The City of Glendale, Arizona

Stormwater Management Plan
Executive Summary

By

Camp Dresser & McKee Inc.

Jointly Funded
by the
City of Glendale and the Flood Control District of Maricopa County

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EXECUTIVE SUMMARY

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1. Introduction

1. Introduction

BACKGROUND AND GOALS OF THE PLAN

The City of Glendale, though located in a generally arid region, does receive significant rainfall during storms throughout the year, but particularly during the intense storms prevalent in the summer and early fall. The City's current storm drainage system is unable to accommodate runoff from these storms, thus creating serious flooding problems.

In order to alleviate these problems, the City selected Camp Dresser & McKee Inc. (CDM) to develop a Stormwater Management Plan. The primary goal of this plan is to reduce the City's existing flooding problems, as well as future problems which may occur as a result of changing land use patterns. The plan is intended to be flexible in order to allow a staged implementation process as well as modifications which may be necessary to respond to future demands not anticipated at the time this plan was formulated.

OVERVIEW OF EXECUTIVE SUMMARY

This Executive Summary is presented in order to highlight the major components of the Stormwater Management Plan prepared by CDM for the City of Glendale. This introductory chapter is intended to summarize key information about the study area, about Glendale's existing storm drainage system, and about the City's current storm drainage problems. In the chapters following this introduction, the Summary will focus on CDM's scope of services, the formulation of the plan, the alternatives considered, the evaluation of those alternatives and the resulting recommended plan, the cost estimates for implementing the plan, and an implementation schedule. In addition, a summary of the proposed Capital Improvement Program has been prepared as a companion to the Executive Summary in order to provide a more detailed synopsis of the improvements being proposed, their costs, and suggested program sequencing.

STUDY AREA

The City of Glendale, located in the center of Maricopa County in south-central Arizona, was originally a trade and service center for the rich agricultural area lying west of the City of Phoenix. A large population influx occurred after World War II due to the conversion of farmland to residential tracts. Glendale's 1985 population, estimated to be 130,000, is expected to increase 50 to 100 percent by the year 2000, according to the City of Glendale General Plan 1980-2005 (1980). The General Plan also predicted that agriculture, which accounted for about 48 percent of land use in 1980, was expected to decline to make way for growth in residential, commercial, and industrial development.

Glendale is situated in the basin of the New River, which originates in the New River Mountains north and east of the city. New River, a tributary of the Agua Fria River, flows generally southwest until it joins the Agua Fria River west of Glendale. In addition to the major watercourses in the area, natural drainage had been provided in the past by washes flowing across the alluvial fan. However, these small washes were obliterated when valley land was converted to agricultural use.

The terrain in the City of Glendale is flat, with a gradual slope of about 4.5 feet per 1,000 feet toward the southwest and 3 feet per 1,000 feet along the principal streets, which run north and south or east and west in a rectangular grid.

EXISTING STORM DRAINAGE SYSTEM

At present, storm runoff is primarily carried in the streets of the City; the flows generally follow the natural gradient of the land toward the south and west. A number of storm drains were installed as part of the construction of State Highway 93 (Grand Avenue) by the Arizona Department of Transportation (ADOT). However, this drainage system was designed to accommodate runoff only in the Grand Avenue area. There are a number of storm drainage pipes, most of which drain to the ADOT Grand Avenue drainage system.

Other storm drain inlets in the downtown area are used to convey water to the irrigation pipes and canals of the Salt River Project (SRP) system supply lines or drain lines. The City maintains these drain inlets and, in some cases, also maintains the drain lines where they have been abandoned by the SRP.

The Arizona Canal Diversion Channel (ACDC) is a drainage structure currently under construction to be located just upstream and nearly parallel to the Arizona Canal. The ACDC will extend about 17.3 miles from Cudia City Wash to Skunk Creek. In areas adjacent to the channel where ponding occurs, pipe inlets will be provided.

The Grand Canal, the primary supply canal for irrigation waters in southwestern Glendale, also receives a limited amount of drainage which enters at locations where the canal is below ground level.

In addition to the drainage structures described above, several retention basins owned and maintained by the City also contribute to the City's drainage system. The City's retention basins -- which are open, grassy areas -- store runoff during storms and release it gradually by evaporation or percolation into the ground. Occasionally, portable pumps have been used to drain these basins. Dry wells are in the design stages to facilitate percolation and reduce retention time in parks. In addition to the City-owned retention basins, there are a number of privately-owned retention basins which were installed under requirements for new building developments.

EXISTING DRAINAGE PROBLEMS

The inadequacy of the current drainage system causes flooding of streets and intersections and subsequent traffic disruption, as well as ponding of water in ditches and gutters at many locations in the City. The flooding problems are most severe where shallow flood flows are interrupted by natural or constructed barriers, which cause ponding. Flooding also results at a number of intersections which have dip crossings where a shallow gutter along one street extends across an intersecting street to

allow passage of stormwater. Some flooding occurs because of water that enters the City from surrounding areas. This is a particular problem in the northern part of Glendale, where stormwater enters from the City of Phoenix.

Flooding problems have occurred along the Grand Canal because water collects where the canal is higher than surrounding ground. Stormwater entering the canal has also caused it to overflow. Excess runoff in the Arizona Canal has caused overflows in the Glendale area, as well. However, when the adjoining ACDC is completed, this problem will be eliminated.

2. Scope of CDM Engineering Services

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The development of the Glendale Stormwater Management Plan involved completion of the tasks and provision of services described below:

Task 1: Acquire and Review Basic Data

CDM reviewed all data necessary to provide a firm basis for a stormwater management plan, including characteristics of the study area (land use, topography, geology, soil characteristics, and rainfall patterns), components of the existing storm drainage system, and existing drainage problems.

Task 2: Prepare Study Area Map

Several working maps of the study area were prepared, including those presented in the plan depicting the study area, general infiltration rates in the City, existing stormwater drainage system, general stormwater areas designated for this study, maps for each alternative considered, and layout of the recommended plan. Figure 1 presents the study area and the stormwater areas used in developing this plan.

Task 3: Define Stormwater Model

The use of a computerized runoff simulation model was chosen as the most desirable method for determining the peak flows and for obtaining runoff hydrographs for each subdrainage area in the City. The Stormwater Management Model (SWMM) developed by the Environmental Protection Agency (EPA) was felt to be the most appropriate tool because of its capabilities for simulating runoff and routing subsequent hydrographs for both rural and urban areas.

