Reata Pass/ Beardsley Wash Alignment Study

Alluvial Fan Task Force
November 1992
Adopted November 17, 1992

City of Scottsdale, Arizona

Parks Department, Plannning and Community Development Department, Transportation Department

Reata Pass/Beardsley Wash Alignment Study

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EXECUTIVE SUMMARY:

The Reata Pass/Beardsley Wash Alignment study was developed by the Reata Pass Task Force due to increased planning and development activity within the floodplains north of the Central Arizona Project (CAP). The primary objective for the task force was to identify and develop a stormwater management plan for the Reata Pass and Beardsley Washes and their associated floodplains which will:

- reduce flood hazards and the need for flood insurance
- integrate with the existing environment
- maximize the potential for project implementation and funding
- provide and integrate public recreational and cultural facilities

The task force proposes management of the stormwater runoff in a channel alignment which is sensitive to existing desert topography, land ownerships, and consistent with planned land uses and transportation networks. A conceptual Desert Greenbelt design for stormwater management integrates a variety of environmentally sensitive outdoor recreational opportunities and embodies Scottsdale's cultural heritage.

The task force examined existing Sonoran Desert conditions and engineering standards to develop four potential channel alignments for the routing of stormwater flows to storage basins north of the CAP and are listed as follows:

- Reata Pass Wash Alignment
- Beardsley Wash Alignment
- Thompson Peak Alignment
- Southwestern Alignment

In addition to these four alignments the task force considered a "No Action" alternative.

Based on the goals and objectives identified by the task force these four alignments were rated according to their impacts in the following categories:

- Land use
- Right-of-Way Acquisition
- Hydraulic Considerations
- Environmental Impacts
- Cost

The Reata Pass Alignment was identified as the preferred alternative based upon the evaluation criteria and preliminary cost analysis of the four alignments. This alignment was considered favorable due to its environmental sensitivity, consistency with the Desert Greenbelt concept and the goals and objectives identified by the study.

The task force recommends a further in-depth study of the Reata Pass Wash Alignment. The purpose of such a study will be to determine final engineering and cost feasibility for this alignment as well as to determine the best possible final alignment for stormwater management. Additional research and development of an implementation plan and identification of short and long term funding mechanisms must also be established.

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1.0 INTRODUCTION

In the 1960's the City of Scottsdale was confronted with increasing development upon the Indian Bend Wash Floodplain. Due to the flood hazards associated with this, the City began reviewing alternatives for a stormwater management plan. Faced with the possibility of a concrete lined channel running through the heart of the City, the citizens of Scottsdale proposed a Greenbelt concept form of flood control. In place of the proposed concrete channel, a lush vegetated system of parks would be used to not only provide stormwater control, but as an asset to the City and its citizens by providing a center for recreational activities and cultural events year round.

Following severe flooding along the wash in the early 1970's, the citizens of Scottsdale approved a bond for the construction of the Indian Bend Wash Greenbelt. The resulting system has proven to be an award winning method of effectively managing floodwaters while maintaining and providing cultural and recreational benefits to the entire community.

Following growth in the 1980's, Scottsdale again finds itself with similar issues of expansion and proposed development in the floodplains north of the Central Arizona Project (CAP). Described as alluvial fans, these floodplains are fundamentally different from familiar riverine floodplains and impose difficult drainage conditions for development. Because of these conditions and the desire to conserve and protect as much of the natural Sonoran Desert resource as possible, the City is once again exploring alternative methods of managing floodwaters. The goals of such management would be to reduce the flood hazard, reduce/remove the need for high cost flood insurance, protect the existing environment, and benefit the community by integrating planned recreational and cultural facilities.

Since the natural Sonoran Desert character and the amount of floodwater make a lush Greenbelt concept inappropriate, a new Desert Greenbelt concept is being considered. This type of greenbelt differs significantly from the standard Greenbelt concept used on the lower Indian Bend Wash. Instead of constructing a wash with grass and trees, native areas will be left as unchanged as possible, and improved areas will use native plants and materials to maintain the character of the natural surrounding Sonoran Desert. Once again, in place of a concrete lined drainage channel, a stormwater management facility within the natural desert environment will be integrated with adjoining land uses and amenities for recreation and cultural activities.

The purpose of this study is to review the flooding hazards, identify goals and objectives for stormwater management, review conceptual channel cross sections, and recommend potential channel alignments that will be integrated as part of an overall Regional Stormwater Management Plan. This report is not intended as a design report, but instead focuses on identifying a conceptual channel alignment for Reata Pass and Beardsley washes.

2.0 PROBLEM STATEMENT

After the adoption of the drainage element of the City of Scottsdale General Plan for the area north of the CAP, the Federal Emergency Management Agency (FEMA) identified boundaries of potentially hazardous flooding conditions by delineating flood hazard zones. Generally in the floodplains north of the CAP, these flood zones occur on alluvial fans created by the erosion of upstream mountain ranges; the "AO" zone being the most hazardous of these zones.

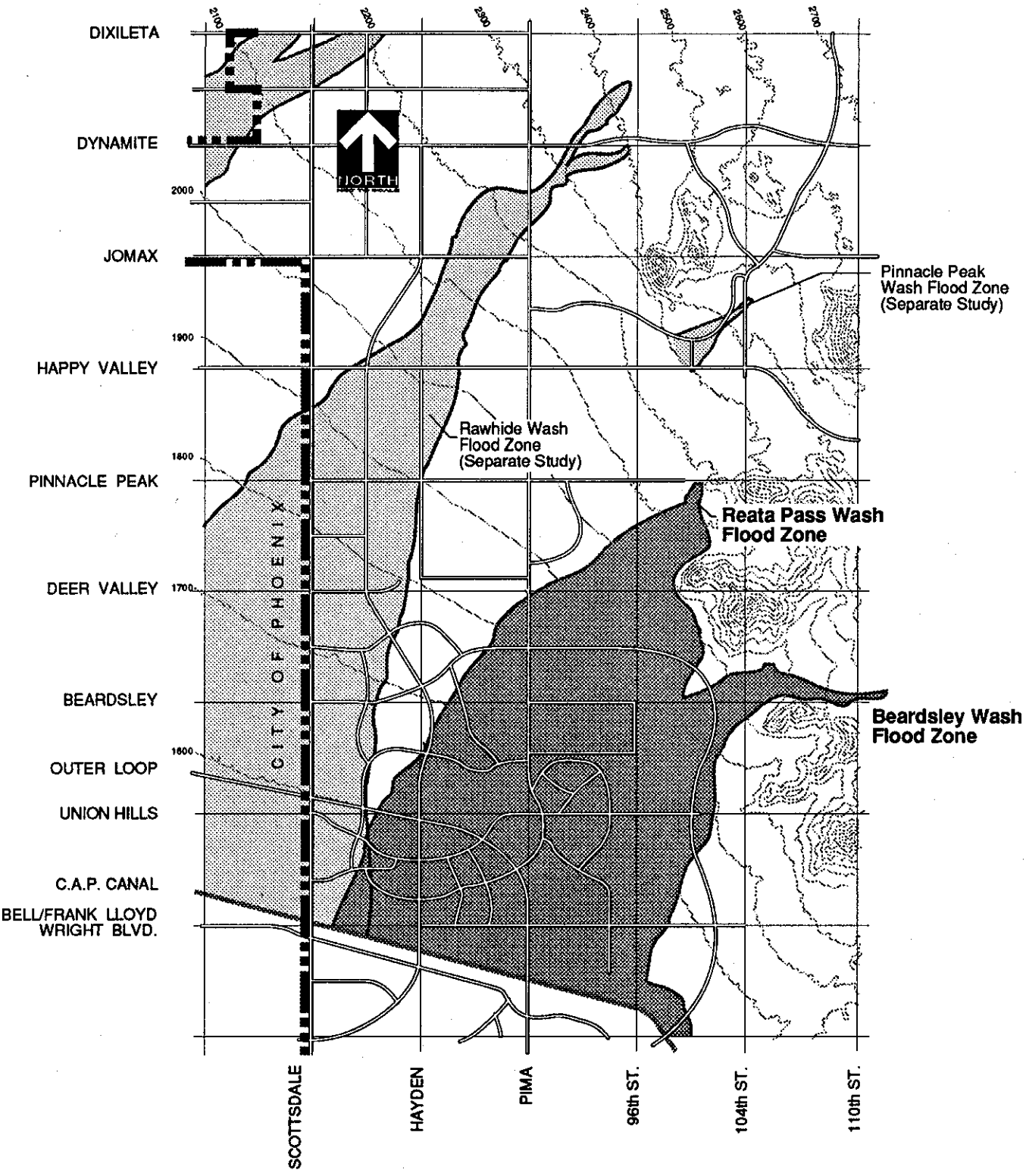
Constraints have been placed on development occurring in AO zones designated by FEMA that require property owners to elevate building pads to protect the structure from flooding. Further constraints mandate that lending organizations require the purchase of flood insurance to mitigate their risk. Large portions of currently undeveloped and low intensity land north of the CAP have been identified by FEMA as an alluvial fan AO zone and are subject to these requirements. The areas effected are shown in Figure 1.

Results of investigations of actual alluvial fan flooding events throughout the arid southwestern portion of the United States indicate alluvial fans do not have predictable drainage patterns, even when some defined natural watercourses exist (Figure 2). Most natural channels are only capable of containing more frequent two to five year flood events from bank to bank, larger less frequent events are not confined within these channels. This lack of confinement, as well as the loose sediment of the alluvial fan, creates the problem of major floodwaters quickly establishing new flow paths quite unpredictably during each new flood event and is the cause for most flooding hazards.

In typical riverine systems the overbank flows that occur in larger flood events are usually contained within adjacent land formations such as river terraces or valley side slopes which parallel the main channel. In alluvial fan situations such as north of the CAP, once the channels emerge from the McDowell Mountains on to the alluvial fan slopes there are no confining land formations to contain larger overbank flood flows. Due to this lack of confinement, it is not appropriate to rely on the location of previous flow paths to predict future flow paths and hazardous locations.

Since the flows from the apex of the Reata Pass and Beardsley washes have the potential of moving across the entire fan area unpredictably, large areas of land are affected and subject to potential flooding, requiring elevated building pads and flood insurance (Figure 1). Such potential flooding imposes a threat to life and property for any level of existing or proposed development. Severely elevated building pads adversely impact the Sonoran Desert environment, and flood insurance creates an additional obstacle to cost effective development and places an economic burden on existing and future residents.

To remove these problems and to encourage sensitive development anticipated by the General Plan, stormwater management must be provided.



Legend

Reata Pass/Beardsley Alluvial Fan Flood Zones

Additional Alluvial Fan Flood Zones

Note: The purpose of these figures is completely illustrative only. For more detailed information, contact the City of Scottsdale.

