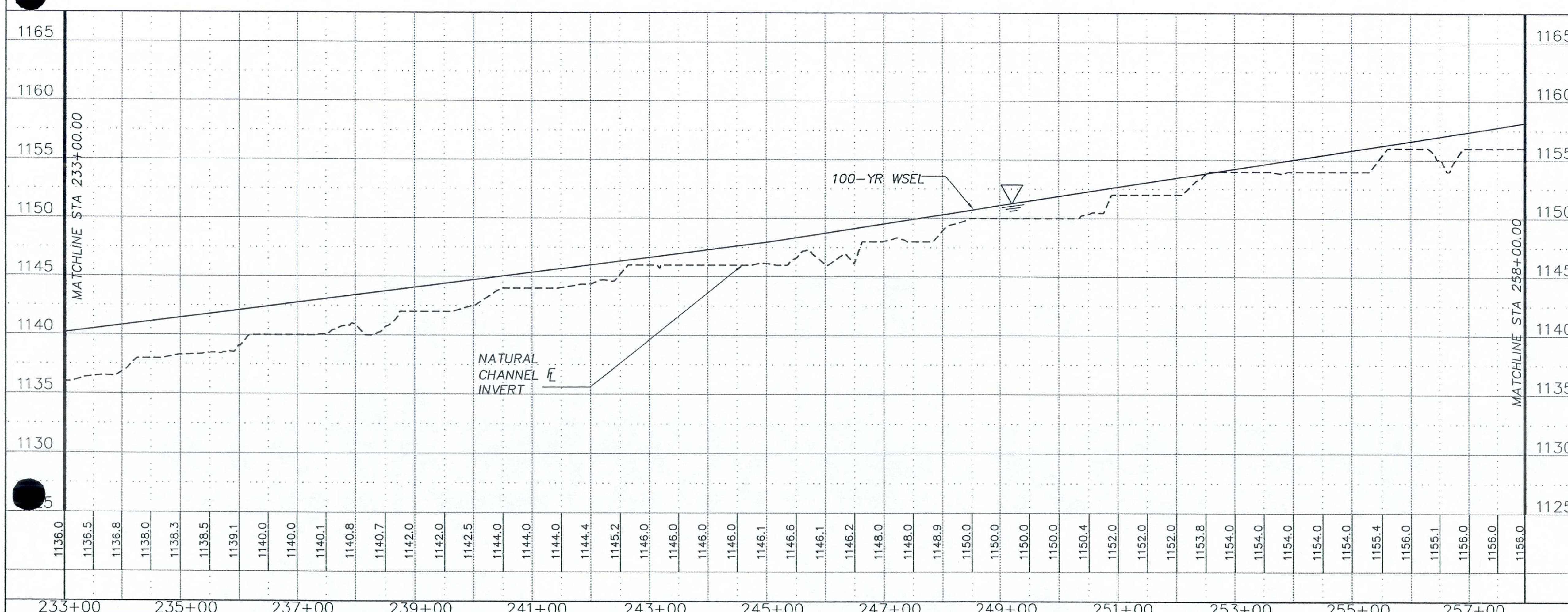
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP9	STA 208+00.00 TO 233+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP09-REVA.dwg





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP10-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

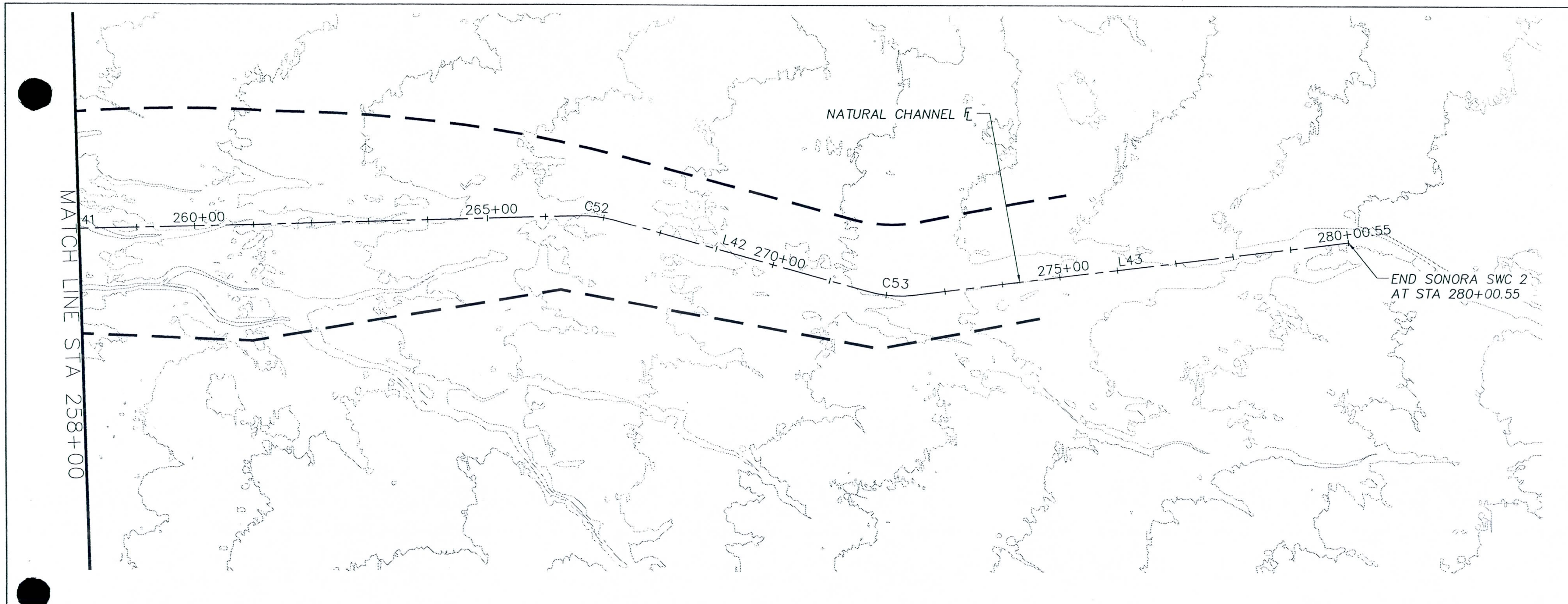
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

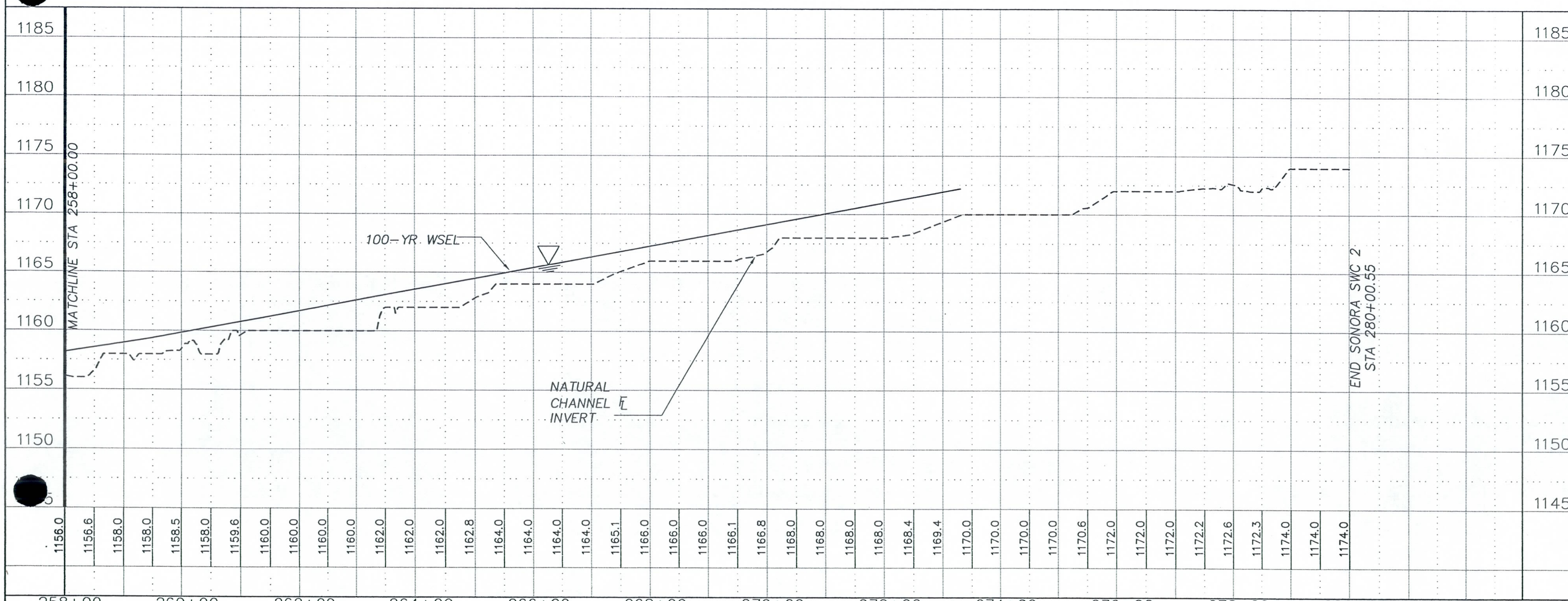
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP10	STA 233+00.00 TO 258+00.00	- -





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-2\ SONORA-SWC-2-PP11-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

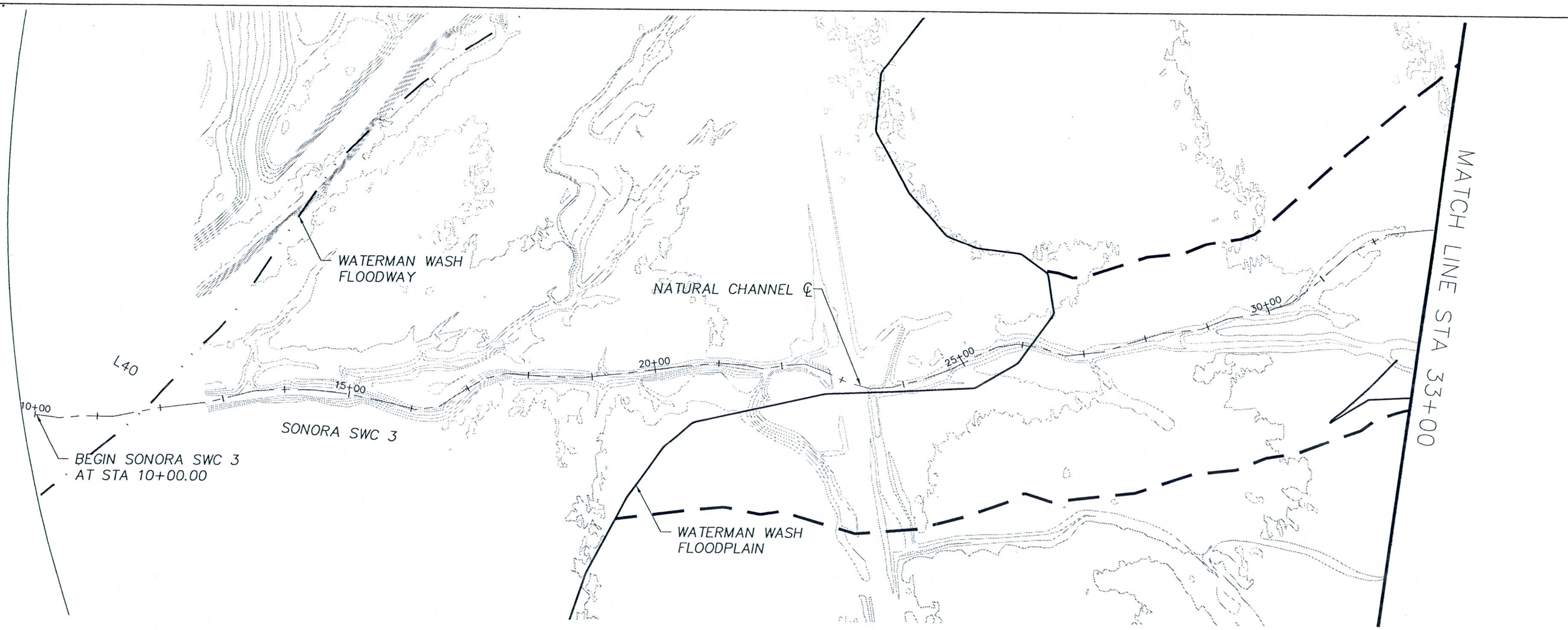
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 2

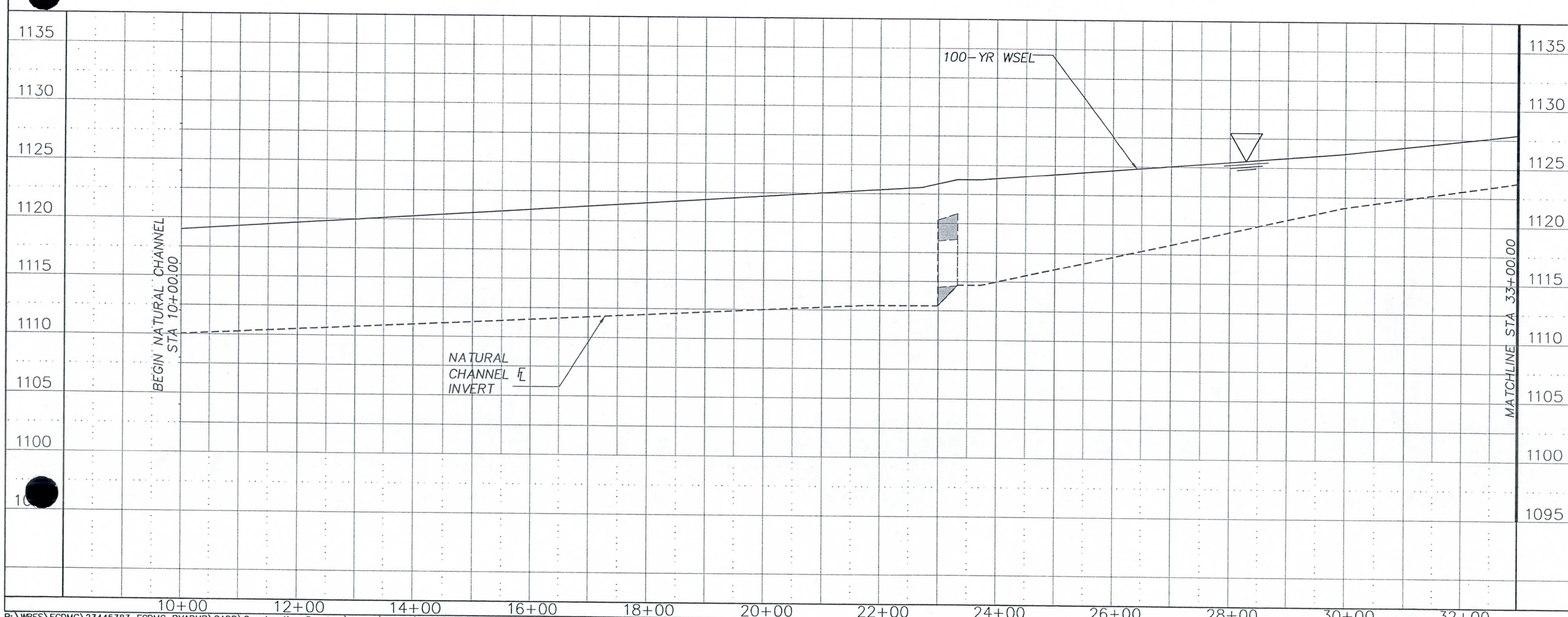
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP11	STA 258+00.00 TO 283+00.00	- -





