GILA DRAIN

WESTERN CANAL ALTERNATIVES

CONCEPTUAL DESIGN STUDY

BY

DIBBLE & ASSOCIATES

CONSULTING ENGINEERS

PHOENIX, ARIZONA

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO. 12863
KENT M. DIBBLE
Date Signed 5/31/85
ARIZONA, U.S.A.

WITH

BOYLE ENGINEERING CORP.

SAN DIEGO, CALIFORNIA

Property of
Flood Control District of MC Library
Please return to
28[illegible] Durango
Phoenix, AZ 85009

G

MAY 31, 1985

FINAL REPORT
GILA DRAIN
Western Canal Alternatives
Conceptual Design Study

Submitted to
Flood Control District of Maricopa County
3335 West Durango
Phoenix, Arizona 85009

&

committee members

City of Mesa
City of Chandler
City of Gilbert
City of Tempe
City of Phoenix
Salt River Project
Arizona Department of Transportation

By

Dibble & Associates Consulting Engineers
3625 North 16th Street
Phoenix, Arizona 85016
(602) 264-6149

with

Boyle Engineering Corporation
7807 Convoy Court
San Diego, California 92111
(619) 268-8080

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO. 12863
KENT M. DIBBLE
Date Signed 5/31/85
ARIZONA, U.S.A.

May 31, 1985

TABLE OF CONTENTS

		Page No.
I.	Executive Summary	
	A. Backgound & Summary	1
	B. Discussion	1
	C. Conclusions & Recommendations	2
	D. Cost Summary	3
II.	Introduction	
	A. Background	5
	1. City of Mesa	
	2. City of Tempe	
	3. City of Gilbert	
	4. City of Chandler	
	5. Arizona Dept. of Transportation	
	6. Salt River Project	
	7. F.C.D.M.C.	
III.	Alternatives Analysis	
	A. Description of Alternatives	11
	a. Alternative 1	
	b. Alternative 2A	
	c. Alternative 2B	
	d. Alternative 3	
	e. Alternative 4	
	f. Alternative 5	
	g. Alternative 6	
	B. Alternative 6 - Northern Alignment (Price Rd.)	20
	a. Dependance on the outer loop	
	b. Right-of-Way	
	c. Construction	
	d. Freeway Crossings	
	e. Major Crossing	
IV.	Cost Analysis	25
V.	Conclusions and Recommendations	41

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO. 12863
KENT M. DIBBLE
Date Signed 5/31/91
ARIZONA, U.S.A.

VI. Appendix
A. Concept Design Elements 44
1. Data Collection
2. Retention Basins
3. Water Quality
4. Hydrology
5. Hydraulics
6. S.R.P. Criteria
7. Right of Way
8. Pumping Facilities
9. Construction Sequencing
10. Major Utility Locations

B. Summary of Task Force Meetings 55
1. Dec. 21, 1983 Meeting
2. Feb. 7, 1984 Meeting
3. March 21, 1984 Meeting
4. April 30, 1984 Submittal
5. Sept. 6, 1984 Meeting
6. Dec. 6, 1984 Meeting
7. March 5, 1985 Meeting

VII. Exhibits
A. Outline of Gila Drain Watershed
B. Retention Basins
C. Alternate 1
D. Alternate 2A
E. Alternate 2B
F. Alternate 3
G. Alternate 4
H. Alternate 5
I. Alternate 6
J. Profile of Alternate 3
K. Profile of Alternate 6

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO.
12863
KENT M. DABBLE
Date Signed 5/31/85
ARIZONA, U.S.A.

I. EXECUTIVE SUMMARY

A. BACKGROUND AND SUMMARY

The last decade has seen a phenomenal growth in population in the Tempe-Mesa portion of the Phoenix Metropolitan area. This growth is extending into the communities of Chandler and Gilbert. With this growth has come a vast increase in both storm water runoff and the potential for catastrophic damage to the newly developed areas. Lacking well defined natural drainage courses in this arid region, the general approach to stormwater management has been the use of detention/retention facilities. Once storm waters were captured in the basins, the problem has been disposal of the impounded storm waters. The use of the excess capacity in the Western Canal as an outfall drain is no longer adequate, and the Salt River Project plans to phase out established use of the canal as a storm water drain. Expanded use of the Gila Drain has long been sought as a solution to this problem, but negotiating for the rights has proved so difficult that the Gila Drain is no longer considered a viable option for solving all but a small portion of the various communities' needs.

The purpose of this conceptual design study is to identify several alternate solutions to the problem; analyze them as to effectiveness, feasibility, and cost; coordinate with the various communities and agencies involved; and recommend the preferred alternative.

B. DISSCUSSION

Several alternatives were investigated, all of which ultimately discharge into the Salt River. The alternates fell into two main categories. The first category would convey water by gravity along the alignment of the Western Canal from the Carriage Lane detention Basins to 48th or 32nd Street or both. The alternates called for using capacity within the Western Canal, a parallel conduit, or a combination of the two. The

second category would pump water into a forebay structure at the Carriage Lane detention basins, then convey it north along Price Road via a pressure conduit to the Salt River. The alternates provide conveyance from the various communities per their desires as follows: Gilbert, 100 cfs; Chandler, 100 cfs; Mesa, 130 cfs (all to the Salt River). The total conveyance is 330 cfs. Tempe is not a direct participant in the main system.

The main findings are as follows: Alternates which use only the canal are cheapest but dependant on Salt River Project operations. These alternates also introduce storm water of questionable quality into the irrigation system. Totally separate alternates are the most expensive but are also the most dependable; being independent of Salt River Project operations, and eliminating water quality problems. Combined systems are intermediate in cost but pose water quality concerns and difficult operational problems with splitting the discharge between the two systems.

Because of the water quality concerns and Salt River Project's shift away from allowing stormwater in their canals, alternates involving use of the Western Canal for capacity are effectively eliminated, except as interim measures.

C. CONCLUSIONS & RECOMMENDATIONS

Of the two alternatives wholly separate from the Western Canal, the Price Road alternate (Alternate 6 in the text) which would provide a series of pumps, forebay and pressure pipe line and gravity drain along Price Road, is the preferred one. Alternate 3 which would provide a parallel gravity conduit along the Western Canal right-of-way would be very expensive to construct. The available right-of-way along the Western Canal is narrow considering the size of the conduit required to convey the desired discharge is 108" + 0114" in diameter. Achieving adequate clearance for the conduit and the actual construction would be difficult in this limited space. The Price Road alternate follows the alignment of the proposed Outer Loop

freeway, and the wider right-of-way offers much easier construction. In addition, the Price Road alignment could provide the Arizona Department of Transportation a convenient joint outfall for their projected stormwater needs, and would also offer the possibility of intercepting Mesa stormwater at the Superstition Freeway rather than routing it to the Carriage Lane detention facility at the Western Canal.

Given the immediate need for a drainage outfall for Mesa, the needs of Gilbert and Chandler, and the start of design for the Outer Loop highway along the Price Road corridor, we would recommend immediately moving into Phase II and Phase III, Preliminary and Final Design.

D. COST SUMMARY

The construction costs as presented at the Task Force meetings and as discussed in this study are preliminary estimates intended for overall concept evaluation and though conservative in nature, do not reflect the following items:

a. Cost for right-of-way acquisition
b. Cost of minor utility relocations
c. Cost for escalation, due to duration
d. Cost for construction design
e. Cost for construction management

The cost for the various alternatives range from a low of $3 million for Alternate 1, around $8 million for Alternate 4, $12-13 million for Alternate 2A, 2B, and 5, to a high of over $15 million for Alternate 3. The cost of Alternate 6 (Price Road) is around $13 million, not including any participation by the Arizona Department of Transportation.

The following table summarizes the estimated construction cost and cost allocation for each alternative. A more detailed cost breakdown is contained in Section IV, Cost Analysis.

COST SUMMARY AND ALLOCATIONS

GILA DRAIN - WESTERN CANAL
ALTERNATIVES 1, 2A, 2B, 3, 4, 5, 6

ALT NO	TOTAL COST	FCD 40%	CITIES 60%	GILBERT 41.9%	CHANDLER 27.9%	MESA 30.2%
1	$ 2,900,000	$1,160,000	$1,740,000	$ 729,060	$ 485,460	$ 525,480
2A	13,410,000	5,364,000	8,046,000	3,371,274	2,244,834	2,429,892
2B	12,555,000	5,022,000	7,533,000	3,156,327	2,101,707	2,274,966
3	16,040,000	6,416,000	9,624,000	4,032,456	2,685,096	2,906,448
4	8,100,000	3,240,000	4,860,000	2,036,340	1,355,940	1,467,720
5	12,610,000	5,044,000	7,566,000	3,170,154	2,110,914	2,284,932
6	13,400,000	5,360,000	8,040,000	3,368,760	2,243,160	2,428,080

II. INTRODUCTION

A. Background

The Gila Drain Task Force has authorized Dibble & Associates Consulting Engineers with Boyle Engineering Corporation (BEC) to prepare a conceptual design report: Gila Drain Project, Western Canal Alternatives.

The Gila Drain watershed encompasses portions of the cities of Mesa, Gilbert, Chandler, Tempe, Phoenix and unincorporated areas of Maricopa County. The Gila Drain has physical boundaries as follows: Roosevelt Water Conservation District Canal and Floodway on the east, the Gila River on the south, the South Mountains on the west, and the Salt River on the north. (See Exhibit A). This area totals 162,980 acres.

There have been several studies to determine the optimum utilization for the watershed drainage: (1) U.S. Corps of Engineers, Summary Report for Flood Control - Gila Floodway, dated September, 1977; (2) Coe & Van Loo, Preliminary Design Report, Gila Drain, dated April, 1979; (3) Hydrology for Gila Drain Watershed, Various Studies, Maricopa County Flood Control District. All studies have dealt with the natural outfall of the watershed, which is the Gila Drain through Tempe and the Gila River Indian Reservation to the Gila River.

The Gila Drain committee, comprised of the Cities of Mesa, Gilbert, Chandler, Tempe, Phoenix, the Arizona Department of Transportation, the Maricopa County Flood Control District, and Salt River Project, has abandoned the natural outfall of the Gila Drain to the Gila River for the purposes of this study because of the difficulty in negotiating access and flowage rights through the Gila River Indian Reservation.

The current drainage problems have occurred because of the exponential growth and urbanization of this study area within the last decade. Localized flooding and resulting litigation could occur if a definite solution to this outfall problem is not resolved quickly.

The following is a summary, by Community, of current and future drainage concerns.

1. City of Mesa

The City of Mesa for the purposes of this conceptual design study has a design capacity of 130 cfs. This capacity does not include the series of retention basins located along the Superstition Freeway (S.R. 360) (see Exhibit B). These retention basins eventually outfall via the Mesa Drainage Ditch at Carriage Lane (Sec 7 T1S R4E). From this basin a 5 cfs pump bleeds off storm runoff into the Western Canal.

The 130 cfs capacity which Mesa has requested to be used, represents the present volume that can be delivered by the existing storm drain in Broadway Road which presently empties into the Tempe Canal.

2. City of Tempe

The City of Tempe is a participant in the Gila Drain Committee, but will not have any design discharge to contribute for this conceptual study. At present Tempe is planning a detention basin(s) identified as the Knox Road Retention Facility which will be using the Gila Drain or the city's Kyrene Road storm drain as an outfall. Tempe is also planning a joint venture for a storm drain facility with the City of Phoenix, along 48th Street south of the Salt River (see Exhibit F - Alternalte 3).

3. City of Gilbert

The City of Gilbert has estimated that the City will need 100 cfs of capacity for future needs. However, at present Gilbert has only a 36 inch storm drain that empties into the SRVWUA Lateral 9.5 immediately west of the S.P.R.R. crossing (Sec. 12 T1S. R4E.).

4. City of Chandler

For the purposes of this study, Chandler has also indicated the desire for a 100 cfs capacity in the common Gila Drain outfall to the Salt River. The City of Chandler will be responsible for conveying their 100 cfs capacity to the Carriage Lane Retention Facility

5. Arizona Department of Transportation

The Arizona Department of Transportation has no plans to participate in the Gila Drain alternatives unless Price Road is chosen as a possible alignment for the Gila storm drain. The Arizona Department of Transportation has expressed an interest to participate in a joint use Price Road Storm Drain, if a gravity drain philosophy is adopted. Their contribution will be only the storm water they intercept, and this volume will not be finalized until the Expressway design has been completed.

The Arizona Department of Transportation is currently acquiring the right-of-way necessary for the Outer Loop Expressway. Purchases have been finalized from Price Road and the Superstition Freeway to University Drive and Price Road. The Arizona Department of Transportation anticipates completion of acquisition to the Salt River in 1985.

The Arizona Department of Transportation has completed a basic on-site drainage concept study for the Outer Loop Expressway, at the request of the City of Mesa. This study included the subject of draining the accumulated flows from the Superstition Freeway Retention Basins 1 - 11 north to the Salt River (See Exhibit B). Also, this study reviewed the fact that it takes 80 days to release the 1667 acre feet from these retention basins. The study did not include the 130 cfs from the Broadway Road Storm Drains (2-48" pipes) which Mesa has committed to this concept design study.

The following additional studies were used by the Arizona Department of Transportation for the concept study:

(1) Yost & Gardner, February, 1975 Report, between the Tempe Canal and Roosevelt Water Conservation District.

(2) Highway Plan Services, "Preliminary Profiles of the Profiles of the Price Road Corridor Expressway for an Elevated and Dressed Concept, January, 1983."

(3) American Engineering Drainage Report for the Portion of Freeway between Dobson Road and State Route 87. This report contains descriptions of all utilities in the Price Road area.

(4) Arizona Department of Transportation Construction Plans for the Superstition Freeway from Kyrene Road Retention Basin to Center Street.

6. <u>Salt River Project</u>

The Salt River Project plans no financial participation, but will cooperate with the task force, so that if a solution can be agreed upon and use of their facilities is needed, policy can be reviewed.

Salt River Project owns and operates both Lateral 9.5, the Western Canal, and the Tempe Canal. The Lateral 9.5 originates as a branch of the Consolidated Canal and runs along the midsection line west to Price Road and the Tempe Canal. This canal is unlined and flows through a primarily agricultural area. The Western Canal originates at Price Road and the Tempe Canal and flows west past Kyrene Road where it then turns and flows around the north side of the South Mountains. This canal is both lined and unlined and runs through developed sections of Tempe and Phoenix. The Tempe Canal which is the boundary between the cities of Mesa and Tempe is a lined canal which delivers water to the Western Canal at Carriage Lane.