Figure #1:
Alluvial Fan Flood Zones

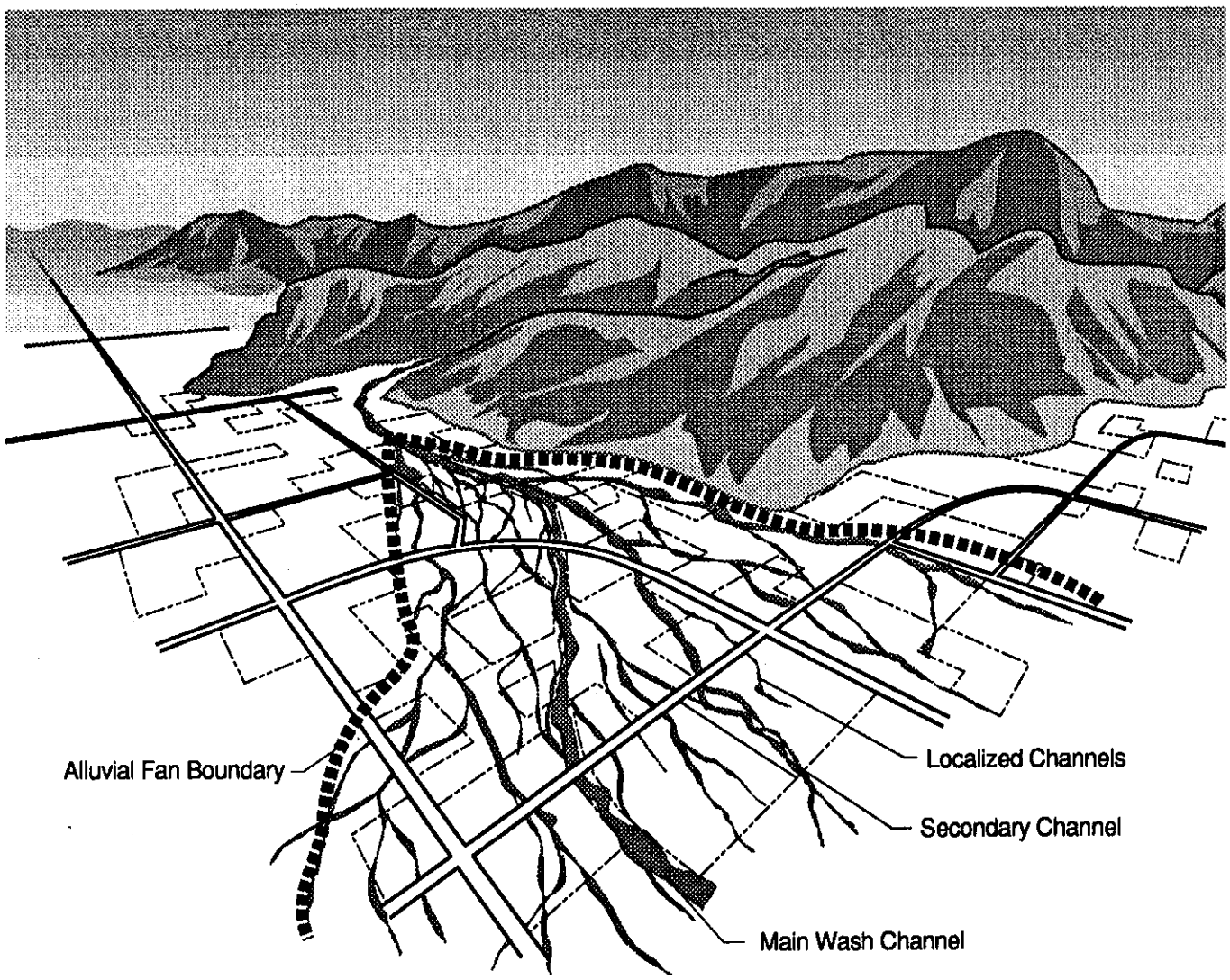


Figure #2:
Conceptual Alluvial Fan Channel Distribution

3.0 GOALS

The following goals were established to research, develop, and select a stormwater management system for the alluvial fan hazards of Reata Pass and Beardsley washes.

- Identify channel alignments which will:
  - -Manage peak flows of Reata Pass and Beardsley washes.
  - -Partially or completely remove the threat of property damage or loss of life due to alluvial fan flooding.
  - -Utilize and retain as much of the existing natural desert channels and environment as possible.
  - -Effectively integrate with land ownerships, planned land uses, and transportation net works.
  - -Maximize public benefits, including recreational, aesthetic, and cultural.

- Remove the "AO" designation from the fans, thus removing the need for flood insurance and reducing the height of building pads.

Such a system would be a significant component of a stormwater management plan for each individual fan, which would be integral to a regional stormwater management plan for the areas of Scottsdale north of the CAP.

4.0 THE DESERT GREENBELT AND STORMWATER MANAGEMENT

Managing alluvial fan stormwater hazards in the Sonoran Desert setting of Rawhide and Pinnacle Peak washes offers some unique challenges. Taking into consideration the area's natural attributes, as well as the engineering and hydraulic restrictions, it has become apparent that the type of Greenbelt seen in the Lower Indian Bend Wash area would be incompatible with the Sonoran Desert and unachievable in this area. However, by combining the Greenbelt approach to stormwater management with sensitivity to the natural environment, a "Desert Greenbelt" would provide a drainage solution that combines the advantages of an Indian Bend Greenbelt with the existing Sonoran Desert environment.

Unlike the Indian Bend Wash facilities, the majority of the Desert Greenbelt would be native or revegetated to native appearance and provide passive recreational facilities within the drainage channel. Passive activities and facilities, such as multi-use trails, nature areas, and picnic facilities, have minimal impact on existing or proposed land uses surrounding the channel. Activity hubs are envisioned where park dedication sites adjoin the channel. Although no park sites are currently planned for either of these washes, such hubs could offer the more traditional park/ recreational facilities such as ball fields, courts, and playgrounds. In either passive or traditional recreational facilities, the right-of-way associated with the drainage facilities necessary for a stormwater management plan would be utilized.

When discussing a stormwater management plan for a specific watershed in conjunction with the Desert Greenbelt System, certain differences between the two should be made clear. The Desert Greenbelt System attempts to protect the alluvial fan areas of a major wash from flooding caused primarily by runoff generated upstream of the apex. This protection then removes the fan from a FEMA "AO" zone, thereby eliminating the need for costly flood insurance and severely elevated building pads. A stormwater management plan must deal with the upstream runoff as well as flows generated downstream of the apex and the increase in flows due to development.

By dealing with runoff generated from mountain ranges and high desert areas to the north, or off-site runoff, the Desert Greenbelt System provides the "backbone" of a system for conducting stormwaters from the point where they are no longer naturally contained, safely through inhabited areas, to an area where they can be detained or retained (Figure 3).

Just as the major natural washes rely on smaller localized channels to convey stormwater generated locally, or on-site runoff, so to does a stormwater management plan. Under such a plan, the Desert Greenbelt System, in conjunction with existing washes and other drainage facilities such as channels, storage facilities, levees, etc., would form the backbone of a stormwater management plan. Smaller channels and existing natural channels would be required to remove on-site generated runoff to the Desert Greenbelt System safely and reliably.

Although the goals of the two overlap, the Desert Greenbelt System functions as only a part of an overall stormwater management plan, focusing primarily on off-site runoff. As development continues in the desert areas north of the CAP, the problem of increased on-site runoff will continue to grow. Currently, each individual development must provide storage or direct stormwater through or around their property to existing outlet points downstream. Without the

direction and guidance a stormwater management plan provides, these individual solutions are often harmful to the environment and compound drainage problems downstream.

Even though having the Desert Greenbelt System in place would remove the threat of flooding capable of property damage and hazardous conditions on alluvial fans, it would not remove the threat of localized flooding from on-site runoff. Establishing the Desert Greenbelt System as a "backbone", development, with a planned direction and guidance could occur within the desert resulting in less disruption to the environment and be the foundation for a unified, reliable drainage network.