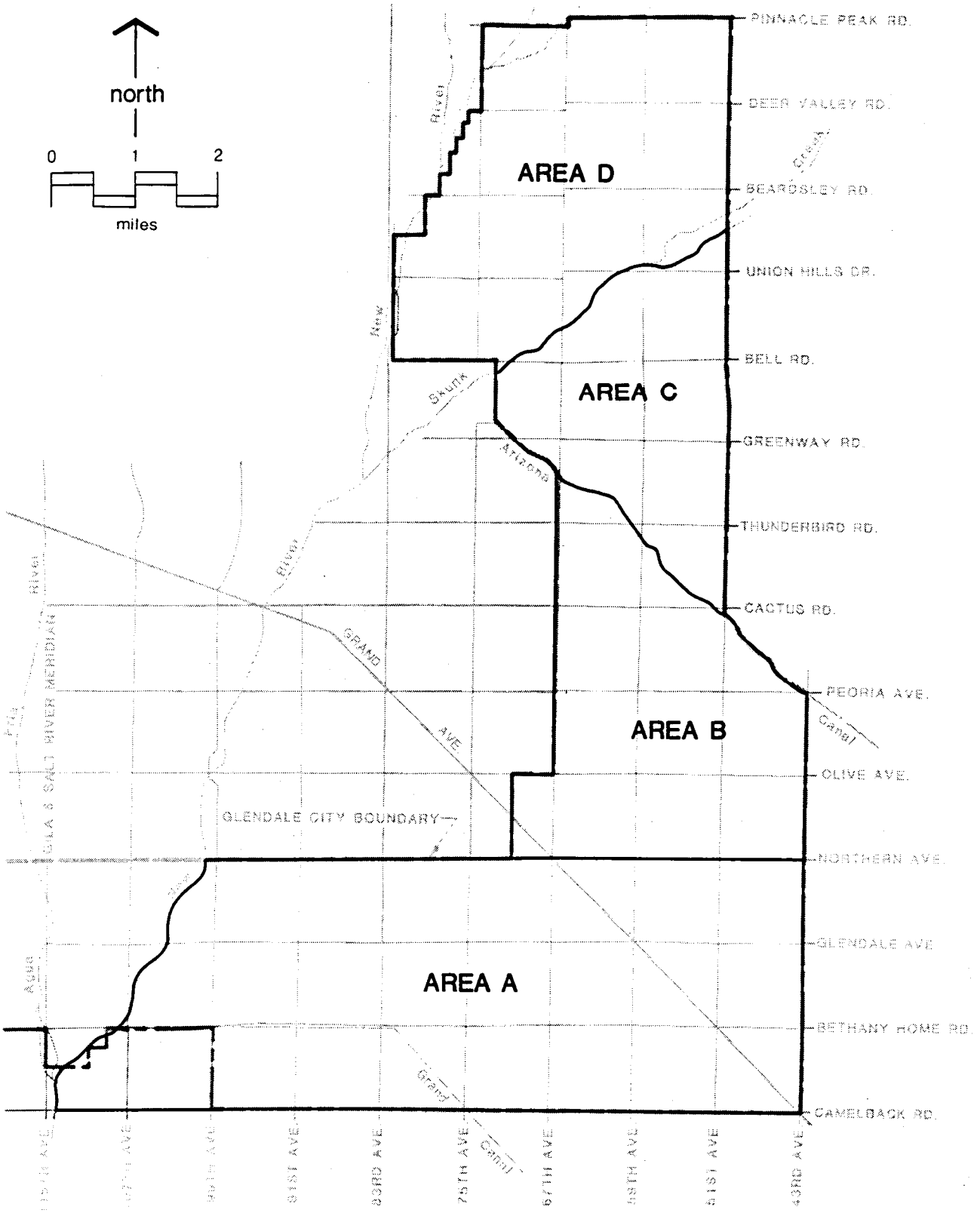

FIGURE 1

STUDY AREA

Task 4: Model the Existing Storm Drainage System

Input data for the SWMM model was developed for each subdrainage area, including calculation of area, slope, and width; estimation of the amount of impervious area from land use maps; estimation of infiltration rates; calculation of roughness values of connecting pipes; and assessment of the storage parameters. The design rainfall used in the SWMM model to analyze existing conditions and project future conditions was determined by examining historical rainfall data and reviewing methods used by other cities and agencies near Glendale.

Task 5: Prepare Conceptual Storm Drainage Alternatives

In order to develop alternatives for storm drainage improvements, the existing drainage facilities were carefully tabulated and verified. In addition, the study area was divided into four main areas based on current drainage patterns: Areas A, B, C, and D. Several alternatives were generated; five for Areas A and B and two for Area C. Area D, consisting primarily of the Arrowhead Ranch Development, was not included in the stormwater plan because it will have an independent stormwater system. Basic design concepts developed by CDM and design standards required by the City were applied as appropriate to each alternative.

Task 6: Evaluation of Alternatives

The drainage system configurations for each alternative were examined in relation to four criteria: (1) capital cost, (2) compatibility and disruption, (3) acceptability to the public, and (4) environmental factors. Subsequently, the costs of each recommended system were evaluated in relation to various amounts of detention storage and levels of flood protection.

Task 7: Prepare Master Storm Drainage Plan

A master storm drainage plan was formulated based on the evaluation of alternatives, the general design concepts developed by CDM, and the design standards required by the City.

Task 8: Prepare a Capital Improvement Plan

CDM developed a capital improvement plan which consisted of the following: the costs of each alternative (with and without detention facilities), including the costs of land purchases; engineering, administrative, and legal fees; and provision for contingencies. CDM also estimated annual operation and maintenance costs (with and without detention facilities) and recommended a schedule for construction phasing.

Task 9: Implement Stormwater Model on City's Computer

The SWMM model has been implemented on the City's computer and will be valuable in future studies of drainage patterns and in making necessary modifications to the recommended plan.

3. Plan Formulation

3. Plan Formulation

CONCEPTS

CDM developed several concepts upon which development of the Glendale Stormwater Management Plan was based. These are discussed below.

1. Minimize Disruption of Existing Facilities and Agriculture

   Existing drainage facilities were tabulated and verified by field inspection in order to avoid disruption of water and sewer lines already in place. SRP irrigation and drainage facilities, as well as Santa Fe Railroad facilities, were also taken into account.

2. Install an Underground Pipe and Box Culvert System

   It was felt that an underground pipe and box culvert system would provide greater safety than an open ditch system. However, ditches could be used on an interim basis in areas where immediate installation of pipes could not be justified. For pipes larger than 7 to 8 feet in diameter, box culverts of equivalent capacity would probably be a less costly substitute.

3. Follow the Natural Land Slope and Existing Street Grid

   It was felt that new pipes should follow the natural land slope toward the southwest as much as possible and be aligned with the existing rectangular grid of streets in order to eliminate the need to obtain additional rights-of-way.

4. Locate the System Within City Limits

   The pipes were routed so that the entire length of each pipe, from drain to outlet, be within the City of Glendale. For this reason, all stormwater from land south of the Arizona Canal was assumed to be carried at least as far south as Northern Avenue and then West to New River.

5. Reduce the Total Cost of the System by Recommending Detention or Retention Facilities

   Detention and retention facilities can reduce the peak storm runoff by storing runoff during storms and then gradually releasing the runoff after the storm. Therefore, in a system with either type of facility, less burden is put on the drainage pipe network resulting in less pipe construction overall and lower capital costs.

The two types of facilities differ in that retention basins have no outlet and the stormwater is released only by evaporation or percolation; detention basins allow the release of stormwater gradually through a small outlet. Detention facilities are preferred for the City because they will interfere less with alternative activities such as park recreation.

DESIGN CRITERIA

The design criteria which provided the basis for the development of this Stormwater Management Plan are discussed below.

1. City Regulations

   City drainage regulations, as set forth in Chapter 17A of the City Code, require that residential subdivisions, as well as commercial and industrial areas, retain all stormwater from a 10-year, 2-hour storm. Local streets must be constructed to carry the runoff from a 10-year storm between the curbs because any flow in addition to local runoff will overtop the curb and enter adjacent lands.

2. Other Design Criteria

   a. Where there are no stormwater inlets, the entrance to side streets should be slightly humped so that stormwaters flowing in gutters on one mile and one-half mile streets will not enter the side streets.

   b. Pipes will flow full. In certain cases, the pipes can flow under pressure if the hydraulic gradeline at the adjacent inlets is 0.5 feet or more below the gutter invert.

3. Design Rainfall

   Many cities and agencies near Glendale use the rainfall intensity-duration-frequency curve developed for Phoenix as the basis for determining the peak design rainfall. These curves were found appropriate for use in constructing a design storm to be used in the SWMM model for the Glendale Stormwater Plan. Using the Phoenix intensity-duration-frequency curve, average rainfall intensities were read for 15-minute intervals ranging from 15 minutes to 6 hours.

4. Alternatives Considered

4. Alternatives Considered

STUDY AREAS

For the purpose of developing alternative stormwater plans, the City was divided into these four main areas:

A. Camelback Road to Northern Avenue

B. Northern Avenue to ACDC

C. ACDC to Skunk Creek

D. North of Skunk Creek

These areas, as shown on Figure 1, were selected based primarily on existing drainage patterns. Area A, which includes most of the land area currently developed within the City, drains westerly to New River downstream of its confluence with Skunk Creek. Area B is situated immediately to the north of Area A and also drains to New River downstream of the Skunk Creek confluence. Area B was considered separately, however, to facilitate evaluation of alternative discharge routes to New River, either directly to the west or to the south through Area A. Drainage in Area C is toward the south to the ACDC, which forms the drainage barrier between Areas B and C. Most of Area D drains to Skunk Creek, which forms the drainage barrier between Areas C and D. The extreme western portion of Area D drains to New River upstream of its confluence with Skunk Creek.

Areas A and B: Camelback Road to ACDC

For the purposes of this discussion, the alternatives considered for Areas A and B were described jointly. This was done because storm runoff from Area B is routed through Area A in some of the alternatives considered.

A total of five alternative drainage systems were considered for Areas A and B which are identified as Alternatives 1, 1A, 2, 3, and 4. The specific pipe network layout for each alternative is described below.