During the course of this conceptual design study Salt River Project has issued some new design criteria concerning the use of their canal systems for storm water runoff. (See Appendix "Concept Design Elements")

7. Flood Control District of Maricopa County

The Flood control District of Maricopa County (M.C.F.C.D) has actively pursued a resolution to the Gila Drain problem for the last 10 years. They have sponsored several design studies, plus conducted many in house reasearch projects on this subject. The M.C.F.C.D. has not been able to find a reasonable solution that would solve the existing drainage problems and not violate the June 21, 1923 agreement between the Salt River Water Users Association and the United States Government for the construction of a Drain Ditch across the Gila River Indian Reservation. In brief, the agreement limits the amount of run off to 75 cfs.

Because of this, the M.C.F.C.D. has, at the request of the other participants in this Task Force Committee authorized this concept study to be performed. The M.C.F.C.D. recognizes the severity of this problem and has agreed to act as the

coordinating agency for the investigation.

Financially, the M.C.F.C.D. has agreed to participate, though their exact participation has not been defined, it has been indicated to be substantial. Through the M.C.F.C.D. participation combined with the cost allocations from the other various participating communities, that a mutual resolution to this long standing problem can be found.

III. ALTERNATIVES ANALYSIS

The purpose of each alternative is the same -- to convey stormwater from the detention basins along the corridor to the Salt River. These alternatives fall into two broad categories based on the route over which the stormwater is conveyed. The first category includes alternatives which follow the 9.5 lateral and the Western Canal from the Carriage Lane detention basin to either 48th or 32nd Street and then down one or both of those streets to the Salt River. The second category conveys the stormwater along Price Road from the Carriage Lane detention basin directly north to the Salt River. Alternatives within the first category differ from each other in how much stormwater is conveyed in the canal and how much is conveyed in a parallel conduit. The alternatives run from the extreme of all stormwater being conveyed in the canal, to dividing the flow between the canal and a parallel conduit, to the other extreme of conveying the entire discharge in a parallel conduit. The second category alternative includes pumping stormwater from the detention basin and then conveying the flow through a pressure pipe along Price Road to north of the Superstition Freeway, then gravity flow to the Salt River.

A. DESCRIPTION OF ALTERNATIVES

1. Alternate 1

This alternate (see Exhibit C) uses the capacity of the Western Canal and the 9.5 Lateral to convey stormwater pumped from detention basins to outfall pipes in 48th Street and 32nd Street. The City of Gilbert would pump 100 cfs into the 9.5 Lateral at or near Cooper Road. An additional 230 cfs is pumped into the Western Canal at the Carriage Lane detention basin (Price Road). This alternate depends on the Salt River Project making capacity available by reducing flows upstream and by

making deliveries to downstream users. The outfall pipe in 48th Street would be available for the Salt River Project to use as a wasteway during dry weather and when it is not otherwise being used for storm flows.

This alternate has the advantage of minimum cost since the only improvements are the outfall drains, pumping facilities, and flow control structures, with no disruption to the Salt river Project right-of-way. Disadvantages are that the system is dependent on the Salt River Project operation of the Western Canal and problems of water quality due to direct discharge of storm runoff into the canal.

2. Alternate 2A

This alternate (see Exhibit D) uses a combination of excess capacity in the Western Canal along with a separate parallel pipe system to convey stormwater from the detention basins to the outfall drains. As in the first alternate and all other alternates, the 48th Street drain is available for Salt River Project use as a wasteway when not being used for draining the detention basins. The advantages of this alternate are lower cost than a completely independent parallel system and the available capacity in the canal is not dependent on Salt River Project operations. The disadvantages are as follows: Since the excess capacity of the Western Canal is lower downstream of the Highline Pumping Plant, water must be diverted from the Western Canal to the parallel system. This would require a control structure which complicates the design. Direct discharge of stormwater into the canal will pose water quality problems. Locating the parallel pipe in the Salt River Project right-of-way would require coordination with Salt River Project and would pose underground conflict problems. Construction in the limited Salt River Project right-of-way would be difficult.

3. Alternate 2B

This alternate (see Exhibit E) is similar to Alternate 2A except it would include lining of the Western Canal and Lateral 9.5 to increase its capacity and thus reduce the capacity and size required for the parallel conduit. The advantages of this alternate would be the elimination of approximately 5 miles of conduit from Gilbert to Price Road (the City of Gilbert would use the canal for its discharge), the size of the parallel conduit would be reduced, and concrete lining of the Western Canal would reduce maintenance for Salt River Project. Disadvantages would be the high cost of lining the canal, disruption of the canal operation during construction (this may not be acceptable to Salt River Project), a diversion structure would still be required at the Highline Pumping Plant, and parallel pipeline location would still require coordination with Salt River Project along with posing underground conflict problems.

4. Alternate 3

This alternate (see Exhibit F) utilizes a separate parallel conduit to convey the entire discharge from the detention basins to the Salt River via a 48th Street drain. The advantages of this alternate are that the capacity for stormwater pumping is independent of Salt River Project operations and the problem of water quality in the Western Canal is eliminated. The disadvantages of this alternate are the greater expense of a completely separate system over one which utilizes the Western Canal. Location of the pipeline within the right-of-way requires careful coordination with Salt River Project. Difficult construction problems may be encountered due to limited working space.

After initial screening the Task Force selected Alternate 3 for further study.

The final refinement of Alternate 3 discusses the following:

a. Right-of-Way
b. Construction
c. Freeway Crossings
d. Gravity System
e. Salt River Project Operations & Approval
f. Utility Relocations

These six areas need particular emphasis.

a. Right-of-Way

Alternate 3 has an existing right-of-way along the northern side of the Western Canal. This right-of-way varies in dimension from 150' to up to 250' with the Canal (approximately 30' to 50' in width) running in the center. The Salt River Project requires that the maintenance roads on both sides of the Canal remain undisturbed (14' to 16'). The total corridor for construction is now narrowed to 96-195', by eliminating the Canal and two maintenance roads. Dividing this strip by two (each side of the right-of-way) brings the north bank construction corridor down to 50'-100' width.

b. Construction

Though limited in right-of-way, these obstacles could be overcome. Because of the combination of a large diameter pipe and limited right-of-way, most excavation would be nonconventional. The trenching operation would have to be on the north bank of the canal while the spoil material would have to be loaded to trucks on the south bank.

When an open trench condition exists, there is no room for staging any of the pipe except along the south bank. Large cranes, operating at a 40-45 foot radius (minimum) to swing to the north bank, would pose another problem. When one considers the extensive overhead utilites and limited access

maintenance roads along the right-of-way, plus the intricate scheduling difficulties, the standard unit price of this alternate would increase.

One other point that should be recognized with Alternate 3 construction is the possibility of dewatering the open trench. The Western Canal is unlined in certain reaches and due to the close proximity of the canal to the proposed alignment, the migration of water to the open trench could pose additional costs and delays in the construction schedule.

c. Freeway Crossings

The proposed alignment of Alternate 3 has two freeway crossings. The Western Canal runs under Interstate 10 on the southern side of the State Route 360 (Superstition Freeway) interchange (Sec. 32 TIN R4E). The approximate length of the existing box culvert is 380'. The construction methods available for crossing I-10 are either jack and bore or tunneling. An open cut situation would be an impossibility, due to the interruption of access to the freeway.

The proposed 48th Street storm drain is in the design phase at present. The Arizona Department of Transportation has scheduled the 48th Street overpass for improvements, but does not plan on this being designed and constructed in the near future. The probable pipeline location for the I-10 crossing will be west of 48th Street. The 48th Street drain will fall into the same category as the Western Canal at I-10. The only method for crossing will be a jack and bore or tunneling operation, the approximate length being 400-440', depending on alignment.

d. Gravity System

The major advantage of Alternate 3 is that this system

design is a gravity drain. Though pumping will be necessary to lift the design volume from the retention basin into the pipe line, no additional pumping will be necessary over the approximate 49,000 L.F. (9.28 miles) of storm drain. The operational and maintenance cost for this type of system over the life of the drain would be considerably less than that of Alternate 6.

e. Salt River Project Operations and Approval

If Alternate 3 were to be adopted by the Gila Drain Task Force, Salt River Project would have to be integrated into the design and review process. Salt River Project has two major engineering divisions. The irrigation division has control of all water facilities and, the power division which is concerned with not only the local electrical utilities but with regional power generation and distribution as well. The Western Canal, being in close proximity to the Kyrene Generating Plant (Sec. 10 TIS R4E), is a key corridor for utility access for southern Tempe, Mesa, Chandler, and Gilbert. Though the majority of regional power facilities are located on the southern side of the Western Canal and would not be totally disruptive to construction, there exists numerous local utility lines on the northern side of the Western Canal that would need relocation. Scheduling and actual construction that would precede the construction of Alternate 3 would be a major undertaking. There is further discussion on these utility relocations in a later section (see Utility Relocations).

The Salt River Project requires both sides of the Western Canal be accessible at all times. There are many metering systems, pumping facilities, power lines, and general maintenance that are on-going on a daily basis. An interruption in delivery of contracted water or power could have legal ramifications beyond the scope of this investigation.

f. Utility Relocations

The following is a listing of Salt River Project utility relocations associated with the Western Canal that would be necessary if Alternate 3 were adopted. This listing begins at the Carriage Lane facility and ends at 32nd Street.

LOCAL UTILITY RELOCATIONS

Carriage Lane to 32nd Street along the northern right-of-way of the Western Canal

Structure	Location	SRP Location
Well Site B-483-103	Sec. 12 TIN R4E	N/A
Well Site No ID	Sec. 11 TIN R4E	N/A
24" Lat. C.P.	Sec. 11 TIN R4E	7-1.4
24" Lat. C.P.	Sec. 11 TIN R4E	7-1.6
Well Site C.P.	Sec. 11 TIN R4E	N/A
Power Line (Double Pole)	Sec. 10 TIN R4E	Running to Kyrene Generating Plant
30" Lat. C.P.	Sec. 10 TIN R4E	7-22.1
Weir	Sec. 10 TIN R4E	N/A
Measuring Bridge	Sec. 10 TIN R4E	N/A
Power Line (Single Pole)	Sec. 10 TIN R4E	Running Parallel from Kyrene Plant North
24" Drain C.P.	Sec. 10 TIN R4E	At Guadalupe Road
Power Line (Single Pole)	Sec. 33 TIN R4E	Running Parallel from Kyrene Plant at Baseline
S.P.R.R.	Sec. 3 TIN R4E	N/A
Lat. 5.2	Sec. 32 TIN R4E	N/A
30" Drain C.P.	Sec. 32 TIN R4E	N/A
24" Drain C.P.	Sec. 32 TIN R4E	N/A
Lat. 5.4 30" C.P.	Sec. 32 TIN R4E	N/A

24" Drain C.P.	Sec. 32 TIN R4E	N/A
36" Drain C.P.	Sec. 36 TIN R4E	N/A

Though not a complete listing, with the combination of local utility relocations, eight major street crossings and two freeway crossings, the list becomes quite extensive.

5. Alternate 4

This alternate (see Exhibit G) is similar to Alternat 2A in that both the Western Canal and a parallel conduit are utilized. The parallel conduit is smaller than required for completely conveying the desired discharge but allows for immediate commencement of stormwater evacuation of the detention basins while Salt River Project lowers the level in the canal to increase capacity. As capacity becomes available in the Western Canal, more and more stormwater can be pumped into the canal. The City of Gilbert uses the 9.5 Lateral for its discharge. The advantages of this alternate are reduced cost because of smaller sizes of parallel pipes, some capacity is immediately available for pumping from detention basins into the parallel conduit, the section of pipe from Cooper Road to Price Road is eliminated, and the delay in pumping from the detention basins into the canal will mitigate the water quality problem since the initial pumping (with the highest concentration of pollutants) will be to the parallel conduit. The disadvantages are that the ultimate capacity in the canal is dependent on Salt River Project operations. Stormwater will still be pumped into the canal thus continuing to pose a water quality concerns. Larger basins and longer detention times will be required than in Alternates 2A, 2B, 3 and 5. And pipeline location will need to be coordinated with Salt River Project.

6. Alternate 5

This alternate (see Exhibit H) is the same as Alternate 4 but uses a larger parallel conduit to increase the amount of stormwater conveyed in the parallel system, decreasing the dependence on Salt River Project capacity. The parallel conduit would extend to the City of Gilbert. The greater initial capacity of the parallel conduit, increased disposal of the initial stormwater high in pollutants, and decreased dependence on Salt River Project operations are advantages of this alternate. The disadvantages; are greater costs over Alternate 4; a continued dependence on Salt River Project operations; and water quality concerns due to the need to utilize canal capacity during longer events. Also,the use of SRP right-of-way will require coordination with the Salt River Project.

7. Alternate 6 (Price Road Alternate)

This alternate (see Exhibit I) differs from all others in that, it conveys stormwater north along Price Road via a conduit rather than west along the Western Canal. Since this route does not follow the natural fall of the valley, flow in the conduit would have to be under pressure for at least the southern reach of the outfall. The system would work by pumping stormwater from the Carriage Lane detention basin to the system, providing the static head to overcome the entrance losses, exit losses and the friction losses in the pipe. The Cities of Gilbert and Chandler would need to convey their stormwater (200 cfs) to the Carriage Lane detention basin. Gilbert could accomplish this with a pipe paralleling the 9.5 Lateral, as in Alternate 3, or as a temporary measure, the City of Gilbert could use Lateral 9.5. The City of Mesa will contribute 130 cfs to the outfall pipeline north of the Superstition Freeway. This water is presently being discharged into the Tempe Canal.

The advantages of this alternate are similar to Alternate 3 since the capacity for pumping is independent of Salt River Project operations and the problem of water quality in the Western Canal is eliminated. A significant advantage of this alternate over Alternate 3 is the greater room in the Price Road (Outer Loop) freeway right-of-way. The main disadvantage is the need to coordinate with the Arizona Department of Transportation and the expressway, especially in regard to timing since the flood control situation is becoming critical while the construction of the Outer Loop freeway is some time in the future. While the need to coordinate with the Arizona Department of Transportation complicates the project, there is the possibility of participation in the drain by the Arizona Department of Transportation since they will need to dispose of stormwater intercepted by their freeway.

B. ALTERNATE 6 - NORTHERN ALIGNMENT (PRICE ROAD)

Alternate 6 is the only alignment investigated that does not utilize right-of-way along the Western Canal. Alternate 6 as proposed, is a combinatiom of force main and gravity pipe from the Carriage Lane facility to the Salt River outfall. A pressure situation exists because the intermediate elevation at Broadway Road (1200' approximately) is 20' - 30' higher than the Carriage Lane Retention Facility.