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-3\ SONORA-SWC-3-PP01-REVA.dwg

LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

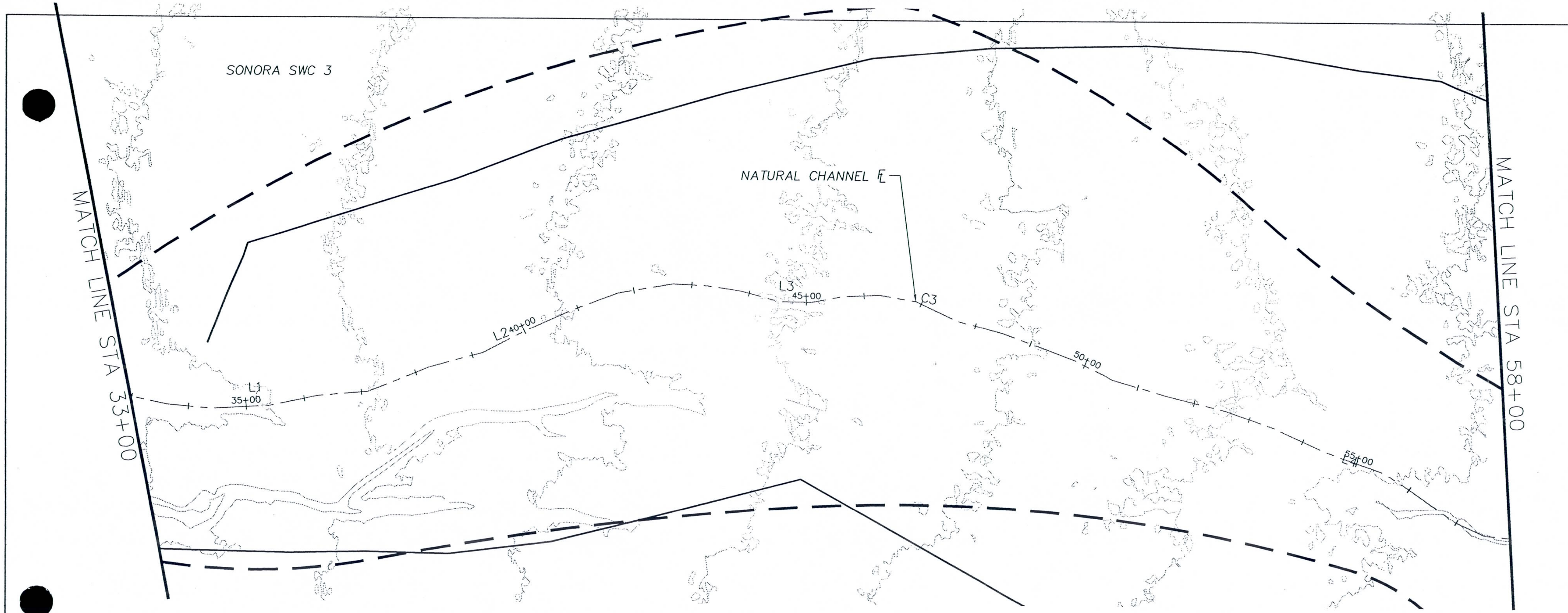
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

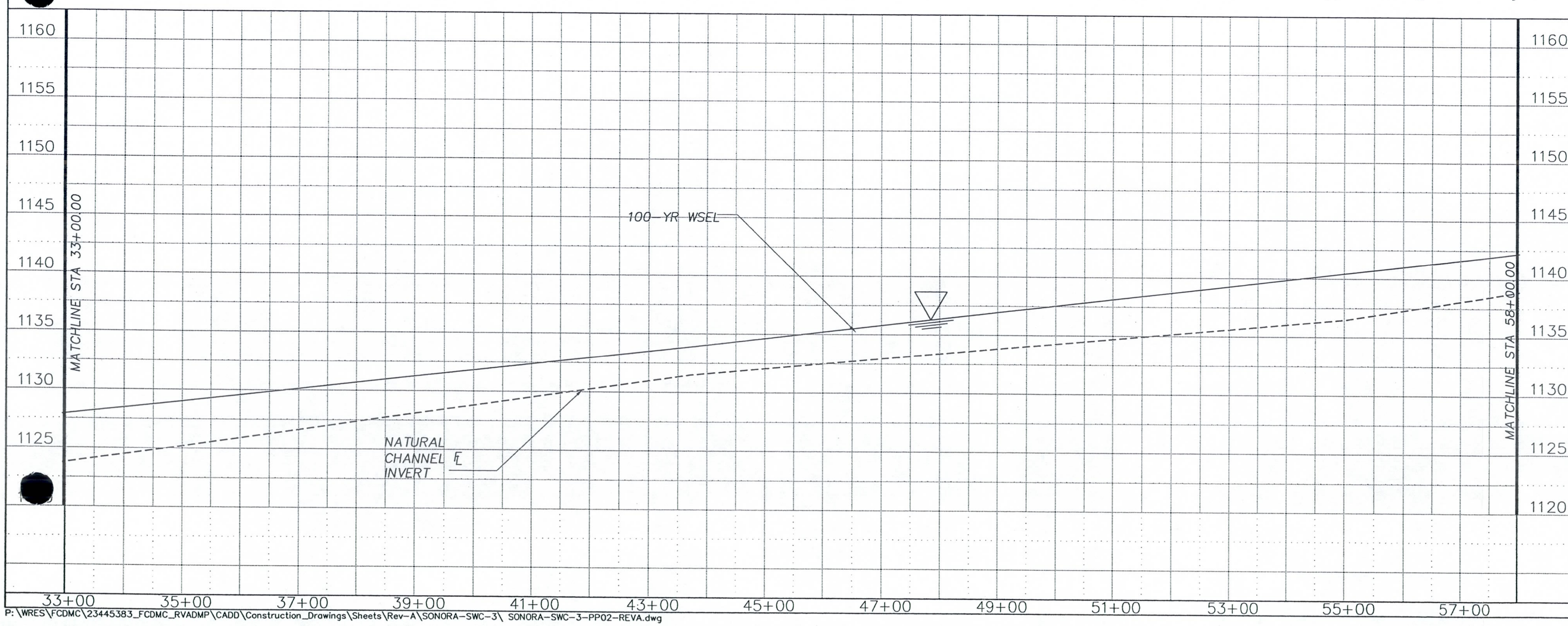
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 3

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP1	STA 10+00.00 TO 33+00.00	- -





P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-3\ SONORA-SWC-3-PP02-REVA.dwg

LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

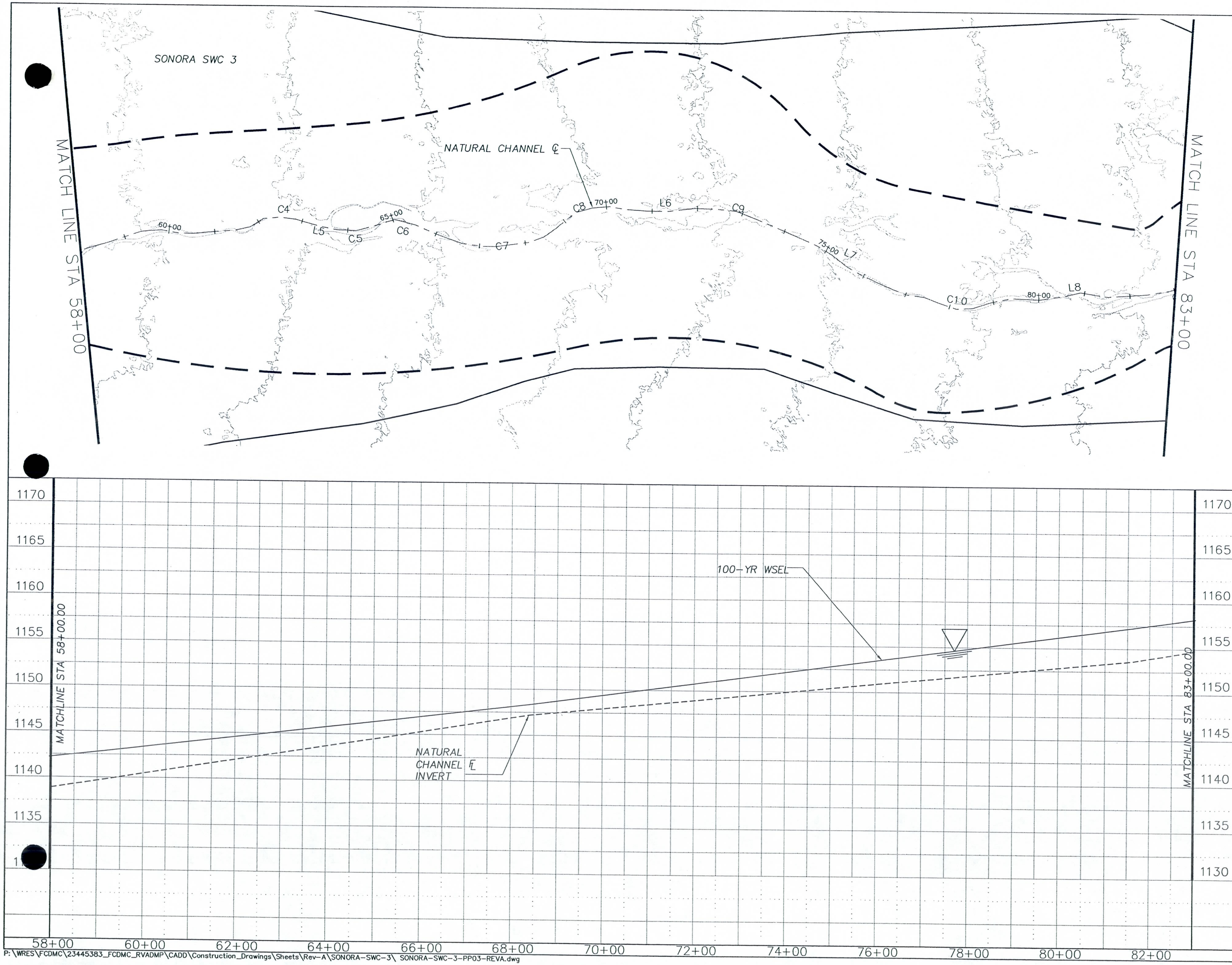
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 3

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04-2011
	DRAWN	JT	04-2011
	CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP2	STA 33+00.00 TO 58+00.00	- -



LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 3

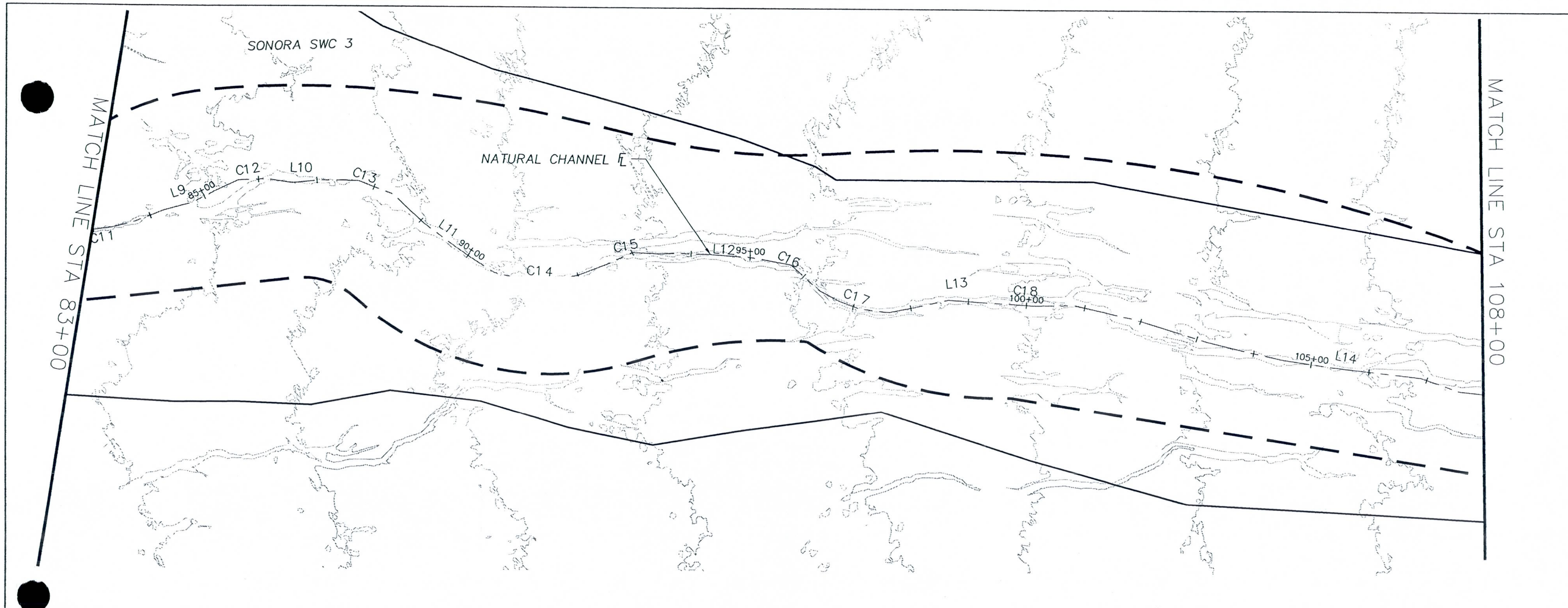
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

