City of Scottsdale
Desert Greenbelt Project

ALTERNATIVES ANALYSIS REPORT IN SUPPORT OF A 404 PERMIT APPLICATION REATA PASS/BEARDSLEY WASH PIMA FLOODPLAIN

The Desert Greenbelt
SCOTTSDALE, ARIZONA

Main Report
Volume 2 of 5
June 1999
Prepared by:

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ALTERNATIVES ANALYSIS REPORT

IN SUPPORT OF A 404 PERMIT APPLICATION

PREPARED FOR THE CITY OF SCOTTSDALE

DESERT GREENBELT PROJECT

Prepared by

Simons, Li & Associates, Inc.
San Diego, California

June 15, 1999

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I. INTRODUCTION

The purpose of this document is to describe the results and findings of an alternatives analysis in support of a 404 Permit application for the City of Scottsdale's Desert Greenbelt project. As part of this report process, Simons, Li & Associates (SLA) prepared a baseline conditions report for the study area. The baseline conditions report, included within this document as Volume I, includes an investigation of existing and future-without-project conditions of the Reata Pass/Beardsley Wash alluvial fan and Pima Floodplain within North Scottsdale, Arizona, and is essential for the proper understanding of the alternatives analysis presented in this volume (Volume II).

The study area, shown in Figure 1.1 of the Baseline Conditions report (Volume I), is bordered by the McDowell Mountains to the east, Dynamite Boulevard to the north, Scottsdale Road to the west, and the Central Arizona Project (CAP) to the south. In brief, the baseline conditions report shows that:

- The Reata Pass/Beardsley Wash alluvial fan is subject to a severe and unpredictable flood hazard delineated by the Federal Emergency Management Agency. The Pima Floodplain is also subject to flood damage.

- The Reata Pass/Beardsley Wash alluvial fan and Pima Floodplain areas are currently approximately 70% developed (67% for Reata Pass/Beardsley Wash floodplain and 75% for Pima Floodplain). Total units approved are 3,859 for the Reata Pass/Beardsley Wash alluvial fan and 4,541 for the Pima Floodplain. Flood damage potential under current conditions for the combined floodplains is estimated at approximately $3,890,800 per year.

- The entire Reata Pass/Beardsley Wash alluvial fan and Pima Floodplain are subject to development. Maximum build-out of approximately 6,776 units on the Reata Pass/Beardsley Wash alluvial fan and 5,644 on the Pima Floodplain should occur sometime between the years 2002 and 2025. Zoning is in place for the study area, and, if past trends continue this property will be developed. The Corps of Engineers has granted 404 Permits for extensive development on the alluvial fan. Future permits are also expected to be authorized.

- Development and flood protection in the past have not been on a regional basis. Flood protection is mainly provided by elevating homes to the level of the regulatory flood. This practice is allowable under FEMA regulations, but does not eliminate the existing flood hazard or the potential for damage due to the unpredictability of alluvial fan flows. All structures on the Reata Pass/Beardsley Wash alluvial fan are

potentially subject to a flood insurance requirement. Flood-control channels built piecemeal by developers do not have the capacity to collect and convey all alluvial fan flows as is required by FEMA for flood protection.

Based upon the information summarized in the baseline conditions report and the supporting Economic Analysis (Appendix D), the City of Scottsdale recognized a need (See Section 2.1) to provide regional flood-control to protect development in the study area.

During the past ten years the City has conducted studies and public involvement to determine the best possible alignment and design for regional flood control. A wide variety of alternatives, most \of which are represented in this report, were investigated over this ten-year period by the City, the Corps of Engineers, the Flood Control District of Maricopa County, the Arizona State Land and Transportation Departments, specialized consultants and the public. Figure 1.1 shows a drainage concept plan from 1989 by the City of Scottsdale. This early concept alignment for the Reata Pass/Beardsley Wash is basically the same as the proposed project. Figures 1.2 and 1.3 show the Thompson Peak alignment and the Southwest alignment for the Reata Pass/Beardsley Wash, both of which were eliminated from further consideration by the Scottsdale City Council after a two-year public involvement program due to cost and environmental concerns. This report examines all of the alternatives studied during the past ten years except for the Reata Pass/Beardsley Wash alignments shown in Figures 1.1, 1.2 and 1.3.

The City identified the largest and longest natural channel on the alluvial fan as being particularly appropriate for a flood control project alignment. This existing natural channel, referred to as the East Wash in the Baseline Conditions Report, forms an approximate natural boundary between the developed and undeveloped portions of the alluvial fan. The channel is partially incised at a level below the adjacent alluvial fan surface. Flows in these incised portions of this channel are confined, significantly below the adjacent surface of the alluvial fan, and have no opportunity to spread across the fan surface. The East Wash is so situated that right-of-way can be acquired without displacing any existing residents.

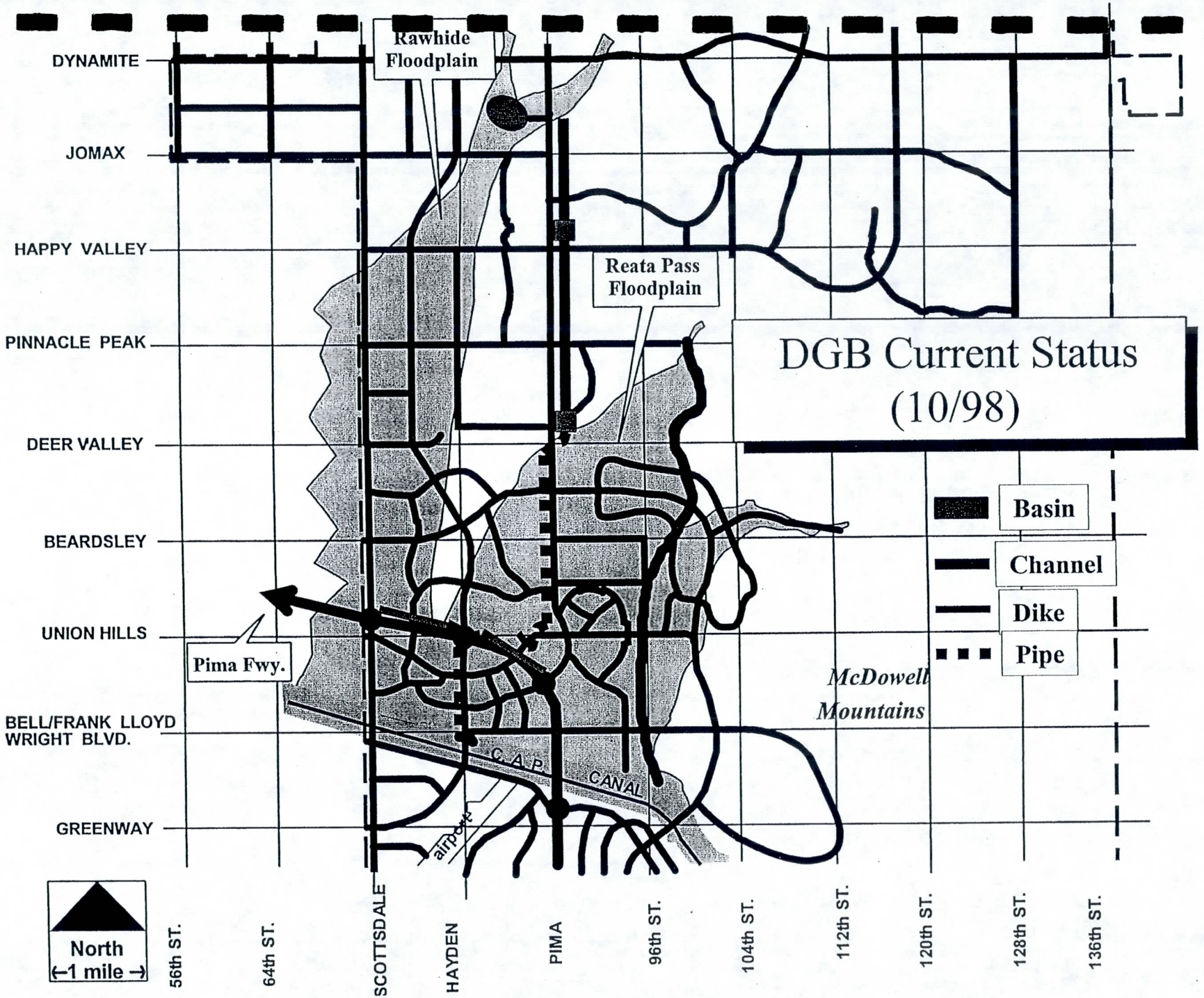


Figure 1.1. 1989 Conceptual Drainage Design Plan.

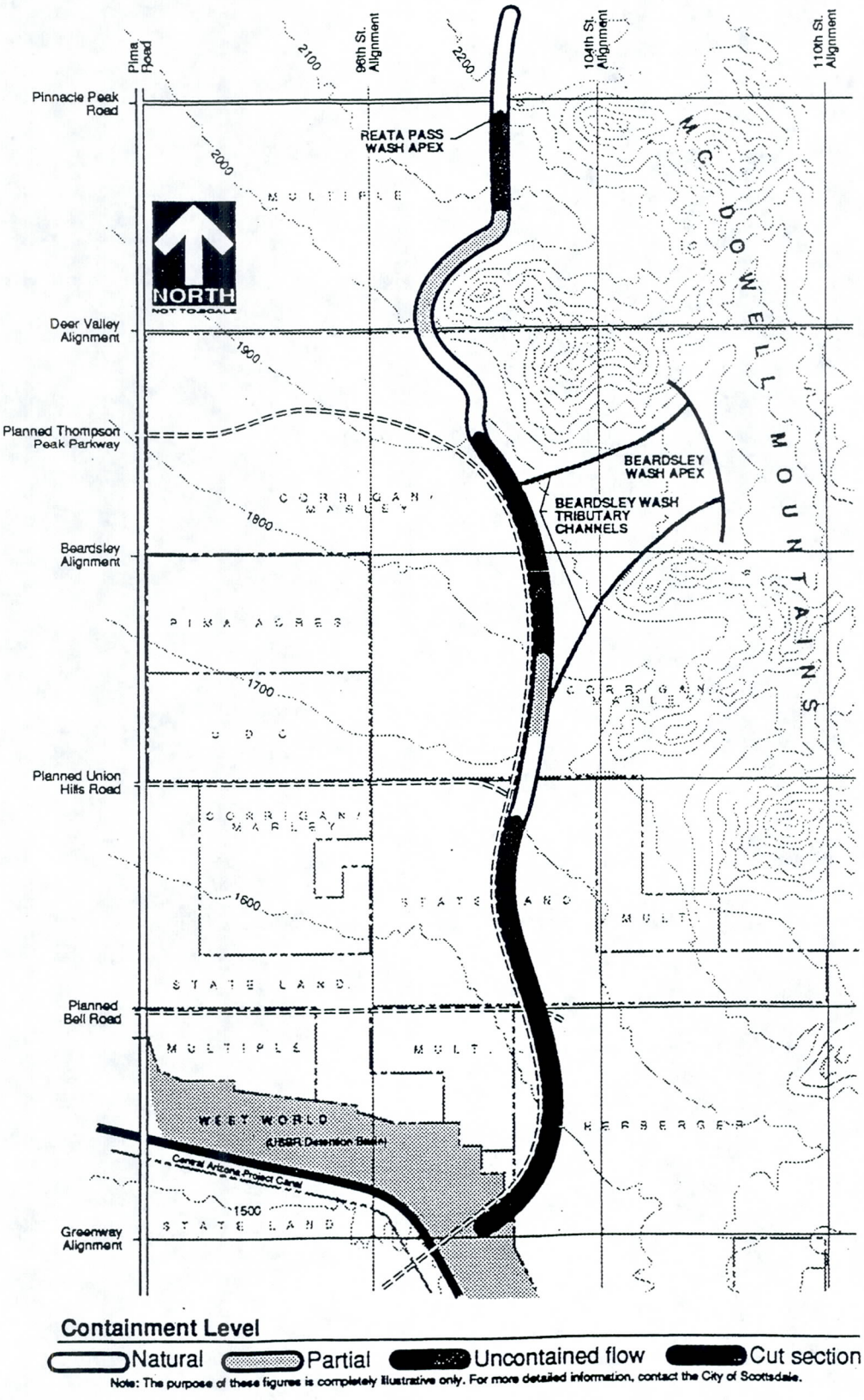


Figure 1.2. Thompson Peak Alignment.

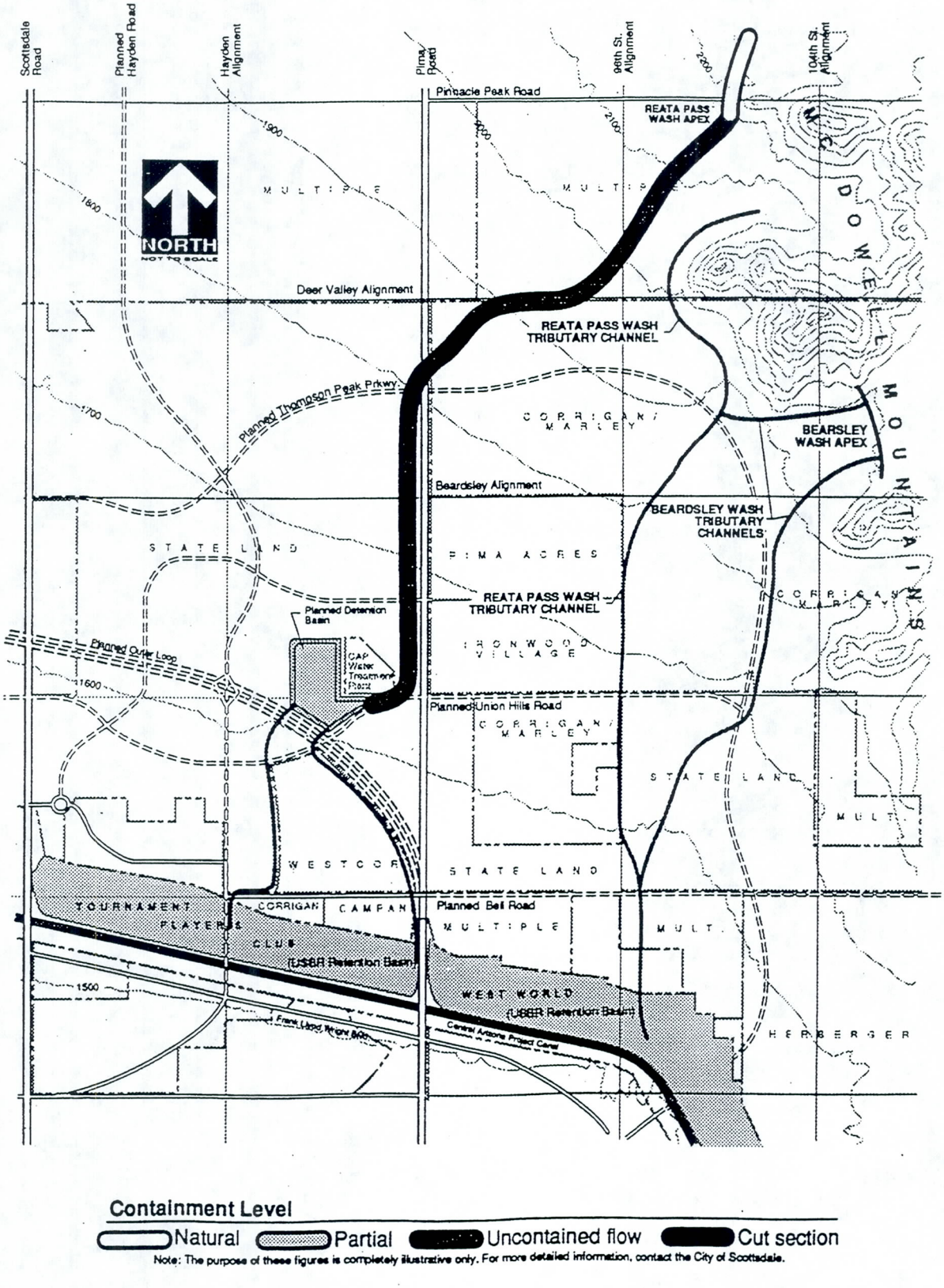


Figure 1.3. Southwest Alignment.

Flood protection for the Pima Floodplain was also studied over a period of ten years by the City of Scottsdale and the other agencies noted above. The Pima Floodplain has long been a source of flood complaints by City residents. A variety of flood protection alignments and designs were considered, some of which are represented in this report. Because of the presence of the Reata Pass/Beardsley Wash alluvial fan crossing Pima Road, and the uncertain and ultrahazardous nature of the flooding there, a stand-alone project for the Pima Floodplain was not deemed feasible. The City identified a preferred Pima Floodplain solution, consisting of a series of underground storm drains and detention basins along Pima Road, which is dependent upon a separate system to collect and control the Reata Pass/Beardsley Wash alluvial fan flows.

Two basic downstream alignments for the Pima Road system were considered. The first continued straight along the Pima Road alignment to the Bureau of Reclamation Detention Basin east of the Pima Road alignment. This concept was objected to by the Bureau of Reclamation because it would divert more flow into that detention basin than the basin was designed to take. The Pima Road flood-control system had to be shifted to the west to enter the Bureau of Reclamation detention basin west of Pima Road at the City of Scottsdale Tournament Players Club Golf Course, where some of these flows enter under current conditions.

During a meeting held on July 2, 1998 to discuss the 404 Permit application for the Desert Greenbelt project, the Corps of Engineers indicated that an alternatives analysis should be done in support of the 404 Permit application. The Corps is required to evaluate the application and reach a decision based on federal regulations at 33 CFR, Parts 320 to 330 and 40 CFR Part 230 for implementing Section 404 of the Clean Water Act. The Corps must complete two independent analyses as part of the decision making process: a public interest review, and an analysis for consistency with the guidelines for specification of disposal sites for dredged and fill material, commonly referred to as the 404(b)1 guidelines. The 404(b)1 guidelines require that the alternatives analysis be adequate to establish that the project is the least environmentally damaging, practicable alternative. This is accomplished by comparing the proposed project with other alternatives in terms of practicality, project purpose and overall environmental effects.

This analysis has been prepared to be consistent with Corps requirements by including a reasonable statement of the project purpose, and evaluating several alternatives for consistency with that purpose, practicability, and environmental impact. This analysis is consistent with federal regulations and recent guidance and provides an objective evaluation of the alternatives. The Corps requested that certain alternatives be evaluated in a letter dated August 11, 1998 to the City of Scottsdale. These specific alternatives are:

- **No Action**. The no-action alternative would assume that jurisdictional waters would not be affected by a regional flood control project. These waters would continue to be subject to permit applications by others under the Corps 404 program.
- **Environmental Enhancement**. An environmental enhancement project would provide some protection from flooding, provide recreation, and clearly enhance the environment in doing so.
- **Wider Channel**. The currently-proposed project with a wider channel cross section.
- **Narrower Channel**. The currently-proposed project with a narrower channel cross section.
- **Partial Levee**. The currently-proposed project modified to incorporate downstream outlets as well as a partial levee.
- **Ring Dikes**. Protection of existing infrastructure and development only. This alternative would enable the flood risk to be reduced only in areas containing existing developments. Ring dikes, or levees specific to individual developments were discussed as a method of accomplishing this.
- **Scattered Detention/Retention Facilities.**
- **Streambank Stabilization** (in-place).

All of the alternatives listed above are examined in this alternatives analysis. Alternatives are compared according to the following criteria:

1. Ability to meet the stated project purpose,
2. Impacts to the waters of the U.S.,
3. Other environmental impacts,
4. Engineering feasibility,

5. Construction and maintenance cost,
6. Secondary benefits and impacts,
7. Compliance with local, State, and Federal regulations,
8. Regulatory floodplain and flood insurance considerations, and
9. Mitigation feasibility and cost.

II. PURPOSE AND NEED FOR A FLOOD-CONTROL PROJECT

2.1 Basic Purpose: Remove 100-Year Flood Hazard

The Baseline Conditions Report described the flooding, development and infrastructure conditions on the Reata Pass/Beardsley Wash alluvial fan and Pima Floodplain. The Economic Analysis described damages that are expected to occur under current and future conditions within the 8,550-acre Reata Pass/Beardsley Wash and Pima Floodplain study area. Key points of the baseline and Economic Analysis are summarized below:

- There is an existing, severe flood hazard. The Reata Pass/Beardsley Wash alluvial fan has been mapped by FEMA as a regulatory floodplain subject to alluvial fan flood conditions. Flood depths shown on the FEMA flood insurance rate maps for the regulatory (1% chance) flood range from approximately four feet at the apex (at Pinnacle Peak Road) to one foot at the base (at the CAP canal). Flow velocities range from nine to three feet per second.

  Alluvial fan flooding is unpredictable and potentially devastating to development. According to the National Research Council (1996): *"Alluvial fan flooding is...characterized by flow path uncertainty so great that this uncertainty cannot be set aside in realistic assessments of flood risk or in the reliable mitigation of the hazard. An alluvial fan flooding hazard is indicated by ... an environment where the combination of sediment availability, slope, and topography creates an ultrahazardous condition for which elevation on fill will not reliably mitigate the risk."* Every structure on the alluvial fan is potentially in a direct flow path under current conditions. In the case of the Reata Pass/Beardsley Wash alluvial fan, the 100-year (regulatory) discharge at the Reata Pass apex is 10,000 cfs. Approximately 13,500 tons of sediment would be delivered by a 100-year storm. The Reata Pass Wash alluvial fan was investigated and was rated as a flood-hazard degree 9 out of 10 possible by the U.S. Geological Survey in 1994. According to the State of Arizona Bureau of Geology and Mineral Technology (1979), "*The major washes*

carry runoff and sediment from the mountains and as the stream channel decreases in depth down fan, the runoff spills over the channel sides and debauches onto the fan surface. The drainage system is braided and channels continually change positions. Flooding is generally severe in major storms and overflowing channels add to the sheetflow problems down fan."

- There is currently substantial development, consisting of building pads, golf courses and other grading activity affecting the natural ecosystem on the alluvial fan. That portion of the Reata Pass/Beardsley Wash alluvial fan west of the East Wash described in the Baseline Conditions analysis is currently 67% disturbed, mainly with single-family residences and roadway networks. There are currently 2,776 single-family residences, apartments and condominiums and 1,083 resort and commercial units existing or approved for development on the Reata Pass/Beardsley Wash alluvial fan. The total estimated value of this existing development, with contents, is more than $645,000,000. There is no development within the floodplain east of the East Wash. Figures 2.1 and 2.2 are aerial photographs from 1993 and 1998 showing the increasingly developed nature of the study area.

- Under current development conditions, based on an estimate made by the U.S. Army Corps of Engineers (North Scottsdale Drainage Area, Arizona - Reconnaissance Study, Flood Control and Related Purposes, USACE, 1996), flood damage on the Reata Pass/Beardsley Wash alluvial fan is expected to occur on floods of 2-year return period or larger. This means that flood damage will occur once every 2 years, on the average. The 100-year flood is expected to cause $21,322,000 in inundation damage to structures and contents under current conditions. The Economic Analysis shows that under current conditions the expected annual damage of this flood risk (Reata Pass/Beardsley Wash floodplain only) is $2,320,200. The equivalent annual damage of this flood risk, considering ultimate development, is $5,820,900. There is an unquantifiable risk to life associated with this flood threat.

- The entire Reata Pass/Beardsley Wash alluvial fan is zoned for development, subject to the requirements of Scottsdale's environmental and drainage ordinances. Ownership is almost entirely private or held for future development in the Arizona State Land Trust, as designated urban lands. There is no single private parcel of land in the floodplain that is situated in such a manner as to allow construction of a regional solution that would adequately protect the entire alluvial fan from a 100-year event. Past development has been piecemeal with individual and local attempts at flood protection which have been ineffective at removing the alluvial fan flood designation because they have not addressed the entire regulatory discharge, with sediment, from the apex. The Ironwood Village subdivision is one attempt by a developer to provide flood protection for an individual development by elevating homes and constructing diversion channels at the upstream side of the development. The cost of building this flood-control solution was approximately $3,000,000 in the late 1980's, and the development plan resulted in a complete elimination of natural

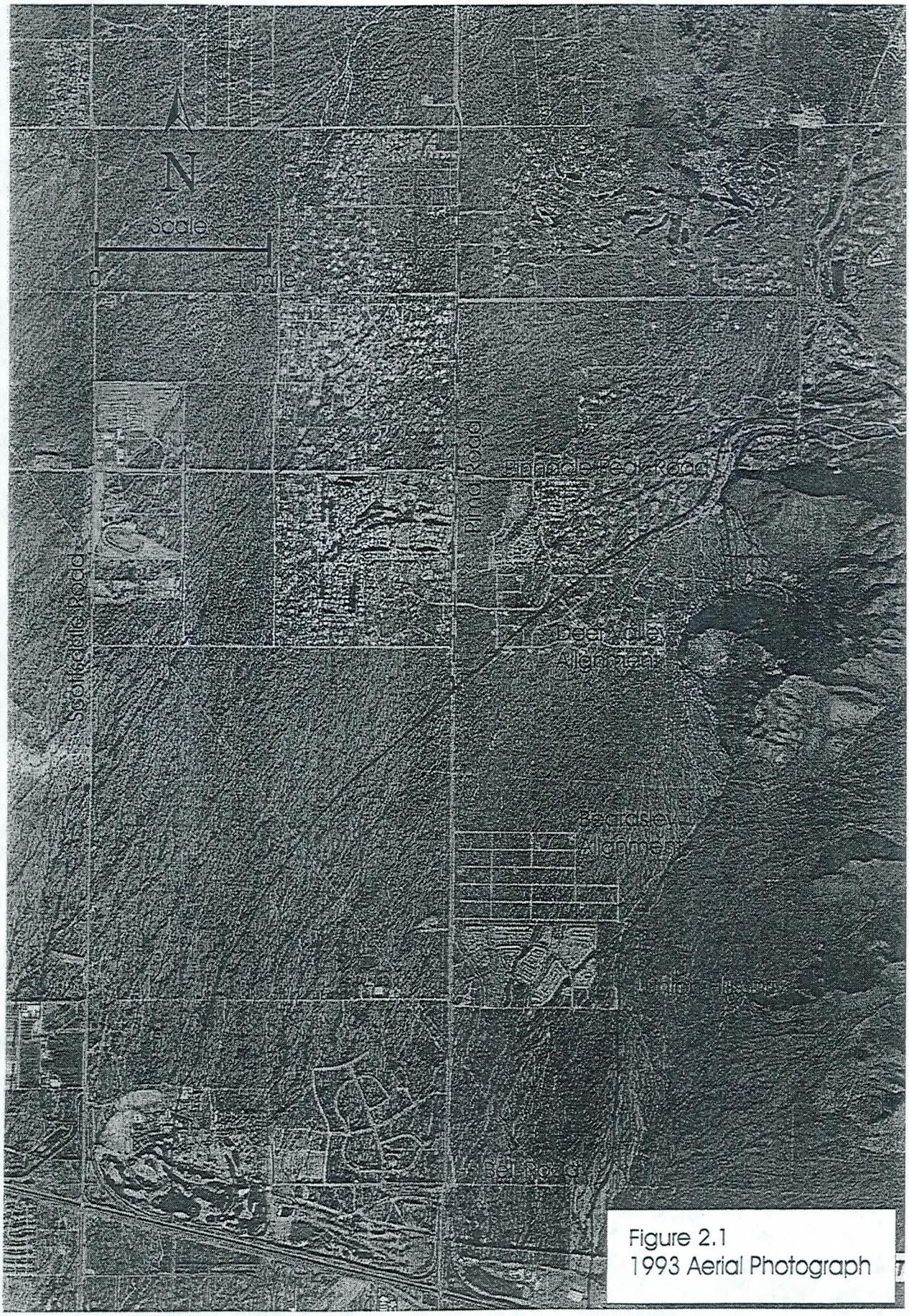


Figure 2.1
1993 Aerial Photograph

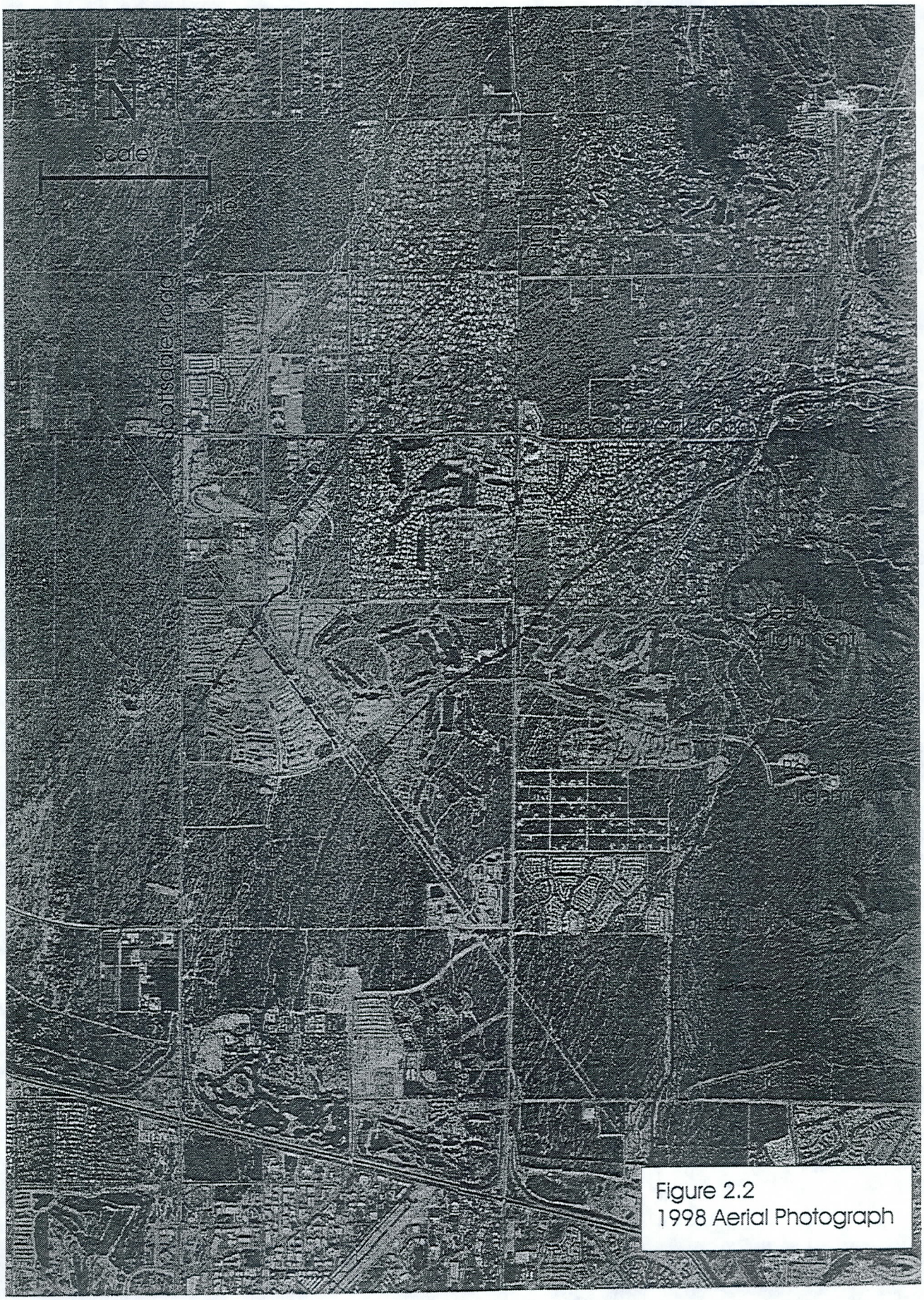


Figure 2.2
1998 Aerial Photograph

habitat in the desert between a few key watercourses. The flood-control solution was rejected by FEMA for a letter of map revision on the grounds that the flood-control channel was not designed to collect and convey the entire apex flow with sediment. This means that it does not protect against a 100-year flood event.

- The Pima Floodplain has not been mapped by FEMA as a regulatory floodplain, but it is an area identified by the City of Scottsdale and the Flood Control District of Maricopa County as historically subject to flooding. This identification is based on experiences of flood damage on the floodplain, and hydrologic and hydraulic analysis. The Pima Floodplain has a history of channel instability leading to extensive lateral erosion in existing developed areas. The 100-year flood depth is approximately one foot from Jomax Road to the CAP canal.

- The Pima Floodplain ecosystem is currently 75% disturbed, mainly with single-family residences and roadway networks. There are currently 3,444 single-family or apartment residences and 1,082 resort and commercial units on the Pima Floodplain. The total estimated value of this existing development (with contents) is nearly $590,000,000.

- Under current development conditions, flood damage on the Pima Floodplain is expected to occur with floods of 2-year return period or larger. This means that flood damage will occur once every 2 years, on the average. The 100-year flood is expected to cause $12,484,000 in inundation damage to structures and contents under current conditions. The Economic Analysis shows that the expected annual damage of this flood risk under current conditions (Pima Floodplain only) is $2,013,300. The equivalent value of all flood risks, assuming ultimate development, is $3,166,300 in annual damages.

Since the Reata Pass/Beardsley Wash alluvial fan was designated as an alluvial fan flood zone by FEMA in 1993, the City of Scottsdale has required new development to elevate building pads to a point where the lowest floor is at or above the estimated regulatory flood depth. This requirement is consistent with FEMA guidelines for flood development. However, prior to 1993 there was no designated flood zone and no such requirement. Approximately 42% of the Reata Pass/Beardsley Wash alluvial fan was developed prior to 1993 (1,330 structures) with lowest floors below the 1993 flood elevations. Furthermore, the structures constructed after 1993, although built according to FEMA guidelines, are still subject to flood damage because of the ultrahazardous nature of alluvial fan flooding. Simply elevating the structure does not remove the flood hazard (see NRC quotation in Section I of the Baseline Conditions Report).

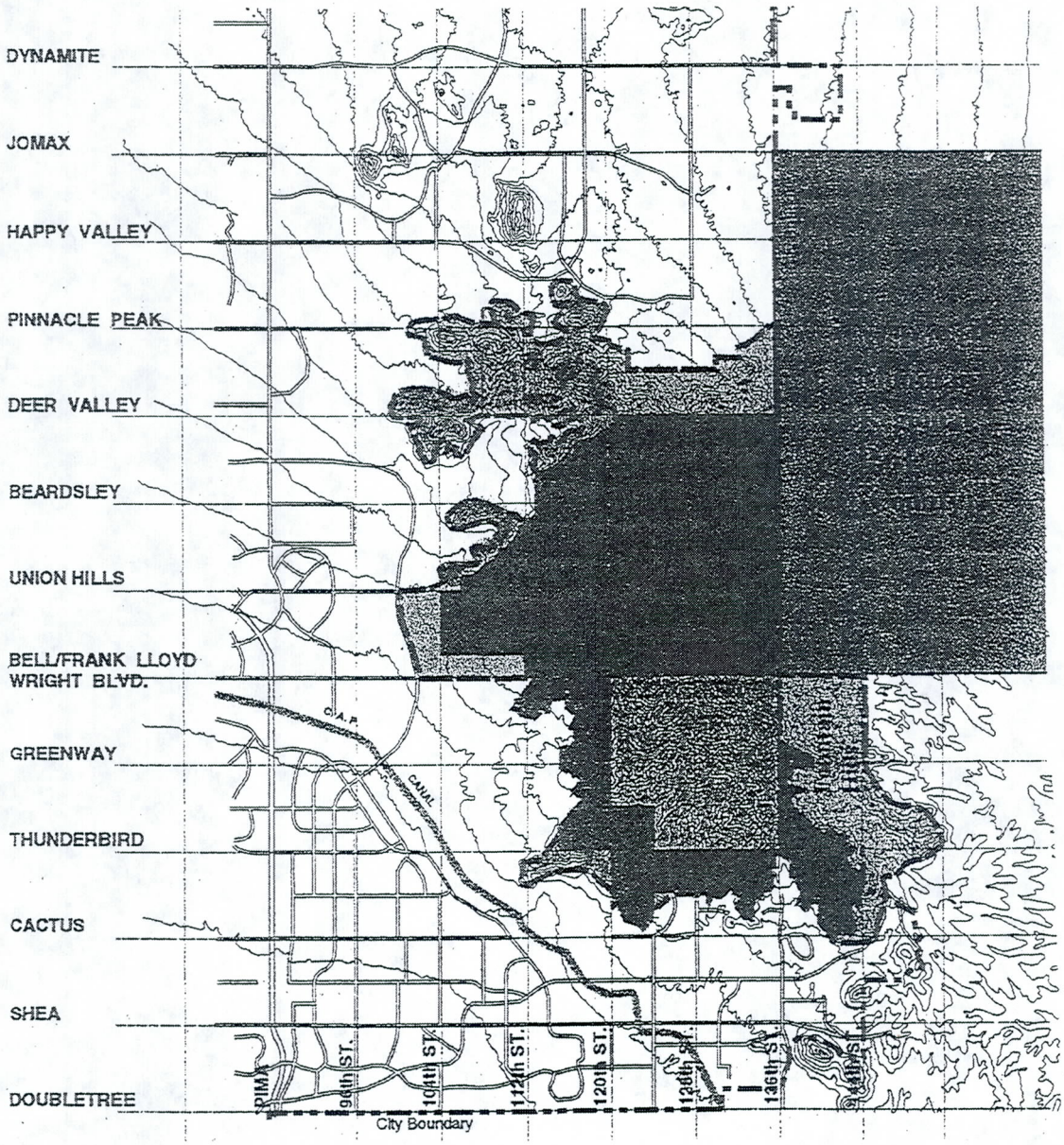
In addition to protection of existing homes, businesses and human life on the two floodplains there will be incidental protection of future development in the undeveloped areas of the Pima Floodplain and the area west of the East Wash in the Reata Pass/Beardsley Wash alluvial fan. The undeveloped portion of the Reata Pass/Beardsley Wash alluvial fan east of the East Wash, represents 11% of the designated floodplain and is zoned for residential development, but is not included in the study area and will not be protected by the proposed project.

The study area contains extensive public infrastructure, mostly in the form of roads, utilities and the City's Water Campus. The roads in particular are subject to flooding. Most roadway drainage crossings, including those on Pima Road which is the main north-south arterial within the study area and currently carries more than 28,000 vehicles per day, are dip crossings subject to periodic flooding. Each time these dip crossings are flooded there is a traffic hazard, a traffic delay, and a clean-up cost. The City of Scottsdale has recently completed the $100,000,000 Water Campus which contains several water and wastewater facilities. Flooding of this facility could threaten public health and safety. A regional flood-control system would greatly reduce or eliminate these public hazards and maintenance costs to public infrastructure. Protection of existing public infrastructure from flooding is included as a major project purpose.

2.2 Recreation

The McDowell Mountains are a major natural landmark of high aesthetic value. These mountains run north-south for approximately eight miles and are a recreational destinations for hikers, bird watchers, naturalists, equestrians and hunters. The City of Scottsdale recognized their natural resource and recreational value when designating them as environmentally-sensitive lands, and by establishing the planned McDowell Sonoran Preserve. Approximately 16,460 acres of Sonoran Desert Habitat are being acquired by the City as a permanent preserve. Figure 2.3 shows the location of this preserve in relation to the study area. The City of Scottsdale desires to ensure general public accessibility to this resource by establishing a corridor for recreational use between the mountains and the population core of the City. The Reata Pass/Beardsley Wash runs along the foot of the range for approximately five miles, providing a north-south access to all the canyons and tributaries from

Planned McDowell Sonoran Preserve



Planned McDowell Sonoran Preserve: 16,460 acres

McDowell Sonoran Preserve (8/98): 8,348 acres

State Trust Land Reclassified as Suitable for Conservation: 2,762 acres

Additional Land in Planned Preserve Protected by Zoning: 1,766 acres

Remaining Land to be Considered for Inclusion in the Preserve

City Boundary

N

city of scottsdale, arizona

Note: Map is for illustration purposes only and is not to scale.

Figure 2.3; McDowell Sonoran Preserve

Thompson Peak to the Troon Village area at the north end of the range. Establishment of a continuous, permanent, recreational corridor linking the two is another purpose of the proposed project.

2.3 Purpose Statement

The basic project purpose is to remove the 100-year flood hazard to protect human life, existing and future homes, businesses and public improvements, and enhance recreation.

1. **Flood Hazard Removal**: To provide 100-yr flood protection for existing and future homes, businesses and public improvements within the FEMA designated Special Flood Hazard Area of the Reata Pass Wash and Beardsley Wash alluvial fans and within the Pima Floodplain;

2. **Flood Protection for Public Improvements**: To provide flood protection for Pima Road, Scottsdale Road, Thompson Peak Parkway, other local streets, the City of Scottsdale Water Campus, and local utilities; and,

3. **Enhance Recreation**: To enhance recreational use of the Reata Pass and Beardsley Wash alluvial fans and provide path and trail linkages to the McDowell Mountains and City-wide recreational corridors.

III. OPPORTUNITIES AND CONSTRAINTS

Opportunities and constraints for flood control within the study area have been explored in detail by the City of Scottsdale, the Maricopa County Flood Control District, the Corps of Engineers and other agencies for the past decade as described in this section. The general opportunities and constraints applicable to the study area as a whole are mainly related to the natural topography, the nature of alluvial fan flooding, the extent and pattern of development and infrastructure within the flood-prone area, and legal restrictions involving the disposition of flood waters. Alternative-specific opportunities and constraints are described in Section 4 of this report.