The following five (5) areas of discussion are provided for clarification of the alignment of Alternate 6. (See Exhibit I)

a. Dependance on the Outer Loop
b. Right-of-Way
c. Construction

d. Freeway Crossing

e. Major Crossings

a. Dependance on the Outer Loop Expressway

This alternate is dependant on the Outer Loop Expressway, which is in the conceptual design phase at present. There are a number of variables for the Outer Loop which would affect this northern alignment. Some areas that need further definition, for this route are:

1. Drainage requirements for the Expressway
2. Firm Geometric Design
3. Construction Schedule
4. Possible extension of the Outer Loop Expressway south from the Superstition Freeway (under study by the Maricopa Association of Governments).

b. Right-of-Way

In the first, or southern reach, Alternate 6 could use a corridor that exists between the Mesa Drainage Ditch and the Tempe Canal as a location between Carriage Lane and the Superstition Freeway (approx. 16,000 ft).

In the second reach, a corridor has been purchased by ADOT for the Outer Loop from the Superstition Freeway to the Salt River and could become a joint use facility. This corridor varies in width from approximately 630.0' to 350.0'. There is at present a concept study showing a depressed design for the expressway. There are no elevations or solid geometrics available, so for purposes of this design concept study the drain is routed along the eastern edge of the corridor paralleling the existing Price Road, to enable interception of storm water from the City of Mesa.

c. Construction

Alternate 6 has more available access than the Western Canal Alternatives. The construction of Alternate 6 could be done by conventional construction practices with the same difficulty that would be encountered in any normal large pipeline construction.

d. Freeway Crossing

As stated previously the drain must cross the Superstition Freeway at approximately Price Road. To cross the freeway there are three concepts available. These are:

(1) elevated profile
(2) depressed profile
(3) at grade profile

(1) Elevated Profile

There exists at present, two overpasses on the Superstition Freeway, in close proximaty to a direct northerly outfall crossing along Price Road. These elevated structures are for Price Road and the Tempe Canal. With the addition of a third elevated structure for the Gila Drain outfall, the following items would need to be thoroughly investigated;

a) Geometric layout for Outer Loop and Superstition inter-change.

b) Construction impact on the level of service for the Superstition Freeway while the elevated structure is being constructed.

(2) Depressed Profile

The Superstition Freeway is in a very deep section at Price Road. The costs associated with constructing the Gila Drain Outfall under the freeway by means of a tunnel or jack and bore would be very high.

(3) At Grade Profile

A near at-grade crossing could be accomplished at a point approximately 3,000 feet east of Price Road where the freeway profile rises to go over the Mesa Drainage Ditch structure. The pressure conduit from the Carriage Lane Dentention Facility would follow the Drainage Ditch alignment to the crossing location. The conduit could then be jacked and bored under the freeway at a much shallower depth and without the concern for interchange structures near Price Road. One disadvantage of this crossing is that an additional 6,000 feet of pipe is required. However, the costs associated with the additional pipe should be offset by the elimination or reduction of the depth and conflicts involved with a crossing near Price Road.

A possible cost savings could also be realized if the flows that are presently channelled to the Carriage Lane Facility via the Mesa Drainage Ditch are routed down the north side of the Superstition Freeway and picked up by the Outer Loop Expressway storm drains. Then the abandoned drainage ditch structure could be used as a corridor to pass the force main through and reduce the cost for a freeway crossing.

e. Major Crossings

The following is a tabulation of the major crossings that Alternate 6 must contend with:

Crossing	
Gudalupe Road	Sec 7 T1S R5E
Baseline Road	Sec 6 T1S R5E
Superstition Freeway	Sec 31 T1N R5E
Southern Avenue	Sec 31 T1N R5E
Broadway Road	Sec 30 T1N R5E
S.P.R.R.	Sec 19 T1N R5E
Apache Boulevard	Sec 19 T1N R5E
University Drive	Sec 19 T1N R5E

If Alternate 6 could be constructed in advance of the Outer Loop Expressway, but integrated into the overall design, then utility and local street relocations could be accomplished and eliminate this scheduling problem in advance of the Outer Loop construction.

IV. COST ANALYSIS

This section has been separated into three sections for purposes of discussion. They are as follows:

1. Construction Cost
2. Cost Allocations
3. Operation and Maintenance Cost

The construction costs as presented at the Task Force meetings and as discussed in this study are preliminary estimates intended for overall concept evaluation and though conservative in nature, do not reflect the following items:

a. Cost for right-of-way acquisition
b. Cost of minor utility relocations
c. Cost for escalation, due to duration
d. Cost for construction design
e. Cost for construction management

The cost for the various alternatives range from a low of $3 million for Alternate 1, around $8 million for Alternate 4, $12-13 million for Alternate 2A, 2B, and 5, to a high of over $15 million, not including any participation by the Arizona Department of Transportation.

The following table summarizes the estimated construction cost and cost allocation for each alternative.

COST SUMMARY AND ALLOCATIONS

GILA DRAIN - WESTERN CANAL
ALTERNATIVES 1, 2A, 2B, 3, 4, 5, 6

ALT NO	TOTAL COST	FCD 40%	CITIES 60%	GILBERT 41.9%	CHANDLER 27.9%	MESA 30.2%
1	$ 2,900,000	$1,160,000	$1,740,000	$ 729,060	$ 485,460	$ 525,480
2A	13,410,000	5,364,000	8,046,000	3,371,274	2,244,834	2,429,892
2B	12,555,000	5,022,000	7,533,000	3,156,327	2,101,707	2,274,966
3	16,040,000	6,416,000	9,624,000	4,032,456	2,685,096	2,906,448
4	8,100,000	3,240,000	4,860,000	2,036,340	1,355,940	1,467,720
5	12,610,000	5,044,000	7,566,000	3,170,154	2,110,914	2,284,932
6	13,400,000	5,360,000	8,040,000	3,368,760	2,243,160	2,428,080

I. 1. CONSTRUCTION COST ESTIMATES

ALTERNATE 1

48TH Street Drain (145 CFS)

1.	54" pipe - Canal to 4,700'N	4,700 L.F.	@ $110.00 =	$	517,000
2.	66" pipe - 4,700'N to 10,700'N	6,000 L.F.	@ $135.00 =	$	810,000
3.	78" pipe - 10,700'N to 15,700'N	5,000 L.F.	@ $160.00 =	$	800,000
4.	Canal Structure				100,000
5.	Freeway Crossing				500,000

32nd Street Drain (55 CFS)

6.	Utilize proposed City Storm Drain		
7.	Canal Structure		$ 100,000
		TOTAL - ALTERNATE 1	$ 2,827,000
		U S E	$ 2,900,000

ALTERNATE 2A

Parallel Pipe

	(50 CFS)		
1.	45" Pipe - Cooper to SPRR	8,000 L.F. @ $ 90.00	= $ 720,000
2.	57" Pipe - SPRR to Dobson	13,300 L.F. @ $115.00	= $1,529,500
3.	48" Pipe - Dobson to Price	5,400 L.F. @ $100.00	= $ 540,000
	(230 CFS)		
4.	Pumping Structure Carriage Lane		= $ 780,000
5.	93" Pipe - Price to Highline	13,200 L.F. @ $190.00	= $2,508,000
	(255 CFS)		
6.	102" Pipe - Highline to 48th	20,000 L.F. @ $205.00	= $4,100,000

48th Street

	(255 CFS)		
7.	66" Pipe - Canal to 4700' N	4,700 L.F. @ $135.00	= $ 634,500
8.	84" Pipe - 4,700'N to 10,700'N	6,000 L.F. @ $170.00	= $1,020,000
9.	96" Pipe - 10,700' N to 15,700'N	5,000 L.F. @ $195.00	= $ 975,000
10.	Freeway Structure		= $ 500,000

32nd Street Drain (55 CFS)

10.	Utilize Proposed City Storm Drain	
11.	Canal Structure	$ 100,000

TOTAL ALTERNATE 2A	$13,407,000
U S E	$13,410,000

ALTERNATE 2B

Parallel Pipe

	(105 CFS)		
1.	Pumping Structure at Carriage Lane		=$ 510,000
2.	69" Pipe - Price to Highline	13,200 L.F. @ $140.00	=$1,821,600
	(180 CFS)		
3.	87" Pipe - Highline to 48th	20,000 L.F. @ $175.00	= 3,480,000

48th Street Drain

	(255 CFS)		
4.	66" Pipe - Canal to 4,700'N	4,700 L.F. @ $135.00	= 634,500
5.	84" Pipe - 4,700'N to 10,700'N	6,000 L.F. @ $170.00	= 1,020,000
6.	96" Pipe - 10,700'N to 15,700'N	5,000 L.F. @ $195.00	= 975,000
7.	Freeway Crossing		500,000

32nd Street Drain

	(55 CFS)		
8.	Utilize Proposed City Storm Drain		
9.	Canal Structure		100,000
10.	Lining of Canal (11 Miles)	195,000 S.Y. @ $18.00	= 3,510,000

TOTAL ALTERNATE 2B	$12,551,000
U S E	$12,555,000

ALTERNATE 3

Parallel Pipe

	(100 CFS)		
1.	57" Pipe - Cooper to SPRR	8,000 L.F. @ $115.00 =	$ 920,000
2.	72" Pipe - SPRR to Dobson	13,300 L.F. @ $145.00 =	$1,928,500
3.	66" Pipe - Dobson to Price	5,400 L.F. @ $135.00 =	$ 729,000
	(330 CFS)		
4.	Pumping Structure @ Carriage Lane		$1,020,000
5.	108" Pipe - Price to Highline	13,200 L.F. @ $220.00 =	$2,904,000
6.	114" Pipe - Highline to 48th St.	20,000 L.F. @ $230.00 =	$4,600,000
7.	Freeway Crossing		$ 500,000
		SUBTOTAL	$12,601,500
		U S E	$12,600,000

48th Street Drain

	(330 CFS)		
7.	75" Pipe - 48th St. to 4,700'N	4,700 L.F. @ $150.00 =	$ 705,000
8.	90" Pipe - 4,700'N to 10,700'N	6,000 L.F. @ $180.00 =	$1,080,000
9.	108" Pipe - 10,700'N to 15,700'N	5,000 L.F. @ $220.00 =	$1,100,000
10.	Freeway Crossing		$ 500,000
11.	Outlet Structure		$ 50,000
		SUBTOTAL	$3,435,000
		U S E	$3,440,000
		TOTAL ALTERNATE 3	$16,040,000

ALTERNATE 4

Parallel Pipe

	(100 CFS)		
1.	Pumping Structure @ Carriage Lane		$ 510,000
2.	69" Pipe - Price to Highline	13,200 L.F. @ $140.00 =	$1,848,000
3.	72" Pipe - Highline to 48th	20,000 L.F. @ $145.00 =	$2,900,000

48th Street Drain

	(145 CFS)		
4.	54" Pipe - Canal TO 4,700'N	4,700 L.F. @ $110.00 =	$ 517,000
5.	66" Pipe - 4,700'N 10,700 'N	6,000 L.F. @ $135.00 =	$ 810,000
6.	78" Pipe - 10,700'N to 15,700'N	5,000 L.F. @ $160.00 =	$ 800,000
7.	Freeway Crossing	=	$ 500,000
8.	Canal Structure	=	$ 100,000

32nd Street Drain

	(55 CFS)		
8.	Utilize Proposed City Storm Drain		
9.	Canal Structure		$ 100,000
		TOTAL ALTERNATE 4	$ 8,085,000
		U S E	$ 8,100,000

ALTERNATE 5

Parallel Pipe

	(50 CFS)		
1.	45" Pipe - Cooper to SPRR	8,000 L.F. @ $ 90.00	= $ 720,000
2.	57" Pipe - SPRR to Dobson	13,300 L.F. @ $115.00	= $1,529,500
3.	48" Pipe - Dobson to Price	5,400 L.F. @ $100.00	= $ 540,000
	(200 CFS)		
4.	Pumping Structure @ Carriage Lane		= $ 780,000
5.	90" Pipe - Price to 48th	33,200 L.F. @ $180.00	= $5,976,000

48th Street Drain

	(200 CFS)		
6.	60" Pipe - Canal to 4,700'N	4,700 L.F. @ $120.00 =	$ 564,000
7.	75" Pipe - 4,700 'N to 10,700'N	6,000 L.F. @ $150.00 =	$ 900,000
8.	90" Pipe - 10,700 'N to 15,700'N	5,000 L.F. @ $180.00 =	$ 900,000
9.	Freeway Crossing		
10.	Canal Structure		$ 100,000

32nd Street Drain

	(55 CFS)	
11.	Utilize Proposed City Storm Drain	
12.	Canal Structure	$ 100,000

TOTAL ALTERNATE 5	$12,609,500
U S E	$12,610,000

ALTERNATE 6

Parallel Pipe

	(100 CFS)		
1.	57" Pipe to SPRR	8000 L.F. @ 115.00 =	920,000
2.	72" Pipe SPRR to Dobson	13,300 L.F. @ 145.00 =	1,928,500
3.	66" Dobson to Price	5,400 L.F. @ 135.00 =	729,000

Price Road

4.	78" Pipe - Carriage Lane to Superstition Frwy.	16,000 L.F. @ 180.00 =	2,880,000
5.	90" Pipe - Superstition Frwy. to Broadway Rd.	7,200 L.F. @ 225.00 =	1,620,000
6.	108" Pipe- Broadway Rd. to Salt River	10,300 L.F. @ 260.00 =	2,678,000
7.	Pumping Structure @ Carriage Lane	=	980,000
8.	Freeway Crossing	=	1,000,000
9.	Canal Crossing	=	500,000
10.	Offset Structure	=	150,000
		TOTAL	$13,385,500
		U S E	$13,400,000

2. COST ALLOCATION

Cost allocations for this study were determined by:

a). Developing Cost Estimates for each participating city to construct a complete separate system which conveys their desired capacity to the Salt River.

b). The above mentioned cost estimates were totalled and percentages of total costs assigned to each participant.

c). The Flood Control District has agreed to contribute as much as 40% of the total cost for the Task Force Storm Drain.

d). The remaining 60% of the total cost was broken down by the appropriate percentages as determined in Step b) and distributed among the participants.

The cost allocation associated with each alternate does not have any consideration for escalation. The cost allocations also do not reflect any monies needed for construction design or construction management.

The following is a tabulation of the percentages that the individual participating cities would contribute for alternates 1,2A, 2B, 4, 5, 6.

Maricopa County Flood Control District	40%
Participating Cities	60%
	100%
Participating Cities Individual Pecentages	
CITY OF MESA	30.2
CITY OF CHANDLER	27.9
CITY OF GILBERT	41.9
	100%

The costs for the separate systems for each city are included. It should be noted that these cost figures do not include any pumping structures, utility relocation or right-of-way acquisition. These numbers were assembled for purposes of discussion. They are intended to give the task force members a reference to the magnitude of the various alternates and the individual costs that would have to be borne.

The Gila Drain Task Force will have to collectively define the actual cost allocations for the final alternative selected. The consultants have attempted to devise a means by which a method is provided that has no advantage given to any individual participant.

