CITY OF PHOENIX
23RD AND 91ST AVENUE
WASTEWATER TREATMENT PLANTS

DRAFT
RESIDUALS MANAGEMENT FACILITY PLAN

VOLUME 5 - PHASE C
EFFLUENT DISCHARGE ASSESSMENT

AUGUST 1980

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MULTI-CITY

SROG TECHNICAL COMMITTEE

MEETING OUTLINE

OCTOBER 6, 1980

I. MEETING PURPOSE - The purpose of the meeting is to determine the direction and develop a proposed implementation plan and schedule for the management of the effluent discharged to the Salt River from the 91st Avenue WWTP.

II. BACKGROUND

- o Residuals Management Facility Plan
- o WQPAC and SROG Committee Recommendations
- o Effluent availability

III. HOLLY ACRES FLOOD COMMISSION

- o Final Report
- o Summary

IV. MARICOPA COUNTY FLOOD CONTROL DISTRICT

- o Studies Underway
- o Clearing Project
- o Potential for Cooperative Effort
- o Recommendation

V. NEXT STEP

- o What
- o How
- o Why
- o Who
- o When

Clean Water!

MAG 208 WATER QUALITY NEWSLETTER
NUMBER 11 PHOENIX, ARIZONA MAY 1980

ADVISORY COMMITTEE HEARS FROM EXPERTS

In the process of reviewing the facility plan for the expansion of the 91st Avenue wastewater treatment plant, many concerns were raised by the MAG Water Quality Policy Advisory Committee. These concerns centered around the impacts of the effluent discharged from the 91st Avenue plant on the downstream area. Also concerned about these impacts are residents of Holly Acres who attribute the growth and germination of salt cedar in the Salt River to the effluent from the 91st Avenue plant. This salt cedar growth they feel contributes to flooding problems in the Holly Acres area.

In response to these concerns, a panel of experts in the areas of groundwater and riparian vegetation addressed the Water Quality Policy Advisory Committee at their April 24th meeting. The following summarizes the presentations of each panel member:

- **Ken Schmidt, PhD, groundwater quality consultant**

Dr. Schmidt stressed that in the area downstream of the 91st Avenue plant both flood flows and sewage effluent contribute to the recharge of groundwater. He also said that because the quality of the groundwater west of 115th Avenue is poor, there is little pumping in the area. Consequently, the groundwater level remains high in this area.

- **Ray Turner, PhD, U.S. Geological Survey**

Dr. Turner discussed the germination and growth processes of the salt cedar. Dr. Turner explained that the mature salt cedar plant will produce 500,000 seeds per year and matures in just one year. He stated that the period of seed production must coincide with proper growing conditions for these plants to establish in an area. The fact that salt cedar is found primarily in river channels suggests that it has a very high water dependency.

- **Will Graf, PhD, Arizona State University**

Dr. Graf explained the factors which contribute to salt cedar growth. The groundwater level beneath the channel appears to be the main controlling factor in the growth of salt cedars. Factors such as flooding, width and depth of river channel, and surface flows, have important impacts on groundwater levels and therefore vegetation growth. Fluctuations in the vegetation in the area downstream of the 91st Avenue plant closely parallel the fluctuation in groundwater levels and removal of effluent from the river should have no effect on salt cedar growth.

Also addressing the committee were Stan Smith, Maricopa County Flood Control District and Andy Marcus, an environmental consultant.

Conclusions reached as a result of the panel discussion were that high groundwater levels are caused by recharge from flood flows, effluent, and limited pumping; high groundwater levels are responsible for growth of salt cedars; and salt cedars would continue to grow and germinate even with the removal of the effluent from the river channel.

Based on the panel discussion, the advisory committee voted to accept these conclusions.

W + E Dept.
7/29/80

AVAILABLE MULTI-CITY EFFLUENT 1980-2000 (MGD)

	FLOW PROJECTION		PROJECTED EFFLUENT USAGE						AVAILABLE EFFLUENT	
	208 Study	City	AG&F	USWCL	B.I.D.	ANPP	R.I.D.	TOTAL	208 Study	City
1980	124.2	128.3	6.52	0	70.0	0	0	76.5	47.7	51.8
1985	134.4	153.8	6.52	0	26.8	38.7	17.9	89.9	44.5	63.9
1990	145.1	177.6	6.52	0	26.8	58	17.9	109.2	35.9	68.4
1995	155.8	201.6	6.52	0	26.8	58	17.9	109.2	44.6	92.4
2000	168.8	225.5	6.52	0	26.8	58	17.9	109.2	59.6	116.3

MGD X 1.12=1000 A.F./Yr.

UNCOMMITTED MULTI-CITY EFFLUENT 1980-2000 (MGD)

	FLOW PROJECTIONS		COMMITTIMENTS					UNCOMMITTED EFFLUENT	
	208 Study	City	AG&F	USWCL	B.I.D.	ANPP	TOTAL	208 Study	City
1980	124.2	128.3	6.52	1.07	26.8	125	159.4	-35.2	-31.1
1985	134.4	153.8	6.52	1.07	26.8	125	159.4	-25.0	- 5.6
1990	145.1	177.6	6.52	1.07	26.8	125	159.4	-14.3	18.2
1995	155.8	201.6	6.52	1.07	26.8	125	159.4	- 3.6	42.2
2000	168.8	225.5	6.52	1.07	26.8	125	159.4	9.4	66.1

FLOW PROJECTION COMPARISON

M.A.G. 208 STUDY VS PHOENIX WASTEWATER DIV. PROJECTION IN M.G.D.

CITY		1979	1980		1985		1990		1995		2000	
		Actual	208 Report	City(1) Projection	208 Report	City Projection	208 Report	City Projection	208 Report	City Projection	208 Report	City Projection
PHOENIX	23RD WWTP	32.2	36.4	32.5	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2
	91ST WWTP	52.5	40.2	53.4	44.0	61.5	49.6	74.4	55.3	87.2	62.4	100.1
	TOTAL	84.7	76.6	85.9	81.2	98.7	86.8	111.6	92.5	124.4	99.6	137.3
GLENDALE		11.6	10.8	12.8	10.8	15.8(3)	12.3	20.6	13.7	25.5	15.3	30.3
MESA		9.6	13.9	11.9	15.7	19.6(2)	17.2	23.7	18.9	27.9	20.7	32.1
SCOTTSDALE		6.8	9.6	8.5	10.2	8.6	10.6	8.7	10.8	8.8	11.3	8.9
TEMPE		7.6	13.2	9.0	16.4	10.9	18.1	12.8	19.8	14.8	21.8	16.7
YOUNGTOWN		0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2
TOTALS		120.5	124.2	128.3	134.4	153.8	145.1	177.6	155.8	201.6	168.8	225.5

(1) Estimated on 6 months actual flow

(2) Mesa WWTP out of service in 1985

(3) Peoria flow to Tolleson WWTP in 1985

CITY OF PHOENIX

23RD AND 91ST AVENUE WASTEWATER TREATMENT PLANTS

DRAFT RESIDUALS MANAGEMENT FACILITY PLAN

VOLUME 5

PHASE C - EFFLUENT DISCHARGE ASSESSMENT

ARTHUR BEARD ENGINEERS, INC.
CAMP DRESSER & McKEE INC.

AUGUST 1980

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23RD AND 91ST AVENUE WASTEWATER TREATMENT PLANTS

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SECTION 1
INTRODUCTION

SECTION 1

INTRODUCTION

PURPOSE AND SCOPE

This assessment evaluates the environmental effects of discharging effluent from the 91st Avenue and 23rd Avenue Wastewater Treatment Plants into the Salt River. Concerns related to water resources, riparian vegetation and wildlife, flood hazards, and insects are specifically addressed. As identified throughout the Final Environmental Impact Statement for the Point Source Metro Phoenix 208 Wastewater Management Plan (USEPA, 1979), these concerns include:

- Potential degradation of surface and groundwater quality due to effluent discharge
- The impacts of effluent discharge on the maintenance of riparian vegetation, which provides wildlife habitat but is also reported to cause increases in floodwater spreading
- The impacts of effluent discharge on present nuisance insect problems
- Public health impacts associated with the effluent

These issues are assessed in the context of two separate conditions of effluent discharge which were selected by the City of Phoenix. The conditions are based on effluent projections as described in Exhibit C (Greeley and Hansen, 1980).

EFFLUENT DISCHARGE CONDITIONS

Two effluent discharge conditions were compared in order to determine the effects of effluent in the area downstream of the 91st Avenue Wastewater Treatment Plant. The first condition considers the impacts of the effluent

discharge assuming total effluent reuse and, therefore, minimum discharge into the Salt River. Under this condition, the only effluent discharged to the Salt River would be 6.52 mgd to meet an existing non-contractual commitment to the Arizona Game and Fish Department. The assessment of this condition reflects the impacts of minimum discharge on the area downstream of the 91st Avenue Plant.

The second condition of discharge assumes that the existing reuse commitments would be fulfilled and the remaining unused effluent would be discharged into the Salt River. Under this condition, discharge to the Salt River would decrease from 90 mgd annual average flow in 1980 to approximately 20.2 mgd annual average flow of effluent in 1986, and then increase to 35.2 mgd by the year 2000. This condition further assumes that the Arizona Nuclear Power Project (ANPP) will use only enough effluent for three units at the Palo Verde Nuclear Generating Station and will allow the unused portion of their contracted effluent to be discharged into the Salt River. The minimum effluent discharge of approximately 20.2 mgd in 1986 was selected for evaluation in this report because maximum impacts are to be expected under this low flow condition.

The discharge point into the river for either condition is assumed to be at the outfall of the existing effluent channel. A further discussion of projected flows and estimated quantities of effluent discharge into the Salt River is provided under "Physical Factors" in Section 2. A description of existing effluent reuse commitments is provided under "Institutional Arrangements," also in Section 2 of this volume.

Effluent discharged from the 23rd Avenue Wastewater Treatment Plant is considered in this assessment as part of the baseline river flow of the Salt River

entering the project area southeast of the 91st Avenue Plant. The effects of effluent discharged to the Salt River from the 23rd Avenue Plant upstream of the 91st Avenue Plant project area are not evaluated in this report; however, the effects of 23rd Avenue Plant effluent on riparian vegetation have been addressed in the 23rd Avenue Plant Upgrading Facility Plan (Greeley and Hansen, June 1980). Surface water quality, groundwater quality and the relationship of these factors to public health are addressed in the draft Effluent Disinfection Facility Plan for the 23rd Avenue Wastewater Treatment Plant (Greeley and Hansen, December 1979) and in the above mentioned Plant Upgrading Facility Plan. Insect problems associated with the 23rd Avenue Plant and its discharges are addressed in Volume III of the same facility plan.

PUBLIC CONCERNS ASSOCIATED WITH EFFLUENT DISCHARGE

Public concerns regarding the impact of effluent discharge into the Salt River have been well documented by the City of Phoenix. In general, these concerns include insect problems attributable to the effluent, the impact of effluent on support of riparian vegetation, and the impact of effluent on surface and groundwater quality, which could potentially affect public health.

Residents in the vicinity of the 91st Avenue Plant have historically noted insect problems (USEPA, 1979). Typical nuisance insects of this area include *Psorophora confinnis* and *Culex pipiens* mosquitoes and non-biting midges of the genus *Chironomus* (ABE/CDM, 1980).

A recent study (ABE/CDM, 1980) found that although *Psorophora confinnis* (floodwater) mosquitoes are probably the major nuisance insect species in the

project area, they were not found to be associated with treatment plant effluent. Common breeding sites include poorly leveled or drained yards and pastures, tailwater ponds, desert ponds, dammed washes, and other areas where water floods an area for three days or more. This assessment focuses primarily on the effects of effluent discharge on Culex pipiens mosquitoes and midges, the insect species which are most related to the effluent.

Another public concern involving effluent discharge is the degree to which it supports downstream riparian vegetation. Both adverse and beneficial impacts of vegetation have been ascribed to the effluent. Effluent presently flows through the Base and Meridian Wildlife Area, which is located east of 115th Avenue and was established by the Arizona Game and Fish Department for preservation of valuable wetland vegetation and wildlife habitat. Further downstream, however, residents of the Holly Acres area who have had their homes and land recently flooded believe that the effluent supports riparian vegetation, particularly saltcedar, which they believe is the dominant factor in the spreading of floodwater on their properties.

According to Babcock (1968), there is a

> ...flood hazard created by the encroachment of certain types of plants on the flood plains of our streams in the Southwest. Most of our streams are no longer subject to the annual floods that kept their channels clear of vegetation; plants in many localities have grown into the stream channels to such an extent that, when an occasional flood does occur, the flow is impeded and adjacent areas are flooded.

The impact of effluent discharge on surface and groundwater quality is of major concern to the Gila River Indian Community and other residents of the project area who live near the 91st Avenue Plant or effluent channel. These

residents are primarily concerned that effluent recharge of groundwater may contaminate their potable water supply wells and that open access to the effluent channel is a public safety hazard. Mitigation of these public concerns associated with the plant is addressed in the 91st Avenue Plant Expansion Draft Facility Plan (Greeley and Hansen, 1980).

PUBLIC PARTICIPATION

Due to the extent of public concern regarding this issue and the technical nature of this report, a panel of the leading experts on groundwater, saltcedar, and historical vegetation of this area reviewed the report and conducted a presentation. The presentation was given before the Water Quality Policy Advisory Committee on April 24, 1980, prior to the committee's acceptance of this report. The presentations, as well as questions from the floor and their respective answers, may be found in Exhibit B of this volume of the Residuals Management Facility Plan.

The Clean Water Act of 1977 requires that the public participate in the decision-making process of all water pollution control activities. Accordingly, the City of Phoenix, as Lead Agency for the Multi-City Subregional Operating Group (SROG) contracted with a public participation consultant to develop and implement a public participation program for the Residuals Management Facility Plan. The public participation program is coordinated by the Multi-City SROG staff. Activities of the program included meetings and workshops, media coverage, informational materials, and public hearings. Section 5 of this volume describes the public participation activities for the effluent discharge assessment.

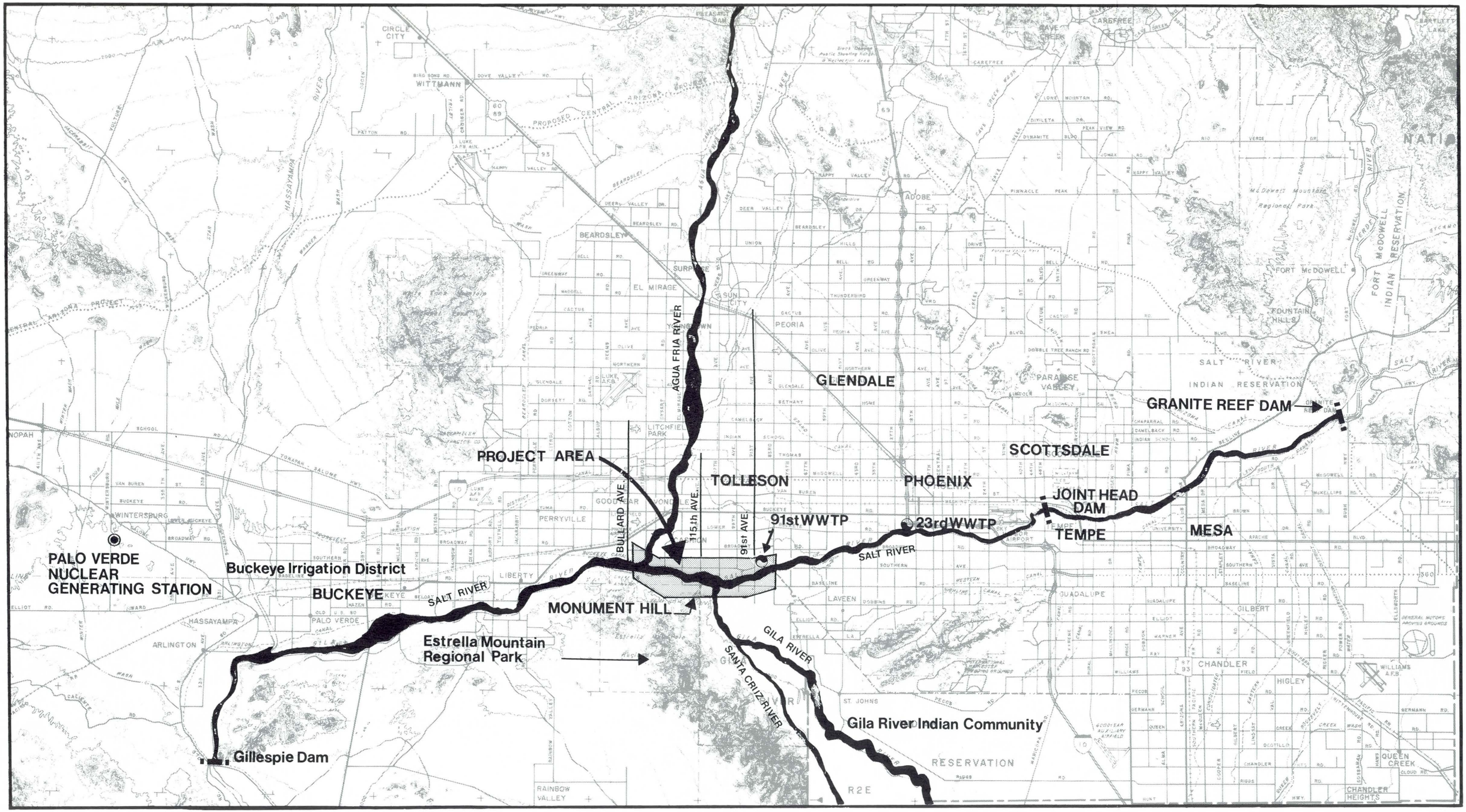
PROJECT AREA

The project area corresponds with that of the 91st Avenue Plant Expansion Draft Facility Plan. As depicted on Plate 1-1, the area includes the land within a two-mile wide corridor along the Salt River channel from 83rd Avenue to the Buckeye Canal headgate about 7.5 miles downstream. Much of the project area is within the 100 year floodplain of the Salt and Gila Rivers.

The 91st Avenue Plant is located on the north bank of the Salt River just east of 91st Avenue and south of Broadway Road. The plant is surrounded on the west, north and east by low density rural/agricultural development with some rural subdivisions of residential housing such as Holly Acres, two to four miles west, and others five to ten miles northwest of the plant. In addition, the Maricopa Colony of the Gila River Indian Community is located on the south bank of the Salt River channel about one mile south of the plant location.

The project area lies entirely within the Gila River drainage basin. Flows of the Salt and Verde Rivers, which converge east of the Phoenix metropolitan area, are controlled by six dams and reservoirs that distribute the joint flows to various canals at the Granite Reef Diversion Dam for irrigation.

Discharge of treated effluent from the 23rd and 91st Avenue Wastewater Treatment Plants helps to support the flow of the Salt River. As described under "Physical Factors" in Section 2, effluent discharge from the 23rd Avenue Plant is considered in this assessment as a part of the baseline river flow entering the project area southeast of the 91st Avenue Plant. The flows of the Salt River combine with irrigation tailwaters and normal stormwater runoff of the Gila River just downstream of the plant. These combined flows



N

Scale: 1 inch = 5.5 miles

Plate 1-1
Project Area Location

arthur beard engineers, inc./CAMP DRESSER & McKEE INC.

and the existing groundwater table sustain a substantial riparian habitat, including the Base and Meridian Wildlife Area. At a location between Litchfield Road and Bullard Avenue, the Buckeye Canal diverts the majority of the surface flow for irrigation purposes.

METHODOLOGY

GENERAL: The assessment of the two effluent discharge conditions was undertaken in several steps. These steps included:

- Determination of needs for relevant environmental information on present and past environmental conditions within the project area. This information centered on surface water, groundwater, vegetation, flooding, and insects.
- Development and evaluation of environmental information. Detailed information was developed for each of the five categories listed above. Information includes present and past conditions and the environmental factors which influence those conditions. Present conditions were quantified to the extent possible for use as a baseline in the assessment.
- Determination of relationships between surface water, groundwater, vegetation, flooding, and insects. Based on the above, the relationships of those factors were identified and quantified to the extent possible.
- Assessment. The information developed for each category and the relationships among them were used as a baseline to determine the impacts of the discharge of effluent under the two conditions.

The following discusses the assumptions and environmental information developed to assess the impacts of the two effluent discharge conditions and explains how the information was used to determine the impacts.

SURFACE WATERS: Basic information on surface water quality and quantity in the project area was developed for the assessment of effluent discharge

impacts. Information on the quality of the surface flow in the project area was needed to address the impact of effluent discharge in terms of puclic health.

Annual average flows and seasonal surface flow fluctuations of the Salt River excluding 91st Avenue Plant effluent were determined to establish that which is referred to as the baseline river flow. The quantity of surface flow, including the baseline river flow and effluent from the 91st Avenue Plant, was used to address possible impacts on riparian vegetation. This included fluctuations in quantities of discharged effluent under existing effluent reuse commitments and the effects of seasonal variation on the baseline flow in the project area.

The baseline river flow was determined using existing information sources. Because actual measuring of irrigation tailwater has not been conducted, an estimation of tailwater contribution to surface baseline river flow was derived on the basis of only those irrigable acreages which discharge to the river and flows for which data is available. Seasonal changes in tailwater flow were determined based on monthly percentages of total irrigation water supplied to agricultural lands.

Total surface water flows under each effluent discharge condition were determined by adding the effluent discharge flow for the first and second discharge conditions to the baseline river flow. A comparison between the two provides the net change in total surface flow expected under the two conditions.

A comparison of surface water flows under the two discharge conditions was made for 1986 when the effluent for Units 1,2, and 3 of the Palo Verde Nuclear Generating Station would be required. The MAG 208 Final EIS (USEPA, 1979)

states that urbanization will continue in the region, resulting in conversion of land use from agricultural to urban. Projection of the baseline river flow which depends on local land uses was not attempted past 1986 because of the uncertainty of future land uses and effluent demant, but was assumed to be constant to the year 2000.

