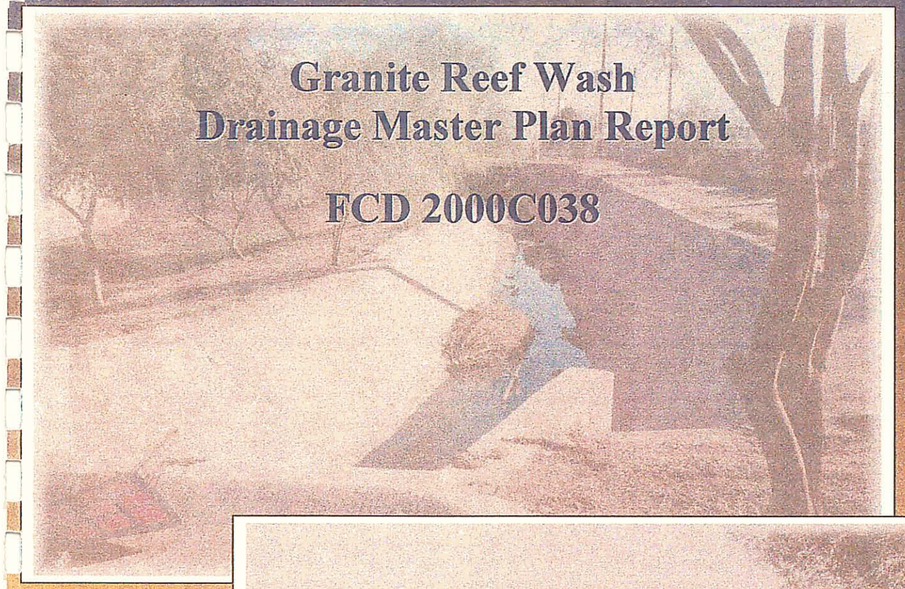
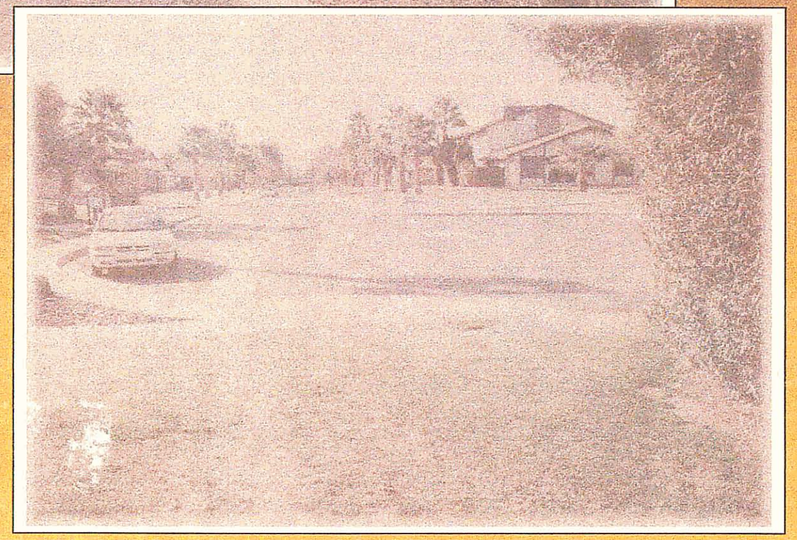
Granite Reef Wash
Drainage Master Plan Report

FCD 2000C038

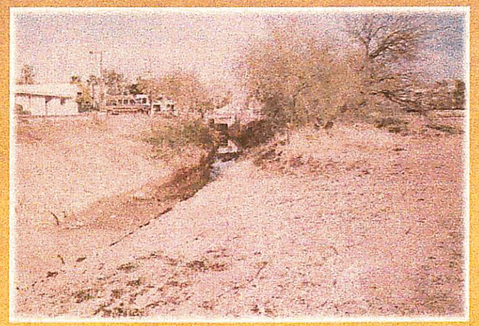




Flood Control District of Maricopa County

GRANITE REEF WASH
Drainage Master Plan Report
FCD 2000C038

CITY OF SCOTTSDALE ARIZONA



GRANITE REEF WASH
DRAINAGE MASTER PLAN
FCD 2000C038

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GRANITE REEF WASH
DRAINAGE MASTER PLAN
FCD 2000C038

EXECUTIVE SUMMARY

Part I - Data Collection

The Granite Reef Wash Drainage Master Plan (DMP) study area is located north of the Loop 202 Freeway, and west of the Loop 101 Freeway, mainly, within the City of Scottsdale (City). It also includes a portion of the Salt River Pima-Maricopa Indian Community (SRPMIC) as shown in **Figure 1.1** and **1.2**.

The watershed area has been significantly reduced with the construction of the Arizona Canal and the Loop 101 Freeway, which cut off flows from the north and east. The historical outfall to the Salt River has also been altered by development and currently is limited to an irrigation tail water ditch. The tailwater ditch discharges into the Salt River through an existing box culvert in the Salt River levee. During storm events, runoff flows along the irrigation fields in the form of sheet flow within the SRPMIC land.

The entire conveyance system does not have enough capacity to convey runoff from a 100-year storm. A Federal Emergency Management Agency (FEMA) delineated floodplain exists between Thomas and McKellips Roads but the agencies involved in this study do not have confidence that this floodplain represents a realistic flood risk zone.

The main purpose of this project is to develop a hydrologic model that is accepted by all agencies and based on this new information, determine if the existing FEMA floodplain is adequate. Also, alternatives were analyzed to improve drainage conditions and, if feasible, remove as many residences as possible from the floodplain.

There are several studies that analyzed the drainage conditions within the study area, including two flood insurance studies (1984 and 1997) and several hydrologic studies. Both the 1984 and 1997 flood insurance studies assumed the same flows. However, the original flood insurance study (1984) was completed before the construction of the Loop 101 Freeway and prior to some of the development in the City of Scottsdale. By examining the results of the hydrologic studies, it was found that the flows estimated by these studies are larger than those used in the FEMA delineation. Thus, the width of the floodplain developed by the flood insurance study is most likely underestimated. For this reason a new hydrology analysis was developed under this study.

Most of the study area is fully developed and significant amount of infrastructure are in place including channels, storm drains and detention basins. However, the main conveyance system for medium to large runoff events is the roadway system. **Figure 1.5** identifies the main drainage infrastructure and further detail is provided in **Table 1.1** located at the end of this report.

There are several reports of flooding problems within the area. Most of these reports are related to street flooding. There were no reports founded of property damage from storm runoff flooding. One exception is the damage reported in 1972 as a result of the breaching of the Arizona Canal at Pima Road, which severely flooded several residences. A list of problems was compiled based on records maintained by City of Scottsdale staff, the District, residents' recollections, and library and web research. Street flooding was mainly reported at McKellips Road west of the wash crossing, and at the intersection of Thomas and Pima Roads. These and other flooding problems locations are identified in **Figure 1.7**.

Part 2 – Alternative Formulation

The alternatives formulated and analyzed in this project were developed as a joint effort by the project team which included representatives from the Flood Control District of Maricopa County (District), The City of Scottsdale (City), the Salt River Pima Maricopa Indian Community (SRPMIC) and Entellus. This was accomplished by conceiving and refining the alternatives in a series of team meetings including an Alternative Formulation Workshop and two Alternative Refinement Meetings.

Based on preliminary data collection and preliminary hydrologic analysis several opportunities and constraints were identified as a base for formulation of alternatives. Additionally, Entellus had identified several locations that appeared feasible for the construction of flood control structures to be used as seed ideas. These seed ideas included detention basins, channels, and storm drains. The location of these seed ideas is presented in **Figure 2.1.**

The team discussed the seed ideas as well as the recommendation provided by previous studies such as the Candidate Assessment Report **(Reference 7)**. The team members were given the opportunity to formulate and rank alternatives and as a result of this brainstorming, five potential alternatives were identified.

These five alternatives were used as a starting point for the development of working alternatives. Entellus performed a preliminary analysis and further identified the most beneficial location for facilities. The results of the preliminary analysis were presented to the team in a series of Alternative Refinement Meetings. Based on the preliminary analysis as well as additional information from team members, the alternatives were modified and the final alternatives formalized as follows:

- Alternative 1 Water Course Restoration
- Alternative 2 Floodprone Property Acquisition
- Alternative 3 Osborn Road Storm Drain
- Alternative 4 Detention
  - Option A Detention Basin at Thomas Road
  - Option B Detention Basin at McDowell Road
  - Option C Detention Basin at Thomas Rd. and McDowell Rd.
- Alternative 5 Regulatory

Comparison of Alternatives

The 100-year peak flows resulting from the implementation of these alternatives varies significantly. Alternatives 4C and 4A provides the greatest reduction to the peak flows reaching the wash. Alternative 5 has minimum implementation cost and alternatives 3 and 4B are the lowest cost structural alternatives. Alternatives 1 and 2 have the highest cost but they remove all structures from the 100-year inundation area. Alternative 1 appealed the most to the study team because it completely solves the flooding problems in the area and has the potential to improve the quality of life and revitalize the neighborhood. However, the high implementation cost is the main disadvantage of this alternative. **Table ES-1** summarizes the results of the evaluation of the alternatives.

Recommendation for Further Analysis

All alternatives appear to be feasible, and contribute to the reducing of flooding risk along the Granite Reef Wash alignment. Alternative 2 – "Floodprone Property Acquisition", is not recommended for further analysis because the implementation cost is too high and it does not provide any advantage over Alternative 1 which is significantly less expensive. This study recommends Alternative 1- "Watercourse Restoration" and Alternative 5 – "Regulatory" for further consideration. Also a combination of Alternatives 3 – "Diversion" and Alternative 4 – "Detention", be considered for further analysis.

Table ES-1
Comparison of Alternatives

Criteria	Parallel 72" Storm Drain on Indian School Rd.*	Current FEMA Floodplain	Alternative 1 Water Course Restoration	Alternative 2 Floodprone Property Acquisition	Alternative 3 Osborn Road Storm Drain	Alternative 4A Detention (Underground Basin at Thomas Rd.)	Alternative 4B Detention (Offline Basin at McDowell Rd.)	Alternative 4C Detention (Basins at Thomas Rd. and McDowell Rd.)	Alternative 5 Regulatory
100-yr Peak Flow at McDowell Rd. (cfs)	1,840	1,240	1,840	1,840	1,600	**1,200**	1,840	**1,200**	1,900 **
Flow reduction by alternative at McDowell Rd. (cfs)	0	N/A	0	0	240	**640**	0	**640**	0
100-yr Peak Flow at McKellips Rd. (cfs)	2,290	1,417	2,290	2,290	2,020	1,860	2,000	**1,610**	2,350 **
Flow reduction by alternative at McKellips Rd. (cfs)	0	N/A	0	0	270	430	290	**680**	0
Implementation Cost (Millions of dollars)	N/A	N/A	$42.3	$141.7	$3.5	$13.9	$2.0	$15.9	**$0**
Number of Structures Removed from floodplain, purchased not included (Permanent / Mobile homes)	N/A	N/A	262/669	**119/91**	170/282	247/315	127/295	250/353	0/0
Number of Structures to be Purchased for implementation of alternative (Permanent / Mobile homes)	N/A	N/A	102/21	245/599	**0/0**	**0/0**	**0/0**	**0/0**	**0/0**
Structures Remaining in Floodplain (Permanent / Mobile homes)		126/(N/A)	**0/0**	**0/0**	194/408	117/375	237/395	114/337	364/690
Total property value within the floodplain –2003 Assessors value after implementation, including purchased structures (Millions of Dollars)		$19.7	**$12.3**	$45.5	$36.2	$25.8	$41.2	$24.5	$62.3
Property Value within floodplain excluding purchased structures		$19.7	**0**	0	$36.2	$25.8	$41.2	$24.5	$62.3
Estimated Annual Flood Insurance Cost - $1,079Average rate per $100,000 of property value (Dollars / year) after implementation		$212,239	**0**	**0**	$391,105	$278,431	$441,257	$264,495	$621,993 ****
Estimated Annual Flood Insurance Cost Savings (Dollars / year)	0	N/A	**$621,993**	**$621,993**	$230,888	$343,562	$180,736	$357,498	$0
Estimated 100-year Flooding Damages - Average damage estimated 10% of property value (Dollars)		$1,967,000	**$0**	**0**	$3,624,700	$2,580,450	$4,089,500	$2,451,300	$7,197,658 ****
Estimated 100-year Flooding Damages Prevented (Dollars)	0	N/A	**$7,197,658**	**$7,197,658**	$3,572,958	$4,617,208	$3,108,158	$4,746,358	$0
Cost/Benefit Ratio (Implementation Cost / Prevented Damages)	N/A	N/A	5.88	19.69	0.97	3.01	**0.64**	3.35	N/A
Number of Families Displaced	N/A	N/A	122	986	**0**	**0**	**0**	**0**	**0**
Neighborhood Enhancement	N/A	N/A	**High**	Possible ***	No	No	Low	Low	No
Agency Acceptance	N/A	N/A	**High**	Possible ***	Mid	Mid	Mid	Mid	**High**
SRPMIC Non-Objection	N/A	N/A	**Non-objection**	**Non-objection**	**Non-objection**	Non-objection if lease holder agrees	**Non-objection**	Non-objection if lease holder agrees	**Non-objection**
Kinder/Gentler	N/A	N/A	**Yes**	Possible ***	No	No	**Yes**	**Yes**	No
Reliability / Dependability	N/A	N/A	**High**	**High**	Mid	Low	**High**	Low	N/A
Outfall Solution			Yes	Possible	No	No	No	No	Yes

* This storm drain has been designed and it will be constructed in the near future. The effect of this storm drain in the Granite Reef Floodplain is negligible. Cost of this improvement was not included in cost estimates
** Existing conditions using new hydrology (no future storm drain on Indian School Rd.)
*** Depending on redevelopment scheme
**** These two values were estimated based on the actual Flood Insurance Rates and Flooding Damages (See Appendix)
Bold indicates the most favorable alternative for each criteria

PART 1. DATA COLLECTION

Project Overview

This study was initiated by the Flood Control District of Maricopa County (District) in 2000 to identify flooding potential along Granite Reef Wash from Thomas Road to its confluence with the Salt River. This was accomplished by developing new hydrology and identifying with hydraulic models areas that have potential for flooding. Further, this project developed and screened initial alternative concepts for reducing flooding potential and made recommendations for improvements. This study was conducted in coordination with the District, the City of Scottsdale (City) and the Salt River Pima Maricopa Indian Community (SRPMIC). This study is a follow up of the *Granite Reef Watershed Flood Mitigation Candidate Assessment Report* prepared by Primatech in 1999 and addressed some of the main concerns identified at that time, in particular, the development of a hydrologic model that is accepted by all interested agencies.

Project Authorization

Arizona Revised Statutes Title 48, Chapter 21, requires the District's Board of Directors to identify flood control problems and plan for the construction of facilities, which eliminate or minimize flooding problems. This project was authorized by a contract between the District and Entellus, Inc. The authorization agreement was identified as Contract FCD 2000C038 dated November 19, 2001. Notice to Proceed was issued by the District on November 28, 2001.

Project Location

The area of study for the Granite Reef DMP falls within the City of Scottsdale and the SRPMIC as presented in **Figure 1.1** and **1.2**. The Granite Reef watershed is bounded by the Arizona Canal on the north, by the Salt River on the south, by the Loop 101 Freeway on the east, and by the Indian Bend watershed boundary on the west. The west boundary meanders along the watershed following the divide between the two watersheds but it is generally located between Granite Reef Road and Hayden Road. The total study area is approximately 6 square miles. The photographs on the next page show the Granite Reef Wash channel at different locations. The channel configuration varies all the way from an inverted crown roadway to an earthen channel, then to a concrete lined channel.

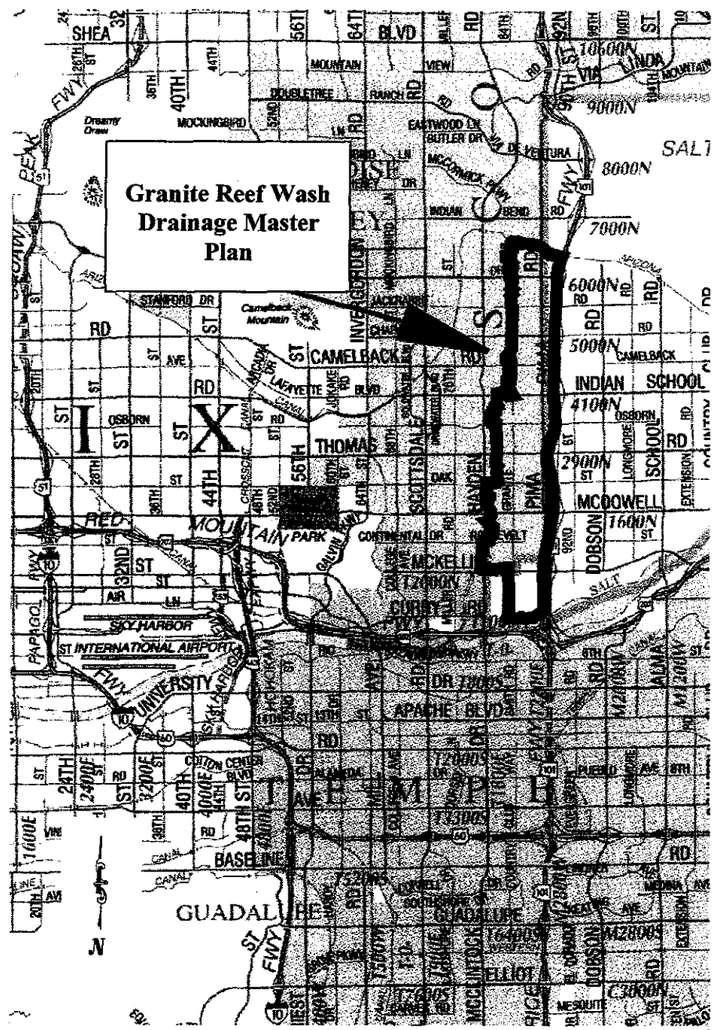


Figure 1.1
Location Map

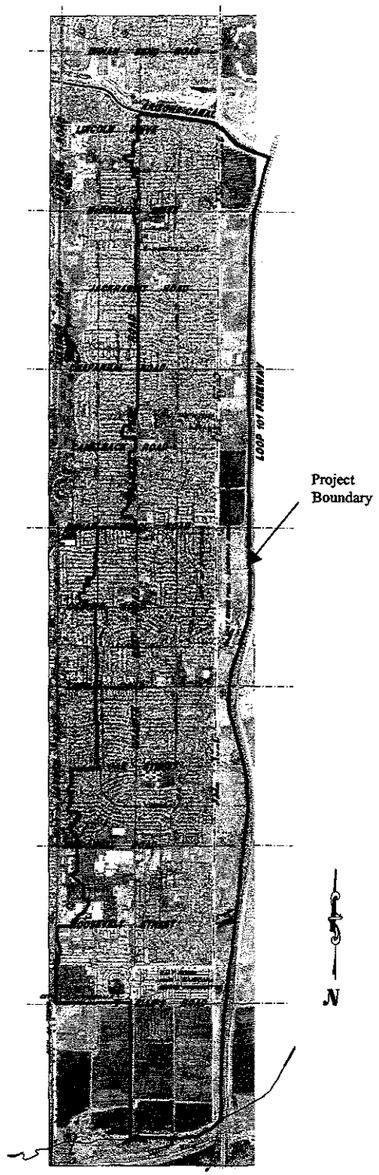
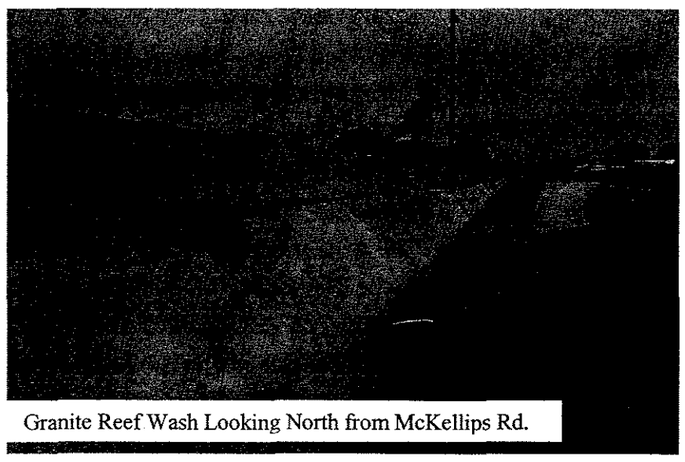


Figure 1.2
Project Area Map

Granite Reef Wash Looking North from McDowell Road



Granite Reef Wash Looking North from McKellips Rd.

Project Area History

Historically, the Granite Reef Wash originated in the McDowell Mountains in north Scottsdale and flowed southwesterly towards the Salt River. The original watershed was approximately 40.6 square miles. Most of the upper portion of the watershed was cut off with the construction of the Arizona Canal and the Central Arizona Project Canal. Contributing area was reduced by these structures to approximately 11 square miles. More recently, the contributing area has been further reduced by the construction of the Loop 101 (Pima Freeway), which cut off all flow from the east reducing the watershed to approximately 6 square miles.

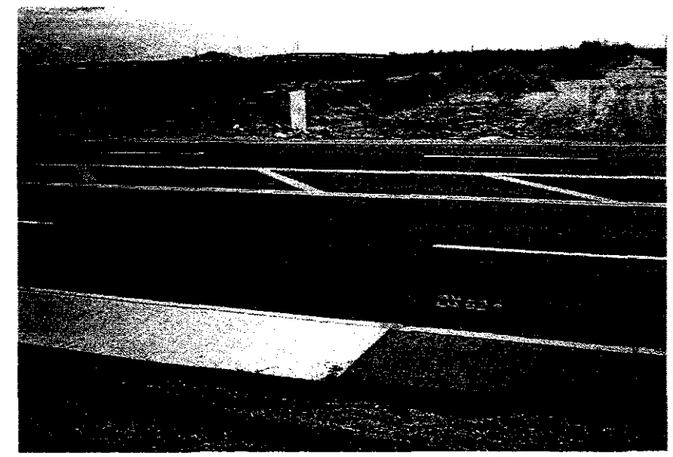
The Granite Reef Wash Drainage Study prepared by Simons and Lee in 1995 estimated the historical flow of the wash using a regression equation. According to this study, the 100-year flow at McKellips Road was approximately 8,800 cfs (41 square miles) but was reduced to 4,300 (11 square Miles) after the construction of the Arizona Canal. However, the most significant difference is not the peak flows, but the flow volumes that were reduced from approximately 3,700 acre-feet to 500 acre-feet. Historically, flows from Granite Reef Wash always outfall into the Salt River through the SRPMIC land. Although runoff from the developed areas has increased, the overall flows within the Granite Reef Wash are substantially less than the historical flows because of the reduced contributing area.

Even though the contributing area was significantly reduced, the wash may experience significant flow during a severe storm and may not have the capacity to safely convey this runoff to the Salt River. Most of the current Granite Reef Wash watershed is a fully developed older neighborhood built before retention regulations were in place. As a result, runoff from the urbanized area has increased significantly. Additionally, the historical alignment of the Granite Reef Wash has been significantly altered by development. The wash has been replaced by a combination of storm drains, channels, and inverted crown streets with very limited capacity.

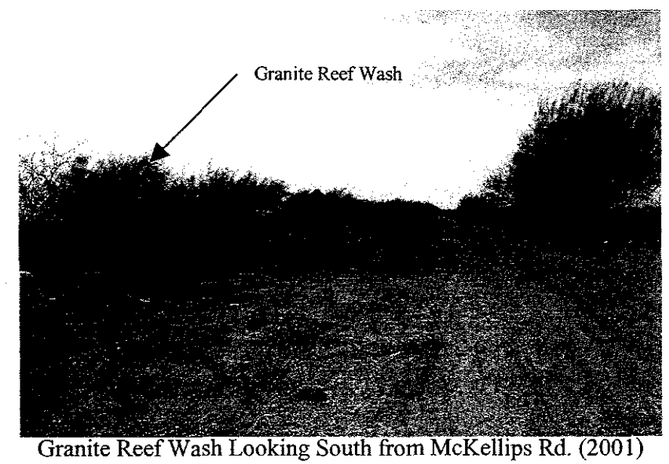
The City has installed several storm drains in the northern portion of the current watershed. These storm drains intercept flows and convey then west to the Indian Bend Wash. Most of these storm drains have been designed for storm events ranging from a 2-year to a 50-year storm, and do not significantly affect peak flows at the wash alignment.

The historical outfall of Granite Reef Wash is the Salt River between the alignment of Pima and Hayden Roads within the SRPMIC land. The Indian Community has leased out the land for agricultural use. The leaser has graded the land and, for the most part, the wash has been filled in. A small tail water ditch was constructed at the approximate location of the original wash but it has very limited capacity and even minor storms tend to cause ponding at McKellips Road.

Review of historical aerial photography from 1937 (**Figure 1.3**) and 1959 (**Figure 1.4**) reveals that Granite Reef Wash channel has been significantly altered. The 1937 aerial photography shows a split flow at the approximate location of the SRP well site (1/4 mile north of McKellips), with one branch flowing southeast through the current SRPMIC trailer park and another branch flowing southwest and joining the Salt River just east of the Hayden Road alignment. Both of these branches outfall to the Salt River within the SRPMIC land.