COST ESTIMATE WORKSHEET
SEPARATE SYSTEM FOR EACH CITY

I. Gilbert - 100 CFS inflow at Cooper Road
Parallel to Canal

1)	57" pipe - Cooper to SPRR	8,000 L.F.	@ $115.00 =	$ 920,000
2)	72" pipe - SPRR to Dobson	13,300 L.F.	@ $145.00 =	$1,928,500
3)	66" pipe - Dobson to Price	5,400 L.F.	@ $135.00 =	$ 729,000
4)	69" pipe - Price to Highline	13,200 L.F.	@ $140.00 =	$1,848,000
5)	72" pipe - Highline to 48 St	20,000 L.F.	@ $145.00 =	$2,900,000
	48th Street			
6.	48" pipe - Canal to 4700'	4,700 L.F.	@ $100.00 =	$ 470,000
7.	60" pipe - 4700'N to 10,700'N	6,000 L.F.	@ $120.00 =	$ 720,000
8.	69" pipe - 10,700'N to 15,700'N	5,000 L.F.	@ $140.00 =	$ 700,000
9.	Freeway Crossing			$ 500,000
			GILBERT TOTAL	$10,715,500

II. CHANDLER - 100 CFS inflow at Price Road

(Same as Gilbert less Items 1,2,&3)
($10,715,000 - $3,577,500 =)

CHANDLER TOTAL $ 7,138,000

III. Mesa - 130 CFS Inflow at Price Road
Parallel to Canal

1.	75" pipe - Price to Highline	13,200 L.F.	@ $150.00 =	$1,980,000
2.	78" pipe - Highline to 48th St	20,000 L.F.	@ $160.00 =	$3,200,000
	48th Street			
3.	51" pipe - Canal to 4,700'N	4,700 L.F.	@ $105.00 =	$ 493,500
4.	66" pipe - 4,700'N to 10,700'N	6,000 L.F.	@ $135.00 =	$ 810,000
5.	75" pipe - 10,700'N to 15,700'N	5,000 L.F.	@ $150.00 =	$ 750,000
6.	Freeway Crossing			$ 500,000
			MESA TOTAL	$7,733,500

Cost Allocation Summary (Separate System For Each City)

II. Chandler	$ 7,138,000	27.9%
III. Mesa	$ 7,733,500	30.2%
	$25,587,000	100.0%

If Alternate 3 is adopted and the proposed Phoenix/Tempe 48th St. storm drain utilized on a joint venture project then the percentages would be modified to include the Cities of Phoenix and Tempe contribution for the reach from 48th St. to the Salt River. Due to the incomplete design & costing for the 48th St. drain, for discussion purposes the City of Phenix and the City of Tempe will have a cost allocation of 50% combined. This percentage is an arbirtrary assignment and subject to modification.

The cost allocations for alternatate 3 from 48th Street to the Salt River would be as follows:

48th Street Section

Maricopa County Flood Control District	40%
Participating Cities	60%
	100%

Participating Cities Individual Percentages

City of Mesa	13.53
City of Chandler	11.23
City of Gilbert	25.24
City of Phoenix	25.00
City of Tempe	25.00
	100.00%

Alternate 6, if selected as a final alternative would have the same cost allocations, as that presented for alternates 1, 2A, 2B, 4 & 5. This is assuming that ADOT would not be participating in the Task Force storm drain and that the storm drain would be independant of the Outer Loop Expressway. Alternate 6 could be modified to include the entire Superstition Freeway Drainage, plus the local flows that the Outer Loop expressway was to intercept or any variations there of. Then the

cost allocations would be redistributed to some extent. This redistribution cannot be listed in this report, because ADOT has not finalized on-site drainage design, or published any conceptual cost estimates.

3. OPERATION & MAINTENANCE COSTS

As discussed in earlier sections, any of the Alternates 1-6 will require some type of pumping facility. For this report, an assumption of an average annual precipitation of 7" will be used. Also, the cities 50 year storm (approximately 3" of rainfall) which produces approximately 1500 acre-feet of storage will be assumed. The following is estimated pumping cost for Alternate 6 which would be the worst course possible. All other pumping schemes would produce pumping lists less than Alternate 6 for an average years storm runoff.

PUMPING COSTS
ALTERNATE 6

7" - Average annual rainfull 7"/3" = 2.33 storms/year
3" - 50 year storm

2.33 x 1500 acre ft = 3500 acre ft = 152,460,000 ft^3 annually

152,460,000 ft^3 / 330 CFS = 128 hrs. pumping/year

128 hrs. of pumping year x 350 hp (pump motors x 5 = 224,583 hp-hrs/year

224,583 hp-hrs/year x 0.746 kw/hp = 167,500 Kw hrs./year

Using 12c/kw hr = $20,100/year
Use = $25,000/year

The $25,000/year figure was used to include security lighting, and and any other electrical consuming devices that would be necessary. In addition to annual pumping costs there will be maintenance costs for the pumps and ancillary equipment. These regularly scheduled inspections and repairs for said equipment will require a crew of 3-men on an annual basis, plus any additional parts or equipment that may be necessary. This same crew when not active on the pumping structure could also be utilized to maintain the storm drain itself, (i.e. removing debris, repairs etc.). The associated cost for maintenance would be as follows:

MAINTENANCE COSTS

ALTERNATE 6

1-3 man crew	$15,000/month x 12	= $180,000/yr.
associated parts and material		$ 45,000
		$225,000 year

The total costs for operation and maintenance of the pumping facility and storm drain would be an estimated $245,000/year, this could be born by all the participants and managed by a single source, (i.e. Mesa, Gilbert, and Chandler).

The numbers presented reflect conservative estimates which include a 200% overhead allowance on the 3 man crew and having to perform any major overhaul on a pump each year. These costs are extremes but, necessary in the concept phases of a project of this magnitude. These numbers can be trimmed by streamlining costs and by implementing such concepts as staged sequencing of start-up on pump motors. Also the possibility of off-peak time pumping, so to take advantage of discounted power rates and keep the peak demand rates as low as possible.

Though many various Operation and Maintenance schemes could be produced and presented, the actual expertise in this area can be formed within the Task Force participants in house management staffs.

V. CONCLUSIONS AND RECOMMENDATIONS

At the present time, the Salt River Project accepts stormwater into their canals at a number of locations, including the Carriage Lane detention basin. This policy is changing, however. The Salt River Project plans to phase out present connections from storm drainage facilities, and therefore any plan which involves the use of the Western Canal for conveyance of stormwater should be considered an interim measure while separate facilities are designed and constructed. Long range plans further call for the construction of a City of Phoenix water treatment plant using the Western Canal as its source of raw water. Using the Western Canal for stormwater discharge could impair the ability of the plant to operate effectively for the extended periods of time needed to empty detention basins.

These considerations tend to preclude Alternates 1, 2A, 2B, 4 and 5 since each of these use the Western Canal for some or all of the required conveyance. This leaves Alternates 3 and 6 as potentially the most appropriate. From the City of Gilbert's standpoint the alternates are about the same since in the long run Gilbert has to convey its stormwater to Price Road. The only difference might be in Gilbert's financial participation in the outfall from the Carriage Lane detention basin, and thus the City's concern would be the comparative costs. The City of Mesa, whose needs are becoming most critical, would be served well by either alternate. The City of Chandler, assuming its input into the system was at the Carriage Lane detention basin, would likewise be accomodated by either alternate. The City of Tempe has two options for draining its proposed Knox Road detention basin besides connection with either Alternates 3 or 6. These options are securing the use of the natural Gila Drain or pumping to their Kyrene Road storm drain. Connection with Alternate 6 at the Carriage Lane detention basin would require pumping two miles farther and ten feet higher than

pumping to the Western Canal at Rural Road.

From the viewpoint of the City of Phoenix, Alternate 3 would require the 48th Street storm drain to be much larger since it would need to be sized to convey the discharge from the upstream detention basins. Alternate 6 would only require a drain capable of acting as a 40 cfs wasteway for the Western Canal. Besides reducing the cost of the 48th Street drain the smaller conduit would take less space in the right-of-way and thus reduce conflicts with existing and future underground utilities.

The Arizona Department of Transportation would be able to utilize Alternate 6, if they so desire. Careful coordination would be necessary to minimize conflicts and subsequent rebuilding/relocation of the Price Road outfall when the Outer Loop freeway is constructed.

Both Alternates 3 and 6 would provide Salt River Project with its needed outfall at 48th Street; however, construction of Alternate 3 would tend to be disruptive of canal operations in both the actual construction and in the rerouting/relocation of structures along the Western Canal. Alternate 6 would only parallel the Tempe Canal for about two miles. The right-of-way is considerably wider than the Western Canal, thus it would appear to be less disruptive.

Both Alternates 3 and 6 are separate from the Salt River Project canals and thereby would be under the operational control of the Task Force Committee through the Flood Control District.

Alternates 3 and 6 appear to be equally effective. Both could convey 330 cfs from the Carriage Lane detention basin to the Salt River. Alternate 6 would not provide the best opportunity for the City of Tempe to participate in the project, but Tempe has already indicated that it does not plan to do so, preferring instead to pursue the Kyrene Road storm drain or the Gila Drain for its stormwater outfall.

Of the two, Alternate 6 appears the more feasible as the available right-of-way along the Price Road corridor is significantly wider than along the Western Canal. Construction would be very difficult in places. Further, the 48th Street drain would be significantly larger for Alternate 3 than for Alternate 6. Since 48th Street is already fully developed, the larger drain could potentially pose extreme utility conflict problems during design and construction and in the future. Alternate 6, since it is following the Outer Loop freeway, has much more room and less potential utility conflicts. Also, since Alternate 6 would be a pressure line from the Western Canal to north of the Superstition Freeway, it need not follow a grade as would the gravity line in Alternate 3.

It is recommended that Alternate 6 be selected by the Task Force Committee for further development in the Preliminary and Final plan phases for the following reasons:

1. The Price Road/Outer Loop alignment corridor appears much more open and available for construction of a large diameter drainage structure.
2. There would be less disruption to Salt River Project facilities, therefore, less need for coordination, review and approval by SRP.
3. The length of the pipeline is significantly less than Alternate 3.
4. The construction cost is less than Alternate 3.

VI. APPENDIX

A. Concept Design Elements

The following concept design elements are discussed as to their involvement in this study:

1. Data Collection
2. Retention Basins
3. Water Quality
4. Hydrology
5. Hydraulics
6. Salt River Project Criteria
7. Right of Way
8. Pumping Facilities
9. Construction Sequences
10. Major Utility Locations

1. DATA COLLECTION

All historical materials presented in this conceptual design report were gathered through a series of meetings and conversations with the various participants. Due to the immense volume of material which has been gathered, please refer to the referenced report(s) and/or contact the individual, city, county, state, or federal organizations for further clarification.

2. RETENTION/DETENTION BASINS

Retention/detention basins have been the solution for handling private/public storm runoff for the majority of municipalities in the study area. At present, most of the City

ordinances call for development to provide adequate on-site retention for a fifty (50) year, twenty four (24) hour storm which amounts to approximately 3 inches of precipitation. This volume is to be removed in varying time periods and through various outlets. The existing storm drains cannot relieve the large amounts of stored runoff. The largest concentration of stored runoff is in the group of retention basins shared by the City of Mesa and the Arizona Department of Transportation (ADOT) along State Route 360. (Superstition Freeway).

The Superstition Freeway intercepts the surface runoff from the north (See Exhibit B). Although several storm drains exist, the majority of storm runoff is collected in these retention basins that lie along the northern right of way of the Superstition. There are presently eleven (11) separate retention basins as follows:

TABLE OF DETENTION BASINS

LOCATION	BASIN NO.	VOLUME (Ac. Ft.)
Carriage Lane	1	168.5
Carriage Lane	2	168.5
Extension Road	3	232
SPRR West	4	271
SPRR East	5	129
Stapley Drive	6	240
Gilbert Road	7	121
Lindsay Road	8	146
Consolidated Canal	9	7
Val Vista Drive	10	109
Eastern Canal	11	76
	Total	1667 Ac. Ft.

This series of retention basins has at present 1,667 Ac. Ft. of storage and bleeds off at a rate of 10 cfs into the Western Canal.

3. Water Quality

Storm water runoff from urban and agricultural areas contains pollutants ranging from trace metals such as chromium, cadmium, copper, lead, and zinc to fecal coliform bacteria, pesticides, and phenolic compounds. The quality of storm runoff is largely a function of the type of material making up the surface of the watershed (e.g., paved streets and highways with vehicular residues vs. agricultural with livestock or treated with fertilizers and pesticides) and climatic conditions, particularly rainfall. A detailed report on water was submitted to the Task Force Committee and discussed at the February 7, 1985 committee meeting. (draft - Water Quality Report, Richard Richter, BEC). Salt River Project is concerned about maintaining the quality of the water it delivers to its users in the rapidly urbanizing environment. Long range plans for the Western Canal call for a water treatment plant (City of Phoenix) water directly from the canal, near 67th Avenue, further increasing the importance of water quality.

While detention of stormwater reduces the concentration of pollutants, particularly heavy metals, primarily through settling (Wigington, et. al., "Accumulation of Selected Trace Metals in Soils of Urban Runoff Detention Basins", Water Resources Bulletion, Vol. 19. No. 5, October, 1983, AWRA), its significance for the Western Canal is unknown. Long term testing and research would be necessary to quantify the water quality impacts of using the Western Canal to carry stormwater.

4. Hydrology

The hydrology was provided by the Flood Control District, except for Tempe. The south Tempe streets 10-year and 100-year discharge was determined using the rational method based upon drainage areas and characteristics provided by Tempe. Each City was responsible for providing the consultants with retention volumes and discharge capacities to be used in this study.

5. Hydraulics

The standard methods for handling storm water runoff is by gravity drainage. Since the natural outfall of the Gila Drain does not appear to be available this leaves the Salt River as the only outfall. This report will consider the hydraulic alternatives of a gravity storm drain or a "forced" main storm drain to the Salt River outfall.

At present the Carriage Lane facility has a stored water surface elevation of 1180.0 +/-. Using the outfall locations of 48th and/or 32nd Street (See Exhibit J), the respective outfall elevations are 1120.0' and 1100.0', allowing a gravity drain design paralleling the Western Canal alignment.