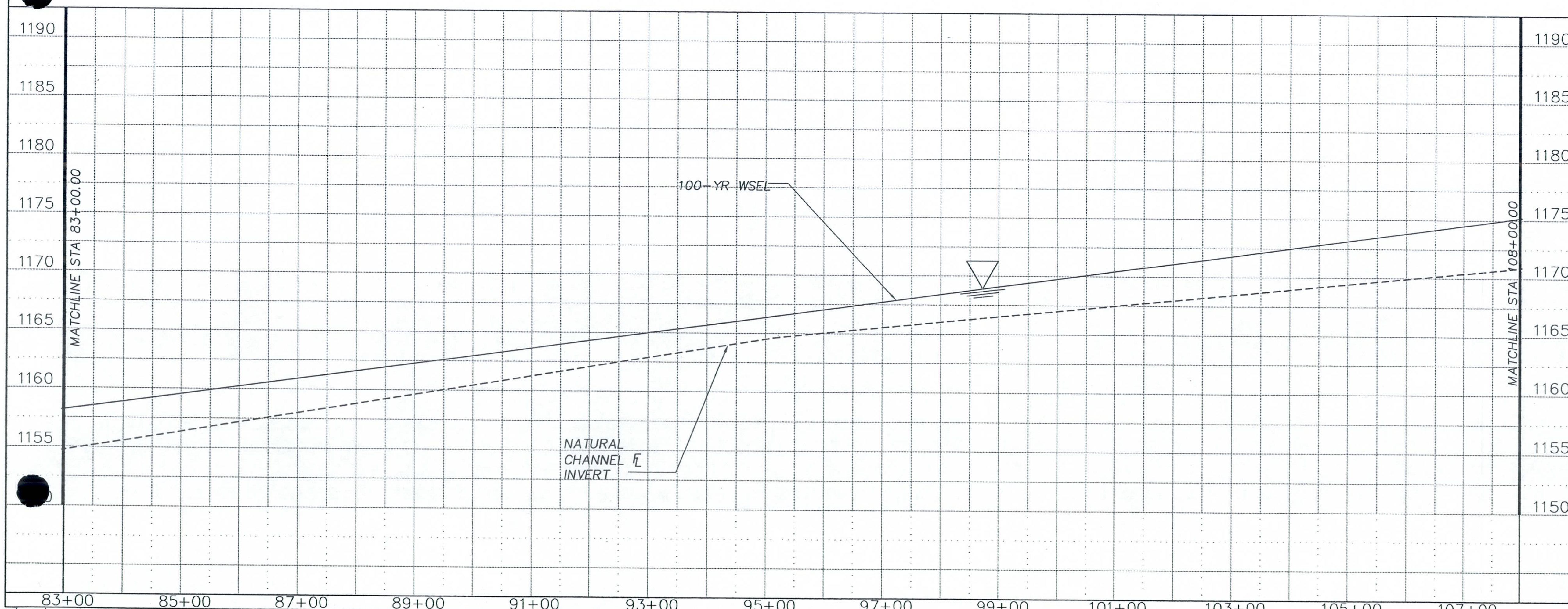
PRELIMINARY NOT FOR CONSTRUCTION

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP3	STA 58+00.00 TO 83+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-3\ SONORA-SWC-3-PP03-REVA.dwg





LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 3

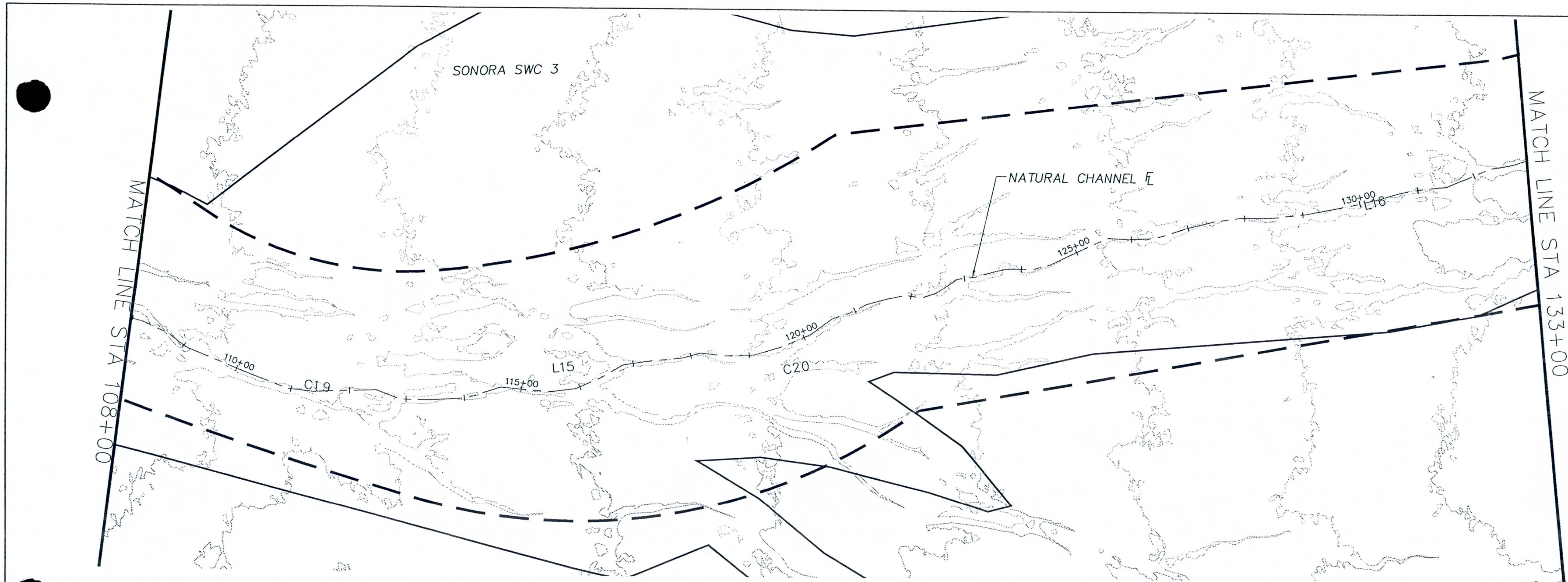
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP4	STA 83+00.00 TO 108+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-3\ SONORA-SWC-3-PP04-REVA.dwg

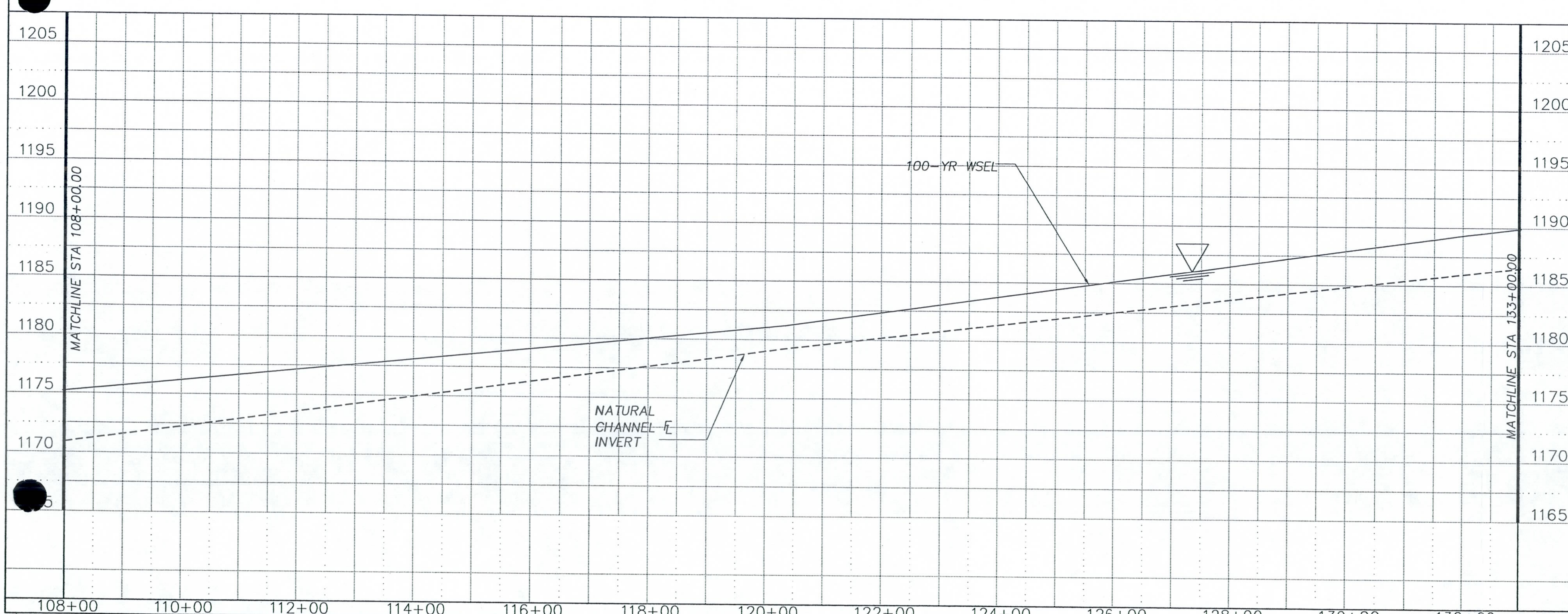


LEGEND

FLOODPLAIN LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 3

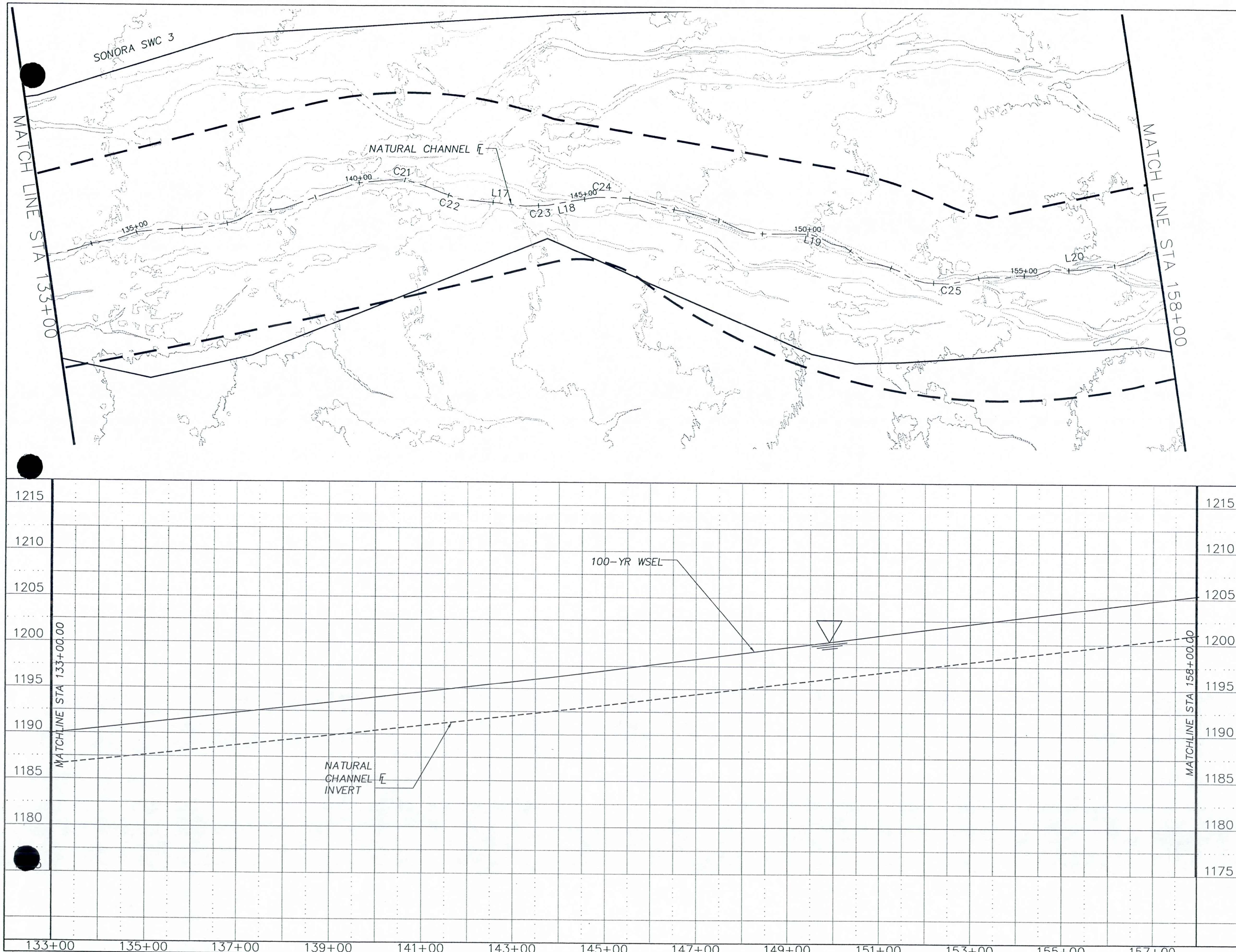
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP5	PLAN AND PROFILE SHEET STA 108+00.00 TO 133+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-3\ SONORA-SWC-3-PP05-REVA.dwg



TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 3

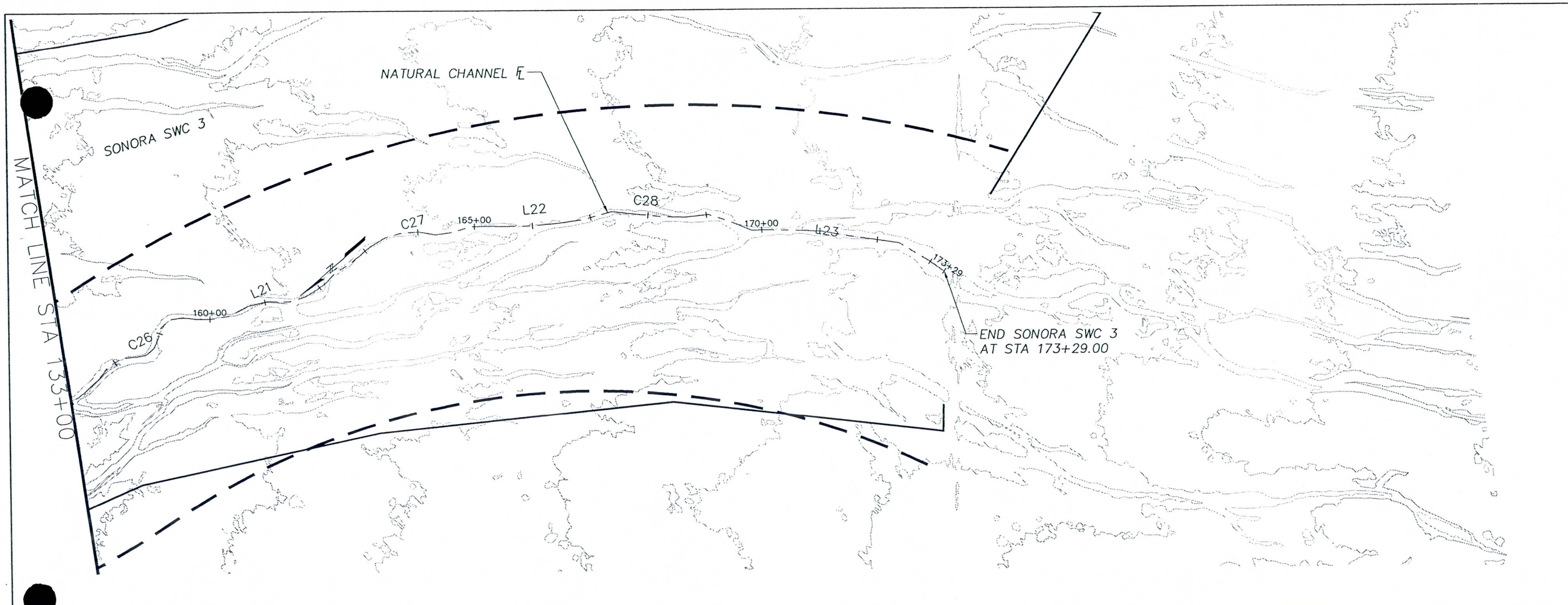
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

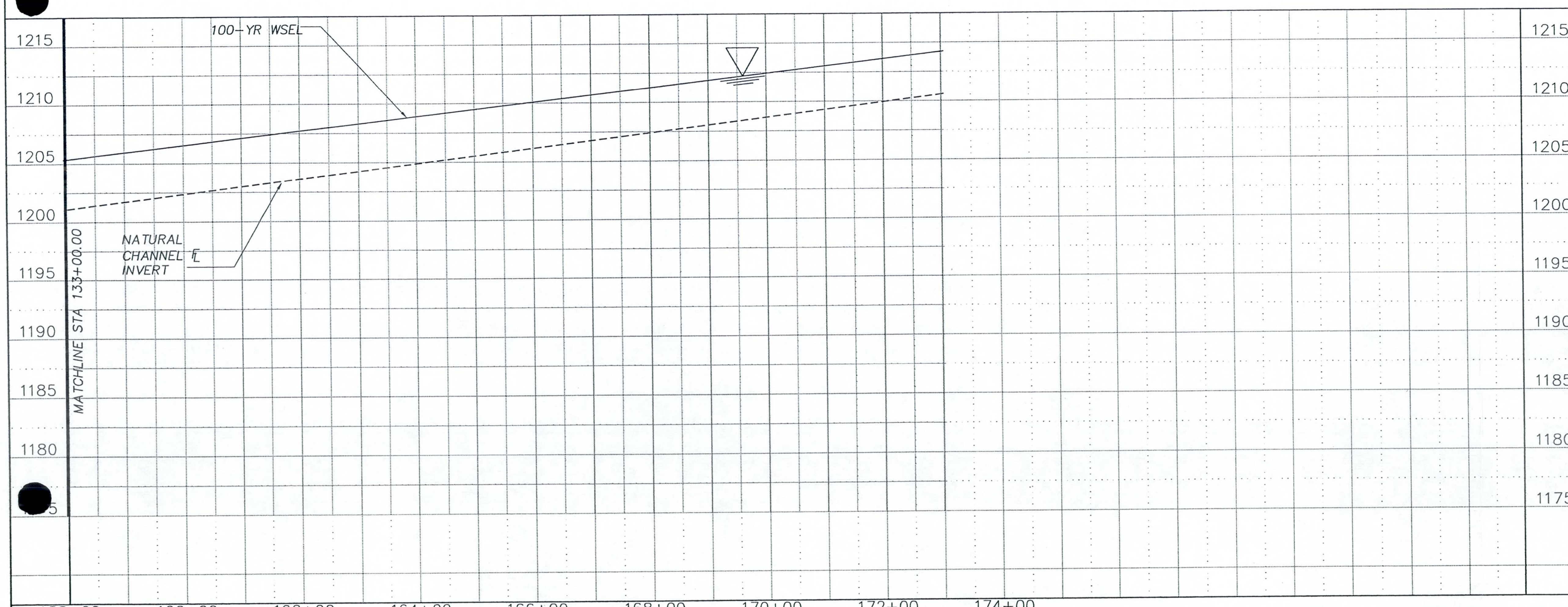
DRAWING NO.		SHEET OF
PP6	PLAN AND PROFILE SHEET STA 133+00.00 TO 158+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-3\ SONORA-SWC-3-PP06-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 3

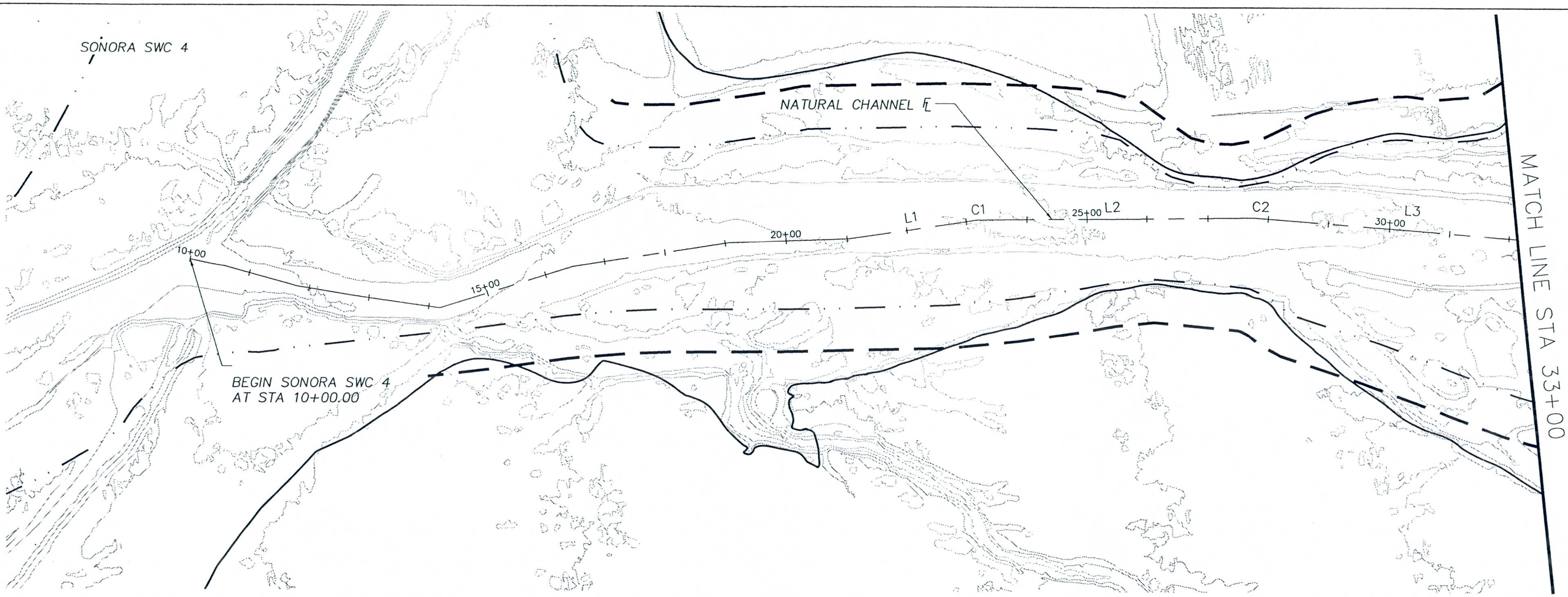
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

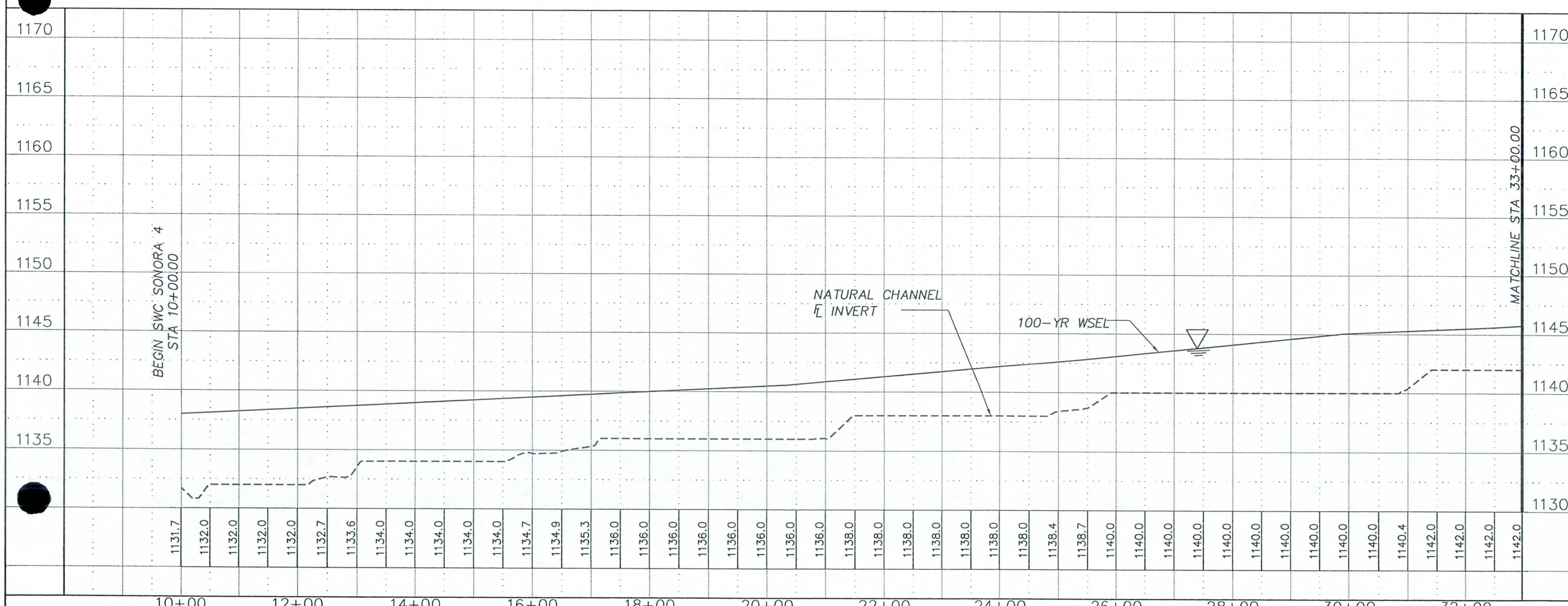
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP7	STA 158+00.00 TO 174+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-3\ SONORA-SWC-3-PP07-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 4