Granite Reef Wash Looking South from McKellips (1995)



Granite Reef Wash Looking South from McKellips Rd. (2001)

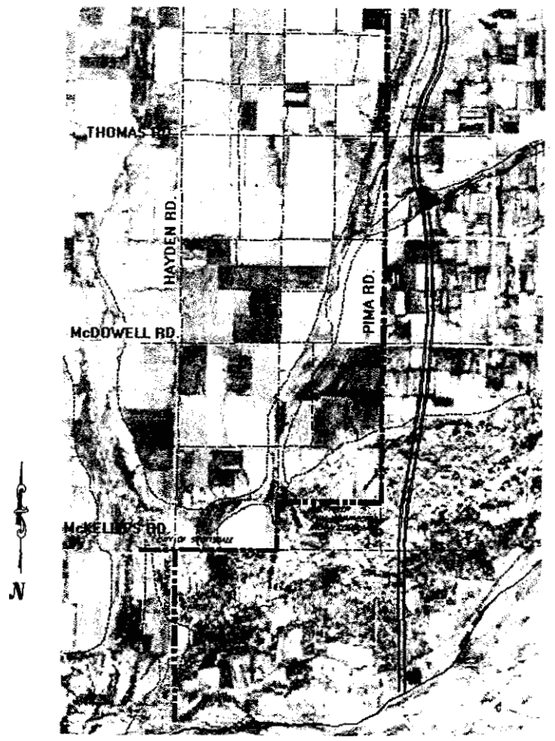


Figure 1.3
1937 Aerial Photograph

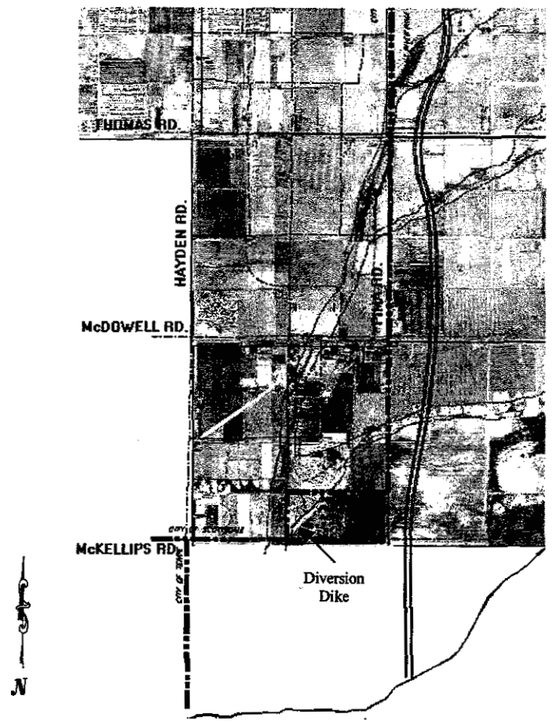


Figure 1.4
1959 Aerial Photograph

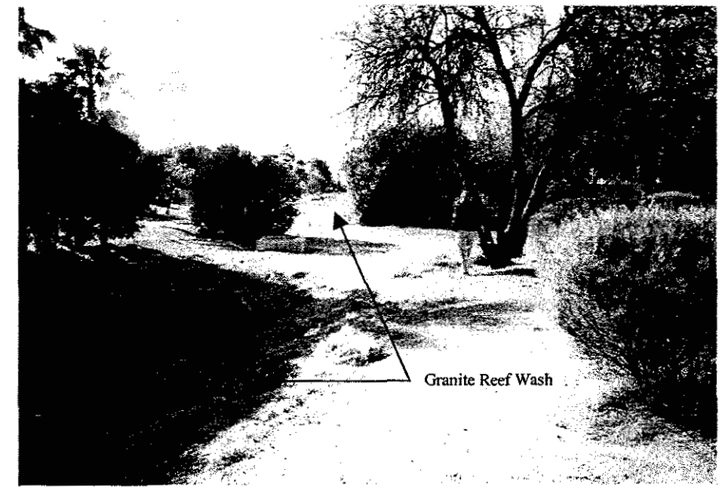
The 1959 photograph (**Figure 1.4**) shows that agricultural development both in the City of Scottsdale as well as in the SRPMIC land altered the original alignment of the wash, forcing it into its current alignment. This photo clearly shows a diagonal berm protecting the agricultural fields within the current SRPMIC trailer park.

In recent years, the lack of an adequate channel below McKellips Road has been a recurring problem affecting traffic and access along McKellips Road during flooding. Recently the Maricopa County Department of Transportation has improved the wash crossing at McKellips by installing a double 3'X10' box culvert and by widening the outlet within the roadway right-of-way to match the culvert outlet width. However, the downstream channel beyond the roadway right-of-way still limits the flow capacity at this location because its inadequate size and lack of maintenance.

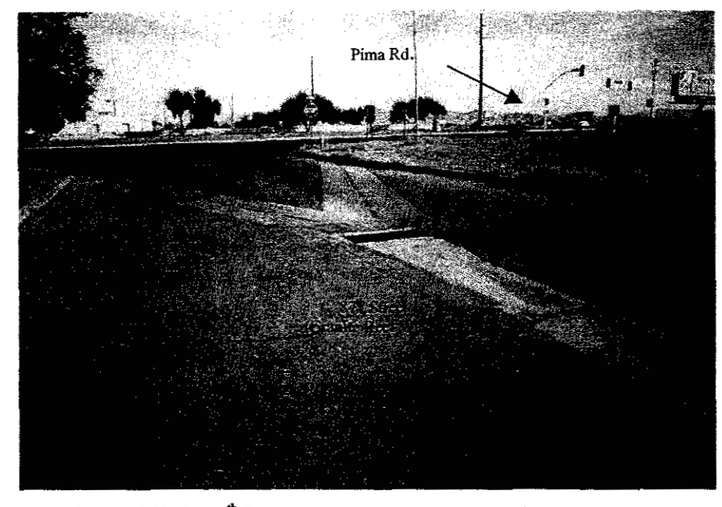
Project Need

The storm water conveyance system within the Granite Reef Wash drainage area has insufficient capacity to collect and convey major storm events; in particular, the 100-year flood event as defined in the FEMA Flood Insurance Study for the City of Scottsdale. Additionally, the wash does not have an adequate outfall to the Salt River through the SRPMIC land south of McKellips Road.

The scope of this project is focused on the original alignment of the Granite Reef Wash starting at the intersection of Pima Road and Thomas Road and extends south to the Salt River. The historical watershed east from this point has been cut off by the Loop 101 Pima Freeway. However, significant flooding has been observed at this intersection by runoff generated north of Thomas Road from both the City of Scottsdale and SRPMIC land. From Thomas Road to McKellips Road, the natural wash has been replaced by a combination of channels, roadway sections, and storm drains that, for the most part, do not have adequate capacity to convey runoff from a significant storm.



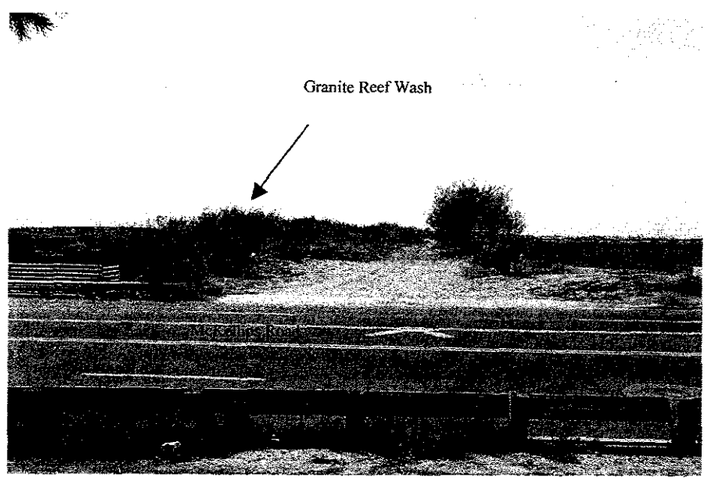
Granite Reef Wash North of Belleview Street Looking South Towards 84th Place



Granite Reef Wash (87th Street) Looking North Towards Thomas Road

In the past, there was no consensus on the 100-year peak flows along Granite Reef Wash. As a consequence, the actual floodplain boundary is also unknown. As currently mapped, the effective Federal Emergency Management Agency (FEMA) floodplain could be too narrow and some residents may unknowingly be at risk, or it could be too wide, in which case residents are currently required to pay flood insurance which may not be needed.

South of McKellips Road, the wash discharges into an irrigation tail water ditch through the SRPMIC land. This ditch does not have adequate capacity to convey even minor storm runoff. As a result, storm runoff ponds along McKellips Road and creates a hazardous condition, forcing this main arterial road to close during major storm events. Lack of maintenance of the tail water ditch resulted in heavy overgrown vegetation along the entire reach. The condition of this channel further contributes to the conveyance difficulties in this area.



Granite Reef Wash Looking South Across McKellips Road

Project Objectives

The purpose of the Granite Reef DMP is to update the hydrology of the watershed, identify possible improvements to minimize flooding potential within the watershed, and to look into reducing the floodplain inundation area along the Granite Reef Wash through verification of flow or by identifying effective improvements.

There are three major objectives of the study:

- The first objective is to quantify the reported drainage problems within the study area.
- The second objective is to assess the adequacy of existing infrastructure in terms of drainage and flood protection.
- The third objective is to develop a plan to prevent the study area from potential flood damage caused by a 100-year storm and to reduce the floodplain along Granite Reef Wash.

Several hydrologic models had been developed for this area. However, the flows obtained from these models varied significantly. There is a lack of agreement on which model, if any, is appropriate. Therefore, a key part of this third objective is to develop a hydrology model to meet the current District and City standards, and is acceptable to all key stakeholders.

Project Participation

The District has funded this project and both the City and the SRPMIC were involved throughout the entire process and their needs and expectations were taken into consideration. Public participation was withheld until, and if, Phase II of this project (further evaluation of alternatives) is undertaken.

In addition to the above mentioned agencies, Entellus coordinated and obtained information and input from the following agencies:

Arizona Department of Transportation (ADOT)
Maricopa County Department of Transportation (MCDOT)
United States Corps of Engineers (COE)
Arizona Department of Water Resources (ADWR)
Bureau of Indian Affairs (BIA)
Arizona Department of Environmental Quality (ADEQ)
Environmental Protection Agency (EPA)
Local utility companies

Previous Studies

Several previous studies have been conducted in the study area. These studies were reviewed and useful information was used to develop the new hydrology and potential solution alternatives. The most relevant studies reviewed include:

Granite Reef Wash Flood Mitigation Candidate Assessment Report prepared by Primatech Engineers and Consultants in 1999 .

Granite Reef Wash Floodplain Delineation Study prepared by Entellus, Inc. in 1997

Report on Granite Reef Wash Drainage Study prepared by KVL Consultants, Inc. in 1995.

Granite Reef Wash Drainage Study prepared by Simons, Li & Associates in 1995.

Storm Water Master Plan and Management Program, City of Scottsdale prepared by Boyle Engineering Corporation in 1993.

FEMA – Flood Insurance Study – Maricopa County, Arizona and Incorporated Areas (FEMA 1984)

Complete references for these reports as well as other reports and documents are included in **Table 1.2**.

The regulatory flows published by FEMA are substantially lower than the results obtained by the more recent studies. The 100-year flow from some of these studies at McKellips Road are summarized below:

FEMA (1984)	1,417 cfs
Simons, Li & Associates (1995)	4,160 cfs
KVL Consultants, Inc. (1995)	5,205 cfs

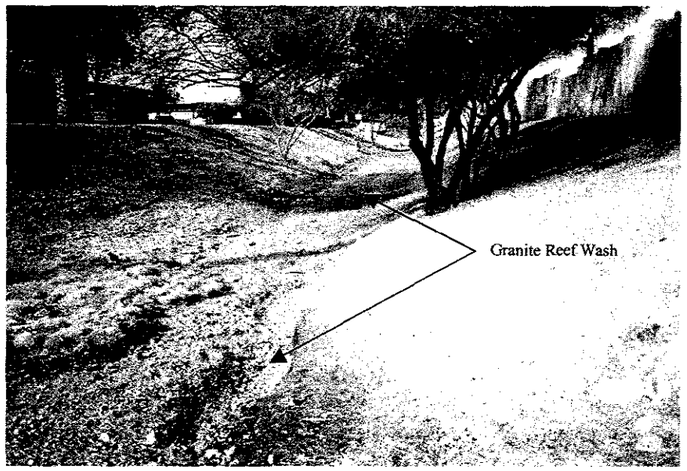
As shown in the data above, there is a wide range between the results of the different studies. Most of the differences can be explained by the different assumptions used, and in particular, the land use in the SRPMIC area. In addition to the assumptions, these studies used methodologies that are not accepted by all interested agencies, further decreasing confidence in the usefulness of these studies.

The two flood insurance studies used the same flows developed in 1984 before the construction of the Loop 101 Freeway and before some of the development within the City of Scottsdale had taken place. From the comparison of flows, the regulatory FEMA flow is the lowest of all the studies and, since the floodplain was delineated

based on this flow, it may appear that the width of the floodplain may have been underestimated.

Existing Facilities

Most of the watershed is already developed with the exception of the SRPMIC land. Therefore, there is a significant amount of infrastructure in place. The drainage system primarily consists of transportation corridors that double as a conveyance system during storm events. However, there are several storm drains, detention basins, drainage channels, and other drainage structures within the watershed. **Figure 1.5** shows the location of the main drainage facilities identified by this study. The following paragraphs and **Table 1.1** (located at the end of this report) provide additional information about these facilities including ownership, capacity, and effectiveness. Additional **Figures 1.6A** and **1.6B** shows the main development within the study area.



Granite Reef Wash Looking West from 87th Street North of McDowell Road

Information about these facilities was obtained mainly from as-built plans, survey, field measurements, and drainage reports. In addition, the capacity of facilities not specified in the previous sources were determined using normal depth calculation for open channels and close conduit analysis for storm drains. The main existing drainage structures are storm drains located in the northern portion of the watershed, which divert flows to the Indian Bend Wash. The storm drains are located at Jackrabbit Road, Chaparral Road, Camelback Road, and Indian School Road. These storm drains were designed to handle runoff from a 25- to 50-year storm. In addition to these main storm drains, there are other smaller storm drains primarily along Pima Road and McDowell Road that were designed to handle the 2-year storm; the storm drain in the alignment of the Granite Reef Wash conveys the 1- to 2-year flow. There are also some open channels mainly along the Granite Reef Wash alignment and along Pima Road but most of the flow is conveyed through the roadway system with Granite Reef Road, Pima Road, and 87th Street as the main north-south conveyance.

Some of the subdivisions within the study area have constructed their own drainage facilities, mostly small detention basins and diversion channels. One of these subdivisions is Scottsdale Summit, located north of Thomas Road and west of Pima Road. As part of their drainage system, they constructed a channel along the southeast corner of the subdivision to divert local flow to the Pima Access Road. Also along the northern boundary of this subdivision, there is a channel that intercepts flows from the north and conveys it to the Pima Access Road. This flows is then conveyed along the access road south towards Thomas Road and eventually flows across Thomas Road and into the Granite Reef Wash alignment along 87th Street. This information was obtained from the field and by reviewing the Master Drainage Study Report for the subdivision (See **Table 1.2,** Item 56 for reference information). Other subdivisions, such as The Trails at Scottsdale, have detention basins along their east and south boundaries.

Other drainage facilities include a series of detention basins within the Motorola Plant to attenuate local flows within the plant. Also, the City recently constructed a large detention basin (4.2 Acre-feet) at McDonald Road west of Pima Road. This detention basin serves as an outfall for the Pima Road storm drain and local flows. There are several large catch basins along McDonald Road to intercept roadway flows and conveyed them to the basin. The basin outlets into the Pima Road storm drain and eventually to the Chaparral Road storm drain to the Indian Bend Wash. Flows in excess of the capacity of the storm drain flow south along roadway alignments and eventually enter Granite Reef Wash.

Whenever available, as-built information was obtained for these facilities. A listing of the as-built information obtained is included in **Table 1.2**.

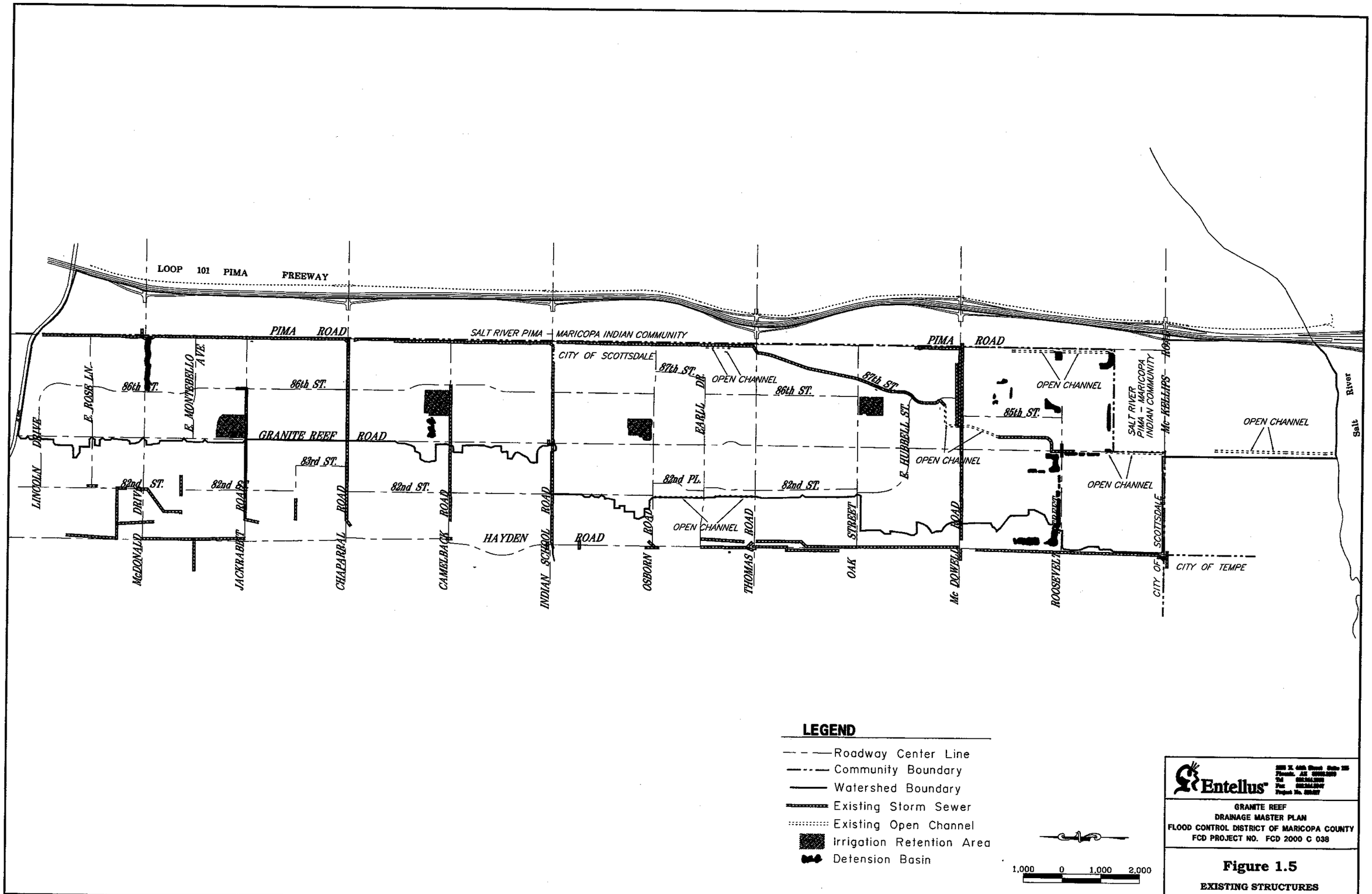
The City of Scottsdale is planning to construct another storm drain along Indian School Road to divert flow to Indian Bend Wash. This storm drain would be a 72-inch pipe paralleling the existing 72-inch storm drain. The City is constructing the crossing at Hayden Road as part of a joint project with ADOT. The rest of the storm drain has been designed and is scheduled to be built within a few years.

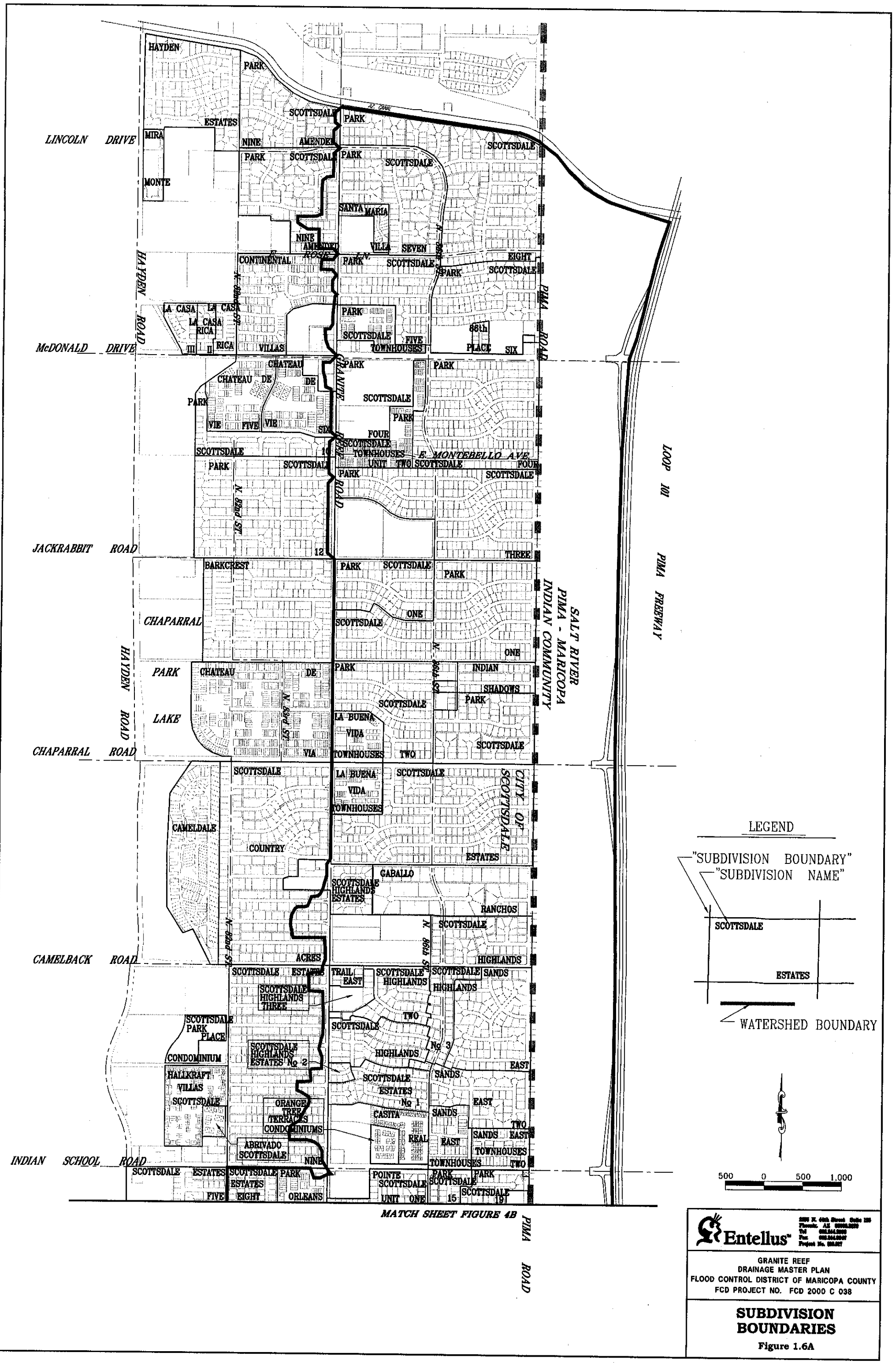
Flooding Problems

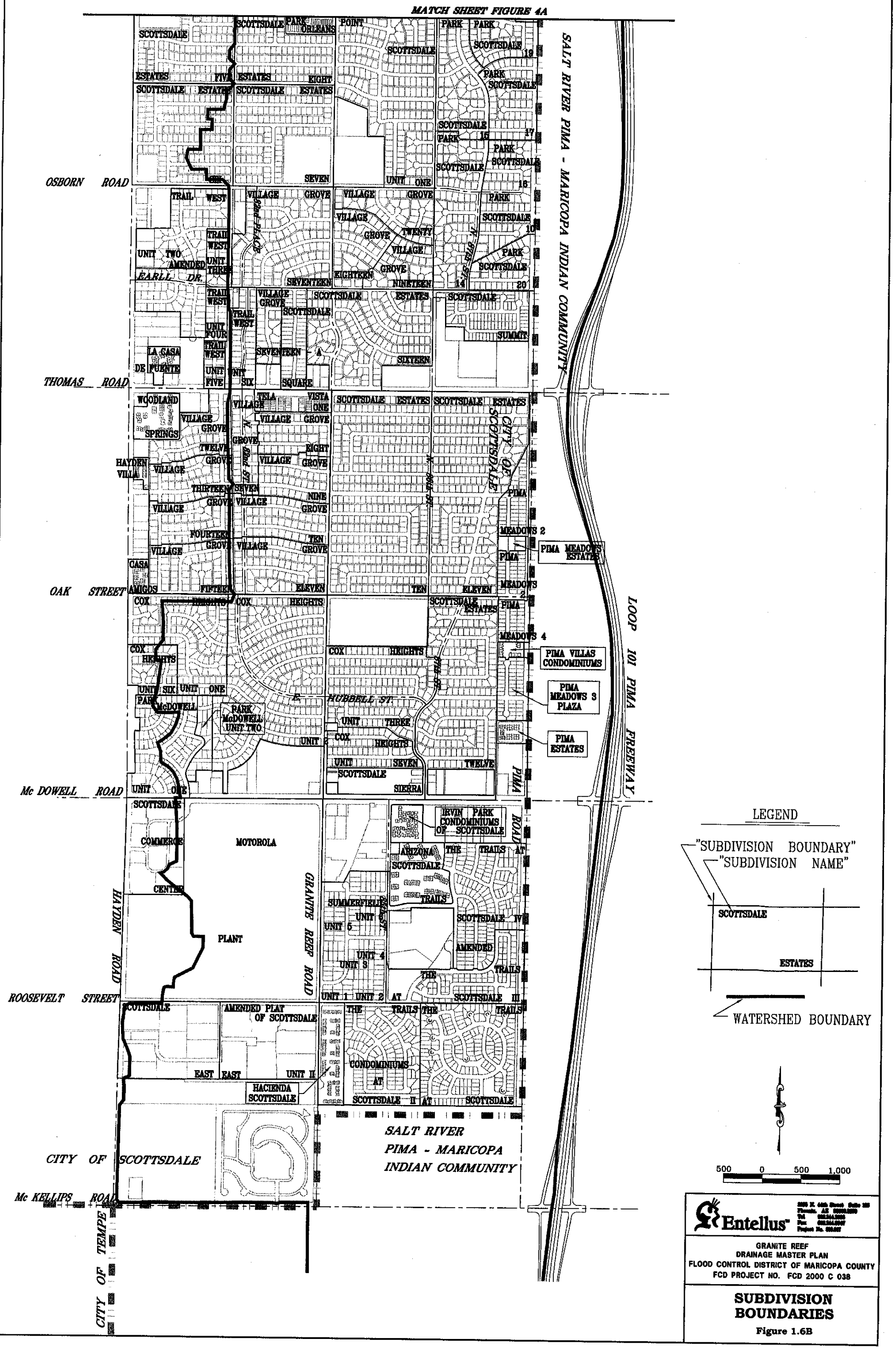
The SRPMIC does not maintain records of citizen complaints with respect to flooding problems. City of Scottsdale staff indicated that most complaints in the area are related to flood insurance requirements as a result of the FEMA floodplain. Citizens feel that since the construction of the Loop 101 Freeway, the flow to Granite Reef Wash has been cut off and they are no longer at risk of flooding and should not need to purchase flood insurance. Entellus requested information about known flooding problems from Maricopa County Department of Transportation (MCDOT), the District, the City and local residents. Additionally, the local library's periodicals were researched for published flooding data within or near the study area. The result of this effort is summarized in below and the locations identified in **Figure 1.7**.