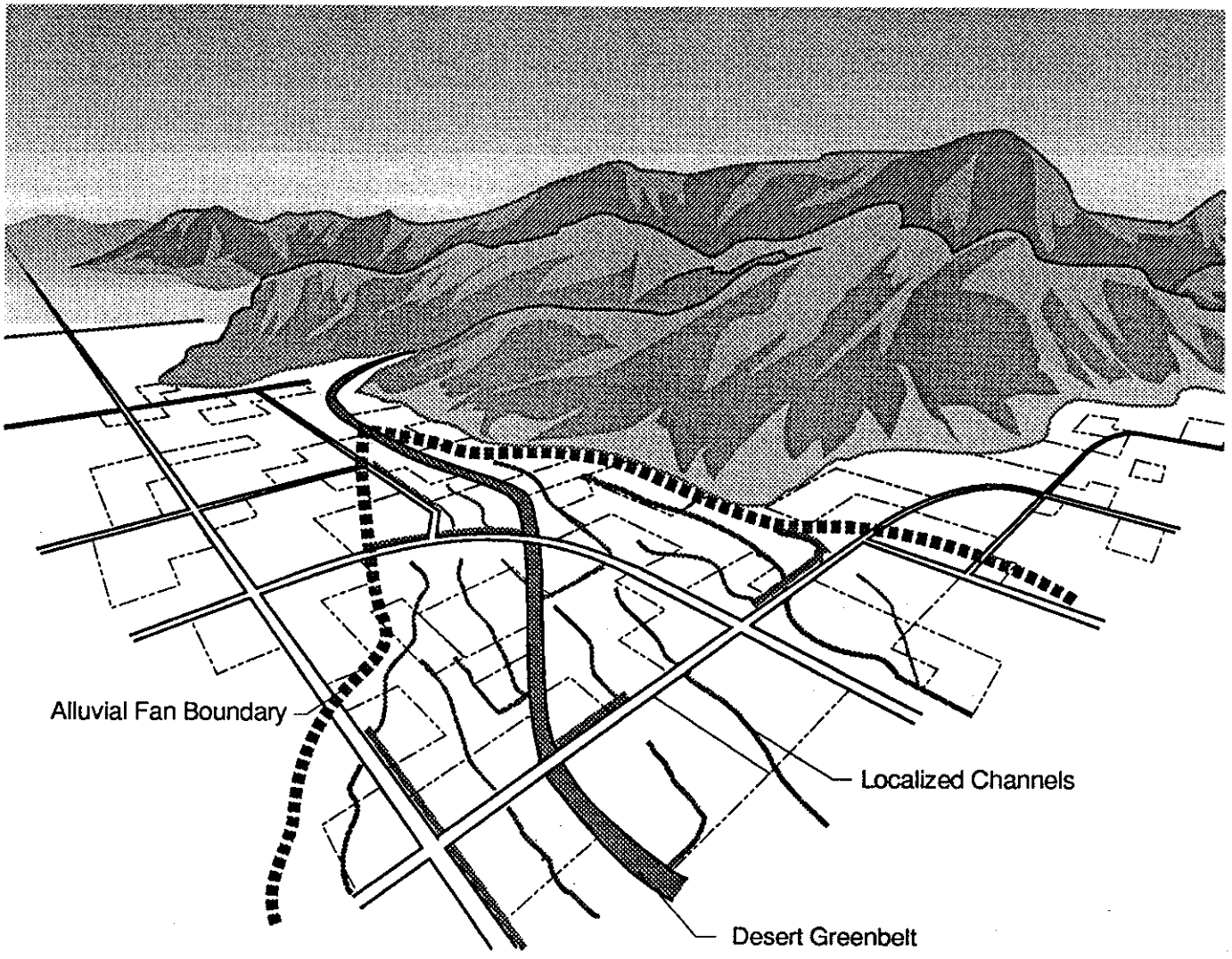


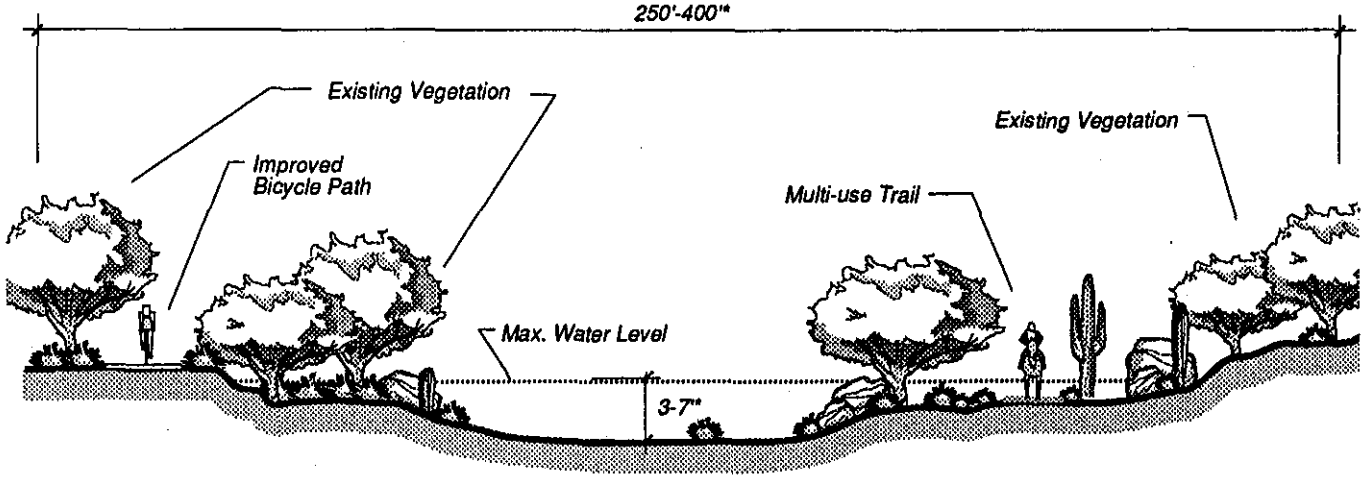
Figure #3:
Conceptual Stormwater Management Plan

5.0 CONCEPTUAL CHANNEL CROSS SECTIONS

Each of the alignment alternatives identified have locations where varying degrees of improvements would be required to assure that floodwaters would remain within the existing or planned channels. For the sake of illustration, the typical cross sections of these various configurations have been separated into the four most commonly needed improvements. The exact design of each individual cross section will vary depending upon engineering requirements, with the most commonly occuring cross sections as follows: Natural Containment, Partial Containment, Uncontained Flow, and Cut Sections.

5.1 NATURAL CONTAINMENT

Areas of natural containment are where the existing natural channel is able to contain floodwaters with nominal improvements and/or structural modifications. This results in minimal disruption to the channel and the surrounding vegetation. Improved bicycle paths and non-paved multi-use trails would be established with limited disruption to existing channel vegetation along either side as topography allows.



Typical Characteristics:

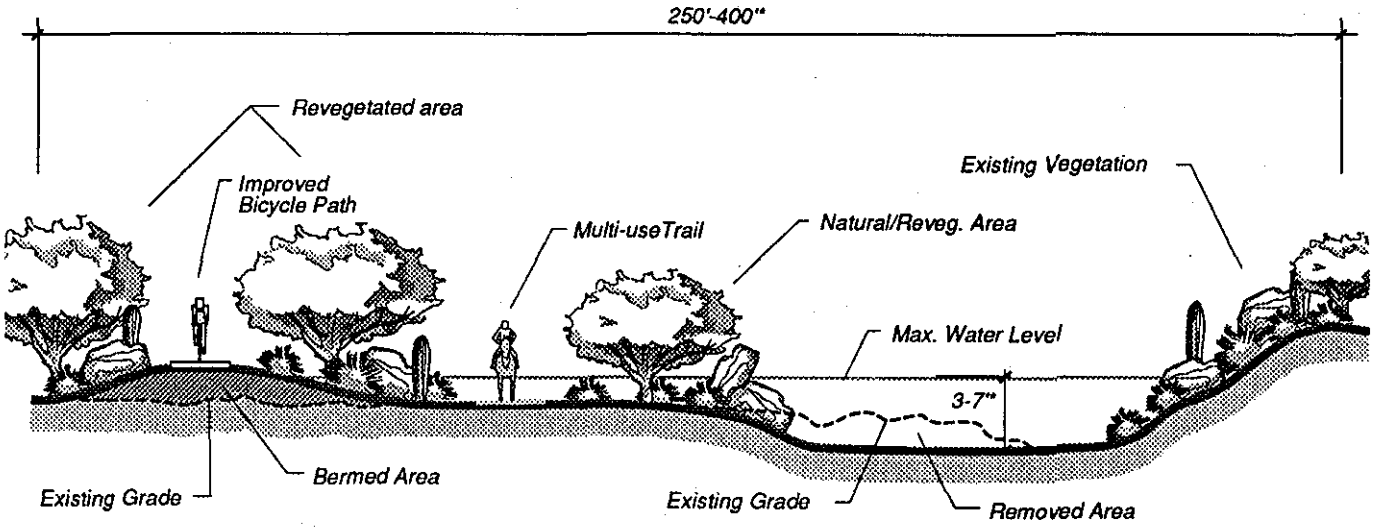
Not To Scale

- *3'-7' deep X 250'-400' wide existing, natural channel.*
- *Provides for multi-use trails and bicycle paths on either side of channel.*
- *Minimal disruption of existing channel and vegetation.*
- *Sufficient capacity exists within the natural channel for floodwaters.*

**Width and depth are dependent upon hydraulics, existing capacity and planned improvements.*

5.2 PARTIAL CONTAINMENT

Used in areas where the natural channel has the ability to contain some, but not all of the floodwaters, a partial containment channel would maintain the natural channel and vegetation where possible. The existing channel might be partially excavated to provide a low flow channel within the existing wash, and small berms may be added to ensure containment of floodwaters. The existing natural channel and vegetation would be retained where possible, with disturbed areas revegetated to blend with the existing surroundings. Once again multi-use trails and bicycle paths would be established.



Typical Characteristics:

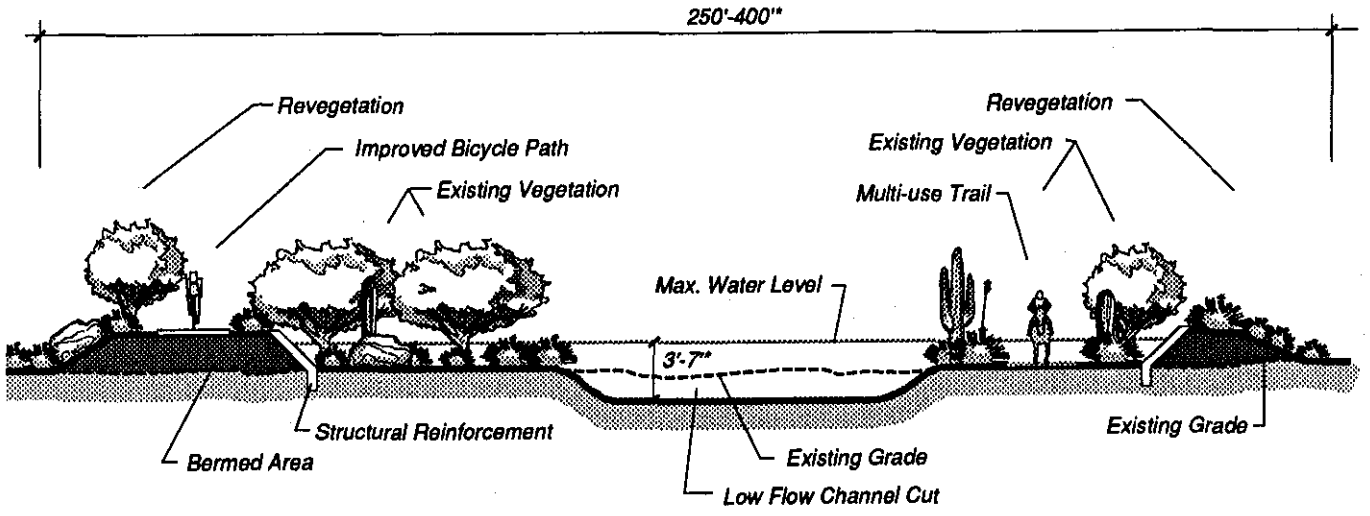
Not To Scale

- *3'-7' deep X 250'-400' wide existing, natural channel.*
- *Provides for multi-use trails and bicycle paths on either side of channel.*
- *Partial improvement required to natural channel through berming and /or excavation.*
- *Existing vegetation blended with revegetated areas.*
- *Used in areas where natural channel has the ability to contain some but not all floodwaters.*

**Width and depth are dependent upon hydraulics, existing capacity and planned improvements.*

5.3 UNCONTAINED FLOW

In areas where little or no existing channel is evident, generally the flatter slopes of the alluvial fan, extensive improvements are required to contain flood waters. In areas where right of way concerns are evident, and space is limited, an entirely man-made channel would have to be constructed to enclose the floodwaters. Such a channel would require structural reinforcement to meet with federal standards and would require significant revegetation as much of the existing vegetation would be disturbed during the construction process. Existing vegetation would be salvaged and reused. Amenties would include multi-use trails and bicycle paths.