For all alternatives, drainage from Area B is collected along 51st, 59th and 67th Avenues, routed southerly to Northern Avenue and then westerly to Grand Avenue. This establishes the Northern-67th-Grand Avenue intersection as the common drainage outlet point from Area B.

Alternative 1

For this alternative, drainage from Area B is routed directly west along Northern Avenue to New River. Drainage from most of Area A is collected along Camelback Road and is then conveyed westerly to New River.

Alternative 1A

Runoff from Area B is first routed one-half mile south along 67th Avenue and is then directed westerly to New River along Orangewood Avenue, an alignment midway between Northern and Glendale Avenues. This alternate discharge route was selected to avoid utilities located along Northern Avenue. Runoff from the portion of Area A east of 75th Avenue is collected along Camelback Road and conveyed westerly, as in Alternative 1. However, runoff is then routed northwesterly along the Grand Canal and finally westerly along Bethany Home Road to New River. This alternate discharge route from Area A was selected to avoid crossing of the Grand Canal. This route also avoided installation of a major pipe beneath Camelback Road east of 75th Avenue, thus reducing interference with existing utilities.

Alternative 2

For this alternative, runoff from Area B is routed directly south to Camelback Road. Drainage from most of Area A is collected along Camelback Road and conveyed westerly to New River, as in Alternative 1. Therefore, for this alternative, runoff from nearly all of Areas A and B drains to a single major collector along Camelback Road which discharges to New River.

Alternative 3

Runoff from Area B is routed to New River parallel to Northern Avenue and offset one-half mile to the south, as in Alternative 1A. Runoff from most of Area A is collected along an alignment parallel to Camelback Road and offset one-half mile to the north. This discharge route for Area A was selected to avoid installation of a major drainage pipe beneath the entire length of Camelback Road, thus reducing interference with existing utilities.

Alternative 4

Runoff from most of Area A is routed to New River parallel to Camelback Road and offset one-half mile to the north, as in Alternative 3. Runoff from Area B is routed south along 67th Avenue, west between Glendale Avenue and Bethany Home Road, and finally south along 83rd Avenue to the main drainage collector in Area A. This indirect flow path from Area B, rather than the direct path south along 67th Avenue as in Alternative 2, was selected to minimize the size of the main drainage collector needed to cross the Grand Canal.

Area C: ACDC to Skunk Creek

Two alternative drainage systems were considered for Area C, which are identified as Alternatives 5 and 6. The specific pipe network layout for each alternative is described below.

Alternative 5

For this alternative, all runoff from Area C is routed south to ACDC.

Alternative 6

For this alternative, runoff from Area C south of Bell Road is routed south to ACDC. However, runoff from Area C north of Bell Road is routed westerly to Skunk Creek.

Area D: North of Skunk Creek

The area north of Skunk Creek consists of three parts: the proposed Arrowhead Ranch, the lands north of Arrowhead Ranch, and the lands south of Union Hills Drive. Arrowhead Ranch will have an independent stormwater system that will carry some runoff westerly to New River and some southerly to Skunk Creek. Stormwater from the lands north of Arrowhead Ranch will flow southwesterly to a levee around Arrowhead Ranch, at which point a portion will be directed westerly to New River and the remainder southerly to Skunk Creek. Stormwaters from the lands south of Union Hills Drive will flow in roadside ditches to New River and Skunk Creek.

Since the proposed drainage facilities for Arrowhead Ranch will be entirely within Arrowhead Ranch and stormwater from the other two parts of Area D are currently accommodated, or will be accommodated as part of land development projects, no further improvements were considered in Area D as part of the stormwater plan.

PIPE NETWORK LAYOUTS

The specific pipe network for each alternative described above are illustrated on Figures 2 through 8.