A well-documented flooding problem was identified at the crossing of Granite Reef Wash at McKellips Road. McKellips Road has been closed several times because flooding created a hazardous condition. MCDOT, in an effort to alleviate conditions, has improved the crossing by installing a new double 3'H X 10W' box culvert and cleaning the outlet within the roadway right-of-way. However, the downstream channel through the SRPMIC remains unimproved and not maintained. Therefore, it does not have adequate capacity to convey even minor flows.

There are also reports that the intersection of Pima Road and Thomas Road experiences frequent flooding primarily by runoff from the SRPMIC land crossing Pima Road towards the historical alignment of Granite Reef Wash, and also by runoff from the City of Scottsdale collected along the Pima Access Road. City staff stated that a severe storm (sometime after 1995) forced the City to close some roads in this vicinity. Also the City has received several complaints from the neighborhood near the northwest corner of this intersection.


LOOP 101 PIMA FREEWAY
PIMA ROAD
SALT RIVER PIMA – MARICOPA INDIAN COMMUNITY
CITY OF SCOTTSDALE
PIMA ROAD
E. ROSE LN.
E. MONTEBELLO AVE.
86th ST.
86th ST.
87th ST.
OPEN CHANNEL
86th ST.
87th ST.
OPEN CHANNEL
85th ST.
SALT RIVER PIMA – MARICOPA INDIAN COMMUNITY
McKELLIPS ROAD
OPEN CHANNEL
Salt River
LINCOLN DRIVE
GRANITE REEF ROAD
83rd ST.
EARLL DR.
E. HUBBELL ST.
OPEN CHANNEL
OPEN CHANNEL
82nd ST.
82nd ST.
82nd ST.
82nd PL.
82nd ST.
OPEN CHANNEL
McDONALD DRIVE
JACKRABBIT ROAD
CHAPARRAL ROAD
CAMELBACK ROAD
HAYDEN ROAD
INDIAN SCHOOL ROAD
OSBORN ROAD
THOMAS ROAD
OAK STREET
Mc DOWELL ROAD
ROOSEVELT
CITY OF SCOTTSDALE
CITY OF TEMPE
LEGEND
Roadway Center Line
Community Boundary
Watershed Boundary
Existing Storm Sewer
Existing Open Channel
Irrigation Retention Area
Detension Basin
1,000 0 1,000 2,000
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
Figure 1.5
EXISTING STRUCTURES
FILE: N:\300\310021\dwg-reports\Existing Structures Plate.dwg DATE: 08/21/02


LINCOLN DRIVE
McDONALD DRIVE
JACKRABBIT ROAD
CHAPARRAL ROAD
INDIAN SCHOOL ROAD
CAMELBACK ROAD
HAYDEN ROAD
PIMA ROAD
LOOP 101 PIMA FREEWAY
SALT RIVER PIMA - MARICOPA INDIAN COMMUNITY
CITY OF SCOTTSDALE
E. MONTEBELLO AVE.
MATCH SHEET FIGURE 4B
LEGEND
"SUBDIVISION BOUNDARY"
"SUBDIVISION NAME"
WATERSHED BOUNDARY
500 0 500 1,000
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
SUBDIVISION BOUNDARIES
Figure 1.6A


MATCH SHEET FIGURE 4A
OSBORN ROAD
THOMAS ROAD
OAK STREET
Mc DOWELL ROAD
ROOSEVELT STREET
Mc KELLIPS ROAD
HAYDEN ROAD
GRANITE REEF ROAD
PIMA ROAD
SCOTTSDALE ROAD
EARLL DR.
E. HUBBELL ST.
SALT RIVER PIMA - MARICOPA INDIAN COMMUNITY
LOOP 101 PIMA FREEWAY
CITY OF SCOTTSDALE
CITY OF TEMPE
PIMA MEADOWS ESTATES
PIMA VILLAS CONDOMINIUMS
PIMA MEADOWS 3 PLAZA
PIMA ESTATES
IRVIN PARK CONDOMINIUMS OF SCOTTSDALE
HACIENDA SCOTTSDALE
MOTOROLA
PLANT
LEGEND
"SUBDIVISION BOUNDARY"
"SUBDIVISION NAME"
WATERSHED BOUNDARY
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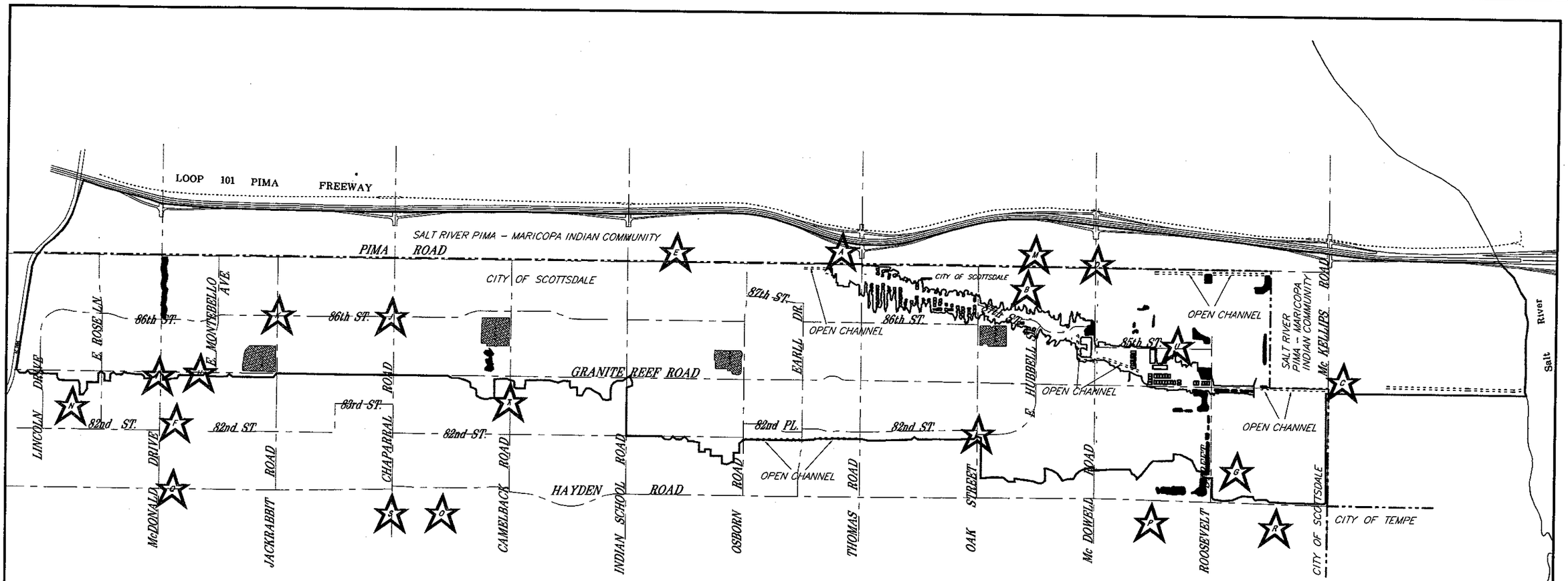
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
SUBDIVISION BOUNDARIES
Figure 1.6B



A — RUNOFF FROM SRP–MCI CONCENTRATE AT THIS INTERSECTION AND FLOW ACROSS PIMA ROAD.

B — IDENTIFIED 100 YEAR FLOODPLAIN.

C — FLOODING FORCES MCDOT TO CLOSE McKELLIPS ROAD ON SEVERAL OCCASIONS.

D — PONDING IN VACANT LOT ON NW MOST CORNER OF MCDOWELL AND PIMA. GROUND APP. 1 FT LOWER THAN ROADWAY ELEVATION.

E — FLOW FROM INDIAN COMMUNITY CONCENTRATES A FLOW SOUTH ALONG PIMA RD. RECENTLY STORMDRAIN CATCH BASINS ALLEVIATE THIS PROBLEM, BUT LARGER STORMS (OVER 2–YR STORMS) WILL CONTINUE TO FLOW OVER LAND AT THE ALIGNMENT.

F — 82ND ST. AND MCDONALD DR, NW CORNER WATER LAPPING AT DOOR OF RESIDENT.

G — S OF ROOSEVELT, E OF HAYDEN CONDO PARKING LOT FLOODED.

H — HOUSE FLOODING IN 1970/71.

I — FLOODING OF BASHA'S PARKING LOT.

J — CHRONIC FLOODING PROBLEM POSSIBLY CORRECTED BY CHAPARRAL RD. STORMDRAIN.

K — CHRONIC FLOODING PROBLEM POSSIBLY CORRECTED BY JACKRABBIT RD. STORMDRAIN.

L — PONDING AROUND 81ST WAY AND OAK ST AREA NE–CORNER OF 81ST ST AND OAK–FIXED

M — WATER NOT DRAINING AT SOUTH ENTRANCE–PONDING OCCURS.

N — STREET PONDING

O — PONDING IN STREET GUTTER ALONG 78TH ST.

P — PUDDLING ALONG CULVER ST GUTTER SUBSIDENCE.

Q — DRAINAGE PROBLEM ON NORTH SIDE OF McDONALD.

R — GUTTER PROBLEM AT CORNER AND FLOODING OF VARIOUS HOUSES AND YARDS IN AREA.

S — STANDING WATER AT ENTRANCE.

T — PONDING IN NEIGHBORHOOD ALLEY.

U — SUMMERFIELD AREA– SEVERAL COMPLAINTS OVER THE YEARS REPORTING FLOODING.

LEGEND

- Roadway Center Line
- Community Boundary
- Watershed Boundary
- Existing Storm Sewer
- Existing Open Channel
- Ponding Area
- Basin Area

1,000 0 1,000 2,000

Entellus

GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038

Figure 1.7

KNOWN FLOOD-PRONE AREAS

A 100-year flood hazard zone has been identified along the historical alignment of the Granite Reef Wash. The original floodplain was first delineated in 1984 and revised in 1997. Both of these studies used the same flow. However, the flows used in these studies are not well documented and cannot be corroborated. Subsequent hydrologic studies developed by other agencies used methodologies and assumptions that were not consistent and accepted by all agencies. As a result, there is a low degree of confidence and no consensus on flows and the delineated FEMA floodplain along Granite Reef Wash.

As part of this study, a new hydrology was developed and adopted by all agencies. The new hydrology analysis is further discussed on Part 2 and documentation for this analysis is included in the *Granite Reef Wash Drainage Master Plan Hydrology Report* **Table 1.3** details some the effects of the new flow on the floodplain and compares it to the current FEMA floodplain

TABLE 1.3

Effect of New Flows on the Floodplain

	Current FEMA Floodplain	Actual Floodplain (New Flows)	Difference
100-yr flow at McKellips Rd.	1417 cfs	2350 cfs	933 cfs
100-yr flow at McDowell Rd.	1240 cfs	1900 cfs	660 cfs
No. of Structures within the floodplain (permanent/mobile homes)	126 / NA	364 / 690	238 / 690

According to City staff and area residents, water periodically flows along 87th street, but it is mostly contained within the roadway. Long time residents have seen water high enough to jump the curb and flood front yards, but they cannot recall any homes being flooded from storm runoff. However, in 1972 some homes were flooded when the Arizona Canal was breached at Pima Road.

The following is a list of known flooding problems compiled from City staff records, resident recollections, and District and MCDOT records. These locations are also identified in **Figure 1.7**.

- **Location A** - Thomas and Pima Roads - Run-off from SRPMIC at intersection and flow across Pima Road. Also, flow from SRPMIC combines with runoff from the City mainly flowing along the Pima Access Road and crosses Thomas Road near the Pima Road crossing.
- **Location B** - Granite Reef Wash 100-year floodplain.
- **Location C** - McKellips Road - Flooding forces MCDOT to close McKellips Road on several occasions.
- **Location D** - NW corner McDowell and Pima Roads - Ponding in vacant lot, ground approximately 1 ft lower than roadway elevation.
- **Location E** - Pima Road between Osborn and Indian School Roads - Flow from Indian Community concentrates flow south along Pima Road. Recently storm drain catch basins alleviate this problem, but larger storms (over 2-year storms) will continue to flow over land at the alignment.
- **Location F** - NW corner 82nd Street and McDonald Drive - Water lapping at door of residence. (Outside project boundary)
- **Location G** - South of Roosevelt and east of Hayden - Condominium parking lot flooded.
- **Location H** - 1970-71 - Corner of Granite Reef Road and Solano Drive – Local resident recalls flow on the road and occasionally jumping the curb, home flooded in 1970 (or 1971).
- **Location I** - SE corner McDonald Drive and Granite Reef Road - Flooding at Basha's parking lot.
- **Location J** - Chaparral Road and 86th Street - Chronic flooding problem possibly corrected by Chaparral Road storm drain.
- **Location K** - Jackrabbit Road and 86th Street - Chronic flooding problem possibly corrected by Jackrabbit Road storm drain.
- **Location L** - 12/04/92 - 2301 N. 81st Way - Ponding around 81st Way and Oak Street area, NE corner 81st Street and Oak fixed.
- **Location M** - 1/26/93 - 1650 N. Pima Road - Water not draining at south entrance - ponding occurs.
- **Location N** - 9/30/92 - 8308 E. Malcomb - Street ponding. (Outside project boundary)
- **Location O** - 9/6/91 - 78th Street and Meadowbrook - Ponding in street gutter along 78th Street. (Outside project boundary)
- **Location P** - 8/21/91 - 7924 E. Culver Street - Puddling along Culver Street - gutter subsidence. (Outside project boundary)
- **Location Q** - 3/19/93 - McDonald Drive and Hayden - Drainage problem on north side of McDonald. (Outside project boundary)
- **Location R** - 10/11/00, 10/30/00 - 720 N. 78th Street - Gutter problem at corner and flooding of house and yards. Neighbor to the north also affected (Outside project boundary)
- **Location S** - 4/19/99 - 79th Street and Chaparral Road - Standing water at entrance. (Outside project boundary)
- **Location T** - 8308 E. Camelback Road - Ponding in neighborhood alley.
- **Location U** - Summerfield Area - Several complaints over the years reporting flooding.

Review of the meteorological records revealed that several moderate storms have occurred within the study area. However, no major storms have been reported. Most of the information compiled was related to the Indian Bend Wash watershed and, even though the lower portion of this watershed is adjacent to the Granite Reef Watershed, most of the contributing area extends further north and could be exposed to completely different storm events. The National Climatic Data Center (NCDC) recorded several storm events near the project area.

The following is a summary of data obtained from NCDC's web site: (http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms).

- Over an inch of rain in only 15 minutes near Hayden and McDowell Roads on July 17, 2001.

- A strong storm system moved through the valley producing heavy rain and resulted in street flooding and roadway closures. Phoenix fire department responded to four swift-water rescues. Flooding was reported around Indian Bend Wash. October 10, 2000.

- Streets and roads flooded after receiving about 1.5 inches of rain per hour. July 29, 1999.

- An outbreak of thunderstorms in Scottsdale produced very heavy rainfall which caused some localized flooding. Automobiles were stuck in Indian Bend Wash at McCormick Parkway between Hayden Road and Scottsdale Road. Water flowing through Indian Bend Wash rose to three feet which caused closure of some roads for a time. Rainfall totals around the area were between one and two inches. August 26, 1997.

- Thunderstorms produced heavy rain as they moved through Scottsdale. Indian Bend Wash, which is normally dry, flooded quickly and forced closure of two roads. There was a report of street flooding at Scottsdale and McDowell Roads. A spotter in south Scottsdale reported a storm total of .80 inches of rainfall. Wind gusts to 45 mph accompanied the storms. August 18, 1996.

- Strong winds downed small and medium-sized trees as well as street signs. Heavy rain accompanied the winds in south Scottsdale. Thunderstorm winds blew over a tree which crashed onto a roof of an apartment and damaged part of the ceiling. Wind blew over hundreds of trees in the downtown area and snapped several power poles. More than two inches of rain fell, flooding streets and homes, and filled Indian Bend Wash. September 28, 1995.

The District maintains a network of rainfall gauges throughout the County. Data collected from these sites are available at their web site (http://www.fcd.maricopa.gov). Review of the rain gauge at Indian Bend Wash and McKellips Road indicates that some significant storms have occurred in the area and verify some of the information obtained from NCDC. Some of the most significant events registered since data has been collected from this station (1988) are:

- September 28, 1995 - 3.54 inches in 24 hours

- August 26, 1997 - 2.44 inches in 24 hours

- July 7, 1999 - 1.34 inches in 24 hours

- October 26, 1998 – 1.04 inches in 24 hours

Structure No.	Structure Type	Location	Ownership	Structure Size	As-built #	Capacity	Level of protection
				(acres)		(acres)	
P1	Pond	NE corner Granite Reef Rd and Jackrabbit Rd	Mohave School	9.2		9.2	N/A
P2	Pond	NW corner Camelback Rd and 86th St	Navajo School	8.876		8.9	N/A
P3	Pond	NE corner Osborn Rd and Granite Reef Rd	Pima School	6.266		6.3	N/A
P4	Pond	S of Oak St and 86th St	Hohokam School	6.084		6.1	N/A
						(acre-ft)	
B1	Basin	McDonald Dr, 86th St to Pima Rd	COS	3.422		4.3	2 hr - 100 yr
B2	Basin	N of Camelback Rd, between Granite Reef Rd and 86th St	COS	1.542		2.1	2 hr - 100 yr
B3-B5	Basin	3 basins between 85th Pl, 86th Pl and Belleview Pl, Moreland St	Scotsdl the Trails	0.43		0.2	2 hr - 100 yr
B6	Basin	E of 86th Way, between Belleview Pl and 86th St	Scotsdl the Trails	0.323		0.9	2 hr - 100 yr
B7	Basin	N Roosevelt St between 85th Pl and Latham St	Scotsdl the Trails	1.401		5.9	2 hr - 100 yr
B8	Basin	W of Pima Rd and S of Portland St	Scotsdl the Trails	0.729		3.0	2 hr - 100 yr
B9-B15	Basin	7 basins N of Roosevelt St between Hayden Rd and Granite Reef Rd	Motorola	4.463		15.6	2 hr - 100 yr
B16-18	Basin	3 basins W of Granite Reef Rd between Roosevelt St and East D St	Scotsdl East Unit 2	1.065		0.5	2 hr - 100 yr
B19	Basin	E of Granite Reef Rd and NE of D St	Mobile home park	0.2		0.7	2 hr - 100 yr
B20	Basin	S of Fillmore St, E of Granite Reef Rd	Scotsdl the Trails	0.967		2.1	2 hr - 100 yr
B21	Basin	S of E Roosevelt Circle, between 87th St and Pima Rd	The Trails @ Scotsdl	1.615		6.5	2 hr - 100 yr
				(w x depth)		(cfs)	
Cul-1	Roadway crossing	Culvert at McDowell and 87th St	COS	12' x 8'		960	100 yr
Cul-2	Roadway crossing	Culvert at N or McKellips and Granite Reef Rd	COS	2-10' x 8'		1472	10 yr
Cul-3	Roadway crossing	Office Building over Wash	COS	3 span bridge (70' x 9')			50 yr
Cul-4	Roadway crossing	Culvert at Granite Reef Rd and McKellips Rd	MCDOT				2 yr
				(top w x depth)		(cfs)	
C1	Channel	Granite Reef Rd from S of Roosevelt St to McKellips Rd	MCDOT	15' x 5'		551	2 -yr
C2	Channel	Pima Rd from S of McDowell Rd to N of McKellips Rd	COS	8' x 2'		11	2 -yr
C3	Channel	SW of Coronado Rd and 87th St to N of 84th Pl and Belleview St	COS	10' x 3'		148	2 -yr
C4	Channel	S of Earll Dr between 81st Pl and 82nd St to Thomas Rd	COS	5' x 2'		22	2 -yr
C5	Channel	Osborn Rd at 82nd St to Earll Dr between 81st Pl and 82nd St	SRP-Irrigation	7' x 2'		25	N/A
C6	Channel	S of Cherry Lynn Rd to S of Pinchot Ave along Pima Rd	COS	5' x 2'		43	2 hr – 100 yr
C7	Channel	S of McKellips Rd and 87th St	SRPMIC	10' x 3'		111	
C8	Channel	Pinchot Ave and 87th Way connecting to channel	COS	5' x 1'		8	2 - yr
				(in)		(cfs)	
SD-01	Storm drain	@ Roosevelt and Granite Reef Rd	COS	54	FC-7551		
SD-02	Storm drain	N. of Roosevelt E. of Granite Reef Rd	COS	48		68	
SD-03	Storm drain	Hayden to Granite Reef Rd on McDowell	COS	18		4	
				(in)		(cfs)	

Structure No.	Structure Type	Location	Ownership	Structure Size	As-built #	Capacity	Level of protection
SD-04	Storm drain	McDowell Rd from Granite Reef Rd to Pima	COS	48	96-70	80	
SD-05	Storm drain	McDowell Rd from Granite Reef Rd to Pima	COS	42	96-70	51	
SD-06	Storm drain	McDowell Rd from Granite Reef Rd to Pima	COS	48	96-70	104	
SD-08	Storm drain	N. on Pima from McDowell Rd	COS	42	94-109	47	2 hr storm
SD-09	Storm drain	N. on Pima from McDowell Rd	COS	24	94-109	14	2 hr storm
SD-10	Storm drain	From McDowell N. to Thomas Rd Along 87th Street	COS	48	SD-068	50	
SD-18	Storm drain	From Thomas N. to Indian School Rd on Pima Rd	COS	48	95-120	97	2 hr storm
SD-19	Storm drain	From Thomas N. to Indian School Rd on Pima Rd	COS	54	95-120	47	2 hr storm
SD-20	Storm drain	From Thomas N. to Indian School Rd on Pima Rd	COS	30	95-120	21	2 hr storm
SD-21	Storm drain	From Thomas N. to Indian School Rd on Pima Rd	COS	24	95-120	9	2 hr storm
SD-22	Storm drain	From Thomas N. to Indian School Rd on Pima Rd	COS	18	95-120	4	2 hr storm
SD-23	Storm drain	From Thomas N. to Indian School Rd on Pima Rd	COS	15	95-120	5	2 hr storm
SD-25	Storm drain	From Hayden to Pima Rd on Indian School Rd	COS	72	SD 8313	96	
SD-28	Storm drain	E. of Hayden Rd +/- 523ft. To 86th St on Camelback Rd	COS	60	SD-7623	92	
SD-30	Storm drain	Just E. of Hayden Rd to Pima Rd on Chaparral Rd	COS	96	89-19	525	
SD-31	Storm drain	Just E. of Hayden Rd to Pima Rd on Chaparral Rd	COS	90	89-19	259	
SD-32	Storm drain	Just E. of Hayden Rd to Pima Rd on Chaparral Rd	COS	84	89-19	128	
SD-33	Storm drain	Just E. of Hayden Rd to Pima Rd on Chaparral Rd	COS	60	89-19	63	
SD-34	Storm drain	Just E. of Hayden Rd to Pima Rd on Chaparral Rd	COS	36	89-19	61	
SD-37	Storm drain	From Indian School Rd north to Chaparral Rd on Pima Rd	COS	42	96-01	34	2 hr storm
SD-38	Storm drain	From Indian School Rd N to Chaparral Road on Pima Rd	COS	36	96-01	22	2 hr storm
SD-39	Storm drain	From Indian School Rd N to Chaparral Road on Pima Rd	COS	30	96-01	19	2 hr storm
SD-40	Storm drain	From Indian School Rd N to Chaparral Road on Pima Rd	COS	24	96-01	8	2 hr storm
SD-41	Storm drain	From Indian School Rd N to Chaparral Rd on Pima Rd	COS	18	96-01	4	2 hr storm
SD-07	Storm drain	100 LF of pipe runs E./W. approx.~1,395 ft. N. of McKellips on Pima Rd	COS	24	96-70		2 hr storm
SD-46	Storm drain	From Chaparral Rd to McDonald Dr on Pima Rd	COS	24	98-107	13	2 hr storm
SD-52	Storm drain	From McDonald Dr to the AZ. Canal on Pima Rd	COS	30	99IB073	21	2 hr storm
SD-53	Storm drain	From McDonald Dr to the AZ. Canal on Pima Rd	COS	24	99IB073	13	2 hr storm
SD-55	Storm drain	From wash E.of Hayden Rd to 86th St on Jackrabbit Rd	COS	18			

GRANITE REEF WASH
DRAINAGE MASTER PLAN
FCD 2000C038

PART 2. ALTERNATIVE FORMULATION

Overview

This DMP was initiated by the District in 2000 to identify flooding potential along Granite Reef Wash from Thomas Road to its confluence with the Salt River. This was accomplished by developing new hydrology and then identifying with hydraulic models, areas that have potential for flooding. Under this project, initial alternative concepts for reducing flooding potential were developed and screened, and recommendations for improvements were made.