GROUNDWATER: Information on groundwater quality and quantity was necessary to address the potential effects of effluent discharge in the project area. Dr. Kenneth Schmidt, a groundwater quality expert, was contracted to determine these effects (see Appendix J, Vol. VII of this Residuals Management Facility Plan. The relationships between groundwater levels and geological conditions, the effects of flooding and surface flows on groundwater recharge, and the effect of groundwater levels on the support of riparian vegetation were then determined.

VEGETATION: Information on riparian vegetation in the project area was required in order to address issues concerning maintenance of riparian wildlife habitat and to address the concern that riparian vegetation results in increased floodwater spreading in the project area. This included identification of the riparian species in the area and the environmental conditions required for their establishment and survival. Present and historical information on density and distribution was developed based on literature searches, examination of aerial photographs and field investigations. The key to the evaluation of riparian vegetation in the project area was the determination of relationships between surface water and groundwater conditions and the establishment and survival requirements of riparian species. Conclusions and assessment of future vegetative growth under the two effluent discharge conditions were then prepared.

FLOODING: Several factors were required to assess the potential for increased flooding under the two conditions of effluent discharge. These included information on historical flood flows, effects of vegetation on flooding, historical changes in the river channel and floodplain, and information on flood profiles under varying flood flow conditions. An element of the flooding assessment included an investigation of changes in the river channel and recent flood intensities in order to address possible causes of floodwater spreading. In this assessment, the largest recent flooding events were compared with the floodplain frequency map to determine probable areas of inundation. The assessment of flooding associated with the two conditions of effluent discharge was then performed.

INSECTS: The information necessary for the assessment of insect problems associated with the two conditions of effluent discharge was based on Appendix G of the 91st Avenue Wastewater Treatment Plant Expansion Draft Facility Plan. The impacts of the two effluent discharge conditions on insects were then determined.

SUMMARY: There are presently several studies underway which relate to some of the major issues and concerns addressed in this assessment. The analysis and conclusions presented in this assessment have been based on existing information and documents. These are cited in the list of references. Quantified conclusions concerning certain impacts were not possible based on the information presently available. These are noted in the text and summarized in Section 4, "Issues to be Resolved."

SECTION 2
ENVIRONMENTAL ASSESSMENT

SECTION 2

ENVIRONMENTAL ASSESSMENT

PHYSICAL FACTORS

The factors addressed in this portion of the assessment are essentially related to the project area water resources. These physical factors are of primary importance in determining the relationship between the surface and groundwater characteristics and vegetative growth. The specific physical factors included in this analysis are surface water quantity, surface water quality, geology, groundwater quantity, and groundwater quality.

SURFACE WATER QUANTITY: The 91st Avenue Wastewater Treatment Plant began discharging effluent in 1958; by 1962 the effluent flow had increased to about 4 mgd. From 1964 to 1965 effluent discharge increased from approximately 5 mgd to 23 mgd. Presently, about 90 mgd (approximately 100,000 acre-feet per year) of effluent is discharged from the plant to the Salt River channel about three miles upstream of the Salt-Gila River confluence. This flow combines with the project area average annual baseline river flow of approximately 38,200 acre-feet. The combined waters flow westward in the channel, past the Salt-Gila River confluence and beyond the confluence of the Agua Fria River. At about this point, a majority of the flow is diverted into the Buckeye Canal and used for irrigation by the Buckeye Irrigation Company.

The baseline river flow is maintained by several surface and groundwater inflows. Some of these flows are rather continuous contributions, while others are seasonally variable. Only those flows and contributions which were directly quantifiable were used in this assessment.

TABLE 2-1

ESTIMATED UPSTREAM WATER SUPPLY TO THE PROJECT AREA (Acre – Feet/Year)

UPSTREAM WATER SUPPLY: (Above 91st Avenue Outfall)		
INFLOW -	23rd Avenue Effluent[1]	41,800
	Cooling Water (NE¼24-T1N-R2E)[1]	1,500
	Rainfall[2]	200
	Underflow[2]	100
	Groundwater Inflow[2]	300
	Subtotal	43,900
OUTFLOW -	Diversion[1]	250
	Evapotranspiration[1]	3,900
	Groundwater Recharge[1]	33,400
	Subtotal	37,550
	NET AVERAGE FLOW*	6,350

* Not Including Flood Flows

SOURCE:

[1] Halpenny and Clark, 1977.
[2] USEPA, 1979.

Rainfall data analysis was based on monthly percentages of the area's annual average precipitation of 7.48 inches, which provides an average of 1,400 acre-feet per year of rainwater to the river channel.

Irrigation tailwaters contribute a large part of the seasonal flows of the river. These flows include a relatively continuous flow of 7,300 acre-feet per year entering the river from the south, just upstream of the project area (Halpenny and Clark, 1977 and USEPA, 1979). Direct discharge from the north side of the river enters at several points and contributes approximately 600 acre-feet per year (Carriage Losses, SRP, 1980). In general terms, runoff from those irrigable acreages immediately adjacent to the channel contribute 1,200 acre-feet per year. These flows comprise a total of 9,100 acre-feet per year of irrigation tailwater. The discharge points of these tailwaters and the method of determining the quantities are supplied in Exhibit A. Monthly contributions of tailwater to the river are given on Table 2-2, along with other flows which make up the baseline river flow.

Gila River flows result mostly from stormwater runoff and are quite variable. Data pertaining to Gila River flows at the confluence of the Salt River were derived from a 20-year composite of flows (1958-1977) from USGS guaging stations upstream of the Salt-Gila confluence on the Gila River near Laveen (#9-4890) and the Santa Cruz River near Laveen (#9-4795).

The greatest period of records available for these stations on a yearly and monthly basis is for the past 36 years; these figures are shown graphically in Exhibit A. However, as stated previously, only the most recent 20 years were used, since the 91st Avenue Plant began discharging effluent in 1958.

FIGURE 2-1

PROJECT AREA RIVER BASELINE FLOW
1980-1986

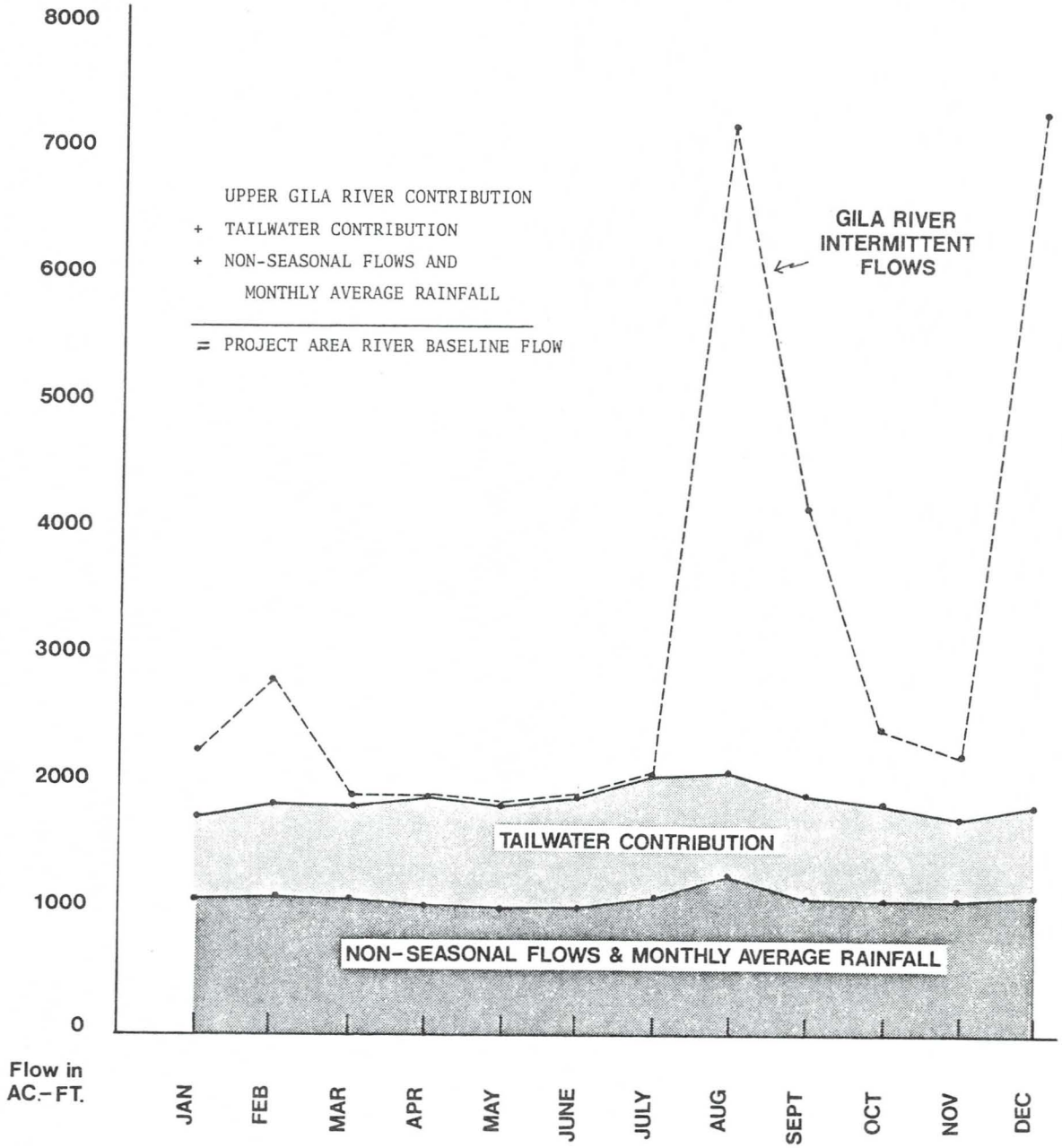


TABLE 2-3
EFFLUENT REUSE PROJECTIONS FOR THE 91st AVENUE TREATMENT PLANT

(120 mgd - Annual Average Flow Basis)

Year	Estimated Projected Flow (mgd)	EFFLUENT REUSE COMMITMENT			DISCHARGE TO SALT-GILA RIVER (5,6)		ADDITIONAL EFFLUENT REQUIRED TO MEET REUSE COMMITMENTS(7)
		AGFD (mgd)	BIC (mgd) (1)	PVNGS (mgd) (2,3)	With Units 4&5 (mgd)	Without Units 4&5 (mgd)	With Units 4&5 (mgd)
1980	90	6.52	26.81	-		90	
1981	93	"	"	-		93	
1982	95	"	"	-		95	
1983	98	"	"	20.7 (Unit 1)		50.5	
1984	101	"	"	38.7 (Units 1&2)		35.5	
1985	103	"	"	38.7 (Units 1&2)		37.5	
1986	105	"	"	58.0 (Units 1,2,3) (4)		20.2	
1988	110	"	"	77.3 (Units 1-4)	6.52	25.2	.63
1990	120	"	"	96.6 (Units 1-5)	"	35.2	9.93
1995	120	"	"	96.6 (Units 1-5)	"	35.2	9.93
2000	120	"	"	96.6 (Units 1-5)	"	35.2	9.93

AGFD-Arizona Game and Fish Dept./BIC-Buckeye Irrigation Co./PVNGS-Palo Verde Nuclear Generating Station

1. BIC water expected to be drawn off PVNGS pipeline.
2. Only PVNGS Power Generating Units 1,2 and 3 have been approved to date.
3. Greeley and Hansen, 1980.
4. Assumes average annual requirement of 19.3 mgd for each of units 4 & 5.
5. Includes 6.52 mgd committed to AGFD.
6. Assumes Flushing Meadow allocation available for reuse.
7. Based on per unit requirements. ANPP is contractually allowed up to approximately 125 mgd annual average supply of effluent.

The 91st Avenue Plant presently adds approximately 90 mgd of effluent to the Salt River channel flow. In this arid region, the effluent has proven to be a valuable resource. The 91st Avenue Plant is in the process of being expanded as identified in the MAG 208 Plan. The effluent, including the projected flows to 120 mgd, is already subject to reuse commitments as follows:

- Up to 30,000 acre-feet per year (approximately 26.8 mgd) to Buckeye Irrigation Company for restricted agricultural irrigation.
- Up to 7,300 acre-feet per year (approximately 6.52 mgd) to the Arizona Game and Fish Department for a wildlife management area in the Salt River bed near 115th Avenue (not a contracted allocation).
- 1,200 acre-feet per year (approximately 1.07 mgd) to the U.S. Water Conservation Laboratory for the laboratory's research facilities at Flushing Meadows. However, these facilities were washed out by 1978-79 floodwaters.
- Up to 140,000 acre-feet per year (approximately 125 mgd) to the Arizona Nuclear Power Project. The Multi-cities/ANPP contract specifies that the effluent may be used at the Palo Verde Nuclear Generating Station (PVNGS) or any other power generating facility ANPP may choose.

The plant effluent is currently discharged along the north bank of the Salt River where it eventually mixes with the baseline river flow, as previously described. The river water flows to Buckeye Heading, where the majority is diverted and used for irrigation. As a result of this discharge two reuse commitments are satisfied: 1) effluent allocated to AGFD which flows through the downstream riparian habitat, and 2) effluent drawn off by the Buckeye Irrigation Company for restricted agricultural irrigation.

As indicated in Table 2-3, discharge of all effluent from the plant into the Salt River is expected to continue until about 1983 when Arizona Nuclear Power Project (ANPP) is scheduled to bring the first power generating unit commercially

on line. Buckeye Irrigation Company has made arrangements to have its supply of effluent conveyed through the same pipeline that ANPP would use for its allotment. Therefore, the BIC flow and effluent required by the ANPP commitment would be removed from the river.

The increasing use of effluent by ANPP as the remaining units are brought on line would significantly change the quantity of plant effluent discharged to the river. The flows in Table 2-3 indicate the remaining effluent as an annual average. However, when the flows are assessed on a monthly basis, the discharge is shown to be seasonally variable. The cooling water demand for Palo Verde Nuclear Generating Station (PVNGS) would be the highest during the summer months and would decline during the colder seasons. Table 2-4 indicates the monthly requirements as each power generating unit becomes operational (Exhibit C, Greeley and Hansen, 1980). Monthly fluctuations in the baseline river flow would serve to offset the seasonal demands of cooling water for ANPP, which would tend to produce a more uniform flow in the river beyond 1986.[1] Figure 2-2 illustrates this offsetting effect of reduced effluent discharged under the seasonally higher requirements of PVNGS and the simultaneous increase in the baseline river flow.

The baseline river flows (i.e. without effluent) were determined based on the existing conditions, specifically in terms of present land uses. According to the MAG 208 Final EIS (USEPA, 1979), the region is expected to continue to

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[1] 1986 is the first year all three units will be on line. However, the start-up for the third unit is not scheduled until May of that year. Therefore, the corresponding months in 1987 are provided to indicate a full year of effluent demand.

TABLE 2-4

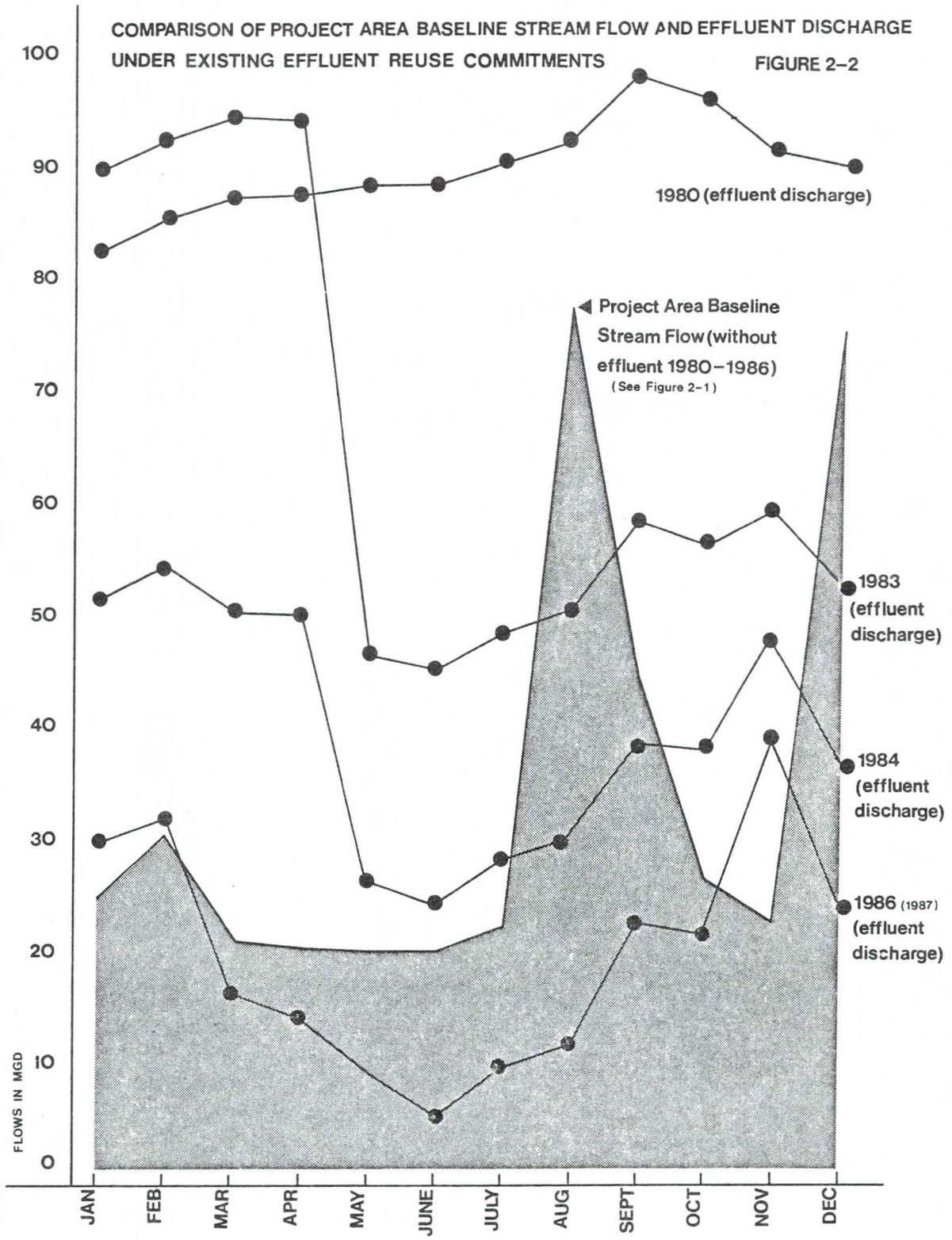
REDUCTION IN PLANT EFFLUENT DUE TO COMMITMENTS AND CORRESPONDING DISCHARGE TO THE RIVER

Month	Plant Effluent Flows, mgd 91st Ave. *	Effluent Commitments PVNGS/BIC mgd *		Plant Effluent Flows mgd to the River	
1980					
January	83.4			83.4	
February	86.2			86.2	
March	88.0			88.0	
April	88.0			88.0	
May	88.9			88.9	
June	88.9			88.9	
July	91.6			91.6	
August	93.4			93.4	
September	98.9			98.9	
October	97.0			97.0	
November	92.5			92.5	
December	90.7			90.7	
1983					
January	90.2	-		90.2	
February	93.1	-		93.1	
March	95.1	-		95.1	
April	95.1	-		95.1	
May	96.0	48.9		47.1	
June	96.0	50.2		45.8	
July	99.0	49.9		49.1	
August	100.9	49.9		51.0	
September	106.8	48.5		58.3	
October	104.9	47.8		57.1	
November	100.0	40.4		59.6	
December	98.0	44.7		53.3	
1984					
January	92.5	39.9		52.6	
February	95.5	40.2		55.3	
March	97.5	46.3		51.2	
April	97.5	46.9		50.6	
May	98.5	71.0		27.5	
June	98.5	73.6		24.9	
July	101.5	73.0		28.5	
August	103.5	73.0		30.5	
September	109.5	70.2		39.3	
October	107.5	68.8		38.7	
November	102.5	54.0		48.5	
December	100.5	62.6		37.9	
1986			**(1987)		**(1987)
January	96.6	53.0	66.3	43.6	30.3
February	99.8	52.4	67.0	47.4	32.8
March	101.9	65.8	85.3	36.1	16.6
April	101.9	67.0	87.1	34.9	14.8
May	102.9	93.1		9.8	
June	102.9	97.0		5.9	
July	106.1	96.1		10.0	
August	108.2	96.1		12.1	
September	114.5	91.9		22.6	
October	112.4	89.8		22.6	
November	107.1	67.6		39.5	
December	105.0	80.5		24.5	

SOURCE:

*Greeley & Hansen, 1980.

**Unit 3 is not expected to come on line until May of 1986. The 1987 figures for January through April represent Unit 3 as being on line.


COMPARISON OF PROJECT AREA BASELINE STREAM FLOW AND EFFLUENT DISCHARGE
UNDER EXISTING EFFLUENT REUSE COMMITMENTS
FIGURE 2-2
1980 (effluent discharge)
Project Area Baseline Stream Flow (without effluent 1980-1986)
(See Figure 2-1)
1983 (effluent discharge)
1984 (effluent discharge)
1986 (1987) (effluent discharge)
FLOWS IN MGD
100
90
80
70
60
50
40
30
20
10
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC

grow in population. This would result in a continuation of the present trend of conversion from agricultural land to urban development. The contribution of irrigation tailwater to the baseline river flow after 1986 is difficult to predict and could not be quantified for this assessment. Because these reduced flows of irrigation tailwaters cannot be quantified, flows were assumed to remain constant to the year 2000 for this study.

The quantity of plant effluent discharged to the Salt River is expected to change with time. As discussed previously, the effluent has become a valuable resource and its effective reuse is of significant interest. The main focus of this assessment is to determine the effects of two possible effluent reuse conditions on the maintenance of surface water flows in the river for the entire year. The two effluent conditions consist of: 1) the discharge of only the 6.52 mgd for AGFD with total reuse of the remaining effluent, and 2) allocations of effluent to the existing reuse commitments beyond 1986 with the unused portion being discharged to the river.

A general reduction in the existing relatively consistent flow of effluent discharged into the Salt River would be expected from either effluent discharge condition. As a result, channel flow characteristics would shift in both effluent discharge conditions to a more seasonally variable flow, primarily because on an annual basis the total river flow would reflect a higher proportion of irrigation tailwaters and stormwater runoff from the Upper Gila. The difference between the two effluent conditions would be expected to be the greatest during the winter when the plant effluent discharge would be the most dominant. The river flows under the two effluent conditions are provided in Table 2-5 and represented in Figure 2-3.