3.1 Opportunities

The following is a list of opportunities for flood protection within the study area:

- The East Wash is a natural and logical alignment for a flood-control channel by virtue of the fact that it: 1) has its origin at the fan apex and heads directly southward until it reaches the Bureau of Reclamation /WestWorld retention basin (Figure 2.1 of the Baseline report shows the location of the East Wash in relation to the Reata Pass/Beardsley Wash floodplain), 2) forms an approximate boundary between the developed and undeveloped portions of the Reata Pass/Beardsley Wash alluvial fan, 3) is the shortest distance from the apex to a safe discharge point (Bureau of Reclamation detention basins), and 4) is already partially contained by high ground with existing capacity in places to contain the entire apex flow. No other flow path on the alluvial fan has these characteristics.

- Pima Road is a logical, existing corridor along which to construct a flood-control system. This existing corridor extends well upstream and downstream of the limits of the Pima Floodplain and is already disturbed from a habitat standpoint.

- The Bureau of Reclamation retention basins upstream of the CAP are a logical and safe discharge point for a flood-control system. These basins receive all of the discharge under current conditions, and were designed for maximum expected flood volumes from ultimate upstream build-out.

- A linear, regional flood-control system provides an opportunity to establish a permanent recreational, non-vehicular access corridor to the McDowell Mountains.

- A regional flood-control system along Pima Road provides the opportunity for 100-year protection of ADOT's Loop 101 Freeway, the City of Scottsdale's Pima Road, and existing homes and businesses at a lower cost than would be the case if these facilities were protected individually.

- A regional flood-control system removes the FEMA flood designation and eliminates the need for federally-required flood insurance and elevated building pads on the Reata Pass/Beardsley Wash alluvial fan.

- Improvement district and Flood Control District of Maricopa County funding is currently available. This funding is time-sensitive and may not be available in the future.

3.2 Constraints

The following is a list of constraints for flood protection within the study area:

- The Reata Pass/Beardsley Wash floodplain area is classified as an alluvial fan. Therefore, FEMA requires that any flood-control solution have the capacity for the entire Reata Pass apex flow of 10,000 cfs plus sediment and debris loads. Section 65.13 of FEMA's "National Flood Insurance Program and Related Regulations" (revised October 1, 1994) specifically states: "In general, elevations of a parcel of land or a structure by fill or other means, will not serve as a basis for removing areas subject to alluvial fan flooding from an area of special flood hazards. FEMA will credit on NFIP maps [i.e. remove the Zone AO designation] only major structural flood control measures whose design and construction are supported by sound engineering analyses which demonstrate that the measures will effectively eliminate alluvial fan flood hazards from the area protected by such measures." Individual flood-control facilities such as levees or diversion channels must adhere to this criterion no matter where they are located on the alluvial fan and whether connected to the apex or not. If flood control facilities do not meet FEMA design criteria and/or are not continuous from the apex to the Bureau of Reclamation detention basin, the flood-prone area is not protected and the flood zone designation cannot be removed.

- Flood-control facilities must be designed to account for sediment as well as flooding. Flood-control facilities not connected to the fan apex must do the same. Individual (non-regional) facilities often involve the deflection or diversion of a flow path. Since sediment is deposited at points of velocity reduction, individual facilities must be designed for worst-case conditions of sediment deposition and scour. Designing to this condition would involve greater bank heights, and depths of scour, leading to greater environmental impacts than would be necessary in a regional system connected to the apex.

- The natural ecosystem in the study area is already approximately 70% disturbed by buildings, roads, golf courses and grading. Aside from the East Wash, there is no open continuous drainage path from the apex to the base of the Reata Pass/Beardsley Wash alluvial fan that has not been encroached upon by existing development. The current design of drainage through these developed areas does not allow enough space for a flood-control channel with capacity of 10,000 cfs or more without relocating homes.

- The City's Floodplain and Drainage Ordinance, as well as FEMA regulations, require that flood protection not create hazards to life or property by increasing the potential for flooding on adjacent property. A watercourse may not be altered unless a professional engineer certifies that the alterations do not increase the flood levels, and will not increase flooding hazards within, upstream or downstream of the altered portion of the watercourse. The ordinance further states that rainfall runoff from

storms of all return frequencies should enter and depart from property after its development in substantially the same manner as under pre-development conditions. Proposals to modify drainage characteristics must be fully justified by engineering data which shall demonstrate to the floodplain administrator that hazards to life and property will not be increased by the proposed modifications.

This means that a flood-control solution that concentrates flow in a manner that is not a natural or historic condition, and which would increase the flood or erosion hazard to adjacent property, is prohibited. This prohibition applies whether the adjacent property is developed or not. Unnatural concentrations of flow by a flood-control project or any development project must be mitigated by constructing additional facilities to spread and slow the water back to historic depths and velocities at the point of discharge to adjacent property or by carrying the channelized flow downstream to a point of logical disposal where no increased risk of damage would occur.

IV. ANALYSIS

4.1 List of Alternatives

Twenty-one alternatives are considered based upon previous analyses prepared by the City of Scottsdale (see Section I: Introduction), alternatives requested by the Corps of Engineers (see Introduction) and alternatives that have been suggested by public comment in this and other similar projects. Below is a complete list and brief description of alternatives.

1. **Scattered Detention/Retention Facilities**. Scattered detention/retention facilities would consist of excavated basins situated on the alluvial fan surface to collect alluvial fan flows and contain them for controlled release into the downstream watercourses (detention) or infiltration into the ground (retention).

2. **Detention at the Alluvial Fan Apex.** Detention at the alluvial fan apex would consist of dams constructed at the apex of the Reata Pass and Beardsley Wash alluvial fans. The dams would contain flood waters and release them at a controlled discharge below the maximum non-damaging discharge. Two dams, one at the apex of the Reata Pass Wash and one at the apex of the Beardsley Wash, would be necessary.

3. **Streambank Stabilization.** Streambank stabilization would involve stabilization of the existing stream banks in-place. The existing drainage pattern would remain, but the banks would be stabilized with riprap, soil cement, concrete, or other non-erodible material.

4. **Relocation.** Relocation would involve purchase of existing homes and other structures within the floodplain boundaries. The floodplain residents would be required to move out of the floodplain after their property was purchased. Purchased homes would be demolished and sites restored.

5. **Environmental Enhancement.** Environmental enhancement would provide some protection from flooding, provide recreation, and clearly enhance the environment in doing so.

6. **Floodproof Existing Structures.** Floodproofing of individual homes would consist of providing sealants to the walls and doors of homes, or installing individual floodwalls or dikes for existing development.

7. **Stop Development.** In this alternative no future development would be allowed on the Reata Pass/Beardsley Wash alluvial fan or Pima Floodplain. There would be no other action taken to prevent flood damage.

8. **Watershed Management.** Watershed management would consist of managing vegetation and land use, and using best management practices to contain runoff on the watershed to ensure maximum absorption and infiltration of runoff, with the objective of reducing flood peaks.

9. **Onsite Detention for Each Development.** This is a variation of the Scattered Detention Basins alternative in which detention or retention basins are installed by individual developments as they are constructed. This requirement would only apply to future development.

10. **No Action.** The No Action alternative would consist of no action by the City of Scottsdale to alleviate the flood hazard on the Reata Pass/Beardsley Wash alluvial fan and the Pima Floodplain.

11. **Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin.** This alternative is the proposed project for the Reata Pass/Beardsley Wash system. It consists of a levee and channel system that extends along the alignment of the East Wash from the apex of the alluvial fan upstream of Pinnacle Peak Road to the Westworld Detention Basin. This alternative represents that portion of the proposed project for the Reata Pass/Beardsley Wash system.

12. **Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive**. This alternative consists of a levee and channel system that extends along the alignment of the East Wash from the apex of the alluvial fan upstream of Pinnacle Peak Road to Union Hills Drive.

13. **Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive with Detention Basin at Union Hills Drive.** This alternative consists of a levee and channel system that extends along the alignment of the East Wash from the apex of the alluvial fan upstream of Pinnacle Peak Road to Union Hills Drive with a detention basin downstream of Union Hills Drive

14. **Wider Channel**. A wider channel is essentially the same as the proposed project, but with banks placed farther apart than those of the proposed project.

15. **Reata Pass Wash Partial Levee Project, Fan Apex to Westworld Detention Basin**. This alternative follows the same alignment as the proposed project, but utilizes a single levee wherever possible to prevent flows from entering the developed area without confining flows to a constructed channel.

16. **Protect Existing Development Using Levees (Ring Dikes).** This alternative consists of floodproofing existing individual residential structures and clustered homes using floodwalls or levees. The natural washes that have been identified as part of the U.S. waters and under the jurisdiction of the USACE would be left intact to the maximum extent possible. Flood flows would continue to spread across the alluvial fan as they do under current conditions, but existing development would be protected from these flows by the floodwalls or levees.

17. **Reata Pass Wash Narrow Channel Project, Fan Apex to Westworld Detention Basin.** This alternative consists of a fully-lined, vertical-sided, narrow concrete channel that extends along the alignment of the East Wash from the apex of the alluvial fan upstream of Pinnacle Peak Road to the Westworld Detention Basin.

18. **Pima Road Levee/Channel Stand-Alone Project**. This alternative consists of a channel and levee system along the east side of Pima Road. This is a 100-year capacity, stand-alone design assuming no regional flood-control structure to contain Reata Pass/Beardsley Wash flows.

19. **Pima Road Three Basin Stand-Alone Project.** This alternative consists of storm drains, collector channels and three detention basins extending along the alignment of Pima Road from one-quarter mile north of Jomax Road to the U.S. Bureau of Reclamation (USBR) detention basin west of Pima Road. Without regional improvements on the Reata Pass/Beardsley Wash system, this alternative would provide less than 100-year flood protection. This alternative represents that portion of the proposed project for the Pima Floodplain.

20. **Reata Pass Levee and Channel Project, fan Apex to Westworld Detention Basin, with Pima Road Three Basin Project.** This alternative is the proposed project, consisting of the Reata Pass Levee and Channel Project, Fan Apex to Westworld

Detention Basin with the Pima Road Three Basin Stand-Alone Project described above.

21. **Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin, with Pima Road Three Basin Project and Low-Flow Diversion.** This alternative consists of the Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin with the Pima Road Three Basin Stand-Alone Project described above, and including a low-flow diversion at the apex of the Reata Pass Wash alluvial fan.

4.2 Alternatives Requested by the Corps

The Corps of Engineers requested that certain alternatives be evaluated in a letter dated August 11, 1998 to the City of Scottsdale. These specific alternatives are numbered and listed in the introduction to this alternatives analysis report. The alternatives requested by the Corps of Engineers are represented in the twenty alternatives listed in Section 4.1 as follows:

The Corps requested that no action be considered as an alternative. This is represented as Alternative 10: No Action.

Environmental Enhancement, is represented as Alternative 5: Environmental Enhancement.

The currently-proposed project with various channel cross sections, is represented by: Alternative 14: Wider Channel; Alternative 11: Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin; Alternative17: Reata Pass Wash Narrow Channel Project, Fan Apex to Westworld Detention Basin; Alternative 18: Pima Road Levee/Channel Stand-Alone Project; Alternative 19: Pima Road Three Basin Stand-Alone Project; and, Alternative 15: Reata Pass Wash Partial Levee Project, Fan Apex to Westworld Detention Basin.

The currently-proposed project modified to incorporate downstream outlets as well as a partial levee, is represented by: Alternative 12: Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive; Alternative 13: Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive with Detention Basin at Union Hills Drive; and, Alternative 15: Reata Pass Wash Partial Levee Project, Fan Apex to Westworld Detention Basin.

Protection of existing infrastructure and development only, is represented by Alternative 6: Floodproof Existing Structures, and Alternative 16: Protect Existing Development Using Levees (Ring Dikes).

Scattered detention/retention facilities, is represented by: Alternative 1: Scattered Detention/Retention Facilities; Alternative 2: Detention at the Alluvial Fan Apex; and, Alternative 9: Onsite Detention for Each Development.

Streambank stabilization, is represented by Alternative 3: Streambank Stabilization.

4.3 Analysis Methodology

4.3.1 Overview of The 404(b)(1) Guidelines

The 404(b)(1) guidelines (hereafter, guidelines) are the substantive criteria used by the Corps in evaluating discharges of dredged or fill material into waters of the United States under section 404 of the Clean Water Act. The guidelines require that four criteria be satisfied in order for the Corps to make a decision that a proposed discharge of dredged or fill material is in compliance. Briefly summarized, these criteria are as follows:

1) the discharge must be the least environmentally damaging practicable alternative;

2) the discharge must not violate any water quality standard or toxic effluent standard, or jeopardize a threatened or endangered species;

3) the discharge must not result in a significant degradation of the waters of the United States; and

4) unavoidable impacts to the aquatic ecosystem must be mitigated.

Before the Corps can issue a section 404 permit, it must find that the requirements of the guidelines have been satisfied.

The key criteria for most permit applicants, and the focus of this analysis, is the requirement that the discharge be the least environmentally damaging, practicable alternative. This is a simplification of the actual regulatory requirement; the pertinent sections read as follows:

> *"Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem so long as the alternative does not have other significant adverse environmental consequences.*

(1) for the purpose of this requirement, practicable alternatives include, but are not limited to:

(I) activities that do not include a discharge into waters of the United States or ocean waters,

(II) discharges of dredged or fill material at other locations in waters of the United States or ocean waters,

(2) an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology and logistics in light of overall project purposes [Reference 40 CFR Section 230(q)]. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered;

(3) where the activity associated with a discharge which is proposed for a special aquatic site (as defined in subpart e) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise." [Note: As defined in Federal regulations (40 CFR Part 230, Subpart E), no portion of the Desert Greenbelt project study area is considered a special aquatic site].

The key provisions in this language are practicability and overall project purposes. Again, an alternative is practicable if it is available to the applicant and capable of being accomplished by the applicant after a consideration of costs, existing technology and logistics, in light of the overall project purposes. If a practicable alternative to the proposed project is available, would have less impact on the aquatic ecosystem, and does not include other significant adverse impact, then the proposed project is not the least damaging practicable alternative. Should this occur, the proposed project would not comply with the guidelines.

Guidance has been issued from the Department of the Army regarding application of the 404 (b)(1) guidelines and the analysis of alternatives. The Department of the Army and the Environmental

Protection Agency jointly issued a memorandum titled "Appropriate Level of Analysis Required for Evaluating Compliance With the Section 404(b)(1) Guidelines Alternatives Requirements", August 23, 1993. This guidance makes the following salient points:

- The statement of overall project purposes must be reasonably defined. It should not include a specific acreage, number of units or design criteria. It must not be so narrowly defined as to preclude the existence of practicable alternatives or so broadly defined as to render the analysis meaningless or impracticable.

- The analysis should be conducted with the intent of avoiding significant impacts to aquatic resources, and not necessarily providing either the optimal project location or highest and best property use.

- Even where a practicable alternative exists that would have less adverse impact on the aquatic ecosystem, the guidelines allow it to be rejected if it would have "other significant adverse environmental consequences." This allows for consideration of "evidence of damages to other ecosystems in deciding whether there is a 'better' alternative." Hence, in applying the alternatives analysis required by the guidelines, it is not appropriate to select an alternative where minor impacts on the aquatic environment are avoided at the cost of substantial impacts to the other environmental values.

- The intent is to consider only those alternatives that are reasonable in terms of the overall scope/cost of the project. If an alternative is unreasonably expensive to the applicant, the alternative is not practicable. The determination of what constitutes an unreasonable cost should generally consider whether the projected cost of an alternative is substantially greater than the costs generally associated with the particular type of project.

Although not specifically stated in the guidance, it is nonetheless clearly implied that an alternative that does not meet the overall project purposes is not considered practicable.

Based on an agreement between the Corps and EPA, (Mitigation MOA) efforts must first be directed at avoiding and reducing impacts to waters of the United States prior to the evaluation of potential compensatory mitigation measures. Mitigation may be applied only to unavoidable impacts. In keeping with this guidance, this alternatives analysis does not include potential mitigation measures as a means of demonstrating that a particular Alternative has fewer impacts.

4.3.2 Analysis Process

The purpose of the alternatives analysis is to arrive at the least environmentally damaging practicable alternative. The analysis begins with a determination of project practicability in terms of: 1) being available to the applicant; 2) capable of being accomplished after a consideration of costs, existing technology and logistics; and 3) capable of fulfilling the project purpose.

Local regulatory feasibility is included in the analysis because it was found that certain alternatives may be feasible from an engineering standpoint, with construction cost and impacts to waters of the U.S. comparable to the proposed project, but would not be allowable under local regulations and are therefore not available to the applicant. These regulations are public safety and welfare oriented. Alternatives not allowable under local regulations were not considered practicable.

An environmental evaluation, including assessment of impacts to waters of the U.S., is then done to determine potential environmental impacts. Practicable alternatives are compared to determine the least environmentally damaging practicable alternative according to the 404(b)1 guidelines.

The proposed project is represented by Alternative 20: Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin with Pima Road Three Basin Project. Alternatives 14 and 19: Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin, and Pima Road Three Basin Stand-Alone Project, also represent the proposed project, but separated into two stand-alone projects for the Reata Pass/Beardsley Wash and Pima Floodplain. Since these alternatives represent the proposed project, determinations of practicability in terms of cost are made in comparison to these projects, where applicable.

4.4 Analysis Results

4.4.1 Alternative 1: Scattered Detention/Retention Facilities

Description and Characteristics

Scattered detention/retention facilities would consist of excavated basins situated to collect alluvial fan flows and contain them for controlled release into the downstream watercourses (detention) or

infiltration into the ground (retention). The flat topography of the alluvial fan surface is not suitable for above ground basins contained by dams. There could be a large recreation component to these basins.

Engineering Feasibility and Construction Cost

Because of the uncertainty of flow path (see NRC quotations in Section I of the Baseline Conditions Report), every detention basin constructed on the alluvial fan would be required to collect and detain or retain the entire 100-year flood volume to achieve the project purpose. An indeterminant number of detention basins would be needed. Minimum active detention volume for each would be approximately 550 acre feet. Minimum area of excavation, assuming 30-foot depth, would be 26 acres. At least 1.5 million cubic yards of material would be excavated for each structure. Extensive levees or channels would have to be constructed to funnel water into the basins. Given these constraints, the only logical and effective place for a detention basin is at the apex.

Local Regulatory and Logistical Feasibility

Scattered detention/retention basins are not feasible from a logistical standpoint for the reasons described above.

Project Purpose

Alternative 1 is not practical and would fulfill no project purpose:

Potential Environmental Impacts

Scattered detention/retention basins, because of their required number and size, would have a very extensive environmental impact, particularly on the natural habitat, wildlife, land use, traffic and visual resources. Because this alternative is not practicable, impacts to waters of the U.S. are not estimated.

Conclusion

Alternative 1, Scattered Detention/Retention Basins, is not practicable because it is not feasible from an engineering and logistical standpoint. Unless located at the alluvial fan apex (see Alternative 2), scattered detention/retention basins do not meet the FEMA requirement of "major structural flood control measures whose design and construction are supported by sound engineering analyses."

4.4.2 Alternative 2: Detention at the Alluvial Fan Apex

Description and Characteristics

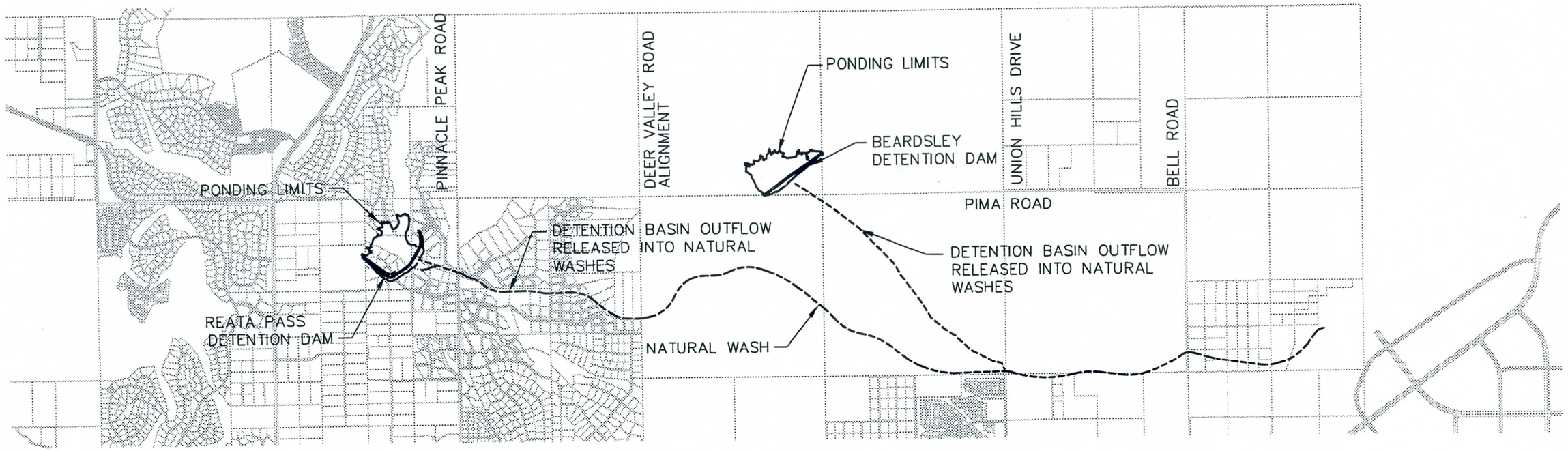
Detention basins at the fan apex would consist of two large basins, one at the Reata Pass fan apex and one at the Beardsley Wash fan apex, as shown in Figure 4.1. Preliminary concept designs of these basins are shown in Figures 4.2 and 4.3. Water would be contained in the basins through the use of dams approximately 40 feet high. The discharge released downstream of the basins would be below the maximum non-damaging discharge.

Engineering Feasibility and Construction Cost

The apex detention basins are feasible from an engineering standpoint. However, the preliminary cost estimate is $22,000,000 higher than the proposed project due primarily to the need to purchase a number of very costly homes and land in the Reata Pass apex area, and to the need to design the Reata Pass and Beardsley Wash basins to 75,000-cfs and 58,000-cfs probable maximum floods (estimated by SLA) to comply with Arizona Department of Water Resources dam safety requirements.

Local Regulatory and Logistical Feasibility

As stated above, the apex detention basins must be designed for the probable maximum flood according to Arizona Department of Water Resources dam safety guidelines. This discharge is estimated to be 75,000 cfs for Reata Pass and 58,000 cfs for Beardsley Wash. The resulting dams are very large. Logistically, construction of the Reata Pass basin would result in the need to purchase and destroy approximately fifteen existing Pinnacle Peak Estates homes. This would be unacceptable to the local community.



N

3000 1500 0 1500 3000

1"=3000'

DETENTION BASIN SIZE

STRUCTURE	STORAGE	HEIGHT
REATA PASS	554 af	34 ft
BEARDSLEY	284 af	32 ft

sla Simons, Li & Associates, Inc.
Water Resources & Civil Engineering Consultants
3150 Bristol Street, Suite 500
Costa Mesa, CA 92626
Tel. (714) 513-1280 Fax. (714) 513-1278

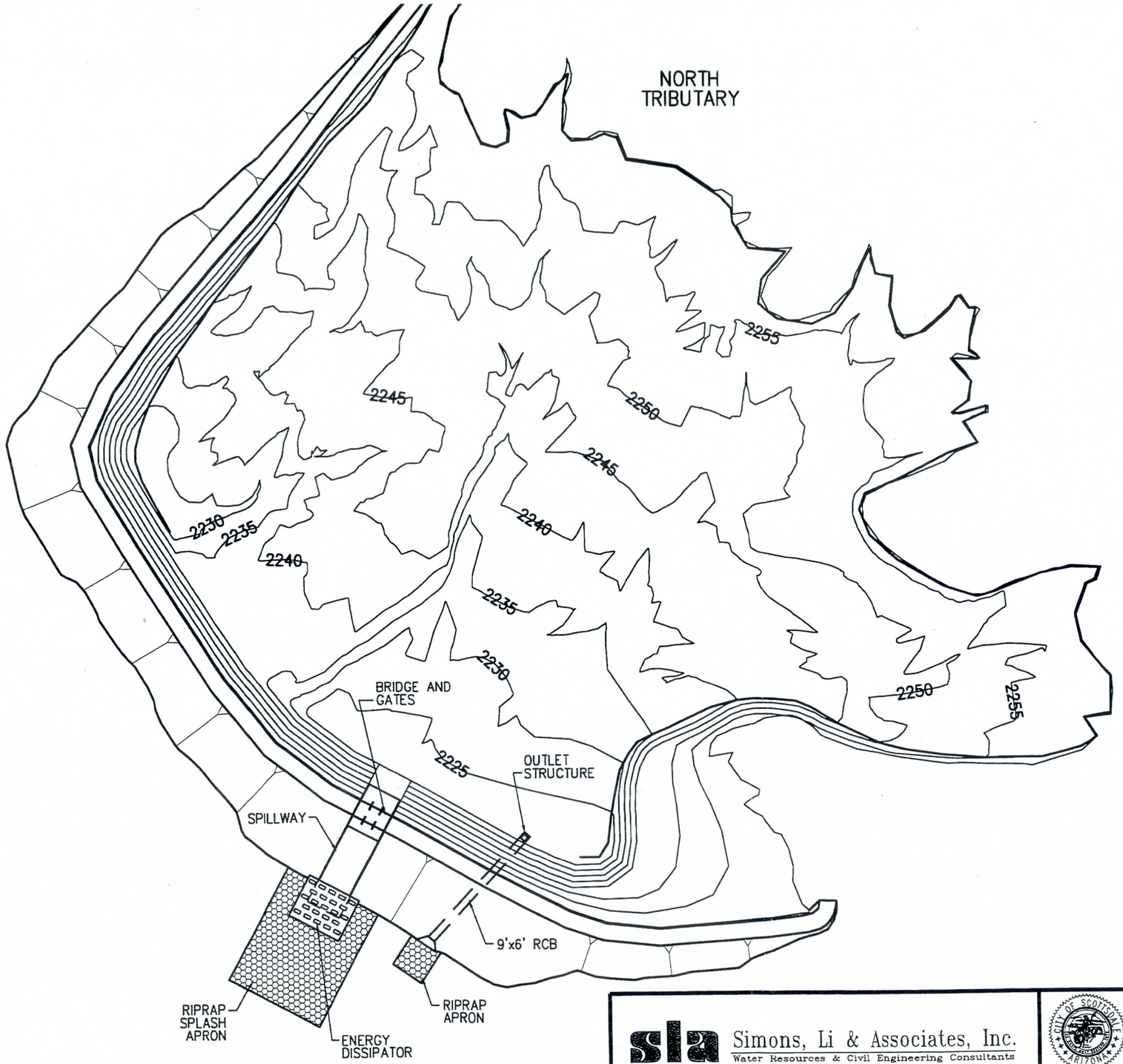
TRANSPORTATION DEPARTMENT

LOCATION MAP FOR DETENTION AT REATA APEX AND BEARDSLEY APEX

FIGURE 4.1 AA-28

The Desert Greenbelt SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 11 ALTF PRJ.DWG



DETENTION BASIN CAPACITIES
BASED ON W.S. ELEVATIONS

ELEV. (FEET)	CAPACITY (AC-FT)
2225	0.00
2230	11.10
2235	34.81
2240	76.74
2245	144.96
2250	245.36
2255	380.72
2259	514.79

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CITY OF SCOTTSDALE ARIZONA

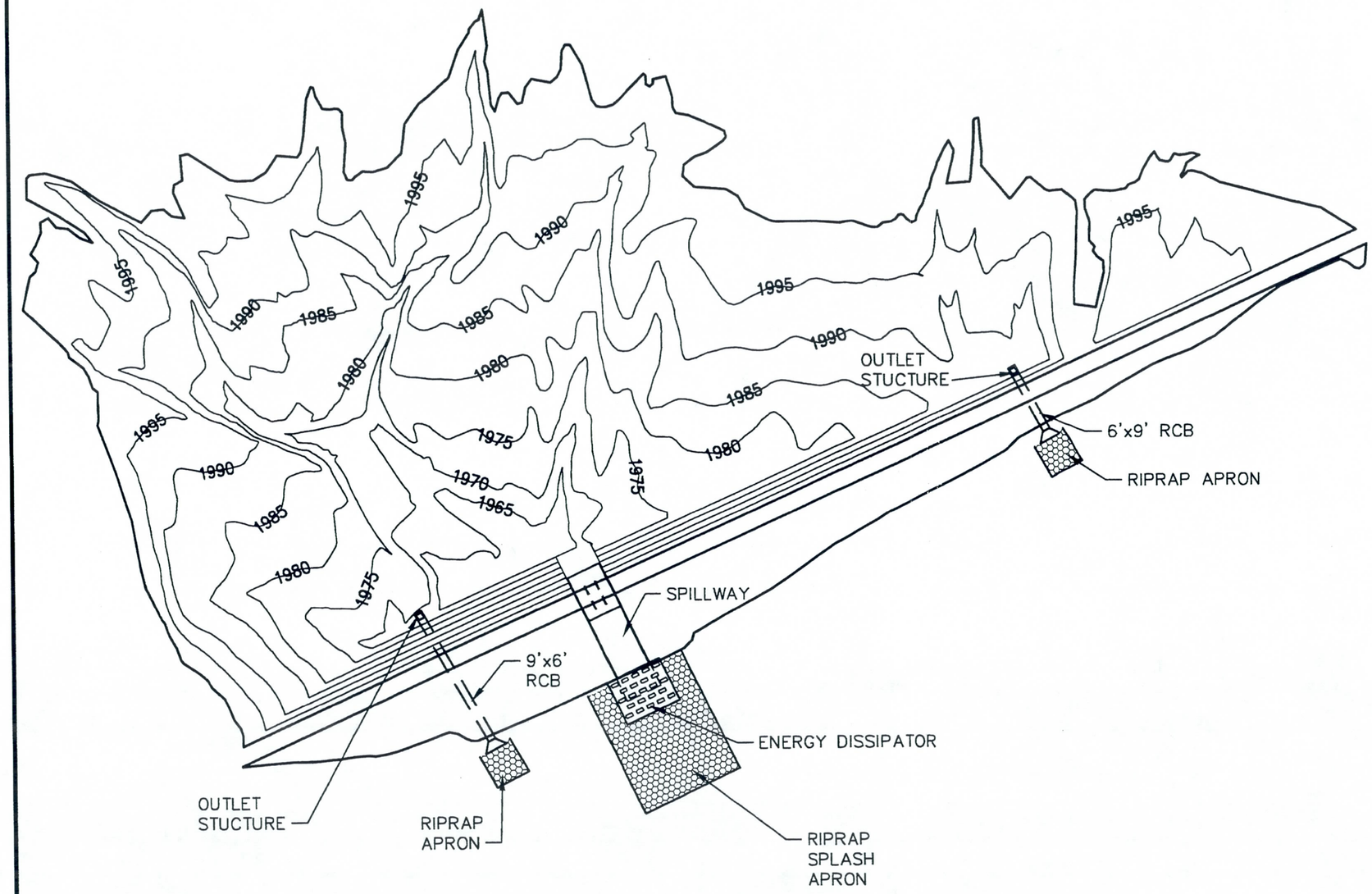
TRANSPORTATION DEPARTMENT

CONCEPT DESIGN FOR REATA PASS APEX DETENTION BASIN

FIGURE 4.2 AA-29

The Desert Greenbelt SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 11B ALTF.DWG



DETENTION BASIN CAPACITIES
BASED ON W.S. ELEVATIONS

ELEV. (FEET)	CAPACITY (AC-FT)
1965	0.00
1970	5.13
1975	17.41
1980	41.91
1985	83.44
1990	147.28
1995	238.50
1997	284.20

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TRANSPORTATION DEPARTMENT

CONCEPT DESIGN FOR BEARDSLEY APEX DETENTION BASIN

FIGURE 4.3 AA-30

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 11C ALTG.DWG

Project Purpose

Alternative 2, if constructed, would partially fulfill the project purpose:

1. **Flood Hazard Removal.** Existing development on the Reata Pass/Beardsley Wash alluvial fan would be protected from Reata Pass/Beardsley Wash flooding. This would be a regional flood-protection system for the protected area, but the regional system would not fully achieve the goal of flood protection for the entire study area. The flood hazard on the Pima Floodplain would continue to exist.

2. **Flood Protection for Public Improvements.** Public infrastructure on the Reata Pass/Beardsley Wash alluvial fan would be protected from apex-generated flooding. Infrastructure in the Pima Floodplain area would not be protected.

3. **Enhance Recreation.** There would be no permanent public recreational corridor. The detention basins would actually reduce recreational use to below current levels by impeding hiking and equestrian access along the Reata Pass wash and into the Wingate Pass area of the McDowell Sonoran Preserve.

Potential Environmental Impacts

The detention basins would create significant adverse landform and visual impacts to the area. Figure 4.4 shows the before and (conceptual) after-construction photographs of the Reata Pass basin as viewed from an existing residence north of Pinnacle Peak Road. Most of the houses in this area would have similar view alterations. Those residents most affected by the visual impact are not in the floodplain and would not benefit by the flood-control project. Figure 4.5 shows the before and (conceptual) after-construction photographs of the Beardsley Wash basin as viewed from the end of Thompson Peak Parkway. The photograph shows that there would be a significant adverse visual impact to the area. Furthermore, the Beardsley Wash basin would be located in the Wingate Pass area of the McDowell Sonoran Preserve and would restrict access to the preserve. Wingate Pass is highly valued by the community for its scenic natural features visible from great distances.

Because this alternative is not practicable, impacts to waters of the U.S. are not estimated. Traffic impacts would be construction-related only. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. There would be destruction and alteration of approximately 80 acres of natural habitat. Both dams would obstruct

major washes which serve as wildlife corridors. Site-specific surveys have not been performed, but it is known that there are cultural resources in the area of the Beardsley Wash detention basin. These could be adversely affected by this alternative.

Conclusion

Detention basins at the fan apex were evaluated by the City of Scottsdale early in the project planning phase and rejected as not a practical alternative. This analysis has come to the same conclusion for the following reasons:

- **Cost.** The estimated detention basin cost is $22,000,000 higher than the proposed project.
- **Logistical Feasibility.** The Reata Pass detention basin would be located in a developed area of the Pinnacle Peak Estates subdivision. Construction of the basin would result in the need to purchase and destroy approximately fifteen existing Pinnacle Peak Estates homes.
- **Project Purpose.** Apex detention basins fulfill only part of the project purpose. Recreational conditions in the area would actually be worsened by the presence of the basins.
- **Environmental Impact.** Apex detention basins would have a significant environmental impact in landform alteration, interruption of wildlife corridors and visual resources.

4.4.3 Alternative 3: Streambank Stabilization

Description and Characteristics

This alternative would involve stabilizing the existing stream banks in-place. The existing drainage pattern would remain, but the banks would be protected with riprap, soil cement, concrete, or other non-erodible material. The goal would be to stabilize the drainage pattern to prevent the unpredictable shifting of flow paths that is one of the characteristics that makes alluvial fan flooding so hazardous.

Engineering Feasibility and Construction Cost

Stabilizing the existing streambanks is possible from an engineering standpoint, but the cost would be much higher than the proposed project because each streambank on each path connected to the apex would have to be stabilized from the apex to the base of the alluvial fan. This would involve the purchase and stabilization of approximately 30 miles or more of channel for the Reata Pass floodplain alone, in comparison to approximately five miles for the proposed channel. The cost would be many times the cost of the proposed channel.

Streambank protection would not remove the flood hazard. Individual natural channels have capacity for only about a two to five-year flood, and capacity decreases down the alluvial fan. Large floods would overtop the banks and tend to form new channels. Irregular sediment deposition can choke a channel and force water out even though the banks are stabilized. According to the National Research Council,

> "*... sudden changes in flow path (avulsions) can occur due to overbank flooding. Even quite large and well-defined channels can be abandoned if a flood breaches one of the channel banks and water flows overbank in depressions between old bar deposits on the fan surface, often eroding a deep channel headward up to the source channel, which is then diverted. Particularly large, kilometer-scale (emphasis added) changes in the positions of the flow paths and active sedimentation zones can occur without the channel occupying or shifting across intermediate positions if the channelized and overbank flow cause sediment to be deposited within and close to the channel, raising the bed and channel margins above the surrounding fan surface. Breaching of the elevated banks in a large flood can allow the flow to travel toward the lower areas between channels or along the fan margins. Small shifts near the fan head can cause dramatic changes in channel position farther down the fan.*"

Given these characteristics of an alluvial fan, streambank protection can only be effective as a FEMA-approved flood protection measure if each channel between the banks has the capacity to convey the entire 100-year discharge all the way to the base of the alluvial fan.

Local Regulatory and Logistical Feasibility

Stabilization of existing banks would be feasible from a local regulatory and logistical standpoint, provided that the very high cost can be met.

Project Purpose

Streambank stabilization would not the purpose of fulfill flood hazard removal.

Potential Environmental Impacts

Environmental impacts of streambank stabilization would be high. Most of the natural vegetation along the existing channel banks connected to the apex would have to be removed, resulting in impacts to habitat, wildlife and waters of the U.S. along at least 30 miles of natural channel. There would be a substantial loss in habitat and visual character of the area.

Because this alternative is not practicable, impacts to waters of the U.S. are not estimated. Traffic impacts would be construction-related only, but fairly substantial on a local level due to the extent of construction. Public health and safety would be unaffected. Groundwater infiltration to the ESRV would be unaffected. Site-specific surveys for cultural resources have not been performed for the entire area, but since most construction would be along active channel banks, the impact to cultural resources should be relatively low.

Conclusion

Streambank stabilization is not practicable because existing channels do not have capacity for 100-year flood discharges. As such, streambank stabilization does not meet the FEMA requirement of "major structural flood control measures whose design and construction are supported by sound engineering analyses." This alternative does not meet the project purpose. Flooding would still occur unless channels are widened to the approximate width of the Reata Pass/Beardsley Wash channel in the proposed project. The construction cost and environmental impact would be many times higher than for the proposed project.

4.4.4 Alternative 4: Relocation

Description and Characteristics

Relocation is sometimes used in cases of very severe flooding where alternative methods of protection are cost-prohibitive. Relocation would involve purchase of existing homes and other structures within the floodplain boundaries. The floodplain residents would be required to move out of the floodplain after their property was purchased. Purchased homes would be demolished and sites restored. Infrastructure would be abandoned.

Engineering Feasibility and Construction Cost

Purchase and removal of existing development is feasible from an engineering standpoint, but the cost would be excessive. Purchase of existing structures in the study area would require an investment of approximately two billion dollars. Undeveloped land would also have to be purchased in order to prevent future development.

Local Regulatory and Logistical Feasibility

Relocation is feasible from a local regulatory and logistical standpoint.

Project Purpose

Relocation would fulfill the project purpose of flood hazard removal by removing the existing structures.

Potential Environmental Impacts

There would be a significant adverse social and economic impact of relocation as residents are removed from their homes and obligated to settle elsewhere. Relocation would have little or no impact to the waters of the U.S. Traffic impacts would be substantial on a short-term basis as people and structures are removed from the area. Long-term public health and safety would be improved on the study area, but there could be adverse impacts elsewhere. Groundwater infiltration to the ESRV would be unaffected. Cultural resources would not be affected.

Conclusion

Relocation is not practicable because of extreme high cost and significant social disruption.

4.4.5 Alternative 5: Environmental Enhancement

Description and Characteristics

The Corps of Engineers suggested an Environmental Enhancement alternative that would provide some protection from flooding, provide recreation, and enhance the environment. Flood-control projects can be designed to provide some protection from flooding and enhance the environment at the same time. The level of flood protection can be dependent upon land availability or results of a benefit/cost analysis rather than being set by federal regulatory standard (as is the case with the Desert Greenbelt Project).

Environmental enhancement is typically done in areas where habitat values are currently degraded. The installation of a flood-control structure provides the enhancement opportunity. For instance, a severely-undersized channel bare of vegetation could be designed to convey more flow while providing the opportunity for the reestablishment of native riparian species. Enhanced flood protection need not necessarily mean that the widened channel would contain the 100-year flood.

In the case of the Reata Pass/Beardsley Wash alluvial fan, the pre-existing vegetation along the channel alignment is considered to be average-quality upper Sonoran habitat, including xeroriparian vegetation, mostly in an undisturbed condition. Although habitat quality naturally varies over the alluvial fan, this vegetation is considered average quality given the natural local environmental conditions. This habitat is not considered to be degraded. Given the current quality of the natural habitat in the area, there is no opportunity for enhancement. An environmental alternative that would provide protection from 100-year flooding and clearly enhance the environment could not be found.

Engineering Feasibility and Construction Cost

An environmental enhancement project is not feasible from an engineering standpoint for the following reasons:

- Current habitat along the channel alignment is not degraded. There is no opportunity for enhancement.
- Unless the entire floodplain is acquired (see Relocation Alternative), a flood control project on an alluvial fan must of necessity involve construction, resulting in environmental impacts which would have to be mitigated. In this case, planting of vegetation in the channel bed is considered mitigation for impacts. Environmental enhancement would have to be in addition to the mitigation associated with construction of the flood-control project.
- The existing undisturbed xeroriparian habitats in the study area are of average quality and in good condition. Expansion of xeric-riparian habitats would require the conversion of upland areas.
- Extensive existing development in the area limits the availability of land for environmental enhancement.
- Because of the nature of alluvial fan flooding, effective flood-control alternatives are more limited than on a traditional river system. The NRC classified the Reata Pass/Beardsley Wash area as an active streamflow alluvial fan. As stated by the NRC (1996): *"major flood control works are necessary to mitigate flood hazards on active alluvial fans."*
- Without 100-year flood protection the project purpose would not be met. The FEMA flood designation would not be removed.