Based on the results of the updated hydrology model, which are presented in the *Granite Reef Wash Drainage Master Plan - Hydrology Report* **(Reference 1)**, unofficial 100-year inundation boundaries were developed for the Granite Reef Wash from Thomas Road to the Salt River. These boundaries are wider than the existing floodplain delineated for the 1997 *Granite Reef Wash Flood Insurance Study* **(Reference 2)**, because the updated hydrology model generated larger flows than those used in the flood insurance study. The new inundation boundaries were obtained by updating the flows in the HEC-2 model that was developed by the 1997 flood insurance study. These boundaries are approximate; further examination would be required in order to meet FEMA criteria. Alternative solutions were evaluated based on the new flows and the associated 100-year inundation boundaries.

In order to meet the objectives and to ensure development of consensus on the results for this project, it was important that all the agencies have the opportunity to provide input and direction during the development of the alternatives. The alternatives were conceived and refined in a series of team meetings. The team members included representatives from the District, the City, SRPMIC, and the Study Consultant (Entellus).

The first alternative development meeting was an Alternative Formulation Workshop. In this meeting, available information was presented to the team. Based on this information, several alternatives were developed and ranked according to evaluation criteria developed in the workshop. The results of the workshop included a set of evaluation criteria and five preliminary alternatives for further development and refinement.

Prior to the Alternative Formulation Workshop, Entellus first gathered relevant information, developed a hydrology model, determined the effect of the new flows on the flooding potential of the Granite Reef Wash, and identified possible locations for new drainage facilities. The data collection effort is documented in **Part 1** of this report, the hydrology is documented in a separate hydrology report (**Reference 1**), the inundation limits based on the new flow estimates for the wash are documented in **Appendix E**, and possible drainage facilities locations are discussed later in this report.

In order to refine the alternatives developed in the Alternative Formulation Workshop, Entellus performed preliminary hydrologic and hydraulic analysis to estimate the size, effectiveness, and cost of each proposed improvement. Two additional team meetings were held during this process to present the results and to refine the alternatives based on the collective consent of the entire team. The analysis and development of the alternatives is presented in this report.

Alternative Formulation Workshop

The Alternative Formulation Workshop was held at the District on March 1, 2002. The objectives of the workshop were to:

- Identify the relevant issues of the project
- Clarify the goals and objective of the project
- Identify opportunities and constraints
- Develop evaluation criteria
- Recommend feasible alternatives to be analyzed further

The following sections are detailed description of the objectives, the screening process, and the consensus reached during the Alternative Formulation Workshop. The minutes from this meeting, including the evaluation matrix, are presented in **Appendix B**.

Issues

The first objective of the Alternative Formulation Workshop was to identify all the key issues associated with this project to ensure that all team members communicate their perception of the issues from their own agency perspective, so no key issues were excluded. The five significant issues identified by the team during the workshop were:

- Lack of consensus in existing hydrology,
- Lack of adequate outfall to the Salt River,
- Lack of viable alternatives due to a high degree of urbanization within the City's portion of the watershed,
- Perception of residents that they should not be in the floodprone area,
- Possibility of no identified flood hazards other than along the alignment of Granite Reef Wash.

As discussed in **Part 1** of this report, there is no consensus on the magnitude of runoff to be expected during a 100-year storm. Consequently, agreement on flooding potential along Granite Reef Wash could not be reached in the past.

Additionally, Granite Reef Wash outfalls to the Salt River through a channel that appears to have capacity for only a fraction of the expected 100-year runoff. Providing an adequate outfall to the Salt River may be difficult because the last reach of the wash is within the SRPMIC land and the required easements may be difficult to obtain due to political and land ownership issues.

Since the majority of the watershed is fully developed, most of the alternative solutions would involve some type of retrofitting. Retrofitting is often more expensive and difficult to accomplish.

Based upon input from the District and the City the public is not aware of the existing flooding problems. Many of the residents along the historical alignment of Granite Reef Wash are required to purchase flooding insurance because they are within a FEMA designated floodplain. However, residents do not believe that the area is floodprone and would like to have the floodplain removed.

The area has not experienced any significant flooding in recent years. Flooding potential was identified for Granite Reef Wash resulting from the flood insurance study. The Granite Reef DMP is focused on

the wash alignment between Thomas Road and the Salt River, but there could be other areas in the watershed that may be subject to severe flooding. Flooding potential elsewhere in the watershed may be identified with use of the updated hydrology model and new survey information. Analysis of these additional areas is not included in the scope of work for this project, but potential problem areas were identified. Most of the runoff north of the wash alignment flows south along roadways and significant street flooding is likely along these roads in particular along Granite Reef Road and the Pima Access Road. Also runoff flowing along the east side of the school grounds flow into Osborn Road and significant flow may occur at this location. Most of the runoff north of the wash alignment flows south along roadways. Significant street flooding is likely along these roads, especially along Granite Reef Road and the Pima Access Road. Also, runoff along the east side of the Pima Elementary School grounds flows onto Osborn Road, and significant flooding may occur along this roadway. A discussion of these potential flooding areas is also included in **Appendix B**.

Goals

The second objective of the workshop was to obtain consensus from all team members on what were the goals for the project. The following is a list of the project's main goals identified in the workshop:

- The updated hydrology model that was created for this DMP must have consensus from the City, the District, and the SRPMIC.
- Recommend a solution that can be implemented.
- This solution should be "kindler/gentler", should incorporate aesthetic and recreational elements while considering environmental and cultural issues.
- The recommended alternative needs to be acceptable to the City, the District, and the SRPMIC.
- The FEMA floodplain for the Granite Reef Wash needs to be certified, or justification for re-delineation of the Granite Reef Wash based on the updated Hydrology model needs to be confirmed.
- Validate the Capital Improvements Projects (CIP) for the City.
- Develop a list of other possible solutions to the drainage problems caused by Granite Reef Wash.

Opportunities

There are a few simple opportunities available within the project area due to the high degree of urbanization. However, the following opportunities were identified.

- Close proximity to Indian Bend Wash (IBW). IBW is as close as half a mile away in some locations, which makes it possible to divert flows west into this drainage system. However, any diversion to IBW needs to be fully analyzed in order to determine possible impacts created by the additional flow.
- The majority of SRPMIC land in the project area is undeveloped and facilities to store or convey runoff could be constructed without affecting existing development.
- There are several school playgrounds that could be modified to serve as shallow offline detention basins.
- There are several roadways within the study area that could accommodate storm drains.

Constraints

The team also identified several constraints that must be considered in the alternative development.

- Any outlet through SRPMIC property south of McKellips Road must not increase the current flow reaching this point.
- The existing outlet is extremely under capacity for the 100-year flow and is not being properly maintained. Any new alternative would need to assume that these conditions would continue.
- The City prefers not to have to use its condemnation authority. Any alternative requiring the purchase of residences needs to show significant benefit to the community or willingness of the residents to sell.
- The area is highly developed. Alternatives will most likely affect residents and existing structures (homes, business and others).
- The alternatives developed for this DMP require retrofitting, which is more expensive than building new facilities on undeveloped land. The "cost/benefit" analysis may result in a cost, which is too high compared to the benefit.

Seed Ideas

Prior to the Alternative Formulation Workshop, several preliminary concepts, or seed ideas, were identified and presented to the team. These seed ideas included detention basins, channels, and storm drains. Also elements of previous studies such as the *Granite Reef Watershed Flood Mitigation Candidate Assessment Report* (CAR) were considered. Due to the large percentage of developed land, the possible locations of new facilities were limited. However, the following locations were identified:

Possible basin locations:

- Just northwest of Thomas Road and 87th Street
- Northeast of Pima Road and Thomas Road
- Southeast of Oak Street and Granite Reef Road
- Southeast of Granite Reef Wash and McDowell Road

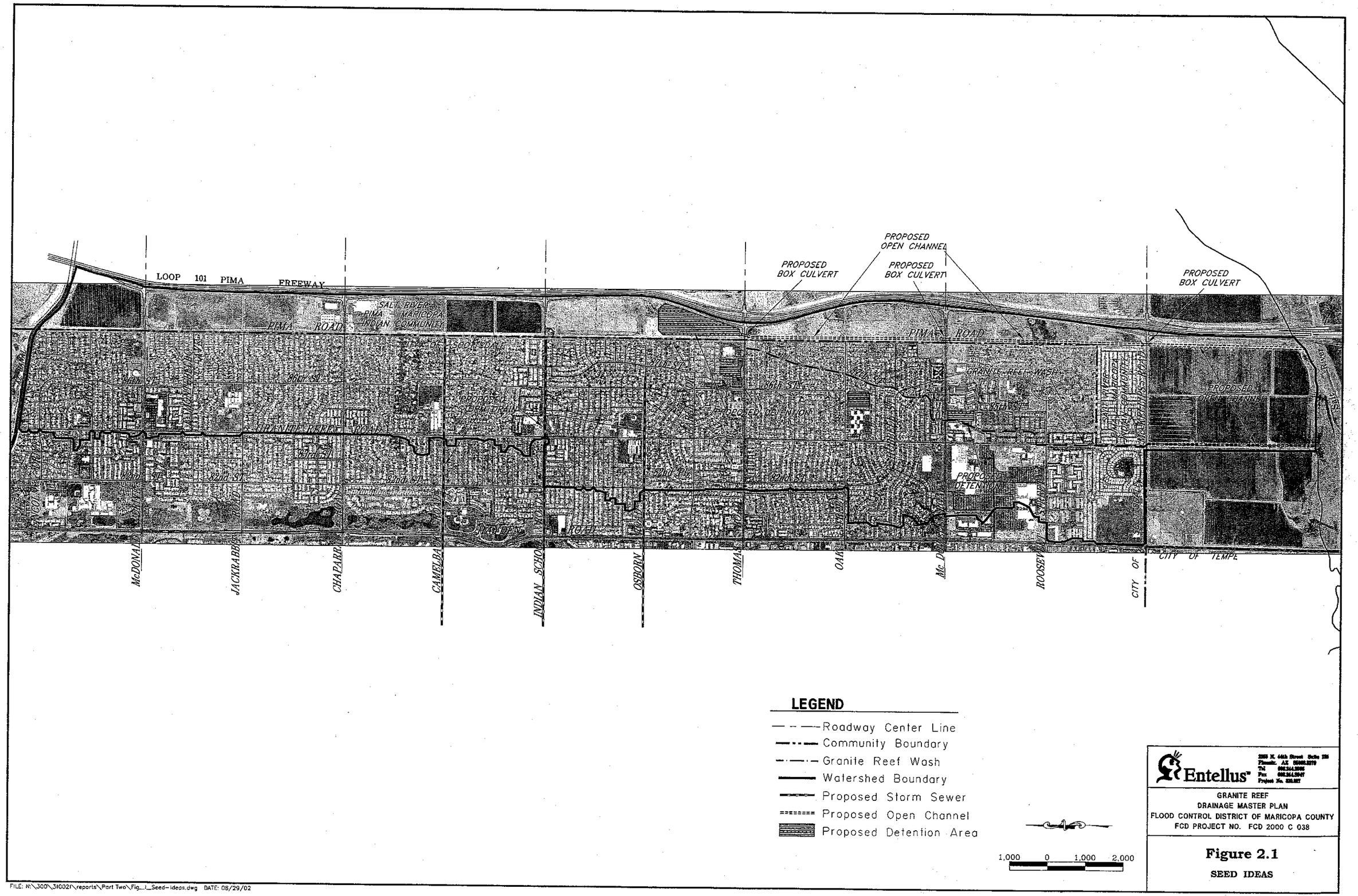
Channel Locations:

- Along Pima Road from Thomas Road to the Salt River
- Along irrigation tail-water ditch from McKellips Road to the Salt River

Storm Drains:

- Along Pima Road from Thomas Road to the Salt River
- Along irrigation tail-water ditch from McKellips Road to the Salt River
- Along Osborn Road from Pima Road to IBW
- Along Indian School Road from Pima Road to IBW
- Along Camelback Road from Pima Road to IBW

A graphic of the seed idea facilities is presented in **Figure 2.1**.



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Screening Alternatives Concepts

Elements from the alternatives presented in the Candidate Assessment Report (CAR), **Reference 7**, were used as seed ideas in the alternative formulation workshop and some of these elements were incorporated into the alternatives analyzed in this reports. The main element that was incorporated is the detention basin within the SRPMIC land. The storm drain along Pima Road was not considered because the SRPMIC representative felt that their agency and the landowners within the SRPMIC most likely would oppose this type of facility. The storm drain along Oak Street was not considered because of significant anticipated utility conflicts and constructibility issues such as minimum cover, and depth of trench.

The City owns a large lot on the northwest corner of the intersection of McDowell Road and Granite Reef Road. This lot used to be a Smitty's Supermarket before it was acquired by the City. The team discussed the possibility of using this site for a detention facility. This site was dismissed because it is relatively far west of the flow path of the runoff (Granite Reef Wash alignment) and it would be difficult to convey flows to this site.

Evaluation Criteria

The following criteria used for evaluating the preliminary alternatives were developed in the workshop:

- The cost/benefit ratio for the proposed alternative. The alternatives that had the lowest cost with the most benefit would score higher in their evaluation.
- Acceptance by City residents.
- Non-objection from the SRPMIC. The SRPMIC would most likely not endorse any alternative, so their non-objection to the alternative was used as an evaluation criteria.
- Is this facility "kindler/gentler" or a sustainable infrastructure asset for the community?
- Reliability of the alternative.
- Approval from the agencies (District, City, and FEMA)
- Constructibility of the alternative. The more difficult an alternative would be to construct and the more disturbances to the neighborhood, the lower it would score on the evaluation.

Preliminary Alternative Evaluation /Ranking

All members of the team were given the opportunity to suggest alternatives for the project. Each of these preliminary alternatives was discussed in detail during the workshop. It was decided by the team to analyze the top five preliminary alternatives by using the brainstorming matrix (See Alternative Formulation Workshop Minutes in **Appendix B**). This matrix rated each alternative against each criteria and gave a weighted value for each criterion. The alternatives were then compared to each other and rated based on the weighted criteria.

The top five preliminary alternatives resulting from the discussions in the workshop were used as a starting point for developing alternatives for this project. The following are the ranking and descriptions of the preliminary alternatives from the Alternative Formulation Workshop. Some of the alternatives have essentially the same ranking scores. Therefore, they were giving the same ranking.

1A) Detention/Diversion. This alternative uses storm drains to divert flows to the Indian Bend Wash and detention basins to reduce the peak flow. Exact location or combinations of these elements were not identified at the time.

1B) Regulatory Solution. This alternative involves re-delineation of the floodplain and/or developing a flood warning system.

2) Watercourse Master Plan. This alternative will analyze the design of a large channel/multi-use facility through the historic Granite Reef Wash alignment.

3) Do Nothing. This alternative would recommend no Capital Improvement or regulatory solution. However, the new hydrology would validate the existing floodplain shown on the current FEMA mapping.

4) Buy Out. This alternative would propose to buy the structures within the floodplain, remove them, and dedicate the land for flood control. This alternative received the lowest score.

Hydrology

One of the main objectives of this project was to develop an updated hydrology model that is accepted by the City, the District, and the SRPMIC. Several hydrologic studies had been performed in this watershed. However, the results of these studies vary significant and the procedures and assumptions used are not acceptable to all interested agencies. The updated hydrology model was developed using HEC-1 model and implementing methodology accepted by the District and the City and based upon more accurate mapping, land use information and current conditions. The 100-year flows at McKellips Road from the different studies are:

FEMA (1984)	1,417 cfs
Simons, Li & Associates (1995)	4,160 cfs
KVL Consultants, Inc. (1995)	5,205 cfs
Entellus, Inc. New (2002)	2,350 cfs

Documentation and results of the hydrology analysis are presented in the *Technical Data Notebook – Granite Reef Wash Drainage Master Plan – Hydrology (TDN)*. This hydrologic analysis included both the 100-year and the 10-year storms. Both the City and the District have approved these analyses as presented in the TDN report. Both agencies agreed that the results and methodology reasonably represent the hydrologic conditions of the watershed. **Appendix B** contains a copy of the May 15, 2002 E-mail (See E-mail Section) from the City accepting the hydrologic analysis results.

The original 100-year model that was developed for this project was modified for each of the alternatives. HEC-1 summary tables from these models are included in **Appendix D**.

Preliminary Alternatives Refinement

The five alternatives identified during the Alternative Formulation Workshop were preliminary and some were not specific. In particular, the Detention/Diversion alternative could mean the analysis of several facilities or combination of facilities. As a result, a number of alternatives were developed in this category. These alternatives will be discussed later in this report. During the development of the alternatives, the project team had the opportunity

of see preliminary results, provide input, give direction, and participate in the refinement of the alternatives. This was accomplished in two team meetings held at Entellus' office on April 18, 2002, and April 29, 2002. From these meetings, the following assumptions and modifications were made to the original alternatives:

- The City is scheduled to construct a 72-inch storm drain along Indian School Road paralleling the existing 72-inch storm drain from Pima Road to IBW. Even though the storm drain is not currently in place, all the alternatives except Regulatory/Do Nothing (workshop Alt. 1B, and 3) were analyzed assuming that this storm drain is operational. The regulatory alternative did not include the effects of the future storm drain because FEMA does not allow future infrastructure to be included in their floodplain delineations.

- The Detention/Diversion Alternative (workshop Alt. 1A) was divided into two separate alternatives. Alternative 3 is now the Diversion Alternative and Alternative 4 is the Detention Alternative.

- The Osborn Road Storm Drain (part of Alt. 3 previously workshop Alt. 1A) examined a storm drain along Osborn Road from Pima Road to the IBW. The size of this storm drain was maximized based on the available corridor along this roadway.

- Four sites were originally considered under Alternative 4 Detention (workshop Alt. 1A); however, two sites were eliminated. A detention site located northwest of Thomas Road and 87th Street was eliminated because currently there are underground tanks located in the open space, and this area is a Superfund Site. The designation of this area as a Superfund Site places severe restrictions on the development of this property due to the existing pollutants. Another eliminated site was located on a school playground on the southeast corner of Oak Street and Granite Reef Road. This site was eliminated because it was not effective in reducing the flow and there were safety concerns due to its proximity to the school. The sites selected for analysis were an underground detention site at the northeast corner of Pima Road and Thomas Road within the SRPMIC land, and an open offline detention basin at McDowell Road just east of the Granite Reef Wash.

- The Do-Nothing Alternative (workshop Alt. 3) was refined and combined with the Regulatory Alternative (workshop Alt. 2). This alternative was renamed "Alternative 5 Regulatory".

- Workshop alternatives 2 and 4 were renamed "Alternative 1 Water Course Restoration" and "Alternative 2 Floodprone Property Acquisition", respectively.

Alternatives Development

The new hydrologic model developed for this project (**Reference 1**) was modified to incorporate the proposed facilities for each alternative in order to determine the effect of the alternative on the 100-year peak flows. Results from the modified hydrology were used to estimate the water surface and inundation limit for each alternative. All the alternatives were based on the updated hydrology and the number of structures affected as well as the cost and benefits were based on the updated floodplain. Current FEMA floodplain was not used in this analysis.

Floodplains within the SRPMIC land were estimated based on the USGS 7.5 minutes Quadrangle topographic mapping and may not accurately reflect the floodplain limits.

For all alternatives except for Alt. 1 the limits of inundations were estimated by modifying the HEC-2 model developed for the 1997 Flood Insurance Study. In most cases, the only parameter modification was the flow. However, Alt. 2 required modification to the cross-sections to account for removal of the structures within the inundation limits. The water surface estimated by the modified HEC-2 model was plotted on the work maps as shown on **Plates 2.1** to **2.5**. From the maps and considering finish floor elevations surveyed as part of the 1997 Flood Insurance Study, the structures affected by the 100-year inundation were identified and tabulated. **Appendix G** identifies the structures at risk and structures to be purchased for each of the alternatives.

In order to analyze and compare the alternatives and to develop an understanding of the benefits associated with each alternative, the value of the properties affected by the alternatives was estimated based on the 2003 Maricopa County Assessors Value. A copy of the relevant assessor data is included in **Appendix G.** Other economical parameters estimated in the analysis of the alternatives included annual flood insurance cost, and estimated flood damages. Both of these parameters were estimated based on the property assessor value. Annual flood insurance cost was estimated based on current rates obtained from FEMA's web site. The average insurance rate was estimated to be approximately $1,079 per each $100,000 of assessed property value. This average rate was estimated based on the Alternative 5 analysis of flood depths for each structure since there are two categories of rates established by FEMA. The Flood Insurance rate for minimum damage is $461 per year for each $100,000 of property value, and the rate for moderate to severe damage is $1,371 per year for each $100,000 of property value. In Alternative 5, the rate for each structure was identified and the total insurance cost was calculated. The average insurance rate was obtained by calculating an equivalent uniform rate (total insurance cost X 100,000 / total property value)

Annual Ins. Cost = Assessed Value / 100,000 * 1079

The average flood damage was estimated at approximately 10% of the assessed property value for all structures within the inundation area.

Another parameter that was considered in the evaluation of alternatives is the percentage cost per total property value. The protected property value was defined as the total value of properties removed from the floodplain by the alternative but it does not include the property value of structures purchased to implement the alternative.

% prop. Value = Impl. cost / protected property value * 100

Protected value = Alt 5 Prop. Value – prop. Value in floodplain

For all alternatives, gauging of public reaction was based on team experience on similar projects, but it does not reflect actual public opinions.

Alternative 1 - Water Course Restoration

Description

This alternative consists of the construction of a multi-use channel generally along the original alignment of the Granite Reef Wash beginning at the intersection of 87th Street and Thomas Road and

ending at the confluence with the Salt River within the SRPMIC land (see **Plates 2.1A** and **2.1B**). This alternative would require purchasing several residences and other structures along the new channel alignment, as well as residences that would not have access due to the creation of this channel. An alteration to the transportation system near the channel would also be required.

This alternative includes two main roadway crossings: one at McDowell Road, the other at McKellips Road. There would also be two wet crossings, one at Oak Street and the other at Roosevelt Street. Additionally, 87th Street and other minor streets would need to be modified by either constructing cul-de-sacs or minor changes to the grade and alignment of the streets.

The typical cross-section of the channel would consist of a passive recreational area with a depth of approximately 6 feet and an active recreational area with a maximum depth of 3 feet. In general, the footprint of the wash is approximately 160 feet wide, but could be narrowed or widened by modifying the relative widths of the active and passive recreational areas.

This alternative is the only alternative that provides a positive outfall to the Salt River, and the only alternative that completely solves the drainage problems in this area. Other advantages of this alternative include recreational opportunities and neighborhood enhancement.

Cost Estimates

The estimated cost for implementation of this alternative is approximately $42.3 million dollars. This cost only includes the elements required to construct the channel and basic landscaping. Recreational and multi-use facilities were not included in this preliminary cost estimate. This alternative was divided into three reaches so that it could be more easily implemented. The first reach extends from Thomas Road to McDowell Road, the second reach from McDowell Road to the SRP well site, and the third reach from the SRP well site to the Salt River. **Table 2.1** summarizes the cost estimates for this alternative. Detailed cost estimates are included in **Appendix G**.