If an alignment from the Carriage Lane retention facility directly North is chosen, a pumping facility will be required to overcome the existing elevation of approximately 1200.0' at Broadway Road. (See Exhibit K)

6. Salt River Project Criteria

Recognizing that the Salt River Project canals and drainage systems are of vital importance to this study, the Salt River Project is participating in evaluation of this Gila Drain alternative concept study. Due to their obligations to both

public and private concerns, the project has developed new policies and criteria for cooperative use of their facilities with regards to storm drainage. The following is a synopsis of Salt River Project's new proposed storm drainage criteria:

a. All requests for new or modified storm drain connections are to be submitted to the Manager, Civil Engineering, for processing. Calculations of volume and flow rates of discharge to the system must be provided.

b. All new storm drain connections will require an outlet of equal flow rates to a governmental storm drain, river bed, or other facility that can adequately dispose of storm runoff.

c. Existing drains that are moved, modified or adjusted due to street widening, intersection improvements, etc., will require an outlet of equal flow rate to a governmental storm drain, river bed or other discharged facility.

d. New or replacement drain connections will not exceed 12 inches in diameter at any site or discharge at a combined flow rate greater than the outlet unless otherwise justified (case by case).

e. All drain connections and discharge rates of storm water into Salt River Project facilities must be approved by the Manager of Water Operations and the Assistant General Manager, Water, prior to issuance of license.

f. Water Quality impacts on shareholders are to be considered.

g. All governmental agencies are encouraged to reduce dependence on the Salt River Project for storm water discharge and to plan for storm drainage facilities to handle existing and future storm runoff. All drains should have an outlet of equal flow rate to a governmental storm drain or to a river bed by January 1, 1995, or be removed from the Salt River Project system.

h. Distance from inlet to outlet will be a function of the available capacity for the transportation of storm flow between inlet and outlet.

i. Storm drain outlets currently in design should be reviewed in an effort to have the design meet the guidelines established in this policy.

j. Retention basin discharge pumping to the Salt River Project system will require an outlet of equal flow rate based on the maximum pumping capacity, and the Salt River Project's ability to transport storm water will be a function of the available capacity in the canal or lateral.

k. Exceptions to the guidelines outlined above may be reviewed on a case by case basis by the Manager of Water Operations and the Assistant General Manager, Water.

The Salt River Project will not participate financially in any of the Gila Drain Alternatives presented. In lieu of any monetary compensation for the use of the right-of-way for whatever Alternate is selected, Salt River Project has requested a 40 cfs outlet at 48th Street from the Western Canal to the proposed 48th Street storm drain. This 40 cfs outlet

incorporates the potential release from Guadalupe Dam, as well as local inflows into the Western Canal. The Salt River Project has also agreed that the Western Canal could be utilized for interim use for storm water disposal until construction of the proposed pipeline is completed.

7. Right-of-Way

This study is going to present two viable alignments; (1) West to an outfall at 48th Street and/or 32nd Street and (2) North along the Western right-of-way of the proposed outer loop expressway. Both alignments will originate at the Carriage Lane retention facility, located on the Northeast corner of Price Road and the Western Canal, (Sec. 7 T1S R5E) with storm water from the Cities of Gilbert and Chandler being conveyed to this point via Lateral 9.5.

The two alignments utilize right-of-ways that belong to SRP or ADOT, for the majority of the project.

The designated right-of-way for the alignment at 48th Street has not been defined, but with coordination between the City of Phoenix, the City of Tempe, and the task force, a joint outfall alignment from the Western Canal to the Salt River can be achieved. The Northern alignment along the outer loop expressway may also need some right-of-way acquisition near the Salt River, but with a coordinated effort with the City of Tempe, and ADOT this could also be resolved.

8. Pumping Facilities

All alternatives will require a pumping facility to lift the storm water out of the retention basin and into the piping system. The Price Road alignment (Alternate 6) will require additional pumping capacity to overcome the differential in

ground elevation, which rises to a high point of approximately Elevation 1200.0 near Broadway Road.

9. Construction Sequencing

The development of this project should be a phased progression of construction segments that would give participating cities immediate relief, and an eventual permanent solution to the problem. The Salt River Project has agreed to interim pumping into the Western Canal until construction of a permanent solution.

SRP has also requested a 40 cfs outfall at 48th Street in lieu of financial compensation for the use of their right-of-way. The construction of the 48th Street outfall for the 40 cfs SRP requirement along with any additional interim capacity from the Carriage Lane retention facility into the Western Canal should be the first items of construction. The outfall could be incorporated into the proposed 48th Street storm drain, which is to be a future City of Tempe and Phoenix joint project.

Once immediate relief has been established, design and construction of the total system should proceed as quickly as possible within normal constraints of funding, coordination, and seasonal requirements. The inlet (pumping) and outlet structure(s) could be sized, designed and constructed during traditionally dry periods.

Due to the complexity and coordinating effort that is necessary for a project of this size, it may be necessary to have a coordinating agency, such as the Flood Control District, to manage this project. Participants from the task force could staff the project with their own in-house expertise to futher accelerate the design/construction phases.

10. Major Roadway & Utility Crossings

The following is a tabulation of major crossing locations for roadways and utilities along each of the proposed alignments.

a. Western alignment (Western Canal)
b. Northern alignment (Price Road)
c. Lateral 9.5
d. 48th Street
e. 32nd Street

a. Western Alignment (Western Canal)

Crossing	Location
Price Road	Sec. 12 TIS R5E
McClintock Drive	Sec. 11 TIS R5E
Canal Drive	Sec. 10 TIS R5E
Guadalupe Road	Sec. 3 TIS R5E
S. P. R. R.	Sec. 3 TIS R5E
Baseline Road	Sec. 3 TIS R5E
56th Street	Sec. 33 TIN R5E
I-10 Freeway	Sec. 32 TIN R5E
48th Street	Sec. 31 TIN R5E
40th Street	Sec. 36 TIN R5E

b. Northern Alignment (Price Road)

Crossing	Location
Guadalupe Road	Sec. 6 TIS R5E
Baseline Road	Sec. 31 TIN R5E
Tempe Canal	Sec. 31 TIN R5E
Southern Avenue	Sec. 30 TIN R5E
Broadway Road	Sec. 19 TIN R5E
S. P. R. R.	Sec. 19 TIN R5E
Apache Boulevard	Sec. 18 TIN R5E
Hayden Canal	Sec. 18 TIN R5E
University Boulevard	Sec. 18 TIN R5E

c. Lateral 9.5 (Gilbert)

Crossing	Location
Cooper Road	Sec. 11 TIS R5E
McQueen Road	Sec. 10 TIS R5E
S. P. R. R.	Sec. 10 TIS R5E
Arizona Avenue	Sec. 9 TIS R5E
Alma School Road	Sec. 8 TIS R5E
Dobson Road	Sec. 8 TIS R5E

d. 48th Street

Crossing	Location
Southern Avenue	Sec. 32 TIN R4E
Broadway Road	Sec. 30 TIN R4E
I-10 Freeway Crossing	Sec. 19 TIN R4E
University Boulevard	Sec. 19 TIN R4E
40th Street	Sec. 24 TIN R4E
North Branch San Francisco Canal	Sec. 19 TIN R4E
Hayden Canal	Sec. 19 TIN R4E

e. 32nd Street

Crossing	Location
Southern Ave.	Sec. 35 TlN R3E
Southern Branch San Fran. Canal	Sec. 25 TlN R3E
Roeser Road	Sec. 25 TlN R3E
Broadway Road	Sec. 25 TlN R3E

B. SUMMARY OF TASK FORCE MEETINGS

The following is a summary of the events that have shaped this concept design report.

1. December 21, 1983. Initial Meeting.

In this meeting the initial tasks were discussed and the various participants submitted support data and initial information (i.e., storm drain maps, as builts, cross sections, etc.). Other discussions such as water quality and the Association's criteria for water quality were brought out.

2. February 7, 1984. Meeting (Water Quality).

On February 7, 1984 a memorandumn was presented to the Gila Drain Committee. This memorandum outlined two basic concepts for the operational systems analysis. The concepts adopted by committee follow:

a. Add the various discharges for the individual participants.
b. Route this discharges to adequate outlet.
c. Disregard consideration of variations in discharge over time.
d. Assume all basins full at time zero.
e. Constant flow into Western Canal.

Included in the February 7th meeting was a dicussion on the draft report for water quality. The outcome of the discussion being that more research was needed by Salt River Project to define and adopt their position in the area of utilization of Salt River Project facilities for urban runoff.

The consultants had a meeting on the same day with SRP. A brief synopsis of this meeting follows:

a. Water Quality

1. Arizona standards for water quality are based on ground water, not urban runoff.
2. Salt River Project has a variety of customers who utilize the water for commercial, recreational, etc., purposes.
3. A Water Treatment Plant is proposed for the year 2005 at the western end of the Western Canal, by the City of Phoenix.
4. Salt River Project wants the Arizona Department of Health Services (A.D.H.S.) to evaluate the risk. Salt River Project makes no guarantees of water quality to its customers.

b. Operations

1. The Western Canal has 290 cfs normal capacity, with studies showing it being as high as 600 cfs, in some locations.
2. During storms, the Canal may have as much as 200 cfs inflow. Also at times Salt River Project may need to put water in the canals from well fields that exist at various locations.
3. Salt River Project stated that if the system is to modeled, a thunderstorm should be considered.
4. Automatic controls should be included at any metering structure wherever it is to be located.

From this meeting it became obvious that modeling the actual operational systems that exist would be out of scope for this study and a parameter that Salt River Project would have to furnish. The outcome was that the design alternatives to be presented would be such that the SRP would coordinate, the integration of their operations to the canal systems. This is why Alternative 2 was utilized. It should also be noted

that the capacity of the Western Canal for Gila Drain storm runoff would be dependant upon the operations of the Canal.

The Salt River Project was in the process of developing guidelines regarding use of their facilities for urban runoff disposal. These guidelines, when adopted, will affect this alternatives study.

3. March 21, 1984. Meeting.

At this meeting, three design alternatives were presented:

a. Alternate 1 (Western Canal, 48th & 32nd Streets*)
   Cost -$3,600,000

* 48th Street and 32nd Street to be utilized by SRP for excess water.

b. Alternate 2 (Western Canal with parallel line from Highline Plant to 48th Street)
   Cost -$8,000,000

c. Alternate 3 (Parallel system within Salt River Project's right-of-way to 32nd Street)
   Cost -$15,800,000

This presentation brought discussion and questions, such as cost, (these were forwarded on the 27th of March), and some additional alternative concepts were analyzed because of comments following review by the task force members.

4. April 30, 1984. Submittal.

In this submittal the preferences of the task force were presented, on Alternatives 1 - 3, then additional alternatives 2A, 2B, 4 and 5 were defined. The alternatives were:

a. Alternative 2A (Utilizes Western Canal and a parallel conduit. 48th and 32nd Streets for excess water only).
   Cost -$12,700,000

b. Alternate 2B (Same as 2A except lining canal to increase capacity)
Cost -$12,100,000

c. Alternate 4 (Western Canal and parallel conduit from Carriage Lane)
Cost -$7,600,000

d. Alternate 5 (Same as Alternate 4 but increase capacity from Cooper Road to 200 cfs)
Cost -$11,900,000

Cost allocations to the participants were also presented.

5. September 6, 1984. Meeting.

Between the April submittal and the September meeting, the design alternatives were analyzed, while new input was found. The final outcome was that Alternative 3 was the only design that would be acceptable to Salt River Project policy and their future customers (City of Phoenix).

Two other alternatives were discussed at this meeting. (1) Pumping along the Price Road corridor for the outerloop expressway, and

(2) use of the natural Gila drain. The task force agreed that for this design study, the Gila drain is not an acceptable outlet, and should not be further considered.

The final topic was the use of the Western Canal on an interim basis. This topic was refined by the addition of an outfall at 48th Street and/or 32nd Street for a wasteway, but would need Board (Salt River Project) approval.

6. December 5, 1984. Meeting.

In this meeting a new alternate, (Alternate 6) was presented. This alternate considers conveying the water North along the Price Road/outer loop Expressway Right-of-Way to the Salt River. This alternate will require a pumping facility to overcome a gradient differential between the Carriage Lane detention facility and the Salt River. Pipe sizes and costs for three different capacities were presented.

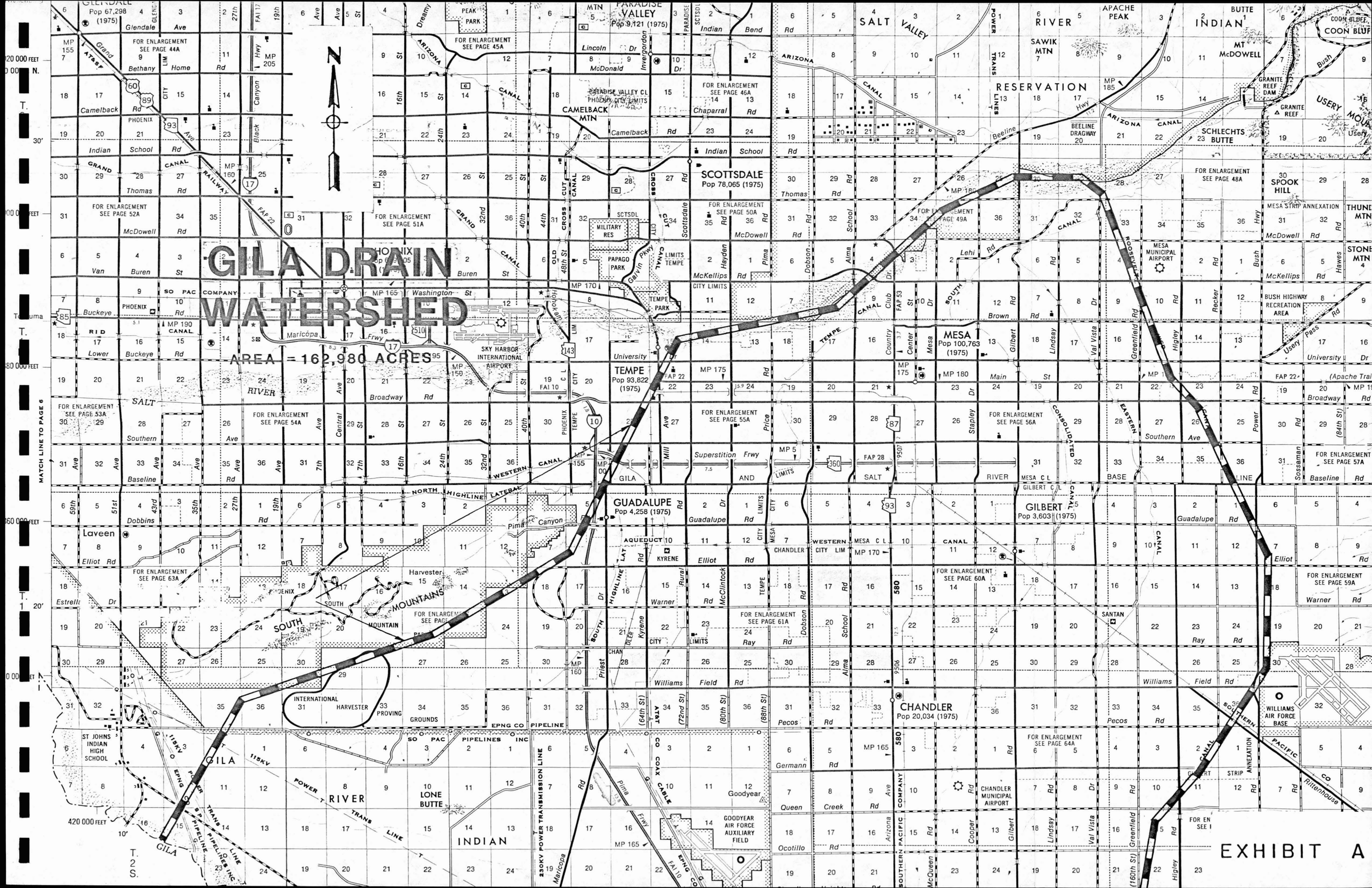
Salt River Project also stated that the use of the Western Canal for pumping on an interim basis would be acceptable.