Typical Characteristics:

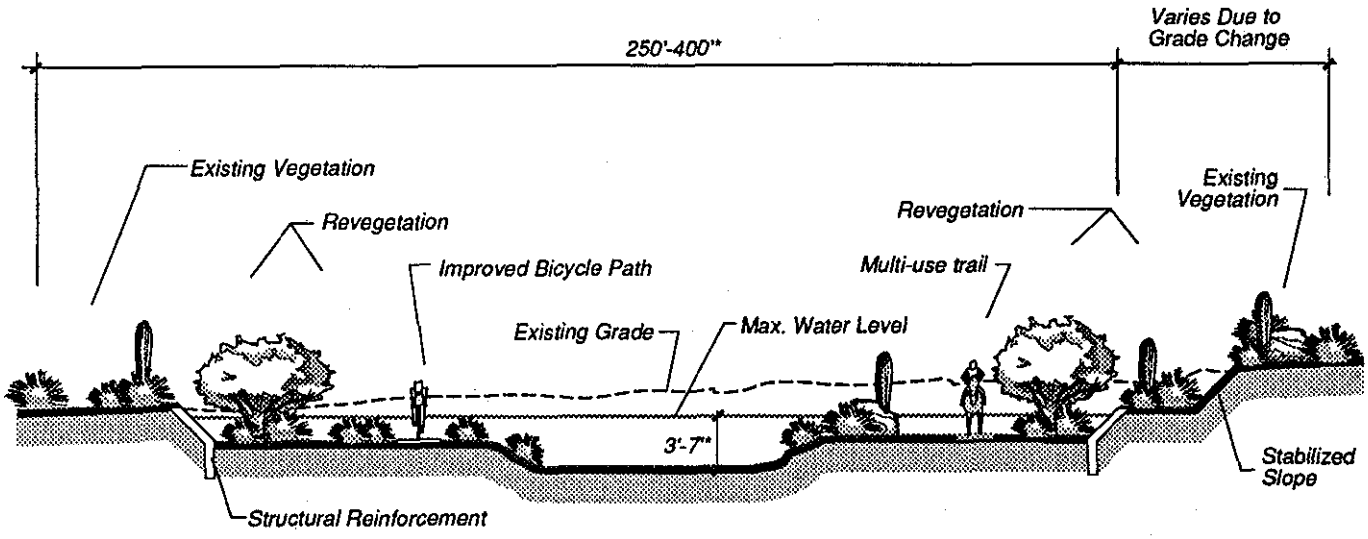
Not To Scale

- *3'-7' deep X 250'-400' wide stucturally reinforced channel*
- *Provides for multi-use trails and bicycle paths on either side of channel.*
- *For use in areas where little or no channel is in existence.*

**Width and depth are dependent upon hydraulics, existing capacity and planned improvements.*

5.4 CUT SECTIONS

In areas where the channel must be removed from existing washes a cut section must be excavated to maintain flow of the floodwaters. Since the entire channel is being created by removing the existing landscape, the channel must be structually reinforced and completely revegetated at significant cost.



Not To Scale

Typical Characteristics:

- *3'-7' deep X 250'-400' wide man made channel.*
- *Provides for multi-use trails and bicycle paths on either side of channel.*
- *Major disruption of surrounding desert.*

**Width and depth are dependent upon hydraulics, existing capacity and planned improvements.*

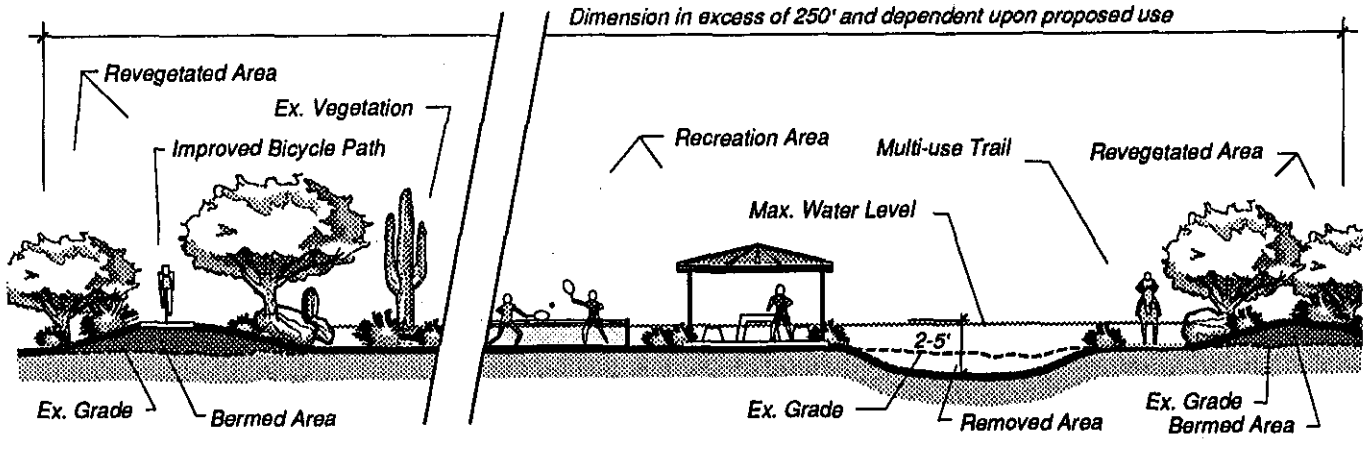
5.5 RECREATION AREA (Shown Below)

Just as with uncontained flow channels and cut sections, recreation areas could be used within sections having little or no existing channel. However, when allowed to become wider in areas where right-of-way is not severely restricted and adjacent land uses allow and/or assist, such sections would require less harsh measures to contain floodwaters. Berming and/or excavation will still be needed, but at a smaller scale. In areas where a cut section would not be needed, the existing vegetation would not be completely removed, but blended with areas of revegetation as in the uncontained flow section. This wider section lends itself to a more heavily used type of park system allowing a combination of multi-use facilities such as trails, ball fields and courts, playgrouds, ramadas, etc. As this section is dependent upon right-of-way and planned adjacent land uses, in areas where such factors are not available, sections more typical to uncontained flow/ cut sections would be used as topography dictated.

This type of multi-objective facility would only be incorporated at locations where the General Plan anticipates such facilities (i.e. school/park) adjoining to the proposed alignment alternatives.

5.6 TRIBUTARY CHANNEL

For all Wash alignment options, tributary channel improvements will be required in addition to the main channel improvements listed. In some of these areas the existing natural wash will be capable of containing the floodwaters that are not being conveyed in the main channel. Where the existing natural washes need to be improved it is estimated that approximately 110 foot of right-of-way would be required as well as structural reinforcement for bank protection. The channel would be landscaped to appear as natural as possible and passive recreational amenities would be encouraged where appropriate.



Typical Characteristics:

Not To Scale

- *2'-5' deep channel.*
- *Provides bicycle paths on either side of channel.*
- *Provides for multi-use trails within channel as well as weaving along banks.*
- *For use in areas where there is little or no channel or natural channel will not contain all floodwaters in place of Uncontained Flow section.*
- *Channel width/depth and alteration amount are determined by the amount of right-of-way available.*
- *Construction of tennis courts, golf courses, picnic ramadas, etc. depending upon right-of-way available.*

6.0 DESCRIPTION OF REATA PASS/BEARDSLEY WASH AND DOWNSTREAM ALLUVIAL FAN AREA

Originating at the mouth of a canyon south of Pinnacle Peak Road and west of the McDowell Mountain Range, the Reata Pass Wash apex begins breaking out of it's natural path and creates a drainage fan that spreads to the southwest, bordered to the east by the foothills of the McDowell Mountains, and spreading west nearly to Scottsdale Road. The toe, or southern boundary of the fan, ends north of the CAP. The areas south of the apex are where unpredictable flooding occurs.

A major problem, typical of alluvial fans, is the ability of the entire flow to move in an unpredictable manner. South of the apex of the Reata Pass Wash the flow could either move to the southwest, move due south, or anywhere between these two extremes. The flows from the Reata Pass Wash could end anywhere within the eastern United States Bureau of Reclaimation (USBR) retention basin or the western USBR basin.

A second mountain canyon drains into the Beardsley Wash which adds to stormwater runoff on the alluvial fan area. There are two separate branches of the Beardsley Wash located south and east of the Reata Pass Wash apex that drain southwesterly across the Reata Pass fan. A stormwater management plan must include the floodwaters of both the Reata Pass and Beardsley watersheds.

Through examination and study of existing conditions and general engineering standards, four potential channel alignments were identified as possible routes to contain stormwater on these fans. The approximate alignments for these channels are shown in Figure 4.

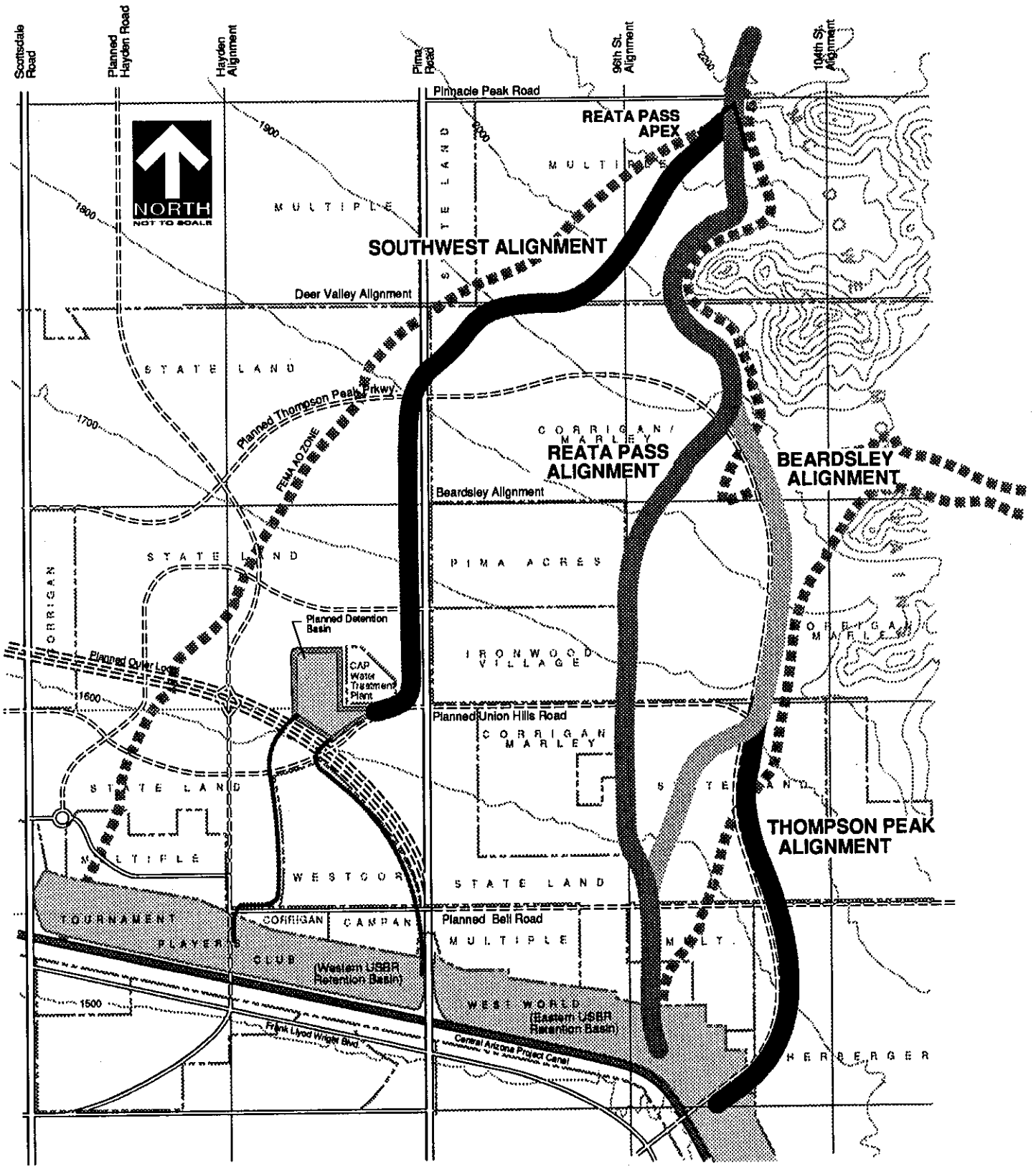


Figure #4
Potential Alignments

Note: The purpose of these figures is completely illustrative only. For more detailed information, contact the City of Scottsdale.