Table 2.1
Alternative 1 – Cost Estimate Summary

Granite Reef Wash Reach No.	Implementation Cost	No. of families displaced	No. of Structures purchased (Permanent / mobile homes)	No. of Structures Removed from floodplain (Permanent / mobile homes)	No. of Structures Remaining in floodplain (Permanent / mobile homes)
1	$25,518,602	94	94 / 0	174 / 0	0 / 0
2	$9,046,529	7	8 / 0	86 / 0	0 / 0
3	$7,776,256	21	0 / 21	2 / 669	0 / 0
TOTAL	**$42,341,387**	**122**	**102 / 21***	**262 / 669**	**0 / 0**

* Includes 6 non residential structures and 2 town homes (7 families)

Evaluation

Positive

All the agency representatives were largely in favor of this concept. The general public within the City may find this alternative attractive, because it revitalizes the neighborhood and provide opportunities for recreation and open space within the neighborhood. The proposed channel in this alternative would provide a multi-use facility that would convey runoff up to the 100-year event providing adequate outfall to the surrounded area, eliminating flooding along several roadways, and providing better traffic flow during rainfall events.

This alternative has the potential of increasing property values within the SRPMIC land, in particular, south of McKellips Road due to the amenities provided by this alternative. The possible increase in property value may be a good incentive for the SRPMIC and the landowners to support implementation of the portion of this alternative within their land.

This is the only alternative that provides a complete solution for the 100-year storm including an adequate outfall to the Salt River. This would protect the neighborhood in a reliable way and eliminate most of the known street flooding. In addition, this alternative would remove all structures from the floodplain. Approximately 262 permanent structures and 669 mobile homes would be protected. The remaining 102 permanent structures and 21 mobile homes would be purchased to implement the alternative. Implementation of this alternative has the potential of saving the neighborhood residents approximately $622,000 annually in flood insurance cost.

Negative

The immediate neighborhood, in particular those properties that may need to be acquired, may oppose implementation of this alternative. This alternative would require the purchase of approximately 102 permanent structures plus some mobile home park property displacing approximately 122 families. Resistance from some of these property owners would be expected. Additionally, the amenities associated with this alternative may attract people to the neighborhood and some of the remaining residents may be concerned with reduced privacy and an increase in the general public in their neighborhood.

Implementation of this alternative would require cooperation between the District, the City, SRPMIC, property owners from both communities, and possible SRPMIC lease holders. This type of cooperation may be difficult to coordinate and may take a long time to get consensus from individual property owners for right-of-way clearance.

Implementation of this alternative would require a significant amount of construction activity in the neighborhood with its associated inconveniences to residents such as noise, dust, roadway closures, street realignment, utility relocation and others.

The cost of implementation of this alternative is approximately $42.3 million. The estimated flood damages to the area without this alternative, were estimated at approximately $7.2 million during a 100-year storm affecting approximately 1054 structures worth an estimated $62 million (See **Appendix G** for detailed calculations). The ratio of the cost of this alternative and the potential cost benefit appear to be too high. The cost of this project is approximately 85% of the total property value protected by the alternative, ($42.3/{62.3-12.3}*100) per formula in page 2.5

Intangible

This alternative has not been presented to the public at this time. Based on the opinion of agency representatives familiar with the area, the study team made assumptions about probable residents reaction to this alternative. However, public support is critical to the successful implementation of this alternative and a better understanding of public opinion is needed to determine the viability of this alternative.

This alternative expands across two different jurisdictions and construction and maintenance would require an Inter-Government Agreement (IGA) to determine areas of responsibility and possible liability issues.

This alternative most likely would have to be implemented in phases because of the cost and the complexity of some of the associated issues such as property acquisition, IGA's, and public support.

Alternative 2 - Floodprone Property Acquisition

Description

This alternative consists of identifying all structures and properties that are floodprone. These structures would be purchased, demolished and the vacant land would be landscaped. **Plates 2.2A** and **2.2B** show the area that would be affected. This alternative includes only acquisition of properties on the northern portion of the wash, between Thomas and McKellips Roads. The area south of McKellips Road is undeveloped SRPMIC land and is not included in this alternative. In this alternative, by removing structures the cross-sectional area available for flow is increased and the water surface drops. This drop in water surface resulted in removal of approximately 119 permanent structures and 91 mobile homes from the 100-year storm inundation area.

Most of the properties that would be acquired under this alternative are within the City. However, the alternative also includes removal of most of the structures located in the SRPMIC trailer park north of McKellips between Granite Reef Wash and Pima Road alignment.

The cost estimates developed for this alternative were based on the assumption that the land would be left as an open space. However, this alternative provides the potential for using the land for a variety of purposes such as multi-use recreational facilities, detention basins, a transportation corridor, residential redevelopment and others.

Cost Estimates

The cost for this alternative is estimated to be approximately $141.7 million. This alternative was divided into two reaches; the first reach extends from Thomas Road to McDowell Road, and the second from McDowell Road to McKellips Road. The cost for each reach, which is presented in **Table 2.2**, is $50 million, and $92 million respectively. Detailed cost estimates for this alternative are included in **Appendix G**.

Table 2.2
Alternative 2 - Preliminary Cost Estimate

Granite Reef Wash Reach No.	Implementation Cost	No. of families displaced	No. of Structures purchased (Permanent / mobile homes)	No. of Structures Removed from floodplain (Permanent / mobile homes)	No. of Structures Remaining in floodplain (Permanent / mobile homes)
1	$50,142,858	172	176 / 0	98 / 0	0 / 0
2	$91,576,540	814	69 / 599	21 / 91	0 / 0
TOTAL	**$141,719,398**	**986**	**245 / 599***	**119 / 91**	**0 / 0**

* includes 13 non residential structures and 60 town homes (215 dwellings)

Evaluation

Positive

This alternative removes all residences from the 100-year storm inundation area (245 permanent structures demolished, 599 mobile homes relocated; 119 permanent structures and 91 mobile homes protected), and provides a relatively large corridor that could be used for a variety of uses. This alternative saves residents approximately $620,000 in annual flood insurance cost.

Although the cost savings for re-development was not included in this analysis, there is a potential for neighborhood re-development that would most likely revitalize the entire area resulting in an increase in quality of life and property values. The public probably would support projects that would provide this type of benefits to their community. However, until the future use of the land is identified it would be difficult to determine public support and possible benefits.

The vacant land could also be used to provide additional storm water storage or ground water recharge projects that could reduce the flows crossing McKellips Road. The reduced flows would alleviate flooding at McKellips Road and back-water effect from the portion of the wash within the SRPMIC land.

Disturbance to the surrounding neighborhood would be minimal, limited to noise and dust associated with the demolition. However, depending on future uses of the vacant land disturbance may be considerable.

Negative

It is anticipated that the immediate neighborhood, in particular those properties that may need to be acquired, may oppose implementation of this alternative. This alternative would require the acquisition of approximately 245 permanent structures and 599 mobile homes displacing approximately 986 families. Therefore, concerns about the public response to this alternative are significant.

The disturbance to the neighborhood may be significant depending on ultimate use of the vacant land. Even if the land is maintained as an open space, significant maintenance and monitoring may be required to insure that the area does not become unsightly or an illegal dumping ground.

This alternative does not address the outfall problem through the SRPMIC land south of McKellips Road. Additionally, because current lease agreements with the Trailer Park north of McKellips and the lack of support from the property owners, the SRPMIC may not be able or willing to implement this alternative. Additionally, SRPMIC is concerned that this alternative would increase the flows reaching their land near McKellips Road.

The cost of implementation of this alternative is approximately $142 million. Additionally, The estimated flood damages to the area without this alternative were estimated at approximately $7.2 million during a 100-year storm affecting approximately 1054 structures worth an estimated $62.3 million (See **Appendix G** for detail calculations). The ratio of the cost of this alternative and the potential cost benefit appear to be too high. The cost of this project is approximately 840% of the total property value (141.7 / {62.3-45.5} * 100) per formula in page 2.5. Implementation includes cost associated with condemnation procedures, demolition and basic landscaping. However, this value does not include cost of additional facilities or cost recovered from re-development of the area.

Intangibles

At this time the future use of the vacant land has not been identified. Public and agency support as well as reliability of this alternative depends on what would be the ultimate use of the land. At the present, it appears that this alternative would be unpractical unless an appropriate use for the land could be found. Until this use is determined, the maintenance, aesthetics, and sustainability merits of

this alternative cannot be evaluated. However, it provides the agencies with opportunities to determine the best use for the land.

This alternative does not include cost or cost recovery associated with future land use or any long-term property tax impacts that may be associated with the removal of the existing structures nor the construction of future ones.

Cooperation between the City and SRPMIC may be important. However, each agency may or may not implement this alternative without significant affect on the other as long as conveyance capacities are not reduced.

Alternative 3 - Osborn Road Storm Drain

Description

The third alternative consists of a storm drain along Osborn Road that drains into the Indian Bend Wash. Due to lack of depth and slope, this storm drain only extends to just east of 86th Street. The storm drain was analyzed assuming that it collects most of the flow at the intersection of 86th Street and Osborn Road with some additional flow at the intersection of Granite Reef Road and Osborn Road. The largest storm drain that could be constructed within the roadway right-of-way was used for this alternative, which was a double 4' x 8' reinforced concrete box. Existing utilities also limited the size of this storm drain. This alternative intercepts flows from the northern portion of the watershed, reducing the amount of flow that reaches the Granite Reef Wash. The reduction of flow translates in lower water surface elevations in the wash. This storm drain intercepts approximately 320 cfs and reduces the flow in Granite Reef Road reaching McKellips Road from 2290 cfs. to 2020 cfs. **Plates 2.3A** and **2.3B** show the location of the improvements and the effect on the Granite Reef Wash 100-year inundation area.

Cost Estimates

The cost estimate for this alternative is approximately $3.5 million. This cost estimate includes construction of the storm drain, lateral inlets, traffic control and utilities relocation. Also, the economical benefits associated with the reduced flows in the Granite Reef Wash were estimated. A summary of the cost estimates is presented in **Table 2.3**. Detailed cost estimates for this alternative are included in **Appendix G.**

TABLE 2.3
Alternative 3 – Preliminary Cost Estimate

Granite Reef Wash Reach No.	Implementation Cost	No. of families displaced	No. of Structures purchased (Permanent / mobile homes)	No. of Structures Removed from floodplain (Permanent / mobile homes)	No. of Structures Remaining in floodplain (Permanent / mobile homes)
1	$3,451,008	0	0 / 0	130 / 0	144 / 0
2		0	0/ 0	40 / 282	50 / 408
TOTAL	**$3,451,008**	**0**	**0 / 0**	**170 / 282**	**194 / 408**

Evaluation

Positive

This alternative would not require the purchase of any residences and probably would generate little objection from the public. Also the SRPMIC would be in favor of this alternative since it reduces the flow entering their land south of McKellips Road. This alternative is consistent with the type of improvements planned by the City in the north portion of the watershed, utilizes standard storm drain construction techniques, and utility conflicts.

Implementation of this alternative will also provide an outfall for local flows and improve traffic conditions in the vicinity during storm events. This alternative will not detract from the current usefulness and appearance of the area, has low maintenance costs and a relatively short construction length.

This is the one of lowest cost structural alternatives with a construction cost of approximately $3.5 million dollars. Implementation of this alternative would remove approximately 170 permanent structures and 282 mobile homes from the 100-year inundation area along Granite Reef Wash with a property value of approximately $26.1 million. The estimated flood damages would be reduced from approximately $7.2 million under existing conditions to approximately $3.6 million (See **Appendix G** for detail calculations). The cost of this project is approximately 13% of the total property value protected (3.5 / {62.3-36.2} * 100) per formula in page 2.5.

Removal from the floodplain of the 170 permanent structures and 282 mobile homes could translate in approximately $231,000 annually saving by the residents in flood insurance premiums.

Negative

This alternative leaves approximately 194 permanent structures and 408 mobile homes within the 100-year inundation area. The property value of these structures was estimated at $36.2 million and the probable damage from a 100-year storm event was estimated at $3.6 million. Additionally, property owners will be required to pay approximately $391,000 annually in flood insurance premiums. The 100-year inundation area resulting after the implementation of this alternative is wider than the current FEMA floodplain and structures outside the current FEMA floodplain will be at risk.

This alternative re-routes runoff to the Indian Bend Wash. There are concerns that the Indian Bend Wash may be adversely affected by receiving flows from areas that were not considered when the channel was designed. The District will not support this alternative unless it is demonstrated that the additional flow will not have detrimental effects in the performance and use of the Indian Bend Wash.

The Osborn Road storm drain proposed in this alternative has to cross Hayden Road just upstream of its outfall into the Indian Bend Wash. Hayden Road is a main arterial road and traffic control issues are significant. Also there are some utilities that may need relocation at this intersection, which may increase traffic issues. Construction activities would create associated inconveniences to residents such as roadway closures, noise, and dust.

This alternative does not provide any opportunities for multi-use and aesthetic enhancement to the neighborhood, which ranked high in the criteria list.

Alternative 4 - Detention

Description

This alternative analyzed the effects of providing Storage facilities at two locations. The first site is located at the northeast corner of the intersection of Pima and Thomas Roads within the SRPMIC land. The second site is located just south of McDowell road and immediately east of the Granite Reef Wash in a lot that is currently vacant. This alternative was divided into three options: Option A analyzed a detention basin at Thomas Road only, Option B analyzed a detention basin at McDowell Road, and Option C analyzed both detention basins combined.

The detention basin at Thomas was assumed to be an underground storage facility with a capacity of 40 acre-feet. The facility was analyzed assuming that 12.1 acres were available (see **Appendix E** for details). This type of facility makes the most sense at this location because it can be easily integrated into the commercial use of the property. The basin at McDowell was assumed to be an open, off-line basin with a capacity of 26.2 acre-feet covering approximately 4 acres. For the purpose of this analysis the basin was assumed to be 10-feet deep with 6:1 side slopes.

Cost Estimates

The cost estimates for these alternatives are: Option A $13.9 million, Option B $2 million, and Option C $15.9 million. The estimates considered the construction cost of the basin, inlet and outlet works, Basic landscape and land acquisition. For the basin at Thomas Road it was assumed that full price would be paid for the land. However, this is the worse case scenario. Most likely, since the land will be shared with other commercial facilities (parking lots and roadways), the cost could be only a fraction of the full value. A summary of the cost estimates is presented in **Table 2.4** and detailed cost estimates for these alternatives are included in **Appendix G.**

TABLE 2.4
Alternative 4 – Preliminary Cost Estimate

Option	Granite Reef Wash Reach No.	Implement. Cost	No. of families displaced	No. of Structures purchased (Permanent / mobile homes)	No. of Structures Removed from floodplain (Permanent / mobile homes)	No. of Structures Remaining Unprotected (Permanent / mobile homes)
4A	1	$13,890,801*	0	0	200 / 0	74 / 0
	2	$0	0	0	47 / 315	43 / 375
	Total	**$13,890,801**	**0**	**0**	**247 / 315**	**117 / 375**
4B	1	$0	0	0	84 / 0	190 / 0
	2	$1,976,698	0	0	43 / 295	47 / 395
	Total	**$1,976,698**	**0**	**0**	**127/ 295**	**237 /395**
4C	1	$13,890,801	0	0	200 / 0	74 / 0
	2	$1,976,698	0	0	50 / 352	40/ 337
	Total	**$15,867,499***	**0**	**0**	**250 / 353**	**114 / 337**

* Includes $2.4 million for full land value ($200,000/acre)

Evaluation

Positive-Option A

Option A (underground basin at Thomas Road) does not adversarily affect the City residents and if this alternative is implemented simultaneously with the future development of the land, construction activities and disturbance would be minimized. The underground facility would not detract from the future usefulness and appearance of the area.

The location of the basin in Option A is in a prime commercial parcel within the SRPMIC land, and most likely will be leased in the future to a commercial developer. There is an opportunity to negotiate joint use of portions of the development (parking lots and roads) with the lease holder. By doing so, cost associated with right-of-way could be significantly reduced and the negotiation process simplified since negotiations with large number of property owners within the SRPMIC land would not be required.

This basin significantly reduces the flow entering the Granite Reef Wash. The flow at McDowell Road is reduced from 1840cfs. to 1200cfs. This reduction in flow translates into a lower water surface elevation along the wash and the removal of several structures from the 100-year inundation area. Option A removes approximately 247 permanent structures and 315 mobile homes from the 100-year inundation area worth approximately of $37 million. This option reduces probable property damage by an estimated $2.6 million and could save property owners around $345,000 annually in insurance premiums. Also this option lowers the flow north of McDowell Road below the current FEMA flow (1240cfs) and it is possible that a few structures that are currently in the FEMA floodplain could be removed. The flows at McKellips Road are reduced from 2,290 cfs to 1,860 cfs.

Negative-Option A

Option A (underground basin at Thomas Road) leaves approximately 117 permanent structures and 375 mobile homes within the 100-year inundation area. The property value of these structures was estimated at $26 million and the probable damage from a 100-year runoff was estimated at $2.6 million. Additionally, property owners will be required to pay approximately $278,000 annually in flood insurance premiums. The 100-year inundation area resulting after the implementation of this alternative is wider than the current FEMA floodplain at some locations (between McDowell and McKellips Roads) and structures outside the FEMA floodplain will be at risk.

The cost of this alternative is approximately 38% of the total property value protected (13.9 / {62.3-25.8} * 100) per formula in page 2.5.

This option has no opportunities for recreational or aesthetic enhancement and the facility will require regular maintenance and inspection to insure adequate performance. Sediment deposits and clogging tend to be common problems with this type of facilities.

The implementation timing is dependent on the future development of the site, which at this time is difficult to predict. Additionally, inlet and outlet pipes would have to cross Pima Road across two different jurisdictions requiring some coordination. Traffic control may also be an issue at this location.

Intangible-Option A

The SRPMIC representative indicated that his agency is unlikely to object to the construction and installation of this facility. However, it is also unlikely that they would require the lease holder to cooperate. However, since the facility is within their jurisdiction, an IGA may be required for approval, implementation and maintenance.

Positive-Option B

Option B (off-line basin near McDowell Road) provides no real impact to the City residents other than during construction and SRPMIC supports this option since it reduces the flow entering their land. Impacts during construction are relatively minor and only impact the immediate area.

There are opportunities for multi-use and aesthetically pleasing elements within option B and it is the lowest cost structural solution analyzed in this study. For these reasons, all agencies like this concept. Also, this basin has a significant impact in reducing flows during smaller, more frequent events since the basin inlet would be set below the bank of the channel. This configuration would be effectively decreasing peak flows near the capacity of the wash.

Option B reduces the flow at McKellips Road from 2290cfs to 2000cfs. This reduction in flow translates to a lower water surface elevation along the wash and the removal of several structures from the 100-year inundation area. Option B removes approximately 127 permanent structures and 295 mobile homes from the 100-year inundation area worth approximately $21 million. This option reduces probable property damage by an estimated $3.1 million and could save property owners around $180,000 annually in insurance premiums.

The cost of this alternative is approximately 9% of the total property value protected (2 / {62.3-41.2} * 100) per formula in page 2.5.

Negative-Option B

Option B (off-line basin at McDowell Road) leaves approximately 237 permanent structures and 395 mobile homes within the 100-year inundation area. The property value of these structures was estimated at $41 million dollars and the probable damage from a 100-year runoff was estimated at $4.1 million. Additionally, property owners will be required to pay approximately $441,000 annually in flood insurance premiums. The 100-year inundation area resulting after the implementation of this alternative is wider than the current FEMA floodplain and some structures outside the FEMA floodplain may be at risk.

The detention basin would require some maintenance including vegetation control and clean up.

Positive-Option C

Option C has basically the same benefits as Options A and B but the combined effect of both basins provides better protection to the neighborhood. The flow is reduced at McKellips Road from 2290cfs. to 1610cfs. This reduction in flow translates to a lower water surface elevation along the wash and the removal of several structures from the 100-year inundation area. Option C removes approximately 250 permanent structures and 353 mobile homes from the 100-year inundation area worth approximately $38 million. This option reduces probable property damage by an estimated $4.7 million and could save property owners around $357,000 annually in insurance premiums.

Negative-Option C

This Option has the same negative issues as Options A and B. However, the combination of these two basins does not appear to provide additional benefits. The number of structures protected by Option A is about the same as for Option C. Therefore, the basin at McDowell Road is basically ineffective at further reducing the number of structures at risk.

The cost of this alternative is approximately 42% of the total property value protected (15.9 / {62.3-24.5} * 100) per formula in page 2.5.

Alternative 5 – Regulatory

Description

This alternative would re-delineate the 100-year floodplain based on the approved flows from the updated hydrology model for existing conditions developed during this study. This is the only alternative that did not include the future stormdrain along Indian School Road. This future storm drain was not included because FEMA does not allowed to develop floodplains studies considering future infrastructure. Preliminary delineation indicates that the water surface is approximately one foot higher than the current FEMA water surface. The new floodplain would include several homes not included in the current FEMA floodplain. These homes will be identified so that they would be eligible for Flood Insurance. The existing FEMA floodplain is not mapped south of the SRP well site located midway between McKellips Road and McDowell Road. This alternative recommends that the floodplain be extended all the way to the Salt River in order to provide the City and the SRPMIC with a better tool to regulate development in the area. Topographic mapping within the SRPMIC land is not available at this time. This mapping will be needed in order to complete the delineation.

Cost Estimates

This alternative has no construction cost. However, damages during a 100-year rainfall event as well as annual flood insurance costs for the affected residences were estimated in order to compare the alternative's benefits to other alternatives.

There were two annual flood insurance rates for the Granite Reef Wash, the first annual rate is for minimum damage, and the second rate is for moderate to severe damage. Minimum damage is classified as a residence that has finished floor elevation less than one foot lower than the floodplain water surface elevation. Moderate to Severe damage is defined as a residence whose finished floor elevation is more than one foot lower than the floodplain water surface elevation. The Flood Insurance rate for minimum damage is $461 per year for each $100,000 of property value, and the rate for moderate to severe damage is $1,371 per year for each $100,000 of property value. The annual estimated cost for Flood Insurance premiums for the updated floodplain is $620,000.

The estimated flood damage cost was calculated by classifying the flood damage into three different types, minor damage, moderate damage, and severe damage. Minor damage was used for properties that were flooded by less than one foot, and the estimated damage for this classification was 5% of the property value. Moderate damage was used for properties that were flooded by one to two feet, and the estimated damage for this classification was 10% of the property value. Severe damage was used for properties that were flooded by more than two feet, and the estimated damage for this classification was 20% of the property value. The total estimated cost for flood damage using the updated floodplain is $7.2 million and is presented in **Table 2.5**. The detailed flood damage cost estimate is located in **Appendix G**.

TABLE 2.5
Alternative 5 - Preliminary Cost Estimate

Granite Reef Wash Reach No.	Implementation Cost	No. of families displaced	No. of Structures purchased (Permanent / mobile homes)	No. of Structures Removed from floodplain (Permanent / mobile homes)	No. of Structures Remaining in floodplain (Permanent / mobile homes)
1	$0	0	0 / 0	0 / 0	274 / 0
2	$0	0	0 / 0	0 / 0	90 / 690
TOTAL	**$0**	**0**	**0 / 0**	**0 / 0**	**364 / 690**

Evaluation

Positive

There is no construction cost associated with this alternative and it provides the City and the SRPMIC with a tool to regulate development or re-development in the area. It also informs the public about possible risks associated with large rainfall events. It provides economical protections to the residents by requiring or at least encouraging them to carry flood insurance. Both the District and the City support this alternative.

This alternative may protect the agencies from litigation and liability resulting from flood damages

Negative

This alternative will increase the number of structures that are within the Granite Reef Wash inundation area. Some of the local residents have the perception that since the construction of the Pima Freeway they are protected form flooding and it may be difficult to convince them that they are at risk.

This alternative does not remove any residences from the 100-year inundation area and 1054 residences are at risk with possible estimated damage in the order of $7.2 million.

Intangibles

The SRPMIC is not a participating community in the National Flood Insurance Program. The Agency has not expressed interest or opposition to participation in the program. Both or only one of the communities can implement this alternative.

Comparison of Alternatives

Some of the alternatives would reduce the 100-year peak flow in Granite Reef Wash significantly. However, some others are focused on conveying the expected flows with minimum impact to the neighborhood. **Table 2.6** summarizes the peak flows associated with each alternative.

The combined detention basins at Thomas and McDowell Roads would provide the maximum reduction of flow along the wash. The detention basin at Thomas Road (alternatives 4A and 4C) reduces the flow north of McDowell Road to similar values as those used to develop the FEMA floodplain.

Table 2.6 summarizes the cost and economical benefits associated with each alternative and the less tangible comparison items.

Recommendation for Further Analysis

As stated in Part 1 of this report, one of the objectives of this study is to identify those alternatives that warrant further consideration. Additionally, one of the main objectives was to develop a hydrologic model that accurately represents the conditions of the watershed and is accepted by all agencies involved. The results from this model indicate that the flows used for developing the FEMA floodplain boundaries underestimated the 100-year runoff from the watershed. Under Alternative 5 (Regulatory) the 100-year runoff inundation limits using the updated flows were estimated and it appears that several residences outside the current FEMA floodplain are at risk of flooding during a 100-year storm event.

This study determined that the following alternatives have merits and may be warranted for further analysis:

Alternative 1 – Water Course Restoration. This alternative provides an adequate drainage system all the way to the outfall into the Salt River. It provides complete protection to the area up to a 100-year runoff event. Additional analysis is required to better determine the feasibility of this alternative. Some of these items include public acceptance, phased implementation potential, and SRPMIC support.