Local Regulatory and Logistical Feasibility

Environmental enhancement is not feasible from a logistical standpoint for the reasons described above.

Project Purpose

Since no feasible environmental enhancement alternative could be found, environmental enhancement will not fulfill the project purpose.

Potential Environmental Impacts

Environmental impacts similar to those of the proposed project and related channel alternatives would occur with installation of a flood-control system. See Alternatives 11 to 15 as examples of environmental impacts, including impacts to waters of the U.S.

Conclusion

An environmental enhancement project is not practicable. The existing habitat is not degraded and there is no opportunity for enhancement. The project purpose would not be met if 100-year flood protection is not provided.

An environmental enhancement project could be interpreted to mean an alternative that would place environmental values first, with flood protection and cost as secondary considerations. The channel would be as wide as possible, possibly using levees to contain flood flows, and existing vegetation would be retained wherever possible. Alternative 15, the Partial Levee alternative, fits this interpretation.

4.4.6 Alternative 6: Floodproof Existing Structures

Description and Characteristics

Floodproofing of individual homes is an option to protect existing development from flood damage. One way to accomplish this is to provide sealants to the walls and doors. A second method of floodproofing is to install individual floodwalls or dikes for the existing development.

Engineering Feasibility and Construction Cost

Floodproofing by providing sealants to walls and doors is feasible but not recognized by FEMA as a means to eliminate alluvial fan flood hazards on residential structures. These types of measures are not 100% effective on a traditional (low velocity) floodplain, and would provide marginal to zero protection against high-velocity, debris-laden flow on an alluvial fan. In general, floodproofing by sealants is considered less effective than elevation on fill (most structures on the Reata Pass/Beardsley Wash alluvial fan are elevated to the regulatory flood level), which is not recognized

by FEMA as adequate flood control on an alluvial fan. On an alluvial fan, FEMA only recognizes major structural flood control measures that prevent flow from reaching the structure.

Local Regulatory and Logistical Feasibility

Floodproofing is feasible, but ineffective.

Project Purpose

Floodproofing would fulfil no project purpose.

Potential Environmental Impacts

Environmental impacts would be low, but floodproofing is ineffective as flood hazard reduction. There would be little or no impact to waters of the U.S. Traffic impacts would be construction-related only. Public health and safety, groundwater infiltration to the ESRV, plant communities, wildlife, and cultural resources would be unaffected.

Conclusion

Floodproofing existing structures is not practical because it would not be effective flood protection and is not recognized by FEMA as a means to eliminate alluvial fan flood hazards on residential structures. Floodproofing is not a "major structural flood control measure whose design and construction (is) supported by sound engineering analyses." It would therefore not meet the project purpose.

4.4.7 Alternative 7: Stop Development

Description and Characteristics

A moratorium on future development in the floodplain would prevent flood damages from increasing beyond the current damage potential.

Engineering Feasibility and Construction Cost

Engineering feasibility is not applicable.

The cost would be very high. The undeveloped property within the study area is largely owned by the Arizona State Land Trust, as designated urban lands, and a few private land holders. This area is zoned for development and will be developed in the future unless purchased as permanent open space. At an average cost of $2.00/square foot, purchase of the remaining 2,500 acres (approximate) remaining to be developed on the study area would cost approximately $218,000,000.

Although flood damage for future development would be prevented, existing development would still be subject to flood damage. The damage potential for existing development alone is sufficient to justify a flood-control project. In terms of area, 70% of the Reata Pass/Beardsley Wash and Pima Floodplain are already impacted by development activity. There are currently 3,859 residential and other units existing or approved for development on the Reata Pass/Beardsley Wash floodplain. The Pima Floodplain contains 4,541 units. Zoning for the construction of another 4,000 on the Reata Pass/Beardsley Wash alluvial fan and 2,200 on the Pima Floodplain is already approved by the City, and much of this area has already been permitted by the Corps of Engineers. Equivalent annual damage on these existing, permitted and zoned structures is estimated at approximately $8,500,000 (see Economic Analysis - Appendix D).

Local Regulatory and Logistical Feasibility

Stopping development is feasible from a local regulatory and logistical standpoint by purchasing undeveloped land.

Project Purpose

Stopping future development would not protect existing development, and would therefore not fulfill the primary project purpose of flood hazard removal. No project purpose would be met.

Potential Environmental Impacts

There would be no project-related environmental impacts.

Conclusion

Stopping development as an alternative for this project is not practicable because it would cost many times more than the proposed project and not achieve the primary project purpose of protecting existing development, it is too costly, and would receive significant opposition.

4.4.8 Alternative 8: Watershed Management

Description and Characteristics

Watershed management is sometimes suggested as a method of natural flood control. The goal is generally to manage vegetation and land use on a watershed to ensure maximum absorption and infiltration of runoff, resulting in lower flood peaks.

Engineering Feasibility and Construction Cost

The study watershed is a natural desert with rocky, relatively impervious soils. This desert is not currently in a degraded condition and is not conducive to or in need of artificial practices to retain water. Furthermore, in order to reduce flood damage to a level equivalent to the proposed project, watershed management must reduce the 100-year discharge from approximately 10,000 cfs to approximately 300 cfs. A flood reduction of this magnitude is not feasible using watershed management practices in a desert environment.

Local Regulatory and Logistical Feasibility

Watershed management is not feasible from a logistical standpoint. Much of the upstream watershed area, particular the lower portion, is already developed and would have to be purchased in order to install and maintain watershed management structures.

Project Purpose

Watershed management would fulfill no project purpose.

Potential Environmental Impacts

Establishing and maintaining the amount of vegetation and stream modifications necessary to reduce the runoff significantly would require substantial alteration to the natural desert ecosystem in the contributing watershed. This alteration in itself would be a major impact to the waters of the U.S. and the natural environment.

Traffic impacts would be construction-related only. Public health and safety would be unaffected. Groundwater infiltration to the ESRV would be unaffected. There would be substantial alteration of natural riparian habitat upstream of the fan apex. The effect on cultural resources should be relatively low.

Conclusion

Watershed management is not practical because it would result in substantial impact to the natural ecosystem, and not achieve the level of flood protection required in this case. Watershed management does not meet the FEMA requirement of "major structural flood control measures whose design and construction are supported by sound engineering analyses."

4.4.9 Alternative 9: Onsite Detention for Each Development

Description and Characteristics

Onsite Detention for Each Development is a variation of the Scattered Detention Basins alternative described above. The City of Scottsdale has an onsite storage requirement written as follows:

> *"As a minimum, all development will make provisions to store runoff from rainfall events up to and including the one-hundred-year two-hour duration event."*

The purpose of on-site detention is typically to prevent development-related impervious areas and efficient channels from increasing downstream flood peaks and volumes. This type of detention is required of landowners as part of the development process.

Engineering Feasibility and Construction Cost

Onsite detention would not be effective as an alluvial fan flood protection element because:

- The flood water in the study area is generated in the watershed upstream of the alluvial fan in areas that are already developed or is unlikely to develop due to steep mountain slopes. A portion of the watershed is located in the McDowell/Sonoran mountain preserve. There will therefore be little or no opportunity for the City to legally require on-site detention in this upstream watershed area.

- The alluvial fan flood area is downstream of the flooding source. Detention on the alluvial fan surface would have no effect on this upstream-generated flooding.

- On-site storage can only reduce the effects of development. It has limited or no effect on historic flows across a property. In this case the existing 100-year discharge of approximately 10,000 cfs would have to be reduced to less than 1,000 cfs by onsite detention in order to remove the 100-year flood hazard on the alluvial fan.

Local Regulatory and Logistical Feasibility

Onsite detention is already required by the City of Scottsdale.

Project Purpose

Onsite detention is ineffective at reducing upstream flood peaks and cannot fulfill any project purpose.

Potential Environmental Impacts

Onsite detention basins would take up space that could otherwise be left as natural open space within development areas. Because this alternative does not meet the project purpose, impacts to waters of the U.S. are not estimated.

Traffic impacts would be construction-related only. Public health and safety would be unaffected. Groundwater infiltration to the ESRV would be unaffected. Cultural resources within the detention basins would be affected.

Conclusion

Onsite detention for each development is not practicable because flood discharges are generated upstream of the alluvial fan where there is no opportunity for onsite detention. Onsite detention is ineffective at reducing large, historic flood discharges. It further does not meet the FEMA requirement of "major structural flood control measures whose design and construction are supported by sound engineering analyses."

4.4.10 Alternative 10 - No Action

Description and Characteristics

The No-Action alternative would involve no action by the City of Scottsdale to provide flood protection to the Reata Pass/Beardsley Wash alluvial fan and Pima Floodplain area.

Engineering Feasibility and Construction Cost

The No-Action alternative has no engineered elements and no project-related cost.

Local Regulatory and Logistical Feasibility

The No-Action alternative involves no project-related construction and is feasible.

Project Purpose

The No-Action alternative would not fulfill the project purpose:

1. **Flood Hazard Removal.** There would be no flood hazard removal. The extensive, existing residential and resort development and public infrastructure on the Reata Pass/Beardsley Wash and Pima Floodplain would continue to be at risk of uncontrolled and unpredictable flooding. Minimal flood protection would be achieved only where the lowest floor of existing development has been raised to the level of the regulatory floodplain. The current expected flood damage of $3,890,800 per year on the average for existing structures would continue and increase to $11,025,500 per year by the year 2030 (See Appendix D - Economic Analysis).

   Drainage channel capacities would not be sufficient for the 100-year apex flows on the Reata Pass/Beardsley Wash. The potential for wide and unpredictable channel

shifts during large floods would continue, leaving every structure on the alluvial fan potentially in the direct flow path.

Redundant, localized flood control measures would continue to be built as they have in the past, with associated similar adverse environmental impacts.

The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would remain. All residents on the alluvial fan would continue to be subject to federal flood insurance and building requirements. As the level of development continues to grow, there will be more structures that will require the purchase of flood insurance. The amount expended by residents for flood insurance premiums will continue to grow.

2. **Flood Protection for Public Improvements.** There would be no flood protection for Pima Road, Thompson Peak Parkway, other local streets, the City of Scottsdale Water Campus, or local utilities.

3. **Enhance Recreation.** Recreational use of the Reata Pass and Beardsley Wash alluvial fans would not be enhanced and there would be no permanent public corridor providing path and trail linkages to the McDowell Mountains from the CAP/Westworld area.

Potential Environmental Impacts

There would be no project-related environmental impacts or impacts to the waters of the U.S. The future-without-project condition described in the Baseline Conditions report would take place as described. The waters of the U.S. on the alluvial fan would continue to be subject to permit applications by others under the Corps Section 404 Program.

Impacts to the natural alluvial fan habitat by future land development not associated with the project proposed under this permit application can be expected to occur under the No Action alternative. Elevating the building pad on fill is the standard method of complying with FEMA regulations on the Reata Pass/Beardsley Wash alluvial fan. Fill must be sloped away from the edge of the structure at a relatively flat slope to be structurally and aesthetically suitable. Assuming one foot of fill with 6:1 side slopes on an average, 2,500-square-foot house, approximately 1.344 square feet of land would be impacted by fill outside the walls of each elevated structure. Approximately 123 acres of desert habitat would be affected in total for the approximately 4,000 homes remaining to be built

on the Reata Pass/Beardsley Wash alluvial fan. In addition, some impacts on the waters of the U.S. can be expected as a result of increased building pad construction.

Conclusion

Alternative 10, No Action, is not practicable because it does not meet any project purpose. Alternative 10 would leave the Reata Pass/Beardsley Wash alluvial fan and the Pima Floodplain subject to the severe threat of flooding and flood damage described in the Baseline Conditions Report and the Economic Analysis.

4.4.11 Alternative 11: Reata Pass Levee and Channel Project, Fan Apex to WestWorld Detention Basin

Description and Characteristics

This alternative is the proposed project for the Reata Pass/Beardsley Wash system. Alternative 11 (Figure 4.6) consists of a levee and channel system that extends along the alignment of the East Wash from the apex of the alluvial fan upstream of Pinnacle Peak Road to the Westworld Detention Basin. Key project components are described in Table 4.1.

Table 4.1. Key Components for Proposed Reata Pass/Beardsley Wash System.

Channel Reach (Approximate)	Reach Length (Approximate)	Key Project Characteristics
Upstream of Pinnacle Peak Road	1,100 feet	A floodwall directs apex flow into a concrete lined channel under Pinnacle Peak Road
Pinnacle Peak Road to 7,300 feet downstream of Pinnacle Peak Road	7,300 feet	Soil cement lined channel (bed and banks) with numerous drop structures and grade control structures. Channel depth eight to twelve feet. Channel bottom width 64 to 130 feet.
7,300 feet downstream of Pinnacle Peak Road to Thompson Peak Parkway alignment	3,000 feet	Open channel with soil cement banks and natural bed with the exception of two grade control structures and a proposed bridge crossing. Channel depth approximately 6 to 12 feet Portions of the west bank are above the existing ground by 1 to 6 feet. Natural channel bottom width ranges from 265 to 450 feet.

Table 4.1. Key Components for Proposed Reata Pass/Beardsley Wash System.

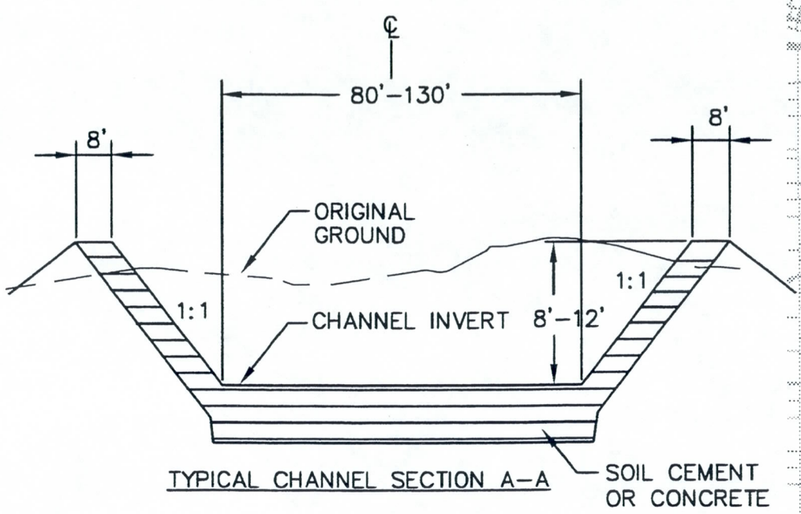
Thompson Peak Parkway alignment to approximately 850 feet downstream of the Beardsley Road alignment	1,950 feet	No construction proposed.
850 feet downstream of the Beardsley Road alignment to 3,200 feet downstream of the Beardsley Road alignment	2,350 feet	Levees ranging in height from four to ten feet above adjacent (dry side) natural ground. Levees are protected from erosion by soil cement. Natural channel bed between the levees. The levee toedown ranges from twelve to seventeen feet. Width between the levees ranges from 180 to 680 feet.
3,200 feet downstream of the Beardsley Road alignment to Bell Road	8,000 feet	Open channel with soil cement lined banks, earthen invert and soil cement drop structures. Channel depth eight to twelve feet. Most drop structures are three feet in height. Channel bottom width is 180 feet.
Bell Road to 2,900 feet downstream of Bell Road	2,900 feet	Levees ranging in height above adjacent ground from 3 feet to 9 feet. Width between the levees ranges from 190 to 420 feet. Levee toedown ranges from 12 feet to 17 feet.
2,900 feet downstream of Bell Road to Westworld Detention Basin	1,600 feet	Soil-cement-lined channel with earth bottom. Channel depth 9 feet to 16 feet. Channel width approximately 150 to 190 feet.

Engineering Feasibility and Construction Cost

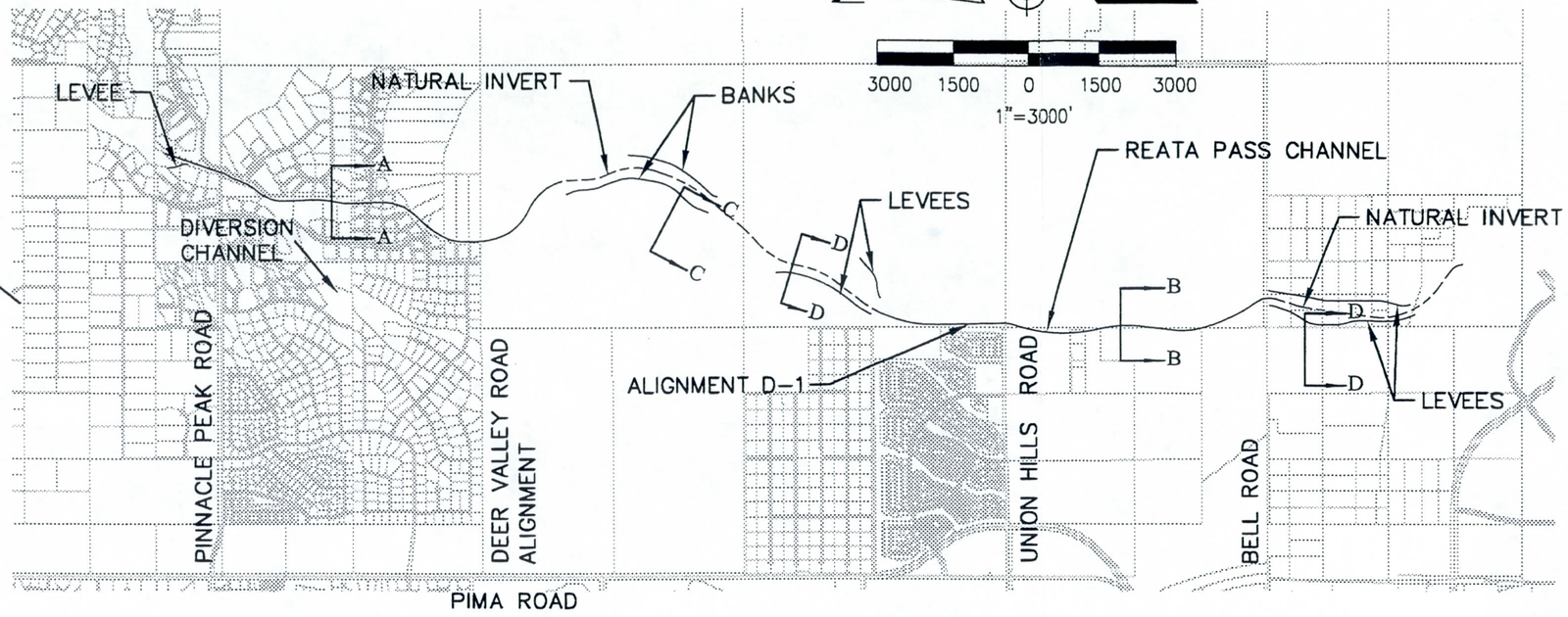
The proposed channel collects all Reata Pass flows at the apex before they spread onto the alluvial fan. Flows are confined and controlled for the entire channel and levee length. The channel bank and levee height and toedown are designed for maximum long-term and 100-year sedimentation, scour and flow depth. The design is feasible from an engineering standpoint and would remove the existing development on the Reata Pass/Beardsley Wash alluvial fan from the FEMA flood designation as indicated by approval from FEMA for a Conditional Letter of Map Revision. Project construction cost is estimated at $41,237,000.

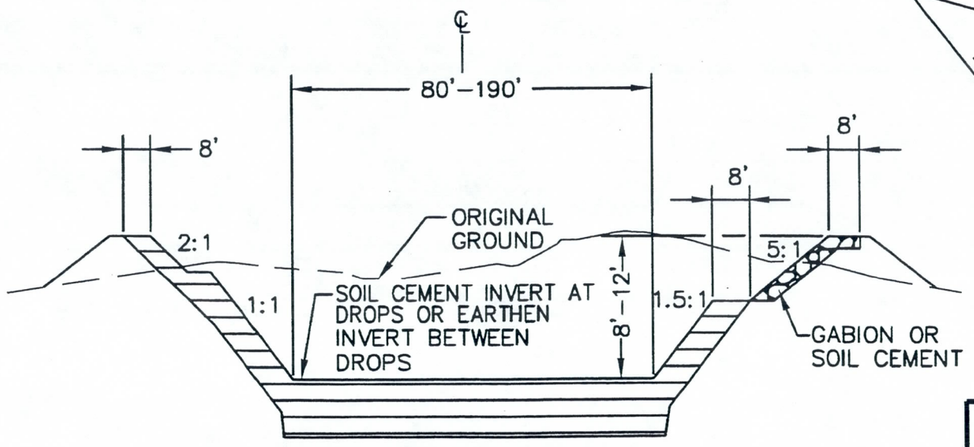
Local Regulatory and Logistical Feasibility

Alternative 11 is feasible from a local regulatory and logistical standpoint.

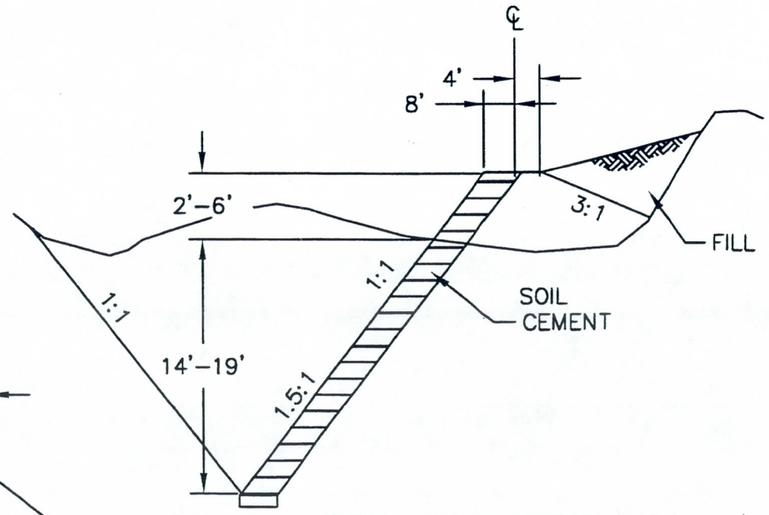


TYPICAL CHANNEL SECTION A–A

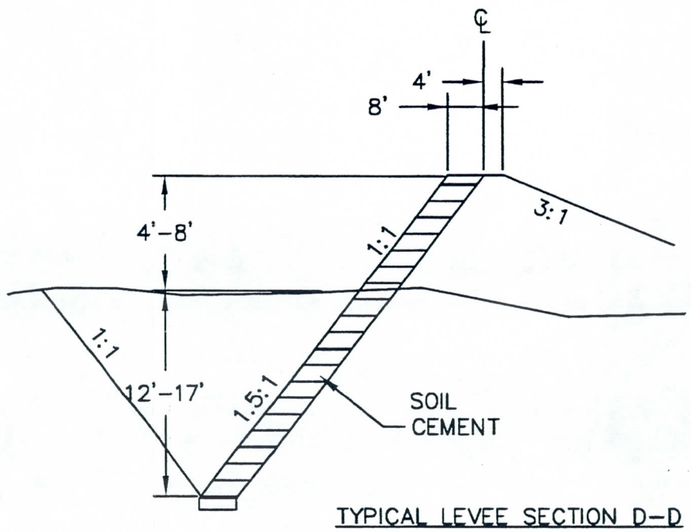




TYPICAL CHANNEL SECTION B–B



TYPICAL BANK SECTION C–C



TYPICAL LEVEE SECTION D–D

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TRANSPORTATION DEPARTMENT

ALTERNATIVE 11 REATA PASS LEVEE AND CHANNEL PROJECT

FAN APEX TO WESTWORLD DETENTION BASIN

FIGURE 4.6

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 07 ATLD-1.DWG

Project Purpose

Alternative 11 would partially fulfill the project purpose:

1. **Flood Hazard Removal.** Existing development on the Reata Pass/Beardsley Wash alluvial fan would be protected from Reata Pass/Beardsley Wash flooding. Figure 4.7 shows the area protected. The Pima Floodplain area would not be protected. This would be a regional flood-protection system for the protected area, but the regional system would not fully achieve the goal of flood protection for the entire study area. Redundant, localized flood control measures would be required in the unprotected area shown in Figure 4.7.

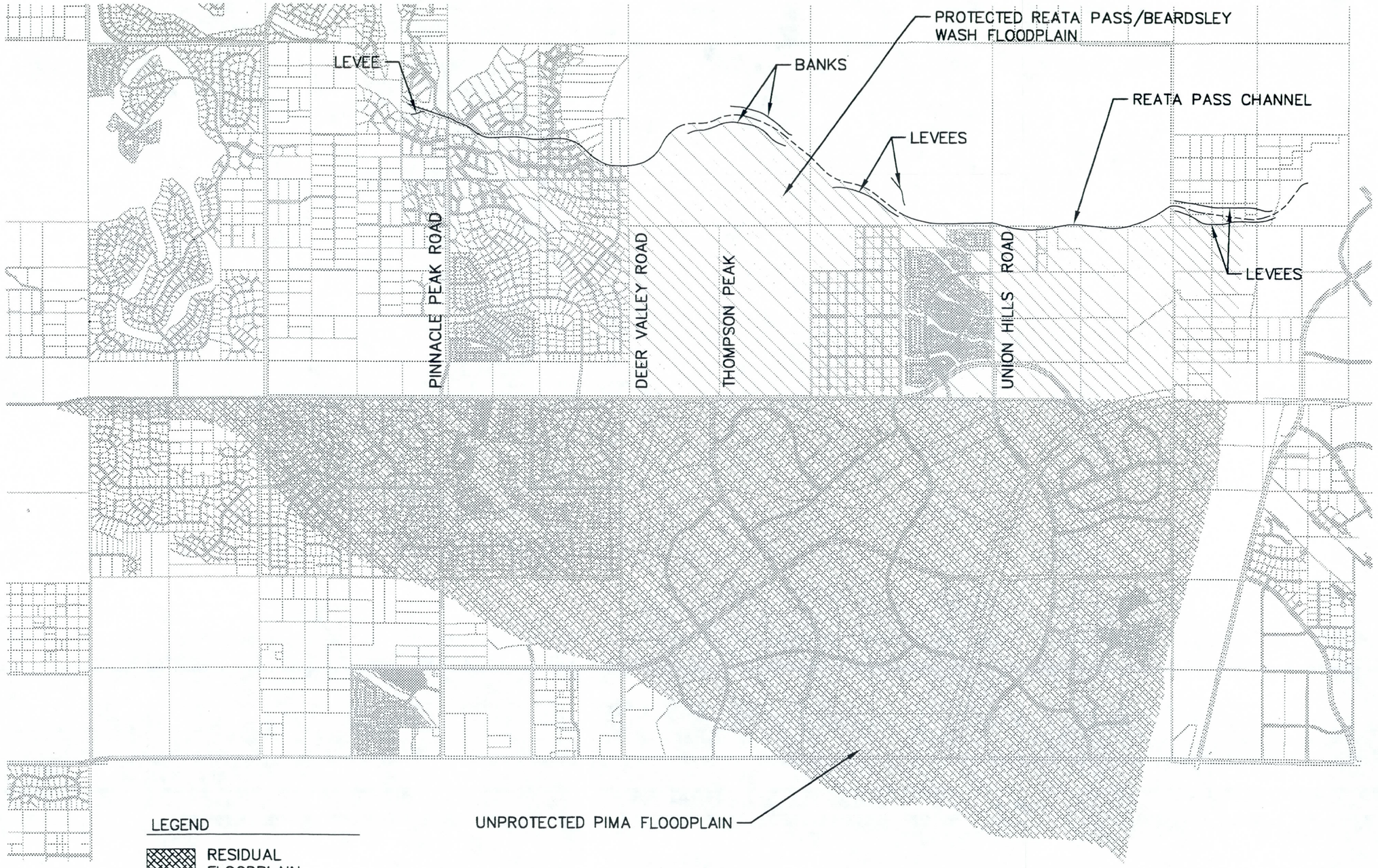
   The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would be removed for the protected area shown in Figure 4.7. The flood insurance and building pad requirements for that area would be eliminated.

2. **Flood Protection for Public Improvements.** Public infrastructure within the protected area shown on Figure 4.7 would be protected from apex-generated flooding on the Reata Pass/Beardsley Wash alluvial fan. Infrastructure within the Pima Floodplain would not be protected.

3. **Enhance Recreation.** A permanent recreational corridor would be established along the East Wash alignment between Westworld and the apex of the Reata Pass alluvial fan.

Potential Environmental Impacts

Alternative 11 would have 64.0 acres total impact to the waters of the U.S. on the Reata Pass/Beardsley Wash alluvial fan. These include 15.5 acres direct impact, 27 acres indirect impact resulting from cut-off of flows at the Reata Pass apex, 7.1 acres indirect impact resulting from cut-off of flows from the North Beardsley Wash secondary apex in the vicinity of Union Hills Drive, and 14.4 acres miscellaneous indirect impacts resulting from cut-off of channel bends and braids along the flood-control channel. Direct impacts are those that would be impacted by the actual construction of the project along the alignment shown in Figure 4.6. There are no impacts in the Pima Floodplain.



LEGEND

- RESIDUAL FLOODPLAIN
- PROTECTED AREA

N

3000 1500 0 1500 3000

1"=3000'

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TRANSPORTATION DEPARTMENT

ALTERNATIVE 11
PROTECTED AREA

FIGURE 4.7 AA-52

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 08 ALTD PRT.DWG

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the alluvial fan or until the impacted watercourse is intersected by un-impacted waters of the U.S. of similar size. On Reata Pass and Beardsley Wash there are no intersecting waters of similar size and so indirect impacts are calculated to extend as far as five miles to the base of the alluvial fan.

The removal of apex-generated flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan downstream of the fan apex. The amount of this runoff increases with distance down the alluvial fan. This runoff is sufficient to generate many separate unconnected (to the apex) waters of the U.S., beginning at a point approximately 2,400 feet downstream of the Reata Pass apex. There is tributary inflow to the upper Reata Pass alluvial fan from watersheds totaling nearly 500 acres in size (See Baseline Conditions Report Section 4.10.4). This area is approximately one-tenth the size of the Reata Pass watershed at the fan apex. Further, there is qualitative evidence from the City of Scottsdale that the 800 cfs flow observed to enter the Reata Pass alluvial fan in a southwest direction in the 1996 flood did not reach Pima Road. Using an infiltration rate calibrated on this observation it was determined that the discharge associated with the waters of the U.S. (330 cfs) would travel approximately 4,800 to 6,500 feet down the alluvial fan before infiltrating completely into the ground (See Appendix A). Hydrologic analysis shows that under current development conditions, the ordinary high water discharge can be produced from runoff generated on the alluvial fan surface at a point somewhere between 2,900 and 3,600 feet downstream of the apex. This is consistent with the finding that the nearest unconnected waters of the U.S., with riparian habitat, begins approximately 2,400 feet downstream of the apex.

The above hydrological information demonstrates that watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-

impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Total riparian vegetation impacts would be approximately 187 acres, of which approximately 39 acres would be direct impact. The rest, approximately 148 acres, would be indirect impacts from alteration of the hydrologic regime. Approximately 48 acres of this indirect impact is in areas where local runoff is considered sufficient to maintain the existing vegetative habitat. The remaining 100 acres of wash habitat may decline, or shift to a more upland type in areas of the alluvial fan with reduced flows. The greatest potential for indirect impacts to vegetation is in the upper fan area (east and west channels), between the apex and Deer Valley Road, and on the east channel of Reata Pass Wash, downstream of North Beardsley Wash. These areas support some of the most extensive and diverse wash habitat in the project area. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced.

Overstory species adversely affected by the 100-acre effective indirect impact would likely include blue palo verde, velvet mesquite and catclaw acacia. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced. These individuals may be slowly replaced with overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood).

The plants that may potentially decline and be replaced by others are not numerous on the Reata Pass/Beardsley Wash alluvial fan. A vegetative survey recorded them only on the upper portion of the alluvial fan. Blue palo verde density on the upper alluvial fan was found to average less than one individual per acre. Velvet mesquite density averaged just 0.2 individuals per acre.

Any change in the desert wash wildlife habitat will likely be subtle, and will occur over a very long time period. Ironwood densities may actually increase, and wildlife species that utilize the blue paloverde would likely be able to switch to the structurally similar ironwood or to the foothill paloverde. Given the nature of the possible indirect impacts to wildlife in the affected washes, and

the likely ability of wildlife species to adapt to relatively subtle changes in vegetation composition should such a shift occur, indirect impacts to wildlife are considered adverse but not significant.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

The remaining 48 acres of indirect impact to vegetation are either in areas far removed from apex or other significant tributary flows, or are already affected by diversions associated with existing development. These areas are less likely to support obligate wash species (e.g., blue palo verde, mesquite, catclaw acacia) and are largely sustained by local watersheds. It is likely that local watersheds would continue to sustain these areas with the project in place. Consequently these areas are not expected to be adversely affected by the project.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Alternative 11 would avoid an estimated 123 acres of impact to the alluvial fan habitat that would occur as a result of the need for future land development not associated with the proposed project to elevate buildings above the Reata Pass/Beardsley Wash100-year flood elevation if the No Action alternative is adopted.

Traffic impacts would be construction-related only. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. A cultural resources survey conducted for the proposed project found no sites of importance. The channel would have a visual impact, but this impact would be mitigated by revegetation, landscaping and contouring of the channel and banks.

Conclusion

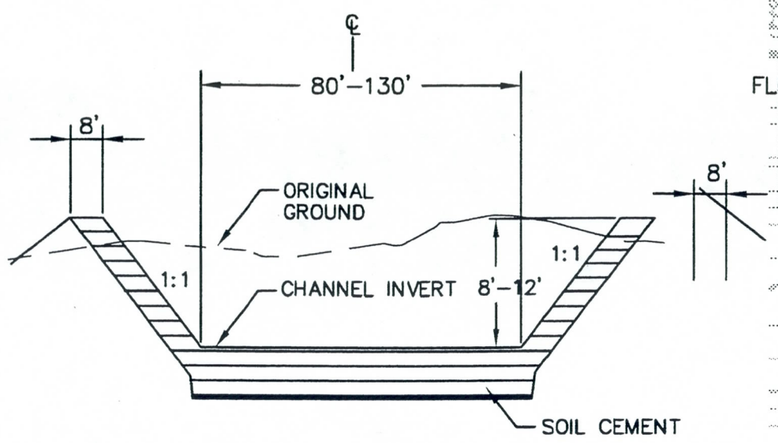
Alternative 11, Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin, is practicable but as a stand-alone project does not completely meet project purpose. Specifically, the Pima Floodplain area and associated infrastructure would receive incomplete flood protection or no flood protection under this alternative.

4.4.12 Alternative 12: Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive

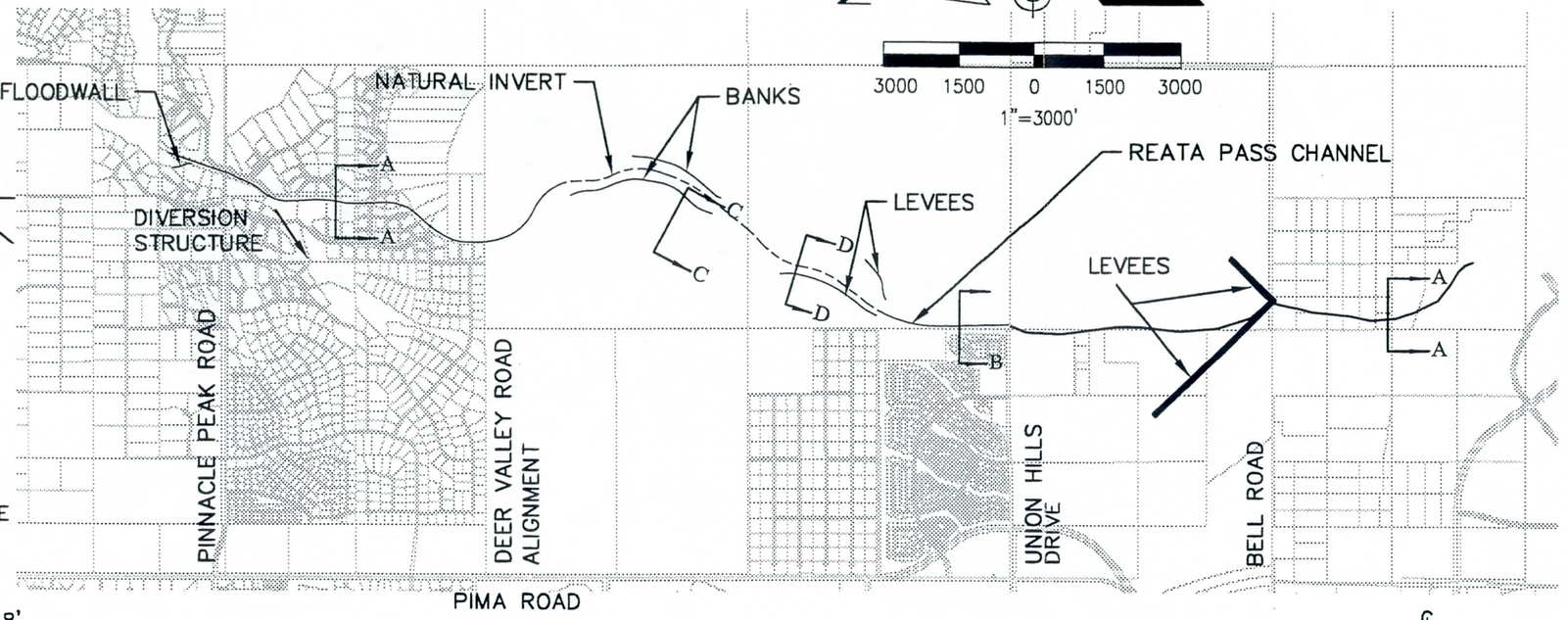
Description and Characteristics

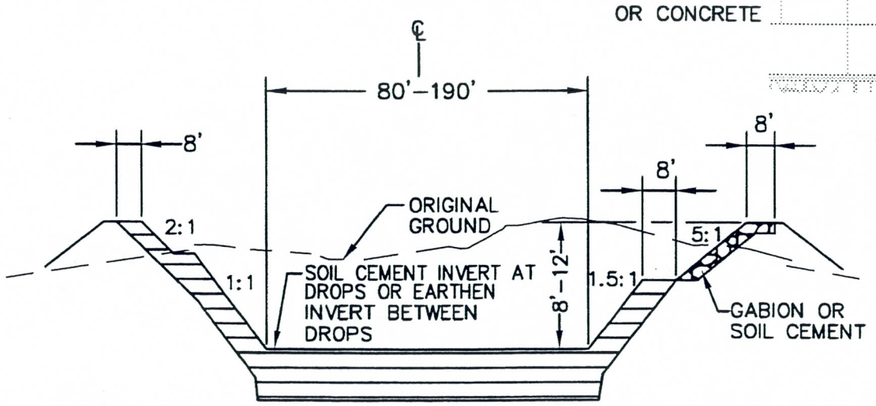
This alternative (Figure 4.8) is the minimum necessary to protect existing development using the East Wash alignment. Alternative 12 is identical to Alternative 11 upstream of Union Hills Drive.