TABLE 2-5
PROJECT AREA RIVER FLOW UNDER THE EFFLUENT REUSE CONDITIONS (1986)

MONTH	91st Ave Plant Unused Effluent 1986[1] (mgd)	Baseline River Flow[2] (mgd)	FIRST CONDITION Baseline Flow and Effluent Discharge of 6.52 mgd[3] (mgd)	SECOND CONDITION Baseline Flow and Effluent Flow[4] (mgd)
January	30.3	24.6	31.1	54.9
February	32.8	30.7	37.2	63.5
March	16.6	21.3	27.8	37.9
April	14.8	20.7	27.2	35.5
May	9.8	20.3	26.8	30.1
June	5.9	20.6	27.1	26.5
July	10.0	22.4	28.9	32.4
August	12.1	77.9	84.4	90.0
September	23.6	45.1	51.6	68.7
October	22.6	26.6	33.1	49.2
November	39.5	23.6	30.1	63.1
December	24.5	75.8	82.3	100.3

[1]From Table 2-4. Assumes effluent commitments to PVNGS and BIC by pipeline. January through April numbers are actually 1987 since Reactor 3 is not expected to come on line until May of 1986.

[2]From Table 2-2.

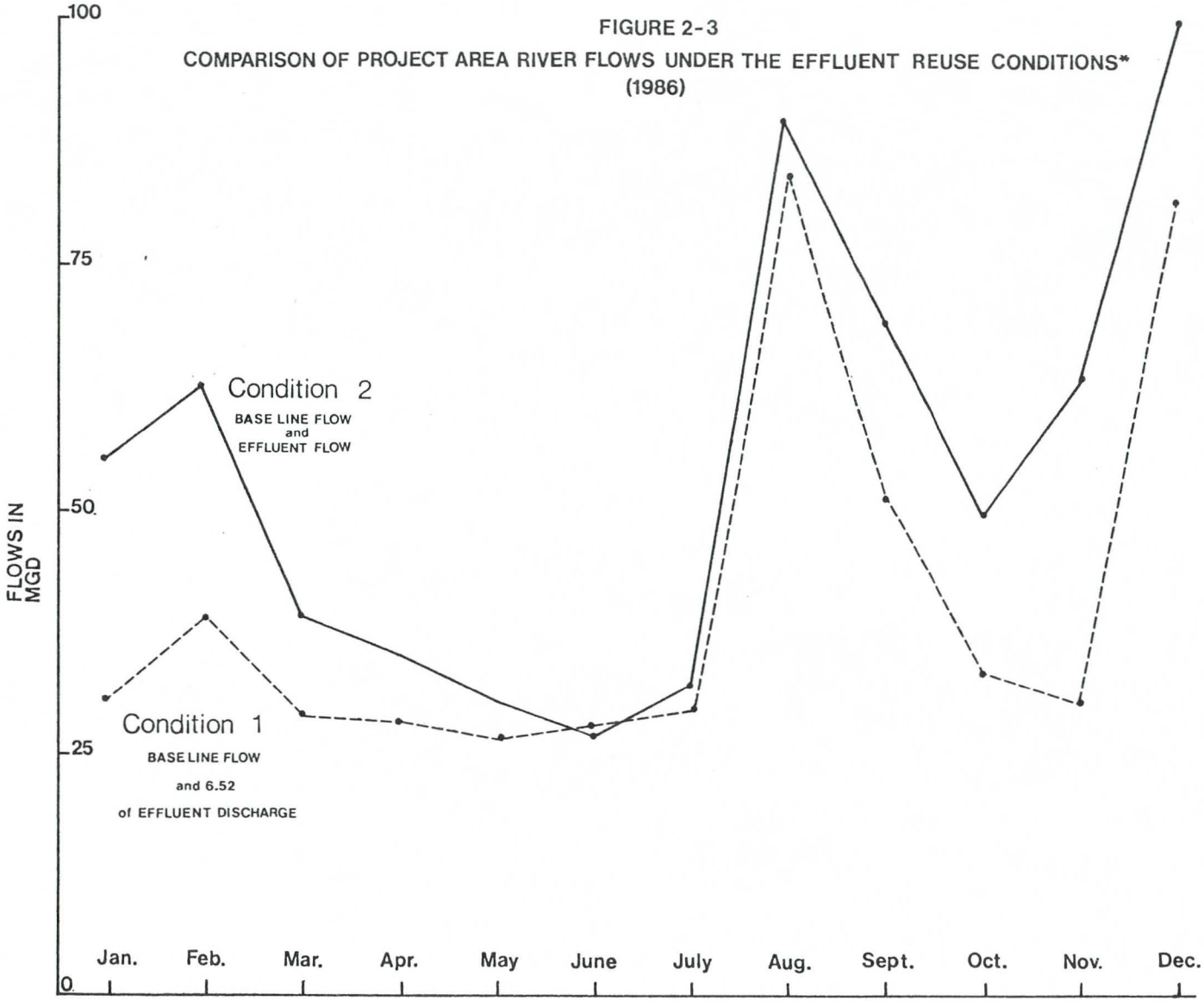
[3]River flow under first condition assumes 6.52 average annual discharge into Salt River.

[4]River flow under second condition assumes 20.2 annual average discharge into Salt River.

SOURCE: ABE/CDM, 1980.

FIGURE 2-3

COMPARISON OF PROJECT AREA RIVER FLOWS UNDER THE EFFLUENT REUSE CONDITIONS*
(1986)

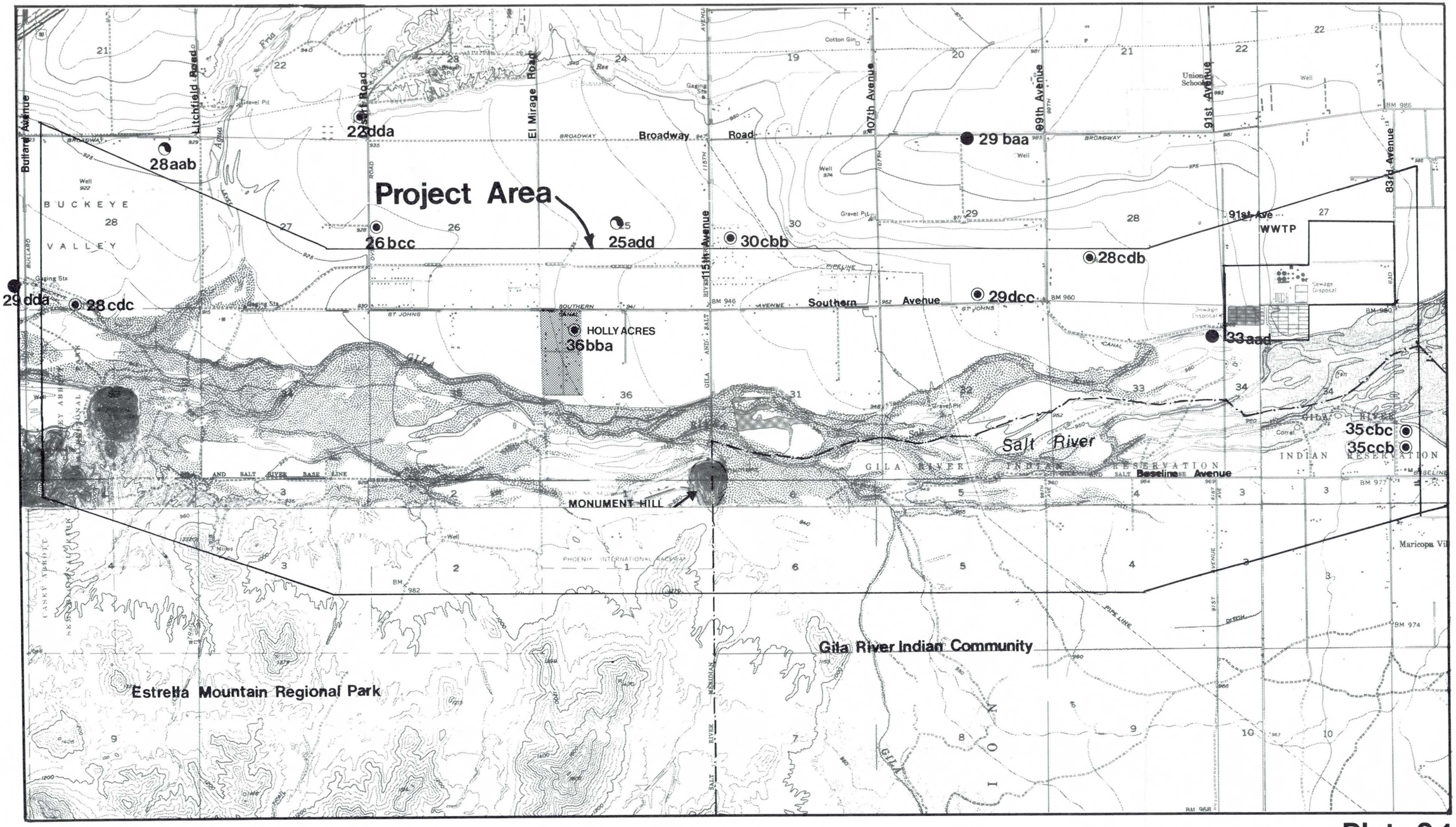


As indicated, the first condition (6.52 mgd only) would provide for the lower annual average river flow of the two conditions. This low flow would be most noticeable from November through March. The impacts that would be expected on the downstream ecosystem are discussed in the section on biological factors.

SURFACE WATER QUALITY: In general, the discharge of treatment plant effluent to any typical receiving stream results in the addition of several pollutants which reduce water quality. These pollutants are Biochemical Oxygen Demand (BOD) which lowers the dissolved oxygen, elevated levels of ammonia (NH_3), and chloramine toxicity due to disinfection. However, in this case the receiving stream is predominantly irrigation tailwaters which contain pollutants of their own, such as a high total dissolved solids (salinity) content along with a slight elevation in pH and total suspended solids (SS). Combining these discharges ultimately dilutes the various constituents specific to each discharge. For example, the irrigation tailwaters are characterized by a high concentration of salinity, whereas the effluent salinity content is low. Therefore, the mixing of the two flows reduces the overall level of salinity in the river water. This would also occur for the other various pollutants previously stated. The effects of the low salinity effluent on the recharge and the dilution of high salinity groundwater would be about the same as that described for surface water. The BOD and ammonia of the effluent is usually contained in the surface soil, however, and would not reach the groundwater (ABE/CDM, 1979). No significant change is expected under either effluent condition.

GEOLOGY: The project area is located in an area of particular geological interest. The available data indicates a significant relationship between the area's geomorphology, surface water flow and depths to groundwater in this segment of the river. The subsurface geology is such that the basement rocks in the project area are arranged in fault-block sequences; mountain units are bounded by faults and are uplifted with respect to the nearby rocks. Conversely, the sediment-filled valleys are the bordering blocks; they are bounded by faults and lowered with respect to the surrounding rocks (Graf, 1980). Specific to the project area, this is characterized by the ridge of mountains which runs parallel to the southern border of the river channel. This ridge of mountains essentially starts at Monument Hill (115th Avenue) and extends to the butte which is topped by the Goodyear Survey Mark (adjacent to the Agua Fria River). The lowered portion of the fault is evidenced by the sediment-filled valley, which begins along the river channel and continues north through the project area.

Several distinct geologic units are found in the project area. The subsurface geology was derived from wells drilled throughout the area; the wells are located on Plate 2-1. The uppermost material beneath the majority of the area is Recent alluvium. This unit is comprised of coarse-grained deposits (primarily boulders, gravel, and sand) up to 200 feet thick, and is a prolific aquifer. The next distinctive unit ranges in depths from about 180 to 270 feet below land surface. This unit is comprised primarily of clay and silt and may be comparable to the "Middle Fine-Grained Unit" of the U.S. Bureau of Reclamation (1977). Because of its low permeability, this unit is a poor water producer.



Source: Schmidt, 1980

N

Scale: 1"=2700'

- Subsurface Geology
- Water Levels
- Chemical Quality

Plate 2-1
Location Of Selected Wells With Hydrogeologic Records

arthur beard engineers, Inc. / CAMP DRESSER & McKEE INC.

It has been concluded that relatively impermeable geologic materials are present at relatively shallow depths near the Gila River west of Monument Hill. The subsurface geologic structure between Monument Hill and the Estrella Mountain Regional Park is such that shallow groundwater levels are favored. Hardrock either crops out at the land surface in this area or is present at relatively shallow depth, forming a boundary to the groundwater system south of the Gila River. In this southern part of the project area, near the mountain front, a substantial amount of water can be produced from the conglomerate layer (Appendix J; Schmidt, 1980).

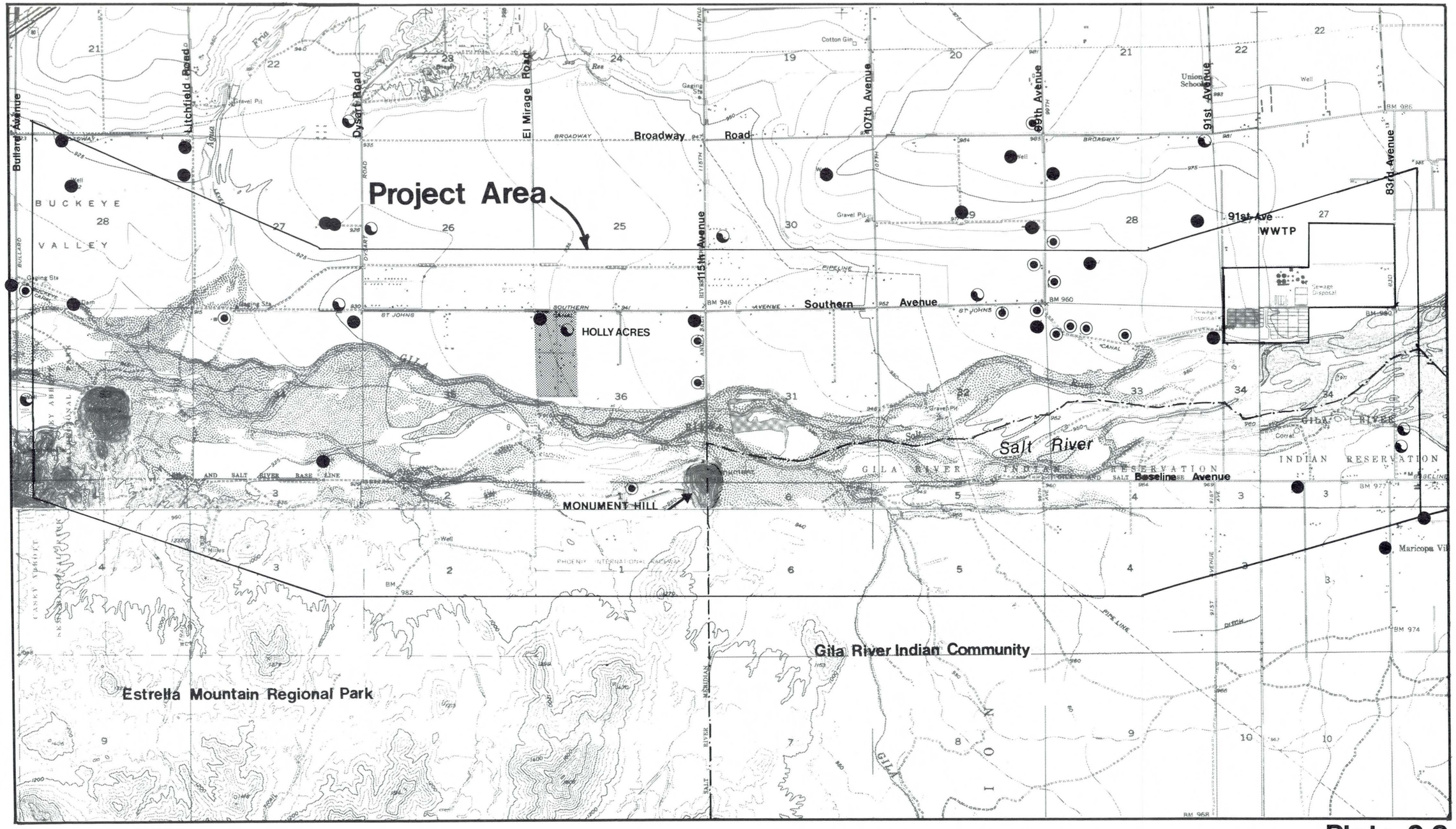
GROUNDWATER QUANTITY: The project area has historically been underlain by relatively shallow groundwater levels as compared to other parts of the Salt River Valley. This is largely due to the subsurface geologic structure, sources of groundwater recharge such as flood flows and other discharges, and the relatively small amount of pumpage (Schmidt, 1980).

Halpenny and Greene (1975) reported on a water balance investigation of the Salt and Gila Rivers between 23rd Avenue and Gillespie Dam. By the end of the 1950's, flow in the Gila River at the Buckeye Heading had decreased to the point where water was present only after storms. Groundwater levels along the channel began to decline up through 1965 due to expanded pumpage and a decrease in stream flow. However, west of 115th Avenue, water levels did not fall significantly below the Gila River channel. Well data near 91st Avenue and the Salt River indicate that the groundwater level exceeded 40 feet in the early 1950's. After 1965, several sources of recharge became important in the project area. These include periodic flood flows and relatively continuous discharges

of effluent and other water in the channel of the Salt River. The combined effect of these sources has been to substantially raise water levels in the area from 1965 to the present, as indicated by hydrogeologic studies of wells in the area shown on Plate 2-1 and 2-2 (Appendix J; Schmidt, 1980).

Groundwater levels presented in the hydrograph on Figure 2-4 indicate that in the short term, water levels in wells in the project area fall during drought periods and rise during wet periods. During wet periods, two predominant factors control the depth to groundwater. First, there is direct recharge during flood flows. Second, pumpage is usually decreased substantially at the time of flood flows because of abundance of available canal water. These factors combine to produce a rather marked response in water levels following flood flows, which is expressed on Figure 2-4. In the long term, there has been a gradual rise in water levels since the mid-1960's in the project area, and this is attributed to recharge from effluent and the prevalence of more runoff in the Salt River than occurred in previous decades.

Information regarding depth to water beneath the channel of the Salt and Gila Rivers in the project area is scarce because of a lack of measurements for wells which tap only the Recent alluvium. However, extrapolation of measurements from wells to the north and south of the Gila River near the Agua Fria River confluence suggests that groundwater levels beneath the western part of the project area have been at or near the elevation of the river channel (less than five feet deep) since the mid-1960's. East of Monument Hill, however, depth to water has often ranged from 10 to 20 feet beneath the Salt River channel (Schmidt, 1980).



Source: Schmidt, 1980

N

Scale: 1"=2700'

- Domestic or
- Irrigation
- Public Supply Stock

Plate 2-2
Location Of Selected Wells In The Project Area

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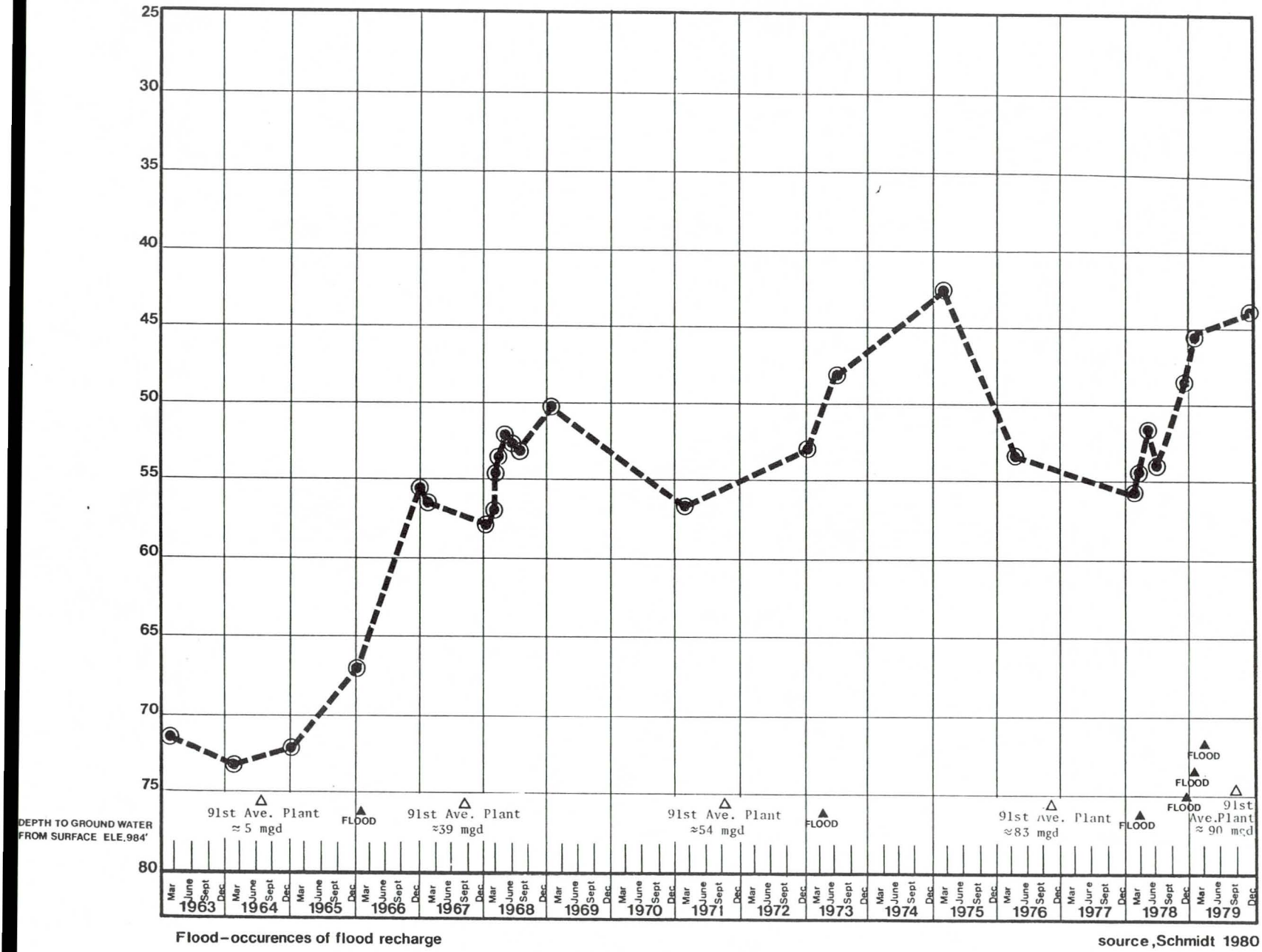


Flood–occurences of flood recharge

source ,Schmidt 1980

Figure 2-4

Ground Water Depths In Response To Recharge

A comparison of the project area geomorphology and available well data indicates that this segment of the river channel within the project area is characterized by two groundwater regimes, with the east and west separation occurring at 115th Avenue. This is based on the fact that the western part exhibits typically high groundwater levels, as previously stated, and the levels in the eastern part respond more readily to recharge as a result of lower groundwater levels (Figure 2-4). The depth to water beneath the channel is important because it partially controls the amount of recharge that can occur from water in the channel. In general, the deeper the water level, the more storage space there is for recharge.