A combination of Alternatives 3 and 4 - Diversion and Detention. The detention basin at the northeast corner of Thomas Road and Pima Road intersection within the SRPMIC land or basin at McDowell Road do not completely solve the flooding problems but reduces the area affected by the 100-year storm and provides some protection from more frequent events. Some of the elements that need to be further analyzed include feasibility of underground storage, potential for agreements with future lease holders, and SRPMIC acceptance. Alternative 3 – Osborn Road Storm Drain did not appear to significantly reduce the flows entering Granite Reef Wash but additional analysis is recommended to determine if a combination of elements from Alternatives 3 and 4 provide a better protection along the wash.

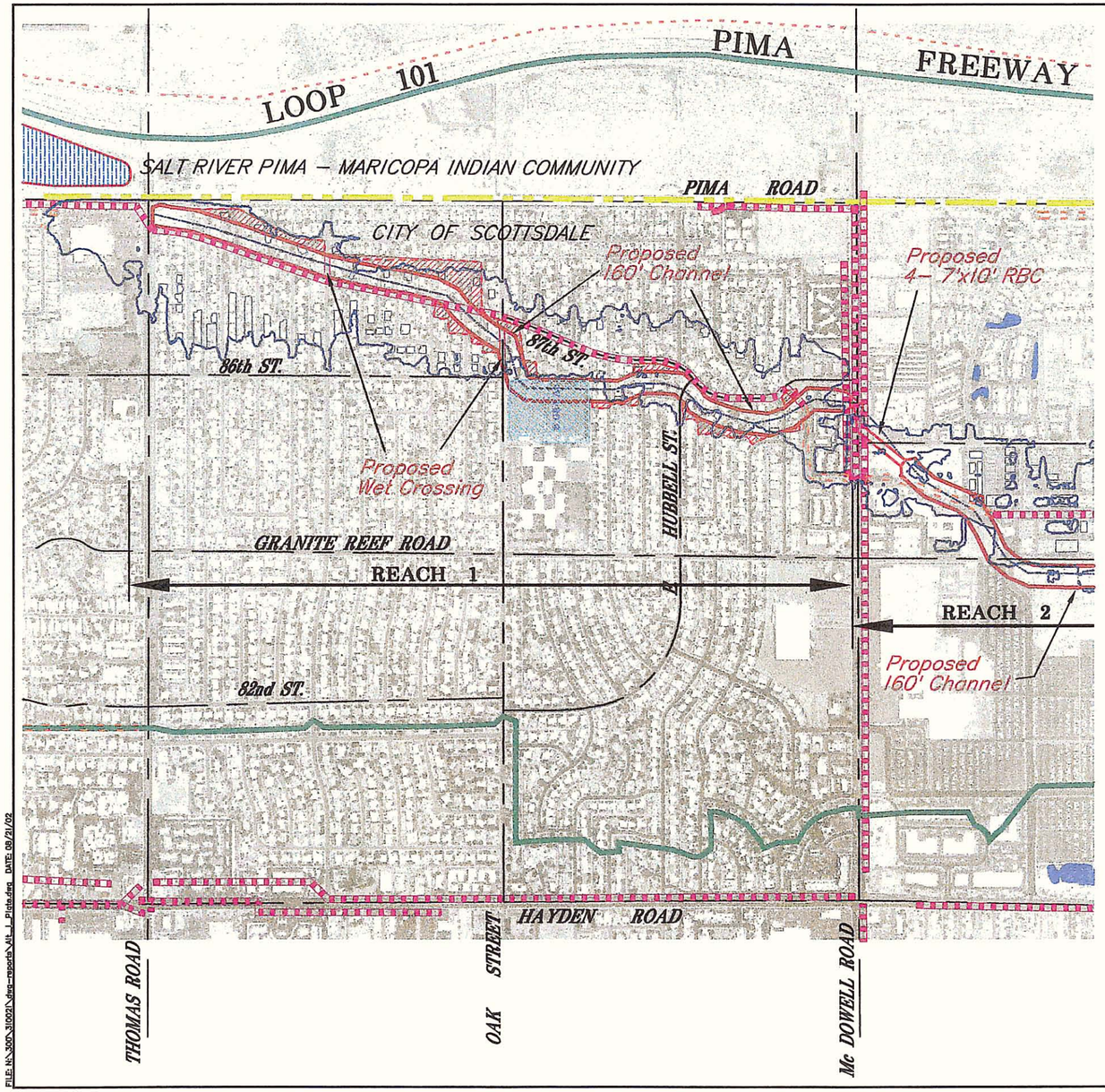
Alternative 5 – Regulatory. This alternative identifies potential hazards and provides financial protection to residents through the National Flood Insurance Program. In addition, it allows the City to regulate any future development or redevelopment of the area. Furthermore, the analysis under this alternative indicates that some residences and properties within the SRPMIC would be affected by the 100-year runoff. No FEMA floodplain has been delineated within the SRPMIC land. Thus, this study encourages SRPMIC to participate in the National Flood Insurance Program.

At this time Alternative 2 - (Floodprone Property Acquisition) does not appear to provide significant benefits compared to Alternative 1. The cost of this alternative is significantly higher than any of the other alternatives. Therefore, it does not appear that further analysis of this alternative is warranted.

TABLE 2.6
Comparison of Alternatives

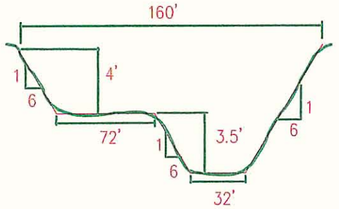
Criteria	Parallel 72" Storm Drain on Indian School Rd.*	Current FEMA Floodplain	Alternative 1 Water Course Restoration	Alternative 2 Floodprone Property Acquisition	Alternative 3 Osborn Road Storm Drain	Alternative 4A Detention (Underground Basin at Thomas Rd.)	Alternative 4B Detention (Offline Basin at McDowell Rd.)	Alternative 4C Detention (Basins at Thomas Rd. and McDowell Rd.)	Alternative 5 Regulatory
100-yr Peak Flow at McDowell Rd. (cfs)	1,840	1,240	1,840	1,840	1,600	**1,200**	1,840	**1,200**	1,900 **
Flow reduction by alternative at McDowell Rd. (cfs)	0	N/A	0	0	240	**640**	0	**640**	0
100-yr Peak Flow at McKellips Rd. (cfs)	2,290	1,417	2,290	2,290	2,020	1,860	2,000	**1,610**	2,350 **
Flow reduction by alternative at McKellips Rd. (cfs)	0	N/A	0	0	270	430	290	**680**	0
Implementation Cost (Millions of dollars)	N/A	N/A	$42.3	$141.7	$3.5	$13.9	$2.0	$15.9	**$0**
Number of Structures Removed from floodplain, purchased not included (Permanent / Mobile homes)	N/A	N/A	262/669	**119/91**	170/282	247/315	127/295	250/353	0/0
Number of Structures to be Purchased for implementation of alternative (Permanent / Mobile homes)	N/A	N/A	102/21	245/599	**0/0**	**0/0**	**0/0**	**0/0**	**0/0**
Structures Remaining in Floodplain (Permanent / Mobile homes)		126/(N/A)	**0/0**	**0/0**	194/408	117/375	237/395	114/337	364/690
Total property value within the floodplain –2003 Assessors value after implementation, including purchased structures (Millions of Dollars)		$19.7	**$12.3**	$45.5	$36.2	$25.8	$41.2	$24.5	$62.3
Property Value within floodplain excluding purchased structures		$19.7	**0**	0	$36.2	$25.8	$41.2	$24.5	$62.3
Estimated Annual Flood Insurance Cost - $1,079Average rate per $100,000 of property value (Dollars / year) after implementation		$212,239	**0**	**0**	$391,105	$278,431	$441,257	$264,495	$621,993 ****
Estimated Annual Flood Insurance Cost Savings (Dollars / year)	0	N/A	**$621,993**	**$621,993**	$230,888	$343,562	$180,736	$357,498	$0
Estimated 100-year Flooding Damages - Average damage estimated 10% of property value (Dollars)		$1,967,000	**$0**	**0**	$3,624,700	$2,580,450	$4,089,500	$2,451,300	$7,197,658 ****
Estimated 100-year Flooding Damages Prevented (Dollars)	0	N/A	**$7,197,658**	**$7,197,658**	$3,572,958	$4,617,208	$3,108,158	$4,746,358	$0
Cost/Benefit Ratio (Implementation Cost / Prevented Damages)	N/A	N/A	5.88	19.69	0.97	3.01	**0.64**	3.35	N/A
Number of Families Displaced	N/A	N/A	122	986	**0**	**0**	**0**	**0**	**0**
Neighborhood Enhancement	N/A	N/A	**High**	Possible ***	No	No	Low	Low	No
Agency Acceptance	N/A	N/A	**High**	Possible ***	Mid	Mid	Mid	Mid	**High**
SRPMIC Non-Objection	N/A	N/A	**Non-objection**	Object in their mobile home park	**Non-objection**	Non-objection if lease holder agrees	**Non-objection**	Non-objection if lease holder agrees	**Non-objection**
Kinder/Gentler	N/A	N/A	**Yes**	Possible ***	No	No	**Yes**	**Yes**	No
Reliability/Dependability	N/A	N/A	**High**	**High**	Mid	Low	**High**	Low	N/A
Outfall Solution			Yes	Possible	No	No	No	No	Yes

* This storm drain has been designed and it will be constructed in the near future. The effect of this storm drain in the Granite Reef Floodplain is negligible. Cost of this improvement was not included in cost estimates
** Existing conditions using new hydrology (no future storm drain on Indian School Rd.).
*** Depending on redevelopment scheme
**** These two values were estimated based on the actual Flood Insurance Rates and Flooding Damages (See Appendix)
Bold indicates most favorable alt. For each criteria



LEGEND

- Roadway Center Line
- Community Boundary
- Watershed Boundary
- Existing Storm Sewer
- Existing Open Channel
- Anticipated 100 Year Floodplain
- Proposed Limits of Residences Affected
- Proposed Channel Bank
- Proposed Channel Centerline
- Irrigation Retention Area
- Detention Basin
- Approximated Inundation Area



TYPICAL SECTION 1

350 0 350 700

Entellus

GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038

Alternative 1
WATER COURSE RESTORATION
PLATE 2.1A

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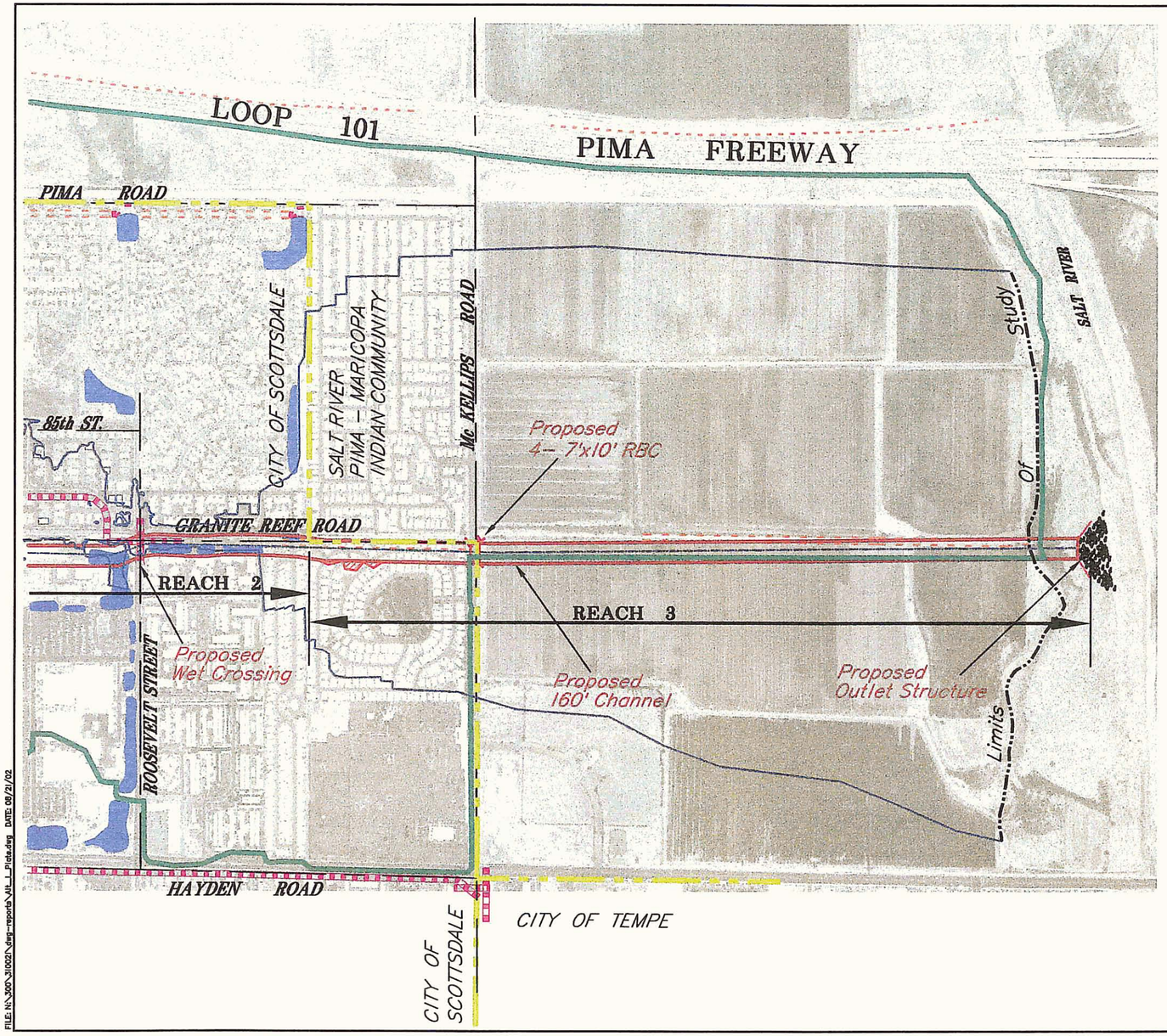
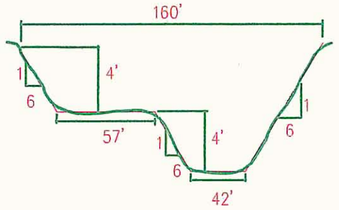


LEGEND

- Roadway Center Line
- Community Boundary
- Watershed Boundary
- Existing Storm Sewer
- Existing Open Channel
- Anticipated 100 Year Floodplain
- Proposed Limits of Residences Affected
- Proposed Channel Bank
- Proposed Channel Centerline
- Irrigation Retention Area
- Detention Basin
- Approximated Inundation Area



TYPICAL SECTION 2

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Entellus

GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038

Alternative 1

WATER COURSE RESTORATION

PLATE 2.1B

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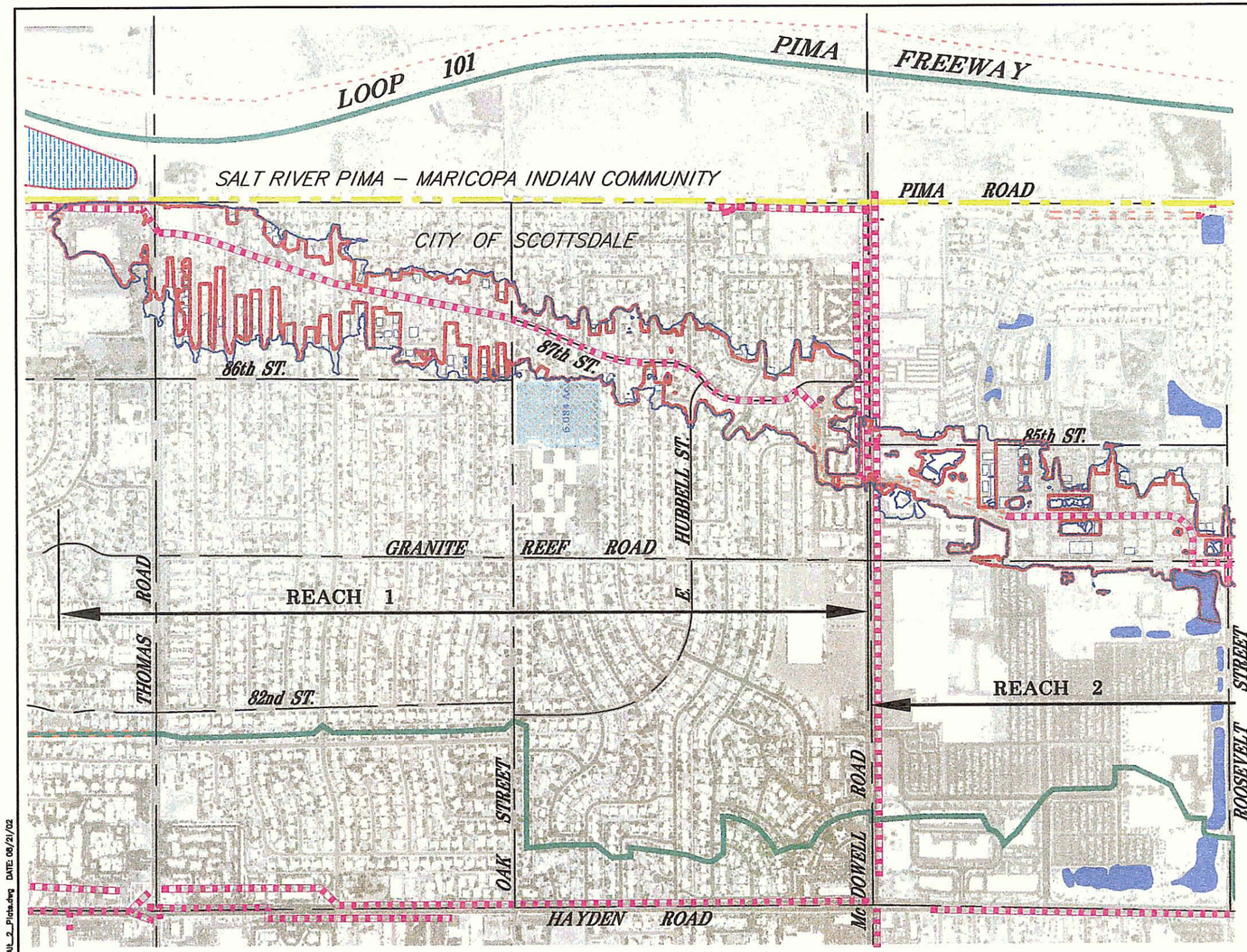

LEGEND

- Roadway Center Line
- Community Boundary
- Watershed Boundary
- Existing Storm Sewer
- Existing Open Channel
- Anticipated 100 Year Floodplain
- Alternative Inundation Limits
- Irrigation Retention Area
- Detention Basin
- Approximated Inundation Area

350 0 350 700

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DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038

Alternative 2
FLOODPRONE PROPERTY ACQUISITION
PLATE 2.2A

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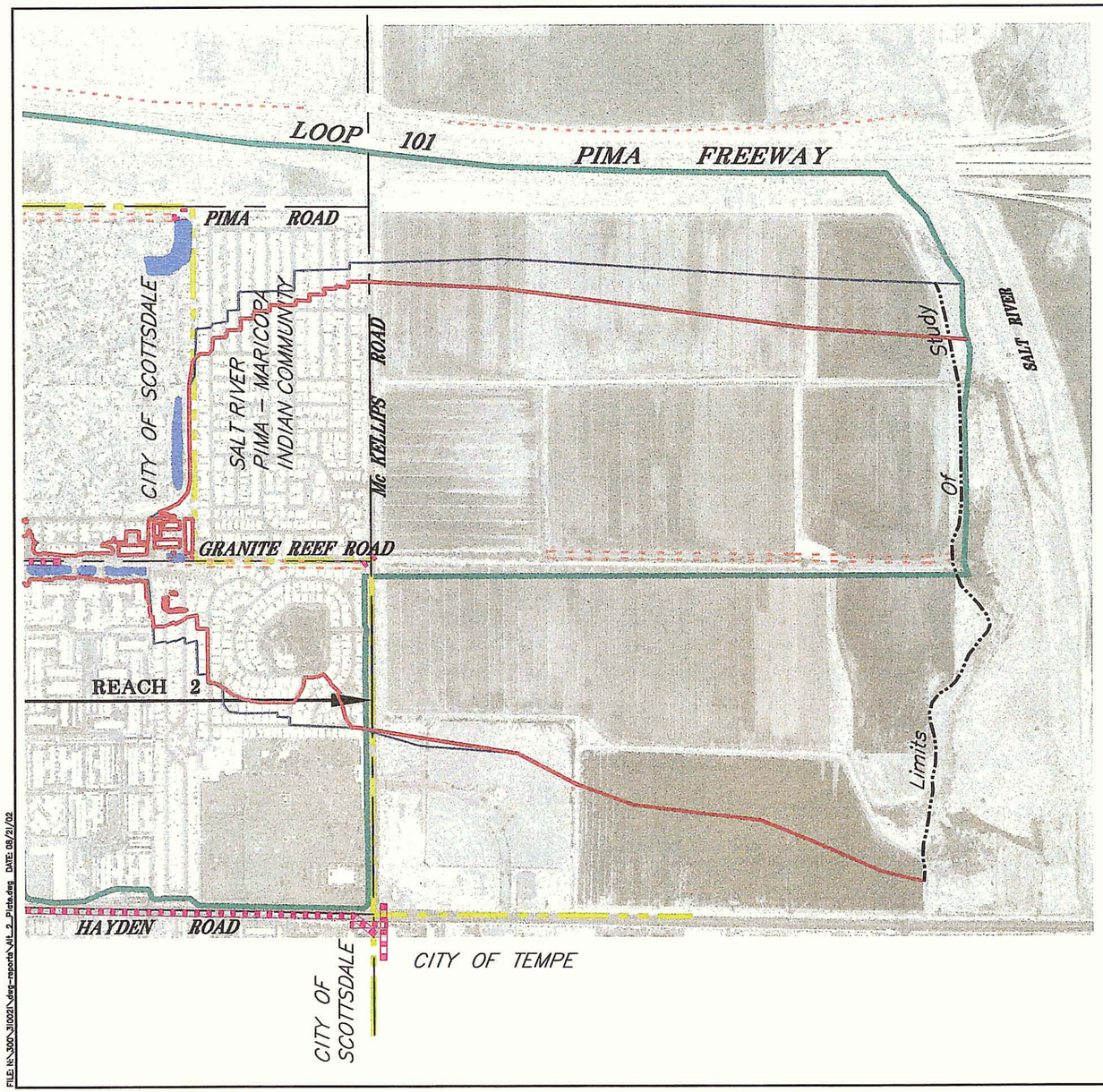

LEGEND

- Roadway Center Line
- Community Boundary
- Watershed Boundary
- Existing Storm Sewer
- Existing Open Channel
- Anticipated 100 Year Floodplain
- Alternative Inundation Limits
- Irrigation Retention Area (6.084 Ac)
- Detention Basin
- Approximated Inundation Area