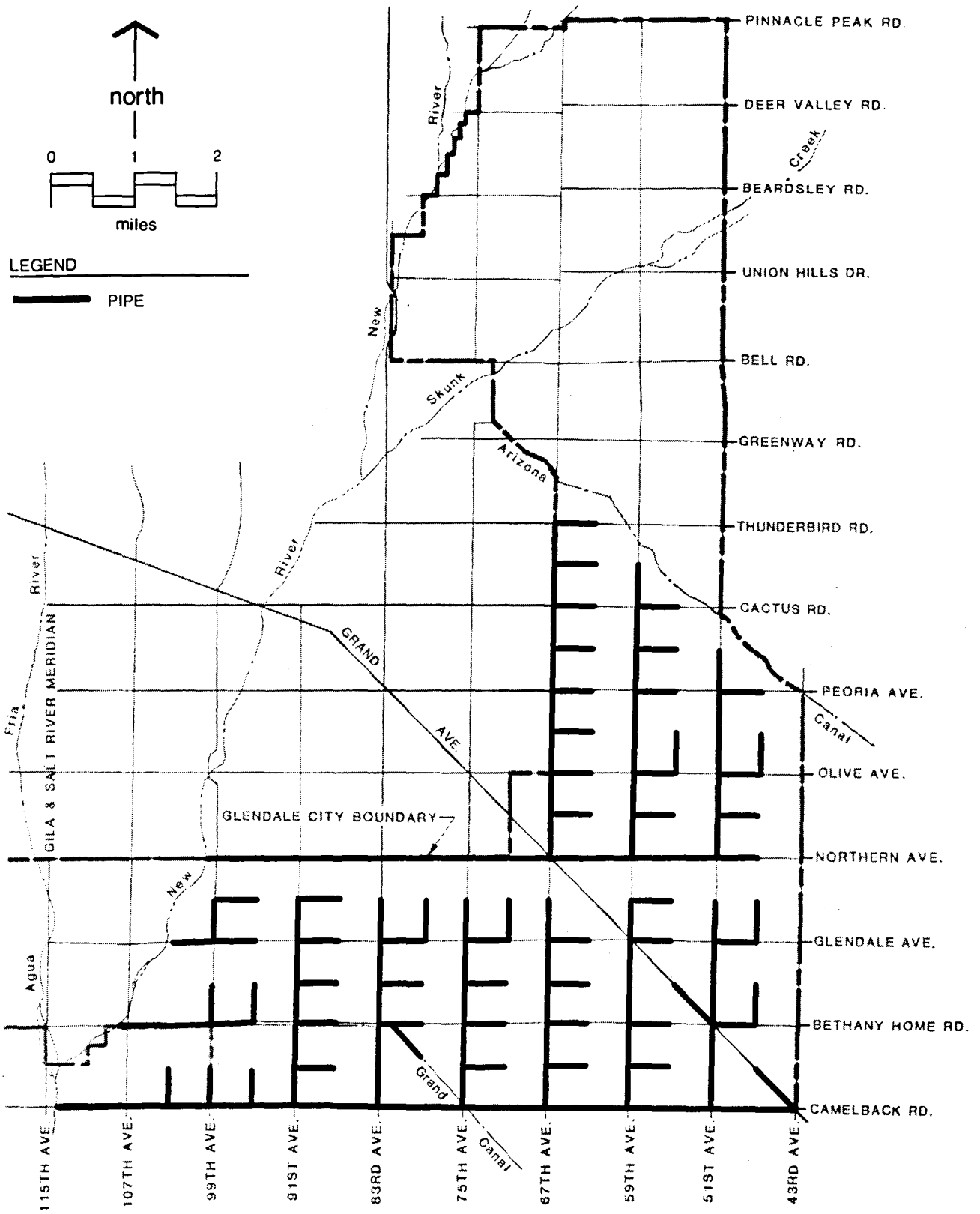

FIGURE 2

ALTERNATIVE 1

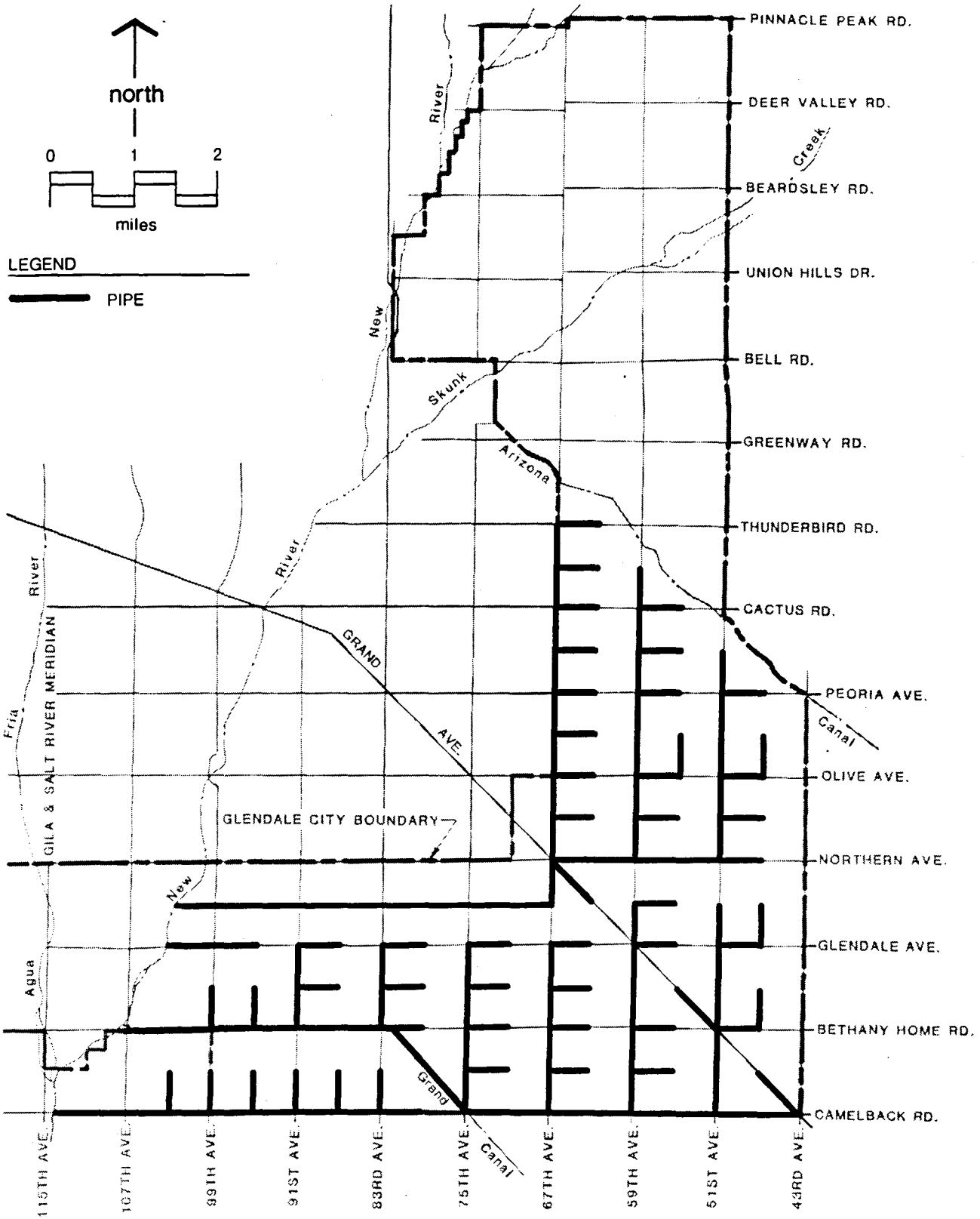

FIGURE 3

ALTERNATIVE 1A

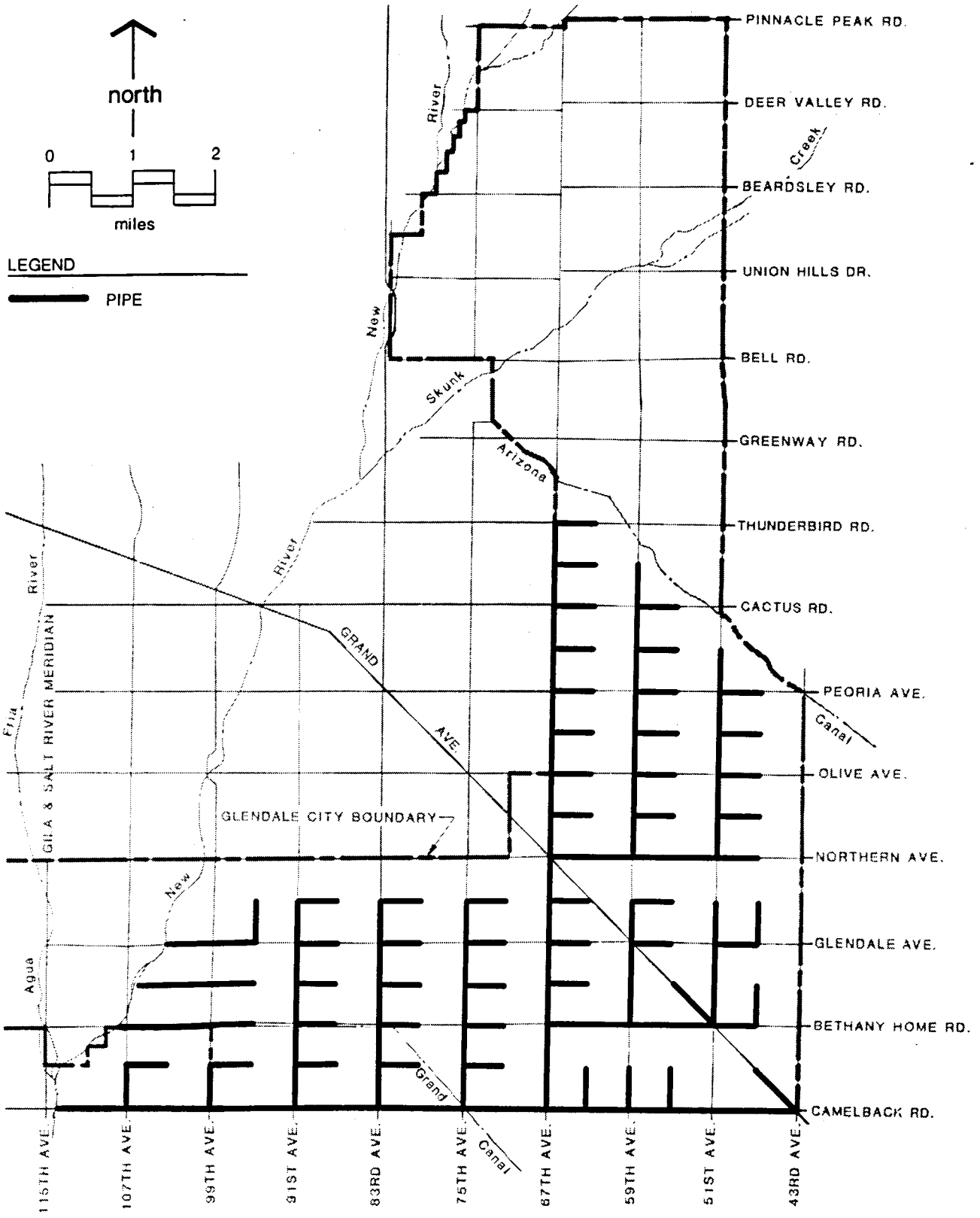

FIGURE 4

ALTERNATIVE 2

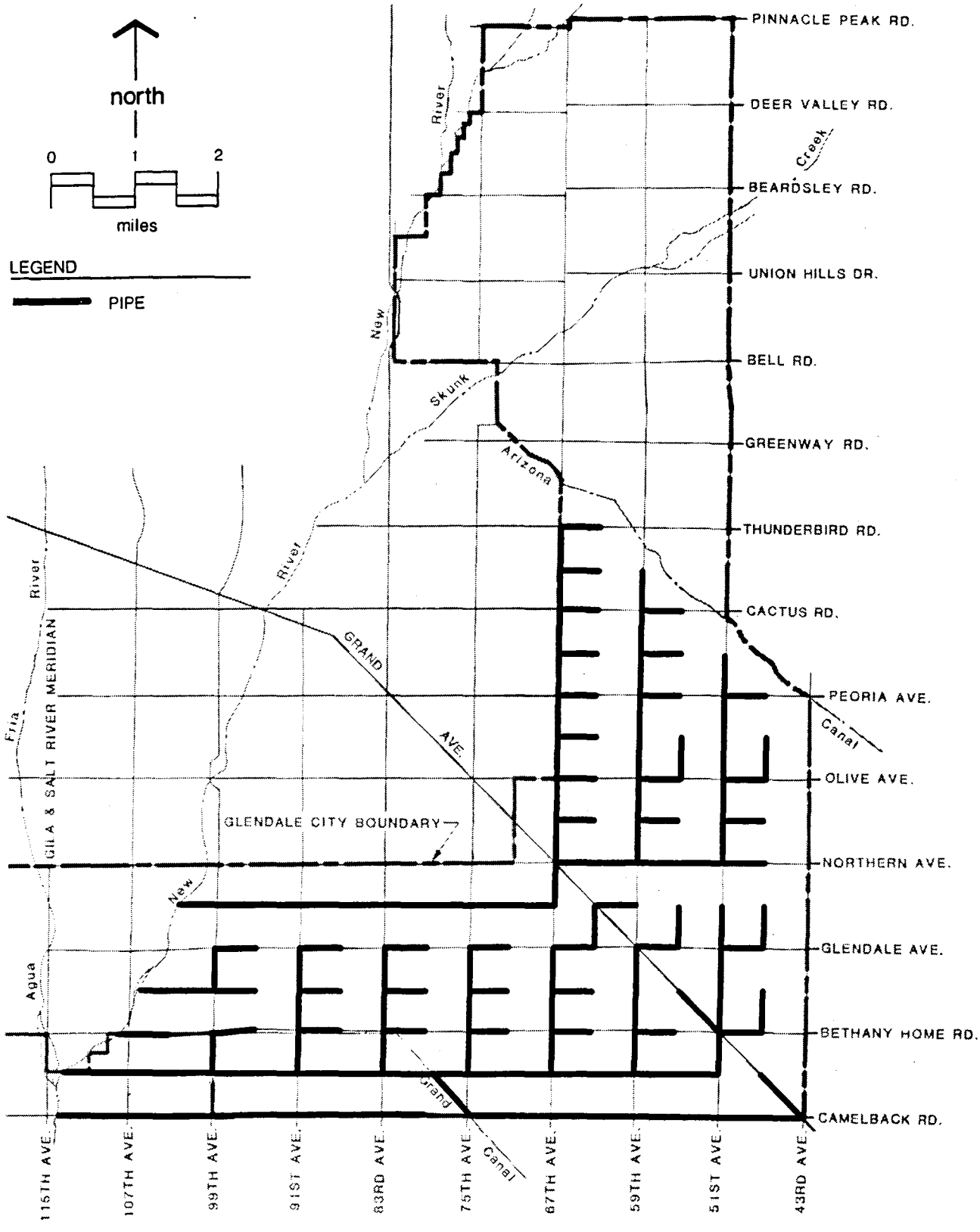

FIGURE 5

ALTERNATIVE 3

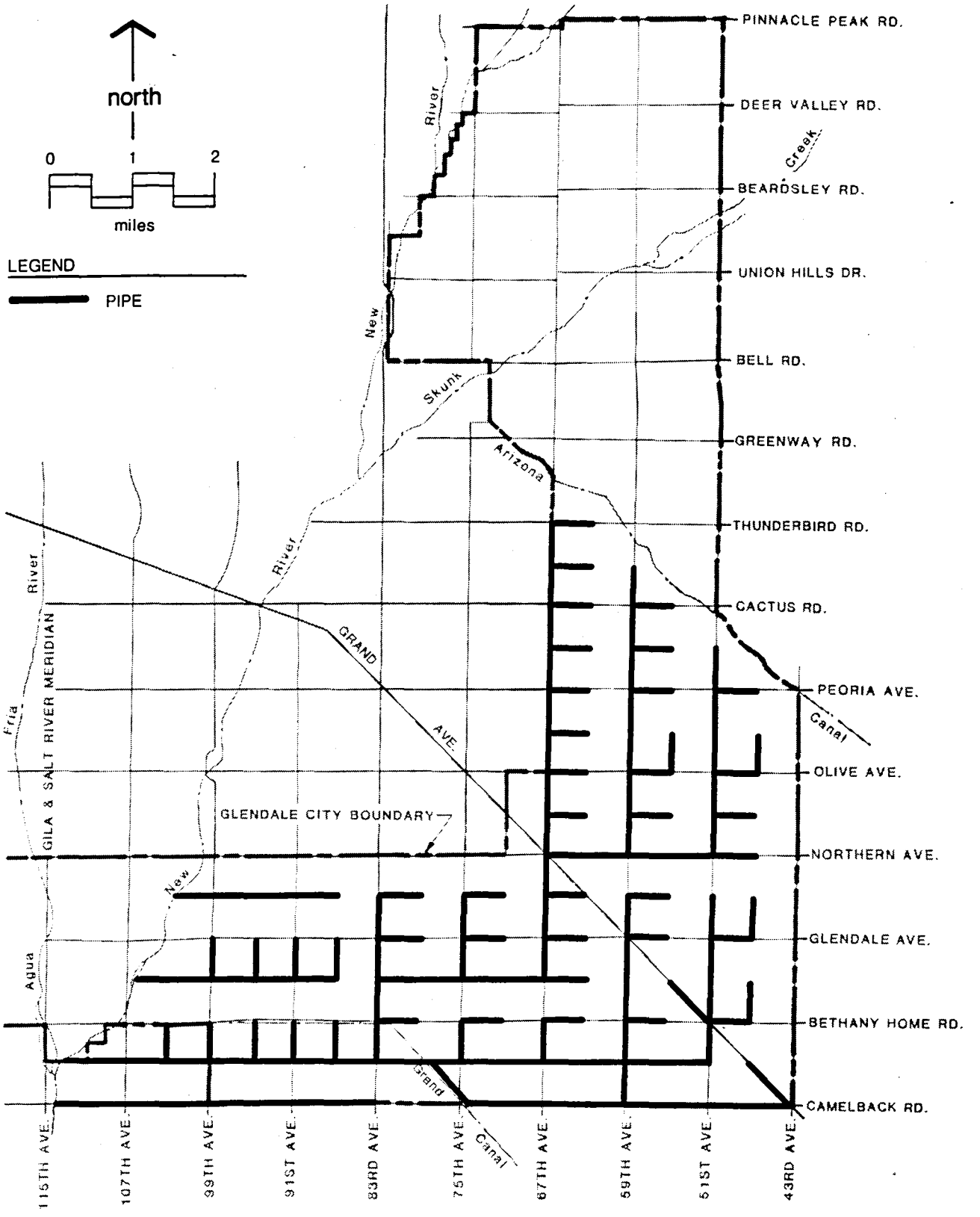

FIGURE 6

ALTERNATIVE 4

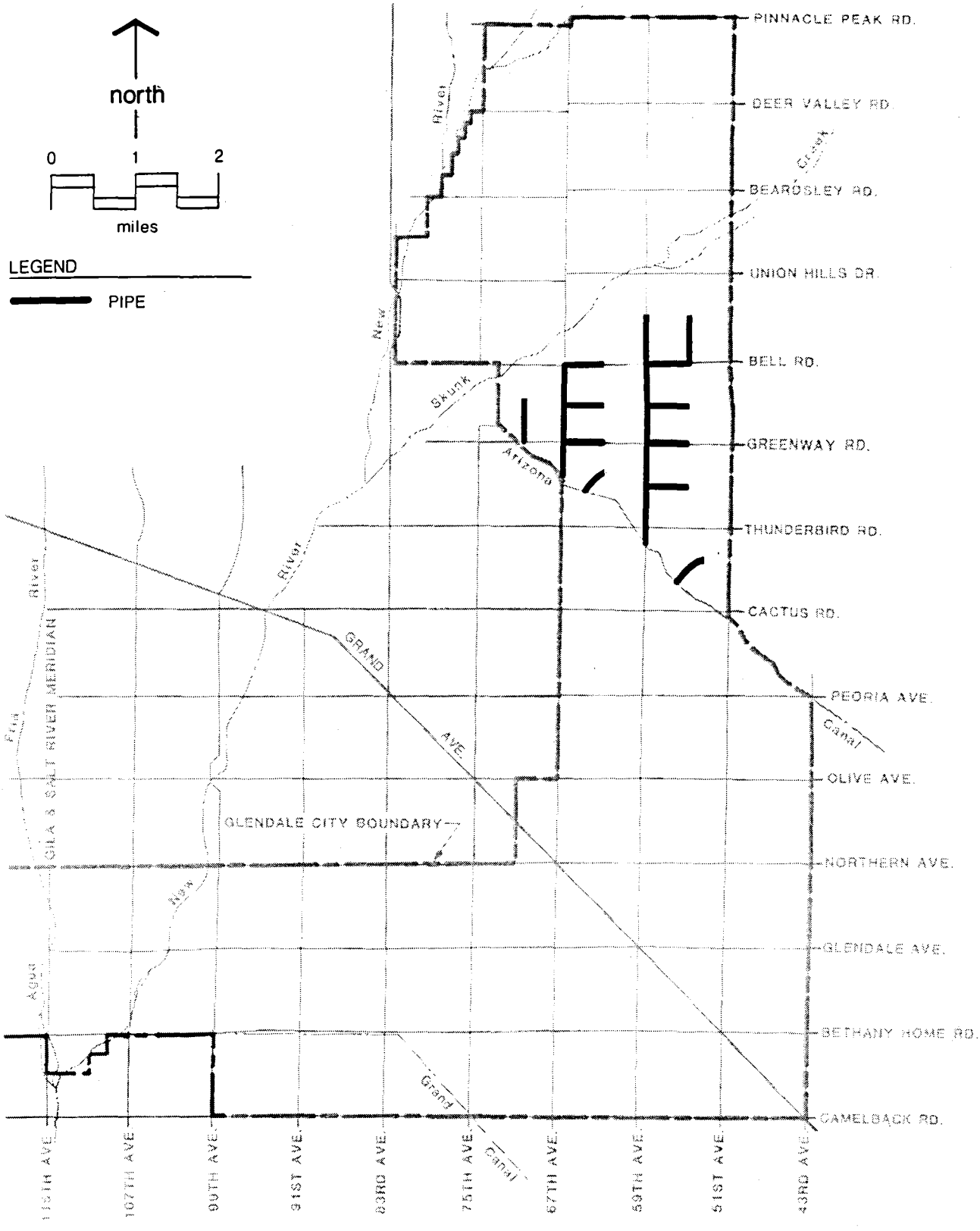

FIGURE 7

ALTERNATIVE 5

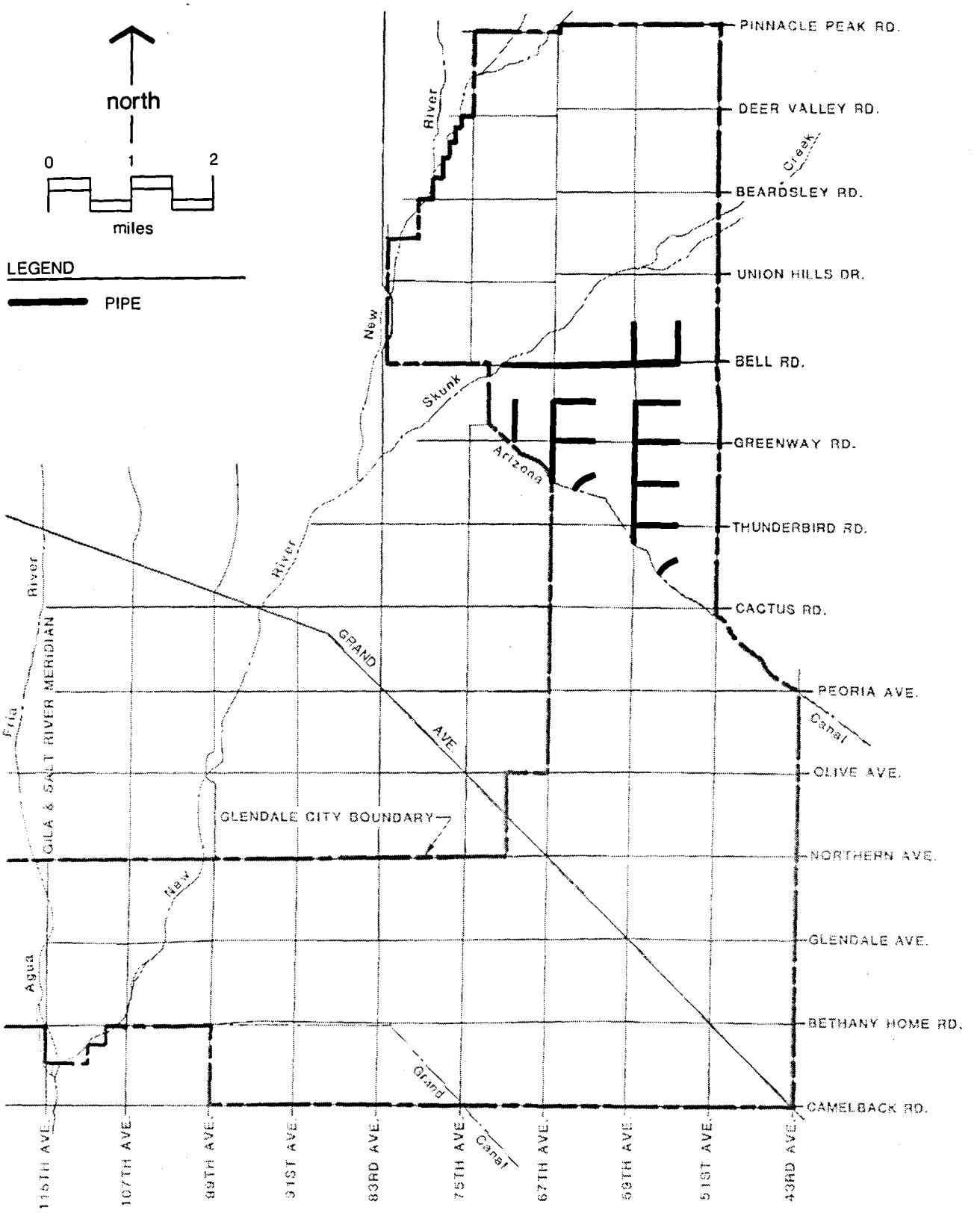

FIGURE 8

ALTERNATIVE 6

5. Evaluations, Findings, and Recommended Plan

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EVALUATION

In order to compare and evaluate the various drainage system alternatives, an evaluation matrix procedure was employed based on the following criteria:

1. Capital cost;
2. Compatibility and disruption;
3. Acceptability to the public; and
4. Environmental factors.

Each drainage system configuration was rated positive (+), negative (-), or neutral (0) in relation to each criterion listed above. It should be noted that the configurations were