This analysis (Schmidt, 1980) indicates that the eastern section groundwater level depends more on recharge, with the primary sources of recharge to the groundwater in the project area being:

1. Seepage of flood waters from the floodplains of the Salt, Gila, and Agua Fria Rivers.
2. Seepage of effluent and irrigation tailwater from the channels of the Salt and Gila Rivers.
3. Deep percolation of irrigation return flow.

In comparison, for the present discharge rate of about 100,000 acre-feet per year, recharge of 91st Avenue Plant effluent in the project area is probably about 8,000-10,000 acre-feet per year, while for the 1965-66 flood flows, an estimated 15,000-20,000 acre-feet were recharged in the project area, primarily east of Monument Hill. These calculations and a review of water-level measurements for wells in the project area indicate that flood flows have three primary impacts on groundwater recharge (Schmidt, 1980):

1. They supply direct recharge.

2. They clear the channel of the organic mat formed by the effluent discharge, the removal of which temporarily greatly enhances the seepage of effluent and other surface water from the stream channel.

3. They coincide with periods of abundant canal water, which results in minimal pumpage.

The difference between the two effluent conditions would primarily affect the eastern part, where the depth to groundwater is such that larger recharge would occur. Under the first condition, with only 7,300 acre-feet per year of effluent discharge, an estimated 1,500 acre-feet per year of recharge would be expected from 91st Avenue Plant effluent. The majority of this recharge would take place in the eastern portion as a result of the lower groundwater level, which provides a greater recharge potential. The recharge capabilities in the western part would be less, because of a high groundwater level which reduces storage availability. During dry periods, water levels in the eastern area could decline several feet per year more than normally expected during such periods. Under the second condition, with the remaining committed effluent discharged, an estimated 4,000-8,000 acre-feet per year of recharge from 91st Avenue Plant effluent would be expected to occur, the majority of which would be in the eastern part of the project area. Recharge from other sources of water would continue. Water levels would probably decline slightly on the long term under this alternative; however, the precise magnitude of this decline is unknown, but a rate less than one foot per year is likely. The rate and degree of groundwater level decline would be offset as a result of recharge by floods or other large discharges (Appendix J; Schmidt, 1980).

Plate 2-2 shows selected well locations and use of the area groundwater, with the most predominant use being for irrigation.

GROUNDWATER QUALITY: The chemical quality of groundwater in the shallowest strata of the project area is poor. Schmidt (1978) assessed the regional groundwater characteristics of several chemical constituents (Table 2-6). In general, groundwater to the north of the project area exhibits a decrease in the salinity content with an increase in nitrate.

Wells north of the Salt and Gila Rivers and on a down gradient from recharge of flood water and effluent appear to have relatively low salinity water. An example is the well at Holly Acres which is about one-half mile from the river channel. Water from this well had a low nitrate content and a total dissolved solids content of about 800 mg/l in 1979 (Schmidt, 1980).

Numerous other chemical analyses for trace elements have been performed on samples of water from public supply wells in the project area. The only constituent found in amounts exceeding the USEPA drinking water limits is iron. The limit for iron is based on aesthetic, not health concerns, and is recommended only. Much of the groundwater in the Recent alluvium, which is the major aquifer in the area, is considered "marginal" to "unstable" for domestic use and irrigation, due to high salinity, chloride, and hardness. Therefore, much of the drinking water in the project area is reportedly supplied by bottled water. The possible reduction of recharge by the low salinity effluent could tend to increase the total dissolved solids content of the groundwater in the area, particularily in the eastern part. However, this would be expected to be minimized by recharge from flood flows.

TABLE 2-6
CHEMICAL ANALYSIS FOR WATER FROM WELLS IN THE PROJECT AREA

Constituent (mg/1)	(A-1-1)				(B-1-1)			
	28 cdb	29 dcc	30 cbb	35 ccb	22 dda	26 bcc	28 cdc	36 bba
Calcium	216	465	120	30	126	69	108	42
Magnesium	72	185	63	14	39	39	70	19
Sodium	639	640	342	259	312	264	272	200
Carbonate	0	0	0	0	0	0	0	0
Bicarbonate	422	239	156	127	134	151	400	118
Sulfate	348	620	212	118	195	93	261	78
Chloride	1070	1830	760	344	636	624	656	356
Nitrate	26	11	11	3	4	2	23	< 1
Fluoride	-	< 0.2	0.3	0.9	0.2	0.3	0.3	0.6
Total Hardness ($CaCO_3$)	770	1920	559	133	580	336	546	183
Iron	-	0.1	< 0.1	< 0.05	0.2	0.44	-	< 0.1
Manganese	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	-	< 0.05
Chromium	-	< 0.01	0.01	-	< 0.01	< 0.01	-	< 0.01
Arsenic	-	< 0.01	< 0.01	-	< 0.01	< 0.01	-	< 0.01
pH	7.6	7.4	7.6	7.8	-	7.8	7.6	8.0
Electrical Conductivity (micromhos @ 25°c)	4320	-	-		2130	1850	3730	-
Total Dissolved Solids	2580	4250	1730	840	1512	1078	1772	790
Date	11/08/68	04/05/79	04/02/79	06/77	08/22/76	08/11/76	07/77	04/05/79
Perforated Interval (feet)	50-140	-	410 T.D.	389-407	500 T.D.	-	55-421	176 T.D.
Lab	SRP	ADHS	ADHS	ATL	ADHS	ADHS	U of A	ADHS

Data from MAG 208 program and files of Arizona Department of Health Services, Maricopa County Health Department, and Bureau of Indian Affairs.

Schmidt, 1980

BIOLOGICAL FACTORS

RIPARIAN VEGETATION: Riparian vegetation in the project area has a history closely related to groundwater fluctuations. The groundwater fluctuations are in turn dependent on surface flows, flooding, and other recharge. The historical description below of both the groundwater and the riparian vegetation is presented as a basis for understanding present conditions and future impacts. The three major riparian species to be considered are saltcedar (*Tamarix chinensis*), cottonwood (*Populus fremontii*) and willow (*Salix spp.*). Information is based on photographic evidence, research articles and field reconnaissance. The historical discussions are followed by a description of the existing vegetation in the eastern and western groundwater areas. The future impacts on vegetation under the two effluent discharge conditions are then assessed for the eastern and western parts of the project area.

Groundwater History. Groundwater levels in the project area are high compared to other parts of the Salt River Valley (Appendix J; Schmidt, 1980). Groundwater was close to the surface under the Salt River channel in 1920 (Halpenny and Greene, 1975), but because of increased pumpage and decreased streamflow, groundwater levels declined through 1965. West of 115th Avenue, however, the decline under the channel was not as significant. This is largely due to the presence of relatively impermeable geologic materials at shallow depths. After 1965, several sources of recharge became important in the project area. These include periodic flood flows and relatively continuous discharge of sewage effluent and other waters in the channel of the Salt River.

History of Riparian Vegetation. Prior to the 1920's, riparian vegetation in the project area probably consisted primarily of native cottonwood and

willow with small bosques of mesquite. The earliest account of saltcedar (an introduced, exotic species) in the Gila River was around 1900. Saltcedar was apparently common in the river bottom near Tempe in 1901, and by 1902 saltcedar could be seen along the Gila River around Gila Bend, but it did not appear to be well established (Robinson, 1965). Saltcedar is of particular importance in this assessment since it may be related to flooding. According to Horton and Campbell (1974),

> ...saltcedar and other species tend to clog channels because the seedlings invade sandbanks and sandbars close to the stream. As they develop a barrier, sediment collects in the heavy stands. Floodflows are then diverted onto the surrounding lands. These diversions tend to spread the woody barriers more widely which further increases the flooding.

Heavy growth of saltcedar was reported at Gillespie Dam on the Gila River in 1929. During the same year, it was reported as a nuisance along unlined laterals of the Roosevelt Irrigation District in the Buckeye area and "jungles" of it were reported along the Gila River (Robinson, 1965).

Photographs taken in 1941 (available at Maricopa County Flood Control District - MCFCD) show fairly dense riparian vegetaiton in most of the area. From 91st Avenue to the Salt/Gila confluence (approximately 115th Avenue), the vegetation was relatively sparse, consisting primarily of riparian tree species along the low flow channels with little growth outside the channel. From the Salt/Gila confluence to the Agua Fria/Gila confluence, the bed of the channel had approximately 60 percent coverage with a few widely dispersed clumps of trees and several open areas. West of the Agua Fria/Gila confluence, the growth consisted of large trees covering about 80 percent of the channels with few open spaces.

Partial photographic records from 1949 (U.S. Army Corps of Engineers) indicate an increase in the areal extent of riparian vegetation. The area from 91st Avenue to the Salt-Gila River confluence (115th Avenue) remained relatively the same, but west of the confluence there was a slight increase in extent and density of vegetation. Soil Conservation Service (SCS) aerial photographs from 1954 indicate only a slight reduction in growth along the Salt River from 91st Avenue to the Salt-Gila River confluence. West of the Salt-Gila River confluence, the vegetation remained relatively the same.

In the late 1950's an extensive thinning of vegetation began to occur. Photographic records of 1959 (MCFCD) show a general reduction in areal extent of riparian vegetation. By this time, the area from 91st Avenue to the Salt-Gila confluence was practically barren. Very little vegetation was present, even along the channel. From the Salt-Gila confluence to the Agua Fria-Gila confluence, dense growth occurred only along the low flow channels, with the area outside the channel exhibiting many open spaces and some scattered growth. West of the Agua Fria, dense growth occurred along the low flow channel only, with about 20 percent coverage outside the channel. The vegetation was essentially the same in SCS photographs from 1964.

Comparison of 1964 photographs with 1978 and 1979 photos indicates a general trend toward increasing density and coverage throughout the project area.

Some general conclusions can be drawn from the above information. First, saltcedar growth in the project area probably started during the 1920's. Riparian vegetation was probably at its greatest density in the late 1940's.

In the 1950's a reduction in the extent of coverage began to occur, and probably continued until about 1967, when a gradual reversal began. The extent and density of riparian vegetation has apparently been slowly increasing from the late 1960's to the present. However, the area east of the Salt-Gila confluence has always demonstrated much less dense growth than west of that point.

The changes in the extent and density of vegetation, particularly west of 115th Avenue, are largely dependent on gross groundwater fluctuations. The fluctuations in turn largely depend on flood flow, effluent and other recharge, and pumping rates. Prior to 1965, there was a 25 year period without flood flows. During this period, groundwater pumping increased, and after 1950, flow in the Gila River at the Buckeye Heading had decreased to the point where water was present only after storms (Halpenny & Greene, 1975). A simultaneous reduction in vegetation occurred during the same period of declining groundwater levels.

Some man-made changes in the river bottom may have contributed to growth of vegetation in localized areas. Any change of this type cannot be specifically quantified; however, some residents believe that the ponds built by AGFD, roads built across the river, and alterations to the effluent channel have contributed to saltcedar growth. In a deep groundwater area, changes such as these would be expected to result in growth of vegetation immediately adjacent to the source of water. However, subsequent removal of the water would be expected to cause the vegetation to die unless its roots had reached the groundwater.

The 91st Avenue Treatment Plant commenced operation in 1958. With approximately 0.1 mgd annual average flow being discharged, the effluent did not

travel far. By early 1962, however, effluent discharges increased to about 4 mgd annual average flow and reached the Buckeye Heading six and one-half miles downstream. Effluent discharge from the 91st Avenue Plant increased to approximately 23 mgd annual average flow in 1965 (Halpenny and Greene, 1975). Increases in vegetation, however, did not begin until after the flood of December 1965-January 1966. The increase in groundwater level from recharge of these flows was probably the primary factor in increased vegetative growth. The low groundwater levels prior to 1965 allowed greater recharge capacity. Several sources of recharge became important in the project area, as previously mentioned. These include periodic floodflows and relatively continuous discharge of effluent and other waters which supported new vegetation. In general terms, the riparian vegetation has been increasing in areal extent and density since the late 1960's.

Because the project area has value for wildlife, much of the river bed from 91st Avenue to 115th Avenue has been proposed as a natural area by the Arizona State Parks Board. The proposal involves 1,120 acres of land and will require a voluntary, cooperative agreement among all of the landowners prior to becoming a registered natural area. A natural area status does not impose any legal restrictions on the land, but recognizes the site as a special area in which management and protection of resources are encouraged.

The site of the proposed natural area includes a segment of the Salt River and riparian habitat between 91st and 115th Avenues in the eastern part of the project area. The southern boundary is adjacent to the northern edge of the Gila River Indian Community (Smith and Bender, 1973).

Current ownership of the river bed within the project area is varied. The southern half of the river bed between 91st Avenue and 107th Avenue is owned by the Gila River Indian Community, with the remaining land divided among private, state and municipal ownerships. However, west of 107th Avenue to the Buckeye Heading, the majority of the land is either owned by the Arizona Game and Fish Department (AGFD) or designated as State Trust Land. A portion of this land within the proposed natural area is currently controlled by the AGFD as the Base and Meridian Wildlife Area, located in the Salt River channel just east of 115th Avenue. The AGFD had constructed several ponds that were used as waterfowl resting areas and were important to migratory as well as resident wetland wildlife; however, the earthen dams constructed for this purpose were washed out during the recent floods.

Existing Vegetation. The project area contains a groundwater regime that is comprised of two groundwater parts, as described in "Physical Factors." The division between the eastern and western groundwater parts extends northward from Monument Hill at approximately 115th Avenue. Because the difference in groundwater level between the eastern and western areas results in contrasting vegetative distribution, these areas are discussed separately.

o Eastern Part - At present, surface flow and depth to groundwater appear to influence both areal extent and species composition of riparian vegetation in this area. This area is characterized by deeper groundwater levels than those found in the western area, although at present they are probably near the surface due to recent flooding and other recharge; levels are approximately ten feet near 115th Avenue and generally range from 10-20 feet beneath the Salt River channel upstream to about 91st Avenue. In general, the ground-

water level declines about seven feet per mile upstream from 115th Avenue to an approximate depth of 70 feet at the 23rd Avenue Plant (Schmidt, 1980).

The relatively deep water table of the eastern part of the groundwater regime is unattainable by many plant species. Table 2-7 shows the maximum root depths for mature cottonwood, willow, and saltcedar. Cottonwood roots are not known to reach down farther than 25-30 feet, while willow does not extend below 15 feet to groundwater (Robinson, 1958), and seven feet is more likely (Zimmerman, 1969). Unlike cottonwood and willow, the roots of saltcedar may reach relatively deep groundwater levels of approximately 30-60 feet (Water Resource Associates, 1975). However, these depths are for established trees. Younger trees and seedlings require shallow groundwater and/or surface flows.

As a result, between 91st and 115th Avenues, willow and cottonwood trees are primarily restricted to areas adjacent to surface water flow. No willow trees exist away from the surface flow. Saltcedar is found growing in dense stands near surface water and also in areas not watered by surface flows. These latter areas are characterized by dry surface soil and, as discussed, a relatively deep water table (approximately 10-20 feet).

Although the minimum surface flow necessary for the maintenance of riparian vegetation in this area is not known, these flows directly impact adjacent vegetation and help to maintain higher groundwater levels.

A report is presently being completed by the U.S. Fish and Wildlife Service on the stream flow effects on maintenance of cottonwood for the Verde River. Further studies would be necessary to determine a theoretical minimum flow essential for maintaining riparian tree species in this area. These

TABLE 2-7
ROOT DEPTHS AND EVAPOTRANSPIRATION RATES

Species	Location	Depth to Water Table	Maximum Root Depth	Average Tree Height	Evapotranspiration Rate (acre feet/acre/year)	Source
Cottonwood	Safford Valley, AZ	7 ft.	25-30 ft.	no data	6.0 (100% volume density)	Gatewood et al. 1950 and Turner, 1951
	San Luis Rey River, CA	4 ft.			5.2 (100% volume density)	Muckel et al. 1945
		3 ft.			8.1 (100% volume density)	
Willow	Safford Valley, AZ	7 ft.	< 15 ft.	no data	6.0 (100% volume density)	Gatewood et al. 1950 and Turner, 1951
	Winnemucca, NV	4 ft. (Alkali conditions)			3.03 (less than 100% volume density)	Robinson, 1970
	Safford Valley, AZ	∧ 7 ft.		13 ft.	7.2 (100% volume density)	Gatewood et al. 1950 and Turner, 1951
	Safford Valley	4.0		13 ft.	9.2 (100% volume density)	Gatewood et al. 1950
Tamarisk or Saltcedar	Safford Valley	8.0	30-60 ft.	13 ft.	7.0 (100% volume density)	
	23rd Avenue to Gillespie	Taken into account		Taken into account	5.5 (75-100% areal density)	Water Resource Associates, 8/75
	23rd Avenue to Gillespie	Taken into account		Taken into account	4.5 (50-75% areal density)	
	23rd Avenue to Gillespie	Taken into account		Taken into account	2.9 (25-50% areal density)	
	23rd Avenue to Gillespie	Taken into account		Taken into account	1.0 (10-25% areal density)	

studies would include a tree count, densities, a determination of evapotranspiration rates for individual species, percolation rate of a surface water flow, depth to water table and surface water evapotranspiration rates. Table 2-7 presents evapotranspiration rates calculated for several arid areas. The rates show considerable variation both between species and areas depending on several factors. Therefore, an accurate determination of the rates for this project area would require site specific analysis.

o Western Part - In general, the vegetation in the western part of the project area appears to be supported more by readily accessible groundwater than by surface flow. The subsurface geologic characteristics of this portion of the project area favor shallow groundwater levels. As a result, the western part is characterized by groundwater levels at or near the elevation of the Gila River channel. These levels have remained relatively shallow because of comparatively small amounts of pumpage and continued flows for recharge to the groundwater (Schmidt, 1980).

In this area, willow and cottonwood trees, as well as saltcedar, are found growing near the surface water flow. Saltcedar stands are also extensive in areas away from the surface flow and include relatively large willow trees. Just east of Bullard Avenue, individual willow trees are found growing throughout the river channel in areas devoid of surface flow. The existence of these willows in the absence of surface flow reflects high groundwater levels in that willow roots have been found to descend to groundwater only seven feet or less in most cases (Zimmerman, 1969). It may be concluded that once the willow is established, its maintenance becomes dependent on a shallow groundwater table. Overall, the vegetation appears to be supported more by groundwater levels than

by surface flow. However, as noted previously, surface water recharge is a factor in the maintenance of groundwater levels.

Future Vegetation. The future of riparian vegetation in the project area will depend on both groundwater levels and surface flows. Issues of public concern deal with both the maintenance of riparian habitat and the impacts of effluent discharge on that habitat.

The impacts of the two effluent discharge conditions on riparian habitat are addressed in the following discussion. The first condition of effluent discharge reflects the impacts of minimum discharge assuming only 6.52 mgd of effluent for AGFD discharged into the Salt River. The second effluent condition assumes discharge into the river of the remaining effluent not used for existing effluent reuse commitments. This condition would result in effluent discharge to the river decreasing from 90 mgd annual average flow in 1980 to approximately 20.2 mgd annual average flow in 1986 based on flow projections provided in the 91st Avenue Plant Expansion Draft Facility Plan. Annual average flow then increases to about 35.2 mgd by the year 2000.

The reduction in effluent discharge which will occur under either condition will affect the eastern and western parts of the project area differently because of the unequal groundwater levels. The minimum monthly flow expected to occur in 1986 under the first discharge condition is 26.8 mgd (minimum baseline river flow of 20.3 mgd plus effluent discharge of 6.5 mgd). It is expected that surface flow should not terminate within the project area.

- Eastern Part - Due to the relatively deep groundwater levels, vegetation in the eastern area depends on surface flow to a greater extent than in the western area where groundwater is higher and more accessible to the vegetation.

Under the first condition, the reduction in annual average stream flow due to total effluent reuse may impact vegetation adjacent to the surface water due to a general reduction in soil saturation. Therefore, vegetation which depends on soil saturation from surface flow may be expected to thin and become distributed in closer proximity to the river channel. Much of the saltcedar located in the eastern part is growing away from surface waters and has been noted as primarily supported by groundwater. This saltcedar would not be expected to be significantly impacted by the reduction in stream flow. Surface flow should continue to provide adequate moisture for the germination and seedling establishment of riparian tree species adjacent to the channel.

Based on a report by Turner (1974), a significant change in the establishment of riparian vegetation is not expected to occur as a result of seasonal fluctuations in effluent discharge due to the commencement of reuse allocations. Turner states that "In terms of physiologic requirements for water, the establishment of riparian species is not directly related to the amount of stream discharge." If the alluvium is fully saturated, an increase in flow from 50 cubic feet per second to 5,000 cubic feet per second is unimportant to riparian seedling establishment. More important to the vegetation is the duration of flow during critical growth periods such as germination and seedling establishment in the spring and summer (Turner, 1974).