The flood-control channel ends at Union Hills Drive. Flood flows are allowed to spread unobstructed over the undeveloped area to the south. The Coyote Ice Den and the Tesseract School (Figure 4.9) are protected by levees which collect and contain the alluvial fan flow and convey it to Bell Road. Downstream of Bell Road flood flows are controlled with soil cement levees which extend a length of 2,900 feet. The levees range in height from 3 feet to 9 feet and the toedown ranges from 12 feet to 17 feet. Channel bottom width between the levees ranges from 80 to 420

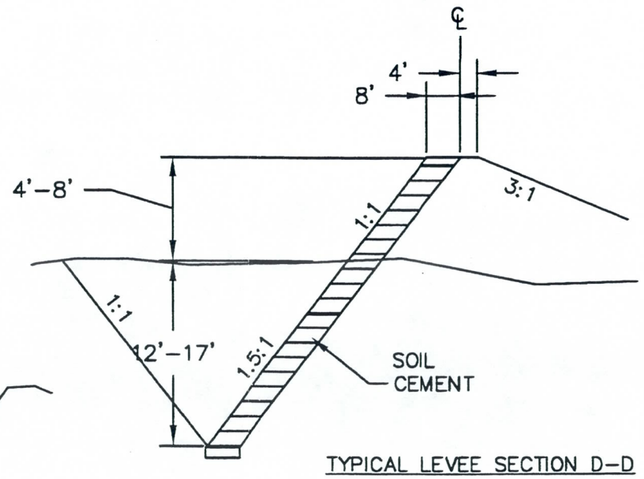


TYPICAL CHANNEL SECTION A–A

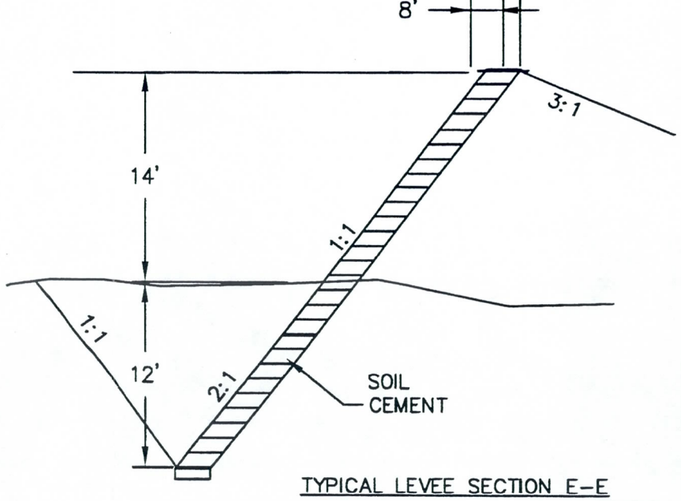




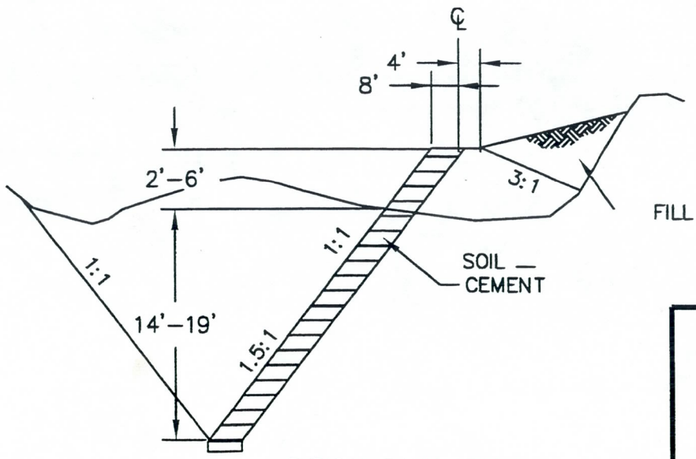
TYPICAL CHANNEL SECTION B–B



TYPICAL LEVEE SECTION D–D



TYPICAL LEVEE SECTION E–E



TYPICAL BANK SECTION C–C

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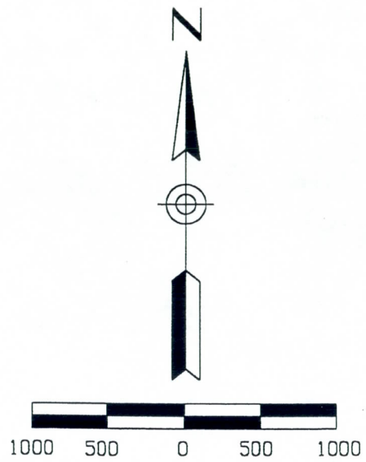
TRANSPORTATION DEPARTMENT

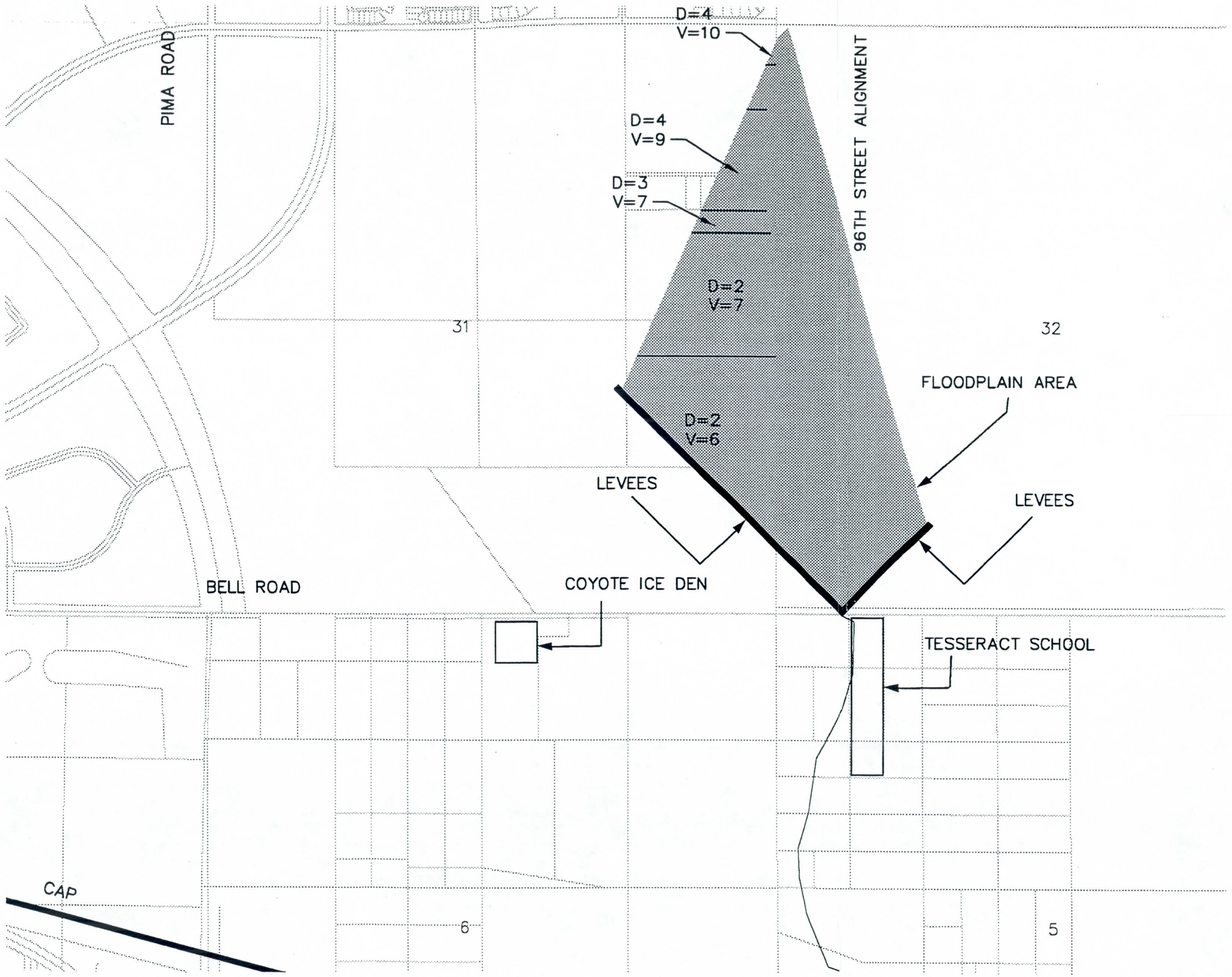
ALTERNATIVE 12 REATA PASS LEVEE AND CHANNEL PROJECT FAN APEX TO UNION HILLS ROAD

FIGURE 4.8 AA-57

The Desert Greenbelt SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 02 ATLB.DWG





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TRANSPORTATION DEPARTMENT

ALTERNATIVE 12

INCREASED FLOOD HAZARD AREA (SHADED)

FIGURE 4.9 AA-58

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 04 HAZARD AREA.DWG

feet. At the downstream end of the project a soil cement channel directs the flow from the levees into the Westworld detention basin. The depth of this channel ranges from 9 feet to 16 feet.

Engineering Feasibility and Construction Cost

This alternative collects all Reata Pass and Beardsley Wash flows before they spread onto the alluvial fan west of the East Wash. Flows are confined and controlled for the entire channel and levee length. The channel bank and levee height and toedown are designed for maximum long-term and 100-year sedimentation, scour and flow depth. The design is feasible from an engineering standpoint and would remove the existing development on the Reata Pass/Beardsley Wash alluvial fan upstream from Union Hills Drive from the FEMA flood designation (upstream of Union Hills Drive this alternative is identical to Alternative 11, which has already received a Conditional Letter of Map Revision from FEMA). The Coyote Ice Den and the Tesseract School would also be protected. The project construction cost is estimated at $70,466,000 (See Appendix B) including purchase of land upon which the flood hazard would be significantly increased (See Section 5.2.3).

Local Regulatory and Logistical Feasibility

Alternative 12 would significantly and adversely alter the hydrology for the area just downstream of the discharge point at Union Hills Drive. This point is at a location on the current Reata Pass/Beardsley Wash alluvial fan where the FEMA floodplain is approximately 11,500 feet wide. Under current conditions the risk of being hit by the full force of the 10,000-cfs 100-year flow is considerably less at any point on Union Hills Drive than it is at the fan apex. After construction of this channel, the risk would be the same as at the fan apex for the area immediately downstream of the discharge point. In other words, the regulatory flood depth at that point would be increased from one foot to four feet. Regulatory flow velocities would be increased from four feet per second to ten feet per second. This is a significant and adverse increase in hydrologic risk for that area receiving flows from the flood-control channel.

The release of concentrated flows, as would occur with this alternative, is prohibited without appropriate mitigation or compensation for the increased risk. The City of Scottsdale's Floodways and Floodplains ordinance states:

> *"A development is prohibited if it would create hazards to life or property by increasing the potential for flooding either on the property to be developed or on adjacent property to any other property. Further: A watercourse may not be altered . . . unless professional engineer certifies that the alterations do not increase the flood levels, and will not increase flooding hazards within, upstream or downstream of the altered portion of the watercourse."*

This ordinance further states:

> *"Rainfall runoff from storms of all return frequencies should enter and depart from property after its development in substantially the same manner as under pre-development conditions. Any proposals to modify drainage characteristics must be fully justified by engineering data which shall demonstrate to the floodplain administrator that hazards to life and property will not be increased by the proposed modifications."*

The relocation of the alluvial fan apex to Union Hills Drive as would be done for this alternative would violate the City of Scottsdale's Floodways and Floodplains ordinance by creating a significant and adverse flooding impact downstream of the location where flood waters would be discharged at Union Hills Drive. The area downstream of the new discharge point would have to be re-mapped to reflect the new, significantly-increased flood and erosion hazard. Figure 4.9 shows the approximate location of the new alluvial fan floodplain. As described in Section 5.2.6, this would be a violation of the City of Scottsdale's Floodways and Floodplains ordinance and would be a significant, adverse impact to the flood-prone property between the discharge point at Union Hills Drive and the levees which funnel water to Bell Road for the protection of the Coyote Ice Den and the Tesseract School. This impact could be mitigated and the alternative made feasible by purchase of this property. Consequently, this purchase price is included in the project cost estimate.

Project Purpose

Alternative 12 would partially fulfill the project purpose:

1. **Flood Hazard Removal.** Existing development on the Reata Pass/Beardsley Wash alluvial fan would be protected from Reata Pass/Beardsley Wash flooding. This would be a regional flood-protection system for the protected area, but the regional system would not fully achieve the goal of flood protection for the entire study area. Figure 4.10 shows the area protected. Redundant, localized flood control measures would be required in the unprotected area shown in Figure 4.10.

   The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would be removed for the protected area shown in Figure 4.10. The flood insurance and building pad requirements for that area would be eliminated. The area of increased hazard on Figure 4.9 would be re-mapped to reflect higher flood depths and velocities.

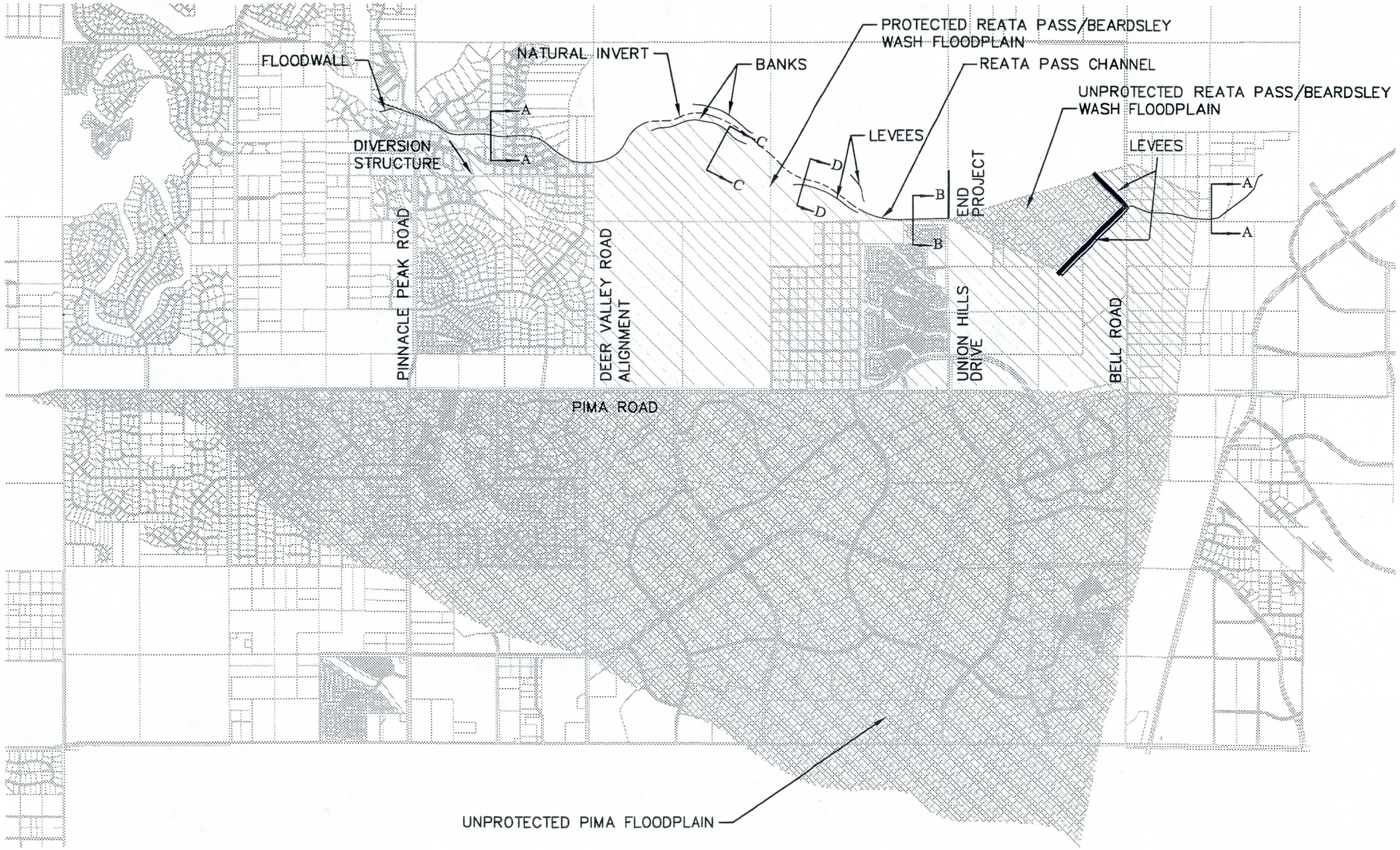
2. **Flood Protection for Public Improvements.** Public infrastructure within the protected area shown on Figure 4.10 would be protected from apex-generated flooding on the Reata Pass/Beardsley Wash alluvial fan. Infrastructure in the Pima Floodplain area would not be protected.

3. **Enhance Recreation.** A permanent recreational corridor would be established along the East Wash alignment between Union Hills Drive and the apex of the Reata Pass alluvial fan, but there would be no established connection between Union Hills Drive and Bell Road.

Potential Environmental Impacts

Alternative 12 would have 61.7 acres total impact to the waters of the U.S. on the Reata Pass/Beardsley Wash alluvial fan. These include 15.2 acres direct impact, 27 acres indirect impact resulting from cut-off of flows at the Reata Pass apex, 5.1 acres indirect impact resulting from cut-off of flows from the North Beardsley Wash secondary apex in the vicinity of Union Hills Drive, and 14.4 acres miscellaneous indirect impacts resulting from cut-off of channel bends and braids along the flood-control channel. Direct impacts are those that would be impacted by the actual construction of the project along the alignment shown in Figure 4.8.

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the



N

3000 1500 0 1500 3000

1"=3000'

LEGEND

RESIDUAL FLOODPLAIN

PROTECTED AREA

sla Simons, Li & Associates, Inc.
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3150 Bristol Street, Suite 500
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Tel. (714) 513-1280 Fax. (714) 513-1278

TRANSPORTATION DEPARTMENT

ALTERNATIVE 12

PROTECTED AREA

FIGURE 4.10 AA-62

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOSO3\EXHIBITS\SHT-FIG 03 ATLB PRT.DWG

alluvial fan or until the impacted watercourse is intersected by un-impacted waters of the U.S. of similar size. On Reata Pass and Beardsley Wash there are no intersecting waters of similar size and so indirect impacts are calculated to extend as far as five miles to the base of the alluvial fan.

The removal of apex-generated flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan downstream of the fan apex. The amount of this runoff increases with distance down the alluvial fan. This runoff is sufficient to generate many separate unconnected (to the apex) waters of the U.S., beginning at a point approximately 2,400 feet downstream of the Reata Pass apex. There is tributary inflow to the upper Reata Pass alluvial fan from watersheds totaling nearly 500 acres in size (See Baseline Conditions Report Section 4.10.4). This area is approximately one-tenth the size of the Reata Pass watershed at the fan apex. Further, there is qualitative evidence from the City of Scottsdale that the 800 cfs flow observed to enter the Reata Pass alluvial fan in a southwest direction in the 1996 flood did not reach Pima Road. Using an infiltration rate calibrated on this observation it was determined that the discharge associated with the waters of the U.S. (330 cfs) would travel approximately 4,800 to 6,500 feet down the alluvial fan before infiltrating completely into the ground (See Appendix A). Hydrologic analysis shows that under current development conditions, the ordinary high water discharge can be produced from runoff generated on the alluvial fan surface at a point somewhere between 2,900 and 3,600 feet downstream of the apex. This is consistent with the finding that the nearest unconnected waters of the U.S., with riparian habitat, begins approximately 2,400 feet downstream of the apex.

The above hydrological information demonstrates that watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Total riparian vegetation impacts would be approximately 180 acres, of which approximately 38 acres would be direct impact. The rest, approximately 142 acres, would be indirect impacts from alteration of the hydrologic regime. Of the 142 acres of potential indirect impacts, about 96 acres are expected to be most affected by the elimination of apex flows. Approximately 46 acres of this indirect impact is in areas where local runoff is considered sufficient to maintain the existing vegetative habitat. The remaining 96 acres of wash habitat may decline, or shift to a more upland type in areas of the alluvial fan with reduced flows. The greatest potential for indirect impacts to vegetation is in the upper fan area (east and west channels), between the apex and Deer Valley Road, and on the east channel of Reata Pass Wash. These areas supports some of the most extensive and diverse wash habitat in the project area. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced.

Overstory species adversely affected by the 96-acre effective indirect impact would likely include blue palo verde, velvet mesquite and catclaw acacia. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced. These individuals may be slowly replaced with overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood).

The plants that may potentially decline and be replaced by others are not numerous on the Reata Pass/Beardsley Wash alluvial fan. A vegetative survey recorded them only on the upper portion of the alluvial fan. Blue palo verde density on the upper alluvial fan was found to average less than one individual per acre. Velvet mesquite density averaged just 0.2 individuals per acre.

Any change in the desert wash wildlife habitat will likely be subtle, and will occur over a very long time period. Ironwood densities may actually increase, and wildlife species that utilize the blue paloverde would likely be able to switch to the structurally similar ironwood or to the foothill paloverde. Given the nature of the possible indirect impacts to wildlife in the affected washes, and the likely ability of wildlife species to adapt to relatively subtle changes in vegetation composition

should such a shift occur, the indirect impacts to wildlife species are considered an adverse impact that is not significant.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Alternative 12 would avoid an estimated 123 acres of impact to the alluvial fan habitat that would occur as a result of the need for future land development not associated with the proposed project to elevate buildings above the Reata Pass/Beardsley Wash100-year flood elevation if the No Action alternative is adopted.

Traffic impacts would be construction-related only. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. A cultural resources survey along the general alignment of this alternative, conducted for the proposed project, found no sites of importance. The channel would have a visual impact, but this impact could be mitigated by revegetation, landscaping and contouring of the channel and banks.

Conclusion

Alternative 12 is not practicable because of substantially higher cost than the proposed project (Alternative 11), and it is less effective than Alternative 11 at meeting the project purpose. Specifically, the Reata Pass/Beardsley Wash FEMA floodplain area would not be completely eliminated, and there would not be an established recreational connection between Union Hills Drive and Bell Road. The avoided impact to waters of the U.S. (2.8 acres) is small in comparison to the $26,400,000 higher cost than Alternative 11.

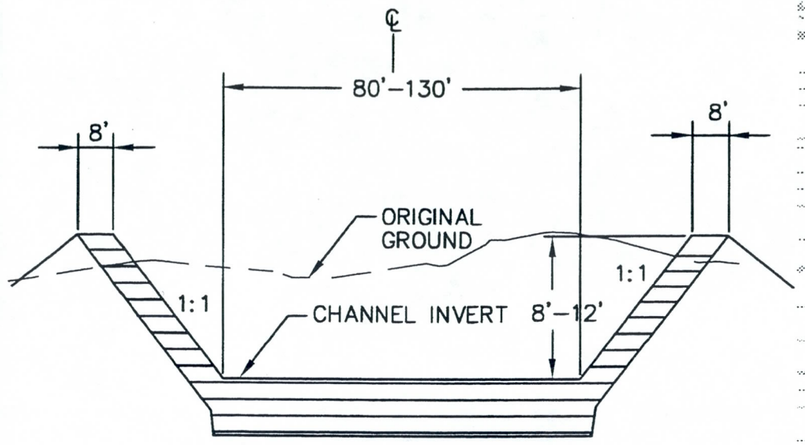
4.4.13 Alternative 13: Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive with Detention Basin at Union Hills Drive

Description and Characteristics

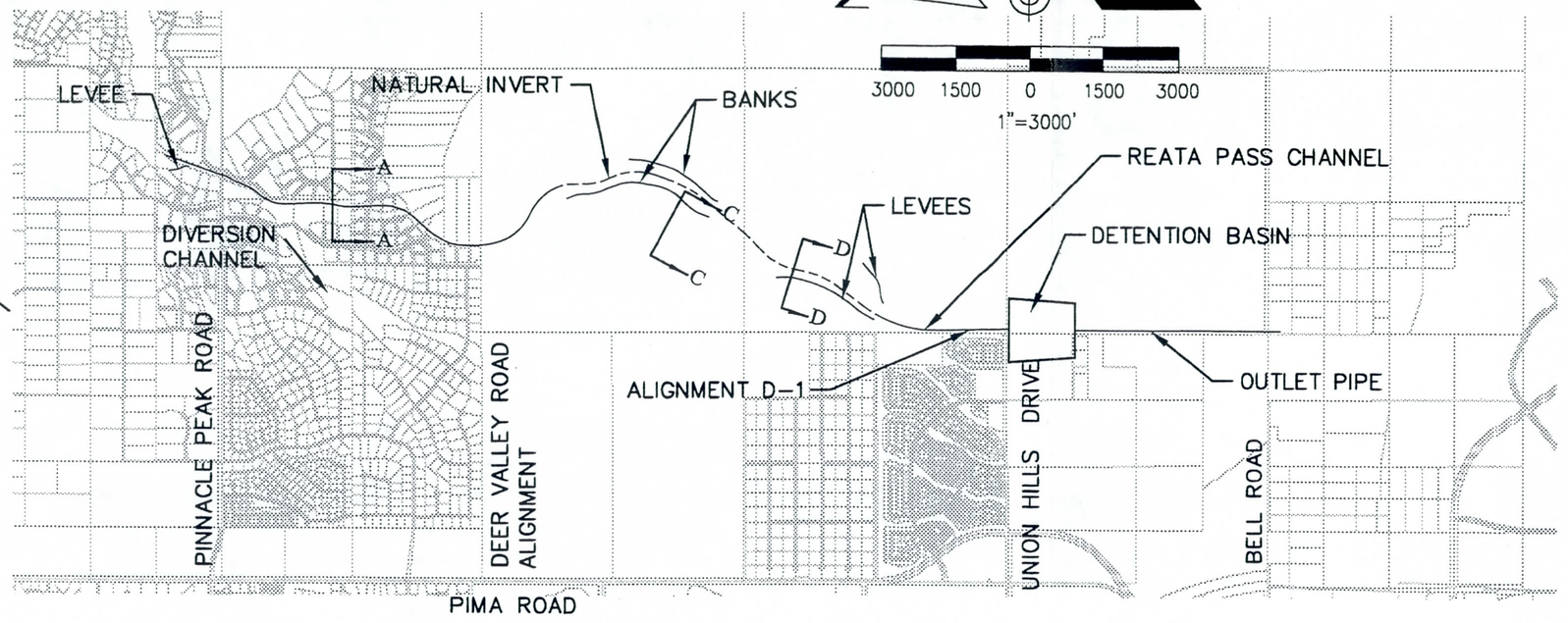
Alternative 13 is identical to Alternative 12 upstream of Union Hills Drive, with a detention basin at Union Hills Drive (Figures 4.11 and 4.12) to mitigate for adverse impacts identified for Alternative 12 in the area downstream of Union Hills Drive. The 40-acre detention basin would be below the level of the existing ground and drained by an underground box culvert extending to daylight 4,200 feet downstream. There would be no other improvements below Union Hills Drive.

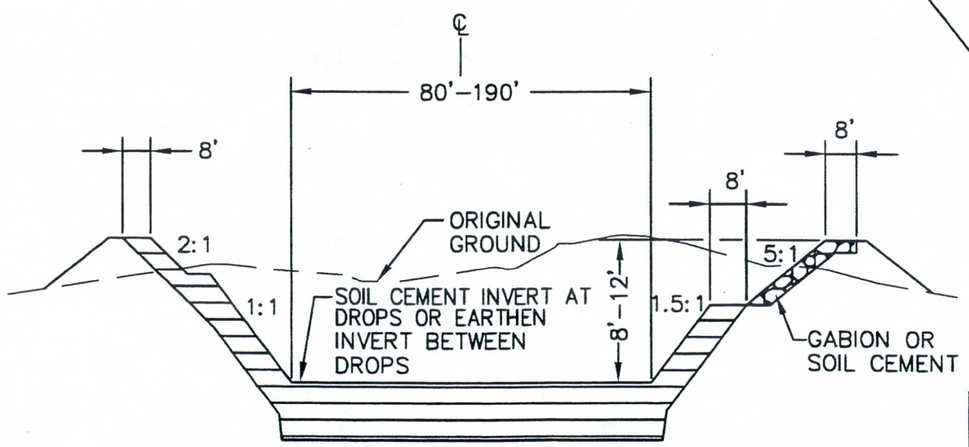
Engineering Feasibility and Construction Cost

This alternative collects all Reata Pass and Beardsley Wash flows before they spread onto the alluvial fan. Flows are confined and controlled for the entire channel and levee length. The channel bank and levee height and toedown are designed for maximum long-term and 100-year sedimentation, scour and flow depth. The design is feasible from an engineering standpoint and would remove the existing development on the Reata Pass/Beardsley Wash alluvial fan from the FEMA flood designation (upstream of Union Hills Drive this alternative is identical to Alternative

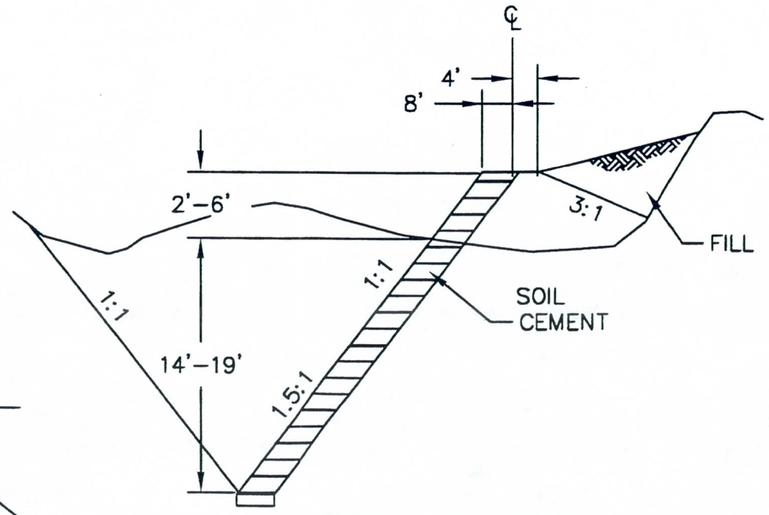


TYPICAL CHANNEL SECTION A–A

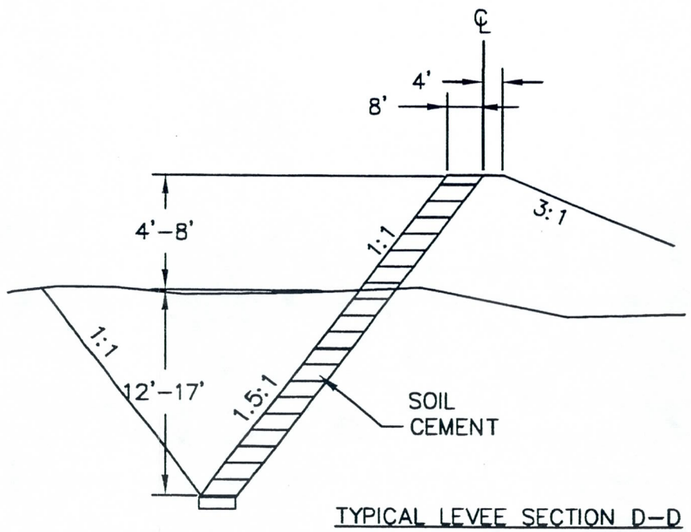




TYPICAL CHANNEL SECTION B–B



TYPICAL BANK SECTION C–C



TYPICAL LEVEE SECTION D–D

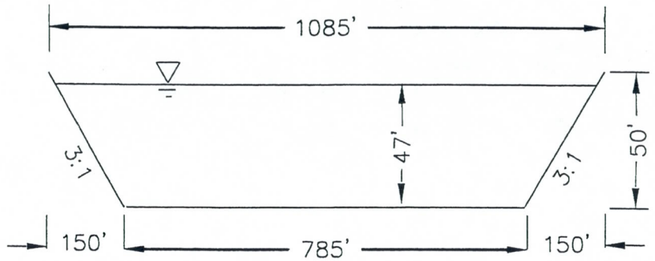
Simons, Li & Associates, Inc.
Water Resources & Civil Engineering Consultants
3150 Bristol Street, Suite 500
Costa Mesa, CA 92626
Tel (714) 513-1280 Fax. (714) 513-1278

TRANSPORTATION DEPARTMENT
ALTERNATIVE 13 REATA PASS
LEVEE AND CHANNEL PROJECT
FAN APEX TO UNION HILLS DRIVE WITH
DETENTION BASIN AT UNION HILLS

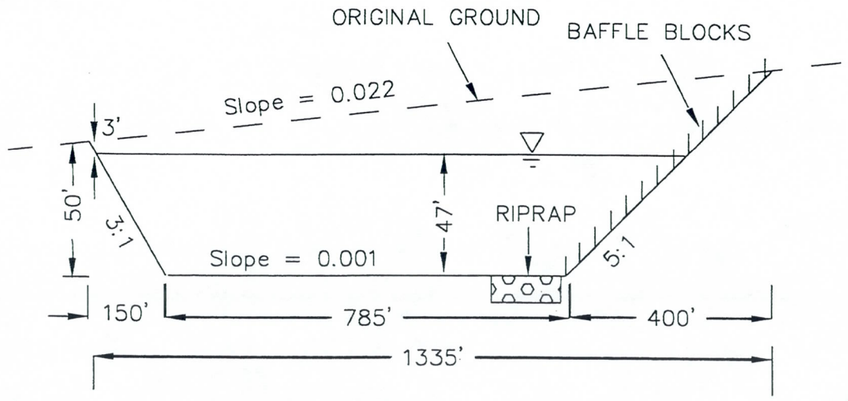
FIGURE 4.11 AA-67

The Desert Greenbelt
SCOTTSDALE, ARIZONA

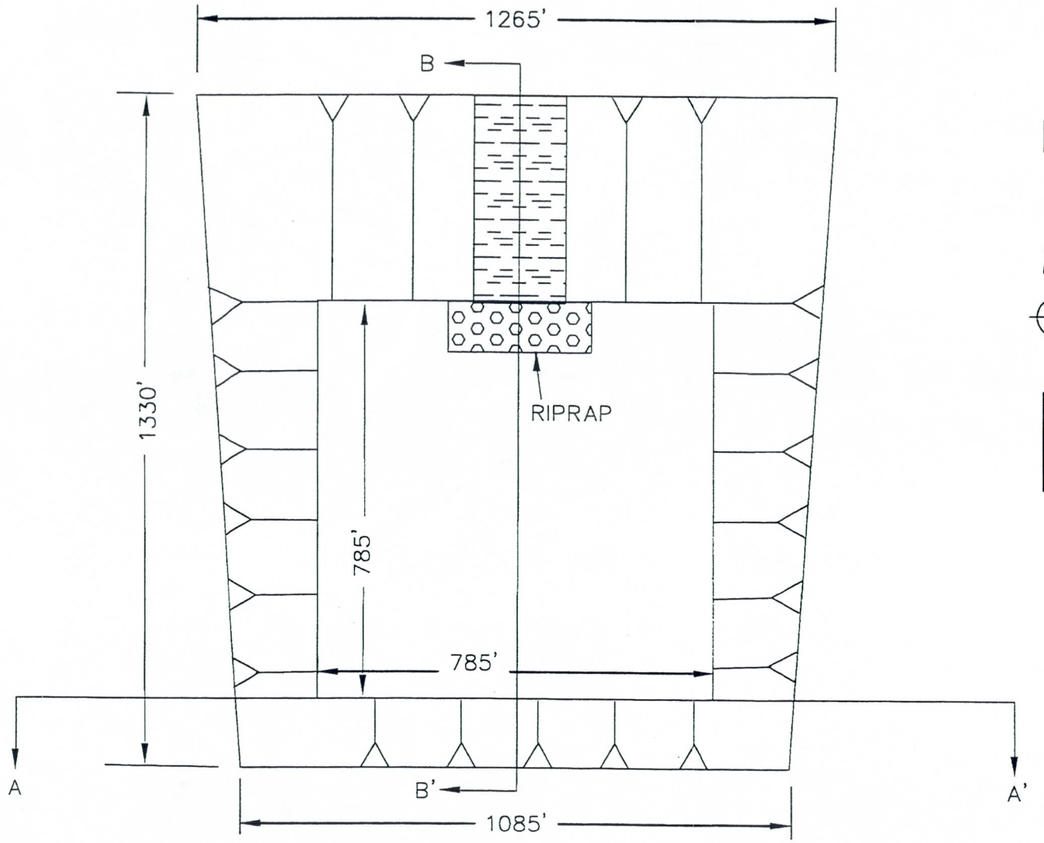
M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 05 ATLC.DWG



SECTION A–A' SCALE: 1" = 1500' (horizontal)
1" = 7500' (vertical)



SECTION B–B' SCALE: 1" = 1500' (horizontal)
1" = 7500' (vertical)



PLAN VIEW SCALE:

1500 750 0 750 1500
1"=1500'

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sla Simons, Li & Associates, Inc.
Water Resources & Civil Engineering Consultants
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Costa Mesa, CA 92626
Tel. (714) 513-1280 Fax. (714) 513-1278

TRANSPORTATION DEPARTMENT

ALTERNATIVE 13
DETENTION BASIN DETAILS

FIGURE 4.12 AA-68

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOSO3\EXHIBITS\SHT-FIG 05 ATLC.DWG

11, which has already received a Conditional Letter of Map Revision from FEMA). The project construction cost is estimated at $52,192,000 to $69,912,000 depending upon the transportation costs for material excavated from the detention basin at Union Hills.

Local Regulatory and Logistical Feasibility

Alternative 13 is feasible from a local regulatory and logistical standpoint.

Project Purpose

Alternative 13 would partially fulfill the project purpose:

1. **Flood Hazard Removal.** Existing development on the Reata Pass/Beardsley Wash alluvial fan would be protected from Reata Pass/Beardsley Wash flooding. Figure 4.13 shows the area protected. This would be a regional flood-protection system for the protected area, but the regional system would not fully achieve the goal of flood protection for the entire study area. The Pima Floodplain area would not be protected. Redundant, localized flood control measures would be required in the unprotected area shown in Figure 4.13.

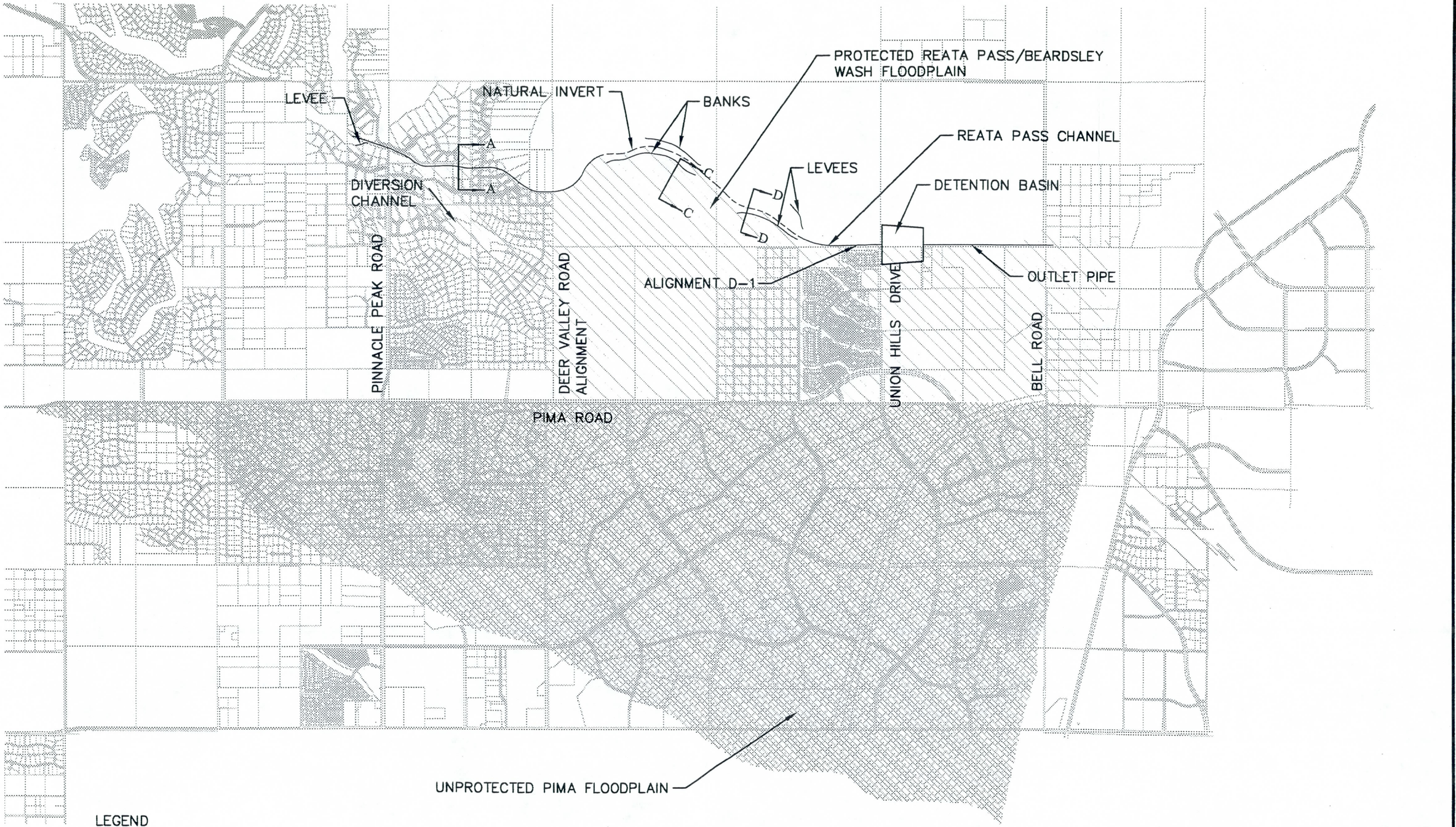
   The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would be removed. The flood insurance and building pad requirements for that area would be eliminated.

2. **Flood Protection for Public Improvements.** Public infrastructure within the protected area shown on Figure 4.13 would be protected from apex-generated flooding on the Reata Pass/Beardsley Wash alluvial fan. Infrastructure in the Pima Floodplain area would not be protected.

3. **Enhance Recreation.** A permanent recreational corridor would be established along the East Wash alignment between Union Hills Drive and the apex of the Reata Pass alluvial fan, and south of Bell Road, but there would be no link between Bell Road and Union Hills Drive.

Potential Environmental Impacts

Alternative 13 would have 64.3 acres total impact to the waters of the U.S. on the Reata Pass/Beardsley Wash alluvial fan. These include 15.8 acres direct impact, 27 acres indirect impact resulting from cut-off of flows at the Reata Pass apex, 7.1 acres indirect impact resulting from cut-



LEGEND

RESIDUAL FLOODPLAIN

PROTECTED AREA

N

3000 1500 0 1500 3000

1"=3000'

sla Simons, Li & Associates, Inc.
Water Resources & Civil Engineering Consultants
3150 Bristol Street, Suite 600
Costa Mesa, CA 92626
Tel. (714) 513-1280 Fax. (714) 513-1278

TRANSPORTATION DEPARTMENT

ALTERNATIVE 13
PROTECTED AREA

FIGURE 4.13 AA-70

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 06 ATLC PRT.DWG

off of flows from the North Beardsley Wash secondary apex in the vicinity of Union Hills Drive, and 14.4 acres miscellaneous indirect impacts resulting from cut-off of channel bends and braids along the flood-control channel. Direct impacts are those that would be impacted by the actual construction of the project along the alignment shown in Figure 4.11. There are no impacts in the Pima Floodplain.