evaluated only in relation to each other, and not to projects outside the scope of this Stormwater Management Plan. The results of the preliminary evaluation procedure are presented in Table 1 and are discussed below in the Findings subsection.

In addition to the preliminary evaluation matrix procedure, the recommended alternatives were then evaluated in relation to three levels of detention storage and two levels of flood protection. Detention was analyzed in terms of (1) no detention facilities and large-sized drains, (2) minimum detention facilities and moderately-sized drains, and (3) more detention facilities and small-sized drains. Flood protection was analyzed in terms of design capacity for both 2- and 10-year frequency storms.

Various systems were then postulated which included the size of the required facilities and the estimated construction costs. The results of the cost analysis for both detention storage and level of protection are shown in Table 2. Costs represented here include 20 percent for engineering, legal, and administration plus 20 percent for contingencies.

TABLE 1

EVALUATION MATRIX

	Area A and B					Area C	
Alternative	1	1A	2	3	4	5	6
Evaluation Criteria:							
1. Capital Costs	0	+	-	0	-	+	0
2. Compatibility and Disruption	+	+	-	+	-	+	+
3. Acceptability to the Public	0	+	-	0	-	+	0
4. Environmental Factors	0	0	0	0	0	0	0
Overall Evaluation:	0	+	-	0	-	+	0

+ = Favorable
0 = Neutral
- = Unfavorable

TABLE 2

EVALUATION OF DETENTION STORAGE AND LEVEL OF PROTECTION

		Preliminary Costs in Millions of Dollars					
		No Detention		Minimum Detention		Detention	
Area		2-yr	10-yr	2-yr	10-yr	2-yr	10-yr
A	Camelback Road to Northern Avenue	95	136	*	109	*	94
B	Northern Avenue to ACDC	53	83	34	53	*	45
C	ACDC to Skunk Creek	11	15	10	14	10	13
D	North of Skunk Creek[1]	*	*	*	*	*	*
	Subtotals	159	234	*	176	*	152

*Items not calculated.

[1]Area D was not evaluated for detention storage and level of protection because most of it lies within the Arrowhead Ranch properties, which will have an independent stormwater system.