350 0 350 700

Entellus

GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038

Alternative 2
FLOODPRONE PROPERTY ACQUISITION
PLATE 2.2B

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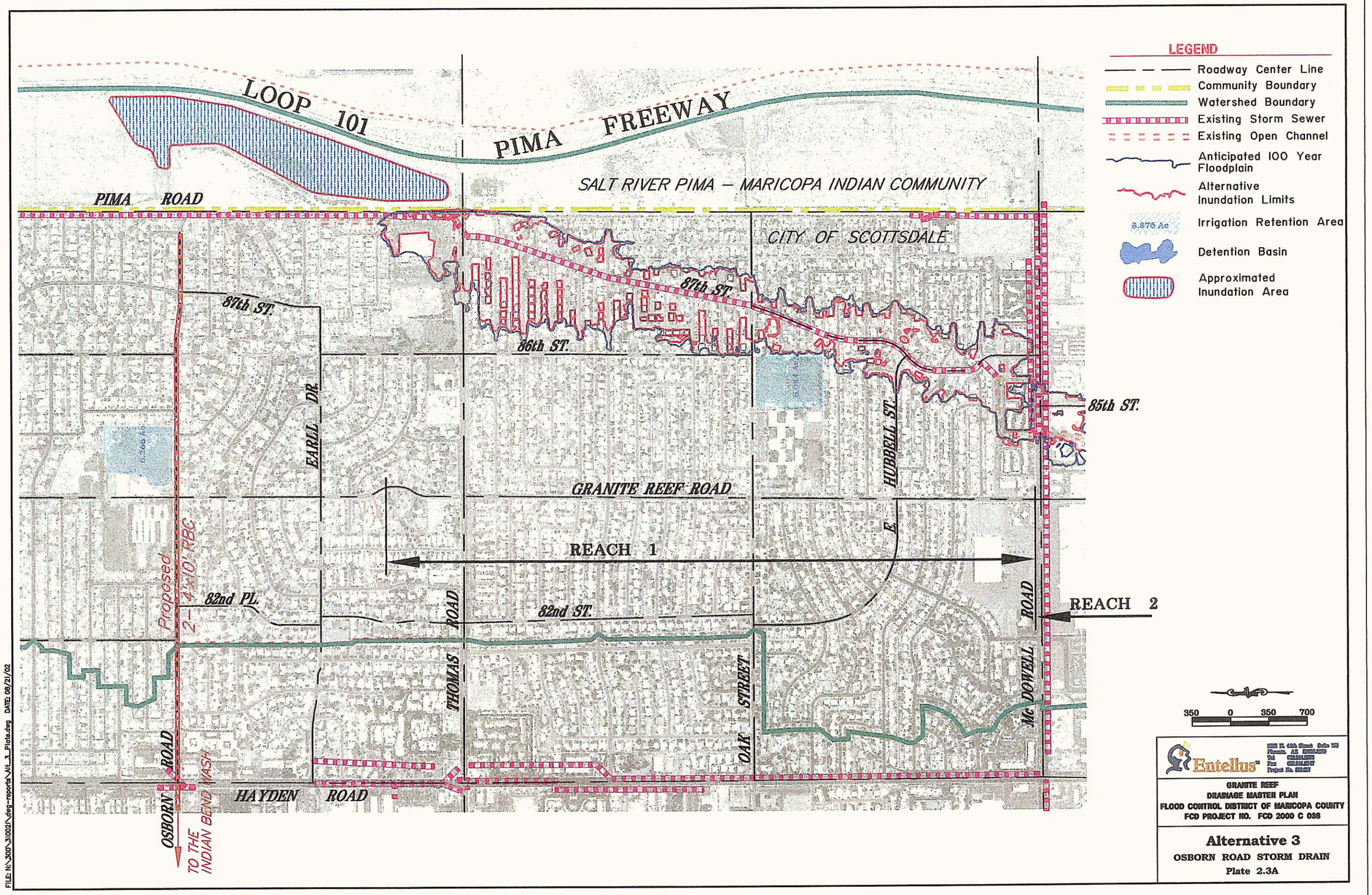
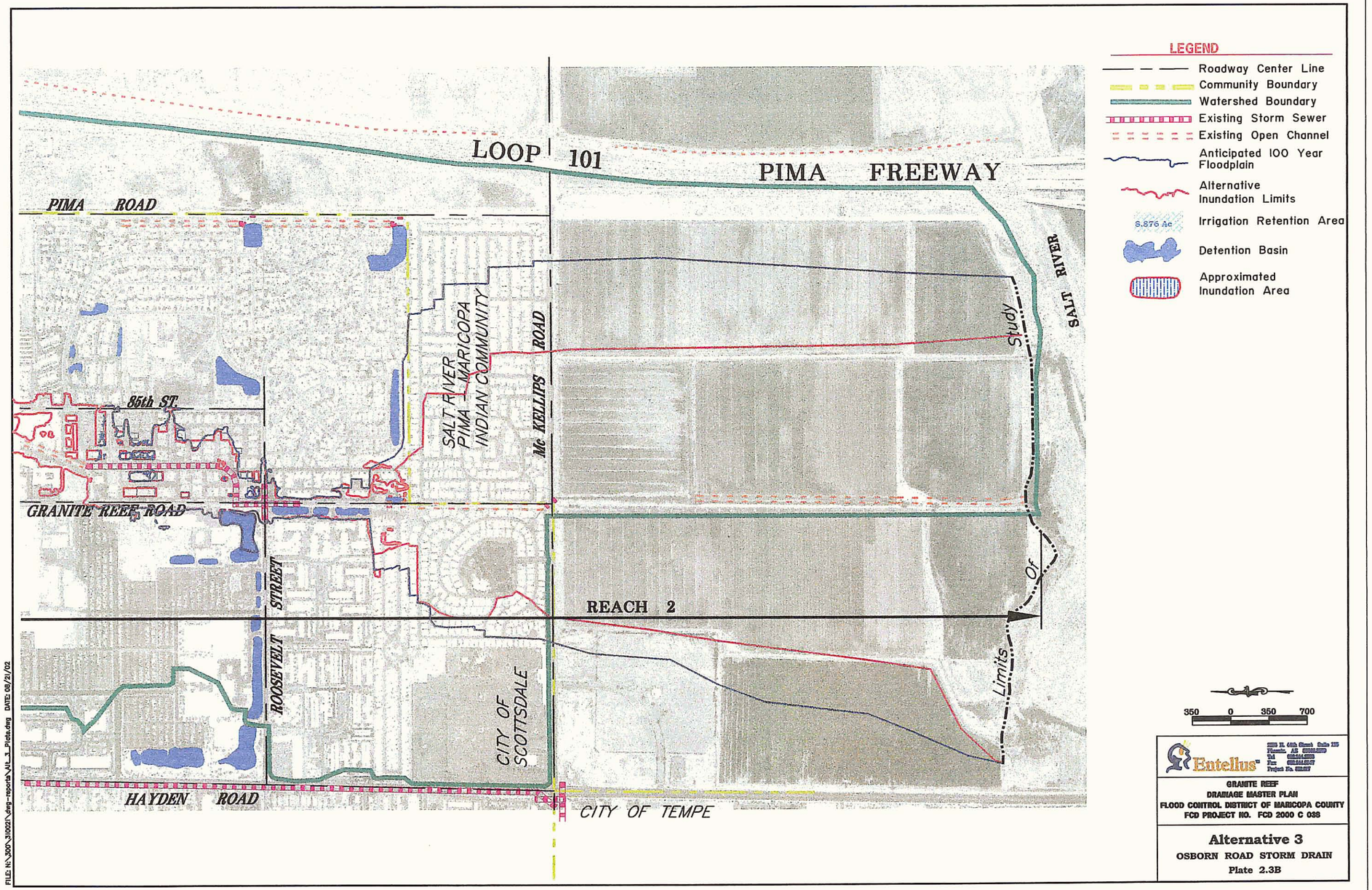
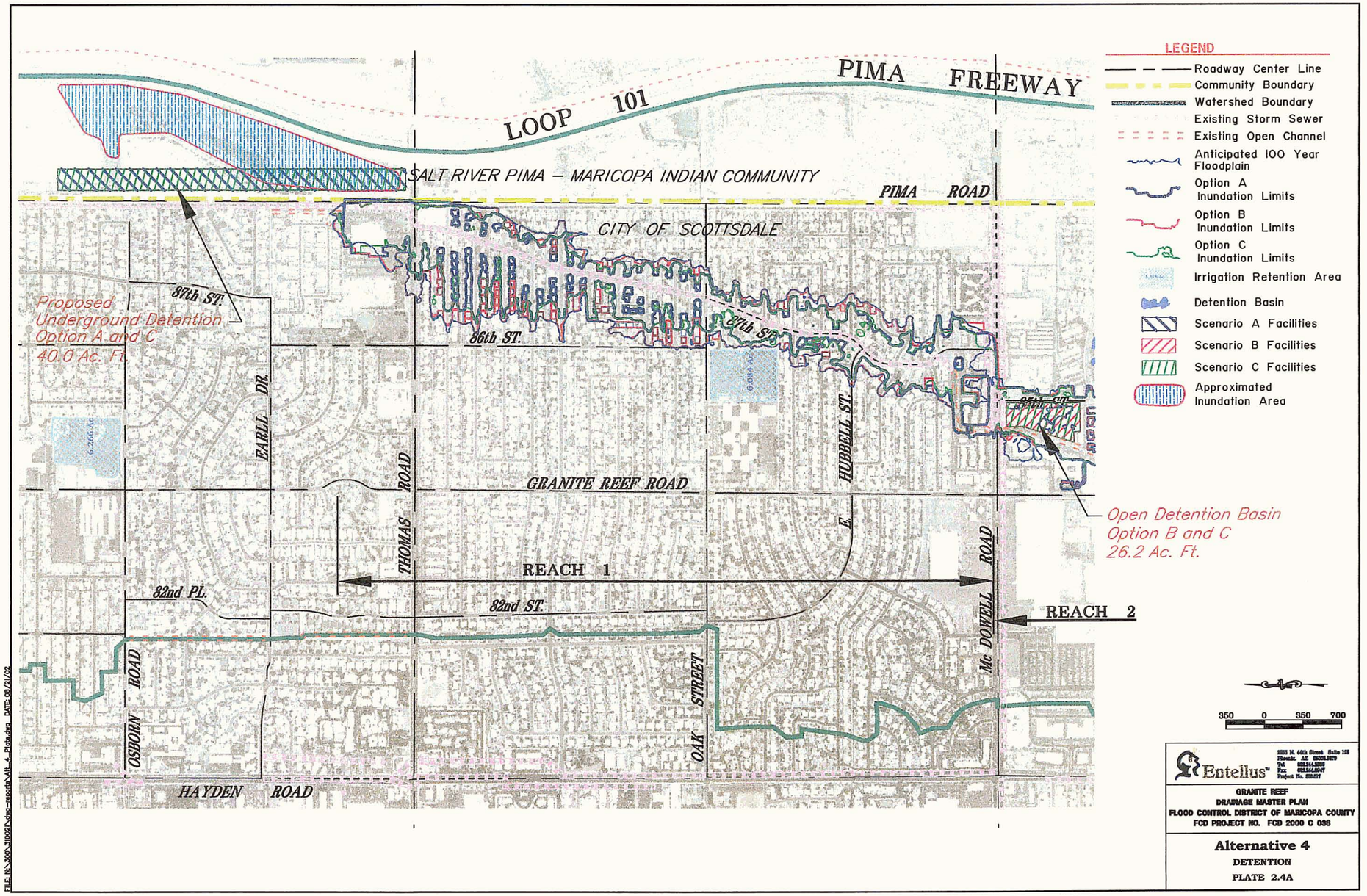
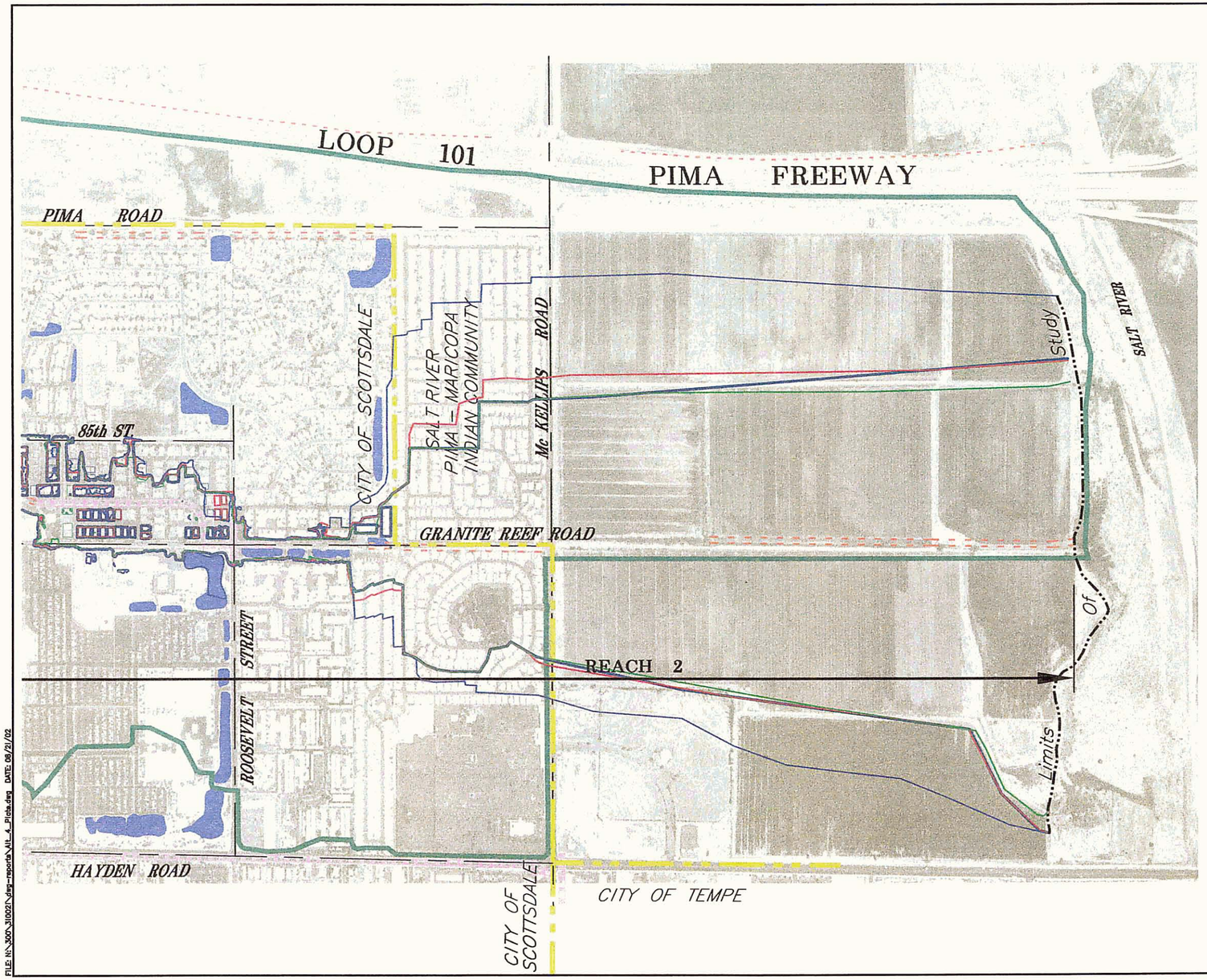

LOOP 101
PIMA FREEWAY
SALT RIVER PIMA – MARICOPA INDIAN COMMUNITY
CITY OF SCOTTSDALE
PIMA ROAD
87th ST.
86th ST.
85th ST.
82nd PL.
82nd ST.
EARLL DR.
HUBBELL ST.
E. GRANITE REEF ROAD
REACH 1
REACH 2
Proposed 2-14'W10' RBC
THOMAS ROAD
OAK STREET
McDOWELL ROAD
OSBORN ROAD
HAYDEN ROAD
TO THE INDIAN BEND WASH
LEGEND
Roadway Center Line
Community Boundary
Watershed Boundary
Existing Storm Sewer
Existing Open Channel
Anticipated 100 Year Floodplain
Alternative Inundation Limits
Irrigation Retention Area
Detention Basin
Approximated Inundation Area
350 0 350 700
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
Alternative 3
OSBORN ROAD STORM DRAIN
Plate 2.3A
FILE: N:\300\-310021\dwg-reports\AIL_3_Plate.dwg DATE: 08/21/02


LOOP 101
PIMA FREEWAY
PIMA ROAD
85th ST.
GRANITE REEF ROAD
SALT RIVER PIMA MARICOPA INDIAN COMMUNITY
Mc KELLIPS ROAD
ROOSEVELT STREET
REACH 2
CITY OF SCOTTSDALE
HAYDEN ROAD
CITY OF TEMPE
SALT RIVER
Study Limits
LEGEND
Roadway Center Line
Community Boundary
Watershed Boundary
Existing Storm Sewer
Existing Open Channel
Anticipated 100 Year Floodplain
Alternative Inundation Limits
8.876 Ac
Irrigation Retention Area
Detention Basin
Approximated Inundation Area
350 0 350 700
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
Alternative 3
OSBORN ROAD STORM DRAIN
Plate 2.3B
FILE: N:\300\310021\dwg-reports\Alt_3_Plate.dwg DATE: 08/21/02


LOOP 101
PIMA FREEWAY
SALT RIVER PIMA – MARICOPA INDIAN COMMUNITY
PIMA ROAD
CITY OF SCOTTSDALE
87th ST.
86th ST.
87th ST.
85th ST.
Proposed Underground Detention Option A and C 40.0 Ac. Ft.
EARLL DR.
THOMAS ROAD
HUBBELL ST.
GRANITE REEF ROAD
E. Mc DOWELL ROAD
REACH 1
REACH 2
82nd PL.
82nd ST.
OSBORN ROAD
OAK STREET
HAYDEN ROAD
Open Detention Basin Option B and C 26.2 Ac. Ft.
LEGEND
Roadway Center Line
Community Boundary
Watershed Boundary
Existing Storm Sewer
Existing Open Channel
Anticipated 100 Year Floodplain
Option A Inundation Limits
Option B Inundation Limits
Option C Inundation Limits
Irrigation Retention Area
Detention Basin
Scenario A Facilities
Scenario B Facilities
Scenario C Facilities
Approximated Inundation Area
350 0 350 700
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
Alternative 4
DETENTION
PLATE 2.4A



LEGEND

- Roadway Center Line
- Community Boundary
- Watershed Boundary
- Existing Storm Sewer
- Existing Open Channel
- Anticipated 100 Year Floodplain
- Option A Inundation Limits
- Option B Inundation Limits
- Option C Inundation Limits
- Irrigation Retention Area
- Detention Basin
- Scenario A Facilities
- Scenario B Facilities
- Scenario C Facilities
- Approximated Inundation Area

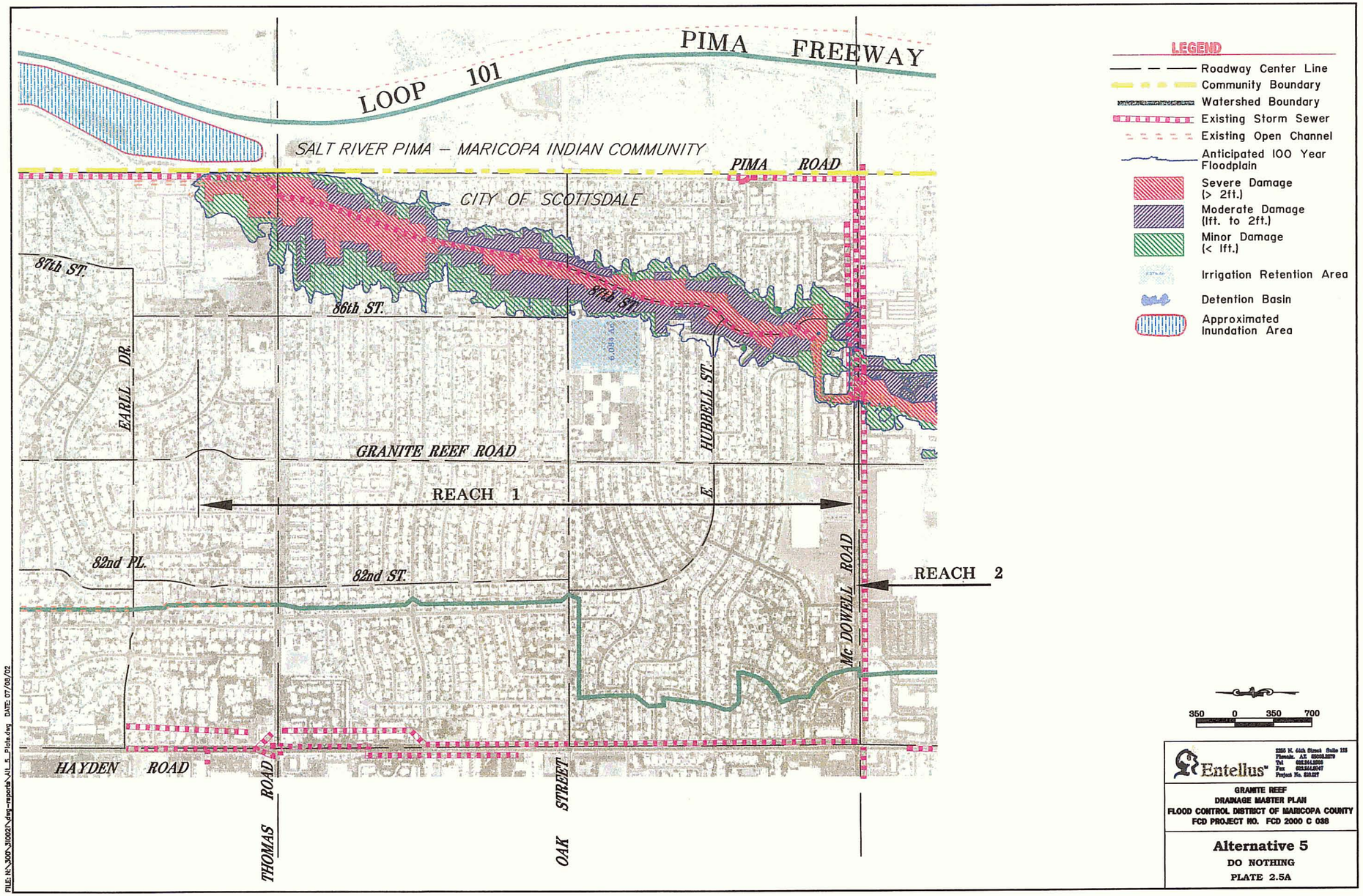
350 0 350 700

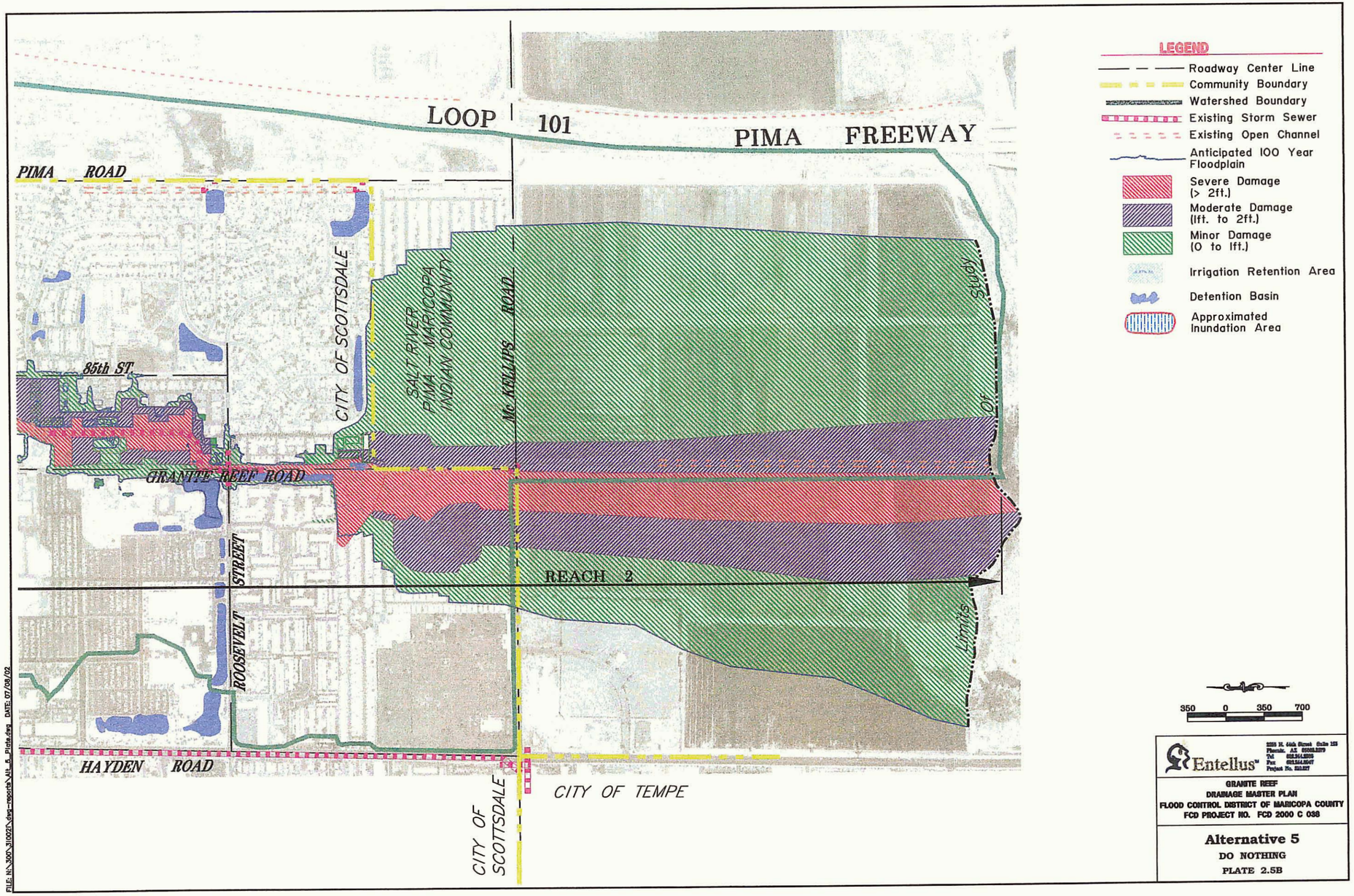
Entellus

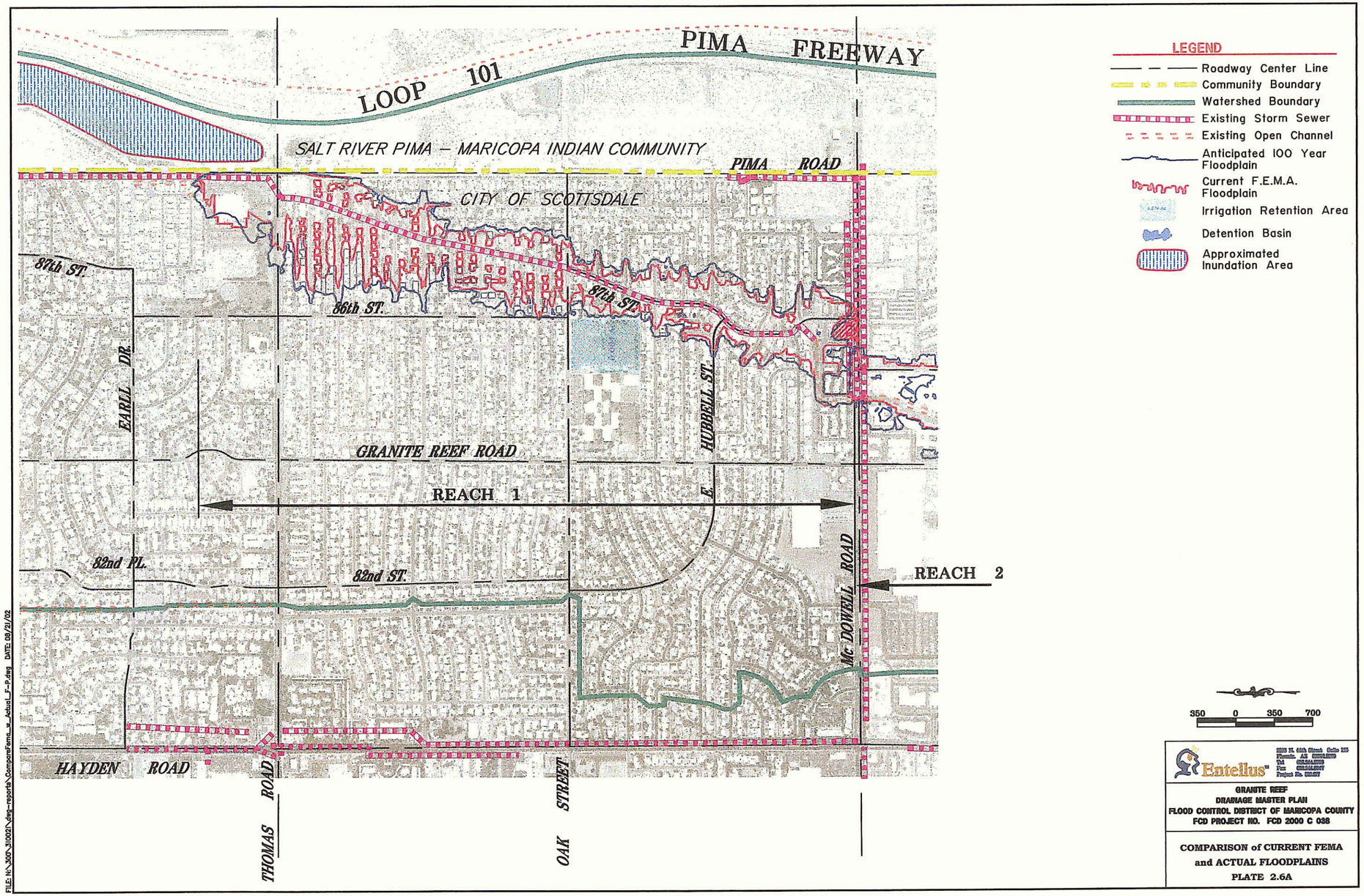
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038