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the alluvial fan or until the impacted watercourse is intersected by un-impacted waters of the U.S. of similar size. On Reata Pass and Beardsley Wash there are no intersecting waters of similar size and so indirect impacts are calculated to extend as far as five miles to the base of the alluvial fan.

The removal of apex-generated flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan downstream of the fan apex. The amount of this runoff increases with distance down the alluvial fan. This runoff is sufficient to generate many separate unconnected (to the apex) waters of the U.S., beginning at a point approximately 2,400 feet downstream of the Reata Pass apex. There is tributary inflow to the upper Reata Pass alluvial fan from watersheds totaling nearly 500 acres in size (See Baseline Conditions Report Section 4.10.4). This area is approximately one-tenth the size of the Reata Pass watershed at the fan apex. Further, there is qualitative evidence from the City of Scottsdale that the 800 cfs flow observed to enter the Reata Pass alluvial fan in a southwest direction in the 1996 flood did not reach Pima Road. Using an infiltration rate calibrated on this observation it was determined that the discharge associated with the waters of the U.S. (330 cfs) would travel approximately 4,800 to 6,500 feet down the alluvial fan before infiltrating completely into the ground (See Appendix A). Hydrologic analysis shows that under current development conditions, the ordinary high water discharge can be produced from runoff generated on the alluvial fan surface at a point somewhere between 2,900 and 3,600 feet downstream of the apex. This is consistent with the finding that the nearest unconnected waters of the U.S., with riparian habitat, begins approximately 2,400 feet downstream of the apex.

The above hydrological information demonstrates that watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Total riparian vegetation impacts would be approximately 187 acres, of which approximately 39 acres would be direct impact. The rest, approximately 148 acres, would be indirect impacts from alteration of the hydrologic regime. Approximately 48 acres of this indirect impact is in areas where local runoff is considered sufficient to maintain the existing vegetative habitat. The remaining 100 acres of wash habitat may decline, or shift to a more upland type in areas of the alluvial fan with reduced flows. The greatest potential for indirect impacts to vegetation is in the upper fan area (east and west channels), between the apex and Deer Valley Road, and on the east channel of Reata Pass Wash, downstream of North Beardsley Wash. These areas supports some of the most extensive and diverse wash habitat in the project area. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced.

Overstory species adversely affected by the 100-acre effective indirect impact would likely include blue palo verde, velvet mesquite and catclaw acacia. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced. These individuals may be slowly replaced with overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood).

The plants that may potentially decline and be replaced by others are not numerous on the Reata Pass/Beardsley Wash alluvial fan. A vegetative survey recorded them only on the upper portion of the alluvial fan. Blue palo verde density on the upper alluvial fan was found to average less than one individual per acre. Velvet mesquite density averaged just 0.2 individuals per acre.

Any change in the desert wash wildlife habitat will likely be subtle, and will occur over a very long time period. Ironwood densities may actually increase, and wildlife species that utilize the blue paloverde would likely be able to switch to the structurally similar ironwood or to the foothill paloverde. Given the nature of the possible indirect impacts to wildlife in the affected washes, and the likely ability of wildlife species to adapt to relatively subtle changes in vegetation composition should such a shift occur, the indirect impacts to wildlife species are considered an adverse impact that is not significant.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Alternative 13 would avoid an estimated 123 acres of impact to the alluvial fan habitat that would occur as a result of the need for future land development not associated with the proposed project to elevate buildings above the Reata Pass/Beardsley Wash100-year flood elevation if the No Action alternative is adopted.

Traffic impacts would be construction-related only. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. A cultural resources survey along the general alignment of this alternative, conducted for the proposed project, found no sites of importance. The channel and detention basin would have a visual impact, but this impact could be mitigated by revegetation, landscaping and contouring of the channel and banks.

Conclusion

Alternative 13, Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive with Detention Basin at Union Hills Drive, is not practicable because of substantially higher cost than the proposed project (Alternative 11), and it is less effective than Alternative 11 at meeting the project purpose. Specifically, there would not be an established recreational connection between Union Hills Drive and Bell Road. The impact to waters of the U.S. is 2.1 acres higher than the Alternative 11 impact.

4.4.14 Alternative 14: Wider Channel

Description and Characteristics

A wider channel is essentially the same as the proposed project (Alternative 11), but with banks placed farther apart. As considered herein, a wider channel on the Reata Pass/Beardsley Wash is considered a stand-alone project.

Engineering Feasibility and Construction Cost

During the design analysis for the proposed project (Alternative 11), it was found that approximately the upper 6,500 feet of the flood-control channel for the Reata Pass/Beardsley Wash could not be made wider without encroaching into and destroying existing homes. There is no opportunity for

a wider channel in this reach. Beginning approximately 6,500 feet downstream of Pinnacle Peak Road, and extending to the confluence with the Beardsley Wash, the channel width is limited by existing topography. The proposed channel (Alternative 11) is as wide as the topography will allow in this reach. The only opportunity for a wider channel is in the reach downstream of the confluence with Beardsley Wash (South of Sierra Pinta Drive).

All features of the wider channel project would be similar to the proposed project (Alternative 11) except for channel width. Channel depth is not significantly altered by widening the channel. For example, the proposed channel in the widened reach is approximately 200 feet wide at the bottom. Channel depth with freeboard is approximately 7.5 feet. Widening the channel by 50% to 300 feet would reduce the depth with freeboard by 17% to approximately 6.2 feet. Widening the channel by 100% to 400 feet would reduce the depth with freeboard by 28% to 5.4 feet. Construction cost of a wider channel would be approximately the same as for the proposed channel. Construction savings by reducing channel bank and excavation depth would be offset by wider grade-control structures and excavation width.

The total cost of a wider channel would be higher than the proposed project due to right-of-way requirements. The length of the wider reach is approximately 2.4 miles. At an average cost of $80,000/acre of land, each foot of width in addition to the width of the proposed project would cost an additional $23,270 in right-of-way.

Local Regulatory and Logistical Feasibility

A wider channel downstream of the Beardsley Wash confluence is feasible from a local regulatory and logistical standpoint.

Project Purpose

A wider channel would partially fulfill the project purpose:

1. **Flood Hazard Removal.** Existing development on the Reata Pass/Beardsley Wash alluvial fan would be protected from Reata Pass/Beardsley Wash flooding. The protected area is the same as for the proposed project (Alternative 11). The FEMA flood designation would be removed. The Pima Floodplain area would remain subject to flooding.

2. **Flood Protection for Public Improvements.** Public infrastructure within the protected area would be protected from apex-generated flooding on the Reata Pass/Beardsley Wash alluvial fan. Infrastructure in the Pima Floodplain area would not be protected.

3. **Enhance Recreation.** A permanent public recreational corridor would be established along the East Wash alignment.

Potential Environmental Impacts

Since the channel in the wider reach is mainly an excavated channel, widening can only have the effect of increasing the amount of habitat and waters of the U.S. affected in comparison to the proposed project. Environmental impacts would be similar to, but greater than those of the proposed project.

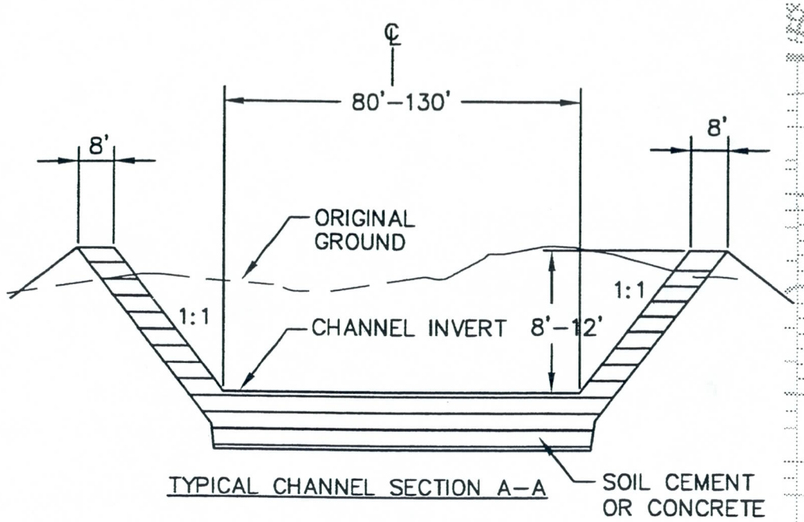
Conclusion

A wider channel is practicable, but would be more costly and have greater environmental impact than the proposed project.

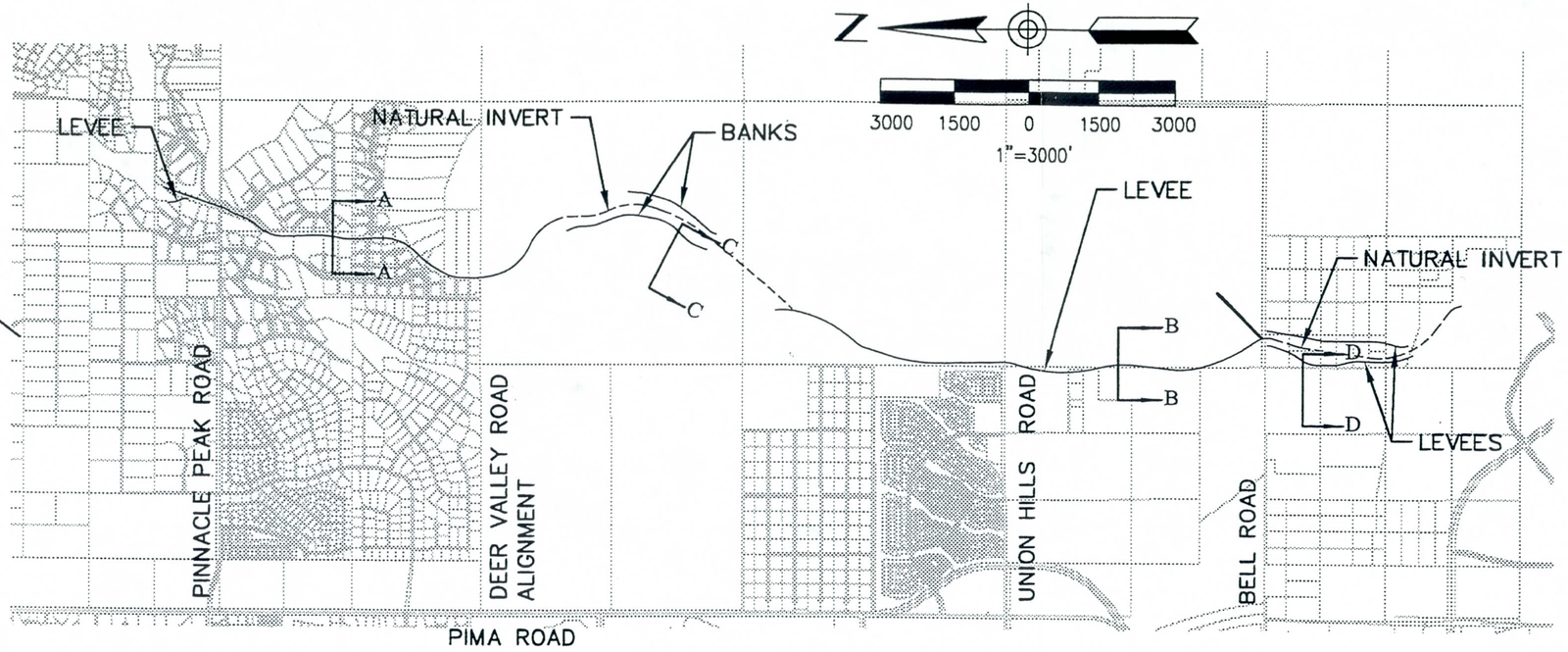
4.4.15 Alternative 15: Reata Pass Wash Partial Levee Project, Fan Apex to Westworld Detention Basin

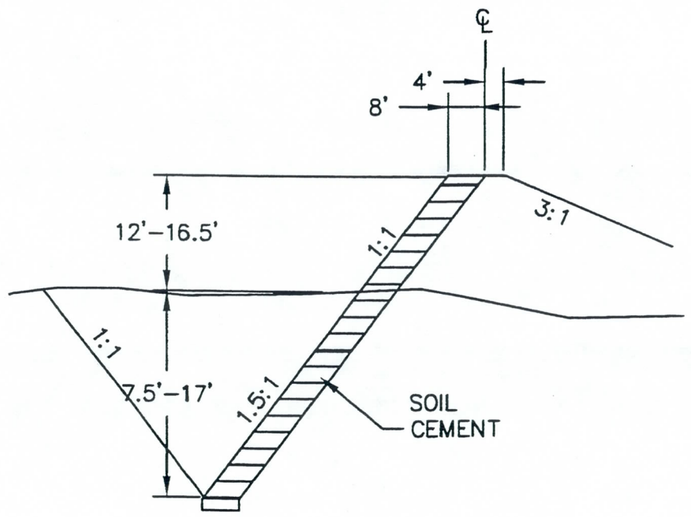
Description and Characteristics

The Partial levee alternative uses a single levee to turn flows away from the existing developed areas. East of the levee flooding would continue as before, although increased in depth and velocity in some areas by the levee. The area west of the levee would be protected. The single levee has the advantage that the project construction area can be reduced in comparison to an excavated, two-sided channel to minimize impact to the natural environment. The alignment (Figure 4.14) would be the same as the proposed project.

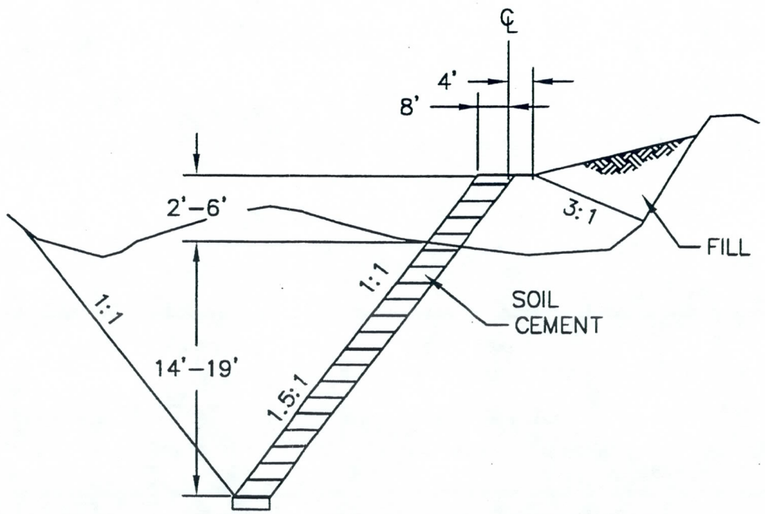


TYPICAL CHANNEL SECTION A–A

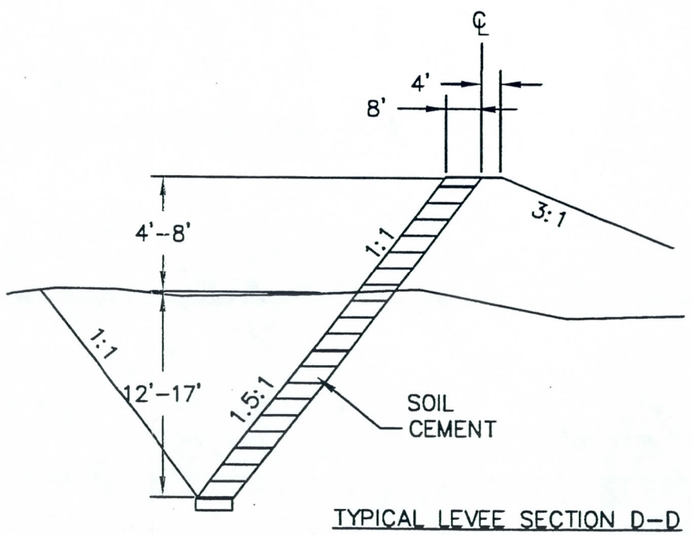




TYPICAL CHANNEL SECTION B–B



TYPICAL BANK SECTION C–C



TYPICAL LEVEE SECTION D–D

sla
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TRANSPORTATION DEPARTMENT

ALTERNATIVE 15: REATA PASS WASH PARTIAL LEVEE PROJECT

FAN APEX TO WESTWORLD DETENTION BASIN

FIGURE 4.14 AA-77

The Desert Greenbelt
SCOTTSDALE, ARIZONA

P:\AZCOS03\EXHIBITS\ALTFIG\ALTF5-9.DWG, 06/07/99

A constraints analysis for the partial levee concept revealed that the upper 6,500 feet of the project is not suited for a partial levee because of flood-prone development on both sides of the alignment. Beginning approximately 6,500 feet downstream of Pinnacle Peak Road, and extending to the confluence with the Beardsley Wash, the location of the levee is limited by existing topography. This area has high ground on the east side of the alignment. The only opportunity for a partial levee is in the reach downstream of the confluence with Beardsley Wash (South of Sierra Pinta Drive).

All features of the Partial Levee Alternative would be the same as the proposed project (Alternative 11) except for that portion downstream of Sierra Pinta Drive and upstream of Bell Road. Between Sierra Pinta Drive and Bell Road there would be a single, at-grade levee as shown in Figure 4.14. This levee would be approximately 12 to 16.5 feet high. At the Bell Road bridge a separate levee would extend to the northeast to collect flood water for protection of the Tesseract School. Downstream of Bell Road this alternative would be identical to the proposed project.

Engineering Feasibility and Construction Cost

The partial levee is feasible from an engineering standpoint if so designed that the levee is high enough that it can take restrain the entire 100-year discharge from the Reata Pass/Beardsley Washes with at least three feet of freeboard as required by FEMA. The levee must also be capable of withstanding maximum (100-year) sediment deposition from the Beardsley Wash under the assumption that the entire flow can impact from the east at any point along the levee. For this reason a levee height of 12 to 16.5 feet is required. The levee toe down is also designed using the assumption of direct impingement of Beardsley Wash flows. The estimated project cost is $43,179,000.

The partial levee, by restricting the width of the floodplain, would increase flow depths and velocities on the east (unprotected) side of the levee. This eastern portion of the Reata Pass/Beardsley Wash floodplain is currently mapped as a flood hazard area by FEMA. The area would have to be re-mapped after construction of the levee. An alluvial fan floodplain analysis shows that flow depths and velocities on approximately 54 acres of land east of the levee would be

increased by the levee (see Figure 4.15). This increased flood hazard on adjacent land would have to be compensated, probably by easement or purchase of the entire 54 acres.

Local Regulatory and Logistical Feasibility

Alternative 15 is feasible from a local regulatory and logistical standpoint provided that the area of increased flood hazard is mitigated through compensation of the land owners.

Project Purpose

Alternative 15 would partially fulfill the project purpose:

1. **Flood Hazard Removal.** Existing development on the Reata Pass/Beardsley Wash alluvial fan would be protected from Reata Pass/Beardsley Wash flooding. The area protected is the same as shown on Figure 4.14. The Pima Floodplain area would not be protected. This would be a regional flood-protection system for the protected area, but the regional system would not fully achieve the goal of flood protection for the entire study area. Redundant, localized flood control measures would be required in the unprotected area shown in Figure 4.14.

   The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would be removed for the protected area shown in Figure 4.14. The flood insurance and building pad requirements for that area would be eliminated. The FEMA map for the area east of the levee would be modified to show the increased flood hazard in this area. Figure 4.15 shows the results of a preliminary floodplain delineation for this area.

2. **Flood Protection for Public Improvements.** Public infrastructure within the protected area (same as shown on Figure 4.13) would be protected from apex-generated flooding on the Reata Pass/Beardsley Wash alluvial fan. Infrastructure within the Pima Floodplain would not be protected.

3. **Enhance Recreation.** The levee between Sierra Pinta Drive and Bell Road would not be suited for a public recreation corridor.

Potential Environmental Impacts

Although the intent of the Partial Levee Alternative is to minimize impacts to the natural environment, the alignment of the partial levee is in an area that has negligible waters of the U.S.

N

SCALE: 1" = 600'

ZONE X

ZONE AO
(DEPTH-2)
(VEL-7)

ZONE AO
(DEPTH-3)
(VEL-8)

BEARDSLEY ALIGNMENT

NORTH BEARDSLEY
FLOODPLAIN BOUNDARY

ZONE AO
(DEPTH-2)
(VEL-7)

96TH STREET ALIGNMENT

ZONE AO
(DEPTH-1)
(VEL-4)

ZONE AO
(DEPTH-2)
(VEL-6)

ZONE AO
(DEPTH-1)
(VEL-5)

ZONE AO
(DEPTH-2)
(VEL-6)

NORTH BEARDSLEY
FLOODPLAIN BOUNDARY

LEVEE
ALIGNMENT

ZONE AO
(DEPTH-2)
(VEL-6)

ZONE AO
(DEPTH-1)
(VEL-5)

UNION HILLS ALIGNMENT

ZONE AO
(DEPTH-1)
(VEL-4)

FLOOD HAZARD DECREASED
AREA = 81.2 ACRES

FLOOD HAZARD INCREASED
AREA = 54.1 ACRES

Figure 4.15 **Area of Increased Flood Hazard Potential for Partial Levee.**

The Desert Greenbelt
SCOTTSDALE, ARIZONA

CITY OF SCOTTSDALE ARIZONA

TRANSPORTATION
DEPARTMENT

TRANSPORTATION
PLANNING

3939 CIVIC CENTER BLVD.
SCOTTSDALE, ARIZONA 85251

SCOTTSDALE DESERT GREENBELT
REATA PASS WASH

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Alternative 15 would have 64.0 acres total impact to the waters of the U.S. on the Reata Pass/Beardsley Wash alluvial fan. These include 15.5 acres direct impact, 27 acres indirect impact resulting from cut-off of flows at the Reata Pass apex, 7.1 acres indirect impact resulting from cut-off of flows from the North Beardsley Wash secondary apex in the vicinity of Union Hills Drive, and 14.4 acres miscellaneous indirect impacts resulting from cut-off of channel bends and braids along the flood-control channel. Direct impacts are those that would be impacted by the actual construction of the project along the alignment shown in Figure 4.14. There are no impacts in the Pima Floodplain.

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the alluvial fan or until the impacted watercourse is intersected by un-impacted waters of the U.S. of similar size. On Reata Pass and Beardsley Wash there are no intersecting waters of similar size and so indirect impacts are calculated to extend as far as five miles to the base of the alluvial fan.

The removal of apex-generated flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan downstream of the fan apex. The amount of this runoff increases with distance down the alluvial fan. This runoff is sufficient to generate many separate unconnected (to the apex) waters of the U.S., beginning at a point approximately 2,400 feet downstream of the Reata Pass apex. There is tributary inflow to the upper Reata Pass alluvial fan from watersheds totaling nearly 500 acres in size (See Baseline Conditions Report Section 4.10.4). This area is approximately one-tenth the size of the Reata Pass watershed at the fan apex. Further, there is qualitative evidence from the City of Scottsdale that the 800 cfs flow observed to enter the Reata Pass alluvial fan in a southwest direction in the 1996 flood did not reach Pima Road. Using an infiltration rate calibrated on this observation it was determined that the discharge associated with the waters of the U.S. (330 cfs) would travel approximately 4,800 6,500 feet down the alluvial fan before infiltrating completely into the ground (See Appendix A). Hydrologic analysis shows that under current development conditions, the ordinary high water discharge can be produced from runoff generated on the alluvial fan surface at a point somewhere

between 2,900 and 3,600 feet downstream of the apex. This is consistent with the finding that the nearest unconnected waters of the U.S., with riparian habitat, begins approximately 2,400 feet downstream of the apex.

The above hydrological information demonstrates that watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Total riparian vegetation impacts would be approximately 187 acres, of which approximately 39 acres would be direct impact. The rest, approximately 148 acres, would be indirect impacts from alteration of the hydrologic regime. Approximately 48 acres of this indirect impact is in areas where local runoff is considered sufficient to maintain the existing vegetative habitat. The remaining 100 acres of wash habitat may decline, or shift to a more upland type in areas of the alluvial fan with reduced flows. The greatest potential for indirect impacts to vegetation is in the upper fan area (east and west channels), between the apex and Deer Valley Road, and on the east channel of Reata Pass Wash, downstream of North Beardsley Wash. These areas support some of the most extensive and diverse wash habitat in the project area. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced.

Overstory species adversely affected by the 100-acre effective indirect impact would likely include blue palo verde, velvet mesquite and catclaw acacia. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced. These individuals may be slowly replaced with overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood).

The plants that may potentially decline and be replaced by others are not numerous on the Reata Pass/Beardsley Wash alluvial fan. A vegetative survey recorded them only on the upper portion of the alluvial fan. Blue palo verde density on the upper alluvial fan was found to average less than one individual per acre. Velvet mesquite density averaged just 0.2 individuals per acre.

Any change in the desert wash wildlife habitat will likely be subtle, and will occur over a very long time period. Ironwood densities may actually increase, and wildlife species that utilize the blue paloverde would likely be able to switch to the structurally similar ironwood or to the foothill paloverde. Given the nature of the possible indirect impacts to wildlife in the affected washes, and the likely ability of wildlife species to adapt to relatively subtle changes in vegetation composition should such a shift occur, the indirect impacts to wildlife species are considered an adverse impact that is not significant.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

The remaining 52 acres of indirect impact to vegetation are either in areas far removed from apex or other significant tributary flows, or are already affected by diversions associated with existing

development. These areas are less likely to support obligate wash species (e.g., blue palo verde, mesquite, catclaw acacia) and are largely sustained by local watersheds. It is likely that local watersheds would continue to sustain these areas with the project in place. Consequently these areas are not expected to be adversely affected by the project.

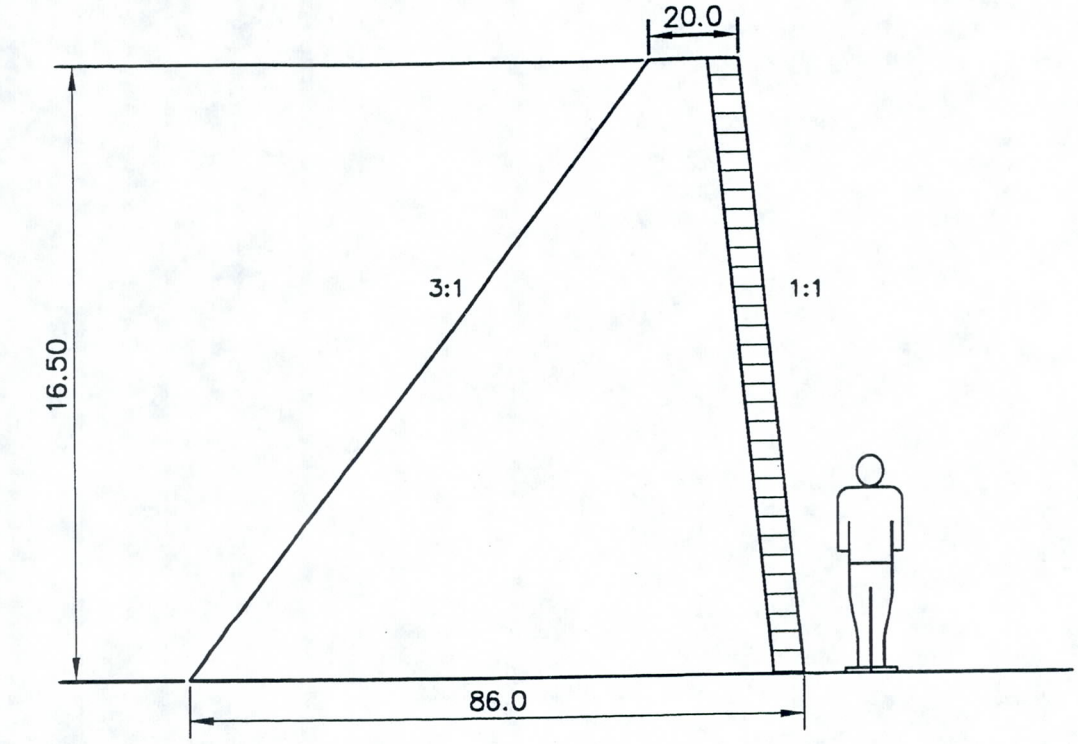
Alternative 15 would result in approximately 28 acres less impact to upland Sonoran Desert scrub than Alternative 11.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

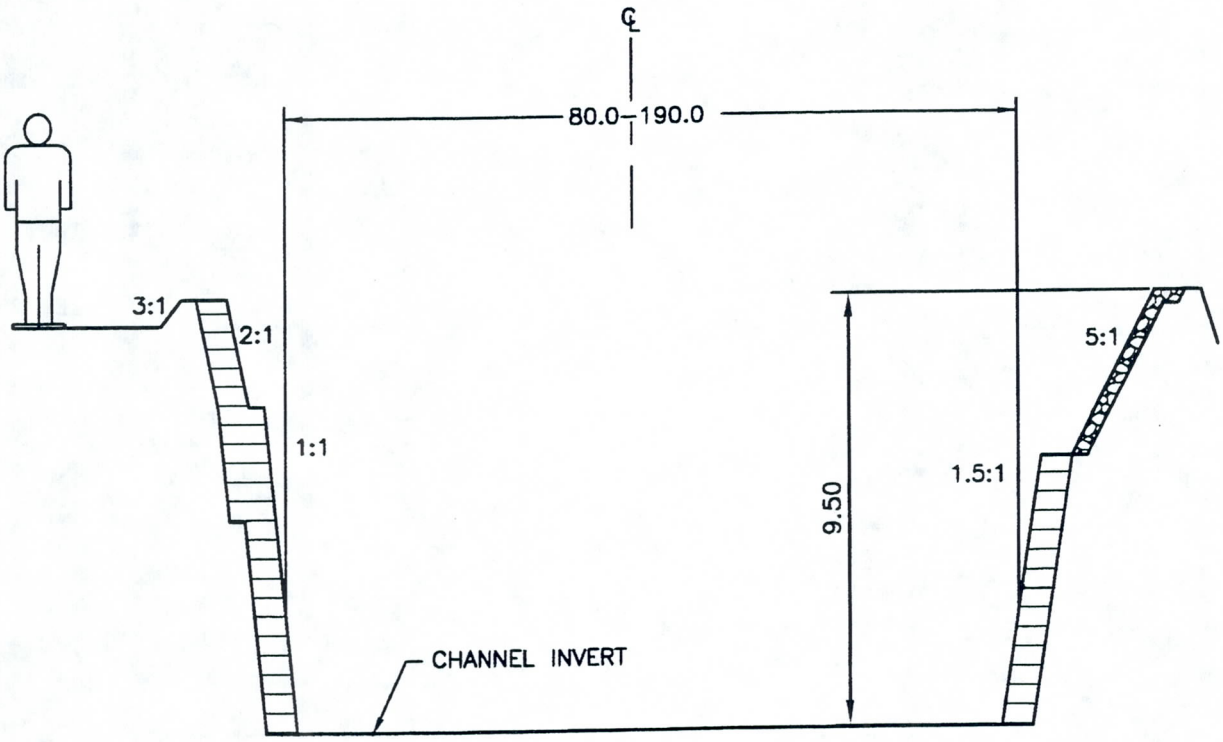
Alternative 15 would avoid an estimated 123 acres of impact to the alluvial fan habitat that would occur as a result of the need for future land development not associated with the proposed project to elevate buildings above the Reata Pass/Beardsley Wash100-year flood elevation if the No Action alternative is adopted.

Traffic impacts would be construction-related only. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. A cultural resources survey along the general alignment of this alternative, conducted for the proposed project, found no sites of importance.

Alternative 15 would have a relatively high visual impact in comparison to the proposed project (Alternative 11) because of the need to construct high above-ground levees rather than a mostly-excavated channel. These levees, up to 16.5 feet high, would be very prominent and obstruct views of the McDowell Mountains. Figure 4.16 illustrates the partial levee cross section in comparison



TYPICAL PARTIAL LEVEE CROSS SECTION



TYPICAL DESERT GREENBELT CROSS SECTION
SOUTH OF SIERA PINTA DRIVE

Figure 4.16 Partial levee typical cross section in comparison to proposed channel

to the proposed channel cross section. Mitigation of the obstruction of views would be impossible. However, the levee could be landscaped and contoured to appear as natural as possible.

Conclusion

Alternative 15, Reata Pass Wash Partial Levee Project, Fan Apex to Westworld Detention Basin, is not practicable because of induced flood hazard on adjacent property resulting in higher cost than the proposed project, significant adverse visual impact to the area, and unsuitability for use as a recreational corridor.

4.4.16 Alternative 16: Protect Existing Development Using Levees (Ring Dikes)

Description and Characteristics

This alternative includes floodproofing existing individual residential structures and clustered homes using floodwalls or levees. The natural washes that have been identified as part of the U.S. waters and under the jurisdiction of the USACE would be left intact to the maximum extent possible. Flood flows would continue to spread across the alluvial fan as they do under current conditions, but existing development would be protected from these flows by the floodwalls or levees. The objective of this alternative would be to minimize environmental impacts by strictly focusing protective measures on existing developed areas only.

Engineering Feasibility and Construction Cost

Close examination of the current development pattern on the alluvial fan, in the context of the hydrologic, physical, engineering and regulatory constraints reveals that this alternative is not feasible. As stated in Section 3.2:

- Individual flood-control facilities constructed piecemeal, such as levees or diversion channels, must be designed for the worst-case, 100-year discharge no matter where located on the alluvial fan and whether connected to the apex or not. This discharge is 10,000 cfs at the fan apex, and it increases as it travels down the alluvial fan. Not only must all of these structures be designed for 10,000 cfs or more, they must be designed under the assumption of Dawdy hydraulic conditions. Using Dawdy hydraulics, 10,000 cfs approaching a levee is at a depth of 2.8 feet, a width of 378

feet, and a velocity of 9.5 feet per second. More-severe hydraulic conditions must be used if the levees artificially concentrate the flow.

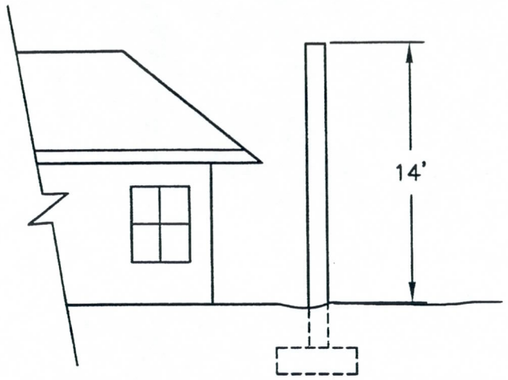
- The dikes must be designed to account for sediment. Since sediment is deposited at points of velocity reduction, these facilities must be designed for worst-case conditions of sediment deposition and scour, which could involve greater bank heights and depths of scour than would be necessary in a regional flood-control system connected to the apex.

- The study area is already 70% developed with buildings, roads, golf courses and other graded areas. Past development has been designed using the minimum FEMA requirements of pad elevation and under the assumption of a regional flood-control system being constructed in the near future. Aside from the East Wash, there is no continuous path from the apex to the base of the Reata Pass/Beardsley Wash alluvial fan that has the capacity for the entire alluvial fan flow. The existing development pattern is not suited for a ringdike concept.

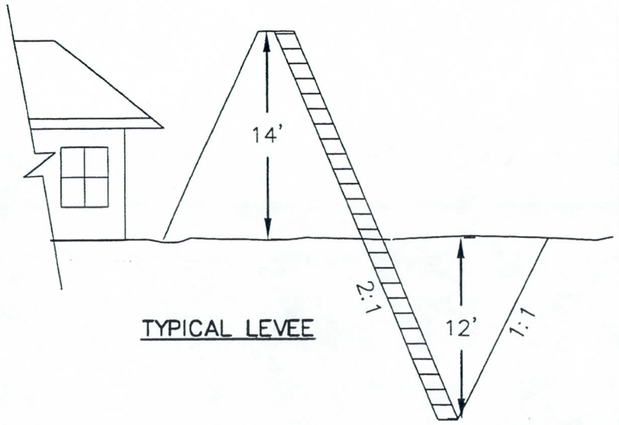
There is historical evidence of the ineffectiveness of these kinds of local improvements on alluvial fans. The National Research Council (1996), describing flooding on alluvial fans in California, stated:

> *"Flood control works such as levees and debris dams at several of the sites were partially or totally ineffective during major floods. For example, at Day and Deer Creeks, Henderson Canyon, and Magnesia Spring Canyon alluvial fans in California, the flood control structures were overwhelmed, and floodwater followed original flow paths and fan topography at and below sites of structural failure. This suggests that (1)* ***major flood control works are necessary to mitigate flood hazards on active alluvial fans****, (2) predevelopment fan topography influences the location of major flooding even after fans are urbanized and minor flood control structures are in place, and (3) flood control works must be designed to address specific types of hazards and special design considerations should be given for areas where water can still reach after flood control structure area installed."* (Emphasis added)

Figure 4.17 provides an example of providing the ringdike alternative to the Ironwood Village subdivision and the Pinnacle Peak Heights subdivision. Ironwood Village is a 712-unit, clustered residential development located approximately three miles downstream from the Reata Pass fan apex. Due to the clustering of the development, this subdivision is probably the best-suited to illustrate ringdike design considerations.

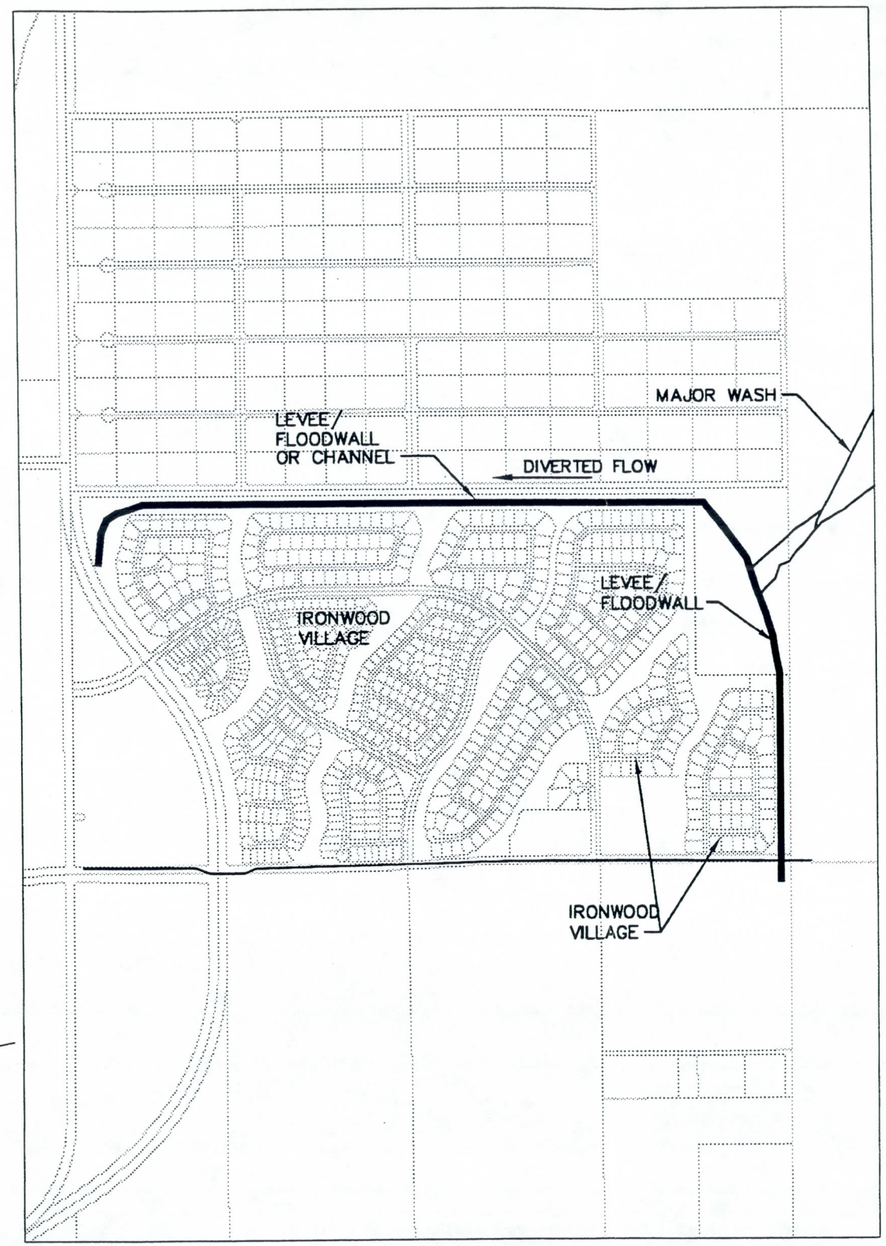


TYPICAL FLOODWALL

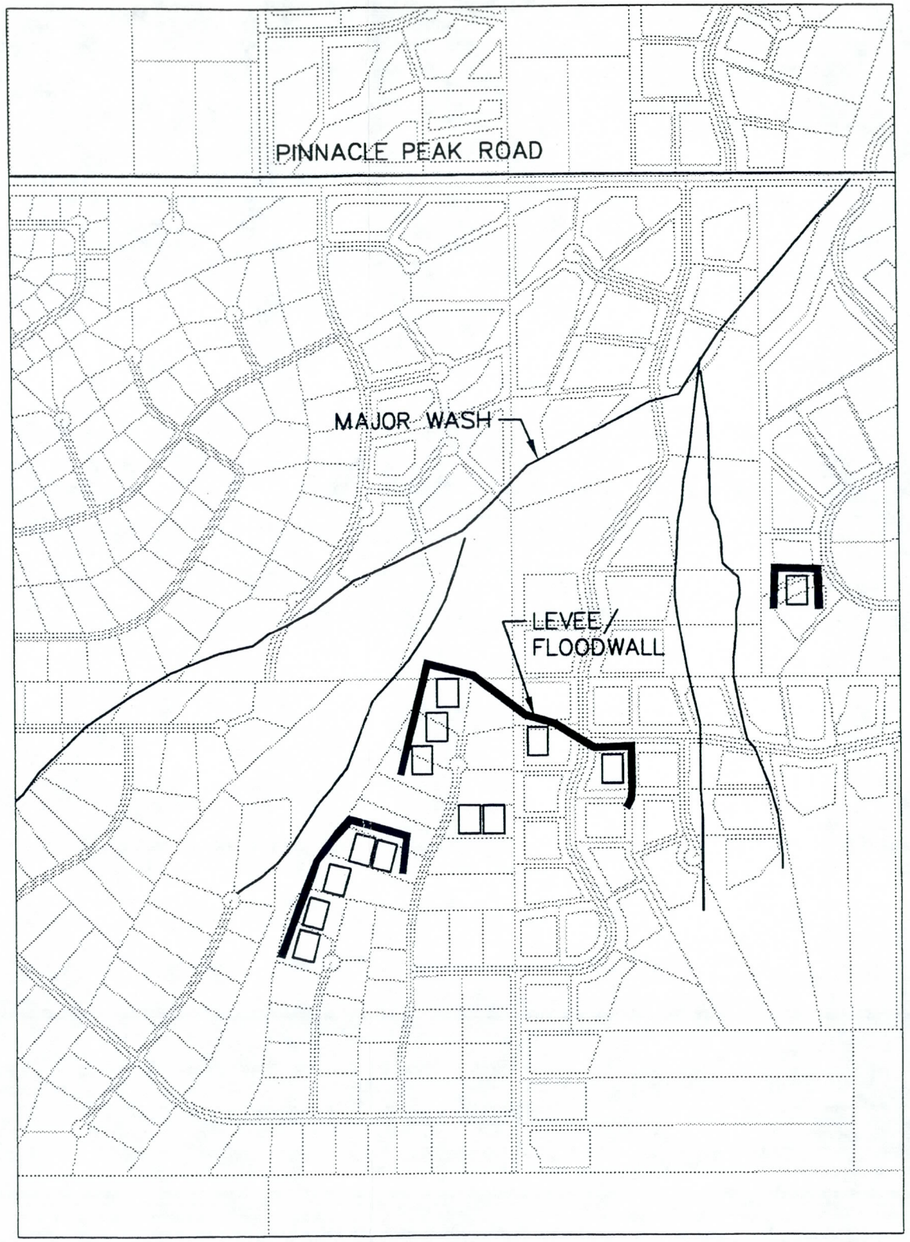


TYPICAL LEVEE

TYPICAL EXAMPLE USING
IRONWOOD VILLAGE SUBDIVISION



SAMPLE PROTECTION FOR
CLUSTERED DEVELOPMENT



SAMPLE PROTECTION FOR
NON-CLUSTERED DEVELOPMENT

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TRANSPORTATION DEPARTMENT

ALTERNATIVE 16:
PROTECT EXISTING DEVELOPMENT USING
LEVEES (RING DIKES) TYPICAL EXAMPLE

FIGURE 4.17 AA-88

The Desert Greenbelt
SCOTTSDALE, ARIZONA

P:\AZCOSO3\EXHIBITS\ALTFIG\SHT5-12.DWG, 06/07/99

Ironwood Village currently has five drainage paths to convey upstream flows through the subdivision. These paths range from approximately 50 to 120 feet in width (total available right-of-way from residential lot line to residential lot line). The paths are currently heavily vegetated, with high resistance to flow. Effective channel depths are approximately three to five feet. Assuming a flow depth of five feet, channel bottom width of 90 feet and channel side slopes of three horizontal to one vertical, the maximum possible flow capacity through this subdivision is approximately 6,500 cfs. This example is for the largest of the five channels, using favorable hydraulic conditions, with no freeboard and no space for maintenance access. Actual design capacity, and capacity of the other four channels, would be much less. These channels under their current condition cannot convey the 10,000 cfs or more required for flood protection.