FINDINGS

As shown in Table 1, Alternative 1A received the highest rating for Areas A and B. The reasons were as follows: (1) Alternative 1A had the lowest cost; (2) it made use of the alignment of the Grand Canal, an existing facility; and (3) it would cause the least disruption of the five alternatives, and therefore would be most acceptable to the public.

For Area C, Alternative 5 received the higher overall rating because it had a lower cost than Alternative 6 and a greater area would drain to the ACDC. Because the ACDC will be a well-built and well-maintained channel, outfalls to this structure may perform better than those going directly to the river where bank erosion and debris may affect the stormwater system.

The environmental impacts of all the alternatives were judged to be neutral because each system would be underground, and therefore would not have any significant positive or negative effects on the environment.

As a result of the evaluations of detention storage and of level of flood protection (summarized in Table 2), it was determined that the increase in benefits provided by facilities with 10-year protection would justify the increased cost of these facilities. Therefore, the implementation of a drainage system that could safely handle the 10-year storm flow was established as a desirable level of protection, which can be most economically provided using a considerable amount of detention storage.

RECOMMENDED PLAN

1. The City should implement Alternative 1A for the southern portion and Alternative 5 for the northern portion of the stormwater system, using the detention facilities to reduce the capital cost of the system. The layout for the recommended system is shown in Figures 9 and 10.

2. If the City elects not to use detention basins at specific sites or if problems arise in acquiring certain detention basin sites, the City should implement the same alternatives, but use the larger pipe sizes corresponding to the "no detention" option in some or all parts of the system.

3. The City requires that all stormwater which falls within a new development be retained within that development for the 10-year storm of 2-hour duration. The current ordinance should be changed to require retention of all stormwater from a 100-year storm of 2-hour duration. This change would raise the retention criteria to that of other municipalities in Maricopa County.

4. The use of a rebuilt Grand Canal could also be considered as an alternative facility. Using the existing canal but providing more capacity through the use of setback levees could be a cost-effective measure. The use of a linear parkway alongside the Grand Canal with a below grade open area to carry excess stormwater might also be used. Pipes under the parkway could be used to convey runoff waters from frequent storms.

5. Since the recommended stormwater plan would provide only 10-year protection, the City should consider some additional measures to minimize the flood damage that would occur during larger storms. Such measures could include using the building code to require flood proofing measures in structures in flood prone areas. Building code requirements could address factors such as type of construction, the location of the structure on the property, and grading of the site.

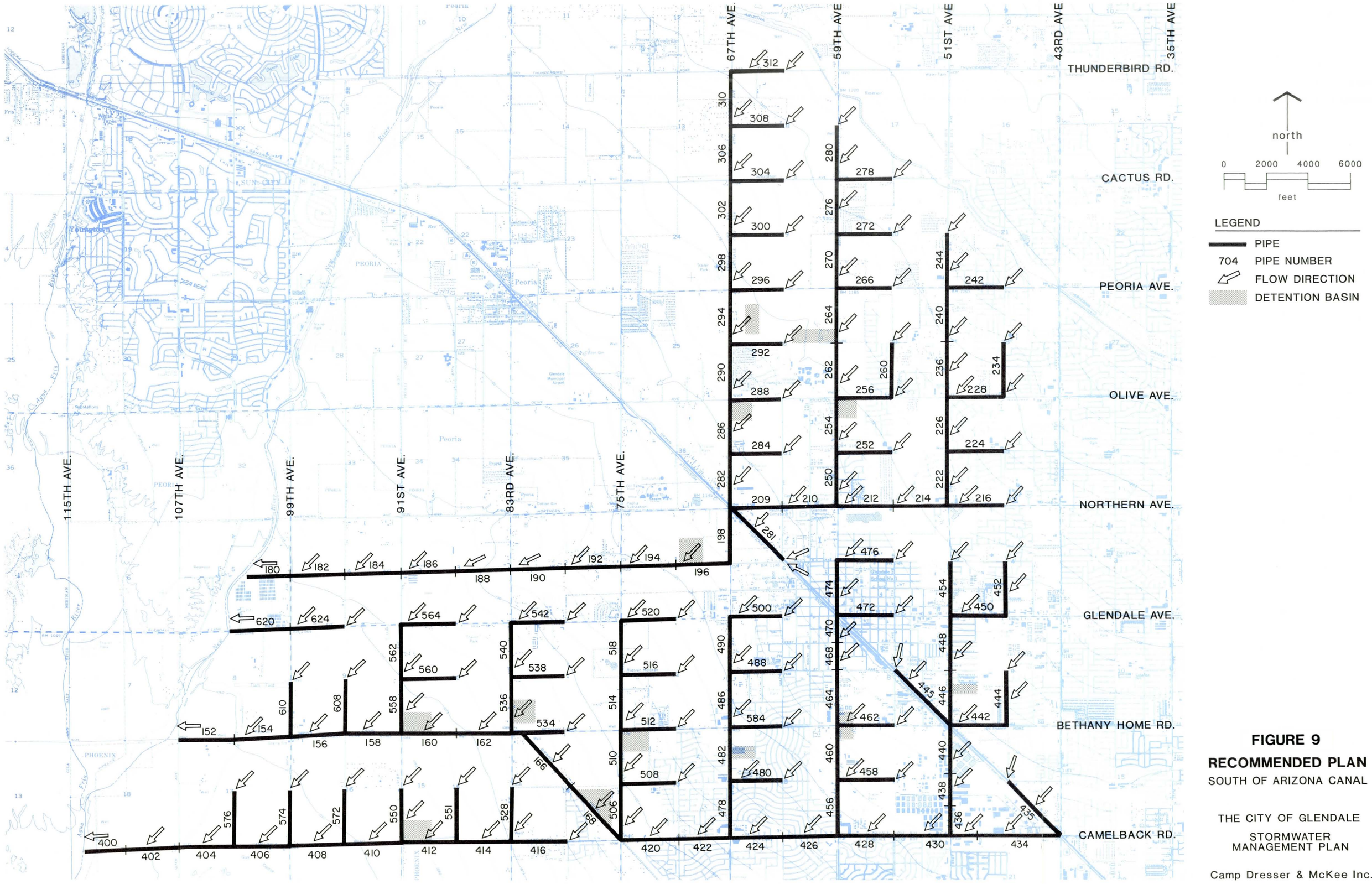

FIGURE 9

RECOMMENDED PLAN

SOUTH OF ARIZONA CANAL

THE CITY OF GLENDALE

STORMWATER MANAGEMENT PLAN

Camp Dresser & McKee Inc.