7.0 DESCRIPTION OF POTENTIAL STORMWATER MANAGEMENT ALTERNATIVES

One of the primary goals of this report was to focus on identification of a conceptual channel alignment for Reata Pass/Beardsley Washes. Through site examination, engineering principles, and planning concerns, five alternatives were selected. Each of the alternatives was selected with the purpose of developing a conceptual stormwater management system sensitive to the existing desert topography, land ownership and consistent with the proposed land uses and planned transportation networks while maximizing public benefits within the spirit of the City of Scottsdale and the Desert Greenbelt concept.

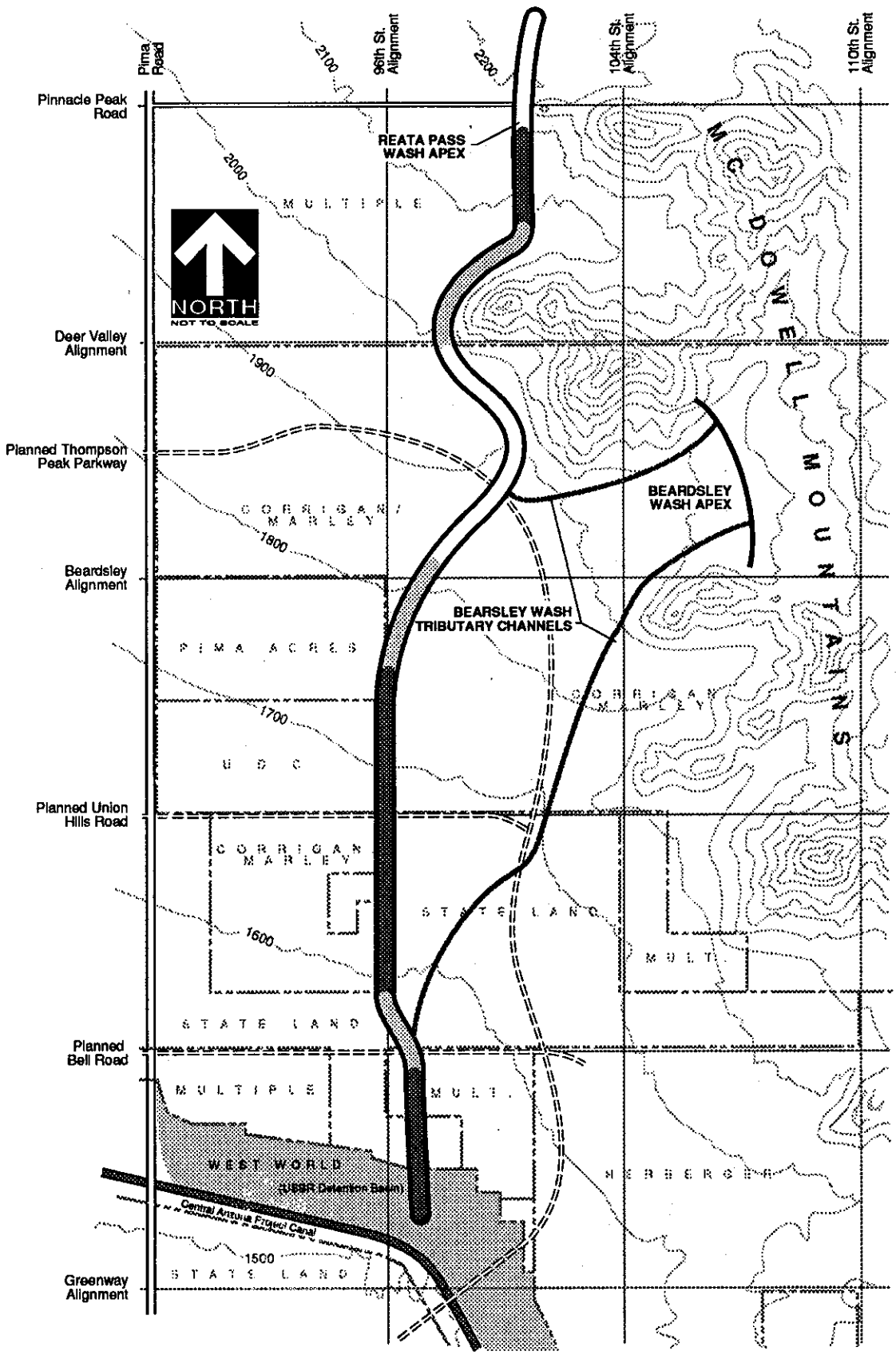
7.1 NO ACTION ALTERNATIVE

Without a structurally managed solution, development on the fans will be mandated by FEMA regulations which require the elevation of structures. Zoning intensities identified in the Scottsdale Land Use Element would be difficult to obtain and expensive to build. Elevated subdivisions, raised building pads, and mass graded subdivision plans would be required to protect property and lives from existing flood hazards. Even with such potentially inefficient changes, homeowners would still be required to purchase flood insurance from the National Flood Insurance Program. Little if any public benefit would be obtained from such measures, and the Sonoran Desert would be severely impacted.

In order to remove areas from special flood hazard areas, FEMA will only consider major flood mitigation measures supported by appropriate engineering analysis. These mitgation measures may include channels protected by dikes (berms) and detention basins.

7.2 REATA PASS ALIGNMENT

Collecting floodwaters from the mountain canyon north of Pinnacle Peak Road, the Reata Alignment begins in a wide natural, well defined, sandy channel. From it's apex south of Pinnacle Peak Road, the alignment runs through some existing single family developments following an existing wash with partial or no containment of floodwaters, until rounding the foothills of the McDowell Mountains and regaining a natural capacity channel again. Losing definition in it's mid section as it continues south, waters would be directed with improvements to existing channels that run to the west of the planned Thompson Peak Parkway through Corrigan-Marley and State Land ownerships into the eastern USBR basin. Portions of the Beardsley Wash floodwaters would be contained in two separate but smaller tributary channels (Section 6.3) following the Beardsley Wash Alignment which would connect to the Reata Pass Wash Channel.



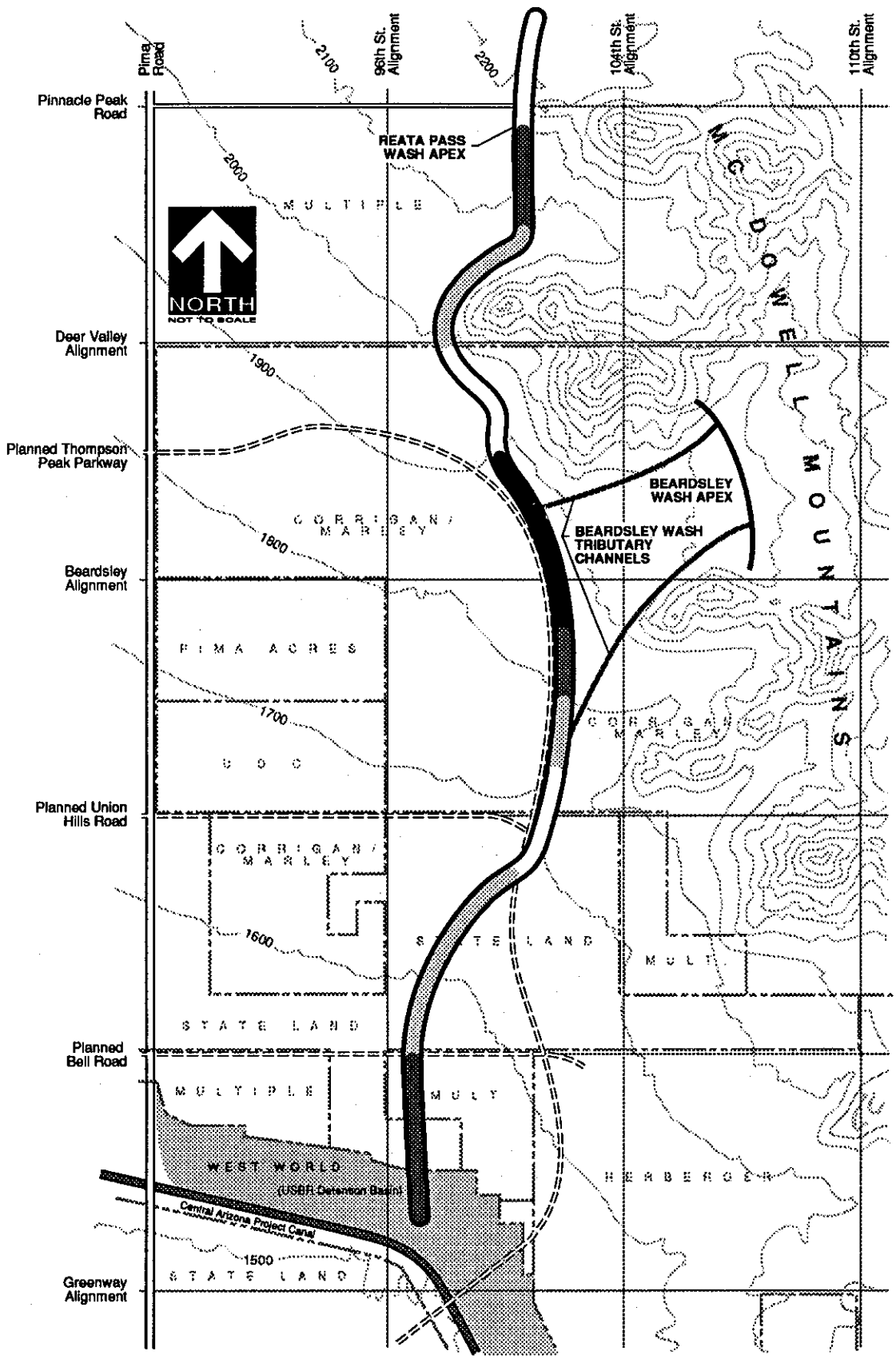
Containment Level

Natural | Partial | Uncontained flow | Cut section

Note: The purpose of these figures is completely illustrative only. For more detailed information, contact the City of Scottsdale.