Since the existing channels through Ironwood Village do not have capacity for the apex flow, flows must be diverted around the subdivision as shown in Figure 4.17. This diversion could be accomplished by a dike, an open channel, or combination of the two. Two conceptual scenarios are presented.

The first scenario is an open channel on the upstream side of Ironwood Village along Hualapai Drive in the Pima Acres subdivision. The land along the north boundary of Ironwood Village slopes toward the west. The slope and right-of-way are sufficient to design a normal-depth channel capable of carrying 10,000 cfs. However, normal depth is not applicable in this situation. Flows would enter this channel perpendicularly from the side, resulting in a spatially-varied flow condition in the channel. Energy losses from flow cascading into the channel, as well as from normal roughness resistance, result in a much larger channel cross section than would be necessary under normal flow conditions. Sediment carried by incoming flow would be dropped in the channel as the incoming flow turns 90 degrees in direction. Up to 6 acre feet of sediment would be brought in. This amount of sediment is capable of completely filling a channel 140 feet wide and seven feet deep (the approximate maximum dimensions of a channel in this area) for a distance of 270 feet. Such an influx of sediment would reduce or eliminate the flood-control capacity of the channel and further add a level of uncertainty to the design.

Because of the unsteady, spatially-varied flow design, and the potential for massive sediment deposition in a collector channel, the second scenario is a levee as shown in Figure 4.17. This levee has similar design constraints to an open channel, but can be designed with sufficient height to ensure protection of the homes within the Ironwood Village subdivision. A conceptual design analysis, included for reference in Appendix B of this document, gives the levee height as 14 feet including freeboard. The flow depth plus sediment accumulation adjacent to the levee would be 9.1 feet, which would pond water for a distance of 365 feet upstream of the levee. This distance, plus the 87-foot width of the levee, would be sufficient to inundate homes in the Pima Acres subdivision.

The design considerations described above for Ironwood Village would be repeated for every subdivision within the study area if Alternative 16 (Ring Dikes) is to be used.

An evaluation of the Pinnacle Peak Heights and Pinnacle Peak Vistas area of the upper Reata Pass alluvial fan further illustrates the difficulty of protecting individual homes and subdivisions using individual levees. Pinnacle Peak Heights is a subdivision of scattered, relatively large homes located north of the Deer Valley Road alignment. These homes have been constructed at low density with minimal disturbance to the desert habitat. Individual levees around the homes would each have to be designed for the entire 100-year discharge and therefore conform to the basic design cross section shown in Figure 4.17. Figure 4.18 shows a conceptual design for an individual residence. The levee is approximately 70 feet wide and 730 feet long along the centerline. Construction and land purchase cost is approximately $951,000 per residence. This would be a total of approximately $177,000,000 for the 186 approved residences.

Most of the residences in this upper part of the alluvial fan are too close together for individual levees to be practical. The "ringdike" concept must therefore be modified to protect groups of residences with one levee. Figure 4.19 shows a concept configuration of two levees to protect two existing residence groups on the upper alluvial fan. Total levee length is approximately 10,400 feet. Levee cross section is the same in concept as shown on Figure 4.17. Levee height ranges from

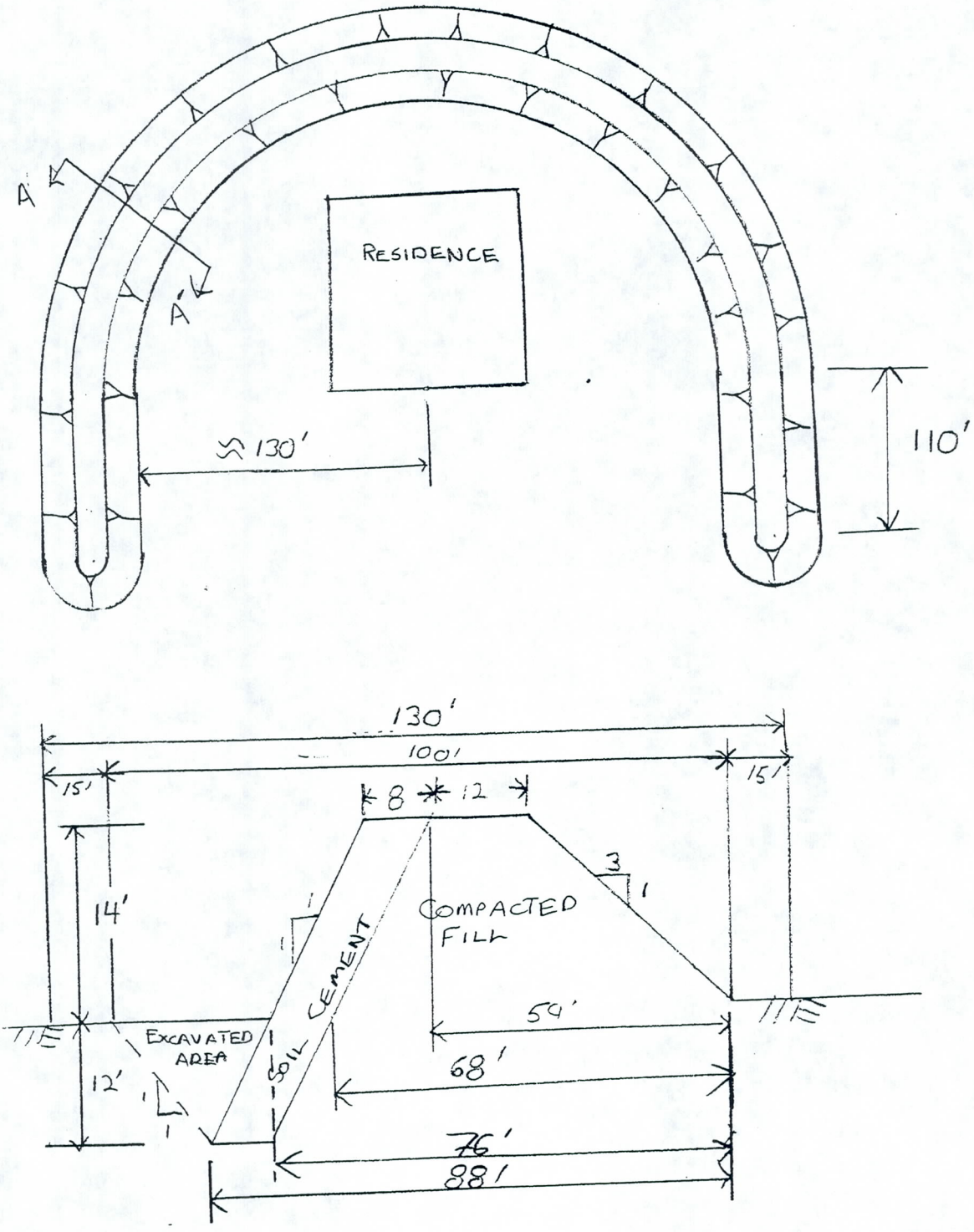


Figure 4.18 Conceptual Design for Ring Dike on an Individual Residence.

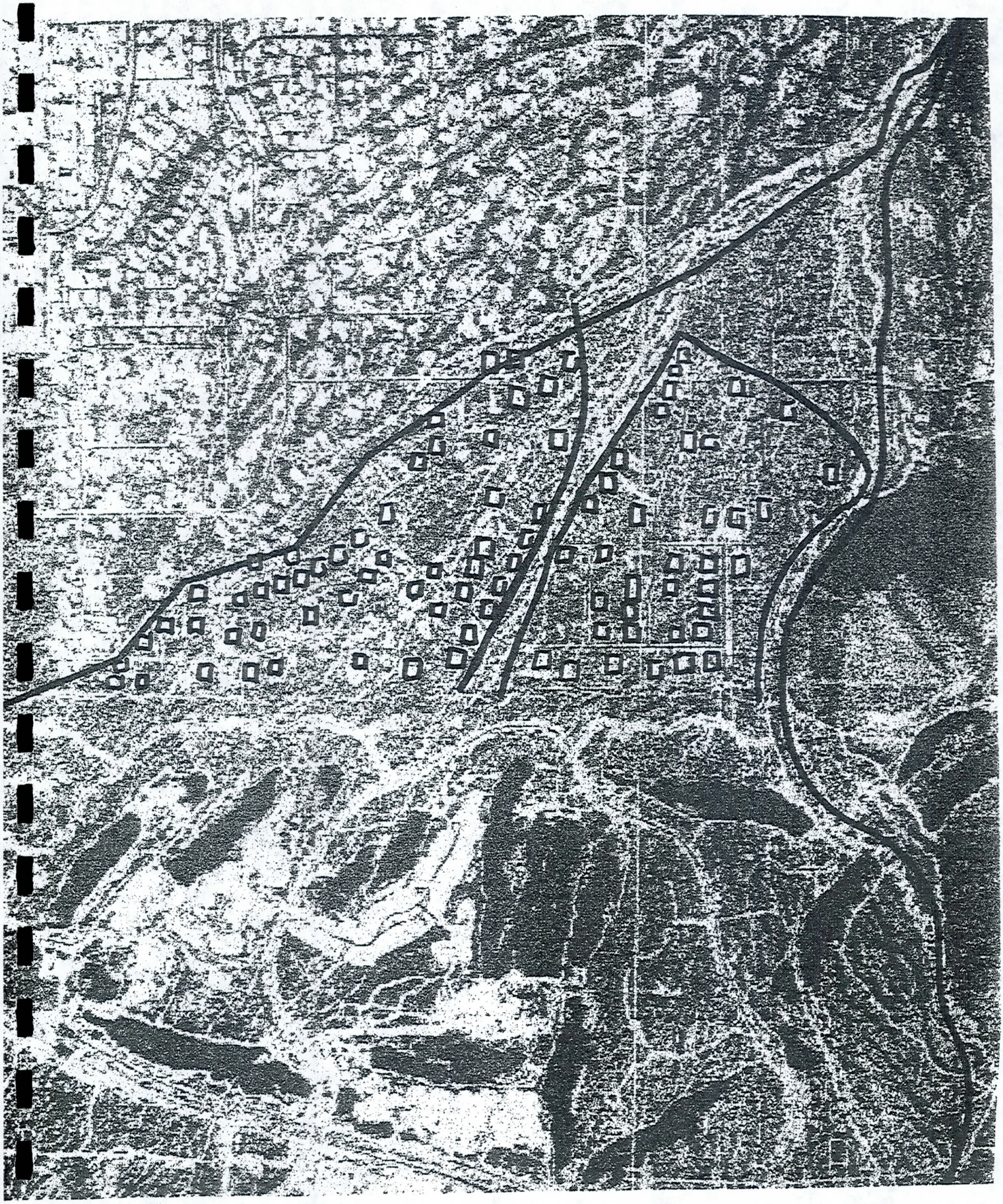


Figure 4.19 Concept Configuration of Levees to Protect Individual Groups of Residences on Upper Alluvial Fan.

approximately 14 feet at the upper transverse portions of the levee where direct flow impingement is expected, to approximately ten feet where flow runs parallel to the levee.

The levee configuration shown in Figure 4.19 in effect creates two flood-control channels. One is approximately along the alignment of the proposed Desert Greenbelt channel, the other discharges into the downstream development. The westernmost channel has to be relatively narrow in order to protect existing residences. This narrow channel would require lining and/or grade-control structures to prevent damage from sediment transport imbalance as the flow velocities increase in this area.

The two channels created by the levee system would discharge flow at higher than natural depths and velocities onto the existing development below, creating two new alluvial fan apexes. Continuation of the same levee concept downstream would inevitably result in two separate channels extending from the apex to the alluvial fan base. The westernmost channel would pass through existing development without sufficient available right-of-way. The overall project cost would be more than twice the cost of the proposed Reata Pass/Beardsley Wash channel.

Alternative 16 is not feasible from an engineering standpoint for the following reasons:

1. FEMA requires that all levees and all channels on an alluvial fan be designed for the entire apex flow.

2. Seventy percent of the study area is already developed or permitted for development.

3. Channels and right-of-way through existing developments do not have capacity for the entire apex flow, resulting in the need to construct channels or dikes forcing flow around entire subdivisions. Diversion channels may not function properly due to complications from sediment inflow and spatially-varied flow.

It is not possible to accurately estimate the cost of this alternative because a preliminary design cannot be made given the engineering, local regulatory and logistical infeasibility of the concept. A very rough, order-of-magnitude estimate can be made from the conceptual Ironwood Village design. The cost of the conceptual design to protect the Ironwood Village subdivision is

approximately $21,100,000. This cost includes purchase of approximately 70 acres of land for construction and the area of induced inundation. Ironwood Village occupies approximately 6% of the total Reata Pass/Beardsley Wash floodplain. The total cost would be many times $21,100,000 to protect the entire floodplain.

Local Regulatory and Logistical Feasibility

Alternative 16 is not feasible from a local regulatory and logistical standpoint. The City's Floodways and Floodplains ordinance requires that flood protection not create hazards to life or property by increasing the potential for flooding on adjacent property. A watercourse may not be altered unless a professional engineer certifies that the alterations do not increase the flood levels, and will not increase flooding hazards within, upstream or downstream of the altered portion of the watercourse. This ordinance further states that rainfall runoff from storms of all return frequencies should enter and depart from property after its development in substantially the same manner as under pre-development conditions. Proposals to modify drainage characteristics must be fully justified by engineering data which shall demonstrate to the floodplain administrator that hazards to life and property will not be increased by the proposed modifications.

Using Ironwood Village as an example, diverting flow around this subdivision as shown in Figure 4.17 would result in a concentration of flow and increased risk of flooding at the discharge point on Pima Road at the west side of the subdivision. This increased flood risk would be directed onto Pima Road and the City of Scottsdale's Water Campus and would be prohibited by the City of Scottsdale's Floodways and Floodplains ordinance unless the flow were then carried in a competent channel to the Bureau of Reclamation detention basins. Conveying flow to the detention basins from subdivisions at the fan apex would in effect be a variation of Alternative 11.

These regulatory considerations would be repeated for every subdivision within the study area if Alternative 16 (Ring Dikes) is to be used. Consequently, Alternative 16 is not feasible from a regulatory and logistical standpoint. Furthermore, aside from the engineering and regulatory infeasibility, environmental impacts would be significant. Alternative 16 would result in a network

of 12-15-foot-high levees throughout the study area, resulting in significant visual impacts, disruption of traffic, and destruction of natural habitat.

Project Purpose

Alternative 16 is not feasible and does not fulfill any project purpose.

Potential Environmental Impacts

Alternative 16, if made to be feasible, would result in a network of 14-foot-high levees throughout the study area, meaning that direct and indirect impacts to the waters of the U.S. would be extended over most of the alluvial fan and could approach 119 acres. Direct and indirect impacts to vegetative habitat and wildlife would be similarly extensive and much greater than for Alternative 11. Diversion of small amounts of flow through these levees in order to sustain habitat in existing washes not impacted by the levee construction would not be practical due to sediment and hydraulic considerations.

There would be significant adverse impacts to the environment. Construction-related traffic impacts would be substantial and long-term. Post-construction traffic patterns would be affected by the need to construct numerous ramps or detours to get traffic over or around the levees. The visual character of the area would be severely altered.

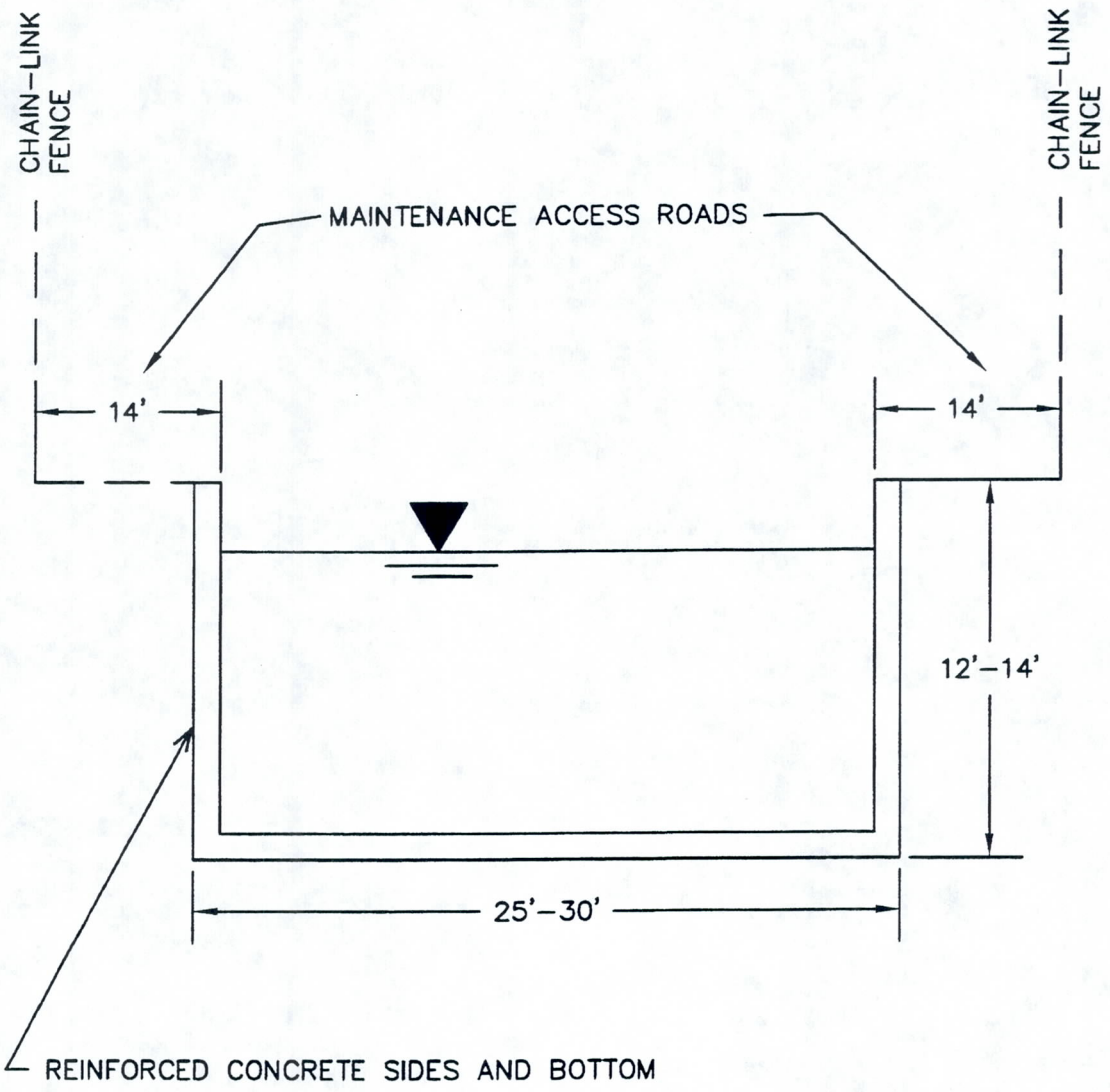
Conclusion

Alternative 16, Protect Existing Development Using Levees (Ring Dikes), is not practicable for the reasons described above. This alternative cannot meet any project purpose. The potential impact to the waters of the U.S. would be substantially higher than for the proposed project.

4.4.17 Alternative 17: Reata Pass Wash Narrow Channel Project, Fan Apex to Westworld Detention Basin

Description and Characteristics

This alternative follows the same alignment as Alternative 11, but uses a fully-lined, vertical-sided concrete channel such as the example shown in Figure 4.20 to minimize impacts to the waters of the



ALTERNATIVE 17:
REATA PASS WASH NARROW CHANNEL PROJECT
FAN APEX TO WESTWORLD

FIGURE 4.20

U.S. The channel would range from 25 to 30 feet wide. Maintenance right-of-way would add another 28 feet in width. Channel depth, including three feet of freeboard, would be 12 to 14 feet. Because of the vertical sides and very high flow velocities, a security fence of chain link or other similar material would be required the entire length along both sides.

Engineering Feasibility and Construction Cost

Alternative 17 collects all Reata Pass flows at the apex before they spread onto the alluvial fan. Flows are confined and controlled for the entire channel and levee length. The design is feasible from an engineering standpoint, but not advisable in this situation for the following reasons:

- Flow velocities would range from 45 feet per second to 51 feet per second for a 100-year flow. Velocities of this magnitude are inherently unsafe. Fifty-one feet per second is equivalent to 35 miles per hour. Anyone caught in this flow would be swept away with such rapidity that rescue would be nearly impossible. Total travel time from the apex to Westworld would be less than ten minutes.

- Velocities higher than about 35 feet per second are prone to cavitation, which could destroy the concrete lining of the channel.

- Sediment transported at high velocities would scour the concrete channel through abrasion. Abrasion from high-velocity sediment has exposed rebar in similar concrete channels in Los Angeles and San Bernardino Counties, California.

- Velocities 45 to 51 feet per second are unstable and can lead to air entrainment and roll waves. Instability could be exacerbated by sediment and debris brought in from the upper watershed or introduced into the channel by people. Instability could lead to a hydraulic jump which would cause the flow to jump nearly 20 feet above the top of the channel.

Project construction cost would be approximately $53,110,000.

Local Regulatory and Logistical Feasibility

Alternative 17 is feasible from a local regulatory and logistical standpoint.

Project Purpose

Alternative 17 would partially fulfill the project purpose:

1. **Flood Protection for Existing Development.** Existing development on the Reata Pass/Beardsley Wash alluvial fan would be protected from Reata Pass/Beardsley Wash flooding. Figure 4.21 shows the area protected. This would be a regional flood-protection system for the protected area, but the regional system would not fully achieve the goal of flood protection for the entire study area. The Pima Floodplain would not be protected. Redundant, localized flood control measures would be required in the unprotected area shown in Figure 4.21.

   The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would be removed for the protected area shown in Figure 4.21. The flood insurance and building pad requirements for that area would be eliminated.

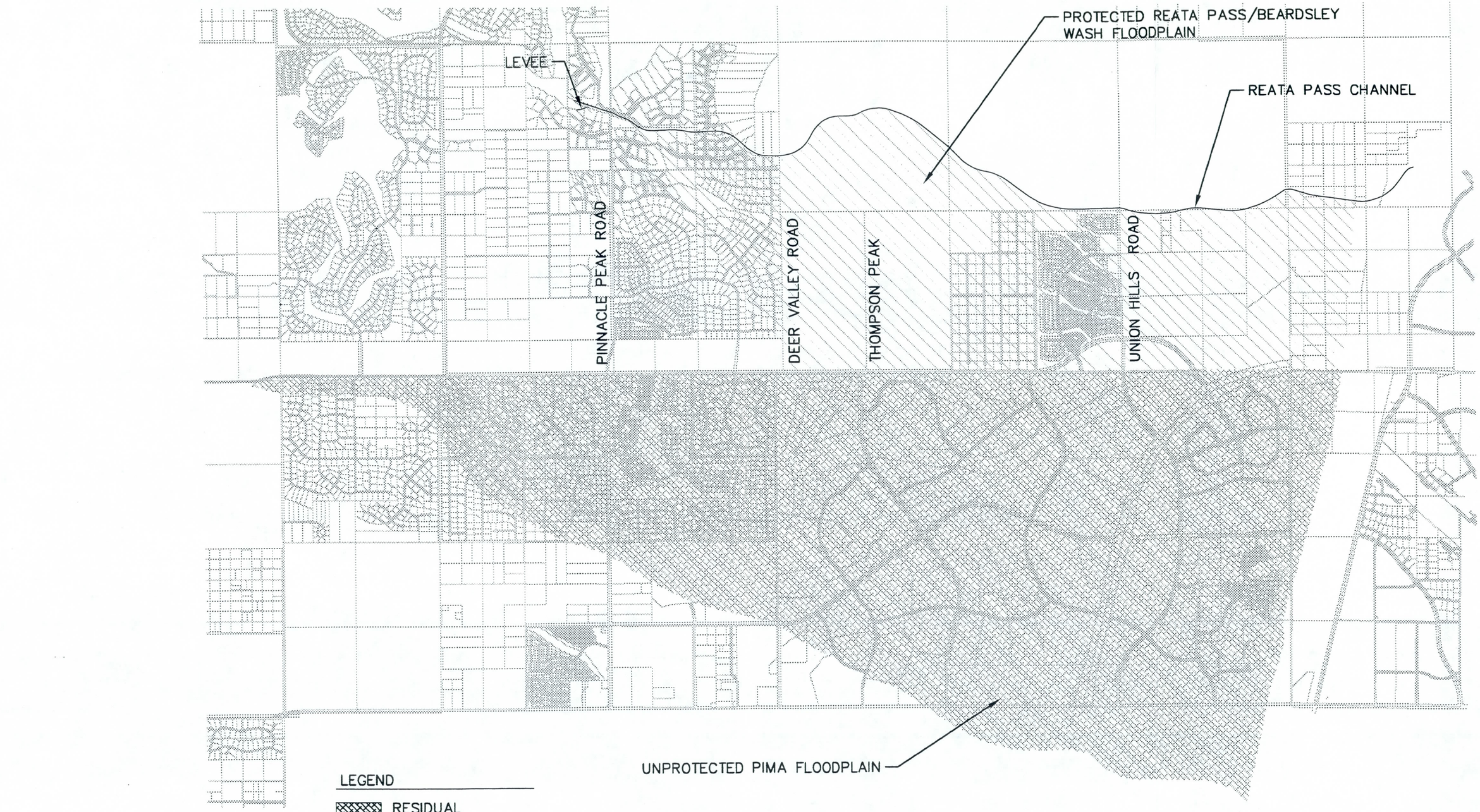
2. **Flood Protection for Public Improvements.** Public infrastructure within the protected area shown on Figure 4.21 would be protected from apex-generated flooding on the Reata Pass/Beardsley Wash alluvial fan. Infrastructure in the Pima Floodplain would not be protected.

3. **Enhance Recreation.** This project would be a single-purpose project and not be suitable for a public recreational corridor.

Potential Environmental Impacts

Alternative 17 would have 64 acres total impact to the waters of the U.S. on the Reata Pass/Beardsley Wash alluvial fan. These include 8.2 acres direct impact, 27 acres indirect impact resulting from cut-off of flows at the Reata Pass apex, 7.1 acres indirect impact resulting from cut-off of flows from the North Beardsley Wash secondary apex in the vicinity of Union Hills Drive, and 21.7 acres miscellaneous indirect impacts resulting from cut-off of channel bends and braids along the flood-control channel. Direct impacts are those that would be impacted by the actual construction of the project (channel alignment same as Alternative 11: Figure 4.11). There are no impacts in the Pima Floodplain.

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the alluvial fan or until the impacted watercourse is intersected by un-impacted waters of the U.S. of similar size. On Reata Pass and Beardsley Wash there are no intersecting waters of similar size and so indirect impacts are calculated to extend as far as five miles to the base of the alluvial fan.



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TRANSPORTATION DEPARTMENT

ALTERNATIVE 17
PROTECTED AREA

FIGURE 4.21 AA-99

The Desert Greenbelt
SCOTTSDALE, ARIZONA

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The removal of apex-generated flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan downstream of the fan apex. The amount of this runoff increases with distance down the alluvial fan. This runoff is sufficient to generate many separate unconnected (to the apex) waters of the U.S., beginning at a point approximately 2,400 feet downstream of the Reata Pass apex. There is tributary inflow to the upper Reata Pass alluvial fan from watersheds totaling nearly 500 acres in size (See Baseline Conditions Report Section 4.10.4). This area is approximately one-tenth the size of the Reata Pass watershed at the fan apex. Further, there is qualitative evidence from the City of Scottsdale that the 800 cfs flow observed to enter the Reata Pass alluvial fan in a southwest direction in the 1996 flood did not reach Pima Road. Using an infiltration rate calibrated on this observation it was determined that the discharge associated with the waters of the U.S. (330 cfs) would travel approximately 4,800 to 6,500 feet down the alluvial fan before infiltrating completely into the ground (See Appendix A). Hydrologic analysis shows that under current development conditions, the ordinary high water discharge can be produced from runoff generated on the alluvial fan surface at a point somewhere between 2,900 and 3,600 feet downstream of the apex. This is consistent with the finding that the nearest unconnected waters of the U.S., with riparian habitat, begins approximately 2,400 feet downstream of the apex.

The above hydrological information demonstrates that watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Total riparian vegetation impacts would be approximately 187 acres, of which approximately 25 acres would be direct impact. The rest, approximately 162 acres, would be indirect impacts from alteration of the hydrologic regime. Approximately 48 acres of this indirect impact is in areas where local runoff is considered sufficient to maintain the existing vegetative habitat. The remaining 114

acres of wash habitat may decline, or shift to a more upland type in areas of the alluvial fan with reduced flows. The greatest potential for indirect impacts to vegetation is in the upper fan area (east and west channels), between the apex and Deer Valley Road, and on the east channel of Reata Pass Wash, downstream of North Beardsley Wash. These areas supports some of the most extensive and diverse wash habitat in the project area. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced.

Overstory species adversely affected by the 114-acre effective indirect impact would likely include blue palo verde, velvet mesquite and catclaw acacia. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced. These individuals may be slowly replaced with overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood).

The plants that may potentially decline and be replaced by others are not numerous on the Reata Pass/Beardsley Wash alluvial fan. A vegetative survey recorded them only on the upper portion of the alluvial fan. Blue palo verde density on the upper alluvial fan was found to average less than one individual per acre. Velvet mesquite density averaged just 0.2 individuals per acre.

Any change in the desert wash wildlife habitat will likely be subtle, and will occur over a very long time period. Ironwood densities may actually increase, and wildlife species that utilize the blue paloverde would likely be able to switch to the structurally similar ironwood or to the foothill paloverde. Given the nature of the possible indirect impacts to wildlife in the affected washes, and the likely ability of wildlife species to adapt to relatively subtle changes in vegetation composition should such a shift occur, the indirect impacts to wildlife species are considered an adverse impact that is not significant.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile

wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Alternative 17 would avoid an estimated 123 acres of impact to the alluvial fan habitat that would occur as a result of the need for future land development not associated with the proposed project to elevate buildings above the Reata Pass/Beardsley Wash100-year flood elevation if the No Action alternative is adopted.

Traffic impacts would be construction-related only. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. A cultural resources survey along the alignment of this alternative, conducted for the proposed project, found no sites of importance.

Since the channel would be mostly excavated, the visual impact would be mostly confined to views of the security fences running alongside the channel. This would be a substantial alteration to the natural character of the area.

Conclusion

Alternative 17, Reata Pass Wash Narrow Channel Project, Fan Apex to Westworld Detention Basin, is not practicable because of substantially higher cost than the proposed project (Alternative 11), and it is less effective than Alternative 11 at meeting the project purpose. Specifically, there would be no recreational benefit. The avoided impact to waters of the U.S. (2.9 acres) is small in comparison to the $11,900,000 higher cost than Alternative 11. Alternative 17 is inconsistent with a natural open space transition into the McDowell Sonoran Preserve and it would have adverse visual and public safety impacts.

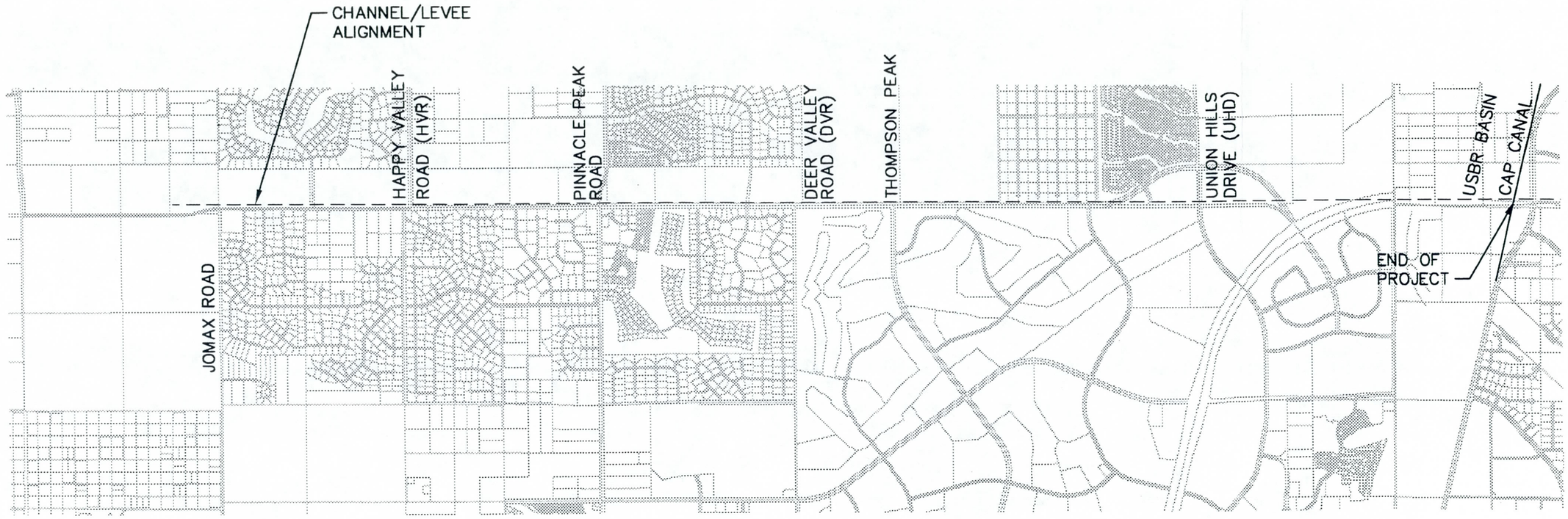
4.4.18 Alternative 18: Pima Road Levee/Channel Stand-Alone Project

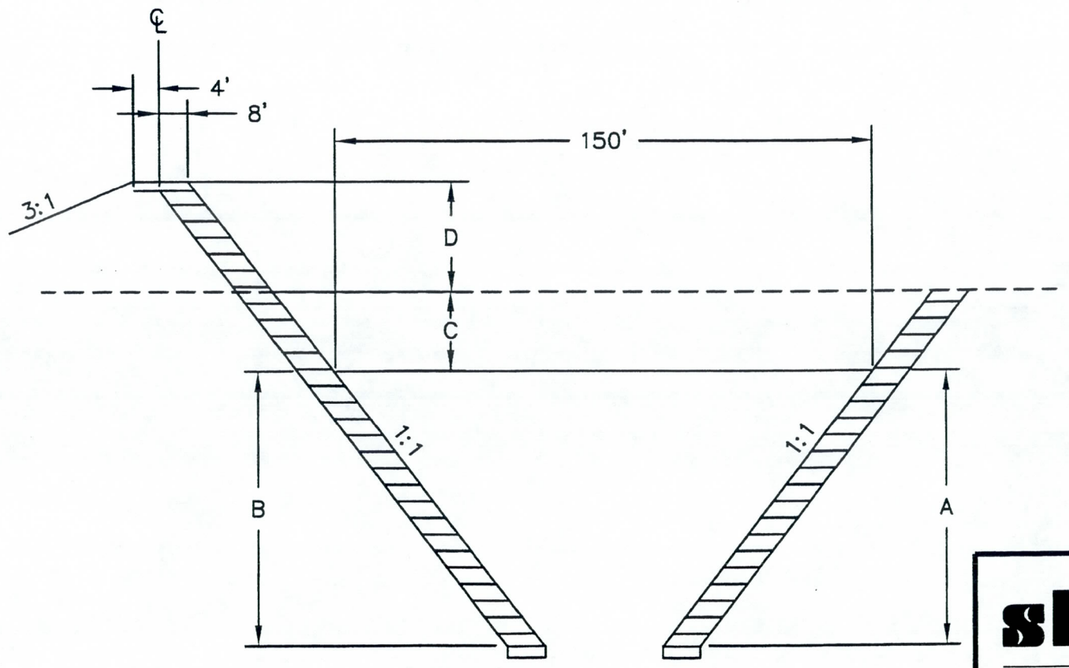
Description and Characteristics

This alternative (Figure 4.22) consists of a channel and levee system aligned along the east side of Pima Road. Grade control structures are included along the channel to stabilize the slope and bridges are required at each of the locations where the channel crosses an existing road. Construction associated with the bridges also necessitates significant raising of Pima Road and the cross streets.

The channel is sized to contain the 100-year flow. This channel dimension will also contain the maximum sediment deposit height that is expected to form as a result of a 100-year flood event. The levee is designed to contain the flow to the east of Pima Road under the condition where the channel has been filled in with sediment and no longer has any conveyance.

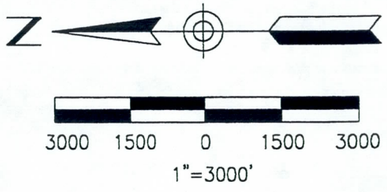
This alternative does not include any improvements along Reata Pass Wash. As a result, the channel improvements need to convey not only flow from the Pima Floodplain, but also any flow from the Reata Pass and North Beardsley apex that can impact that reach of the channel improvements. An investigation of the topographic information shows that from Deer Valley Road to Union Hills Drive along Pima Road flow from the Reata Pass apex can impact the channel. Downstream of Union Hills Drive flow from the Reata Pass and North Beardsley apex can impact the Pima Road Channel. Table 4.2 shows the discharges that were used to size the reaches of the Pima Road Channel.