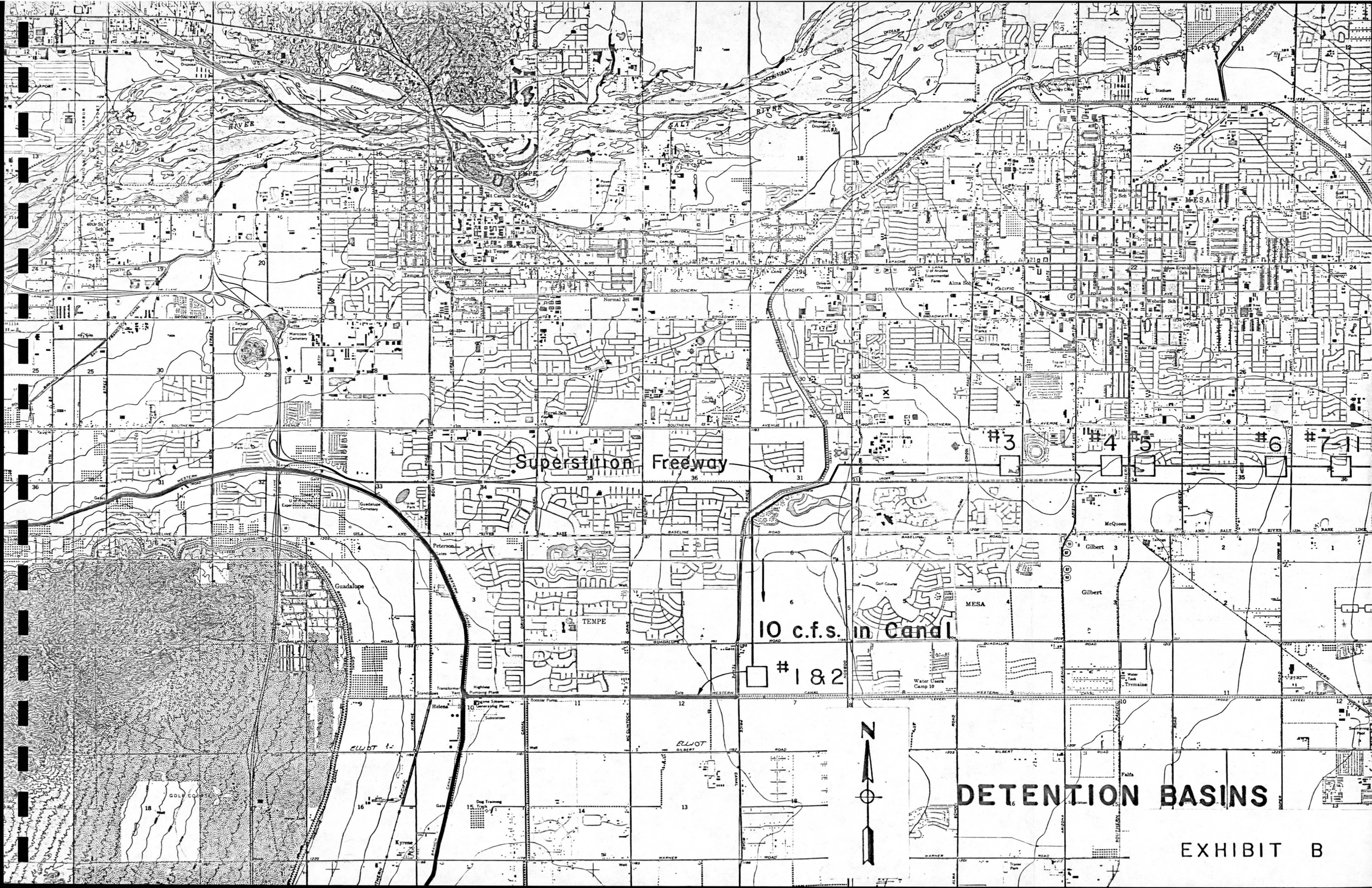
From the discussion that followed, it was concluded that the consultant would further investigate, then present Alternatives 3 and 6.

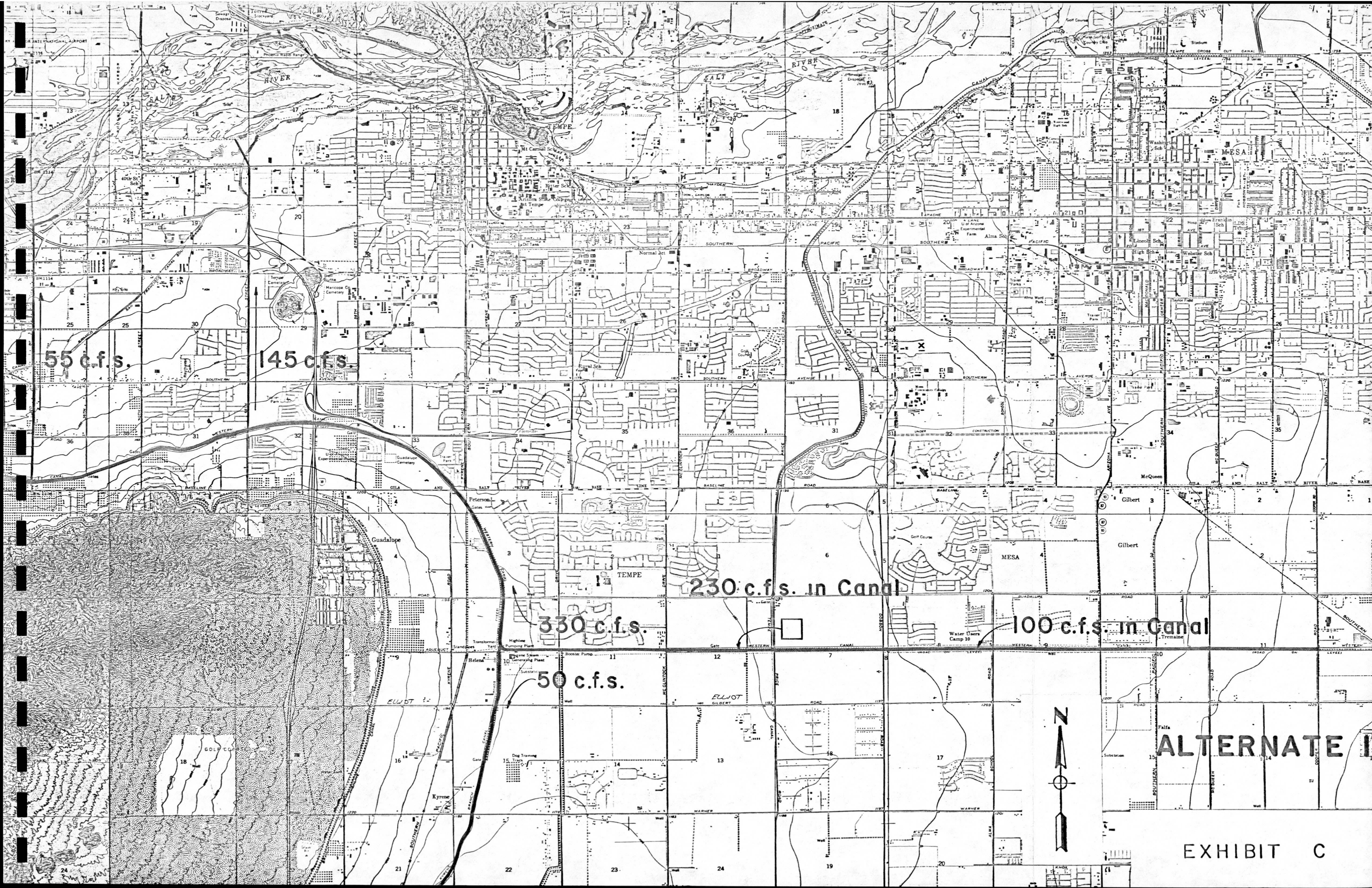
7. March 5, 1985. Meeting.

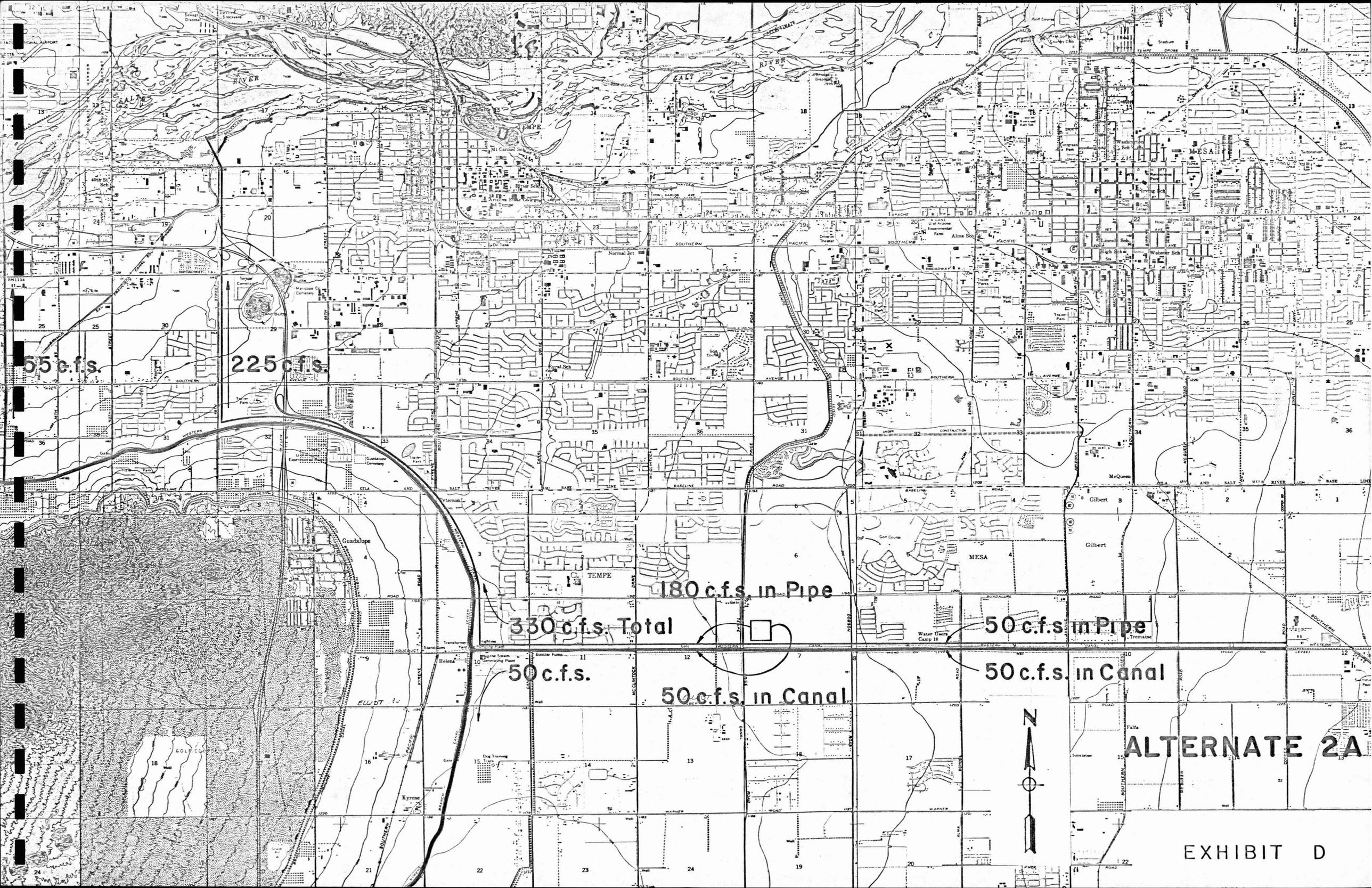
At this final meeting of the Gila Drain Task Force Committee, the Draft Report for the Western Canal Alternatives was presented. Alternates 3 & 6 were identified, discussed, and costs identified. After a brief discussion Alternate 6 was selected as the preferred route for the Gila Drain Outfall.

All members were asked to comment on the Draft Report and forward their comments to the Flood Control District, where they would be complied. The Final Report would incorporate these comments and be distributed by the consultants when all comments had been received.