As depicted in Figure 2-3, under the first condition monthly average flows are expected to remain constant in the spring and increase through the summer, which corresponds to the period of germination and seedling establishment. Cottonwood produces seeds from mid-March to mid-April. A high groundwater level and bare, sandy soil, especially newly deposited alluvial soil, appear

to be optimal for germination and seedling development (Ohmart, 1977); willow apparently requires similar conditions for seedling establishment and germination (personal communication, Ohmart, 1980). During the summer and fall when water requirements of vegetation are the greatest, the seasonal fluctuation of the baseline river flow will result in the greatest monthly flows. As a result, the seasonal variability in surface flow is not expected to significantly alter the germination, seedling establishment, or maintenance of the cottonwood, willow, or aquatic organisms in the eastern portion of the project area. Aquatic organisms should be maintained during low flows since those flows are not expected to terminate before Buckeye Heading.

Similarly, in this area saltcedar is not expected to be impacted by the seasonal variation in surface flow. Saltcedar produces seeds from mid-April to October, with peak distribution of viable seeds in June and July (Merkel et al, 1957). Germination occurs on water, generally in less than 24 hours. Very moist conditions are required for satisfactory germination and seedling establishment and for the first two to four weeks of growth. The necessary conditions may be produced by soil saturation from a surface water or capillary flow to the surface in a high groundwater area (personal communication, Turner 1980). The combination of warm, moist, bare soil, especially that left by receding surface flows, is ideal for saltcedar establishment (Horton et al, 1960). These conditions, which are favorable for the germination of saltcedar, should not be significantly affected by variation in seasonal flows due to a discharge of 6.52 mgd.

In general, the greatest impacts in the eastern area under the first condition should result from the expected reduction in soil saturation due to a

decrease in average annual stream flow. As a result, a thinning of vegetation adjacent to the channel may be expected to occur. Seasonal variation in stream flow should not significantly affect the cottonwood, willow, or saltcedar.

Under the second effluent discharge condition, the reduction in annual average flow from the current 90 mgd to approximately 20.2 mgd should result in impacts similar to those noted above for the first condition. Based on annual average flow, the reduction in yearly surface water quantity could result in decreased soil saturation and a thinning of the vegetation associated with the river channel (cottonwood and willow). The thinning of vegetation is not expected to be as great as that which could occur under the first condition due to the relatively greater stream flow and area of saturated soil occurring in the second condition. Saltcedar is not expected to be significantly affected by the reduction of annual average stream flow in the eastern area because of its ability to reach the lower groundwater table once established.

Seasonal variation in surface flows under the second condition will result in a greater quantity of water available for vegetation during the spring months relative to the amount available in the first condition (see Figure 2-3). The relatively greater surface flow in the spring could result in more germination and seedling establishment of cottonwood and willow along the river channel over that expected in the 6.52 mgd discharge condition due to the larger area of saturated soil.

In summary, within the eastern area, the second effluent discharge condition could result in a thinning and redistribution of riparian vegetation in closer proximity to the river channel due to an expected reduction in soil

saturation over present conditions. However, these impacts are not expected to be as extreme as the effects of the first effluent discharge condition. Seasonal variation in stream flows could enable more germination and seedling establishment of river channel vegetation than the first effluent condition due to greater surface flows in the spring. Saltcedar should not be significantly impacted by either the reduction in annual average flow or the seasonal variability in surface flow under the second condition.

o Western Part - Vegetation in the western part is supported by groundwater to a greater extent than in the eastern part. Currently, groundwater levels are shallow, 5 feet or less, and are expected to remain shallow unless some new large-scale pumpage is developed (Schmidt, 1980). As with the eastern area, the groundwater level in the western area is recharged by flood flows, effluent and other flows. Based on root depths, the groundwater level in the western area is high enough to support cottonwood, willow, or saltcedar. As a result, these vegetative types could be maintained in portions of the western part where surface water does not exist.

Under the first effluent condition (effluent discharge reduced to 6.52 mgd), based on annual average stream flow, the existing vegetation west of approximately 115th Avenue is not expected to be significantly affected. The reduction in surface flows associated with a loss of effluent in this area would probably not appreciably affect the survival and growth of present riparian vegetation because of the shallow depth to groundwater. Both established native and exotic tree species can effectively obtain water for maintenance and growth from the present groundwater.

In general, throughout the western part, an annual reduction in surface flow west of 115th Avenue should not preclude riparian tree germination and seedling establishment. If the groundwater remains high, low sandy spots would continue to provide conditions necessary for seedling establishment.

The seasonal variation in surface flows is not expected to affect the germination, seedling establishment, or maintenance of cottonwood, willow, saltcedar or aquatic organisms in the western part of the project area. Aquatic organisms should be maintained during low water flows since those flows are not expected to terminate before Buckeye Heading. As discussed under "Eastern Part" monthly average flows are expected to remain constant or increase throughout the spring enabling germination and seedling establishment. The increased flows occurring in spring or summer could be beneficial to the growth and reproduction of the riparian tree species in the area because this is a period of active growth for them. Most riparian species are deciduous (drop their leaves in the winter) and would have a reduced water requirement during the winter months. In the absence of a drop in groundwater as a result of new pumping, there should be sufficient water present during spring and summer to allow maintenance and new growth of riparian vegetation from 115th Avenue to the Buckeye Heading.

The effects of the second effluent discharge condition on vegetation in the western area are expected to be similar to those of the first condition. In general, the second effluent condition would probably not appreciably affect the survival and growth of present riparian vegetation. The shallow depth to groundwater enables both established native and exotic tree species to effectively obtain water for maintenance and growth.

Seasonal variation in surface flows under the second condition will result in greater amounts of surface water available for vegetation during the spring months over the quantities available in the 6.52 mgd effluent discharge condition (see Figure 2-3). The relatively greater surface flow in the spring could result in more germination and seedling establishment of cottonwood and willow along the river channel over that expected in the first discharge condition due to the larger area of saturated soil. Saltcedar is not expected to be significantly affected by seasonal variation in stream flow under the second condition.

SOCIOECONOMIC FACTORS

Socioeconomic factors addressed in this assessment concern flooding, institutional arrangements, public health considerations, and nuisance insect problems. The following discussion includes an analysis of flooding within the project area in terms of both historical documentation and current potential. Under "Institutional Arrangements," the floodplain regulations of Maricopa County are described as well as the effluent reuse commitmens of the Multi-cities. Future effluent reuse potential is then addressed. After a discussion on public health regarding potential surface and groundwater contamination from effluent, the role of effluent in nuisance insect problems is described.

FLOODING: A major issue raised by residents in the project area is flooding. The concern that riparian vegetative growth contributes to floodwater spreading is discussed in this section.

General. Presently, upstream impoundments provide water conservation as a primary objective and as such do not provide storage for downstream flood

protection. Flooding in the project area differs in summer and winter; historically, floods have most often occurred in the winter (from November to April). In 1978, 1979, and 1980, above average rainfall resulted in major winter storm flooding. Summer thunderstorms, formed in the Gulf of Mexico, sometimes result in flooding, but they seldom produce enough runoff volume to create serious problems. Flooding from such summer storms is normally confined to small areas and is of short duration. Major historical floods in the Salt River are shown on Table 2-8.

Flooding is expected to occur when the natural channel flow capacity is exceeded, resulting in overflow and inundation of the low lands, which are characteristic of the river channel in the project area. Damages to residential, commercial and agricultural areas depend on the extent of those land uses within the floodplain. Determination of floodwater spreading under various flood flow conditions requires the application of hydrologic and hydraulic principles to the physical conditions which exist in the river channel and overbank areas. In brief, the ability of the river to pass a given flood flow is a function of channel area, depth, slope, and characteristics of the boundaries of the channel, all of which change with time.

The basic information required for a flooding assessment includes estimates of flow in a river under specific hydrologic conditions, determination of the geometry of the river channel at all locations where changes occur, determination of "roughness coefficients" for each river section, determination of backwater effects, and relating the water levels to topography in the floodplain area. A more detailed discussion is available from the U.S. Army Corps of Engineers (1975).

TABLE 2-8
HISTORICAL FLOODS ON THE SALT RIVER

Date	Flood Peak (cfs)
February 1891	300,000
April 1895	115,000
November 27, 1905	200,000
January 19-20, 1916	120,000
January 29-30, 1916	105,000
February 1920	130,000
March 1938	85,000
March 1941	40,000
December 1965-January 1966*	67,000
February 21-May 29, 1973*	22,000
March 2, 1978*	122,000
December 19, 1978*	140,000
January 19, 1979*	88,000
March 29, 1979*	67,400
February, 16, 1980	170,000

Data for early floods obtained from the Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona. U.S. Army Corps of Engineers, Los Angeles District, 1957.

*Data for recent floods obtained from the U.S. Geological Survey, measured at 48th Street and the Salt River (figures are preliminary and subject to revision).

Although a reliable determination of potential flood damage can be made from data collected at a particular time, if certain physical changes occur, the potential for flooding will be altered. Physical changes in the floodway which alter flooding potential include:

1. Encroachment of vegetation, which may cuase a reduction in flow velocity and the deposition of sediment.
2. Scouring of river banks and the channel bottom, and the deposition of suspended materials by an intervening flood, which could result in channel migration and changes in channel hydraulic capacity.
3. Saturation of floodway soils from an intervening flood, preventing groundwater recharge that might otherwise occur and reduce total flood volume.
4. Roadway construction or placement of obstructions in the river channel or floodway which could reduce the hydraulic capacity, causing backwater effects and eventual floodwater spreading.

The project area has experienced a series of floods of varying intensities through the years (see Table 2-8). The flood flows and estimated recurrence intervals, as used by the U.S. Department of Housing and Urban Development, are as follows:

Recurrence Interval	Peak Flow (cfs)
100 years	210,000
50 years	160,000
10 years	37,000

Analysis of Past and Recent Flooding. As discussed above, a number of factors may contribute to changes in flooding potential over time. The flooding issue in the project area centers on the effect of the recent (late 1960's) re-encroachment of saltcedar into the area and its relative impact on

the river's capability to pass flood flows. This concern is apparently based on observations of flood flows in the mid-1960's, which resulted in minor damages, compared to the floods of 1978, 1979, and 1980, which caused more extensive damages. To address this concern, an analysis was conducted to determine the relative changes in the river channel and intensities of the flow which could account for the differences in the flood spreading.

The flood of 1965-66 came after a long period of stability in the river channel. According to the flood history (Table 2-9), the most recent flood prior to this time was in 1941 and was less intense, at 40,000 cubic feet per second (cfs). As stated in the groundwater discussion, the 25 year span was characterized by a loss in a constant surface flow marked by an extensive decline in the groundwater level. Channel stability may have affected the peak flood flow. According to Aldridge (1970, pp. 160-168), the peak flood flow for the 1965-66 flood at Granite Reef Dam was 67,000 cfs and by the time the flow reached Gillespie Dam the peak was reduced to 64,000 cfs. Flow data for a mid-point of 66,000 cfs was determined at the Joint Head Dam on 48th Street. The 66,000 cfs flow was used in the analysis to indicate the peak flow in the project area.

Documentation of flood damages and area of inundation for the 1965-66 flood was not available for the project area; therefore, interpretation of aerial photographs was necessary to determine the amount of land inundated by the 1965-66 flood flow. The photos indicate that the 1965-66 (66,000 cfs) flood would have reached the southernmost border of the present Holly Acres subdivision.

As part of the analysis, the 1965-66 flood was compared to the March 1979 flood with a flow of 68,000 cfs (including 600-700 cfs from the Gila and Santa Cruz Rivers). The March 1979 flood flow was chosen for comparison with the 1965-66 flood because peak flows were similar and a comparison of 1964 aerial photographs with 1979 aerial photographs shows a relative abundance of riparian vegetation in 1979 as opposed to sparse growth in 1964, prior to the 1965-66 flood. The flood of March 1979, according to residents, may have caused some spreading of flood water into the southernmost boundary of the Holly Acres subdivision. This was confirmed by aerial photographs, which showed the increased area of inundation was not great. The comparison, however, proved to be inconclusive without the availability of flood hydrographs, channel topography prior to the flood, and quantifiable flood spreading records.

Factors Affecting Flooding. While the comparison of past and recent flooding proved inconclusive due to lack of quantified information, analysis and investigations identified several factors which may influence floodwater spreading that were found to be in effect during the 1978-80 floods (Table 2-9). These factors were not found to be a part of the 1965-66 flood.

o Vegetation - One of the factors centers around the controversy of the impacts caused by saltcedar in the floodplain. According to Robinson (1958), when saltcedar has become established in a floodplain, there is 1) a depletion of stream flow, 2) an increase in the area inundated by floods, and 3) an increase in deposition of sediment in the areas of saltcedar growth. According to Eakin and Brown (1939, p. 17),

> When...the sediment load of the floodwater is high, there is deposition of sediment in the area of phreatophyte infestation as a result of the

> lower velocity. Such conditions exist along nearly all streams where there is saltcedar infestation, but are particularly prevalent along the Gila and Salt Rivers in Arizona...The preatophytes responsible were largely saltcedar and baccharis. In 1954 the writer observed a deposit of silt 4 to 5 feet thick on the flood plain of the Gila River in an area of dense saltcedar growth. This deposit, so far as could be determined, was formed by a single flood a few years earlier.

Riparian vegetative species such as saltcedar are known to produce a resistance to flow and a stability of the floodplain boundary (Graf, 1978). Due to saltcedar's morphology, it produces dense stands of vegetation which would characteristically decrease flow velocities through the areas of dense growth. This could cause an increase in deposition of sediment carried by previous flood flows. This phenomenon was observed by Burkham (1971) along the Upper Gila River in Safford Valley, where sediment islands and sandbars were formed in areas of low velocity. In terms of changes in the stream channel, however, Burkham concluded that large flood flows were the main cause of the widening of the stream channel and that floodplain vegetation may have been a minor contributing factor.

o Obstructions - To determine further possible changes in the area that may cause increased flooding, a field investigation of the floodway was conducted to determine any natural and/or man-made obstructions which could result in increased backwaters which were not in effect during the 1965-66 flood. The most notable influence appears to be the placement of a landfill in the center of the floodway. In 1973, Maricopa County Highway Department leased a segment of the river channel from the State Land Department to dispose of solid waste. The landfill was located along the eastern edge of El Mirage Road about 2,000 feet south of the Holly Acres subdivision. The landfill

covered about 20 acres of surface area and was later closed in 1977 due to flooding. However, the surface elevation of the abandoned landfill remains approximately 4 to 5 feet (elevation 934±, USGS) above the surrounding channel. Aerial photos taken during the March 1979 flood indicate that the flood outlined the landfill periphery with negligible cresting, and the landfill apparently continued to divert flows while the flood receded. Initially, this removal of floodway capacity would be expected to cause flow diversion and increased backwater, which could result in increased flooding. A reliable determination of this effect would require a detailed hydraulic analysis of this segment of the channel.

Another structural occurrence in the river is roadways; however, these culverted road crossings may not contribute significantly to a backwater effect, since they are washed out at very low flows (personal communication, ADOT, 1980).

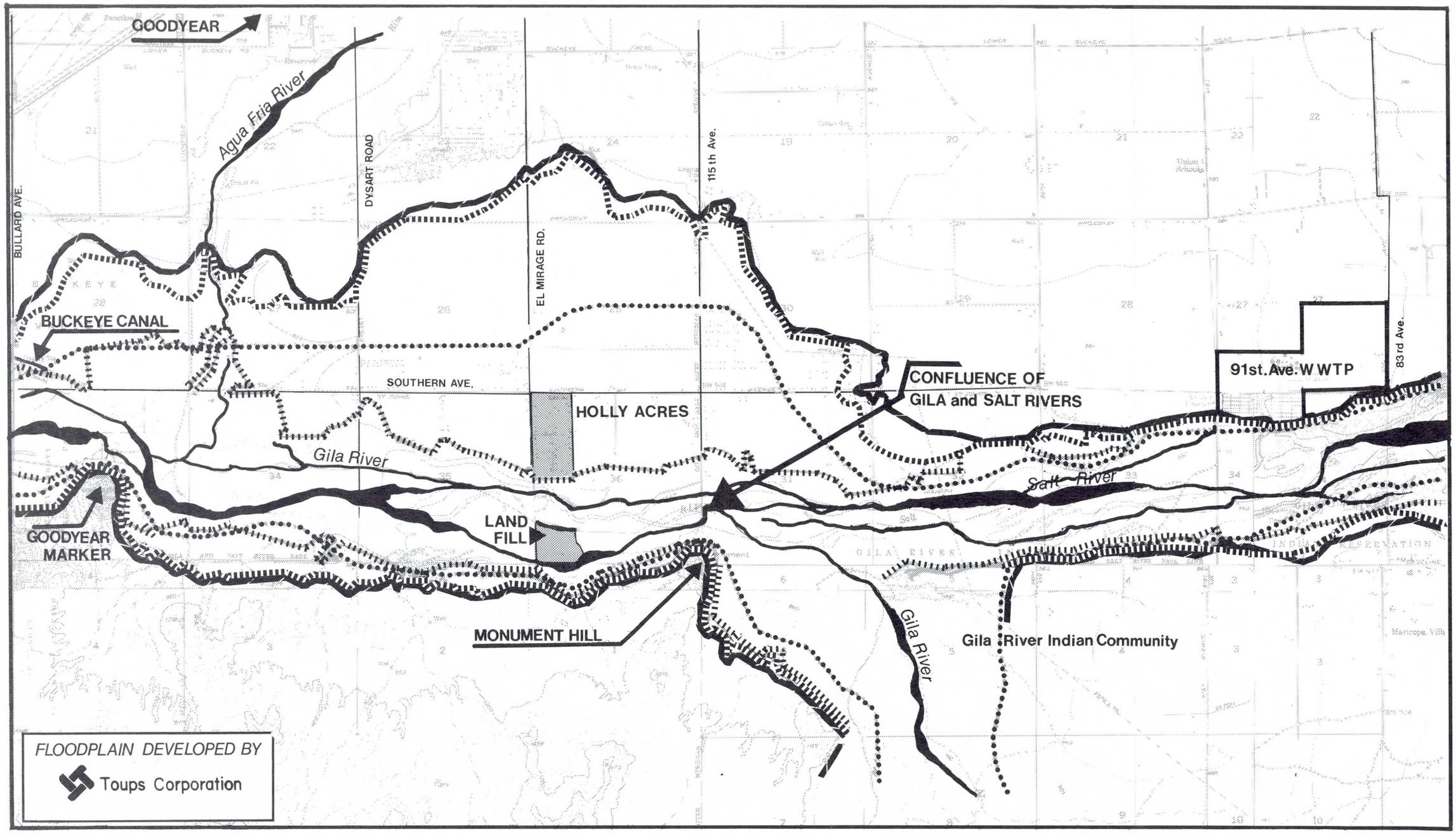
Conclusions. Several conclusions could be made about the recent flooding events, their corresponding changes in the river channel and the overall impact on floodwater spreading. As previously stated, topography and basic channel hydraulic capacity are of primary importance in the conveyance of flood flows. Plate 2-3 shows the location of the Holly Acres subdivision in relation to flood-prone areas; the expected frequency of flooding to the subdivision would be between 10 and 50 years. It should be noted that these relative lines of flood frequency change with time. Such changes occur as a result of alteration in actual river channel capacity, such as increased channel depth from scouring or widening of the floodway by a previous flooding event. It should be further noted that the flood frequency map (Plate 2-3) is

based on the most up-to-date (1976) topography, which may have changed due to the more recent floods. Therefore, location with respect to these floodplains should be used primarily as an indication of flood frequency.

The information indicates that numerous factors could affect floodwater spreading and the degree of damage that results. The most significant of these is the intensity of the flood flow and the location of development in relation to the corresponding floodplain. This relationship most adequately explains the reason for the higher levels of flood-related damages in 1978-79 than in 1965-66.

Plate 2-3 provides the relative frequency of flooding and the location of area development relative to flood-prone areas. To determine the correlation between the most recent floods and the expected areas of inundation, the following information should be used: Table 2-8 provides the peak flows for the recent floods. The largest of these floods (170,000 cfs) occurred in February 1980. The December 1978 flood of 140,000 cfs caused extensive damage to the Holly Acres subdivision. This flow corresponds roughly with the HUD flood frequency curve for a 50-year event at 160,000 cfs. Plate 2-3 shows the areas of land that would be inundated by a 50-year flood; a comparison can be made to locate the expected areas of inundation for the 140,000 cfs flood of December 1978.

The area within the boundary of the 50-year flood designation is characteristically a lowland area, located at the confluence of three major rivers. The indication would therefore be that these topographical characteristics and the location of the development appear to be influential in the extent and significance of area flooding.



(Based on 1976 topography)

- FLOODWAY
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD

PLATE 2-3
PROJECT AREA
FLOOD AREAS

arthur beard engineers, Inc. / CAMP DRESSER & McKEE INC.

In order to minimize flooding potential, a floodplain management plan was developed for the purposes of the Flood Insurance Program (HUD, 1979). One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. Included in the plan was the concept of a floodway which is used as a tool to assist local communities in determining future land uses. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100 year flood can be carried without substantial increases in flood heights. Figure 2-5 represents the concept of the floodway and Plate 2-3 indicates its relative location in the project area.

Based on this assessment, neither effluent discharge condition would create a significant change in present flooding potentials in the project area.

INSTITUTIONAL ARRANGEMENTS:

Floodplain Regulations. The "1975 Floodplain Regulations for the Unincorporated Area of Maricopa County," adopted by the Floodplain Board on July 14, 1975, and amended on October 17, 1977, is a two-district floodplain regulation intended to prevent the dangerous and expensive misuse of floodplains in the county. This regulation divides the Regulatory Floodplain (100 year floodplain) into two areas. The first area, the Floodway District, restricts development to uses which are not susceptible to severe or expensive flood damage and which do not obstruct the flow of flood water. In the Floodway Fringe District, the second area, development must be protected from the 100 year flood either

by floodproofing or by elevating items susceptible to flood damage so that they are above the flood elevations. The majority of the residential areas within the project area along Southern Avenue, including Holly Acres, are within the Floodway District.