7.3 BEARDSLEY WASH ALIGNMENT

Beginning within the same channel as the Reata Pass Wash Alignment, the Beardsley Wash Alignment is then directed to the east of the planned Thompson Peak Parkway following the mountain ranges. In doing so, the channel runs temporarily parallel to existing contours and must be heavily improved with cuts up to 40 feet in depth required to contain floodwaters. Above the Union Hills Road Alignment the wash again begins to use some existing channels until joining with the traditional Beardsley Wash channel, which to the north is a well defined, natural channel losing some definition as it nears Bell Road to the south. From here the floodwaters of both the Reata Pass and Beardsley Washes are combined and are directed south to the eastern USBR basin following existing braided channels.



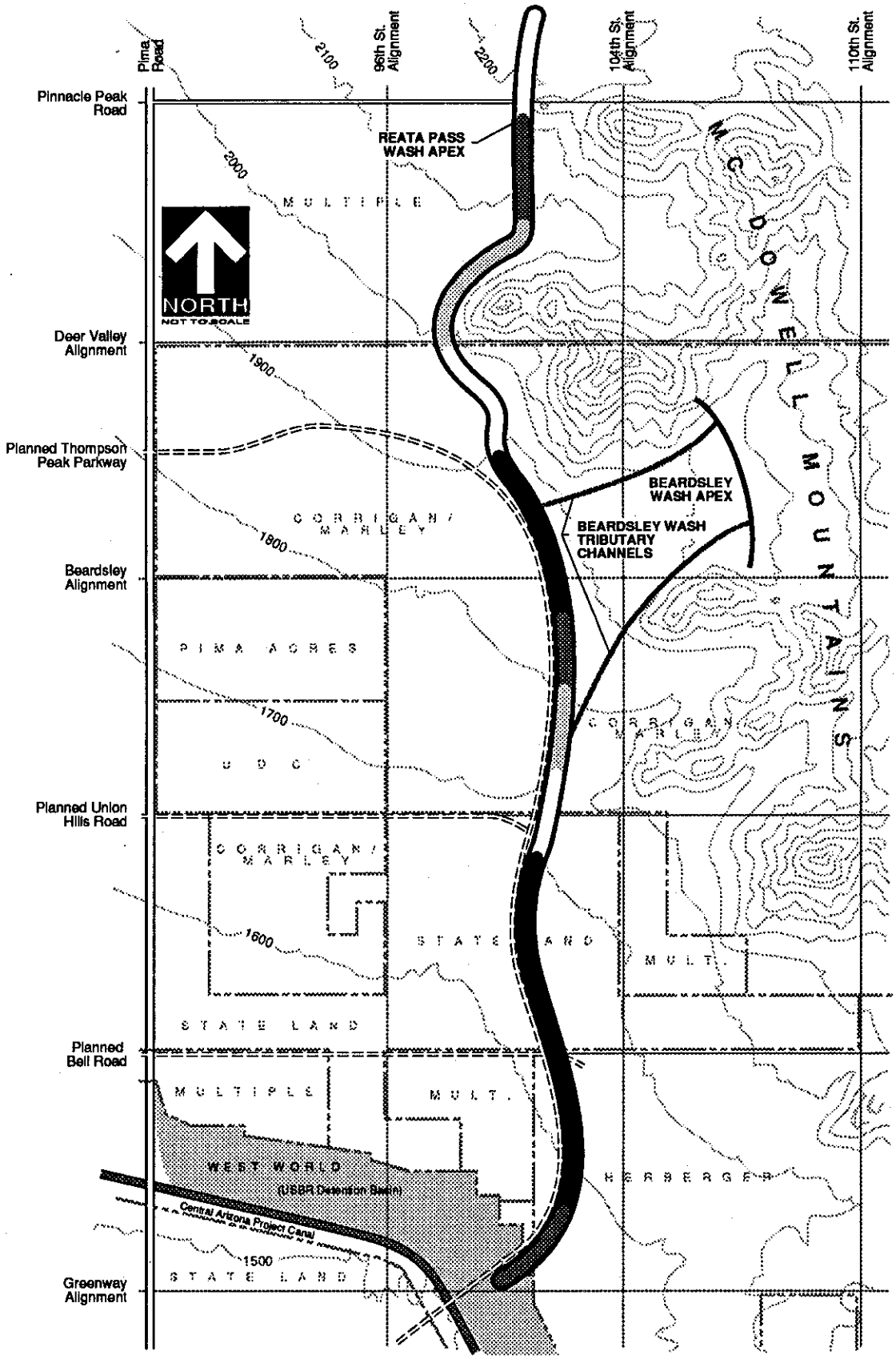
Containment Level

Natural | Partial | Uncontained flow | Cut section

Note: The purpose of these figures is completely illustrative only. For more detailed information, contact the City of Scottsdale.

7.4 THOMPSON PEAK ALIGNMENT

Collecting the floodwaters from both the Reata Pass and Beardsley Washes and following roughly the same route as the Beardsley Alignment, the Thompson Peak Alignment differs in that rather than directing the floodwaters to the west into the traditional Beardsely Alignment, the channel remains on the east side of the planned Thompson Peak Parkway. By doing this, the channel is taken away from existing channels creating a long section of channel which would run parallel to the existing contours. This would then require heavy improvements to bring the channel through the Herberger property to the eastern USBR basin.



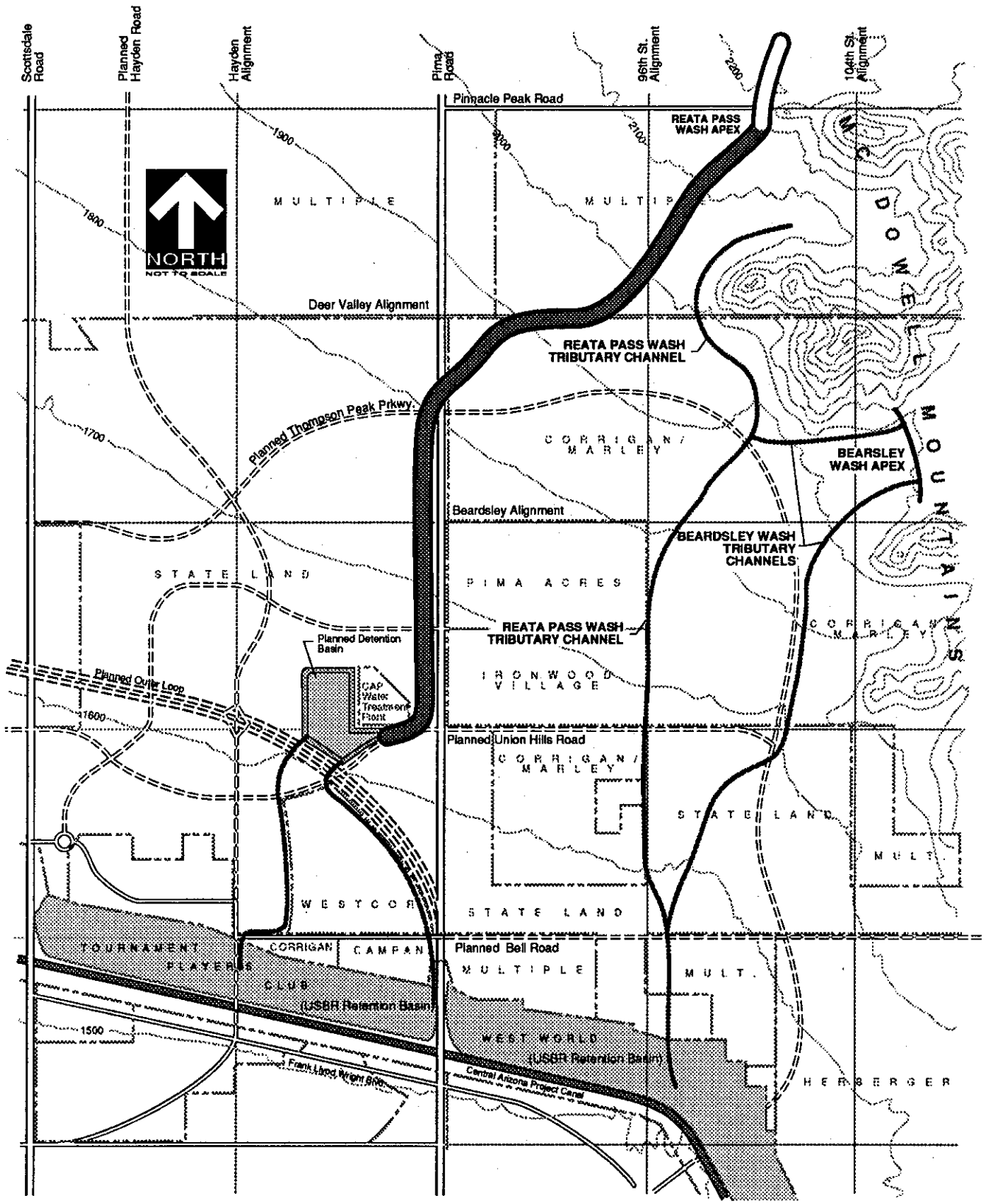
Containment Level

Natural | Partial | Uncontained flow | Cut section

Note: The purpose of these figures is completely illustrative only. For more detailed information, contact the City of Scottsdale.

7.5 THE SOUTHWESTERN ALIGNMENT

Collecting the Reata Pass Wash floodwaters at the mountain canyon north of Pinnacle Peak Road, the Southwestern Alignment is directed southwest over uncontained channels through some existing single family developments and the northwestern corner of Corrigan-Marley property. From there the channel crosses Pima Road into State Land property and continues to use uncontained channels as it follows Pima Road to a planned detention basin north of the planned Outer Loop (the planned detention basin is part of the approved Core North Development Plan). From this basin, separate channels would carry the floodwaters to the western USBR basin to the south. Separate and smaller tributarty channels would be required to manage the floodwaters of both the southern Reata Pass Wash and Beardsley Wash watersheds.



Containment Level

Natural | Partial | Uncontained flow | Cut section

Note: The purpose of these figures is completely illustrative only. For more detailed information, contact the City of Scottsdale.

8.0 EVALUATION CRITERIA

In order to determine which proposed channel alignment best meets the identified goals and objectives the alignments were rated by members of the City staff task force according to their impacts in the following categories:

Land Use:
- existing land uses
- proposed land uses
- major utility corridors
- transportation system
- recreational/open space
- existing drainage facilities

Right-of-Way Acquisition
- number of affected property owners
- degree of existing improvements within right-of-way
- relative cost of right-of-way acquisition
- availability of existing right-of-way and/or easements

Hydraulic Considerations
- effects on USBR retention basins
- erosion and sedimentation
- channel cross section characteristics

Environmental Impacts
- cuts and fills
- vegetation
- wildlife
- archeological
- viewshed
- geology

The individual category and overall ratings as reviewed by the City staff task force are sumarrized on the following pages.