GILA DRAIN
WATERSHED
AREA = 162,980 ACRES
N
GLENDALE
Pop 67,298 (1975)
PARADISE VALLEY
Pop 9,121 (1975)
SALT RIVER INDIAN RESERVATION
SCOTTSDALE
Pop 78,065 (1975)
PHOENIX
MESA
Pop 100,763 (1975)
TEMPE
Pop 93,822 (1975)
GUADALUPE
Pop 4,258 (1975)
GILBERT
Pop 3,603 (1975)
CHANDLER
Pop 20,034 (1975)
SKY HARBOR INTERNATIONAL AIRPORT
MESA MUNICIPAL AIRPORT
CHANDLER MUNICIPAL AIRPORT
WILLIAMS AIR FORCE BASE
GOODYEAR AIR FORCE AUXILIARY FIELD
CAMELBACK MTN
SOUTH MOUNTAINS
MILITARY RES
PAPAGO PARK
TEMPE PARK
PEAK PARK
SCHLECHTS BUTTE
GRANITE REEF DAM
GRANITE REEF
BEELINE DRAGWAY
SPOOK HILL
BUSH HIGHWAY RECREATION AREA
MESA STRIP ANNEXATION
GILBERT STRIP ANNEXATION
INTERNATIONAL HARVESTER PROVING GROUNDS
ST JOHNS INDIAN HIGH SCHOOL
LONE BUTTE
EPNG CO PIPELINE
SO PAC PIPELINES INC
230KV POWER TRANSMISSION LINE
115KV POWER TRANS LINE
NORTH HIGHLINE LATERAL
WESTERN CANAL
ARIZONA CANAL
GRAND CANAL
CROSS CUT CANAL
ROOSEVELT CANAL
EASTERN CANAL
CONSOLIDATED CANAL
SOUTHERN PACIFIC CO
COAX CABLE
MATCH LINE TO PAGE 6
420 000 FEET
460 000 FEET
500 000 FEET
540 000 FEET
580 000 FEET
620 000 FEET
T. 1 S.
T. 2 S.
EXHIBIT A


Superstition Freeway
10 c.f.s. in Canal
#1 & 2
#3
#4
#5
#6
#7
DETENTION BASINS
EXHIBIT B
TEMPE
MESA
Gilbert
Guadalupe
Peterson
Helena
Kyrene
Falfa
Mt Carmel Schools
Arizona State College
Normal Jct
Rural Sch
Maricopa Co Cemetery
Guadalupe Cemetery
Water Users Camp 10
Tremaine
Alma Sch
Lincoln Sch
Webster Sch
Washington Sch
Franklin Sch
High Sch
Stadium
Golf Course
Dog Training
Highline Pumping Plant
Substation
Booster Pump
Trailer Park
Phoenix Radio Range
Stockyard
Tempe Cemetery
Butte
SALT RIVER
TEMPE CROSS CUT CANAL
PACIFIC
SOUTHERN
WESTERN
BROADWAY
GILBERT
ELLIOT
WARNER
BASELINE
GUADALUPE
APACHE
HAYDEN
McQueen
Taylor Field


55 c.f.s.
145 c.f.s.
230 c.f.s. in Canal
330 c.f.s.
100 c.f.s. in Canal
50 c.f.s.
ALTERNATE I
EXHIBIT C
N
SALT RIVER
TEMPE
MESA
Gilbert
Guadalupe
Kyrene
Helena
Peterson
McQueen
Tremaine
Falfa
Water Users Camp 10
Highline Pumping Plant
Kyrene Steam Generating Plant
Booster Pump
Arizona State College at Tempe
Phoenix Radio Range
Twin Butte
Maricopa Co. Cemetery
Guadalupe Cemetery
U of Arizona Experimental Farm
Tempe Jct
Normal Jct
Golf Course
Dog Training Track
Substation
Tempe Cross Cut Canal
Western Canal
Southern Pacific
Baseline Road
Southern Avenue
Broadway
Apache
Warner
Ellwot


55 c.f.s.
225 c.f.s.
180 c.f.s. in Pipe
330 c.f.s. Total
50 c.f.s. in Pipe
50 c.f.s.
50 c.f.s. in Canal
50 c.f.s. in Canal
ALTERNATE 2A
N
EXHIBIT D
TEMPE
MESA
Gilbert
Guadalupe
Mt Carmel School
Normal Jct
Tempe Jct
Alma Sch
Washington Sch
Lincoln Sch
High Sch
Webster Sch
Franklin Sch
McQueen
Peterson
Helena
Kyrene
Tremaine
Falfa
Water Users Camp 10
Golf Course
Stadium
Substation
Fire Station
Dog Training
Booster Pump
Steam Generating Plant
Transformer Yard
Highline Pumping Plant
Tempe Cemetery
Maricopa Co Cemetery
Guadalupe Cemetery
Phoenix Water Ranger
Drive-in Theater
U of Arizona Experimental Farm
Tempe Stockyard
Tempe Sewage Disposal
Tempe Golf Course
Tempe Country Club
Tempe Drop Cut Canal
Tempe Canal
Salt River
Gila and Salt River Base Line
Southern Pacific
Arizona Canal
Eastern Canal
Western Canal
Under Construction
Levee
Aqueduct
Elliot
Baseline
Guadalupe
Broadway
Apache
Southern
Warner
Knox
Alma
Echols
Mc Clintock
Hayden
Rural
Dobson
Gilbert
Lindsay
Mesa
Stapley
Sycamore
Kyrene
Ash
Arizona
Mc Dowell
Mc Kellips
Pecos
Ellsworth
Signal Sch
Tempe Park
Trailer Park
Tempe Beach Park
Alma Ward Park
Taylor Field
Fire Station
Substation
Well
Gate
Pit
Fence
Sign
Tank
Pump
Dam
Levee
Canal
Road
Trail
Railroad
Power Line
Transmission
Bridge
Culvert
Building
Church
School
Park
Cemetery
Golf Course
Stadium
Airport
Sewage Disposal
Stockyard
Fire Station
Substation
Water Tower
Pump Station
Generating Station
Transformer Yard
Highline Pumping Plant
Booster Pump
Steam Generating Plant
Dog Training
Trailer Park
Tempe Beach Park
Alma Ward Park
Taylor Field
Drive-in Theater
Golf Course
Country Club
Experimental Farm
Stockyard
Sewage Disposal
Phoenix Water Ranger
Tempe Cemetery
Maricopa Co Cemetery
Guadalupe Cemetery
Signal Sch
Mt Carmel School
Washington Sch
Lincoln Sch
High Sch
Webster Sch
Franklin Sch
Alma Sch
Water Users Camp 10
Tremaine
Falfa
Kyrene
Helena
Peterson
McQueen
Gilbert
Guadalupe
TEMPE
MESA
Tempe Jct
Normal Jct
Tempe Drop Cut Canal
Tempe Canal
Salt River
Gila and Salt River Base Line
Southern Pacific
Arizona Canal
Eastern Canal
Western Canal
Under Construction
Levee
Aqueduct
Elliot
Baseline
Guadalupe
Broadway
Apache
Southern
Warner
Knox
Alma
Echols
Mc Clintock
Hayden
Rural
Dobson
Gilbert
Lindsay
Mesa
Stapley
Sycamore
Kyrene
Ash
Arizona
Mc Dowell
Mc Kellips
Pecos
Ellsworth

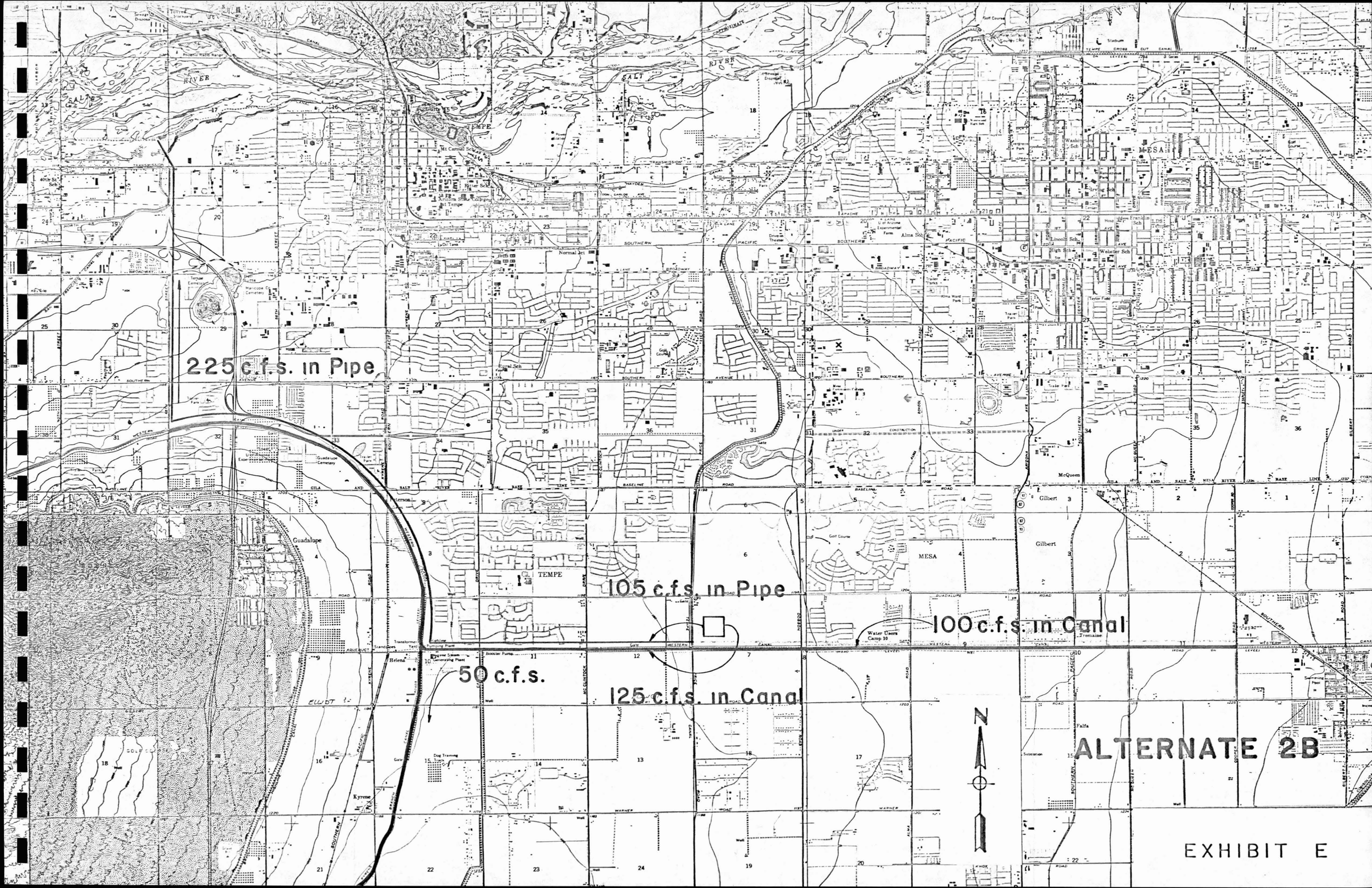
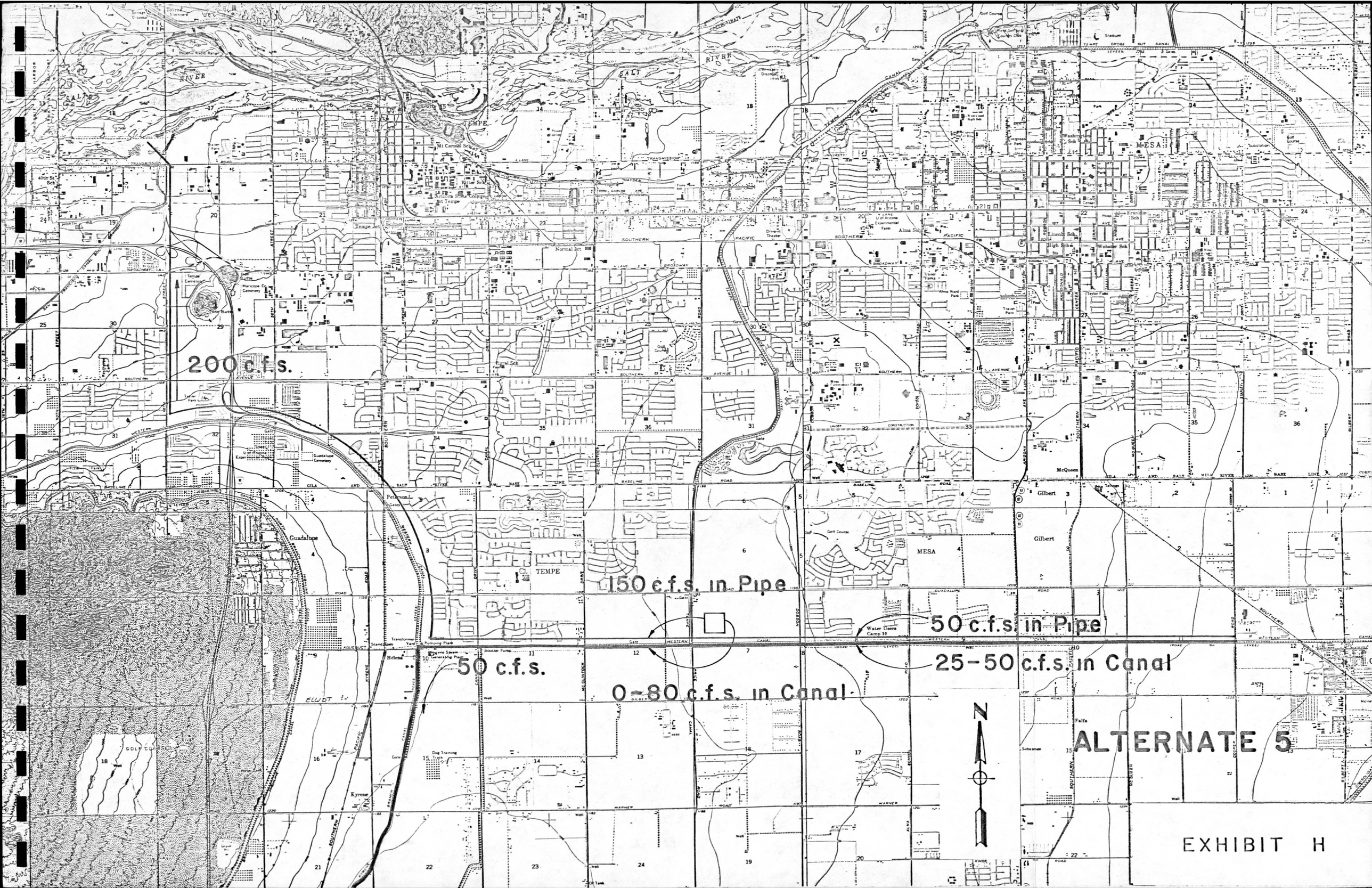

225 c.f.s. in Pipe
105 c.f.s. in Pipe
100 c.f.s. in Canal
50 c.f.s.
125 c.f.s. in Canal
ALTERNATE 2B
N
TEMPE
MESA
Guadalupe
Gilbert
Kyrene
Helena
Alma Sch
Lincoln Sch
High Sch
Webster Sch
Franklin Sch
Washington Sch
McQueen
Falfa
Tempe Jct
Normal Jct
Mt Carmel Sch
River Sch
Arizona State College at Tempe
Maricopa Co Cemetery
Guadalupe Cemetery
Golf Course
Stadium
Substation
Water Users Camp 10
Dog Training Track
Pumping Plant
Booster Pump
Steam Generating Plant
Transformer Yard
Standpipes
Well
Gate
Pipe
Pool
Trailer Park
Mine
Tremaine
Taylor Field
Alma Ward Park
Experimental Farm
Drive-in Theater
Trailer Works
Sewage Disposal Work
Phoenix Water Ranger
Salt River Project
Tempe Cross Cut Canal
Tempe Canal
Salt River
Gila and Salt River Base Line
Southern Pacific
Western Canal
Arizona Canal
Hayden Flour Mills
Transmission
Aqueduct
Levee
Under Construction
Knox
Warner
Baseline Road
Guadalupe Road
Broadway
Elliot
Alma School
Gilbert
Mesa
Lehi
Tempe
Kyrene
Helena
Tempe Jct
Normal Jct
Mt Carmel Sch
River Sch
Arizona State College at Tempe
Maricopa Co Cemetery
Guadalupe Cemetery
Golf Course
Stadium
Substation
Water Users Camp 10
Dog Training Track
Pumping Plant
Booster Pump
Steam Generating Plant
Transformer Yard
Standpipes
Well
Gate
Pipe
Pool
Trailer Park
Mine
Tremaine
Taylor Field
Alma Ward Park
Experimental Farm
Drive-in Theater
Trailer Works
Sewage Disposal Work
Phoenix Water Ranger
Salt River Project
Tempe Cross Cut Canal
Tempe Canal
Salt River
Gila and Salt River Base Line
Southern Pacific
Western Canal
Arizona Canal
Hayden Flour Mills
Transmission
Aqueduct
Levee
Under Construction
Knox
Warner
Baseline Road
Guadalupe Road
Broadway
Elliot
Alma School
Gilbert
Mesa
Lehi
Tempe
Kyrene
Helena