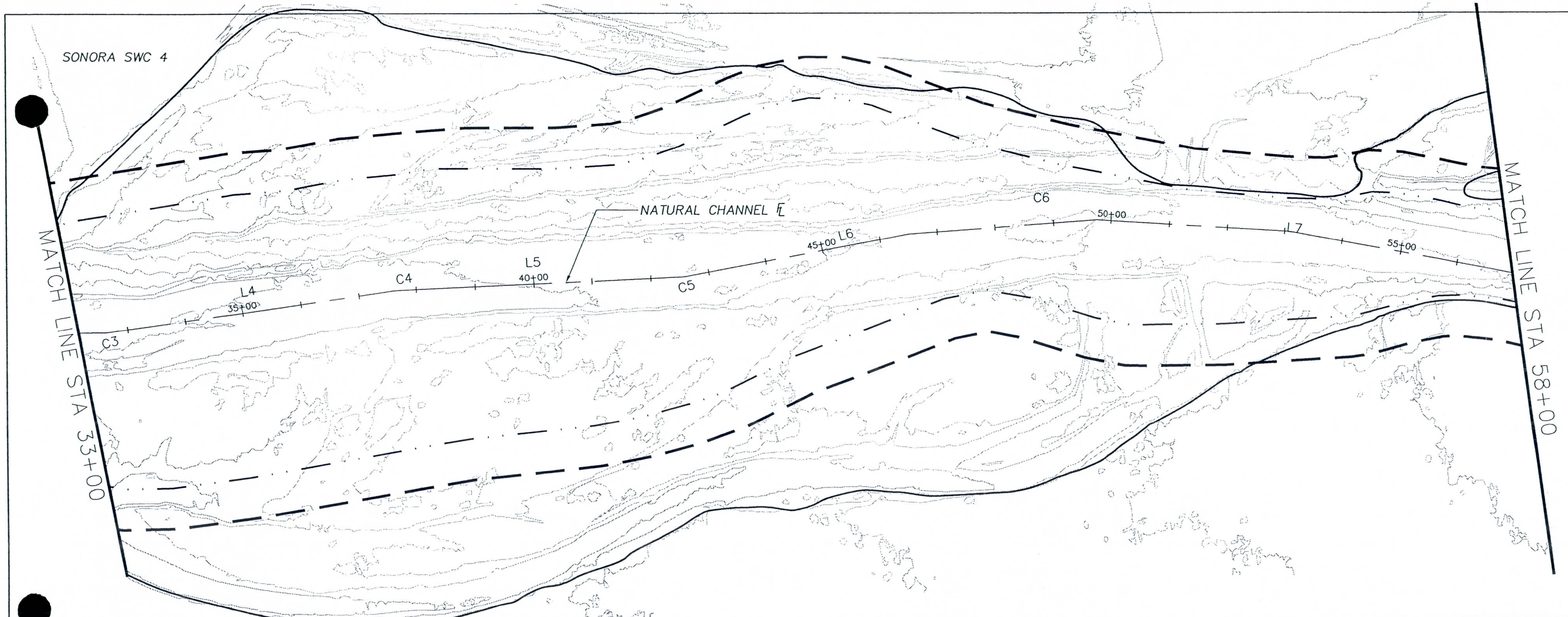
PRELIMINARY NOT FOR CONSTRUCTION

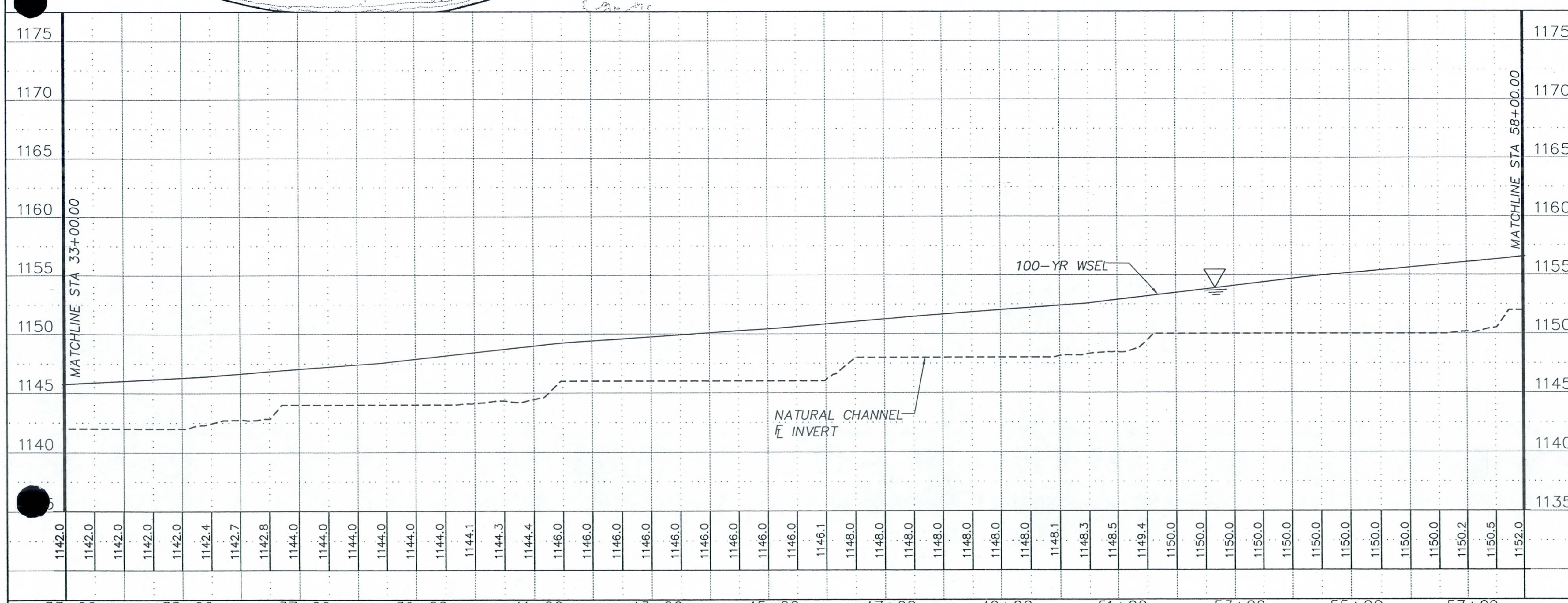
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP1	STA 10+00.00 TO 33+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP01-REVA.dwg





LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 4

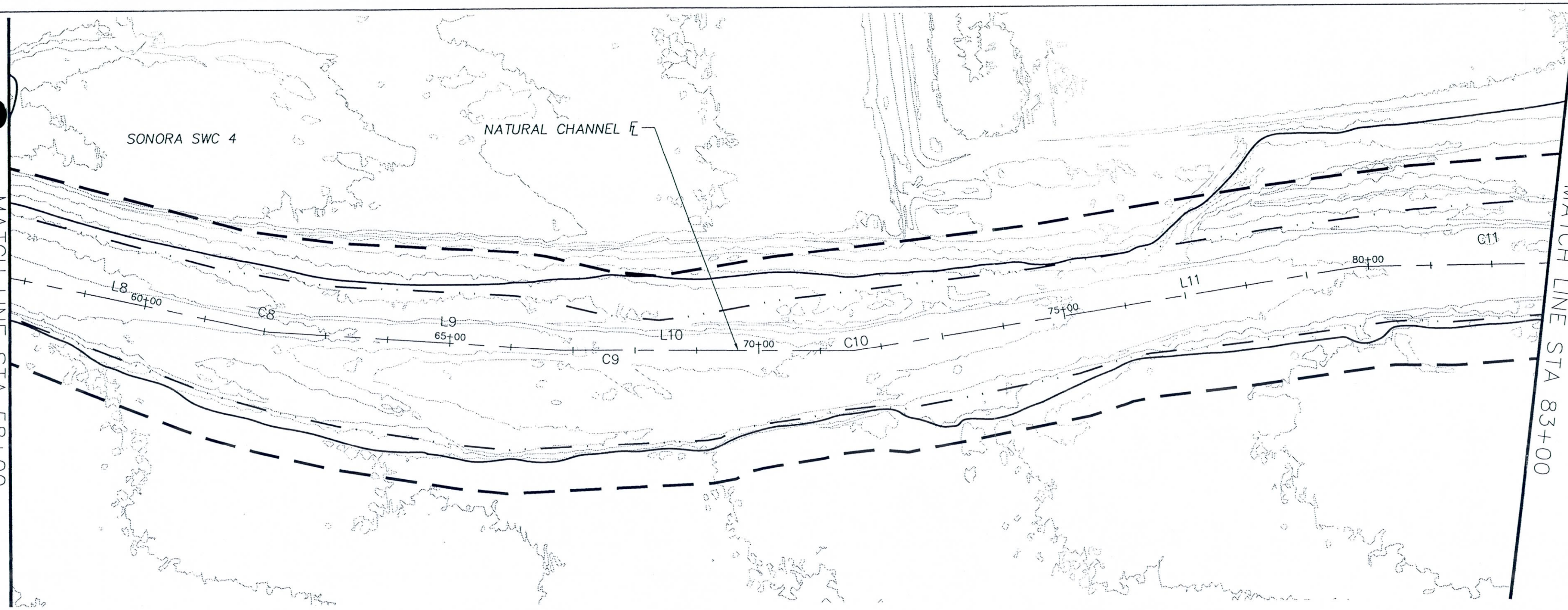
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP2	STA 33+00.00 TO 58+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP02-REVA.dwg



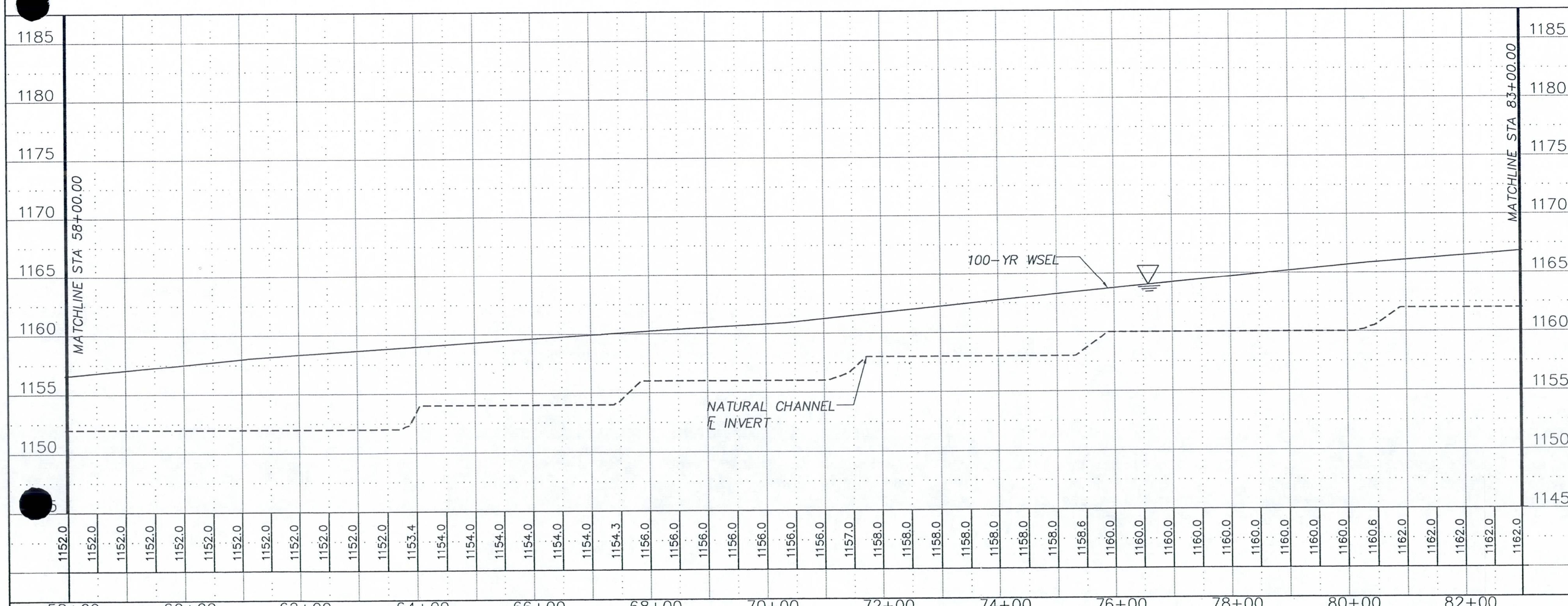
LEGEND

FLOODPLAIN LIMITS

FLOODWAY LIMITS

EROSION HAZARD SETBACKS

FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 4

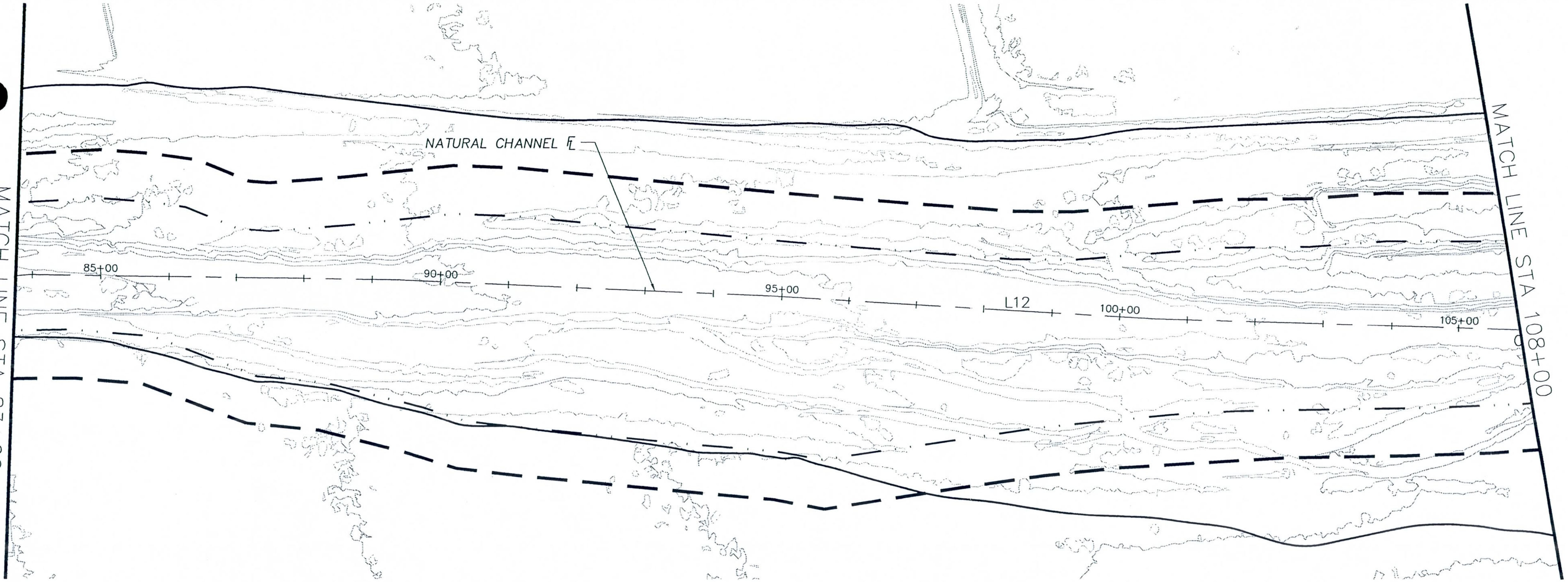
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

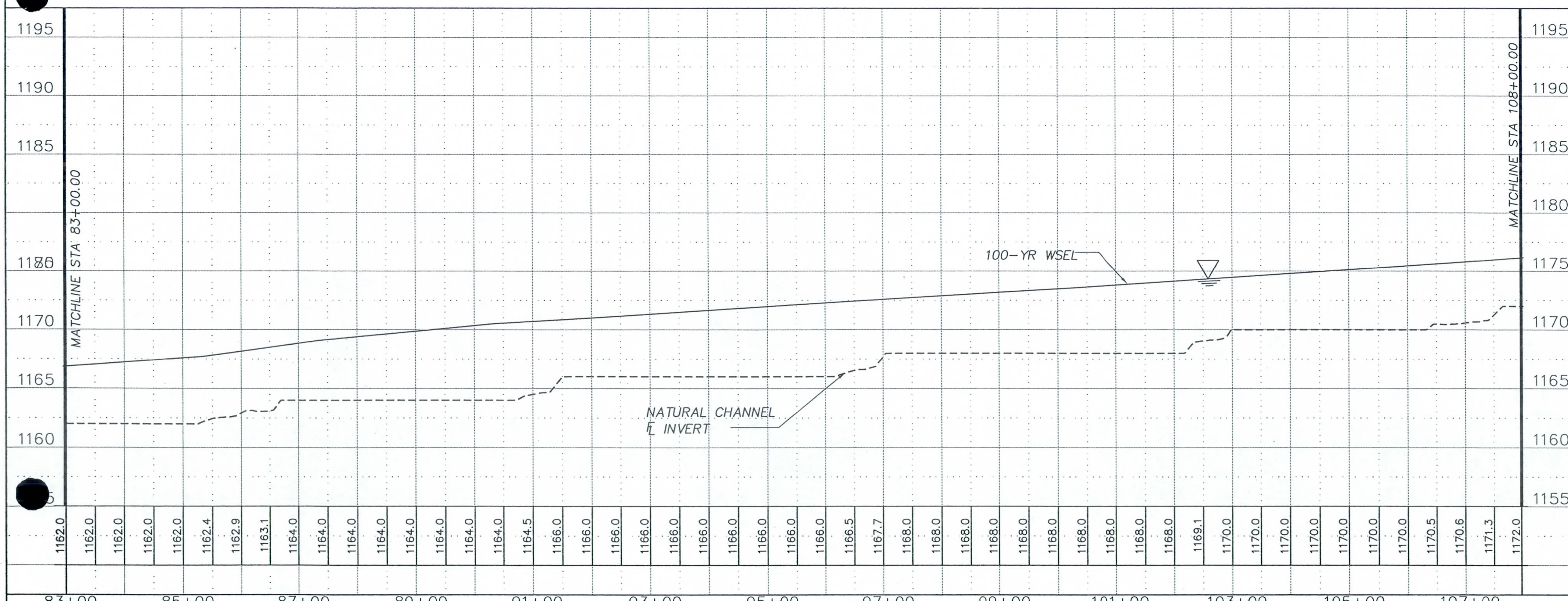
PRELIMINARY NOT FOR CONSTRUCTION

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP3	STA 58+00.00 TO 83+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP03-REVA.dwg





LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 4

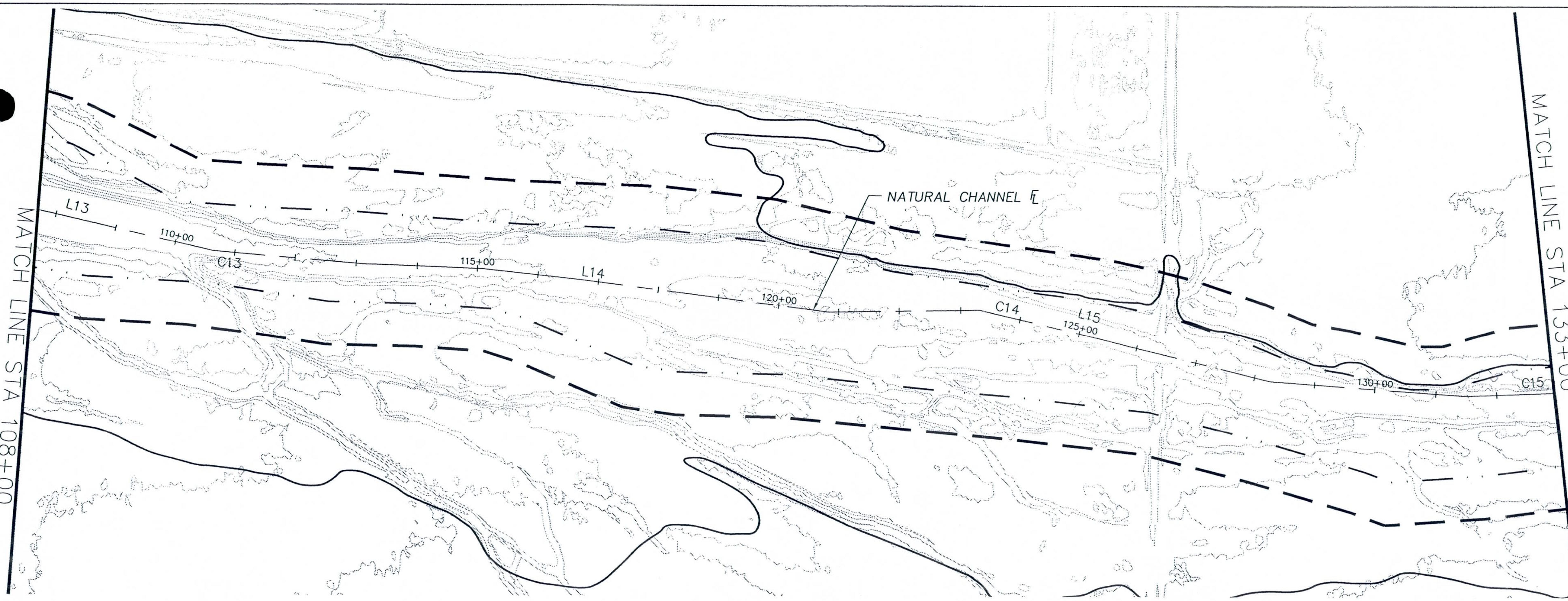
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

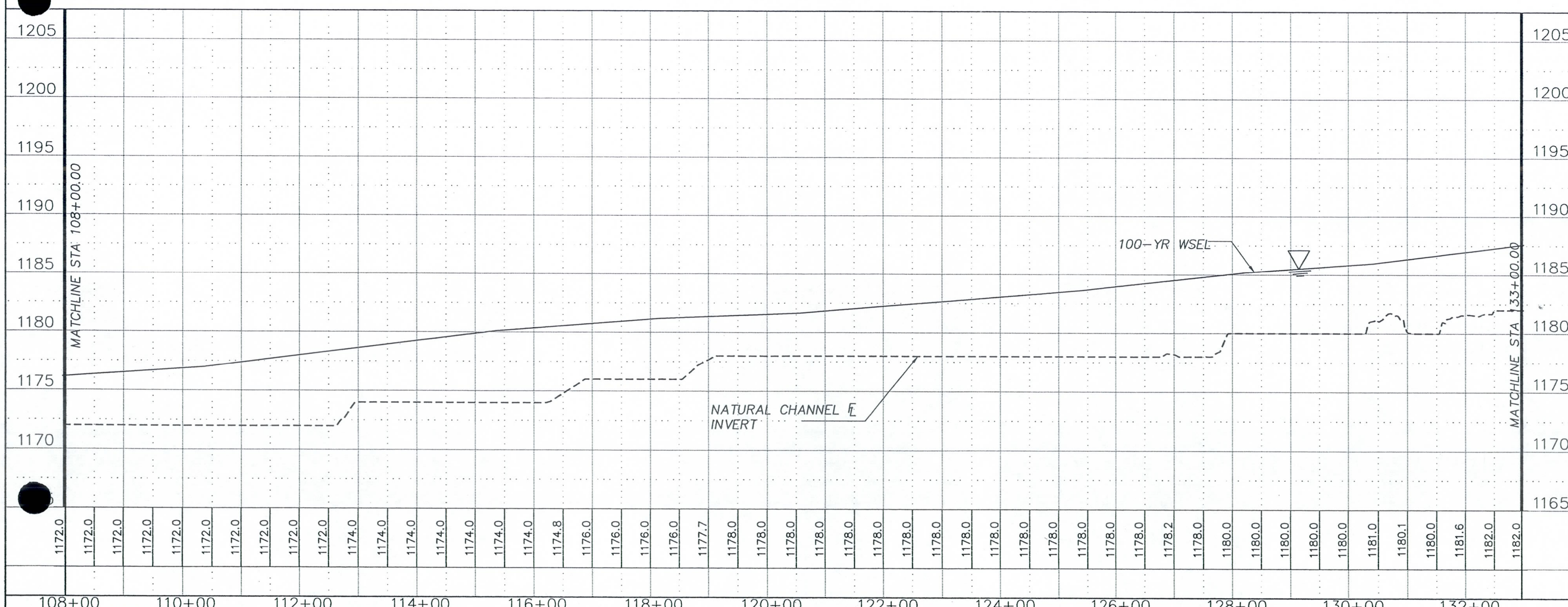
DRAWING NO.		SHEET OF
PP4	PLAN AND PROFILE SHEET STA 83+00.00 TO 108+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP04-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 4

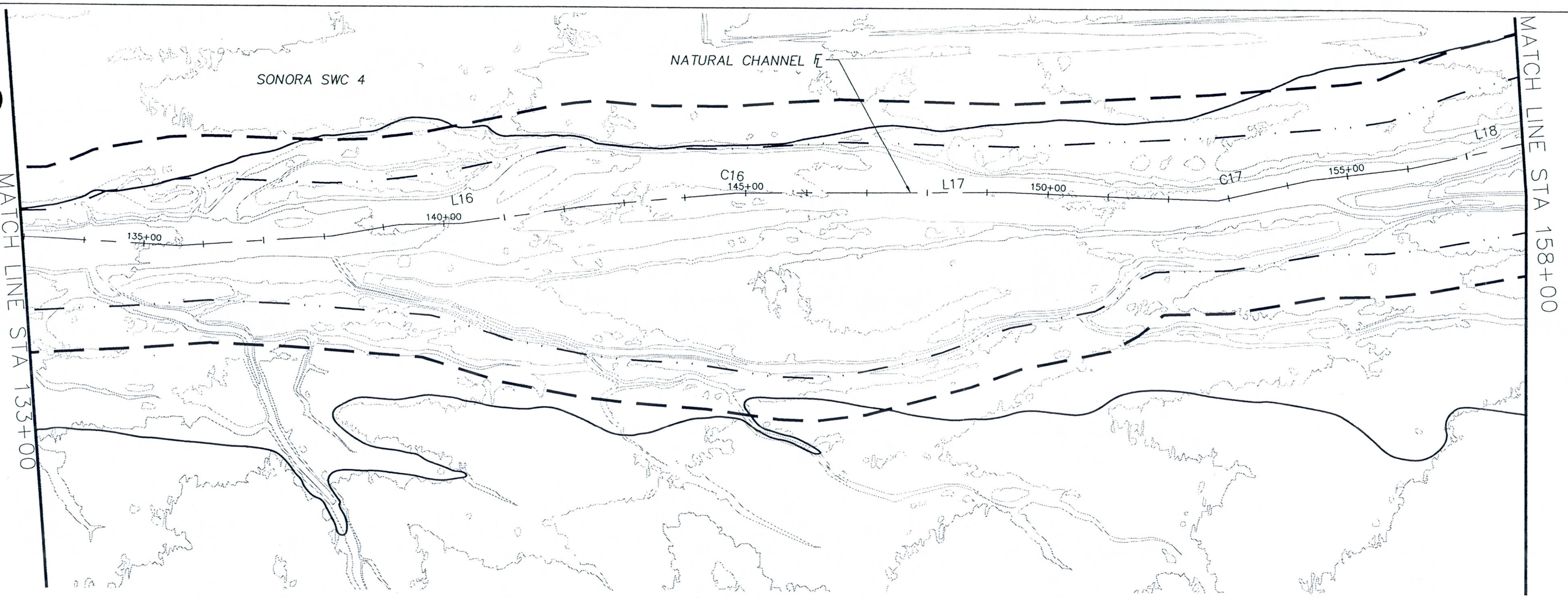
PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	04–2011
DRAWN	JT	04–2011
CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

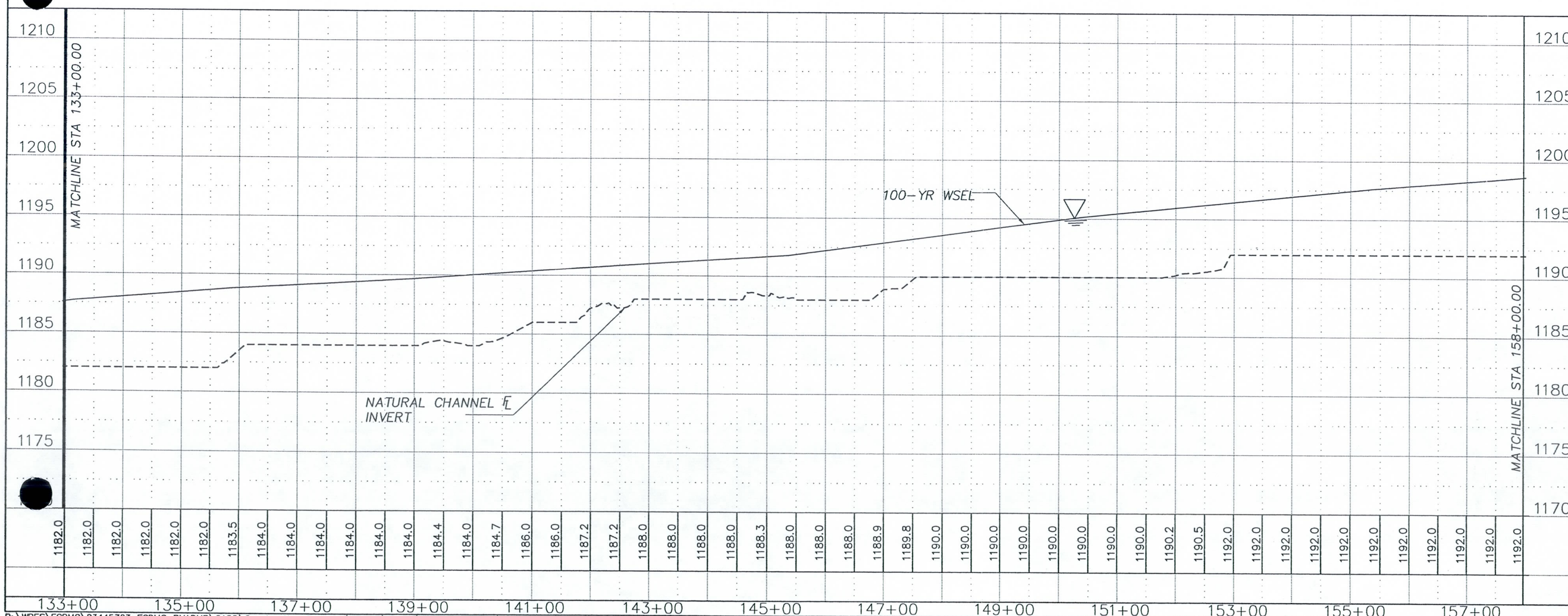
DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP5	STA 108+00.00 TO 133+00.00	– –