Alternative 4
DETENTION
PLATE 2.4B

FILE: N:\300\310021\dwg-reports\Alt_4_Plate.dwg DATE: 08/21/02


LOOP 101
PIMA FREEWAY
SALT RIVER PIMA – MARICOPA INDIAN COMMUNITY
PIMA ROAD
CITY OF SCOTTSDALE
87th ST.
86th ST.
87th ST.
EARLL DR.
HUBBELL ST.
GRANITE REEF ROAD
REACH 1
E.
82nd PL.
82nd ST.
REACH 2
McDOWELL ROAD
HAYDEN ROAD
THOMAS ROAD
OAK STREET
LEGEND
Roadway Center Line
Community Boundary
Watershed Boundary
Existing Storm Sewer
Existing Open Channel
Anticipated 100 Year Floodplain
Severe Damage (> 2ft.)
Moderate Damage (1ft. to 2ft.)
Minor Damage (< 1ft.)
Irrigation Retention Area
Detention Basin
Approximated Inundation Area
350 0 350 700
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
Alternative 5
DO NOTHING
PLATE 2.5A
FILE: N:\300\310021\dwg-reports\AIL_5_Plate.dwg DATE: 07/08/02


LOOP 101 PIMA FREEWAY
PIMA ROAD
85th ST
GRANITE REEF ROAD
ROOSEVELT STREET
HAYDEN ROAD
CITY OF SCOTTSDALE
SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY
Mc KELLIPS ROAD
REACH 2
STUDY LIMITS
CITY OF TEMPE
CITY OF SCOTTSDALE
LEGEND
Roadway Center Line
Community Boundary
Watershed Boundary
Existing Storm Sewer
Existing Open Channel
Anticipated 100 Year Floodplain
Severe Damage (> 2ft.)
Moderate Damage (1ft. to 2ft.)
Minor Damage (0 to 1ft.)
Irrigation Retention Area
Detention Basin
Approximated Inundation Area
350 0 350 700
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
Alternative 5
DO NOTHING
PLATE 2.5B


LOOP 101
PIMA FREEWAY
SALT RIVER PIMA – MARICOPA INDIAN COMMUNITY
PIMA ROAD
CITY OF SCOTTSDALE
87th ST.
86th ST.
87th ST.
EARLL DR.
HUBBELL ST.
GRANITE REEF ROAD
REACH 1
E.
82nd PL.
82nd ST.
REACH 2
McDOWELL ROAD
HAYDEN ROAD
THOMAS ROAD
OAK STREET
LEGEND
Roadway Center Line
Community Boundary
Watershed Boundary
Existing Storm Sewer
Existing Open Channel
Anticipated 100 Year Floodplain
Current F.E.M.A. Floodplain
Irrigation Retention Area
Detention Basin
Approximated Inundation Area
350 0 350 700
Entellus
GRANITE REEF
DRAINAGE MASTER PLAN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJECT NO. FCD 2000 C 038
COMPARISON of CURRENT FEMA
and ACTUAL FLOODPLAINS
PLATE 2.6A
FILE: N:\30f\310021\dsg-reports\CompareFema_w_Actual_F-P.dwg DATE: 08/21/02

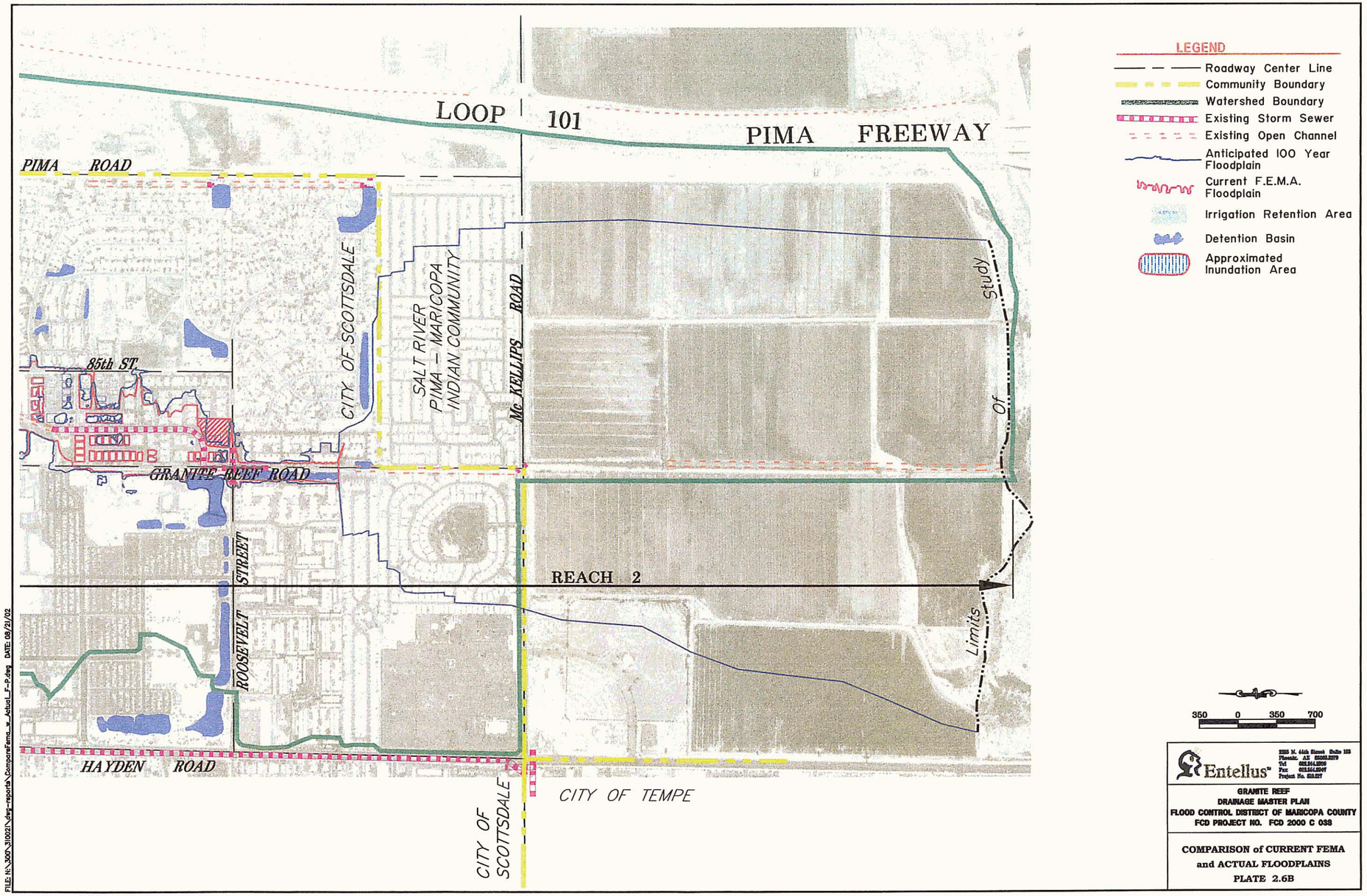


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TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
(C.O.S.) City of Scottsdale								
1	One Stop Shop	Pima Rd Pavement Drainage Report (McDowell Rd to Thomas)	13-48 & 18-48	BRW	March 1994	12/20/01	Hard copy	
2	One Stop Shop	McDowell Rd Widening (Granite Reef to Pima Rd)	13-48 & 18-48	INCA Engineers, Inc.	July 1996	12/20/01	Hard copy	
3	One Stop Shop	Pima Rd Pavement Drainage Report (Thomas Rd to Chaparral Rd)		BRW	May 1995	12/20/01	Hard copy	
4	G.I.S. Department	Images (CD)	400-F0201	C.O.S G.I.S. Dept.	Dec. 2001	12/20/01	CD	
5	G.I.S. Department	Images (CD)	400-F0201	C.O.S G.I.S. Dept.	Jan. 2002	1/04/02	CD	
6	G.I.S. Department	Images (CD)	400-F0201	C.O.S G.I.S. Dept.	Jan. 2002	1/07/02	CD	
7	One Stop Shop	McDowell Rd Widening (Granite Reef to Pima Rd) Final Drainage Report	13-48 to 18-48	INCA Engineers, Inc.	March 1995	12/27/01	Hard copy	
8	One Stop Shop	Report on Geotechnical Investigation (Granite Reef Wash) Channelization	11-47	Speedie & Associates	May 1991	12/23/01	Hard copy	
9	One Stop Shop	Granite Reef Wash Stabilization N of McKellips Rd	11-47	Mathews Kessler & Associates	May 1991	12/23/01	Hard copy	
10	One Stop Shop	Drainage system map		Planning Center		12/27/01	Hard copy	
11	One Stop Shop	Drainage map	P-1	Development Coordination Group	Apr-1991	12/27/01	Hard copy	
12	One Stop Shop	Drainage map	P-2	Development Coordination Group	Apr-1991	12/27/01	Hard copy	
13	One Stop Shop	Drainage map	P-3	Development Coordination Group	Apr-1991	12/27/01	Hard copy	
14	One Stop Shop	Drainage map	P-4	Development Coordination Group	Apr-1991	12/27/01	Hard copy	

TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
15	One Stop Shop	Quarter section sewer map	11-47 & 11-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
16	One Stop Shop	Quarter section sewer map	12-47 & 12-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
17	One Stop Shop	Quarter section sewer map	13-47 & 13-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
18	One Stop Shop	Quarter section sewer map	14-47 & 14-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
19	One Stop Shop	Quarter section sewer map	15-47 & 15-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
20	One Stop Shop	Quarter section sewer map	16-47 & 16-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
21	One Stop Shop	Quarter section sewer map	17-47 & 17-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
22	One Stop Shop	Quarter section sewer map	18-47 & 18-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
23	One Stop Shop	Quarter section sewer map	19-47 & 19-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
24	One Stop Shop	Quarter section sewer map	20-47 to 20-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
25	One Stop Shop	Quarter section sewer map	21-47 to 21-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
26	One Stop Shop	Quarter section sewer map	22-47 to 22-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	
27	One Stop Shop	Quarter section land map	15-48	Scottsdale Geographic Info. System	Dec. 2001	12/27/01	Hard copy	

TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
28	One Stop Shop	Granite Reef Wash Flood Retention Project	1148	C.O.S	Sept-1975	1/28/02	Hard copy	
29	One Stop Shop	Granite Reef Wash Stabilization N of McKellips Rd	114 Project No. F1705 C.O.S No. 54207	Mathews Kessler & Associates, Inc.	May-1991	1/28/02	Hard copy	
30	One Stop Shop	Motorola Expansion (Traffic Impact Study)	124	Bolduc, Smiley & Associates, Inc.	Oct-1988	1/28/02	Hard copy	
31	One Stop Shop	Preliminary Hydrology Study for Scottsdale Commerce Center	12-47 EM #6513	Ellis-Murphy, Inc.	Mar-1984	1/28/02	Hard copy	
32	One Stop Shop	Hydraulic Report (Oak St storm drain)	15-44 HR #863	Hook, Rockwell & Associates	Mar-1975	1/28/02	Hard copy	
33	C.O.S Doug Cullinane	C.O.S. public improvements Pima Rd buffering (Fillmore St to McDowell Rd)	Pr. No. S4702 Bid Call 96-70	BRW	Mar-1996	1/29/02	Hard copy	
34	C.O.S Doug Cullinane	C.O.S. public improvements Pima Rd buffering (Indian School to Chaparral Rd)	Pr. No. S4702 Bid Call 96-01	BRW	Jun-1995	1/29/02	Hard copy	
35	C.O.S Doug Cullinane	C.O.S. public improvements Pima Rd buffering (Chaparral Rd to McDonald Dr)	Pr. No. S4702 Bid Call 98-107	BRW	May-1998	1/29/02	Hard copy	
36	C.O.S Doug Cullinane	C.O.S. public improvements Pima Rd buffering (McDowell Rd to Thomas Rd)	Pr. No. S4702 Bid Call 94-109	BRW	Jun-1994	1/29/02	Hard copy	
37	C.O.S Doug Cullinane	C.O.S. public improvements Pima Rd buffering (Thomas to Indian School Rd)	Pr. No. S4702 Bid Call 95-120	BRW	May-1995	1/29/02	Hard copy	
38	C.O.S Doug Cullinane	C.O.S. public improvements Pima Rd buffering (McDonald Dr to Arizona Canal)	Pr. No. S4702 Bid Call 99IB073	BRW	May-2000	1/29/02	Hard copy	
39	One Stop Shop	Motorola GED, TRO	Not found	Lila Madden				
40	One Stop Shop	Motorola, Inc. Hayden Rd / Roosevelt St	Not found	Lila Madden				
41	One Stop Shop	Granite Reef Wash crossing	Not found	Lila Madden				
42	One Stop Shop	Box culvert @ Granite Reef Wash and McDowell Rd	15864 Pr. No. D-5503 Bid Call 85-80	C.OS	Oct-1985	12/27/01	Hard copy	

TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
43	One Stop Shop	McDowell Rd Improvements (Granite Reef to Pima Rd)	37668 Pr. No. S 1706 Bid Call 96-70	INCA Engineers, Inc.	Mar-1996	12/27/01	Hard copy	
44	One Stop Shop	McDowell Rd bridge inlet (@ Indian Bend Wash)	17051 Pr. No. SD-7547	C.O.S	Jul-1974	12/27/01	Hard copy	
45	One Stop Shop	Scottsdale Community Hospital sewer plans	4911	Evans, Kuhn & Associates, Inc.	May-1981	12/27/01	Hard copy	
46	One Stop Shop	Granite Reef Wash outfall (Roosevelt St to McKellips Rd)	16590 Pr. No. FC-7551	George Iannella	Aug-1977	12/27/01	Hard copy	
47	One Stop Shop	Hayden Rd flood protection	13241 Pr. No. SD-7548-C	George Iannella	Sept-1974	12/27/01	Hard copy	
48	One Stop Shop	Indian School Rd storm drain (Indian Bend Wash to Pima Rd)	15924 Pr. No. SD 8313	C.O.S.	Jul-1984	12/27/01	Hard copy	
49	One Stop Shop	Thomas Rd bridge (inlet and outlet)	17071 Pr. No. SD-7545	George Iannella	Jun-1976	12/27/01	Hard copy	
50	One Stop Shop	Jackrabbit Rd storm drain (86th St to Chaparral Park)	15866 Pr. No. F-5501 Bid Call 85-190	C.O.S	Jul-1985	12/27/01	Hard copy	
51	One Stop Shop	Camelback Rd storm drain	13248 Pr. No. SD-7623	C.O.S	May-1973	12/27/01	Hard copy	
52	One Stop Shop	C.O.S. public improvements Pima Rd buffering (Fillmore St to McDowell Rd)	38304 Pr. No. S4702 Bid Call 96-70	BRW	Mar-1996	12/27/01	Hard copy	
53	One Stop Shop	87th St storm drain (Phase I channel excavation)	13210 SD-068	C.O.S.	Sept-1976	12/27/01	Hard copy	
54	One Stop Shop	Chaparral Rd storm drain (Indian Bend Wash to Pima Rd)	17627 Pr. No. F 9001 Bid Call 89-19	C.O.S.	Aug-1988	12/27/01	Hard copy	
55	One Stop Shop	Floodplain Analysis for the PGA Golf Center		Water Resources Associates	Aug-1987	07/09/02	Hard copy	
56	One Stop Shop	Scottsdale Summit Master Drainage Study	15-48 59pp96	Erie & Associates	May-1997	07/09/02	Hard copy	
57	One Stop Shop	Chaparral Storm Drain Hydrologic Analyses	19-47	C.O.S.	May-1988	07/09/02	Hard copy	

TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
(FCDMC) Flood Control District Maricopa County								
62	Gila and Salt River	Plan & Profile Drawing	Drawer 6-ID # 4/10/54	A.W. Thompson	Dec. 1951	12/14/01	Drawings	
63	Tempe Drainage District	Drainage	M19-101	Tempe Drainage District	1921	12/14/01	Drawings	
64	FCDMC	Hec-1 Model of Granite Reef Wash	FU100-SD.DAT	Simons, Li & Associates, Inc.	July 1994	12/17/01	Hard copy	
65	FCDMC	Hec-1 Model of Granite Reef Wash	FU100.DAT	Simons, Li & Associates, Inc	July 1994	12/17/01	Hard copy	
66	FCDMC	Hec-1 Model of Granite Reef Wash	GR-100.DAT	Simons, Li & Associates, Inc.	1929	12/17/01	Hard copy	
67	FCDMC	Hec-1 Model of Granite Reef Wash	FU100BX.DAT	Simons, Li & Associates, Inc	July 1994	12/17/01	Hard copy	
68	FCDMC	Hec-1 Model of Granite Reef Wash	FU50.DAT	Simons, Li & Associates, Inc		12/17/01	Hard copy	
69	FCDMC	Flood events 1966	007.103	Newspaper and photographs	Jan. 1966	12/27/01	Hard copy	
70	FCDMC	Indian School Rd 45" waterline	A680.514	Brooks & Kelly Consulting Engineering	Oct. 1974	12/27/01	Hard copy	
71	FCDMC	Indian Bend Wash Gila River Basin	A680.902	Secretary of the Army	June 1938	12/27/01	Hard copy	
72	FCDMC	Indian Bend Wash and McDowell Exhibit	A680.925	Neils Ervin Resident Engineering	Sept. 1983	12/27/01	Hard copy	
73	FCDMC	Pima Freeway crossing Arizona Canal	A027.910	ADOT	Dec. 1990	12/27/01	Hard copy	
74	FCDMC	History of the Salt River in Tempe	A125.904	Paul F. Ruff, Associate Professor of Engineering at ASU	Dec. 1965	12/27/01	Hard copy	
75	FCDMC	Granite Reef Wash Salt River to Arizona Canal	MCDOT #68736	Tom Phelan III P.E. & Dick Perrault	1995	1/23/02	Hard copy	

TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
76	FCDMC	Correspondence	Enclosure #1	Charles D. Connett, P.E. & Norman Arno	Jan-Feb 1983	1/23/02	Hard copy	
77	FCDMC	Granite Reef Wash Drainage Study	MCDOT #68736	Simons, Li & Associates, Inc	Jan-1995	1/23/02	Hard copy	
78	FCDMC	Granite Reef Wash Hec-1 input/output	MCDOT #68736 AZ-MCDT-01	Simons, Li & Associates, Inc	Dec-1994	1/23/02	Hard copy	
79	FCDMC	Granite Reef Wash McDonald Drain Project (Project Proposal)	MCDOT #68736	FCDMC	Oct-1994	1/23/02	Hard copy	
80	FCDMC	Granite Reef Wash Drainage Study (Summary of Discharges)	MCDOT #68736	Simons, Li & Associates, Inc	Jan-1995	1/23/02	Hard copy	
81	FCDMC	Granite Reef Wash Drainage Study (Preliminary Report)	MCDOT #68736 Contract No.: CY-1994-15	Simons, Li & Associates, Inc	Jan-1995	1/23/02	Hard copy	
82	FCDMC	Granite Reef Wash (Scope of Work)	MCDOT #68736	MCDOT	Aug-1993	1/23/02	Hard copy	
83	FCDMC	McKellips Rd Drainage Structure @ Granite Reef Wash	MCDOT #68736	Simons, Li & Associates, Inc	Jan-1993	1/23/02	Hard copy	
84	FCDMC	McKellips Rd Drainage Structure @ Granite Reef Wash (84th St)	MCDOT #68736 Inca No. 6921	INCA Engineers, Inc.	Jan-1993	1/23/02	Hard copy	
86	FCDMC	Hec-1 Model of Granite Reef Wash	Coe100.DAT	Simons, Li & Associates, Inc	July 1994	12/17/01	Hard copy	
87	FCDMC	Hec-1 Model of Granite Reef Wash	Sg-grw.DAT	Simons, Li & Associates, Inc	July 1994	12/17/01	Hard copy	
88	FCDMC	Hec-1 Model of Granite Reef Wash	GR-10.DAT	Simons, Li & Associates, Inc	July 1994	12/17/01	Hard copy	
89	FCDMC	Hec-1 Model of Granite Reef Wash	GR-50.DAT	Simons, Li & Associates, Inc	July 1994	12/17/01	Hard copy	
90	FCDMC	Hec-1 Model of Granite Reef Wash	EX100.DAT	Simons, Li & Associates, Inc	July 1994	12/17/01	Hard copy	
91	FCDMC	Granite Reef Watershed Flood Mitigation Candidate Assessment Report	FCD 98-23 PCN# 027-05-01	Primatech, LLC	Oct. 1999	12/17/01	Hard copy	
92	FCDMC	Tempe Drainage Districts 1 and 2 from the Salt River (maps from 1921)	No's 1 and 2	FCD	1965 and 1967	12/17/01	Hard copy	

TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
93	FCDMC	Gila and Salt Rivers Gillespie Dam to Granite Reef Dam Plan and Profile	Appendix 3, Plate 6 of 7	HW Thompson	Dec 1957	12/17/01	Hard copy	
(ADOT) Arizona Department of Transportation								
94	ADOT	E Papago Freeway (202L) (E Papago, Indian Bend-Jct. 101L)	RAM-600-5-507 202L MA 008	ADOT	May-1992	2/4/2002	Hard copy	
95	ADOT	Phoenix urbanized area E Papago Freeway (202L (McClintock Dr -SR. 101L)	RAM-600-5-508 202L MA 008	ADOT	Sept-1992	2/4/2002	Hard copy	
96	ADOT	Offsite Drainage Report Pima Freeway (Stations 2639+00 to 2840+00)	Pr. No. RAM 600-1-513 Tracs No. H 2409-01-D	ADOT	Apr-1993	2/5/2002	Hard copy	
(MCDOT) Maricopa County Department of Transportation								
104	COX Communications	T2N-R4E-Sec. 12,13,24,25,36 E of Hayden Rd, W of Pima, S of Arizona Canal	Cable	COX Communications	June-2001	1/10/02		
105	Mountain Bell	T2N-R4E-Sec. 12,13,24,25,36	Telephone	Mountain Bell	Apr.-1975	1/13/02		
106	SRP	T2N-R4E-Sec. 12,13,24,25,36	Electric	SRP	Nov.-1993	1/13/02		
107	Southwest Gas Corp.	T2N-R4E-Sec. 12,13,24,25,36	Gas	Southwest Gas Corp.	Dec.-2001	1/16/02		
108	MCDOT	McKellips Channel	Not found					

TABLE 1.2 Data Collection Log

ITEM NO.	Data Location	Data Description	Data Description Number	Prepared by	Date	Date Received	Data Format	Data Sign Out Sheet
(SRPMIC) Salt River Pima-Maricopa Indian Community								
119	SRPMIC	SRPMIC Sewer Lines 90th Street to Curry Rd (Pima Freeway Loop 101)	RAM-600-1-346 Plates #42-69	Aztec Engineering	Aug-2000	2/4/2002	Hard copy	
120	SRPMIC	Detention ordinance	Not found	Kent Andrews				
121	SRPMIC	Contour mapping/DTM	Not found	Kent Andrews				
122	SRPMIC	Digital images	CD	Kent Andrews			Digital	
123	SRPMIC	Pima Rd as-builts	Not found	Kent Andrews				
124	SRPMIC	Land Use Maps	Not found	Kent Andrews				
125	SRPMIC	Land Use Maps	Not found	Kent Andrews				
	Other Sources							
130	Entellus, Inc.	Granite Reef Wash Floodplain Delineation Study TDN-Hydraulics	FCD 95-29	Entellus, Inc	May, 1997	1997	Hard copy	