TYPICAL LEVEE LOOKING UPSTREAM

REACH	EAST BANK TOEDOWN (FT) "A"	WEST LEVEE TOEDOWN (FT) "B"	CHANNEL DEPTH (FT) "C"	WEST LEVEE HEIGHT (FT) "D"	LENGTH
U/S OF HVR	25.0	14.5	3.0	11.5	6,600
U/S OF DVR	31.5	24.5	7.0	14.0	10,560
U/S OF UHD	31.5	28.0	8.5	16.0	10,560
U/S OF USBR	32.5	31.5	9.5	17.5	8,400
				TOTAL LENGTH	36,120



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TRANSPORTATION DEPARTMENT

ALTERNATIVE 18: PIMA ROAD LEVEE/CHANNEL STAND-ALONE PROJECT

FIGURE 4.22 AA-104

The Desert Greenbelt SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 16 ATLI PRJ.DWG

Table 4.2. Alternative 18 discharges along Pima Road

Location	Discharge Originating from Pima Floodplain Watershed Only (cfs)	Total Discharge Including Pima Floodplain Watershed and Reata Pass Apex Flow[1] (cfs)
At Happy Valley Road	4,015	4,015
At Deer Valley Road	7,500	17,500
At Union Hills Drive	9,450	22,930
At the Loop 101	14,400	27,880

[1] Used for design of Alternative 18.

Based on the above total discharges the following channel and levee system dimensions were determined (Table 4.3).

Table 4.3. Alternative 18 Design Dimensions

Location	Levee Height	Levee Toedown	Channel Depth	Channel Width	Length
	All Measurements in Feet				
Upstream of Happy Valley Road	11.5	14.5	3.0	150	6,600
Upstream of Deer Valley Alignment	14.0	24.5	7.0	150	10,560
Upstream of Union Hills Drive	16.0	28.0	8.5	150	10,560
Upstream of the USBR Basin	17.5	31.5	9.5	150	8,400

Engineering Feasibility and Construction Cost

Detailed analysis shows that Alternative 18 is feasible from an engineering standpoint, but not practical given the alluvial fan flooding, required design considerations and current land use in the

area. Design considerations are the same as for the diversion channel in Alternative 16 (Ring Dikes). The design is complicated by the fact that the Pima Road alternative channel would be crossed by a number of roads including Pinnacle Peak Road, Thompson Peak Parkway and Union Hills Drive. Installing a levee ranging from 11.5 to 17.5 feet high along the east side of Pima Road would result in the need to re-construct and ramp all of the roads crossing Pima Road to pass over the levee. Each of these ramps must be designed to allow the entire 100-year flow to pass through as it travels south along the east side of the levee. Extremely large culverts or bridges would be needed, or the flow would have to go around the ramps. The area in which the project would be located already has significant development. The levee and channel right-of-way would extend 232 to 263 feet to the east of the Pima Road right-of-way. Existing property and structures within this swath would have to be purchased. Some of the required right-of-way for the channel is within Ironwood Village, a built-out, high density residential area. The expected cost of this project is $135,273,000.

Local Regulatory and Logistical Feasibility

Alternative 18 is feasible from a local regulatory and logistical standpoint.

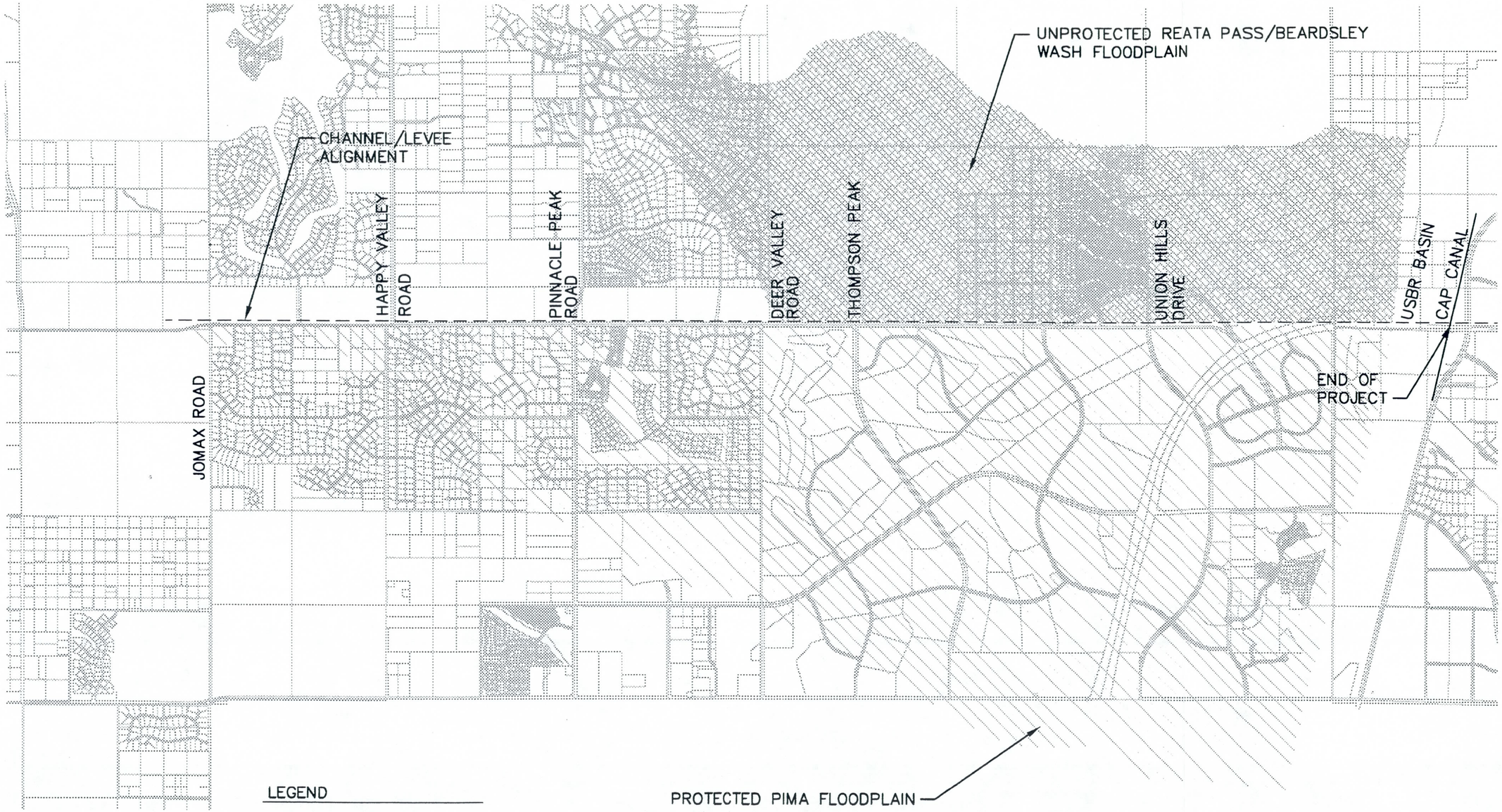
Project Purpose

Alternative 18 would partially fulfill the project purpose:

1. **Flood Protection for Existing Development.** Existing development west of Pima Road would be protected from the Pima Floodplain and Reata Pass/Beardsley Wash alluvial fan. Figure 4.23 shows the area protected. This would be a regional flood-protection system for the protected area, but the regional system would not fully achieve the goal of flood protection for the entire study area. There would be no protection east of Pima Road. Redundant, localized flood control measures would be required in the unprotected area shown in Figure 4.23.

   The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan flood area west of Pima Road would be eliminated, as would the flood insurance and building pad requirements for that area. The area east of Pima Road would remain in the floodplain.

2. **Flood Protection for Public Improvements.** Public infrastructure within the protected area shown on Figure 4.23 would be protected from the Pima Floodplain and apex-generated flooding on the Reata Pass/Beardsley Wash alluvial fan.



LEGEND

RESIDUAL FLOODPLAIN

PROTECTED AREA

N

3000 1500 0 1500 3000

1"=3000'

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TRANSPORTATION DEPARTMENT

ALTERNATIVE 18
PROTECTED AREA

FIGURE 4.23 AA-107

The Desert Greenbelt
SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 17 ATLI PRT.DWG

Infrastructure in the Reata Pass/Beardsley Wash alluvial fan east of Pima Road would not be protected.

3. **Enhance Recreation.** This project would not be suitable for a public recreational corridor. Furthermore, a fully-lined concrete channel would be inconsistent with natural open space character of the area and would not make a good transition into the McDowell Sonoran Preserve. The City of Scottsdale has a history of specifically avoiding this type of channel in favor of more environmentally-sensitive designs (as in the example of the Indian Bend Wash).

Potential Environmental Impacts

Alternative 18 would have 7.5 acres total impact to the waters of the U.S. on the Pima Floodplain. These include 2.1 acres direct impact and 5.4 acres indirect impact resulting from cut-off of flows along Pima Road. Direct impacts are those that would be impacted by the actual construction of the project along the alignment shown in Figure 4.22. There are no impacts in the Reata Pass/Beardsley Wash alluvial fan except where the fan overlaps the Pima Floodplain.

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the alluvial fan or until the impacted watercourse is intersected by un-impacted waters of similar size.

The removal of flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan as is demonstrated by the example of numerous washes unconnected to the apex with enough local runoff to maintain riparian vegetation. Watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Vegetative impacts would be approximately 11.7 acres. Of this, approximately 6.3 acres would be direct impact from channel construction. This impact could be mitigated by replacement in the

channel bottom. The remaining 5.4 acres would be in areas affected by the alteration of hydrology by removal of high flows. All of this indirect impact is in areas where local runoff is considered sufficient to maintain the existing vegetative habitat. Indirect wildlife impacts are therefore considered negligible.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Traffic impacts would be substantial. Each east-west road crossing of Pima Road would have to be re-constructed to go over the channel. This would create substantial construction-related traffic disruption as well as post-construction alteration of traffic patterns. The visual character of the area would be adversely affected by obstruction of views by the above-ground portions of the flood-

control system. Some views of the McDowell Mountains from Pima Road may be completely eliminated. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. Cultural resources have not been surveyed for this alternative, but based on other surveys in the area, cultural resources should not be significant.

Conclusion

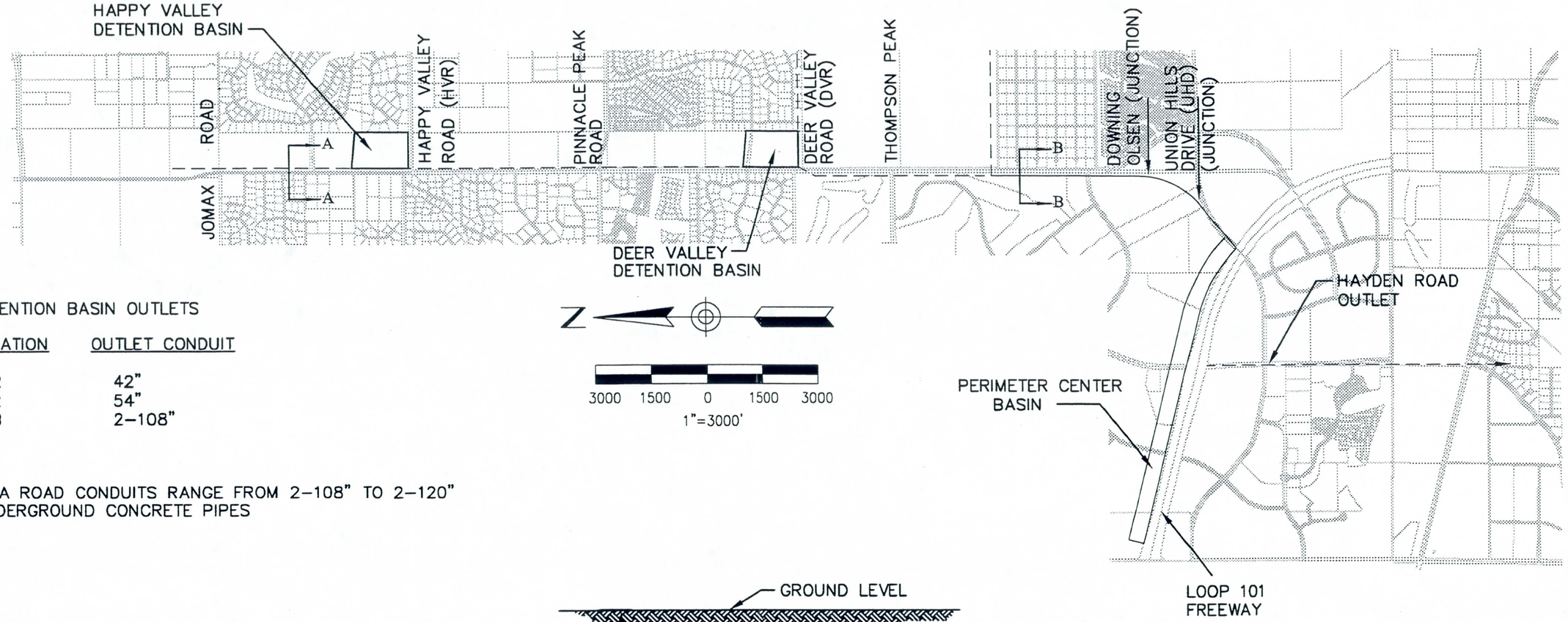
Alternative 18: Pima Road Levee/Channel Stand-Alone Project, is not practicable because of substantially higher cost than the proposed project (Alternatives I and J). As a stand-alone project it only partially meets the project purpose. Specifically, there would be no flood protection for the Reata Pass/Beardsley Wash alluvial fan east of Pima Road, and no recreational element. Alternative 18 would result in substantial disruption of land use along Pima Road. The avoided impact to waters of the U.S. (5.1 acres) is small in comparison to the $62,700,000 higher cost than Alternative 19.

4.4.19 Alternative 19(a) and 19(b): Pima Road Three Basin Stand-Alone Project

Description and Characteristics

Alternative 19 (Figure 4.24) is an underground storm drain under existing pavement of Pima Road from a point approximately 1/4 mile upstream of Jomax Road to the Bureau of Reclamation detention basins. The underground storm drain runs under existing pavement to Sierra Pinta Drive, and then along the west side of Pima Road to a point adjacent to the City's Water Campus where it turns toward the southwest and enters the third detention basin just upstream of the Princess/TPC/Perimeter Center developments. The storm drain then runs along the Hayden Road alignment to the Bureau of Reclamation detention basins.

There are three detention basins. The first two, located at Happy Valley Road and Deer Valley Road, are intended to reduce flood peaks to levels that can be easily conveyed in the underground storm drains proposed in the Pima Road corridor. The third detention basin, located west of Pima Road and upstream of the Princess/TPC/Perimeter Center developments, reduces peak flows and is intended to protect the existing Princess/TPC/Perimeter Center from local drainage generated on the



DETENTION BASIN OUTLETS

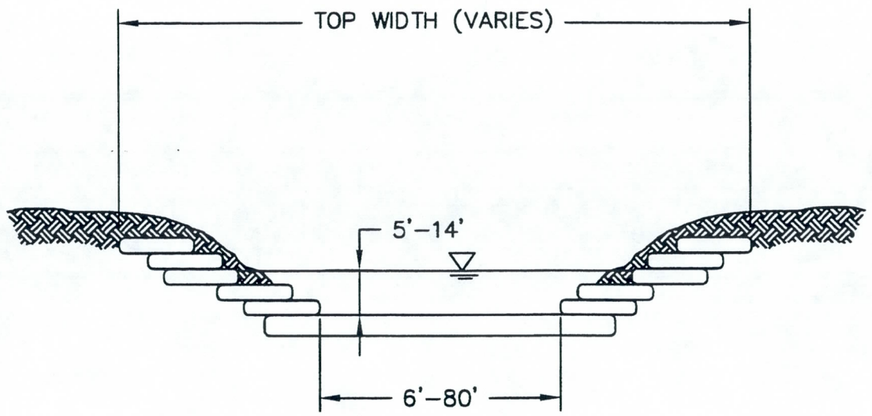
LOCATION	OUTLET CONDUIT
HVR	42"
DVR	54"
PCB	2–108"

PIMA ROAD CONDUITS RANGE FROM 2–108" TO 2–120"
UNDERGROUND CONCRETE PIPES

N

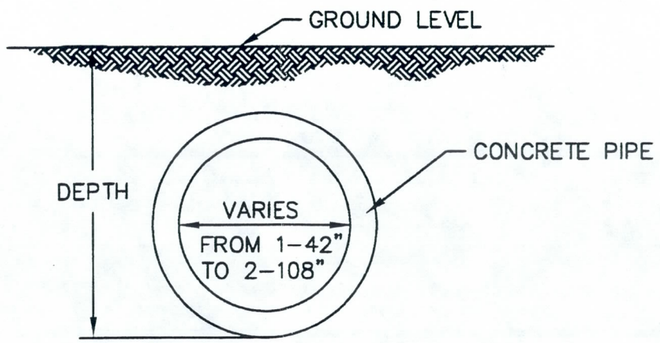
3000 1500 0 1500 3000

1"=3000'



TYPICAL CHANNEL A–A

FROM UPSTREAM OF JOMAX ROAD TO
DEER VALLEY DETENTION BASIN



TYPICAL CONDUITS B–B

FROM DEER VALLEY ROAD
TO DOWNSTREAM LIMIT

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TRANSPORTATION DEPARTMENT

ALTERNATIVE 19:
PIMA ROADS THREE BASIN
STAND–ALONE PROJECT

FIGURE 4.24 AA-111

The Desert Greenbelt
SCOTTSDALE, ARIZONA

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Pima Floodplain area upstream of these developments. This detention basin, referred to as the Core Area detention basin, is elongated in an east-west direction in order to cover the entire drainage frontage upstream of these developments. This basin collects local drainage originating upstream of the developed area and reduces the peak discharge to a level that can be conveyed in underground storm drains along the Hayden Road alignment to the Bureau of Reclamation detention basins.

There are two variations of this alternative 19(a) and 19(b) based on two possible locations for the Core Area Detention Basin (Figures 4.25 and 4.26).

The Core Area detention basin concept originated with the Loop 101 Freeway. Since 1989, the Loop 101 Freeway through the City of Scottsdale has been planned and designed by the Arizona Department of Transportation to be integrated with the Pima Road and Reata Pass/Beardsley Wash improvements to the maximum extent possible. An early concept of the Pima Road drainage improvements is shown in Figure 1.1. This concept shows the Core Area detention basin along the north side of the Loop 101 Freeway.

The current Loop 101 Freeway design is consistent with the original concept and includes a detention basin along the upstream side of the freeway between Pima/Princess Drive and Scottsdale Road. This detention basin, in conjunction with other planned regional improvements, would collect and detain all 100-year flows generated on the Pima Floodplain downstream of the proposed Reata Pass/Beardsley Wash and Pima Road flood-control improvements. The only discharge released through the Freeway would be approximately 2,900 cfs along the Hayden Road alignment. The detention basin would protect the Princess/TPC/Perimeter Center developments downstream of the freeway from flood flows generated in the area west of Pima Road.

The existing Princess/TPC/Perimeter Center developments, shown in Figures 4.25 and 4.26 and approved prior to 1990, were designed under the assumption that a regional flood-control system would be constructed upstream of these developments. Appendix E contains an excerpt from the 1989 Perimeter Center drainage report stating that, at that time, the Loop 101 (Outer Loop) Freeway

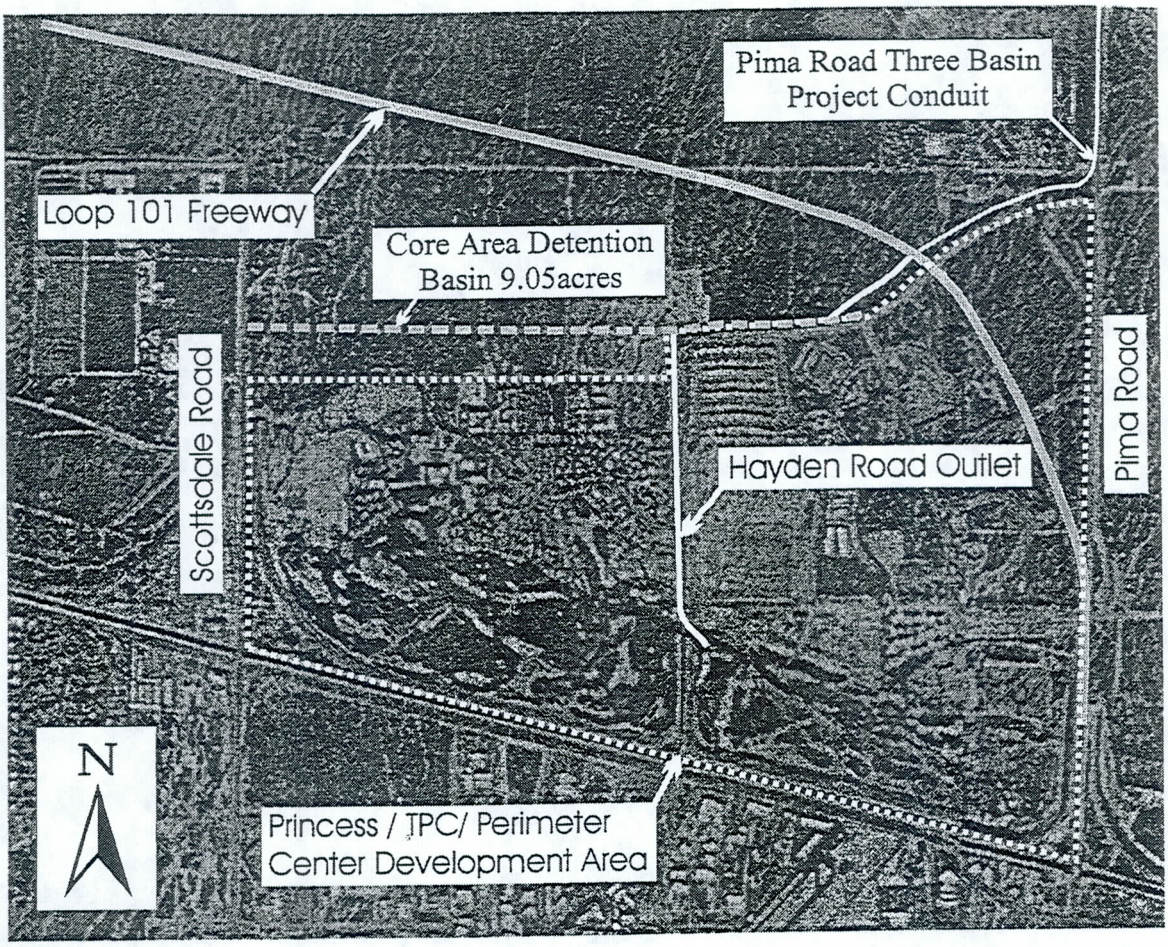

Figure 4.25. Alternative 19(a): Perimeter Center Detention Basin Located Downstream of Loop 101 Freeway.

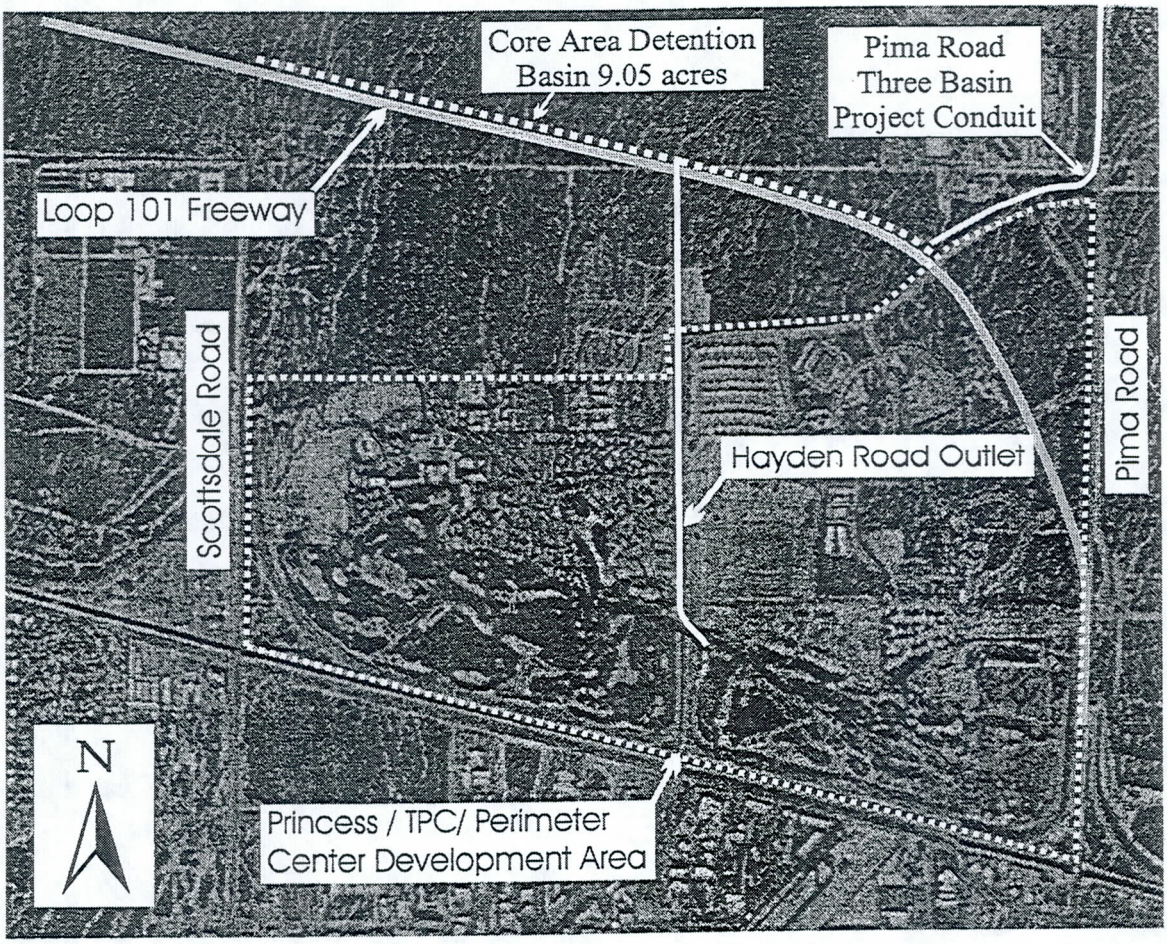

Figure 4.26. Alternative 19(b): Perimeter Center Detention Basin Located Upstream of Loop 101 Freeway Detention Basin Plan.

was expected to block and control flows through detention upstream of the highway. A similar statement is made in the 1988 drainage report for the Crown Court Apartments (also included in Appendix E). Other developments in the Princess/TPC area were approved under the same assumption.

Since completion of this ten-year cooperative design effort, and during the time this report was under preparation, the Loop 101 Freeway was permitted by the Corps of Engineers as a pass-through system through this area (See Corps letter dated December 15, 1998 in Appendix E). Presumably, a pass-through system would have a culvert at every existing drainage way along the two-mile reach between Princess Drive and Scottsdale Road. Although this pass-through system has yet to be designed, it is reasonable to assume at this time that there will be no comprehensive drainage collection system constructed by ADOT as part of the freeway.

Construction of the freeway with a pass-through system would not provide the long-planned flood protection for the existing Princess/TPC area. Alternative 19 therefore includes the Core Area detention basin concept (Figure 4.26) that was the result of a thorough concept design effort conducted over a period of ten years with a significant amount of public and agency involvement and considering a wide range of alternatives.

The Core Area detention basin is intended to work in conjunction with regional flood-control improvements along Pima Road and on the Reata Pass/Beardsley Wash alluvial fan to provide protection for flooding originating on the Reata Pass/Beardsley Wash alluvial fan and Pima Floodplain. This requires that the basin extend a short distance into the Rawhide Wash alluvial fan at a point where the Rawhide Wash and Pima Floodplain overlap (Figure 4.27). The Rawhide Wash alluvial fan already contains extensive development with east-west drainage channels (for instance along the Deer Valley Road alignment) which will tend to discharge Rawhide Wash flow across Scottsdale Road and away from the Princess/TPC area. In addition, the only large, natural wash in the Rawhide Wash alluvial fan flows southwesterly across Scottsdale Road. This may reduce the risk of Rawhide Wash flows entering the detention basin. However, these upstream features do not


Scottsdale Road
Pima Road
N
Scale
0
1 mile
Pinnacle Peak Road
Rawhide Wash
Floodplain
Deervalley
Alignment
Bedrasley
Alignment
Pima/Reata Pass
Floodplain
Union Hills Drive
Pima/
Rawhide
Wash
Floodplain
Overlap
Figure 4.27. Pima and Rawhide Wash Floodplain Overlap

meet FEMA standards for complete protection against alluvial fan flooding. The Core Area detention basin is not intended and not designed to provide 100-year protection from Rawhide Wash flooding in the area of overlap.

Variation 19(a): Core Area detention basin Located Downstream of Loop 101 Freeway Alignment.

Figure 4.25 shows the main features of this alternative in Variation 19(a). In this variation, the Core Area detention basin is located immediately upstream of the existing development and extends from Scottsdale Road to Perimeter Drive.

Variation 19(b): Core Area detention basin Located Upstream of Loop 101 Freeway Alignment.

Variation 19(b), shown in Figures 4.24 and 4.26, has the Core Area detention basin located immediately upstream of the approved alignment of the Loop 101 Freeway. At present all of the Loop 101 Freeway has been permitted for construction by the Corps of Engineers. The two-mile reach between Princess Drive and Scottsdale Road (Figure 4.28) was permitted as a pass-through system, providing no flood protection for the Princess/TPC area.

The Loop 101 Freeway will cross this two-mile reach along approximately the alignment of Union Hills Drive. Union Hills Drive has not been constructed between the Water Campus and Scottsdale Road, leaving the Loop 101 Freeway as the boundary between the Princess/TPC/Perimeter Center and related development and other development to the north.

Engineering Feasibility and Construction Cost

Alternative 19 (both variations) is not feasible as a stand-alone project. This project was initially designed to receive runoff from a total drainage area of approximately 12.4 square miles. It is dependent upon a separate regional flood-control project for the Reata Pass/Beardsley Wash alluvial fan. Without a flood-control system for the Reata Pass and Beardsley Wash, the Pima Road Three Basin project must be constructed assuming the Reata Pass/Beardsley Wash apex flow will enter the

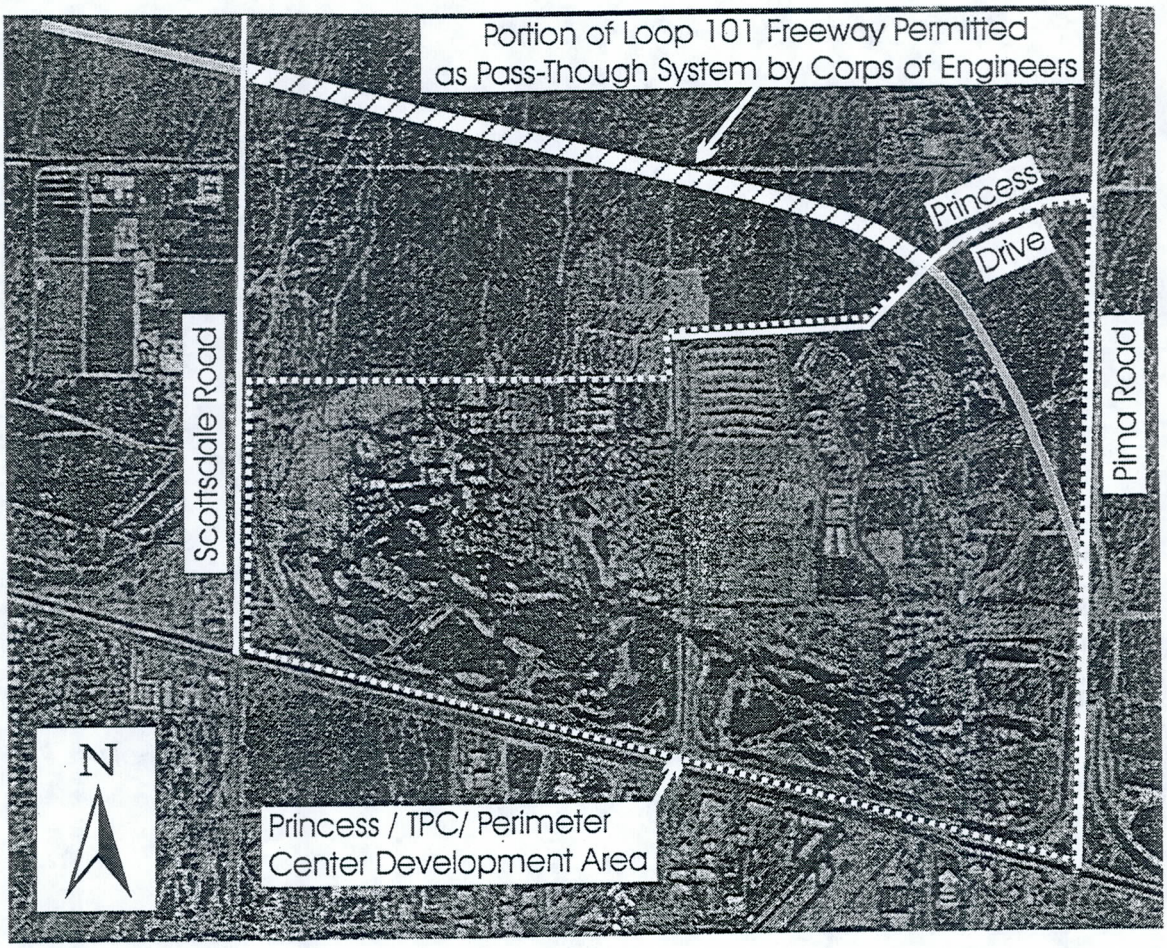

Figure 4.28. Portion of Loop 101 Freeway Permitted as a Pass-Through System by the U.S Army Corps of Engineers

system. The detention basins could be enlarged to accommodate the increased discharge. However, the path taken by the Reata Pass/North Beardsley apex flow is unpredictable and could encounter the system at any point downstream or upstream of a detention basin. Because of the unpredictable flowpaths, detention basins are not effective for flood control when located downstream of the alluvial fan apex.

Because detention basins cannot be relied on to reduce the peak discharge, the conveyance between the detention basins would need to be enlarged to convey the apex flows. As a result, Alternative 19 would have to be enlarged to an alternative very similar to Alternative 18.

Alternative 19 (both variations) is feasible provided that Reata Pass/Beardsley Wash apex flows are contained by another flood-control system such as the proposed Alternative 11: Reata Pass Levee and Channel Project, Fan Apex to WestWorld Detention Basin.

Variation 19(b): Core Area detention basin Located North of Loop 101 Freeway alignment. The cost estimate for Variation 19(b), after subtracting $1,300,000 right-of-way and $1,200,000 excavation donated by ADOT, is $53,081,000. This estimate includes $724,000 right-of-way costs to the City for the Core Area Detention Basin north of the Loop 101 alignment.

Variation 19(a): Core Area Detention Basin Located South of Loop 101 Freeway Alignment. Recent appraisals indicate that right-of-way costs in the vicinity of the Princess/TPC/Perimeter Center area south of the Union Hills Drive alignment are higher than is typical elsewhere in the study area. These high costs, estimated at approximately $12/square foot (as of January 1999), are due to high-density zoning and proximity to the Princess/TPC/Perimeter Center. Consequently, right-of-way cost for the 9.05-acre Core Area detention basin in this area would be approximately $4,700,000, or $3,976,000 higher than the cost for the basin north of the freeway. By including the difference in right-of-way cost and the $1,200,000 excavation cost donated by ADOT for Variation 19(b), the cost of Variation 19(a) is estimated at $58,257,000.

Local Regulatory and Logistical Feasibility

Alternative 19 (both variations) is feasible from a local regulatory standpoint. Logistically, Variation 19(b) is superior for the reason that the Variation 19(a) Core Area detention basin would encroach upon land currently zoned for development, and by its proximity to the Princess/TPC/Perimeter Center could result in decreased value of this existing development. There is no existing development adjacent to the Variation 19(a) Core Area detention basin.

Project Purpose

Alternative 19 would not fulfill the project purpose as a stand-alone project. In conjunction with a regional Reata Pass/Beardsley Wash solution, such as Alternative 11, Alternative 19 (both variations) would meet the entire project purpose.

Potential Environmental Impacts

Table 4.4 provides a summary of impacts to the waters of the U.S. for each of the two variations. Impacts are listed for the entire alternative as well as for the Core Area detention basin alone.

Table 4.4. Summary of Impacts to Waters of the U.S. for Alternative 19 Variations 19(a) and 19(b).

Alternative Variation	Direct Impact (In Acres)	Indirect Impact (In Acres)	Total Impact (In Acres)
19(a) Entire Alternative	4.7	6.0	10.7
19(a) Perimeter Center Basin Only	0.5	1.3	1.8
19(b) Entire Alternative	4.3	8.3	12.6
19(b) Perimeter Center Basin Only	0.1	3.7	3.8[a]

All impacts are in the Pima Floodplain.

[a] Actually 3.75 acres based on determination by U.S. Army Corps of Engineers dated June 15, 1998 (See Appendix F. Direct and indirect impacts differentiated by SLA, not Army Corps.

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the

alluvial fan or until the impacted watercourse is intersected by un-impacted waters of the U.S. of similar size. Indirect impacts on the Pima Floodplain associated with the Core Area detention basin extend to the Bureau of Reclamation detention basin.

The removal of flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan as is demonstrated by the example of numerous washes unconnected to the apex with enough local runoff to maintain riparian vegetation. watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Vegetative impacts would be approximately 17.5 acres. Of this, approximately 13.1 acres would be direct impact from channel construction. This impact could be mitigated by replacement in the channel bottom. The remaining 4.4 acres would be in areas affected by the alteration of hydrology by removal of high flows. All of this indirect impact is in areas where local runoff is considered sufficient to maintain the existing vegetative habitat. Indirect wildlife impacts are therefore considered negligible.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife

species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Traffic impacts would be construction-related only, but fairly substantial due to construction in Pima Road. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. Cultural resources have not been surveyed for this alternative, but based on other surveys in the area, cultural resources should not be significant. Since the majority of this project is below ground, visual impacts would be minor or insignificant.

Conclusion

Alternative 19 is not practicable as a stand-alone project because it does not fulfill the project purpose of flood control. This alternative would be feasible if accompanied by a separate project to contain the Reata Pass/Beardsley Wash flows.

Variation 19(a) avoids 1.9 acres impact to the waters of the U.S. in comparison to Variation 19(b). Most of this avoided impact is indirect impact resulting from the cut-off of flows by the Core Area detention basin. Table 4.4 shows that the direct impact of Variation 19(a) is 0.4 acres higher than that of Variation 19(b). The entire waters of the U.S. impacted by the Core Area detention basin for both variations is in an area that is currently zoned for high-density development which is expected to fill the area between the Loop 101 Freeway and the Princess/TPC/Perimeter Center area in the near future. Much of these waters of the U.S. impacted by the Core Area detention basin are already

disturbed by the existing development to the point where there is little or no natural vegetation present in them. The rest are narrow channels along the lower alluvial fan occupied primarily by limited numbers of foothill paloverde.

The difference in cost between Variation 19(a) and 19(b) is $5,176,000. This difference is made even greater when considering the saving to ADOT (not an applicant to this permit action) in the elimination of the need to install a pass-through system in this area. This saving is estimated at approximately $8,000,000 in design and construction costs. Considering that ADOT has agreed to donate $2,500,000 in right-of-way and excavation for Variation 19(b) the net difference to ADOT is $5,500,000, resulting in a true cost differential of $10,676,000 between Variation 19(a) and 19(b).

Based on these considerations, Variation 19(a) is considered not practicable for the reason of excessive cost in comparison to benefit gained ($5,619,000/acre, or approximately $129/square foot, for 1.9 acres of poor-quality, partially-disturbed waters of the U.S. subject to future high-density development in an area where it has been determined that local runoff is sufficient to maintain the existing riparian vegetation).

4.4.20 Alternative 20: Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin with Pima Road Three Basin Project (Proposed Project)

Description and Characteristics

This alternative represents the entire project as currently proposed by the City of Scottsdale. Alternative 20 is a combination of Alternative 11 (Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin) and Alternative 19 (Pima Road Three Basin Project) as shown on Figure 4.29. The project description and characteristics are identical to those described in Sections 4.11 and 4.19.

Engineering Feasibility and Construction Cost

This alternative collects all Reata Pass flows at the apex before they spread onto the alluvial fan. Flows are confined and controlled for the entire channel and levee length. The channel bank and

LEVEE

BANKS

LEVEES

UNION HILLS DRIVE

REATA PASS CHANNEL

BELL ROAD

LEVEES

HAPPY VALLEY DETENTION BASIN

PR3B

HAPPY VALLEY ROAD (HVR)

PINNACLE PEAK ROAD

DEER VALLEY ROAD (DVR)

THOMPSON PEAK

DOWNING OLSEN (JUNCTION)

UNION HILLS DRIVE (UHD) (JUNCTION)

JOMAX ROAD

DEER VALLEY DETENTION BASIN

ALIGNMENT H-1

ALIGNMENT H-1 HAYDEN ROAD OUTLET

PIMA ROAD STORM DRAIN

PR3B CONDUITS

OUTER LOOP BASIN

N

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1"=3000'

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TRANSPORTATION DEPARTMENT

ALTERNATIVE 20: REATA PASS LEVEE AND CHANNEL PROJECT, FAN APEX TO WESTWORLD DETENTION BASIN, WITH PIMA ROAD THREE BASIN PROJECT

FIGURE 4.29 AA-124

The Desert Greenbelt SCOTTSDALE, ARIZONA

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levee height and toedown are designed for maximum long-term and 100-year sedimentation, scour and flow depth.