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP05-REVA.dwg



LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE



50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 4

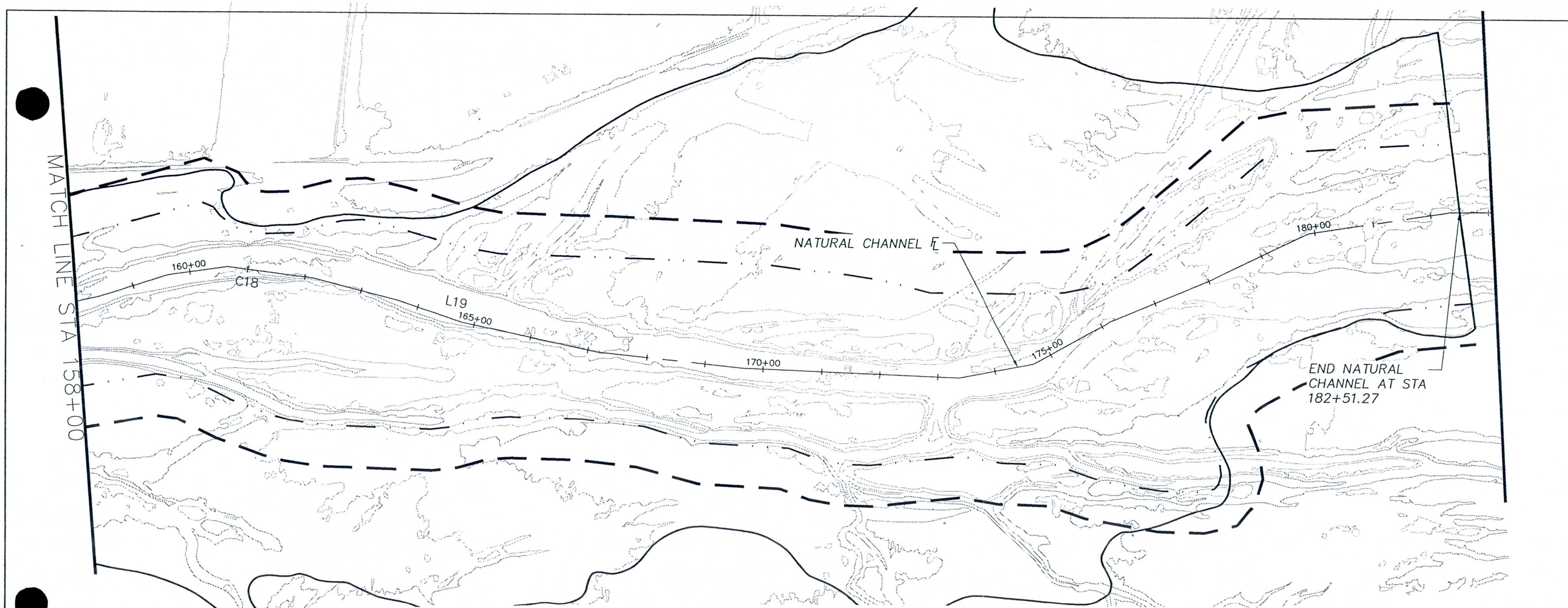
PRELIMINARY NOT FOR CONSTRUCTION

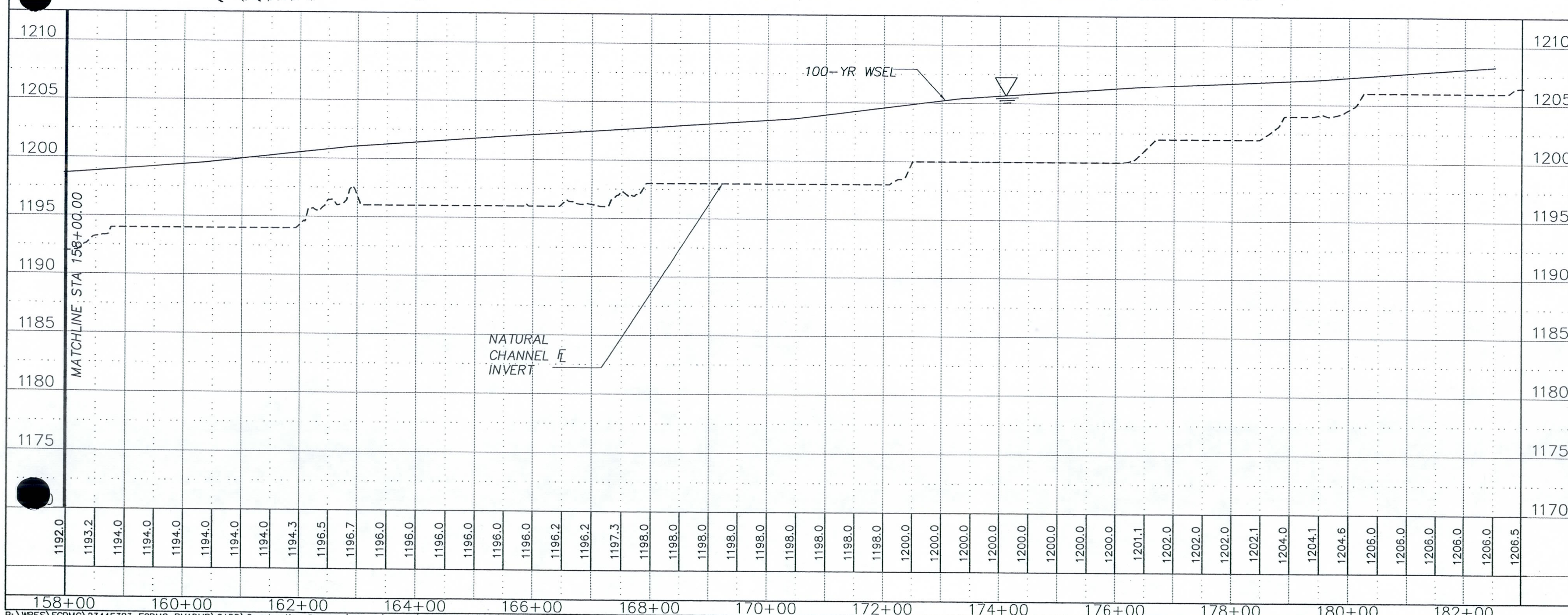
	BY	DATE
DESIGNED	MM	04-2011
DRAWN	JT	04-2011
CHECKED	ES	04-2011

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP6	STA 133+00.00 TO 158+00.00	- -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP06-REVA.dwg





LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- FLOW LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

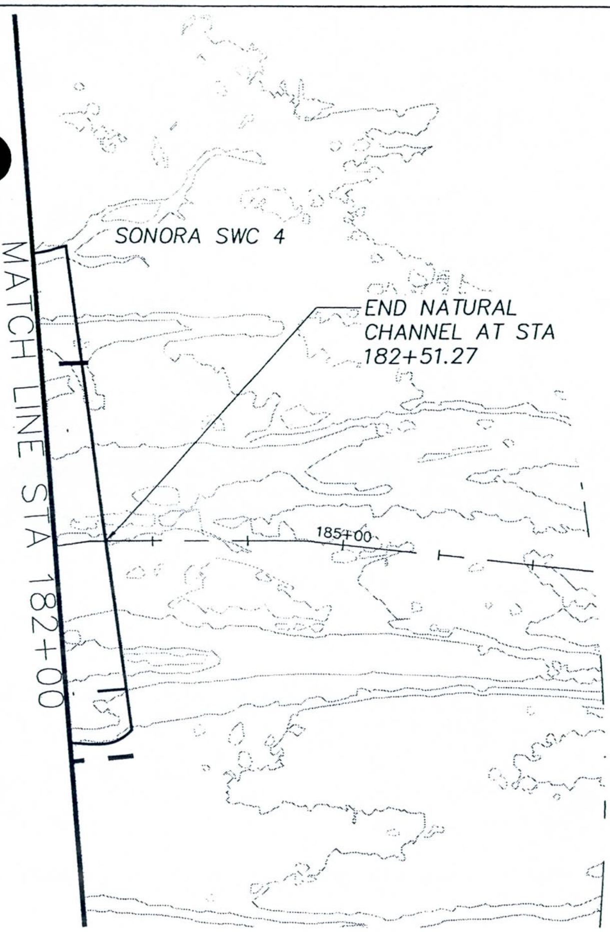
RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029
SONORA SWC 4

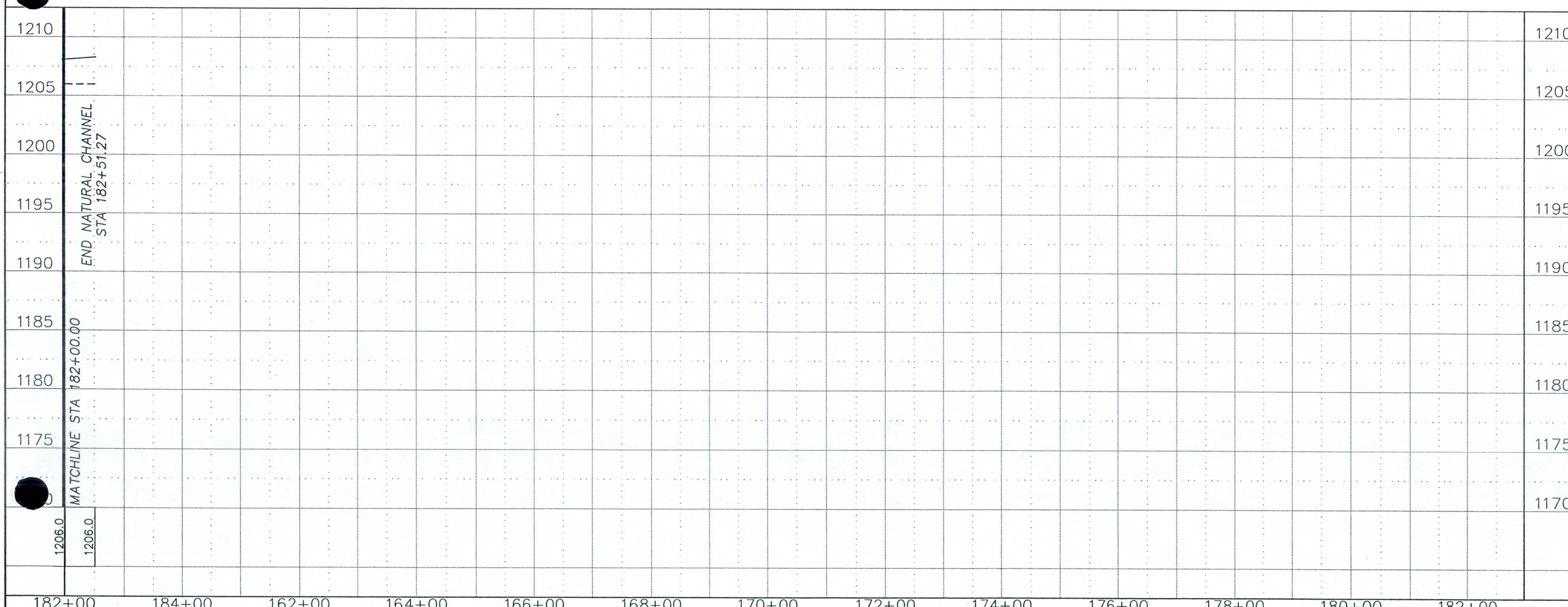
		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	MM	04–2011
	DRAWN	JT	04–2011
	CHECKED	ES	04–2011

URS 7720 NORTH 16TH STREET SUITE 100 PHOENIX, AZ 85020

DRAWING NO.	PLAN AND PROFILE SHEET	SHEET OF
PP7	STA 158+00.00 TO 182+00.00	– –

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP07-REVA.dwg





LEGEND

- FLOODPLAIN LIMITS
- FLOODWAY LIMITS
- EROSION HAZARD SETBACKS
- CENTER LINE

50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263–1100
BLUE STAKE

NO.	REVISION	BY	DATE
A	15% CONCEPTUAL DESIGN SUBMITTAL	MM	07–2010

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

RAINBOW VALLEY ADMP
FCD CONTRACT NO. 2006C029

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	MM	07–2010
DRAWN	KLP	07–2010
CHECKED	TER	07–2010

URS
7720 NORTH 16TH STREET
SUITE 100
PHOENIX, AZ 85020

DRAWING NO.		SHEET OF
PP8	PLAN AND PROFILE SHEET STA 182+00.00 TO 182+51.27	– -

P:\WRES\FCDMC\23445383_FCDMC_RVADMP\CADD\Construction_Drawings\Sheets\Rev-A\SONORA-SWC-4\ SONORA-SWC-4-PP08-REVA.dwg

GLOSSARY

This Glossary taken from the Flood Control District of Maricopa County 2009 *Comprehensive Floodplain Management Plan and Program*, Appendix A (with minor revisions).

100-Year (or Base) Flood: A flood event that statistically has a 1 out of 100 (or 1 percent) chance of being equaled or exceeded on a specific watercourse in any given year. A flood event of this magnitude is often used to determine if flood insurance is either advisable or required on a property.

100-Year Storm: A rainfall event that has a 1 percent chance of occurring or being exceeded in any given year.

Acre-foot: The volume of water necessary to cover an acre of land to a depth of 1 foot. It equals 43,560 cubic feet or 325,851 gallons.

Aggradation: A progressive buildup or raising of the channel bed due to sediment deposition. Permanent or continuous aggradation is an indicator that a change in the stream's discharge and sediment characteristics is taking place.

Alluvial Fan: A geomorphologic feature characterized by a cone or fan-shaped deposit of boulders, gravel, and fine sediments that have been eroded from mountain slopes, transported by flood flows and then deposited in the valley floors and which is subject to flash flooding, high velocity flows, debris flows, erosion, sediment movement and deposition, and channel migration.

ALERT: An acronym for Automated Local Evaluation in Real Time. ALERT was developed in the late 1970s as a format for data transmission and for the manufacture of compatible hardware and software. ALERT systems are used primarily as flood warning.

Approximate Study: A graphic illustration of a delineation of the floodplain by the Floodplain Administrator made from the most reliable sources available where neither a floodplain nor a floodway has been determined by detailed methodology.

Apex: A point on an alluvial fan below which the flow of the major stream that formed the fan becomes unpredictable and alluvial fan flooding may occur.

Area Drainage Master Study (ADMS): A study to develop hydrology for a watershed, to define watercourses, identify potential flood problem areas, drainage problems, and recommend solutions and standards for sound floodplain and stormwater management. The ADMS will identify alternative solutions to a given flooding or drainage problem.

Area Drainage Master Plan (ADMP): A plan that identifies the preferred alternatives of those identified in an ADMS. An ADMP provides minimum criteria and standards for flood control and drainage relating to land use and development.

Bankfull Stage: The point at which the water level in a stream overtops the banks and spreads out onto the floodplain.

Base Flood Elevation: The water surface elevation produced by a base flood or 100-year flood.

Braided Stream: A stream whose flow is divided at normal stage by small islands.

Capacity: The volume of water stored by a dam at the emergency spillway elevation, usually expressed in acre-feet. It differs from storage, which is the volume of water stored at any specific elevation.

Channel (Conveyance): Defined landforms that carry water. The deepest portion of a watercourse through which the majority of runoff is conveyed.

Catch Basin: A chamber or well, usually built at the curb line of a street, for the admission of surface water to a storm sewer or sub-drain.

Clearing/Grubbing: Removal of vegetation without disturbance of existing land surface contours.

Community Rating System (CRS): A program administered by the Federal Emergency Management Agency (FEMA) that recognizes and rewards communities working to reduce flood damages through a variety of approved floodplain management and flood awareness activities. Through the program, a community can reduce the flood insurance premiums that floodprone property owners pay.

Culvert: A hydraulically short conduit that conveys surface water runoff through a roadway embankment or through some other type of flow obstruction.