8.1 EVALUATION OF ALIGNMENT ALTERNATIVES

The figures below are an average of the responses of the city staff task force members using the following evaluation criteria:

Rank:1-5
Accurately describes=5
Various Accuracy levels=2-4
Inacurately describes=1

	Reata Pass	Beardsley	Thompson Peak Pkwy	Southwestern
LAND USE				
The proposed alignment causes minimal disruption to the existing land uses.	4.3	4.3	4.0	2.2
The proposed alignment does not hinder or prohibit future and proposed land uses.	4.3	4.3	3.5	3.5
The proposed alignment does not impact or excessively cross any existing or planned major utility corridors.	3.7	3.8	3.8	2.0
The proposed alignment does not impact or excessively cross any existing or planned transportation routes.	3.5	3.4	3.3	2.2
The proposed alignment provides opportunities for the inclusion of open space tracts with passive rec. facilities.	4.7	4.7	3.3	3.3
The proposed alignment takes advantage of existing drainage facilities such as culverts and channels.	3.6	3.4	2.0	2.3
Average Land Use Rating:	**4.02**	**3.98**	**3.31**	**2.58**
RIGHT-OF-WAY ACQUISTION				
The proposed alignment has few property owners who must be negotiated with to aquire necessary right-of-way.	3.3	3.3	3.5	2.7
The proposed alignment requires no removal and demolition of existing improvements or developments.	4.3	4.3	4.3	4.0

Rank:1-5 Accurately describes=5 Various Accuracy levels=2-4 Inacurately describes=1	Reata Pass	Beardsley	Thompson Peak Rkwy	Southwestern
RIGHT-OF-WAY ACQUISTION				
The proposed alignment's right-of-way is made up of predominately low cost land.	3.3	3.7	3.7	2.7
The proposed alignment takes advantage of existing or stipulated right-of-ways, easements, and/or open space tracts.	3.8	3.7	3.0	2.7
Average ROW Acquisition Rating:	**3.68**	**3.75**	**3.63**	**3.28**
ENVIRONMENTAL IMPACTS				
The proposed alignment minimizes the extent of disturbance associated with the construction of improvements.	3.3	2.7	1.8	2.2
The proposed alignment does not disturb significant stands of natural vegetation.	2.4	2.6	1.8	2.0
The proposed alignment imposes no threat upon any significant wildlife sanctuaries or habitats.	3.8	3.8	3.8	3.8
The proposed alignment does not disrupt or disturb any known archeological sites.	4.3	4.3	4.3	4.3
The proposed alignment and associated improvements do not affect the surrounding viewshed.	3.6	2.5	1.8	3.0
The proposed alignment does not significantly disrupt any known geological features such as major rock outcroppings.	4.8	4.8	3.8	4.8
Average Enviromental Impact Rating:	**3.70**	**3.45**	**2.88**	**3.35**
HYDRAULIC CONSIDERATIONS				
The proposed alignment does not require any modification or retrofitting of existing drainage facilities.	3.7	3.7	4.0	3.7

Rank:1-5 Accurately describes=5 Various Accuracy levels=2-4 Inacurately describes=1	Reata Pass	Beardsley	Thompson Peak Pkwy	Southwestern
HYDRAULIC CONSIDERATIONS				
The proposed alignment facilitates the construction of a channel cross-section which provides reasonable depths of flow, flow velocities, and widths of flow during various storm events up to and including a 100 year event.	4.6	4.6	2.8	3.8
The proposed alignment minimizes erosion and sedimentation problems.	3.8	2.3	2.0	2.3
Average Hydraulic Consideration Rating:	**4.03**	**3.53**	**2.93**	**3.20**
Overall Average Rating:	15.43	14.71	12.75	12.41

NOTE:
The no action alternative was not ranked because the evaluation criteria specifically related to the alternative alignments. The task force is not recommending the no action alternative for the following reasons:

- Building pads would need to be severely elevated, thereby impacting the desert environment.
- The areas could not be removed from special flood hazard areas and flood insurance would be required.
- Zoning intensities identified in the General Plan would be difficult to obtain.
- Sporadic drainage improvements created would be:
  - -inadequate in that drainage problems are transferred to other sites and;
  - -inefficient compared to an integrated regional plan which links the entire watershed and realizes an associated economy of scale.
- Costs of approximately from 130 million dollars would be required for flood protection, construction, and flood insurance over a 30 year time frame in a no action alternative for the Reata Pass/Beardsley Wash AO zones.

8.2 ALTERNATIVE CHANNEL ALIGNMENT COST DATA

	Reata Pass	Beardsley	Southwestern
Excavation[1]	$ 569,700	$ 3,333,800	$ 833,800
Berms	$ 955,900	$ 560,700	$ 1,520,100
Soil Cement	$ 4,030,700	$ 2,937,000	$ 6,411,500
Grade Control Struct.	$ 504,700	$ 541,900	$ 539,100
Bridges	$ 2,229,300	$ 2,340,000	$ 3,894,300
Sub-Total	$ 8,290,300	$ 9,713,400	$ 13,198,800
Apex Structure	$ 500,000	$ 500,000	$ 500,000
Outlet Structure	$ 800,000	$ 800,000	$ 400,000
Detention Basin	$ 0	$ 0	$ 6,100,000
Sub-Total	$ 1,300,000	$ 1,300,000	$ 7,000,000
Clear and Grub[2]	$ 519,200	$ 515,300	$ 738,900
Salvage/Reveg[3]	$ 6,966,300	$ 6,729,500	$ 10,003,600
Sub-Total	$ 7,485,500	$ 7,244,800	$ 10,742,500
Bike Paths[4]	$ 760,500	$ 606,000	$ 1,023,000
Multi-Use Trails	$ 10,100	$ 8,100	$ 13,600
Sub-Total	$ 770,600	$ 614,100	$ 1,036,600
Construction Total	$ 17,846,400	$ 18,872,300	$ 31,977,900
25% Contingency	$ 4,461,600	$ 4,718,100	$ 7,994,500
Total Construction Cost	$ 22,308,000	$ 23,590,400	$ 39,972,400
Right-of-Way[5]	$ 2,219,200	$ 1,410,200	$ 2,432,200
Total Cost	$ 24,527,200	$ 25,000,600	$ 42,404,600

Note:
-All cost data is reflected in 1992 dollars.
-The Thompson Peak Alignment was removed from in-depth cost analysis due to the large amount of cut section required and low overall evaluation ratings. A preliminary cost estimate for this alignment also showed it to be the most costly of the four at 46.8 million.
1: Channel excavation includes the excavation for the soil cement berm protection. Soil cement berm protection is installed to a depth of 4' below channel invert. Grade control structures placed every 1320', 2' width, 6' depth, length equals channel top width plus 10'.
2: Clear and grub includes the cost to clear and grub areas of channel cut and berms.
3: Revegetation/salvage costs assume the area calculated as channel length times the entire right-of-way width. All native plants sufficent to be salvaged are included in this cost. Channel revegetation factors: Natural containment .01, Partial containment .25 Uncontained flow .60, and cut section 1.00.
4: Bike paths are 10' wide. Multi-use trails assume a minor improvement within the proposed channel.
5: Right-of-way widths assume full channel width and berm width (both at grade) plus an additional 8' per side for maintenance.

9.0 RECOMMENDATION

After reviewing the task force evaluation results, it became clear the Reata Pass and Beardsley Wash Alignments were comparable in many categories (i.e.. land use, ROW, environmental impact, hydraulic considerations) and consistently achieved higher rankings than did either the Thompson Peak or the Southwestern Alignments. The significant difference between the Reata Pass and Beardsley Alignments were in the areas of impact on environment, viewshed, sedimentation and erosion, in which the Reata Pass Alignment was superior due to a lack of cut sections, thus giving it an advantage in the category of hydraulic considerations and environmental impact, and a marginally higher overall rating.

After examination by the task force of the relative comparison cost estimates, it was determined that the Reata Pass Alignment was the least costly of the four alignments. The Beardsley Alignment had a similar amount of natural channel, but required a costly cut section to be useful as a stormwater solution. In contrast, the Reata Pass Alignment had similar amounts of natural section, required no cut sections, and had a less severe mix of containment requirements than did the other alignments. The Thompson Peak Alignment proved to be the most costly due to the large amount of cut section required to maintain the Alignment's route to the east of Thompson Peak Parkway. The Southwestern Alignment also proved costly due to the large amounts of containment improvements required, as well as the planned detention basin improvements.

Maintenance requirements and costs for each alternative are consistent for both 'per mile' and overall alignment cost comparisons. The relatively minor differences in yearly cost impacts were not a significant determinant in identifying a preferred alignment.

Based on these evaluations, the task force has identified the Reata Pass Alignment as favorable due to its greater overall environmental sensitivity, consistency with the Desert Greenbelt concept, and the goals and objectives identified by this report. Additionally, with the greater cost effectiveness identified with the Reata Pass Alignment, the task force recommends it as the preferred alternative for stormwater management. As the intent of this report was to identify a potential alignment for stormwater management and not to create a design plan, the task force recommends a further, more in depth, preliminary design study of the Reata Pass Alignment. Performed by an outside consultant, the purpose of this design study would be to determine final engineering and cost feasibility of the alignment as well as determine the best possible final alignment for stormwater management.

10.0 IMPLEMENTATION

The information in this report is not intended to represent all of the potential concerns or engineering analysis required to construct a stormwater management channel for the Reata Pass/ Beardsley Wash Alluvial Fan. However, this report does present general channel alignment concepts which attempt to maximize the uses of the existing natural channels, and multi-use amenities; as well as minimize the width of land required for improvements and number of road crossing structures (Figure 5).