The Pima Road improvements are feasible with the Reata Pass/Beardsley Wash improvements in place. Alluvial fan flows would be collected and controlled by the Reata Pass/Beardsley Wash flood-control channel. Pima Road improvements are sufficient to collect the Pima Floodplain and residual alluvial fan flows generated on the alluvial fan surface. This design would eliminate the flood potential from the entire study area as indicated by approval from FEMA for a Conditional Letter of Map Revision. Figure 4.30 shows the area protected. Project construction cost is estimated at $94,318,000.

Local Regulatory and Logistical Feasibility

Alternative 20 is feasible from a local regulatory and logistical standpoint.

Project Purpose

Alternative 20 would meet the entire project purpose:

1. **Flood Hazard Removal.** Existing development on the Reata Pass/Beardsley Wash alluvial fan and the Pima Floodplain would be protected from flooding. Figure 4.30 shows the area protected. This would be a regional flood-protection system for the entire study area.

   The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would be removed. The flood insurance and building pad requirements for that area would be eliminated.

2. **Flood Protection for Public Improvements.** Public infrastructure within the entire study area would be protected from Reata Pass/Beardsley Wash and Pima Floodplain.

3. **Enhance Recreation.** A permanent recreational corridor would be established along the East Wash alignment between Union Hills Drive and the apex of the Reata Pass alluvial fan.

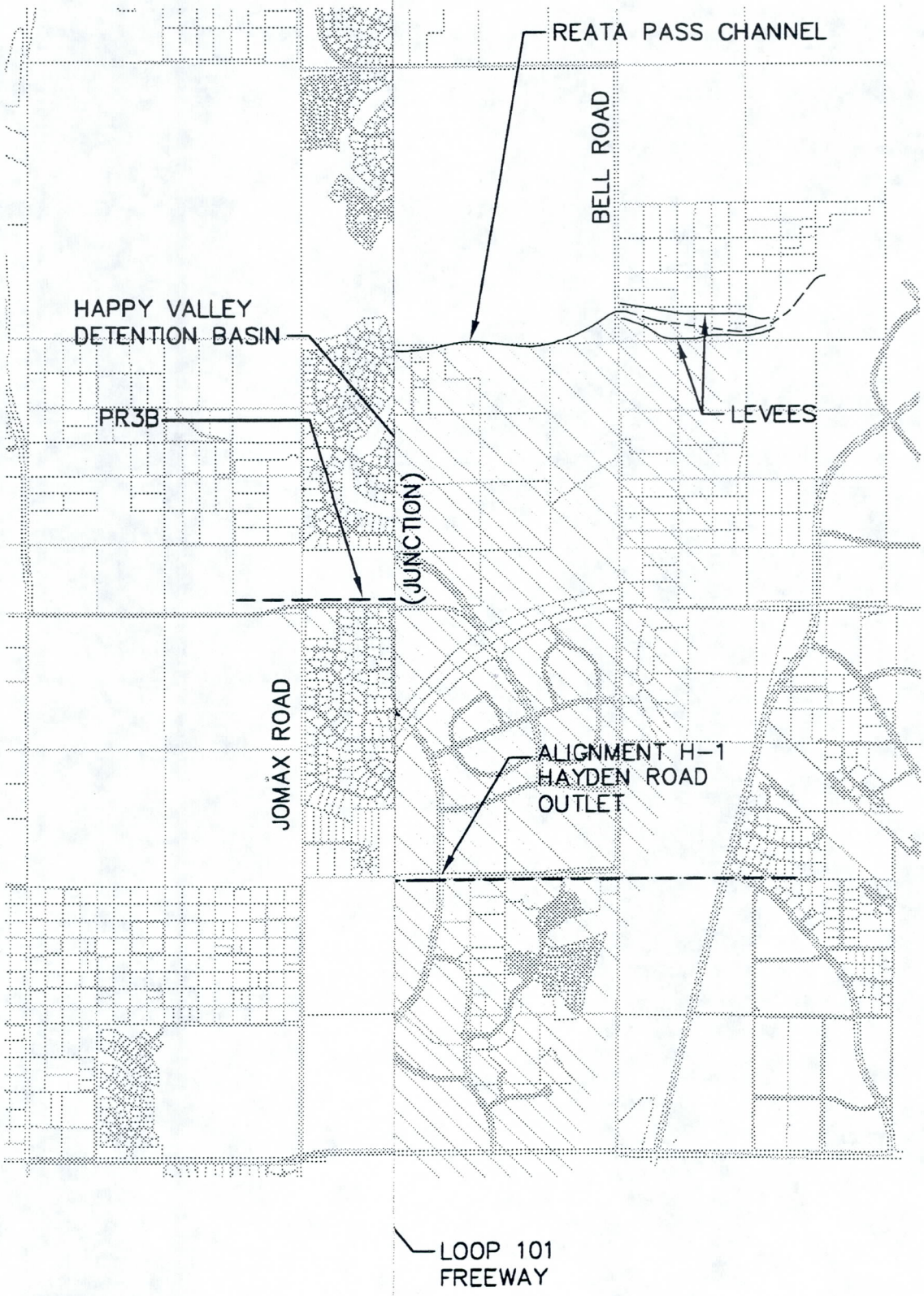


FIGURE 4.30 AA-126

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 20 ALTK PRT.DWG

Potential Environmental Impacts

Alternative 20 would have 72.6 acres total impact to the waters of the U.S. These include 64 acres on the Reata Pass/Beardsley Wash alluvial fan, of which 15.5 acres are direct impact, 27 acres indirect impact resulting from cut-off of flows at the Reata Pass apex, 7.1 acres indirect impact resulting from cut-off of flows from the North Beardsley Wash secondary apex in the vicinity of Union Hills Drive, and 14.4 acres miscellaneous indirect impacts resulting from cut-off of channel bends and braids along the flood-control channel. Some of the indirect impacts extend into the Pima Floodplain overlap area. Pima Floodplain impacts are 12.6 acres which include 4.3 acres direct impact and 4.3 acres indirect impact resulting from cut-off of flows along Pima Road and at the Core Area detention basin.

Direct impacts are those that would be impacted by the actual construction of the project along the alignment shown in Figure 4.29.

The removal of flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan as is demonstrated by the example of numerous washes unconnected to the apex with enough local runoff to maintain riparian vegetation. Watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Total riparian vegetation impacts would be approximately 204 acres, of which approximately 52 acres would be direct impact. The rest, approximately 152 acres, would be indirect impacts from alteration of the hydrologic regime. Of the 152 acres of potential indirect impacts, about 100 acres are expected to be most affected by the elimination of apex flows. The greatest potential for indirect impacts to vegetation is in the upper fan area (east and west channels), between the apex and Deer

Valley Road, and on the east channel of Reata Pass Wash, downstream of North Beardsley Wash. These areas supports some of the most extensive and diverse wash habitat in the project area.

Overstory species adversely affected by the 100-acre effective indirect impact would likely include blue palo verde, velvet mesquite and catclaw acacia. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced. These individuals may be slowly replaced with overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood).

The plants that may potentially decline and be replaced by others are not numerous on the Reata Pass/Beardsley Wash alluvial fan. A vegetative survey recorded them only on the upper portion of the alluvial fan. Blue palo verde density on the upper alluvial fan was found to average less than one individual per acre. Velvet mesquite density averaged just 0.2 individuals per acre.

Any change in the desert wash wildlife habitat will likely be subtle, and will occur over a very long time period. Ironwood densities may actually increase, and wildlife species that utilize the blue paloverde would likely be able to switch to the structurally similar ironwood or to the foothill paloverde. Given the nature of the possible indirect impacts to wildlife in the affected washes, and the likely ability of wildlife species to adapt to relatively subtle changes in vegetation composition should such a shift occur, the indirect impacts to wildlife species are considered an adverse impact that is not significant.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

The remaining 52 acres of indirect impact are either in areas far removed from apex or other significant tributary flows, or are already affected by diversions associated with existing development. These areas are less likely to support obligate wash species (e.g., blue palo verde, mesquite, catclaw acacia) and are largely sustained by local watersheds. It is likely that local watersheds would continue to sustain these areas with the project in place. Consequently these areas are not expected to be adversely affected by the project.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat (*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Alternative 20 would avoid an estimated 123 acres of impact to the alluvial fan habitat that would occur as a result of the need for future land development not associated with the proposed project to elevate buildings above the Reata Pass/Beardsley Wash100-year flood elevation if the No Action alternative is adopted.

Traffic impacts would be construction-related only, but fairly substantial due to construction in Pima Road. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. A cultural resources survey conducted for the Reata Pass portion

of the proposed project found no sites of importance. Cultural resources have not been surveyed for the Pima Road portion, but based on other surveys in the area and the fact that the majority of the improvements are in Pima Road, cultural resources should not be significant. The channel would have a visual impact, but this impact would be minor and mitigated by revegetation, landscaping and contouring of the channel and banks. Since the majority of the Pima Floodplain project is below ground, visual impacts would be minor or insignificant.

Potential Mitigation Measures

Restoration of wash habitat within appropriate reaches of the flood control channel is proposed. The project design incorporates wide channel sections with a natural (unlined) bottom for much of the greenbelt length. This area, which includes about 40 acres, is all restorable to natural wash vegetation. Temporary (construction related) impact areas within the channel can also be restored. A combination of transplanting of mature wash plants and seeding would be employed to facilitate revegetation of these areas. Revegetated channel sections will link with the sections of the flood control corridor where about 13 acres of existing wash habitat will be preserved.

All of the area within the flood-control channel will become waters of the U.S. after construction. Revegetation of the 40-acre restorable portion of the flood control channel will mitigate all of the direct impacts of the waters of the U.S. at a ratio of slightly more than 2:1, and most of the direct impacts (in terms of area) to riparian habitat. Indirect impacts, which would be characterized by a possible, long-term replacement of blue palo verde, velvet mesquite and catclaw acacia with more upland overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood) in the affected areas, would be mitigated by the establishment of blue palo verde, velvet mesquite and catclaw acacia in the restored channel bottom between the confluence of the Beardsley Wash and the Westworld detention basin. The ability of these species to survive on this portion of the lower alluvial fan would be improved through watering of the restored areas by apex flows brought down by the flood-control channel.

Long term monitoring of revegetation areas and preserved habitat by qualified biologists is recommended. Appropriate reference sites in the vicinity should be surveyed for comparison. Contingency mitigation measures, including alternative mitigation sites and/or mitigation strategies would be implemented should monitoring indicate decline of the wash community.

Conclusion

Alternative 20 is practicable and meets the entire project purpose. The proposed mitigation would result in a 2:1 replacement of directly-impacted waters of the U.S., creation of 40 acres of riparian habitat with blue palo verde, velvet mesquite and catclaw acacia on the lower alluvial fan (0.77:1 replacement ratio in terms of area of direct impact to riparian habitat), and long-term monitoring.

4.4.21 Alternative 21: Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin with Pima Road Three Basin Project and Low-Flow Diversion

Description and Characteristics

Alternative 21 is identical to Alternative 20 with the addition of a diversion structure located at the apex of the Reata Pass/Beardsley Wash alluvial fan (Figures 4.31 and 4.32). This diversion structure would divert up to a maximum of 800 cfs onto the alluvial fan surface as shown in Figure 4.32 for every discharge at the Reata Pass/Beardsley Wash apex.

Engineering Feasibility and Construction Cost

Alternative 21 is feasible from an engineering standpoint as described in Section 5.10.2. Project construction cost, with the diversion, is estimated at $94,684,000.

Local Regulatory and Logistical Feasibility

Alternative 21 is feasible from a local regulatory and logistical standpoint.

Project Purpose

Alternative 21 would meet the entire project purpose:

1. **Flood Protection for Existing Development.** Existing development on the Reata Pass/Beardsley Wash alluvial fan and the Pima Floodplain would be protected from

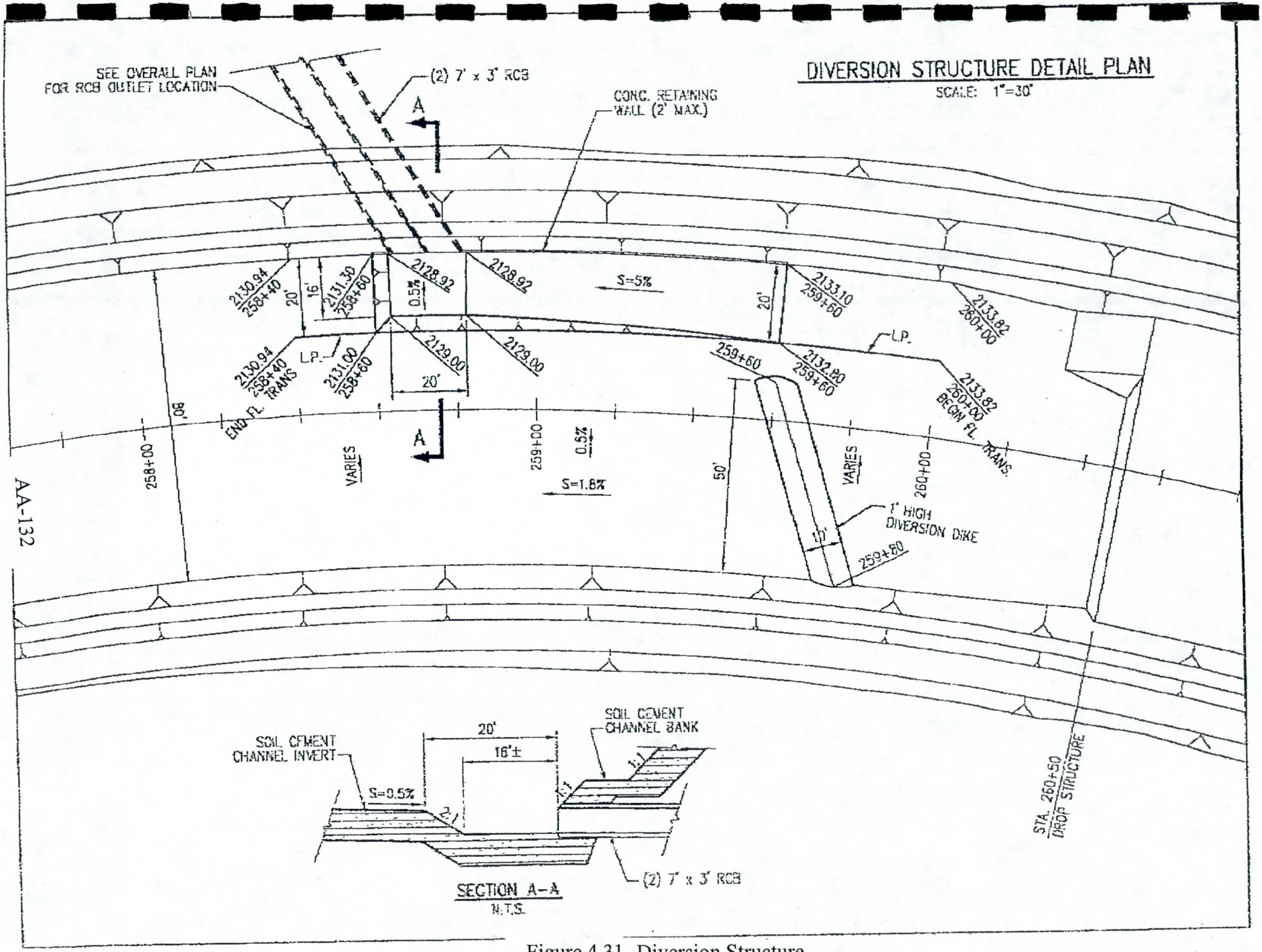
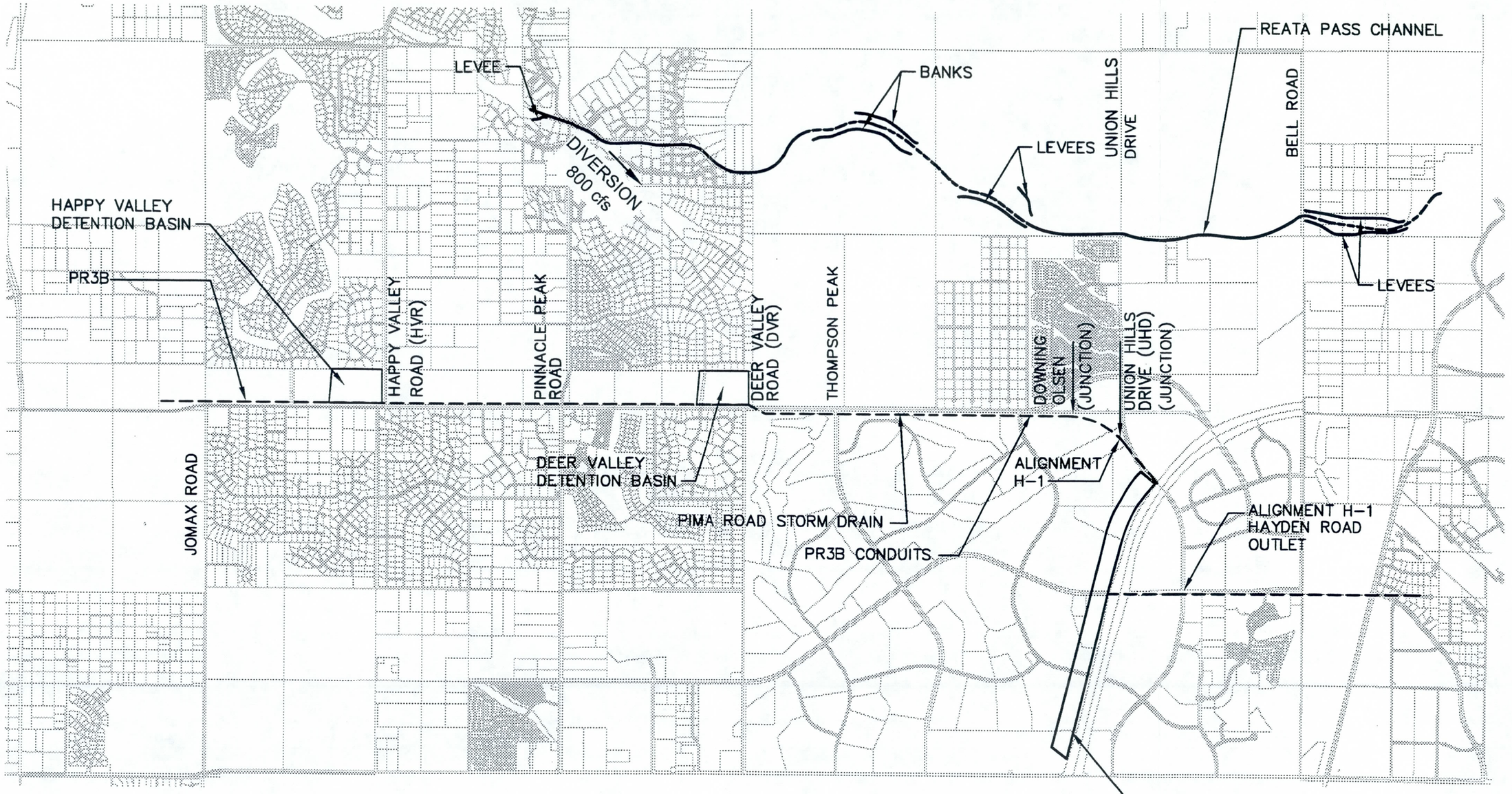


Figure 4.31 Diversion Structure.



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TRANSPORTATION DEPARTMENT
ALTERNATIVE 21 REATA PASS LEVEE AND CHANNEL PROJECT, FAN APEX TO WESTWORLD DETENTION BASIN, WITH PIMA ROAD THREE BASIN PROJECT AND LOW-FLOW DIVERSION

FIGURE 4.32 AA-133

The Desert Greenbelt SCOTTSDALE, ARIZONA

M:\PUBLIC\PROJECTS\AZCOS03\EXHIBITS\SHT-FIG 19 ALTK PRJ.DWG

flooding. Figure 4.30 shows the area protected. This would be a regional flood-protection system for the entire study area.

The FEMA flood designation for the Reata Pass/Beardsley Wash alluvial fan would be removed. The flood insurance and building pad requirements for that area would be eliminated.

2. **Flood Protection for Public Improvements.** Public infrastructure within the entire study area would be protected from Reata Pass/Beardsley Wash and Pima Floodplain.

3. **Enhance Recreation.** A permanent recreational corridor would be established along the East Wash alignment between Union Hills Drive and the apex of the Reata Pass alluvial fan.

Potential Environmental Impacts

Alternative 21 would have 45.6 acres total impact to the waters of the U.S. These include 37 acres on the Reata Pass/Beardsley Wash alluvial fan, of which 15.5 acres are direct impact, 7.1 acres indirect impact resulting from cut-off of flows from the North Beardsley Wash secondary apex in the vicinity of Union Hills Drive, and 14.4 acres miscellaneous indirect impacts resulting from cut-off of channel bends and braids along the flood-control channel. There are no indirect impacts resulting from cut-off of flows at the Reata Pass apex. Pima Floodplain impacts are 8.6 acres which include 4.3 acres direct impact and 4.3 acres indirect impact resulting from cut-off of flows along Pima Road and at the Core Area detention basin.

Indirect impacts to waters of the U.S. resulting from the cut-off of flows to the alluvial fan are calculated at the direction of the U.S. Army Corps of Engineers as extending to the base of the alluvial fan or until the impacted watercourse is intersected by un-impacted waters of the U.S. of similar size. On Reata Pass and Beardsley Wash there are no intersecting waters of similar size and so indirect impacts are calculated to extend as far as five miles to the base of the alluvial fan.

The removal of apex-generated flows does not cause the affected watercourse to dry up completely. A substantial amount of runoff is generated locally on the surface of the alluvial fan downstream of the fan apex. The amount of this runoff increases with distance down the alluvial fan. This runoff

is sufficient to generate many separate unconnected (to the apex) waters of the U.S., beginning at a point approximately 2,400 feet downstream of the Reata Pass apex. There is tributary inflow to the upper Reata Pass alluvial fan from watersheds totaling nearly 500 acres in size (See Baseline Conditions Report Section 4.10.4). This area is approximately one-tenth the size of the Reata Pass watershed at the fan apex. Further, there is qualitative evidence from the City of Scottsdale that the 800 cfs flow observed to enter the Reata Pass alluvial fan in a southwest direction in the 1996 flood did not reach Pima Road. Using an infiltration rate calibrated on this observation it was determined that the discharge associated with the waters of the U.S. (330 cfs) would travel approximately 4,800 6,500 feet down the alluvial fan before infiltrating completely into the ground (See Appendix A). Hydrologic analysis shows that under current development conditions, the ordinary high water discharge can be produced from runoff generated on the alluvial fan surface at a point somewhere between 2,900 and 3,600 feet downstream of the apex. This is consistent with the finding that the nearest unconnected waters of the U.S., with riparian habitat, begins approximately 2,400 feet downstream of the apex.

The above hydrological information demonstrates that watercourses identified for this and other alternatives as having indirect impacts through cut-off of flows will continue to exhibit an ordinary high water mark from local runoff and tributary flow after the flow cut-off. Since the ordinary high water mark defines the area of jurisdiction of the U.S. Army Corps of Engineers, these indirectly-impacted watercourses would continue to be subject to permit applications by others under the Corps 404 program after implementation of this project.

Indirect impacts along the west branch of the Reata Pass alluvial fan are avoided in this alternative by the 800 cfs diversion at the Reata Pass fan apex. This diversion discharge is considered adequate to avoid indirect impacts for the following reasons:

- 800 cfs is more than twice the ordinary high water discharge of 330 cfs at the apex.
- Local and tributary runoff are sufficient to create an ordinary high water mark and establish riparian vegetation within approximately 2,400 feet of the apex without the

apex flows (See Section 4.4.11 of this report and Baseline Conditions Report Section 4.10.4).

- 800 cfs was the largest apex-generated discharge known to flow in a southwest direction from the apex in twenty years. Flows of this magnitude or smaller have been sufficient to maintain the vegetative habitat observed on the alluvial fan for at least that period of time, indicating that the same should be true for the future.

- Hydrologic modeling shows that the proposed diversion at the apex will closely mimic existing conditions. Based on this, and the distribution of wash vegetation in the project area relative to apex and local washes, it appears that the diversions will be quite effective.

Total riparian vegetation impacts would be approximately 154 acres, of which approximately 52 acres would be direct impact. The rest, approximately 102 acres, would be indirect impacts from alteration of the hydrologic regime. Of the 102 acres of potential indirect impacts, about 50 acres are expected to be most affected by the elimination of apex flows. The greatest potential for indirect impacts to vegetation is on the east channel of Reata Pass Wash, downstream of North Beardsley Wash.

The remaining 52 acres of indirect impact are either in areas far removed from apex or other significant tributary flows, or are already affected by diversions associated with existing development. These areas are less likely to support obligate wash species (e.g., blue palo verde, mesquite, catclaw acacia) and are largely sustained by local watersheds. It is likely that local watersheds would continue to sustain these areas with the project in place. Consequently these areas are not expected to be adversely affected by the project.

Overstory species adversely affected by the 50-acre effective indirect impact would likely include blue palo verde, velvet mesquite and catclaw acacia. As a result of less moisture availability, individual plants may suffer a decline in health, and recruitment may be reduced. These individuals may be slowly replaced with overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood).

The plants that may potentially decline and be replaced by others are not numerous on the Reata Pass/Beardsley Wash alluvial fan. A vegetative survey recorded them only on the upper portion of the alluvial fan. Blue palo verde density on the upper alluvial fan was found to average less than one individual per acre. Velvet mesquite density averaged just 0.2 individuals per acre.

Any change in the desert wash wildlife habitat will likely be subtle, and will occur over a very long time period. Ironwood densities may actually increase, and wildlife species that utilize the blue paloverde would likely be able to switch to the structurally similar ironwood or to the foothill paloverde. Given the nature of the possible indirect impacts to wildlife in the affected washes, and the likely ability of wildlife species to adapt to relatively subtle changes in vegetation composition should such a shift occur, the indirect impacts to wildlife species are considered an adverse impact that is not significant.

Although the habitat in the study area is poor to moderate quality for wildlife, the direct disturbance (including temporary disturbance) to Sonoran desert scrub habitat will result in substantial impacts to wildlife in those areas to be disturbed. These impacts would include destruction of less-mobile wildlife individuals, displacement of more mobile individuals, and increased competition, predation and stress on the newly displaced individuals.

Wildlife impacts must be considered in the context of the habitat available in the study area and surrounding region. Due to the large amount of similar habitat in the area and region, and the availability of higher quality (less disturbed) habitat on a regional scale, the direct impacts to wildlife species are considered adverse but not significant. The intensity of these impacts can be lessened with successful implementation of the mitigation measures including replacing Sonoran desert scrub vegetation where possible in areas subject to temporary disturbance, and incorporating native xeroriparian species into the project design to the greatest extent feasible.

Past surveys for the Cactus Ferruginous Pygmy owl *(Glaucidium brasilianum cactorum)* have found none on the project site or vicinity of the project alternatives. The Lesser Long-nosed Bat

(*Leptonycteris curasoae yerbabuenae*) may forage in the area, but the foraging habitat is considered marginal. This alternative is not expected to result in a take of listed endangered or threatened species.

Alternative 21 would avoid an estimated 123 acres of impact to the alluvial fan habitat that would occur as a result of the need for future land development not associated with the proposed project to elevate buildings above the Reata Pass/Beardsley Wash100-year flood elevation if the No Action alternative is adopted.

Traffic impacts would be construction-related only, but fairly substantial due to construction in Pima Road. Public health and safety would be improved through flood-control. Groundwater infiltration to the ESRV would be unaffected. A cultural resources survey conducted for the Reata Pass portion of the proposed project found no sites of importance. Cultural resources have not been surveyed for the Pima Road portion, but based on other surveys in the area and the fact that the majority of the improvements are in Pima Road, cultural resources should not be significant. The channel would have a visual impact, but this impact would be minor and mitigated by revegetation, landscaping and contouring of the channel and banks. Since the majority of the Pima Floodplain project is below ground, visual impacts would be minor or insignificant.

Potential Mitigation Measures

Restoration of wash habitat within appropriate reaches of the flood control channel is proposed. The project design incorporates wide channel sections with a natural (unlined) bottom for much of the greenbelt length. This area, which includes about 40 acres, is all restorable to natural wash vegetation. Temporary (construction related) impact areas within the channel can also be restored. A combination of transplanting of mature wash plants and seeding would be employed to facilitate revegetation of these areas. Revegetated channel sections will link with the sections of the flood control corridor where about 13 acres of existing wash habitat will be preserved.

All of the area within the flood-control channel will become waters of the U.S. after construction. Revegetation of the 40-acre restorable portion of the flood control channel will mitigate all of the direct impacts of the waters of the U.S. at a ratio of slightly more than 2:1, and most of the direct impacts (in terms of area) to riparian habitat. Indirect impacts, which would be characterized by a possible, long-term replacement of blue palo verde, velvet mesquite and catclaw acacia with more upland overstory species tolerant of slightly more xeric conditions (such as foothill paloverde and ironwood) in the affected areas, would be avoided on most of the upper Reata Pass alluvial fan by the 800 cfs diversion. Indirect impacts along the East Wash and downstream of the Beardsley Wash apex would be mitigated by the establishment of blue palo verde, velvet mesquite and catclaw acacia in the restored channel bottom between the confluence of the Beardsley Wash and the Westworld detention basin. The ability of these species to survive on this portion of the lower alluvial fan would be improved through watering of the restored areas by apex flows brought down by the flood-control channel.

Long term (e.g. 10-20 years) monitoring of revegetation areas and preserved habitat by qualified biologists is also recommended. The monitoring should address the hydrologic effectiveness of the diversion in terms of actual wash flows, sediment transport and seed scarification, as well as the distribution, health and regeneration of wash species. Appropriate reference sites in the vicinity should be surveyed for comparison. Contingency mitigation measures, including alternative mitigation sites and/or mitigation strategies would be implemented should monitoring indicate decline of the wash community.

Conclusion

After consideration of ability to meet project purpose, impacts to waters of the U.S., impacts to biological resources, other environmental impacts, and cost, Alternative 21, Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin with Pima Road Three Basin Project and Low-Flow Diversion, is determined to be the least-damaging practicable alternative. Alternative 21 meets the entire project purpose and minimizes impact to vegetation, wildlife and the waters of the U.S. through the 800 cfs diversion onto the alluvial fan. The proposed mitigation would result

in a 2:1 replacement of directly-impacted waters of the U.S., creation of 40 acres of riparian habitat with blue palo verde, velvet mesquite and catclaw acacia on the lower alluvial fan (0.77:1 replacement ratio in terms of area of direct impact to riparian habitat), and long-term monitoring.

V. ALTERNATIVE COMPARISON AND IMPACT SUMMARY

The comparison of alternatives and impacts to the waters of the U.S. are summarized in Tables 5.1 and 5.2.

Table 5.1 Alternative Summary

Alternative	Engineering Feasibility	Local Regulatory Feasibility	Project Purpose[1]	Impacts to Waters of the U.S.[2] (In acres)			Cost	Conclusion
				Total	RPBW[3]	PF[4]		
1. Scattered Detention/ Retention Facilities	Not feasible	Not feasible	No project purpose met	NE[7]	NE	NE	NE	Not practicable because not feasible from an engineering and logistical standpoint
2. Detention at the Alluvial Fan Apex	Feasible	Not feasible	1,2: Met 3: Not met	NE	NE	NE	$63,000,000	Not practicable because of cost, environmental impact, logistical infeasibility, and failure to fulfill entire project purpose. Negative impact on recreation.
3. Streambank Stabilization	Feasible, but does not remove flood hazard	Feasible	1,2: Not met 3: Possibly met	NE	NE	NE	NE	Not practicable because existing channels do not have capacity for 100-year flood discharges. This alternative does not meet the project purpose
4. Relocation	Feasible	Feasible	1,2: Met 3: Not met	None	None	None	More than $2,000,000,000	Not practicable because of excessive cost and significant social disruption.
5. Environmental Enhancement	Not Feasible	Not Feasible	No project purpose met	NE	NE	NE	NE	An environmental enhancement project is not practicable. The existing habitat is not degraded and there is no opportunity for enhancement. See Alternative 15.
6. Floodproof Existing Structures	Feasible	Feasible	No project purpose met	None	None	None	NE	Not practical because it would not be effective flood protection and is not recognized by FEMA as a means to eliminate alluvial fan flood hazards on residential structures.

Table 5.1 Alternative Summary

Alternative	Engineering Feasibility	Local Regulatory Feasibility	Project Purpose[1]	Impacts to Waters of the U.S.[2] (In acres)			Cost	Conclusion
				Total	RPBW[3]	PF[4]		
7. Stop Development	Not applicable	Feasible	No project purpose met	None	None	None	$218,000,000	Not practicable because it would cost many times more than the proposed project and not achieve the primary project purpose of protecting existing development.
8. Watershed Management	Not feasible	Not feasible	No project purpose met	NE	NE	NE	NE	Not practicable because it would result in substantial impact to the natural ecosystem without achieving the required level of flood protection. Probable very high cost.
9. Onsite Detention for Each Development	Feasible but not effective	Feasible	No project purpose met	NE	NE	NE	NE	Not practicable because flood discharges are generated upstream of the alluvial fan where there is no opportunity for onsite detention. Onsite detention is ineffective at reducing large, historic flood discharges.
10: No Action	Not Applicable	Not applicable	No project purpose met.	0	0	0	None	Not practicable because it does not meet any project purpose. Leaves the entire area subject to severe flood hazard.
11: Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin	Feasible	Feasible	1, 2: Partially Met 3: Met	64	64	0	$41,237,000	Practicable, except as stand-alone project does not fulfill complete project purpose.

Table 5.1 Alternative Summary

Alternative	Engineering Feasibility	Local Regulatory Feasibility	Project Purpose[1]	Impacts to Waters of the U.S.[2] (In acres)			Cost	Conclusion
				Total	RPBW[3]	PF[4]		
12: Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive	Feasible	Feasible with purchase of residual floodplain land.	1, 2, 3,: Partially met	61.7	61.7	0	$70,466,000	Not practicable because of substantially higher total cost than Alternative 11. Less effective than Alternative 11 at meeting project purpose. Avoided impact to waters of the U.S. is small in comparison to the increased cost.
13: Reata Pass Levee and Channel Project, Fan Apex to Union Hills Drive with Detention Basin at Union Hills Drive	Feasible	Feasible	1, 2, 3: Partially met	64.3	64.3	0	$52,192,000 to $69,912,000 depending upon excavation transport costs	Not practicable because of substantially higher total cost than Alternative 11. Impact to waters of the U.S. is higher than that of Alternative 11. Less effective than Alternative 11 at meeting project purpose.
14: Wider Channel	Feasible	Feasible	1,2: Partially Met 3: Met	NE: More than for proposed project	NE: More than for proposed project	NE: More than for proposed project	NE: Higher than proposed project	Practicable, except higher cost and environmental impact than for the proposed project.
15: Reata Pass Wash Partial Levee Project, Fan Apex to Westworld Detention Basin	Feasible	Feasible	1,2: Partially Met. 3: Not Met	64	64	0	$43,179,000	Not practicable because of induced flood hazard on adjacent property resulting in higher cost than the proposed project, significant adverse visual impact to the area, and unsuitability for use as a recreational corridor.

Table 5.1 Alternative Summary

Alternative	Engineering Feasibility	Local Regulatory Feasibility	Project Purpose[1]	Impacts to Waters of the U.S.[2] (In acres)			Cost	Conclusion
				Total	RPBW[3]	PF[4]		
16: Protect Existing Development Using Levees (Ring Dikes)	Not feasible	Not feasible. Violates Floodways and Floodplains ordinance	No project purpose met because not feasible.	NE[5]	NE[5]	NE[5]	NE: Cost would be many times the cost of the proposed project.	Not practicable because not feasible from an engineering, local regulatory or logistical standpoint. Cannot meet project purpose.
17: Reata Pass Wash Narrow Channel Project, Fan Apex to Westworld Detention Basin	Feasible but not advisable due to safety and maintenance concerns.	Feasible	1, 2: Partially met. 3: Not met	64	64	0	$53,110,000	Not practicable because does not fulfill project purpose. Creates hazardous in-channel condition. Inconsistent with natural open space transition into McDowell Sonoran Preserve. Avoided impact to waters of the U.S. is small in comparison to the increased cost in comparison to proposed project
18: Pima Road Levee/Channel Stand-Alone Project	Feasible but not practical given required design considerations and current land use	Feasible	1, 2: Partially met 3: Not met	7.5	0	7.5	$135,273,000	Not practicable as a stand-alone project because it only partially fulfills the project purpose. Would result in substantial disruption of land use along Pima Road. Substantial increase in cost in comparison to Alternatives I and J.

Table 5.1 Alternative Summary

Alternative	Engineering Feasibility	Local Regulatory Feasibility	Project Purpose[1]	Impacts to Waters of the U.S.[2] (In acres)			Cost	Conclusion
				Total	RPBW[3]	PF[4]		
19(a): Pima Road Three Basin Stand-Alone Project[6]	Not feasible. Will not function as a stand-alone project.	Feasible	No project purpose met.	10.7	0	10.7	$58,257,000 (Not including $5,500,000 extra cost of Loop 101 Freeway pass-through system)	Not practicable as a stand-alone project because it does not fulfill the project purpose. Practicable if combined with a regional solution on the Reata Pass/Beardsley wash. Not practicable in comparison to 19(b) due to excessive cost in comparison to benefits gained.
19(b): Pima Road Three Basin Stand-Alone Project[7]	Not feasible. Will not function as a stand-alone project.	Feasible	No project purpose met.	12.6	0	12.6	$53,081,000	Not practicable as a stand-alone project because it does not fulfill the project purpose. Practicable if combined with a regional solution on the Reata Pass/Beardsley wash.
20: Reata Pass Levee and Channel Project, fan Apex to Westworld Detention Basin with Pima Road Three Basin Project.	Feasible	Feasible	Entire project purpose met	72.6	64	8.6	$94,318,000	Practicable. Fulfills entire project purpose.

Table 5.1 Alternative Summary

Alternative	Engineering Feasibility	Local Regulatory Feasibility	Project Purpose[1]	Impacts to Waters of the U.S.[2] (In acres)			Cost	Conclusion
				Total	RPBW[3]	PF[4]		
21: Reata Pass Levee and Channel Project, Fan Apex to Westworld Detention Basin with Pima Road Three Basin Project and Low-Flow Diversion	Feasible	Feasible	Entire project purpose met	45.6	37	8.6	$94,684,000	Alternative 21 meets the entire project purpose and minimizes impact to vegetation, wildlife and the waters of the U.S. through the 800 cfs diversion. This is the least-damaging practicable alternative.

1 Project purposes are: 1) Flood Hazard Removal; 2) Flood Protection for Public Improvements; and, 3) Enhance Recreation.
2 Includes direct and indirect impacts. See Table 4.4 for detailed impact summary.
3 Reata Pass/Beardsley Wash impacts. These are impacts that occur as a result of flood-control improvements to the Reata Pass/Beardsley wash. Impacts within the Reata Pass/Beardsley Wash floodplain but related to the Pima Road improvements are classified as Pima Floodplain impacts.
4 Pima Road/Pima Floodplain impacts. These are impacts related to the Pima Road/Pima Floodplain improvements.
5 Not possible to estimate. All waters of the U.S. within study area would potentially be impacted.
6 See Table 5.2 for detailed summary of impacts.
7 Not Estimated for the reason that the project is determined to be not feasible or practicable or does not fulfill project purpose.

Table 5.2. Detailed Summary of Impacts to Waters of the U.S.
(All Impacts in Acres)

Alternative	Direct Impacts Reata Pass/Beardsley Wash	Indirect Impacts Reata Pass/ Wash[1]	Indirect Impacts on North Beardsley Wash[2]	Miscellaneous Indirect Impacts Reata Pass/Beardsley Wash[3]	Total Impacts Reata Pass/Beardsley Wash	Direct Impacts Pima Floodplain	Indirect Impacts Pima Floodplain	Total Impacts on Pima Floodplain	Total Impacts
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	15.5	27.0	7.1	14.4	64.0	0.0	0.0	0.0	64.0
12	15.2	27.0	5.1	14.4	61.7	0.0	0.0	0.0	61.7
13	15.8	27.0	7.1	14.4	64.3	0.0	0.0	0.0	64.3
15	15.5	27.0	7.1	14.4	64.0	0.0	0.0	0.0	64.0
17	8.2	27.0	7.1	21.7	64.0	0.0	0.0	0.0	64.0
18	0.0	0.0	0.0	0.0	0.0	2.1	5.4	7.5	7.5
19(a)	0.0	0.0	0.0	0.0	0.0	4.7	6.0	10.7	10.7
19(b)	0.0	0.0	0.0	0.0	0.0	4.3	8.3	12.6	12.6
20	15.5	27.0	7.1	14.4	64.0	4.3	4.3	8.6	72.6
21	15.5	0.0	7.1	14.4	37.0	4.3	4.3	8.6	45.6

1 Resulting from cut off of flows at the apex.
2 Resulting from cut off of flows at secondary (North Beardsley Wash) apex.
3 Resulting from cut off of channel bends and braids along flood-control channel.
4 Not estimated.
5 Indirect impacts to Pima Floodplain are less than shown for Alternative 18 due to floodplain overlap. Reata Pass/Beardsley Wash impacts shown for Alternatives 10 to 18 actually extend into the Pima Floodplain overlap area.