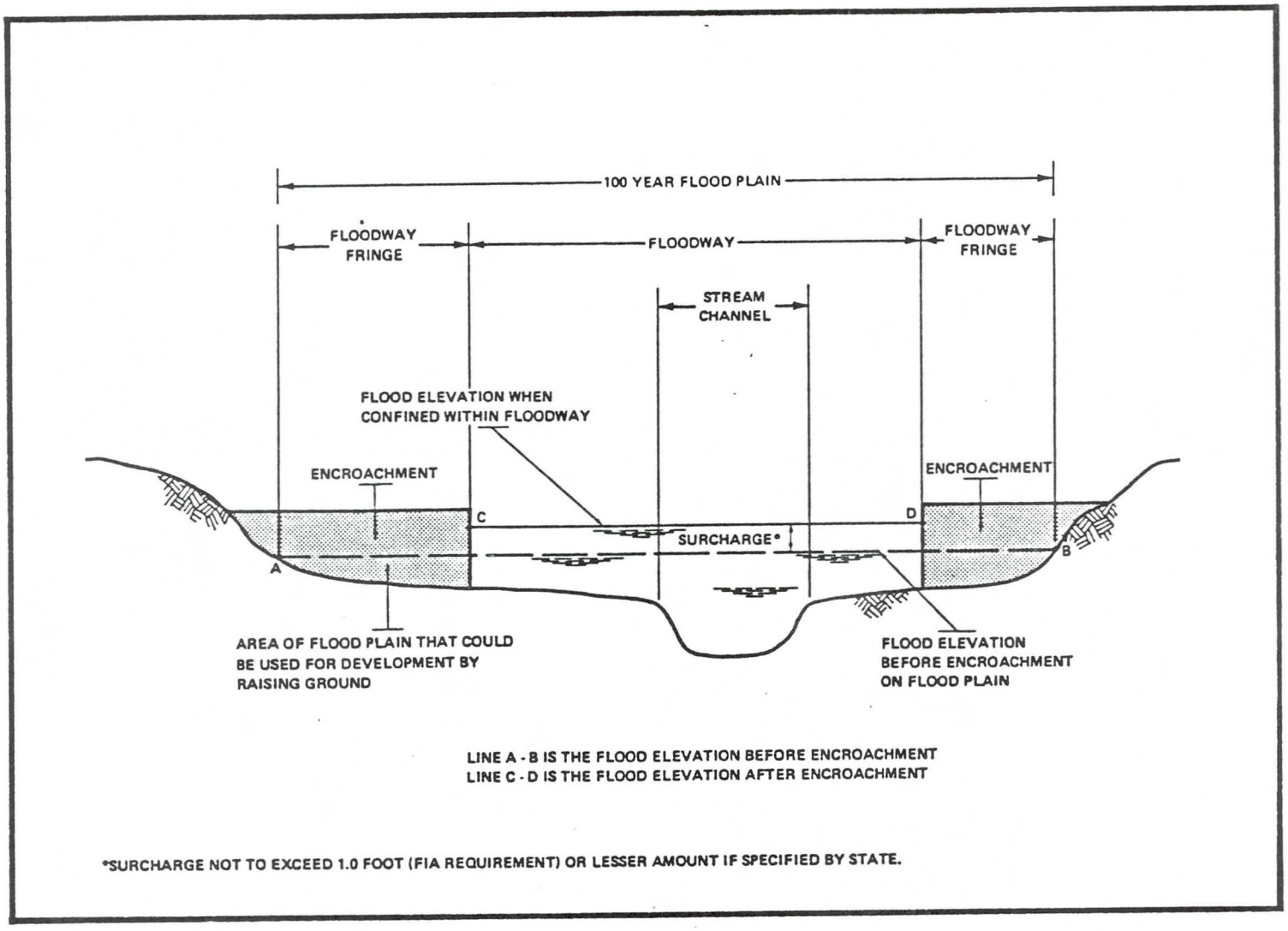
EFFLUENT REUSE:

Existing Reuse Commitments. The Multi-cities, either singly or jointly, have agreed to supply treatment plant effluent from the 91st Avenue Plant to the Arizona Game and Fish Department, the U.S. Department of Agriculture's Water Conservation Laboratory, the Buckeye Irrigation Company, and the Arizona Nuclear Power Project.

The City of Phoenix has agreed to provide the Arizona Game and Fish Department (AGFD) with 20 acre-feet per day (6.52 mgd) of effluent. The AGFD uses the plant effluent as a water supply for vegetative growth that serves as wildlife habitat. The effluent has been supplied to the AGFD through normal discharge into the Salt River with the rest of the plant effluent. This allocation of effluent to the AGFD is a non-contractual commitment.

A commitment of 1,200 acre-feet per year (1.07 mgd) was made to the United States Department of Agriculture's Water Conservation Laboratory for the Flushing Meadows Project. This advanced wastewater treatment research facility was located in the Salt River about one and one-half miles downstream of the 91st Avenue Plant until it was destroyed in the 1978-79 floods. Since there are no plans to reactivate this project, this 1.07 mgd flow is assumed to be available for reuse in this assessment.

The Salt and Gila River flows are drawn off by the Buckeye Canal at an area between Litchfield Road and Bullard Avenue for irrigation. In 1971, the



Source: HUD, 1979

FLOODWAY SCHEMATIC

Figure 2-5

City of Phoenix entered into a 40-year contract with the Buckeye Irrigation Company (BIC) to supply 30,000 acre-feet of effluent per year in monthly increments of 2,500 acre-feet (26.81 mgd). The effluent must be of sufficient quality to permit its use for irrigation of crops not intended for human consumption. Presently, the delivery of effluent to BIC has been by natural channel in the Salt River; however, they have made arrangements to obtain effluent from the plant through the same pipeline that will convey effluent to the Palo Verde Nuclear Generating Station.

A commitment for portions or all of the remaining effluent has been made by the cities of Glendale, Mesa, Phoenix, Scottsdale, Tempe, and Youngtown to the Arizona Public Service Company (APS) and the Salt River Project (SRP). The effluent is presently intended for use as cooling water at the Palo Verde Nuclear Generating Station (PVNGS) as part of the Arizona Nuclear Power Project (ANPP). The PVNGS flow requirements are expected to be approximately 107,000 acre-feet per year (95.6 mgd), which is about 21,400 acre-feet per year (19.1 mgd) for each of five power generating units. Although generating units four and five have been indefinitely delayed, the total commitment presently contracted under the Multi-cities/ANPP Agreement is 140,000 af/yr (125 mgd). This may be used at the Palo Verde Nuclear Generating Station or any other generating facility APS and/or SRP may choose. The contract expires 40 years after the date the last power generating unit is placed into operation or the year 2040, whichever comes first.

The previously described commitments to Arizona Game and Fish Department, the U.S. Water Conservation Laboratory, and the Buckeye Irrigation Company are

higher in priority than the ANPP commitment. Any effluent up to 125 mgd from the 91st Avenue Plant which is not previously committed to other users is to be committed to the ANPP. The 23rd Avenue Plant effluent may be used to fulfill remaining portions of commitment after all of the available supply of 91st Avenue Plant effluent has been allocated.

The effluent will be delivered to ANPP on or adjacent to the plant site. A pipeline is presently being constructed by ANPP which will be used to convey effluent from the 91st Avenue Plant to PVNGS. This pipeline will also convey effluent to the Buckeye Irrigation Company. The contract establishes effluent quality requirements on an annual average basis for three effluent constituents:

1. Phosphate - 60 mg/l
2. Suspended Solids - 30 mg/l
3. BOD_5 - 30 mg/l

The reuse of effluent is a major issue of public concern. Both short- and long-term plans are being developed by the Multi-cities in order to ensure its most beneficial use.

Effluent Reuse Potential. In terms of annual average flows, effluent discharge from the 91st Avenue Plant should be sufficient to meet the expected requirements of existing commitments until such time as the fourth PVNGS unit would become operational in 1988 (see Table 2-4). However, based on monthly average flows, after the third PVNGS unit becomes operational in May of 1986 all effluent from the 91st Avenue Plant is expected to be utilized by existing commitments, at least for short periods of time. Table 2-9 depicts total unused effluent from the 91st Avenue Plant projected for the year 1986.

TABLE 2-9
UNUSED EFFLUENT IN 1986
(MONTHLY AVERAGE FLOW)

1986 MONTH	91st AVENUE PLANT EFFLUENT FLOWS[1] (mgd)	COMMITTED EFFLUENT[1,2] (mgd)		REMAINING UNUSED EFFLUENT[3] (mgd)	
			(1987)		(1987)
January	96.6	59.5	72.8	37.1	23.8
February	99.8	58.9	73.5	40.9	26.3
March	101.9	72.3	91.8	29.6	10.1
April	101.9	73.5	93.6	28.4	8.3
May	102.9	99.6		3.3	
June	102.9	103.5		-0.6	
July	106.1	102.6		3.5	
August	108.2	102.6		5.6	
September	115.5	98.4		17.1	
October	112.4	96.3		16.1	
November	107.1	74.1		33.0	
December	105.0	87.0		18.0	

[1]See Appendix C.

[2]Includes allocations to AGFD, BIC, and ANPP.

[3]Flows derived from data presented in Appendix C.

SOURCE: ABE/CDM 1980.

In June of 1986, effluent from the 91st Avenue Plant will be insufficient to meet existing effluent commitments based on monthly average flow projections. In 1986, a monthly average of only approximately 3.0 mgd should be available for reuse from May through August.

The above discussion is based on expected effluent requirements assuming the operation of three PVNGS units which would require a total annual average of 58.0 mgd of effluent. However, as stated previously, the contractual agreement between the Multi-cities and the ANPP entitles the latter to a maximum of 140,000 acre-feet per year (125 mgd) of effluent. If the ANPP required the maximum quantity of effluent stipulated in the contract, all effluent from the 91st Avenue Plant through the year 2000 which is not previously committed to other users could be fully utilized by ANPP. Based on this assessment, effluent reuse potential beyond existing commitments appears uncertain and greatly dependent upon the requirements of ANPP.

PUBLIC HEALTH: Public health concerns have been expressed by residents of the Gila River Indian Community and others over potential effluent-impacted groundwater as a source of contamination to their potable water supply wells. However, those constituents of concern that have been tested and relate to effluent recharge, such as nitrates, were not found to be at levels that would create a public health impact (Schmidt, 1980). A monitoring program is necessary to further assess the concentrations of other constituents which may be present in the groundwater as a result of natural occurrences.

INSECTS: An additional public concern is that of insect problems in the vicinity of the 91st Avenue Plant. Insects which have been identified as being

associated with the effluent discharge are the Culex pipiens mosquitoes and Chironomid (bloodworm) midges.

In the Insect and Odor Report for the 91st Avenue Plant Expansion Facility Plan (ABE/CDM, 1980), large numbers of Culex pipiens were reported in stagnant pools of effluent and irrigation runoff water near the 91st Avenue Plant. However, these mosquitoes can breed wherever standing water exists for an extended time in the project area and generally do not disperse far from their breeding area. They are suspected vectors of viral encephalitis.

Midges of the genus Chironomus, known as bloodworm midges, were found to be especially numerous in the effluent channel with its high organic matter content. The effluent appears to significantly increase midge numbers by creating an optimum breeding habitat. It is likely that some of the midges breeding in effluent dominated areas are dispersing to areas away from the effluent. While they do not bite, midges can create a nuisance by swarming and clinging to sides of houses and eaves.

Mitigation of many insect problems is provided for in the Effluent Disinfection Facility Plan and the Minor Modifications Facility Plan. These facilities are scheduled for completion of construction by November 1, 1980, and October 1, 1981, respectively. Culex pipiens mosquitoes which breed in the effluent pools near the 91st Avenue Plant should be affected by the construction of disinfection and minor modifications facilities at the plant. The addition of scum removal to the clarifiers will diminish the larval food source by reducing the amount of organic matter deposited in the effluent and Salt River channels. Disinfection at the 91st Avenue Plant should also reduce

Culex breeding in the effluent channel by diminishing the food source for the larvae. However, the impacts noted above will be very localized and as such, Culex mosquitoes may still be expected to breed in significant numbers throughout the riparian habitat, agricultural area, and wherever standing water exists.

The addition of scum removal to the plant will reduce the number of breeding sites for midges by reducing the high organic substrate now being deposited in the effluent and Salt River channels. As described for the Culex mosquitoes, disinfection facilities at the 91st Avenue Plant will reduce the food source for these pollution-tolerant insects. The introduction of chlorine through disinfection should result in the reduction of midges by diminishing the quantity of microscopic organisms which are used as food by midge larvae.

In addition, the improved water quality resulting from these plant alterations would enable a greater diversity of insects to inhabit the effluent channel. The cleaner effluent would allow for the survival of more species and probably result in a more balanced community of organisms, including a decline of pollution-tolerant midges. Balance of community refers to the diversity of insect species found in natural communities. In a balanced community, one species would not normally reproduce in excessive numbers because of competition and predation.

Impacts Under First Condition. The reduction of effluent discharge to 6.52 mgd could diminish breeding sites for Culex mosquitoes. However, Culex mosquitoes may still be expected to breed in significant numbers throughout the riparian habitat, agricultural area, and where there is standing water.

With the expansion of the 91st Avenue Plant, there would be a net improvement in water quality over that resulting from the disinfection and minor modifications to the plant as noted above.

The primary advantage of the plant expansion in terms of impact on insects is the reduction in pollution, or high organic and nutrient content, in the water, factors which increase some species of pollution-tolerant insect populations. The cleaner effluent should result in a balanced community of organisms with no dominant nuisance species. As a result, the reduction of potential breeding sites and increased diversity of competing insect species should result in a decreased number of midges.

In addition, after the completion of minor modifications, effluent disinfection and plant expansion, the seasonal variations in effluent discharge and Salt River base flow should not impact nuisance insect populations, assuming ponding is avoided. Both Culex and midges exhibit peak breeding activity in the summer and fall; in summer, they require about ten or eleven days to complete their life cycle, depending on temperature, moisture and food. Under the 6.52 mgd effluent discharge condition a constant flow of water should be maintained in the Salt River during the insect breeding periods.

Impacts Under Second Condition. As noted above, minor modifications, effluent disinfection, and the plant expansion will significantly improve the quality of the effluent discharged from the 91st Avenue Plant. The improved water quality will decrease the number of C. pipiens and midges related to the effluent by diminishing their breeding habitat. The second effluent discharge condition should not result in significant breeding habitat. Since the quality

of the effluent appears to be a greater factor than effluent quantity in determining the potential for excessive breeding of nuisance insects, the impacts of discharging the remaining unused effluent are expected to be similar to those of discharging 6.52 mgd because both conditions will have cleaner effluent than that presently discharged from the plant. As described in the first effluent discharge condition, with the minor modifications, effluent disinfection and plant expansion, seasonal variations in effluent discharge and Salt River base flow should not impact nuisance insect populations.

CULTURAL FACTORS

Special concerns of area residents regarding insects, flooding attributable to vegetation, and public health are discussed under "Public Concerns Associated with Effluent Discharge" in the introduction to this assessment. In general, community life in the area should be enhanced by the improvement in the quality of effluent under both effluent discharge conditions. Impacts from improved effluent quality would primarily affect current insect problems associated with the effluent in that nuisance insect populations should decrease.

Concern has been expressed over degradation of riparian habitat due to reduction of surface flows. The MAG 208 Final EIS (USEPA, 1979) states that as a mitigation measure to this potential impact, adequate water supply must be assured for valuable wildlife habitat. Either of the two effluent discharge conditions would be expected to result in adequate surface water for vegetation in the portion of the project area west of 115th Avenue, since this vegetation is primarily dependent on the shallow groundwater. The minimum flow required to maintain the riparian vegetation east of 115th Avenue is not now known, however.

Recreational opportunities provided by hunting and bird-watching should not be significantly altered under either effluent condition in the area west of 115th Avenue. Those opportunities may, however, be affected by changes which could occur in riparian vegetation east of 115th Avenue.

SECTION 3
CONCLUSIONS

SECTION 3

CONCLUSIONS

This section presents the results and conclusions of this assessment in terms of the specific concerns presented in the introduction to this report. The conclusions have been based on information examined to date, including documents and correspondence presented in the list of references. Specific issues which require additional study are discussed in Section 4, "Issues to be Resolved."

WATER RESOURCES

Neither the first nor the second effluent condition is expected to appreciably impact project area surface water quality, groundwater quality or groundwater quantity. The most noticeable impact of the effluent discharge conditions would be on surface water quantity; a general reduction in the existing relatively consistent flow of effluent discharge into the Salt River may be expected. As a result, channel flow characteristics would shift under either effluent discharge condition to a more seasonally variable flow, primarily because the river flow would have a higher proportion of irrigation tailwaters. In terms of the general concentration of constituents, surface water quality should not be significantly altered. Groundwater quality and quantity, likewise, are not expected to be significantly altered.

The western portion of the project area exhibits a high groundwater elevation. This is due to a geological fault which results in a subsurface geologic characteristic which favors shallow groundwater levels. The depth to water

beneath the channel is important because it partially controls the amount of recharge that can occur from water in the channel. Typically, the shallower the water level, the less storage space there is for recharge. Therefore, no significant impact on the groundwater quantity in the western part would be expected by variation in effluent flow from the 91st Avenue Plant.

The eastern part of the project area has a somewhat greater depth to groundwater than the western part. Groundwater level in the eastern segment is dependent on recharge from flood flows, effluent, and other flows. In the first condition, 6.52 mgd annual average discharge, an estimated 1,500 acre-feet per year of recharge from 91st Avenue Plant effluent would be expected to occur, the majority which would be in the eastern part of the project area. During dry periods, water levels could decline at a rate of several feet per year in excess of that normally encountered during such periods (Appendix J; Schmidt, 1980). Under the second condition, an estimated 4,000 to 8,000 acre-feet per year (approximately 3.6 to 7.1 mgd annual average) of recharge from 91st Avenue Plant effluent would be expected to occur, primarily in the eastern part of the project area. Water levels may be expected to decline slightly in the long term under this alternative. The precise magnitude of this decline is unknown, but a rate less than one foot per year is likely (Appendix J; Schmidt, 1980).

In terms of groundwater quality, no significant change is likely to result within the western part from either effluent discharge condition. In the eastern part, under the 6.52 mgd effluent discharge condition, salinity of the groundwater could increase slightly due to the reduction in effluent recharge.

Under the second effluent reuse condition, however, the reduction in effluent discharge into the Salt River is not expected to significantly impact groundwater quality because of the small decrease in total groundwater recharge.

Seasonal fluctuations of effluent discharge caused by ANPP withdrawals are not expected to affect overall surface water or groundwater quality. Throughout the year, the combined flows of effluent discharge and the receiving streams ultimately dilute the various pollutants in each. Under the second condition, by 1986, seasonal fluctuations in effluent withdrawals are expected to result in the greater percentage of river flow being comprised of effluent during the winter months. During the summer, the river flow should be predominantly irrigation tailwater.

Therefore, although the overall surface water quality should remain relatively consistent, flows in the river during the winter may be expected to have relatively greater percentages of BOD, ammonia, and chloramine toxicity from the effluent. Summer flows should be comprised of higher percentages of total dissolved solids, total suspended solids, and elevated pH.

RIPARIAN VEGETATION AND WILDLIFE HABITAT

The 208 Final Environmental Impact Statement (USEPA, 1979) states that the riparian vegetation downstream of the 91st Avenue Plant must be assured an adequate water supply. Under either effluent condition, surface flows should be sufficient to maintain both exotic and native riparian vegetation west of 115th Avenue. This vegetation is primarily supported by shallow groundwater levels which are expected to remain stable as long as large-scale pumpage is not developed, and surface flows provide recharge. In general, east of 115th

Avenue, the riparian vegetation is more dependent on surface water flows and gross groundwater fluctuations than the vegetation located to the west. However, further investigation is necessary to determine the minimum surface flow required to maintain this eastern riparian vegetation. The decrease in annual average stream flow is expected to reduce the amount of saturated soil surface in either condition. This is expected to result in a thinning of native riparian vegetation associated with the river channel (cottonwood and willow) east of 115th Avenue.

Seasonal fluctuations caused by ANPP withdrawals should not have any significant effect on the vegetation, either native or exotic, or on aquatic organisms downstream of the 91st Avenue Plant. Flows during the winter are still expected to reach the Buckeye Heading.

FLOOD HAZARDS

Flooding in the project area is one of the major concerns of the local residents. Development in a flood-prone area is one of the most significant reasons for extensive flood damages. These flood-prone areas are most readily determined by the topography of the river channel and adjacent land and intensity of the flood flows. Flooding events are classified by using a specific rainfall quantification, the accumulated runoff to the river, and the capacity of the channel to convey the flow. These frequencies of occurrence are customarily ranked as 10, 50 and 100 year events. As discussed in the text, the exact location of these floodplains may change as does the channel topography. However, they do provide relative frequencies and areas prone to inundation. Plate 2-3 was derived from the most recent topographical data (1976) and should

provide a relatively accurate indication of those areas which would have been inundated by the recent floods.

Changes in the configuration of these floodplains could occur as a result of various factors. The most logical would be obstructions in the floodplain which would inadvertently reduce the channel capacity and increase the potential for overflow. One of the recent changes in the channel would be the addition of a sanitary landfill adjacent to Holly Acres. The contribution of the obstacle during high flood flows would not be expected to be great. A detailed hydraulic analysis would be required to determine the flows and corresponding effects.

The encroachment of saltcedar into the project area has been cited by area residents as the cause for increases in floodway damages they have experienced in recent years. This assertion appears to be based on observation of floods before and after the recent (1967) encroachment of saltcedar into the project area. According to Burkham (1976), "Vegetation growing on a river flood plain has a major effect on the characteristics of a major flood." This has been studied in great detail by the Gila River Phreatophyte Project of the U.S. Geological Survey.

A quantified determination of the effects of saltcedar on the increases in flooding was not possible based on the existing information analyzed as part of this assessment. However, during the course of this assessment, it was found through analysis of the 1965-66 flood of 66,000 cfs, flows would have reached the southern boundary of the portion of land which is now the Holly Acres subdivision. The floods which followed in March 1978 at 122,000 cfs, December 1978 at 140,000 cfs, and February 1980 at 170,000 cfs occurred

after the encroachment of saltcedar. Based on the low elevation of the area, the location at the confluence of three major rivers, and the relative location of development to the corresponding floodplain (as indicated on Plate 2-3), it appears that the greater intensity of the flood flow was the significant factor in the increase in flooded areas.