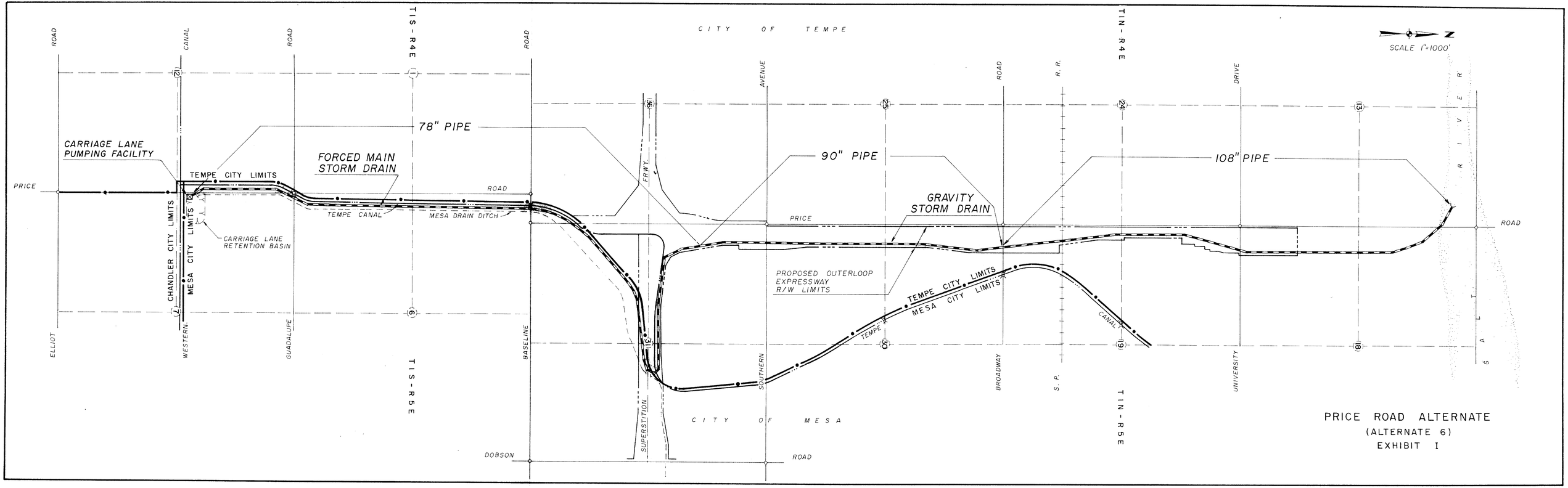
EXHIBIT E

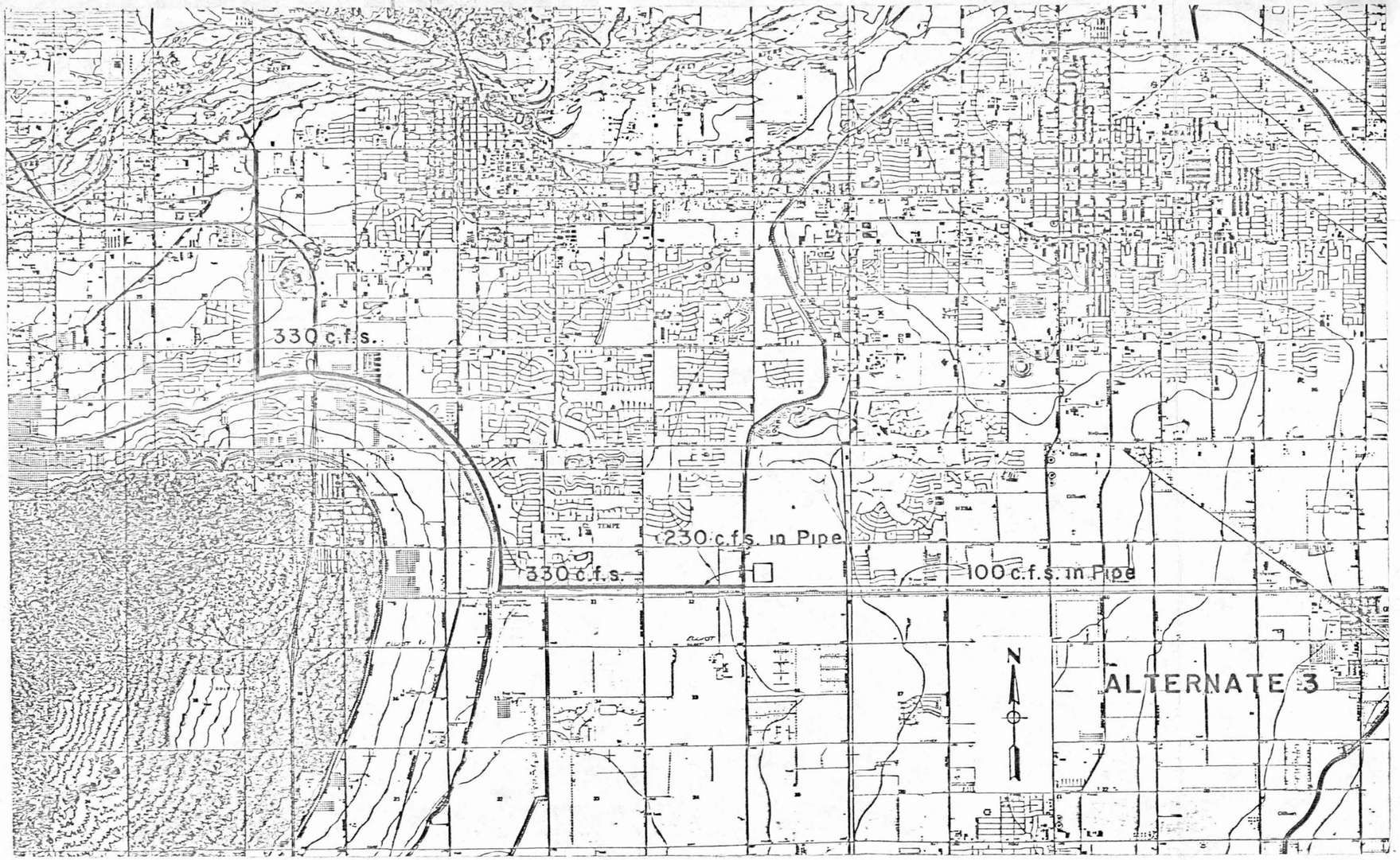
330 c.f.s.
230 c.f.s. in Pipe
330 c.f.s.
100 c.f.s. in Pipe
ALTERNATE 3
EXHIBIT F
TEMPE
MESA
Gilbert
Guadalupe
Kyrene
Falfa
McQueen
SALT RIVER
ELLIOT
SOUTHERN PACIFIC
BASELINE ROAD
GILA AND SALT RIVER BASE LINE
WESTERN CANAL
TEMPE CROSS CUT CANAL
N

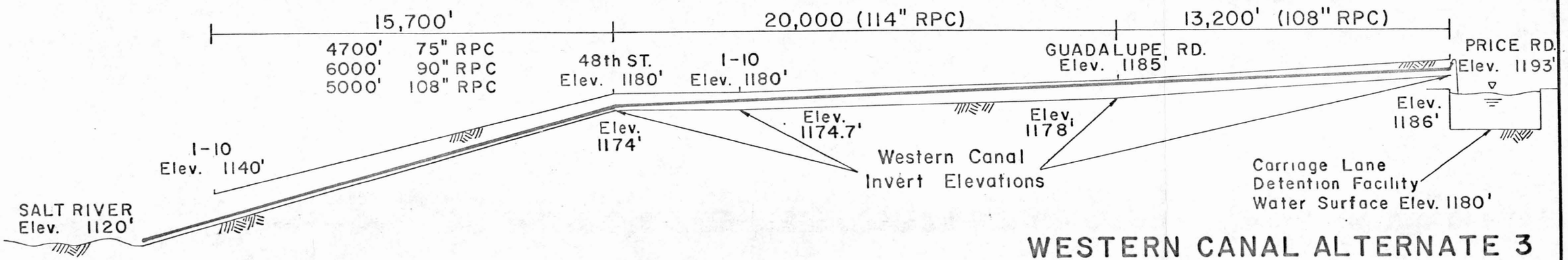
100-145 c.f.s
100 c.f.s. in Pipe
25-100 c.f.s. in Canal
50 c.f.s.
0-130 c.f.s. in Canal
ALTERNATE 4
N
SALT RIVER
TEMPE
MESA
Guadalupe
Gilbert
Kyrene
Helena
Tremaine
Falfa
Peterson
McQueen
Water Users Camp 10
Pumping Plant
Booster Pump
WESTERN CANAL

EXHIBIT G


200 c.f.s.
150 c.f.s. in Pipe
50 c.f.s. in Pipe
50 c.f.s.
25-50 c.f.s. in Canal
0-80 c.f.s. in Canal
ALTERNATE 5
N
EXHIBIT H
TEMPE
MESA
Guadalupe
Gilbert
SALT RIVER
GILA RIVER
Tempe Jct
Normal Jct
Petersen
Kyrene
Falfa
McQueen
Water Users Camp 10
Alma Sch
Mt Carmel Sch
Maricopa Co Cemetery
Guadalupe Cemetery
Golf Course
Stadium
Substation
Pumping Plant
Booster Pump
Dog Training Track
Oil Tank
Well
Gate
Park
Trailer Park
Trade Park
Alma Ward Park
Taylor Field
Washington Sch
Lincoln Sch
High Sch
Webster Sch
Franklin Sch
Irving Sch
Hayden Flour Mills
Phoenix Radio Range
Drive-in Theater
U of Arizona Experimental Farm
Transmission Line
Under Construction
Southern Pacific
Western Canal
Grand Canal
Tempe Canal
Tempe Drainage Canal
Salt River Canal
Tempe Tunnel
Tempe Cut Canal
Hayden Flour Mills Canal
Mesa Drainage Canal
Mesa Canal
Gilbert Canal
Eastern Canal
Arizona Canal
Hohokam Canal
Tempe Butte
Mesa Butte
Guadalupe Butte
Gilbert Butte
Tempe Beach Park
Tempe Cemetery
Tempe Sch
Tempe Jr Coll
Mt Carmel Sch
Mesa Sch
Mesa Jr Coll
Mesa Cemetery
Gilbert Sch
Gilbert Cemetery
Falfa Sch
Kyrene Sch
Petersen Sch
Guadalupe Sch
Helena
Stand Pipes
Transformer Yard
Baseline Road
Guadalupe Road
Warner Road
Elliot Road
Broadway Road
Apache Road
Hayden Road
McClintock Road
Rural Road
Dobson Road
Alma School Road
Ellsworth Road
Gilbert Road
Higley Road
Power Road
Sossaman Road
Crismon Road
Mesa Drive
Mesa Avenue
Southern Avenue
Western Avenue
Gila River Indian Reservation
Salt River Indian Reservation
Maricopa Co
Phoenix Radio Range

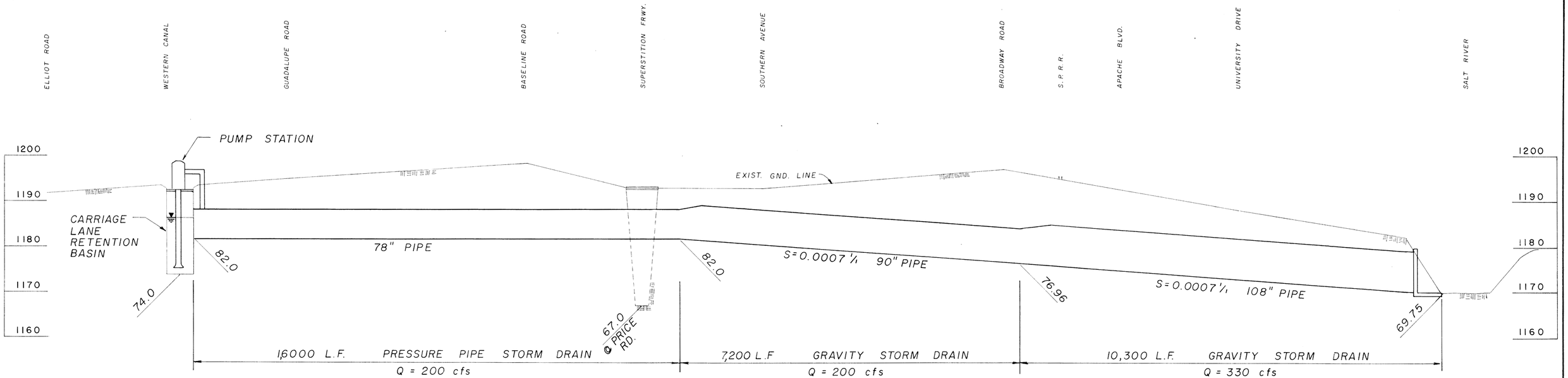

CITY OF TEMPE
SCALE 1"=1000'
N
78" PIPE
90" PIPE
108" PIPE
CARRIAGE LANE PUMPING FACILITY
FORCED MAIN STORM DRAIN
GRAVITY STORM DRAIN
TEMPE CITY LIMITS
MESA CITY LIMITS
CHANDLER CITY LIMITS
CARRIAGE LANE RETENTION BASIN
TEMPE CANAL
MESA DRAIN DITCH
PROPOSED OUTERLOOP EXPRESSWAY R/W LIMITS
PRICE ROAD
ELLIOT ROAD
WESTERN CANAL
GUADALUPE ROAD
BASELINE ROAD
DOBSON ROAD
SOUTHERN AVENUE
BROADWAY ROAD
S. P. R. R.
UNIVERSITY DRIVE
SUPERSTITION FRWY.
TEMPE CANAL
SALT RIVER
T1S-R4E
T1S-R5E
T1N-R4E
T1N-R5E
CITY OF MESA
PRICE ROAD ALTERNATE
(ALTERNATE 6)
EXHIBIT I





WESTERN CANAL ALTERNATE 3
(PRICE RD. TO 48th ST. TO SALT RIVER)

EXHIBIT J



STORM DRAIN PROFILE
(ALTERNATE 6)
EXHIBIT K

SCALE = 1"=1000' HORIZ.
1"=10' VERT.