It is recommended the preferred alternative be further studied to determine final engineering and cost feasibility. This study should examine the proposed alignment under a specific set of engineering design guidelines including, but not limited to, the following:

- Consistency with the Desert Greenbelt concept
- Hydraulic and Sediment Transport Analysis
- Construction Phasing
- Channel Design and Treatments
- Impacts of the outlet on the eastern USBR detention basin. The task force believes that creative design solutions can integrate into existing recreational facilities. These alternatives would include solutions which could enhance and/or compliment the operation of the existing facilities without adversely impacting the facilities or the existing dike.
- Landscaping and amenities within channel
- Opportunities for groundwater recharge
- Detailed Cost/Benefit Analysis

Implementation of the stormwater management channel should also establish and coordinate the following items:

- Public Meetings
- Public Information Program
- Discussion with affected property owners
- Ordinance and Regulations
- Coordination Efforts with other Agencies
- Review and Approval Process
- Additional Environmental Assessment Requirements
- Funding Sources
- Risk Assessment

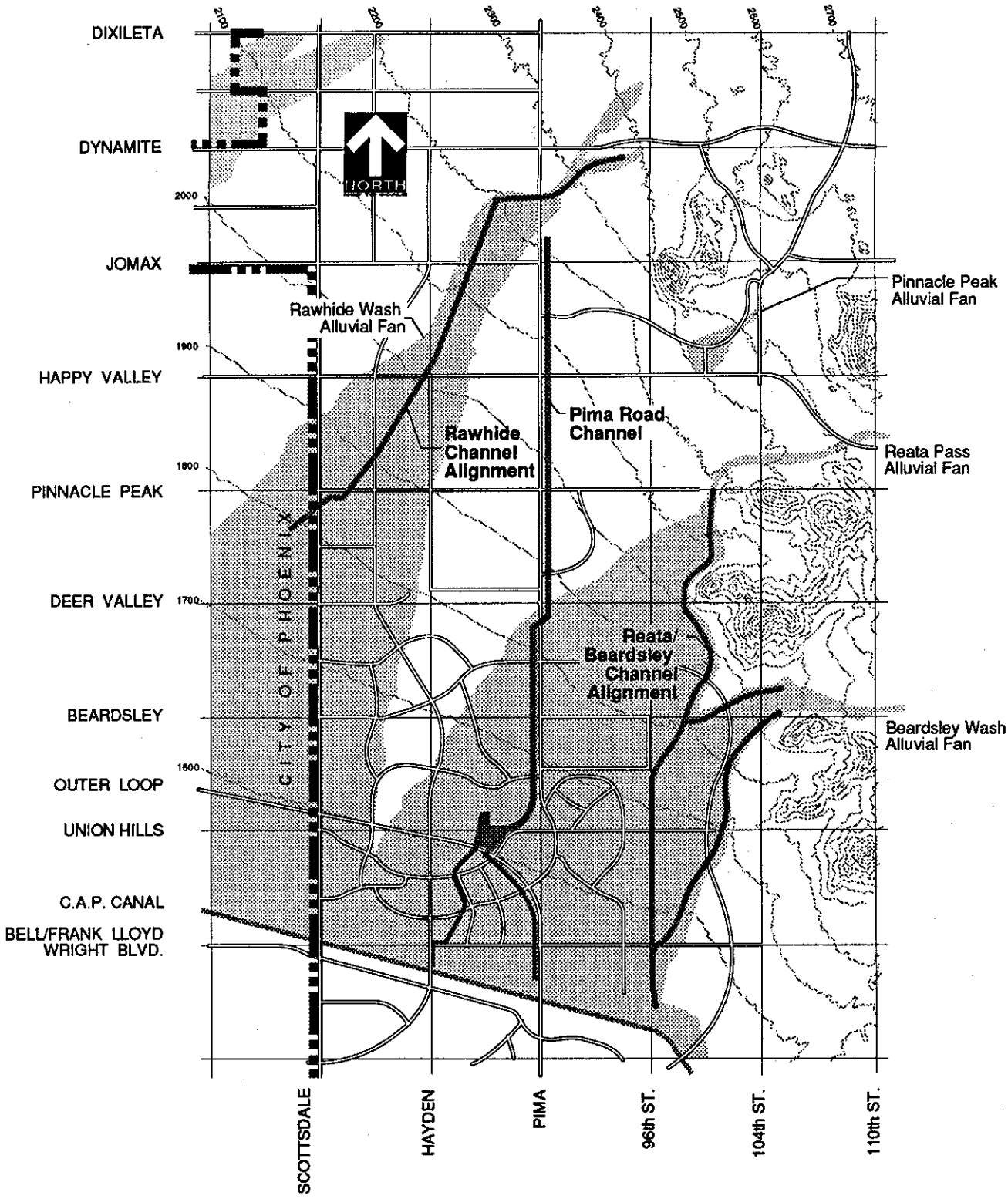


Figure #5:
Recommended Conceptual Regional Stormwater Management Plan

Note: The purpose of these figures is completely illustrative only. For more detailed information, consult the Upper Indian Bend Wash Regional Drainage & Flood Control Plan, July 1992.

11.0 FUNDING

It is anticipated that the cost of the drainage facilities installed to implement the recommended stormwater management plan for the Reata Pass/Beardsley alluvial fan is in the order of $25 million.

It is recommended that other governmental agencies be approached with a view to contributing to the required funds. These agencies should include:

- Maricopa County Flood Control District
- United States Bureau of Reclamation (USBR)
- Arizona Department of Transportation
- United States Army Corp of Engineers

It is also recommended that property owners who benefit from the improvements contribute to the cost. The City of Scottsdale could also contribute a portion from approved Capital Improvement Projects.

Funding mechanisms that should be explored should include:

- Improvement Districts (ID)
- Community Facilities Districts (CFD). This funding mechanism is preferable because under the CFD legislation it is possible to fund the maintenance of the constructed system. The system will have a considerable maintenance requirement because of the nature of the improvements.

It is recommended that a benefit analysis study be initiated to develop a cost apportionment methodology for distributing the costs of the recommended Conceptual Regional Stormwater Management Plan (Figure 5). It is anticipated that benefits for assessment may include, but not be limited to, the following:

- Removal of "AO" flood hazard.
- Relief from mandatory flood insurance costs.
- Relief from required individual stormwater protection (i.e.. raised building pads).
- Potential waiver of on-site retention.
- Provision of access during a 100 year flood event.
- Savings through efficiency of infrastructure, planning and construction.
- Recreation benefits of joint use stormwater structures.
- Environmental preservation/management.

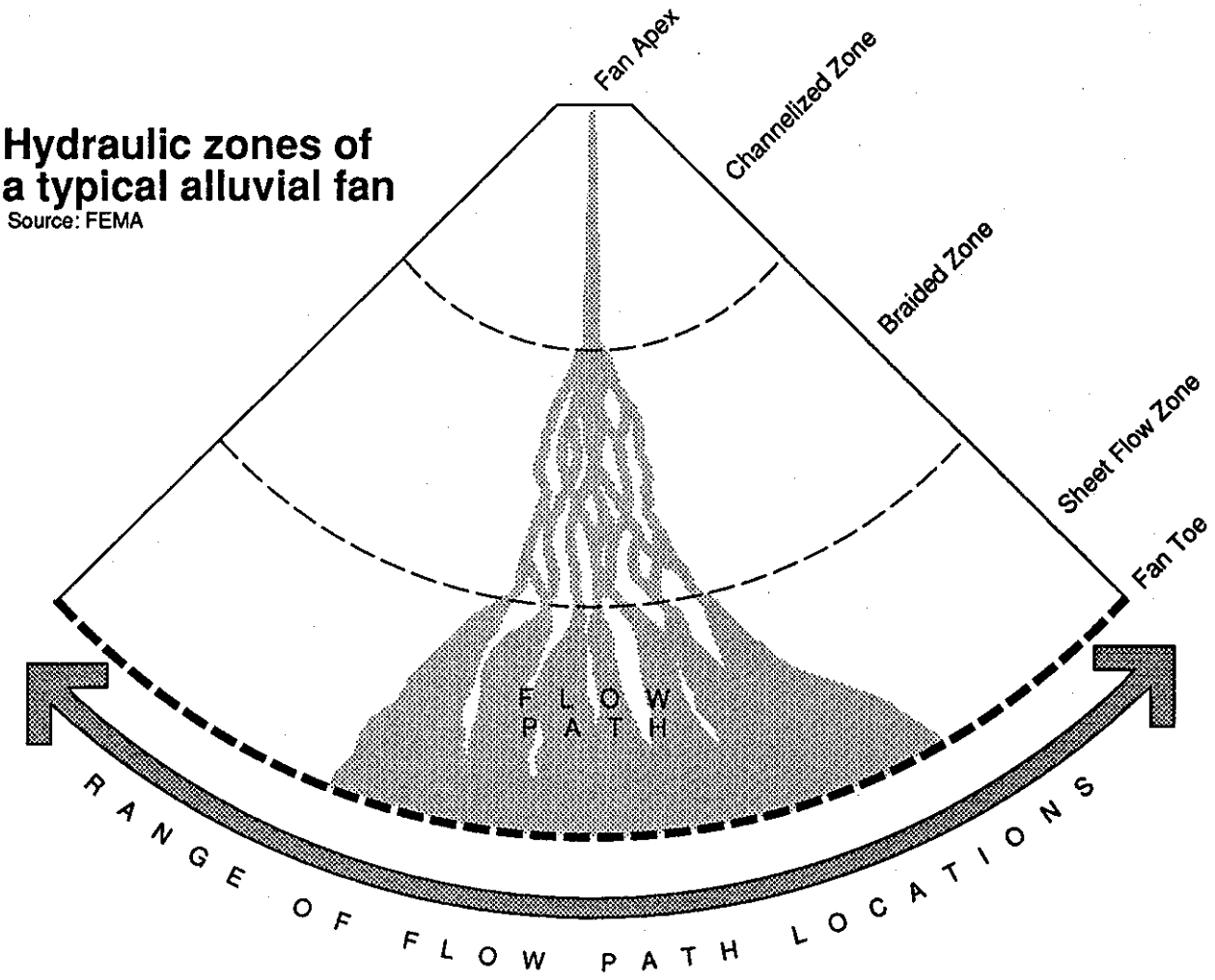
12.0 GLOSSARY

Alluvial Fan: a landform or geologic structure, conical or fan like in shape which is formed by sediments deposited by flowing water.

Alluvial Fan Flooding: flooding occurring on the surface of an alluvial fan originating at the apex and characterized by high-velocity flows; active processes of erosion, sediment transport and deposition, and unpredictable flow paths.

AO Zone: Area of special flood hazards having shallow water depths and/or unpredictable flow paths between one and three feet.

Apex: a point on an alluvial fan below which the flow path of the major stream that formed the fan becomes unpredictable and generally multi-pathed.



Berm: an embankment raised to contain waters within a watercourse to prevent flooding.

CAP: The Central Arizona Project, a U.S. Bureau of Reclamation aqueduct which delivers domestic and agricultural water from the Colorado River along the western boundary of Arizona to the metropolitan area of Phoenix and Tucson. A flood levee which protects the CAP canal forms the boundary between the Upper and the Lower Indian Bend Wash watersheds.

FEMA: The Federal Emergency Management Agency, an instrumentality of the executive branch whose director answers directly to the President of the United States, with the prime responsibility of being the central point of contact for all emergency situation management, for natural and man-caused disasters and with other responsibilities which include providing resources, guidance and assistance to local governments and the management of the National Flood Insurance Program.

Flood: water flowing over the land which exceeds the capacity of a watercourse having a defined bed and banks or a closed container such as a storm drain.

Floodplain: the area of a watercourse and the adjacent land areas that are required to convey the peak discharge of a flood.

Indian Bend Wash: the major stormwater channel in Scottsdale which drains into the Salt River in Tempe.

Lower Indian Bend Wash: refers to the 120 square mile watershed tributary to the Salt River downstream from the CAP protective levee.

Stormwater: water flowing across the land, either contained or not contained, resulting from a rainfall event.

Topography: the detailed and precise physical description of a place and the graphic technique of representing the exact physical features of that place on a map.

Upper Indian Bend Wash: refers to the 86 square mile watershed tributary to the CAP protective levee.

Watercourse: a lake, river, creek, stream, wash, arroyo, channel or other topographic feature on or over which waters flow at least periodically. Watercourses include specifically designated areas in which substantial flood damage may occur.