INSECTS

Neither of the two effluent discharge conditions should have any significant impact on nuisance insects. The current problems with the two nuisance insects associated with the effluent (*Culex* mosquitoes and midges) are expected to be mitigated through the construction of facilities identified in the *Minor Modifications*, *Effluent Disinfection*, and the *Plant Expansion Facility Plans* prior to the reduction in effluent discharge resulting from existing reuse commitments. In addition, seasonal fluctuations of the effluent discharge caused by ANPP withdrawals are not expected to have any effect on nuisance insect populations.

SECTION 4

ISSUES TO BE RESOLVED

SECTION 4

ISSUES TO BE RESOLVED

WATER RESOURCES

Historically, there has been a lack of both water-level measurements and groundwater quality monitoring in the southern portion of the project area. Therefore, the necessity exists for implementing a regular monitoring program for groundwater in the project area between Southern Avenue and Baseline Road. As a part of the monitoring program, water levels should be measured in wells less than 250 feet deep on a quarterly basis. Approximately one dozen existing wells, as close to the river as possible, should be selected for water-level measurements. In addition, about six monitor wells should be installed to fill gaps in the network. These wells should be about fifty feet deep and perforated from about ten feet below the static water level (in the absence of flood releases) to the bottom. Six-inch diameter PVC casing should be installed to allow water sample collection by submersible pumps. Water samples should be collected from this network on a quarterly basis and analyzed for the major inorganic chemical constituents: boron, fluoride, iron, manganese, chromium, arsenic, cadmium and dissolved organic carbon. Temperature, electrical conductivity and pH should be measured in the field. An extensive study of organic chemicals in groundwater of the south part of the project area could also be undertaken.

The data that would be collected could also be used in a more definitive assessment of riparian vegetation that is supported by the groundwater regime.

This data would also help assess any possible future impacts that could occur as a result of changes in groundwater depth.

The baseline river flow was determined using various parameters that were necessary in this assessment and are important to the downstream ecosystem. A more quantified determination of the baseline river flow would enable a more accurate assessment of the precise times and quantities of seasonal fluctuations that would occur in the project area. This could be accomplished by the gauging of flows through road culverts such as at 115th Avenue.

RIPARIAN VEGETATION AND WILDLIFE HABITAT

As stipulated in the MAG 208 Final EIS (USEPA, 1979), sufficient effluent should be discharged to ensure an adequate water supply for the riparian habitat. For the determination of the minimum flows necessary to support the vegetation, several factual aspects would have to be known. Of primary importance would be an updated areal and density quantification of the riparian habitat by species. As stated, quantified flow data on the irrigation tailwaters discharged to the project area would have to be known, particularly because these flows are so seasonally variable. Also needed would be determination of evapotranspiration rates for individual species, percolation rate of a surface water flow, depth to water table and surface water evapotranspiration rates, all on a site specific bases. In addition, a continuation of monitoring the groundwate level in the western portions of the project area is necessary. This would be used to monitor any possible decline caused by pumping which could impact the habitat.

With this data input the flows required to meet the consumptive use rate and the area evapotranspiration rate could be determined.

FLOOD HAZARDS

A number of studies are presently underway which can aid in the determination of flooding potential within the project area. The Central Arizona Water Control Study being conducted by the U. S. Water and Power Resources Service (WPRS) is addressing flood control in the Salt and Gila Rivers. As a part of this study, the Corps of Engineers is sponsoring investigations of phreatophytes (saltcedar) and channel stability in the Salt-Gila River project area. Specific parts of that study include:

- A literature search of phreatophyte control
- An investigation of phreatophyte invasion in the Salt-Gila project area
- Mapping of phreatophyte distribution in the project area
- A study of channel stability and changes in the river channel

Studies such as those noted above can contribute information to the eventual quantification of flooding potential and the influence of vegetation on flooding in the project area.

INSECTS

There are no additional issues to be resolved concerning the effects of the effluent discharge conditions on insects.

SECTION 5
PUBLIC PARTICIPATION

SECTION 5

PUBLIC PARTICIPATION

GENERAL

In response to the need to meet NPDES Permit requirements and concerns of the public, the Multi-cities initiated the Multi-city Facility Plan which included expansion and upgrading of the 91st Avenue plant, upgrading of the 23rd Avenue plant, disinfection at 23rd Avenue, and minor modifications and disinfection at the 91st Avenue plant. Subsequently, to meet deadlines imposed by the Consent Decree, the facility plan was broken out into several separate facility plans. Minor modifications and effluent disinfection at the 91st Avenue plant, disinfection at 23rd Avenue, expansion of the 91st Avenue plant, and upgrading of the 23rd Avenue plant are now complete.

A residuals management facility plan was also separated out because of schedule requirements. The plan has four phases:

- Sludge Solids Disposal/Reuse
- Scum, Screenings, and Grit Disposal/Reuse
- Effluent Discharge Assessment
- Effluent Reuse Study

This chapter describes the public participation activities for the effluent discharge assessment, including study development, response to comments, and other public participation activities.

STUDY DEVELOPMENT AND RESULTS

The effluent discharge assessment was a direct result of the public desire for a plan to manage the effluent discharged from the 91st and 23rd Avenue plants. Before any management plan could be developed, however, it was necessary to know the impacts of effluent discharge to the river. Therefore, the effluent discharge assessment was added to the scope of the residuals management facility plan. Based on existing data and through numerous contacts with affected communities and agencies involved in planning in the study area, the assessment was prepared. The results of the assessment were presented in the form of a working paper to the Water Quality Policy Advisory Committee. Upon review, the advisory committee had questions regarding the data contained in the report. Based on subsequent meetings with communities affected by the study and clarification of data from the report, the report was revised and presented again to the advisory committee. The advisory committee recommended acceptance of the report findings. The SROG Board concurred with the Committee recommendation.

Key meetings in this process were:

o July 19, 1979	Public Workshop - scope of work
o November 4, 1979	Tour of discharge assessment study area by consultants
o January 3, 1980	Holly Acres Community meeting - effluent discharge
o January 18, 1980	Gila River Indian Community meeting
o February 21, 1980	Gila River Indian Community meeting
o February 28, 1980	Advisory Committee meeting - overview of effluent discharge assessment
o March 3, 1980	Advisory Committee meeting - detailed response by consultants to comments on effluent discharge working paper

o March 11, 1980	Gila River Indian Community meeting
o March 13, 1980	Advisory Committee meeting - discussion of Gila River flows
o March 27, 1980	Advisory committee meeting - discrepancies discussed regarding Holly Acres and report
o April 11, 1980	SROG meeting - discuss report
o April 16, 1980	Holly Acres community meeting - effluent discharge
o April 24, 1980	Advisory Committee meeting - panel discussion of effluent discharge and its effects; advisory committee recommends acceptance of report
o April 25, 1980	SROG Board accepts effluent discharge study

OTHER PUBLIC INVOLVEMENT ACTIVITIES

Throughout the residuals management facility planning process, efforts were made to keep public and interested groups informed. A summary of these efforts follows.

Informational Materials

Summary brochures were prepared and distributed to the advisory committee and the public at key points in the study. These included:

o July 19, 1980	Summary Brochure - Residuals Management Facility Plan
o March 3, 1980	Detailed response summary addressing comments on effluent discharge assessment findings
o March 27, 1980	Response sheet comparing findings and clarifyi alleged discrepancies

In addition to these brochures and summaries, articles were published in CLEAN WATER, the MAG 208 Water Quality newsletter.

o September, 1979	"3-Phase Residuals Management Study to Begin"
o May/June, 1980	Article on panel discussion

Advertisements

o July 28, 1980	Legal advertisement of residuals management public hearing
o August 12, 1980	Display ads for residuals management public hearing

Public Hearing

A public hearing will be held in the Maricopa County Auditorium, 205 West Jefferson Street, in Phoenix, at 7:30 pm on September 10, 1980. Elected officials of each participating City and Town will serve as hearing officers.

EFFLUENT DISCHARGE ASSESSMENT FINDINGS

- Effluent discharge is not expected to appreciably impact surface water quality, groundwater quality or goundwater quantity. Surface water quantity will be reduced with more seasonally variables resulting.

- Salt cedar growth is present in the river bed. With removal of all by 6.54 mgd of effluent discharge to the river, no significant change in riparian vegetation is expected west of 115th Avenue. To the east of 115th Avenue, vegetation, depending on the surface water flow would be expected to thin and become distributed closer to the surface water channel. With a discharge reflecting existing reuse commitments (35.2 mgd by the year 2000), no significant changes would be expected to the west of 115th Avenue and to the east the thinning would be less than under the first discharge condition.

- Flooding in the area of the Holly Acres subdivision was addressed in the assessment. The quantification of the effects of salt cedar/ riparian vegetation on flood level increase was not possible based on the existing information analyzed as part of the assessment.

EXHIBIT A
CALCULATIONS

TABLE A-1
ESTIMATED WATER SUPPLY IN THE PROJECT AREA
(Acre-Feet/Year)

PROJECT AREA BASE FLOW:		
INFLOW -	Upstream Water Supply (Table 2-1)	6,350
	Other Effluent[1]	800
	Upper Gila River Flow[3]	15,361**
	Rainfall[1]	1,400
	Underflow[2]	3,500
	Groundwater Inflow[1]	1,700
	Irrigation Tailwater[4]	9,100
	AVERAGE FLOW*	38,211
91st AVENUE PLANT EFFLUENT:		
INFLOW -	Annual Average (90 mgd)	100,000

* Not Including Flood Flows on Salt River.

** The Gila River does not flow continuously. Refer to Fig. A-1, A-2, and A-3. 15,361 ac-ft/yr includes losses for percolation and evapotranspiration.

[1] USEPA, 1979.

[2] Halpenny and Clark, 1977.

[3] USGS Gauging Station (#9-4890, #9-4795) (20-year average, 1958-1977).

[4] Field Reconnaissance and Data Analysis.

TABLE A-2
FLOW CALCULATIONS FOR IRRIGATION TAILWATER

FLOWS IN AC. FT.	
7300	Enters just upstream of the project area from the south (SE¼, Sec. 35, T1N, R1E). Considered to be relatively constant contribution (Halpenny and Clark, 1977 and USEPA, 1979).
600	Consists of direct flows from the north side of the river entering at several points along the channel. See Table A-3. From Carriage Loss Study, SRP, 1980.
1200	This number represents tailwater which would reach the river from irrigable acreages directly adjacent to the channel. An estimated 2000 acres border the north and south banks of the channel. Based on the Arizona Water Commission report (1978), an average application rate for irrigation of about 6.1 feet per acre is used. Utilizing design parameters for land treatment of sewage effluent where application rates and runoff are strictly controlled, the amount of tailwater would vary between 10 and 40 percent of the applied flows (Metcalf and Eddy, 1979). At the lowest, a runoff coefficient of 10 percent, the contribution from these lands would be approximately 1200 acre-feet per year. These flows enter at various points along the channel as shown on Table A-3.
9120 acre-feet per year TOTAL	

TABLE A-3

INFLOW OF TAILWATER OR OTHER DRAINAGE WATER INTO SALT AND GILA RIVERS

(Halpenny and Clark 1975, Table 16)

Discharge Entering From[1]	Section	Township	Range
Right	NE¼24	1 N.	2 E.
Right	SE¼20	1 N.	2 E.
Right	NE¼30	1 N.	2 E.
Left	SE¼30	1 N.	2 E.
Right	SW¼25	1 N.	1 E.
Right	SE¼26	1 N.	1 E.
Right	SE¼26	1 N.	1 E.
Left	SE¼35	1 N.	1 E.
Left	NE¼6	1 S.	2 E.

1 Right and left facing downstream.

TABLE A-4
Calculations Used in Determining Gila River Contribution

acre feet per year

18,855 — Total combined flow of Gila and Santa Cruz as measured at USGS guaging station Laveen (#9-4890 and #9-4795) based on a 20-year average (1958-1977). The monthly flows on Table 2-2 are also based on a 20-year average.

- 3,768 — Percolation losses - Percolation rate: The total percolation rate applied against the Upper Gila River flow was derived from research conducted along several reaches of the Santa Cruz River (Burkham, 1970). The study produced a formula which was used as follows:

Infiltration Rate = C x L x (Flow Rate)$^{0.8}$

C = (0.11) (Variable coefficient derived from study)

L = 13 miles (Distance from guaging stations to Salt-Gila confluence)

(Flow Rate)$^{0.8}$ = (18,855 acre-ft/year)$^{0.8}$ (20-year annual average)

Infiltration Rate = 0.11 x (13) x (18,855)$^{0.8}$

Total for reach = 3,764 acre-feet per year

Monthly rates are given as 314 acre-feet per month. During 4 months, however, the percolation and evapotranspiration losses are greater than the flows. These months are therefore counted as zeroes, bringing the total loss to 2,512 acre-feet per year.

Evapotranspiration losses were figured on a monthly basis for the 13-mile stretch of the river from the guaging stations to the Salt/Gila confluence. This should account for losses incurred after the measurements were taken. A 150-foot-wide area across the channel was used as a basis. This was derived from measurements of aerial photographs of the Gila along that 13-mile stretch, and represents the average width of trees beside the channel in deeper groundwater areas. This acreage, 236 acres, was applied to a loss rate of 5.5 acre-feet per acre (Water Resource Associates, 1975) which is for dense growth (75-100% density) of saltcedar, in an area with similar depths to the water table. This results in a total of approximately 1,300 acre-feet per year lost to evapotranspiration.

- 1,300 — 150 ft x 5280 ft/mile = 792,000 x 13 miles = 10,296,000 ft
÷ 43,560 sq ft/acre = 236 acres x 5.5 loss rate = 1300 acre-feet/year

In order to determine how much of that loss might occur in each month of the year, percentages of monthly loss were figured. No standard percentages were available, so the data of Van Hylckama, 1974, working near Buckeye on the Gila were used. From several tanks, he obtained monthly losses by evapotranspiration. This data was used to derive an average percentage of loss for each month of the year.

Percentage of loss per month:

Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	
.01	.02	.02	.09	.16	.18	.16	.12	.11	.07	.04	.01	= .99

These percentages were applied against a total evapotranspiration rate of 1300 to derive:

Acre-feet per month loss:

Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	
13	26	26	117	208	234	208	156	143	91	52	13	= 1287 (approx. 1300)

This leaves a total remaining per month:

Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
820	1360	429	0	0	0	146	5408	2550	969	771	5553

Minus percolation losses:

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	
= 15,348 TOTAL	506	1046	115	0	0	0	0	5094	2236	655	457	5239	= 15,348 af/yr

% by month Gila expected to flow — In order to determine during which months in any year the Gila might be expected to flow, 36 years of data were examined. Each month which had a total flow of less than the combined evapotranspiration and percolation losses for that month was counted as zero, or not flowing. The percentages were derived from this. In other words, 15 out of 36 January's, or 42%, had flows during January.

SOURCE: Camp Dresser & McKee Inc. 1980.

TABLE A-5

page 1

UPPER GILA RIVER DISCHARGE IN ACRE-FEET FOR 1941-1978

YEAR	STATION	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG	SEPT	TOTAL
1940	-	-	-	-	-	-	-	-	-	-	-	-	-	*
1941	G	718	4,530	6,520	34,750	14,380	32,760	2,200	1,570	726	2,220	11,070	6,330	
	S	808	2,170	2,920	7,170	3,360	14,100	4,500	851	101	2,100	1,440	807	
	TOTAL	1,526	6,700	9,440	41,920	17,740	46,860	6,700	2,421	827	4,320	12,510	7,137	158,101
1942	G	762	1,430	4,230	1,800	1,150	964	807	817	290	300	817	567	
	S	278	383	1,340	1,530	321	375	668	179	61	2,090	628	49	
	TOTAL	1,040	1,813	5,570	3,300	1,471	1,339	1,475	996	351	2,390	1,445	616	21,836
1943	G	512	363	664	2,500	1,290	4,160	1,120	668	75	672	5,670	4,270	
	S	8.1	18	58	131	139	252	125	39	16	20	2,730	4,930	
	TOTAL	520	381	722	2,631	1,429	4,412	1,245	707	91	692	8,400	9,200	30,430
1944	G	680	585	1,380	1,720	1,390	1,460	859	545	417	399	4,150	845	
		81	28	340	115	1,130	460	182	375	49	81	403	554	
	TOTAL	761	613	1,720	1,835	2,520	1,920	1,041	920	466	480	4,553	1,399	18,228
1945	G	419	542	942	976	1,170	311	593	246	264	15	10,320	193	
	S	56	135	483	173	135	238	173	66	17	689	4,940	72	
	TOTAL	475	677	1,425	1,149	1,305	549	766	312	281	704	15,260	265	23,168
1946	G	2,300	563	1,280	1,400	992	643	603	301	125	349	1,660	5,440	
	S	593	17	51	1,190	111	184	270	92	78	2,620	1,720	33,950	
	TOTAL	2,893	580	1,331	2,590	1,103	827	873	393	203	2,969	3,380	39,390	56,532
1947	-	-	-	-	-	-	-	-	-	-	-	-	-	*
1948	-	-	-	-	-	-	-	-	-	-	-	-	-	*
1949	G	88	246	264	474	385	144	117	103	149	4,950	4,880	3,220	
	S	9.5	10	36	79	71	135	177	55	353	624	1,810	7,060	
	TOTAL	98	256	300	553	456	279	294	158	502	5,574	6,690	10,280	25,440
1950	G	85	518	625	199	354	118	17	171	56	5,400	5,380	126	
	S	23	11	57	89	220	177	145	44	23	1,010	2,710	165	
	TOTAL	108	529	682	288	574	295	162	215	79	6,410	8,090	291	17,723
1951	G	128	10	136	147	18	132	16	17	29	708	6,340	264	
	S	20	2.6	16	421	498	188	278	325	303	1,720	30,820	643	
	TOTAL	148	13	152	568	516	320	294	342	332	2,428	37,160	1,007	43,280
1952	G	6.3	6.3	0.8	7,380	762	208	67	34	1.0	422	1,760	17	
	S	194	60	61	159	117	660	1,180	597	411	2,170	3,840	952	
	TOTAL	200	66	62	7,539	879	868	1,247	632	412	2,592	5,600	969	21,065
1953	G	26	666	272	325	305	351	163	165	1.8	1,870	54	7.9	
	S	26	3,580	162	254	472	1,160	1,230	702	547	2,560	885	516	
	TOTAL	52	4,246	434	579	777	1,511	1,393	867	549	4,430	939	524	16,301
1954	G	0	0	0	0	1.6	2,860	134	3.4	0	6,000	39,630	2,290	
	S	66	14	39	126	149	321	331	128	100	2,690	4,950	469	
	TOTAL	66	14	39	126	151	3,181	465	131	100	8,690	44,580	2,759	60,302
1955	G	1.0	26	14	43	8.3	0	0	0	0	15,330	55,000	153	
	S	39	6.1	25	172	57	119	112	72	95	7,570	36,690	207	
	TOTAL	40	32	39	215	65	119	112	72	95	22,900	91,690	360	115,739
1956	G	0	0	19	101	24	0.8	0	3.4	4.6	0.8	0.8	0	
	S	1.4	5.2	0	218	90	99	124	82	3.8	268	75	59	
	TOTAL	1	5	19	319	114	100	124	85	8	269	76	59	
1957	G	0	0	0	493	0	11	1.8	0	0	91	597	0	
	S	34	0	8.3	34	76	148	137	84	11	266	1,000	71	
	TOTAL	34	0	8	527	76	159	139	84	11	357	1,597	71	3,063

continued

*Insufficient data available for 1940, 1947, and 1948.