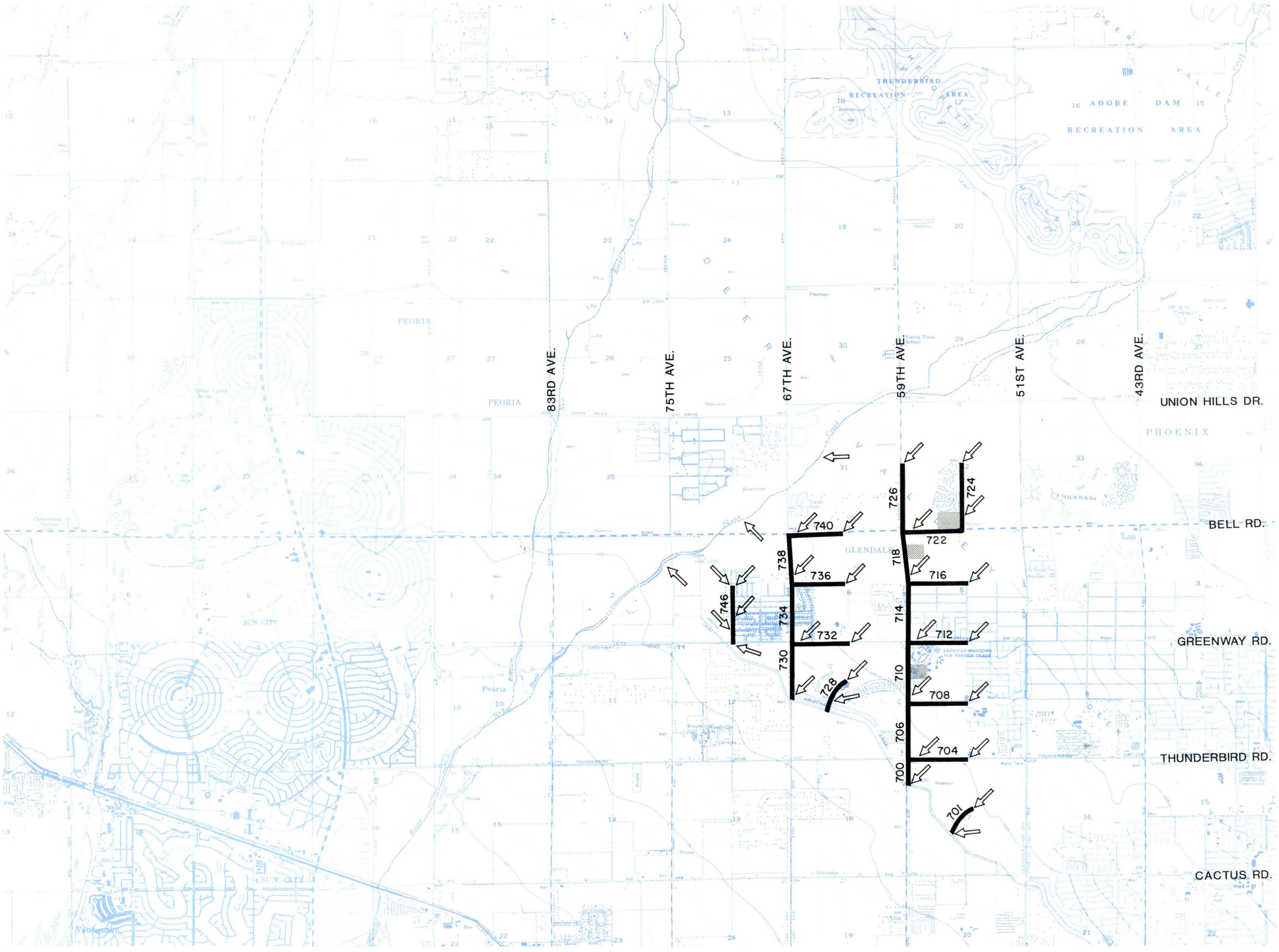

FIGURE 10

RECOMMENDED PLAN

NORTH OF ARIZONA CANAL

THE CITY OF GLENDALE

STORMWATER MANAGEMENT PLAN

Camp Dresser & McKee Inc.

6. Cost Estimates

6. Cost Estimates

CAPITAL COSTS

The capital expenditures needed to implement the recommended plan are summarized in Table 3. Details of the cost breakdown for the facilities required under Alternatives 1A and 5, and for detention facilities under each alternative, are included in the Capital Improvement Program Summary.

The total cost for the no-detention alternative is $232 million, and the cost for the detention alternative is $182 million. The detention alternative represents an expenditure of $50 million less than the no-detention alternative.

OPERATION AND MAINTENANCE COSTS

The recommended trunk stormwater facilities will require on-going operation and maintenance (O&M) effort in order to ensure proper functioning. O&M activities will include the following:

- Inspections of all major pipes and detention basins each month and after all storms that generate significant runoff.
- Sand, soil, and debris removal from all inlets and pipes. Repair work at detention basins, including:
  - replacement of eroded sections;
  - rodent and pest control;
  - vegetation control; and
  - repair of damage from vehicles and vandals.
- Repair of damages incurred during the occurrence of runoff from storm events greater than the 10-year design frequency would also be required.

A summary of the estimated annual O&M costs for the recommended plan, with and without detention facilities, is presented in Table 4.

TABLE 3

CAPITAL COSTS OF THE RECOMMENDED PLAN

Area	Capital Costs in Millions of Dollars			
	No Detention		Detention	
	Total Cost	Cost per Sq. Mile	Total Cost	Cost per Sq. Mile
ALTERNATIVE 1A Camelback Road to ACDC (34.5 sq. miles)				
Pipes	214		137	
Detention Basins	-		29	
	214	6.2	166	4.8
ALTERNATIVE 5 ACDC to Skunk Creek (8.5 sq. miles)				
Pipes	18		14	
Detention Basins	-		1.7	
	18	2.1	15.7	1.8
RECOMMENDED PLAN				
Pipes	232		151	
Detention Basin	-		31	
TOTAL	232		182	

TABLE 4

ANNUAL OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED PLAN

Area	Pipes		Detention Basins		Total	
	No Detention	Detention	No Detention	Detention	No Detention	Detention
Camelback Road to ACDC	$1,068,000	$687,000	$0	$287,000	$1,068,000	$ 974,000
ACDC to Skunk Creek	$ 92,000	$ 68,000	$0	$ 17,000	$ 92,000	$ 85,000
TOTALS	$1,160,000	$755,000	$0	$304,000	$1,160,000	$1,059,000

7. Schedule

7. Schedule

INTERAGENCY COOPERATION

Stormwater from the Cities of Phoenix and Peoria enters the City of Glendale; the reverse also occurs. In addition, the City of Glendale has stormwater interfaces with Maricopa County, the Arizona Department of Transportation, the Corps of Engineers, and the Salt River Project. Because of these conditions, interagency cooperation in the management of stormwater is recommended.

Interagency agreements might address the following subjects:

1. Control of stormwater overflows;
2. Closing of certain streets during periods of heavy runoff;
3. Improvement of existing stormwater facilities;
4. Construction of new stormwater facilities (interim and/or permanent);
5. Runoff controls; and/or
6. Emergency operations plan during flood conditions.

CONSTRUCTION PHASING

It is recommended that the construction of trunk stormwater facilities be separated into three phases: immediate action, short range, and long range.

Phase 1 -- Immediate Action

The implementation of stormwater facilities with detention is heavily dependent upon the availability of land for detention basins. Sites must be large enough and in locations appropriate for creating beneficial effects in downstream conditions. The following activities are recommended for immediate action:

1. Control land use at desired sites. This is of primary concern. Land use control can be accomplished by a variety of means:

- Granting developers increased density, then requesting that portions of their land be dedicated to detention;
- Obtaining an option on desired property;
- Purchasing desired property; or
- Any other method available to the City.

2. Formulate and enter into an interagency agreement with the City of Phoenix that will provide for joint stormwater management where stormwater flows cross 43rd Avenue from east to west near Northern Avenue, and 51st Avenue from east to west in the vicinity of Thunderbird Road.

3. Design and construct interim facilities at those road intersections where flooding occurs during relatively minor storms. The interim improvements would generally conform to the management plan recommendations and could consist of a pipe that temporarily empties into SRP irrigation or drainage facilities, a roadside ditch, a temporary detention basin, a dry well, or a small sump and booster pump system.

Approximate capital expenditures that would be incurred by the City for Phase 1 are estimated to total less than $3 million.

Phase 2 -- Short Range (1985-1989)

Short range activities would include the following:

1. Formulate and enter into interagency agreements with the City of Peoria, Maricopa County (for drainage of lands near Camelback Road and New River), Arizona Department of Transportation (for use of the pipe system along Grand Avenue), Flood Control District of Maricopa County (for discharging stormwaters into the ACDC), and the Salt River Project (for temporary and/or permanent use of SRP's irrigation and drainage facilities).

2. Plan for the design of road improvements that will provide adequate space for constructing stormwater pipes within road rights-of-way. Establish alignments of major water lines and sanitary sewer pipes that will not conflict with the trunk stormwater facilities.

3. Design and construct those stormwater pipes and detention basins that are within or alongside current land development or road improvement projects.

4. Construct pipes or interim open channels at the downstream (west) end of Bethany Home Road and Orangewood Avenue, and proceed upstream as funds become available. This will establish two major stormwater outlets from Glendale to New River.

5. Construct trunk stormwater pipes along 59th and 67th Avenue that drain southerly and empty into the ACDC. These facilities will allow Glendale the use of inlets into the ACDC that currently are under design by the Corps of Engineers.

Approximate capital expenditures that would be incurred by the City for Phase 2 are estimated to be in the range of $5 million to $10 million.

Phase 3 -- Long Range (1990-1999 and 2000-2010)

The long range plan will consist of installing all of the remaining facilities not constructed during Phases 1 and 2. Downstream facilities should be constructed first, with construction proceeding upstream.

Following is a summary of estimated capital expenditures for Phases 1, 2 and 3.

Phase	Period	Estimated Capital Expenditures
Immediate Action	1985-1989	Less than $3 million
Short Range	1985-1989	$10 million
Long Range	1990-1999	$70 million
	2000-2010	$100 million