Dam: An earthen, metal, masonry, or wooden wall or barrier across a flow of water, which is used to restrict or prevent the water from flowing.

Degradation: A deepening of a channel over time, or in a single storm event due to erosion processes.

Delineated Floodplain: A graphic illustration of the area susceptible to inundation by a 100-year flood based upon the results of an authorized study that is included on either the Flood Management Maps for Maricopa County or the Flood Insurance Rate Maps, or both.

Delineation: Defining the physical boundaries of a stream, floodplain, jurisdictional wash, etc.

Detention Basin: A basin or reservoir where water is stored for regulating a flood. It has outlets for releasing the flows during the floods.

Development: Any man-made change to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation, drilling operations, and storage of materials and equipment located within the Special Flood Hazard Area.

Discharge: The amount of water that passes a specific point on a watercourse over a given period of time. Rates of discharge are usually measured in cubic feet per second.

Diversion: A waterway used to divert water from its natural course.

Drainage Basin: A geographical area that contributes surface water runoff to a particular point. The terms "drainage basin," tributary area," and "watershed" can be used interchangeably.

Elevation: A water-level expressed in terms of mean sea level. It differs from stage, which is a water-level in terms of some local datum.

Elevation Certificate: The Elevation Certificate is an important administrative tool of the National Flood Insurance Program (NFIP). It is to be used to provide elevation information necessary to ensure compliance with community floodplain management ordinances, to determine the proper insurance premium rate, and to support a request for a Letter of Map Amendment or Revision (LOMA or LOMR-F).

Embankment: A man-made earth structure constructed for the purpose of impounding water.

Emergency Spillway: An outflow from a detention or retention facility that provides for the safe overflow of floodwaters for large storms that exceed the design capacity of the outlet or in the event of a malfunction. The emergency spillway prevents the water from overtopping the facility.

Encroachment: The advance or infringement of uses, plant growth, fill, excavation, buildings, permanent structures, or development into a floodplain which may impede or alter the flow capacity of a floodplain.

Ephemeral Watercourse: A watercourse or portion of a watercourse that flows only in direct response to rainfall.

Erosion: The process of the gradual wearing away of landmass.

Erosion Hazard Zone: Land adjacent to a watercourse regulated by Maricopa County that is subject to flood-related erosion losses.

Evapotranspiration: Evapotranspiration is the sum of water lost to the air via transpiration by plants and evaporation from water surfaces.

FEMA (Federal Emergency Management Agency): An independent federal agency established to respond to major emergencies that state and local agencies do not have the resources to handle. FEMA seeks to reduce the loss of life and protect property against all types of hazards through a comprehensive, risk-based emergency management program.

Flood or Flooding: A general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of flood waters; (2) the unusual and rapid accumulation or runoff of surface waters from any source; and/or (3) the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm or by an unanticipated force of nature, such as flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in this definition.

Flood Control: Various activities and regulations that help reduce or prevent damages caused by flooding. Typical flood control activities include: structural flood control works (such as bank stabilization, levees, and drainage channels), acquisition of floodprone land, flood insurance programs and studies, river and basin management plans, public education programs, and flood warning and emergency preparedness activities.

Flood Control Advisory Board: A Board of seven members appointed by the Board of Directors. Five members shall be resident taxpayers and qualified electors of the District, at least three of whom shall be residents of the cities in the District. At least one of the Board members who are residents of cities shall be a resident of the largest city in the District. The city engineer of the largest city in the District and the chief engineer or manager of a major irrigation or agricultural improvement District, or their representatives, shall be ex officio members of the advisory Board with all rights and privileges granted to other Board members.

Flood Hazard Zone: Any land area located partially or wholly within a Delineated Floodplain susceptible to flood-related damage as designated on the Floodplain Management Maps. Such Flood Hazard Zones may include but not limited to areas highly susceptible to erosion, stream meander sensitivity, moveable bed, scour, wave action, and subsidence.

Flood Insurance Rate Map (FIRM): An official map on which the Federal Insurance Administration has delineated both the 100-year flood Special Flood Hazard Areas and the risk premium zones applicable to a community.

Flood Insurance Study: The official report provided by the Federal Insurance Administration. The report includes flood profiles and Base Flood Elevations.

Flood Management Map: An official map, which can be either hard copy or in electronic format, for Maricopa County on which the Floodplain Administrator has Delineated Floodplains and other flood related Flood Hazard Zones for the purpose of Floodplain administration.

Flood Proofing: Any combination of structural and non-structural additions, changes, or adjustments to structures that reduce or eliminate flood damage to real estate or improved property, water and sanitary facilities, structures, and their contents.

Flood Response Plan: A plan developed for a particular waterway, watershed, or jurisdiction that identifies flood hazards and defines methods for avoiding them and for minimizing losses to property.

Flood Stage: The point at which the water level in a stream begins to cause damage to structures. It may be below bankfull stage if structures are located in a floodway.

Floodplain: The area adjoining the channel of a watercourse susceptible to inundation by a base flood including areas where drainage is or may be restricted by man-made structures that have been or may be covered partially or wholly by flood water from the 100-year flood.

Floodplain Administrator: The individual appointed by the Board to administer and enforce these Regulations.

Floodplain Clearance: Review and approval of a use of property in or adjacent to a Delineated Floodplain or other delineated flood-related hazard zone for which a Floodplain Use Permit is not required as specified in Section 505 and Section 506.

Floodplain Management: A program that uses corrective and preventative measures to reduce flood and erosion damage and preserve natural habitat and wildlife resources in floodprone areas.

Some of these measures include: adopting and administering Floodplain Regulations, resolving drainage complaints, protecting riparian habitat communities, and assuring effective maintenance and operation of flood control works.

Floodplain Regulations: The regulations and other codes, ordinances, and regulations adopted pursuant to the authority granted in A.R.S 48-3603 through 48-3628 relating to the use of land and construction within a Delineated Floodplain and Floodway or other Special Flood Hazard Areas.

Floodplain Use Permit: A permit that must be obtained from the Floodplain Administrator prior to commencement or continuance of any non-exempt use within the Area of Jurisdiction.

Floodway: The channel of a river or other watercourse and the adjacent land areas necessary in order to discharge the 100-year flood without cumulatively increasing the water surface elevation more than one foot.

Floodway Fringe: The areas of a Delineated Floodplain adjacent to the Floodway where encroachment may be permitted.

Flowage Easement: Legal right to allow water to flow across someone's property.

Flood Retarding Structure: A term most commonly used to describe earthen dams built by the Soil Conservation Service between 1950 and 1985 to protect agricultural lands.

Gage: An instrument that measures some property in the environment, like temperature, wind speed, or precipitation. It is used interchangeably with "sensor." It is spelled g-a-g-e because that is how the U.S. Geological Survey spells it.

Grade Control Structure: A structure used across a stream channel placed bank to bank to control bed elevation, velocity, pressure, etc.

Groundwater: Water within the earth that supplies wells and springs; water in the zone of saturation where all openings in rocks and soil are filled, the upper surface of which forms the water table.

Habitat Mitigation: The compensation for the removal of natural vegetation during the construction of a flood control project by establishing new vegetation elsewhere.

Hydraulics: A field of study dealing with the flow pattern and rate of water movement based on the principles of fluid mechanics.

Hydrology: A field of study concerned with the distribution and circulation of surface water, as well as water dynamics below the ground and in the atmosphere.

Impoundment: Floodwater stored in a basin or behind a dam. It can be described in terms of a water depth (ft) or a volume (acre-ft).

Intensity: When applied to rainfall, intensity is the depth of rain in a specified time. Examples are 1 inch per hour or 1/2 inch in 20 minutes.

Inactive Alluvial Fan: An alluvial fan where flood water typically is within incised channels and adjacent stable land.

Lateral Stream Migration: Change in position of a channel by lateral erosion of one bank and simultaneous deposition on the opposite bank.

Levee: A man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

LOMA (Letter of Map Amendment): An official amendment of a current FIRM accepted by FEMA for a property or a structure. The LOMA verifies that the structure or portions of the property have been removed from a designated-floodplain area.

LOMR (Letter of Map Revision): An official revision of a current FIRM accepted by FEMA, which reflects changes in mapped areas for flood zones, floodplain areas, floodways, and flood elevations.

Low Flow Channel: A channel within a larger channel which typically carries low and/or normal flows

Multi-Use Facility: A detention or retention basin that provides additional benefits to its primary function of flood control. Such benefits include recreation, parking, visual buffers, or water harvesting.

National Flood Insurance Act of 1968: An Act passed by Congress that established the National Flood Insurance Program as a means of mitigating flood damages. The Act makes flood insurance available to communities that adopt and enforce measures to reduce flood losses. Prior to the Act, property owners in floodprone areas typically were not able to obtain this coverage through private insurance companies.

National Flood Insurance Program (NFIP): A federal program that allows property owners to purchase insurance protection against losses due to flooding. In order to participate in this program, local communities must agree to implement and enforce measures that reduce future flood risks in special flood hazard areas.

Natural and Beneficial Functions of Floodplains: Includes, but is not limited to, the following: natural flood and sediment storage and conveyance, water quality maintenance, groundwater recharge, biological productivity, fish and wildlife habitat, harvest of natural and agricultural products, recreation opportunities, and areas for scientific study and outdoor education.

Outlet Structure: A hydraulic structure placed at the outlet of a channel, spillway, pipe, etc., for the purpose of dissipating energy and providing a transition to the channel or pipe downstream.

Peak Flow: The maximum rate of flow through a watercourse for a given storm.

Percolation: The movement of water through the subsurface soil layers, usually continuing downward to the groundwater or water table reservoirs.

Perennial Flow: Watercourses, or a portion of a watercourse, that flow year round.

Precipitation: All forms of water that fall to the earth's surface—including rain, snow, sleet, and hail.

Probable Maximum Flood: The flood runoff that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Reach: A term used to describe a specific length of a stream or watercourse. For example, the term can be used to describe a section of a stream or watercourse between two bridges.

Regulatory Flood Elevation: The elevation which is one foot above the base flood elevation for a watercourse and one foot above the height of the effective outfall or the height of the backwater feature for ponding areas, whichever is greater. Where a floodway has been delineated, the base flood elevation is the higher of either the natural or encroached water surface elevation of the 100-year flow.

Regulatory Floodplain: A portion of the geologic floodplain that may be inundated by the base flood where the peak discharge is 100 cubic feet per second or greater. Regulatory floodplains also include areas which are subject to sheet flooding, or areas on existing recorded subdivision plats mapped as being floodprone.

Retention Basin: A basin or reservoir where water is stored for regulating a flood. Unlike a detention basin, it does not have outlets for releasing the flows; the water must be disposed by draining into the soil, evaporation, or pumping systems.

Riparian Habitat: Plant communities that occur in association with any spring, cienega, lake, watercourse, river, stream, creek, wash, arroyo, or other body of water. Riparian habitats can be supported by either surface or subsurface water sources.

Runoff: The portion of precipitation on land that ultimately reaches streams, especially water from rain or melted snow that flows over ground surface.

Sediment: Soil particles, sand, and minerals washed from the land into aquatic systems as a result of natural and human activities.

Setback: The minimum distance required between a man-made structure and a watercourse. This distance is measured from the top edge of the highest channel bank or the edge of the 100-year flood water surface elevation.

Shallow Flooding: Area of flooding with average depths of 1 to 3 feet.

Sheet Flooding: A condition where stormwater runoff forms a sheet of water to a depth of 6 inches or more. Sheet flooding is often found in areas where there are no clearly defined channels.

Special Flood Hazard Area: Land in a floodplain subject to a 1 -percent or greater chance of flood in any given year. These areas are designated as Zone A, AO, AE, or AH on the FIRM or Floodplain Management Maps and other areas determined by the criteria adopted by the Director of the Arizona Department of Water Resources.

Spillway: An outlet pipe or channel serving to discharge water from a dam, ditch, gutter, or basin.

Stage: A water-level expressed in terms of some local datum. It differs from elevation, which is a water-level in terms of mean sea level.

Station: An ALERT station is a local collection of sensors at a common geographic point. Stations have an ID number corresponding to the precipitation sensor if there is one, or to the water-level sensor at stage-only stations.

Storage: The volume of water stored in a basin or behind a dam—usually expressed in acre-feet. It differs from capacity, which is the volume of water stored at the emergency spillway elevation.

Stormwater: Precipitation from rain or snow that accumulates in a natural or man-made watercourse or conveyance system.

Surface Water: Water that flows in streams and rivers and in natural lakes, in wetlands, and in reservoirs constructed by humans.

Thalweg: The line of maximum depth in a stream. The thalweg is the part that has the maximum velocity and causes cutbanks and channel migration.

Tributary: A stream that contributes its water to another stream or body of water.

Water quality standards: Laws or regulations, promulgated under Section 303 of the Clean Water Act, that consist of the designated use or uses of a waterbody or a segment of a waterbody and the water quality criteria that are necessary to protect the use or uses of that particular waterbody. Water quality standards also contain an antidegradation statement. Every state is required to develop water quality criteria standards applicable to the various waterbodies within the state and revise them every 3 years.

Water table: Level below the earth's surface at which the ground becomes saturated with water. The surface of an unconfined aquifer which fluctuates due to seasonal precipitation.

Watercourse: A lake, river, creek, stream, wash, arroyo, channel, or other topographic feature on or over which waters flow at least periodically. Watercourse includes specifically designated areas in which substantial flood damage may occur.

Watercourse Master Plan (WCMP): A hydraulic plan for a watercourse that examines the cumulative impacts of existing development and future encroachment in the floodplain and future development in the watershed on potential flood damages and/or erosion hazards, and establishes technical criteria for subsequent development so as to minimize potential flood damages for all flood events up to and including the 100-year flood.

Waters of the U.S.: All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce.

Watershed: An area from which water drains into a lake, stream, or other body of water. A watershed is also often referred to as a basin, with the basin boundary defined by a high ridge or divide, and with a lake or river located at a lower point.

Wetlands: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Zone A: An area with an approximate delineation of a floodplain. Floodway boundaries and base flood elevations have not been determined.

Zone AE: An area with a detailed delineation of a floodplain and in which base flood elevations have been determined.

Zone AH: An area with flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations have been determined.

Zone AO: An area with flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average flood depths have been determined. For areas of alluvial fan flooding, velocities may have also been determined.

Zone D: Areas in which flood hazards are undetermined, but possible.

Zone X (shaded): Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from the 100-year flood.

Zone X (unshaded): Areas to be determined outside the 500-year floodplain.