UPPER GILA RIVER DISCHARGE IN ACRE FEET FOR 1941-1978, continued

page 2

YEAR	STATION	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	TOTAL
1958	G	56	1,040	0	.6	209	313	18	0	39	367	5,680	2,260	
	S	1,490	11,900	6.1	57	3,950	1,920	250	23	524	6.9	2,630	723	
	TOTAL	1,546	12,940	6	58	4,159	2,233	268	23	563	374	8,310	2,983	33,463
1959	G	59	0	0	0	0	0	0	0	0	2,040	4,020	0	
	S	0	0	0	0	13	74	12	8.9	5.6	699	12,570	40	
	TOTAL	59	0	0	0	13	74	12	9	6	2,739	16,590	40	19,542
1960	G	647	1,520	6,300	10,150	0	0	0	0	0	0	0	6.9	
	S	677	362	2,960	2,450	19	123	103	42	36	57	204	261	
	TOTAL	1,324	1,882	9,260	12,600	19	123	103	42	36	57	204	268	25,918
1961	G	0	0	0	0	0	0	0	0	0	180	2,300	1,140	
	S	275	0	0	0	0	.2	1	0	0	58	1,830	169	
	TOTAL	275	0	0	0	0	0	1	0	0	238	4,130	1,309	5,953
1961	G	0	0	3,430	840	0	0	0	0	0	0	0	0	
	S	0	0	38	155	42	64	6.9	0	55	93	125	17,040	
	TOTAL	0	0	3,468	995	42	64	7	0	55	93	125	17,040	21,889
1963	G	0	0	0	0	2,740	0	0	0	0	0	6,740	198	
	S	637	0	0	0	2.4	5.8	0	0	0	0	4,740	236	
	TOTAL	637	0	0	0	2,742	6	0	0	0	0	11,480	434	15,299
1964	G	0	0	0	0	0	0	0	0	0	578	6,320	4,220	
	S	1,060	397	0	0	0	0	0	0	0	889	18,260	4,780	
	TOTAL	1,060	397	0	0	0	0	0	0	0	1,467	24,580	9,000	36,504
1965	G	29	0	0	.6	170	0	3	0	0	0	0	0	
	S	0	0	71	50	205	79	86	0	242	13	73	121	
	TOTAL	29	0	71	51	375	79	89	0	242	13	73	121	1,143
1966	G	0	0	30,630	2,670	2,780	0	0	0	0	0	1,450	3,890	
	S	0	5.2	20,460	30	9,500	4	6.9	0	0	0	2,460	6,380	
	TOTAL	0	5	51,090	2,700	12,280	4	7	0	0	0	3,910	10,270	80,266
1967	G	0	0	0	0	0	0	0	0	0	0	0	1,000	
	S	196	0	3.6	0	0	0	0	0	644	8.3	308	811	
	TOTAL	196	0	4	0	0	0	0	0	644	8	308	1,811	2,971
1968	G	113	0	20,320	22	4,438	919	0	0	0	0	0	0	
	S	192	56	26,740	6	759	1,840	14	0	0	32	411	0	
	TOTAL	305	56	47,060	28	5,197	2,759	14	0	0	32	411	0	55,862
1969	G	0	0	0	0	0	0	0	0	0	0	0	0	
	S	24	381	107	92	50	0	0	0	0	20	10	0	
	TOTAL	24	381	107	92	50	0	0	0	0	20	10	0	684
1970	G	0	0	0	0	0	216	0	0	0	24	0	0	
	S	0	0	0	32	20	167	.2	0	0	328	858	3,740	
	TOTAL	0	0	0	32	20	383	0	0	0	352	858	3,740	5,385
1971	G	0	0	0	0	0	0	0	0	0	0	6,720	1,250	
	S	45	0	0	8.7	0	0	0	0	0	0	25,390	3,180	
	TOTAL	45	0	0	9	0	0	0	0	0	0	32,110	4,430	36,594
1972	G	2,480	0	0	0	0	0	0	0	0	0	776	189	
	S	199	114	16	26	0.02	0	0	0	0	0	268	1.8	
	TOTAL	2,679	114	16	26	0	0	0	0	0	0	1,044	191	4,070
1973	G	5,030	83	3.8	0	1,320	685	252	0	0	0	0	0	
	S	7,280	373	212	15	1,360	2,630	27	1	0	0	0	0	
	TOTAL	12,310	456	216	15	2,680	3,315	279	1	0	0	0	0	19,272

continued

page 3

UPPER GILA RIVER DISCHARGE IN ACRE FEET FOR 1941-1978, continued

YEAR	STATION	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	TOTAL
1974	G	0	0	0	0	0	0	0	0	0	421	6,290	0	
	S	0	.1	0	0	0	31	0	0	0	266	43	2.2	
	TOTAL	0	0	0	0	0	31	0	0	0	687	6,333	2	7,053
1975	G	1.2	59	0	0	0	0	0	0	0	7.1	0	0	
	S	65	38	2	0	149	18	5.3	2.9	.2	297	.2	102	
	TOTAL	66	97	2	0	149	18	5	3	0	304	0	102	746
1976	G	0	0	0	0	0	0	0	0	0	15	13	773	
	S	0	39	0	0	0	0	11	6.3	0	188	511	1,330	
	TOTAL	0	39	0	0	0	0	11	6	0	203	524	2,103	2,886
1977	G	473	92	28	45	0	0	0	0	0	482	121	25	
	S	175	1.3	0	10	0	2.4	0	0	0	1.7	151	.4	
	TOTAL	648	93	28	55	0	2	0	0	0	484	272	25	1,607
1978	G	10,510	110	86	2,230	11,070	12,320	3.4	91	47	28	30	64	
	S	7,580	11	52	4,010	4,170	5,850	32	0	.6	292	90	.3	
	TOTAL	18,090	121	138	6,240	15,240	18,170	35	91	48	320	120	64	58,677
GRAND TOTALS		47,255	32,506	133,409	87,070	72,142	90,000	17,161	8,509	5,901	72,596	353,362	128,260	1,048,171
AVERAGES		1,313	903	3,706	2,419	2,004	2,500	477	236	164	2,017	9,816	3,563	29,116

SOURCE: USGS Gauging Station (#9-4890 and #9-4795), 1941-1978.

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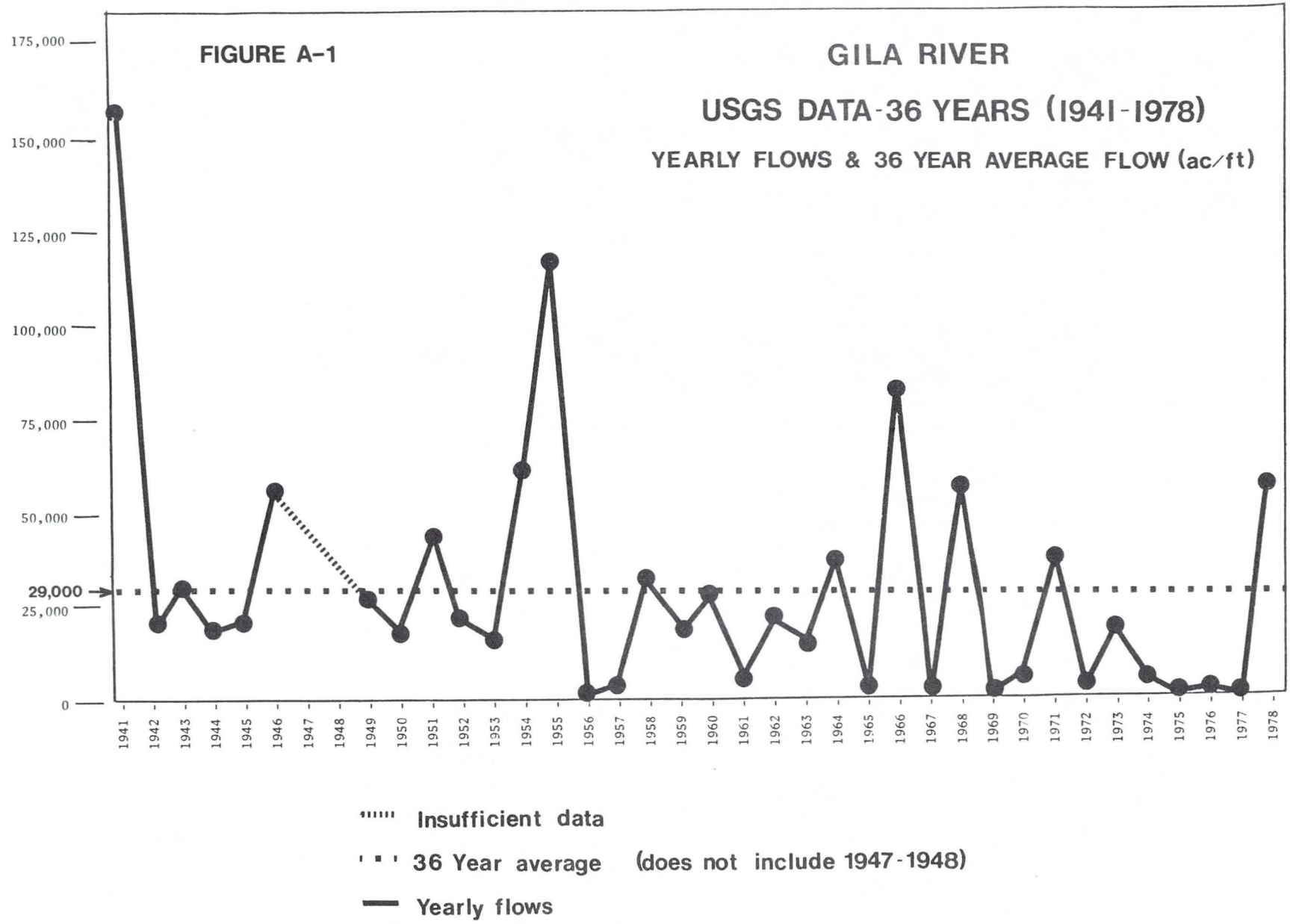


''''' Insufficient data

' ▪ ' 36 Year average (does not include 1947-1948)

— Yearly flows

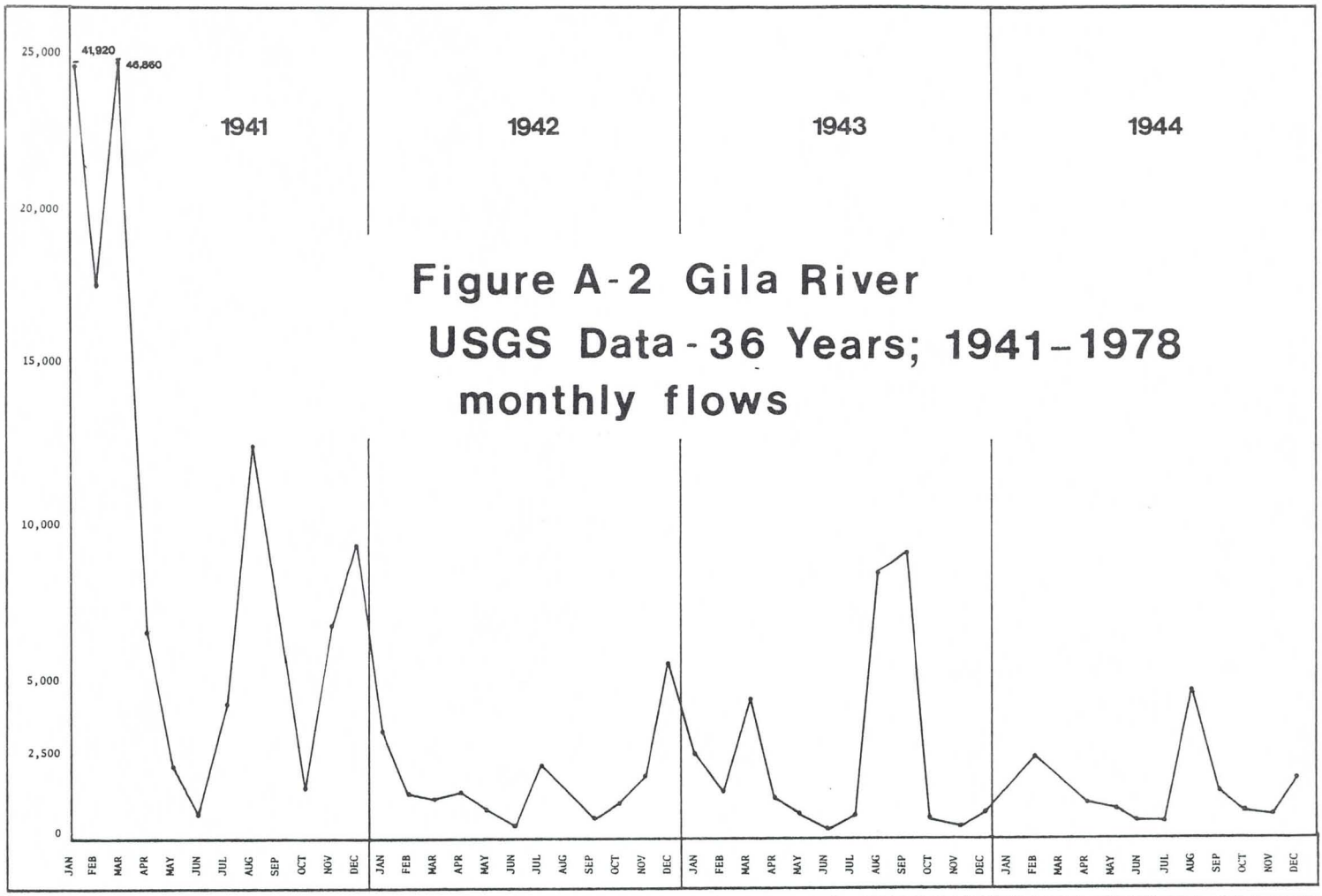
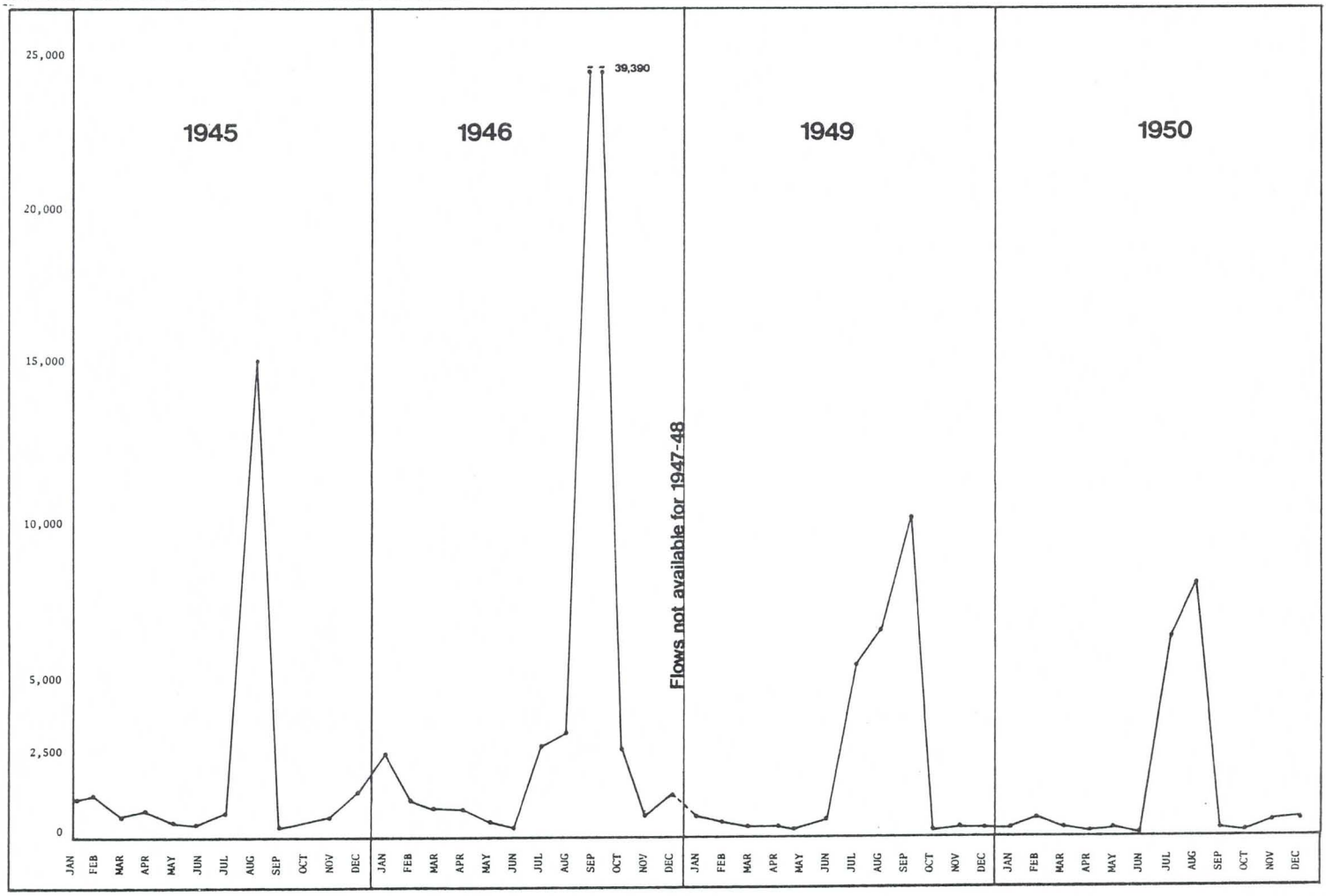
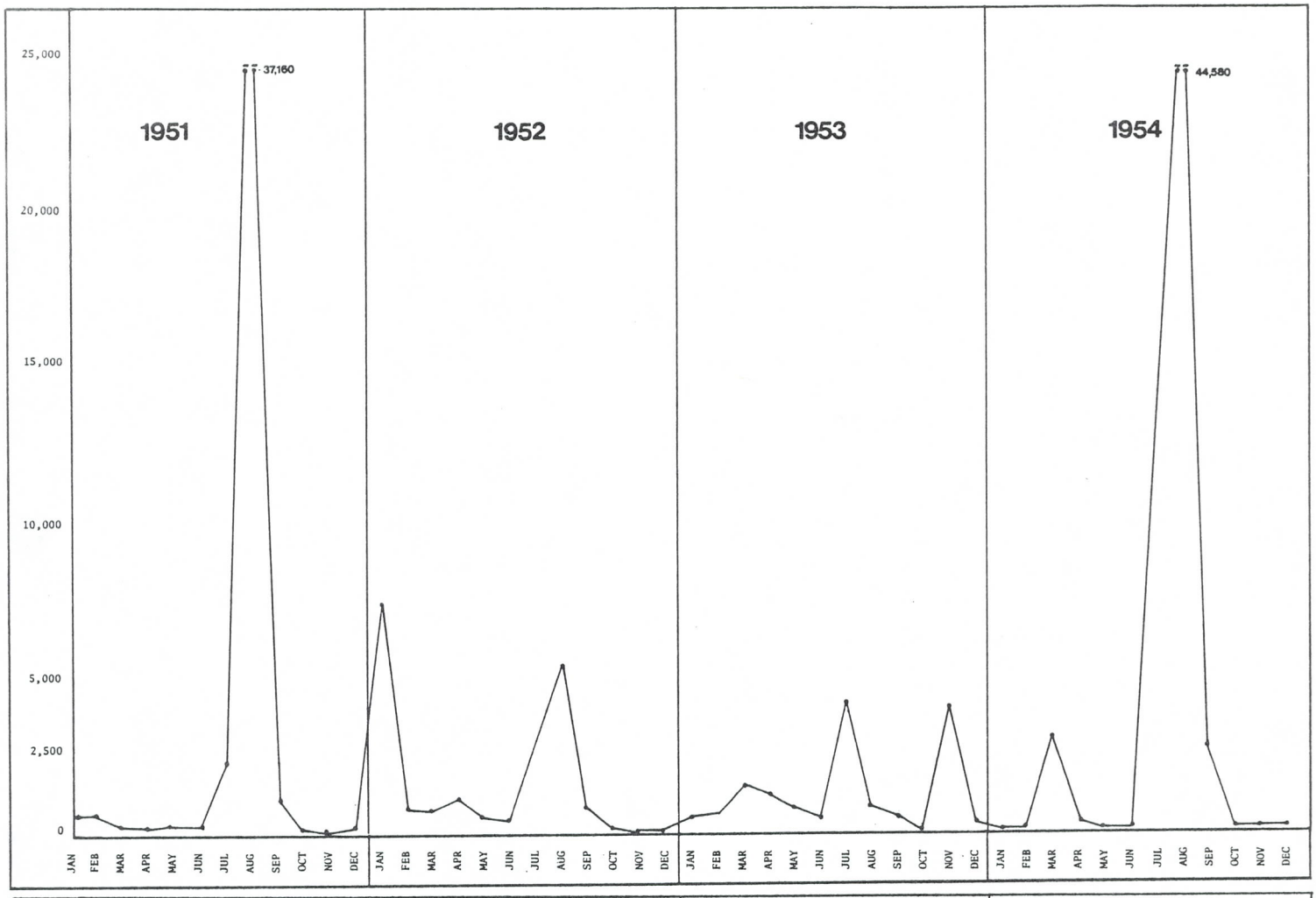
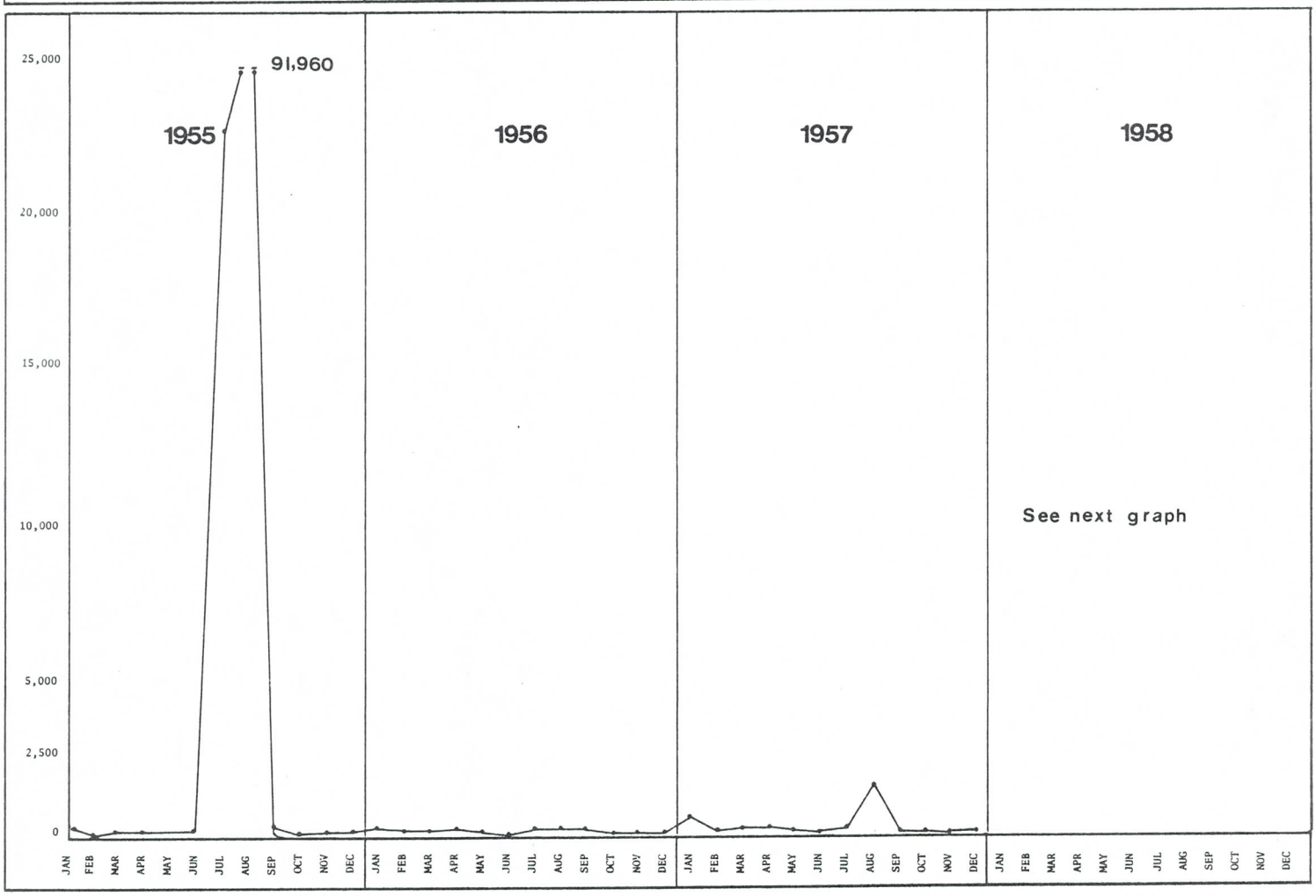
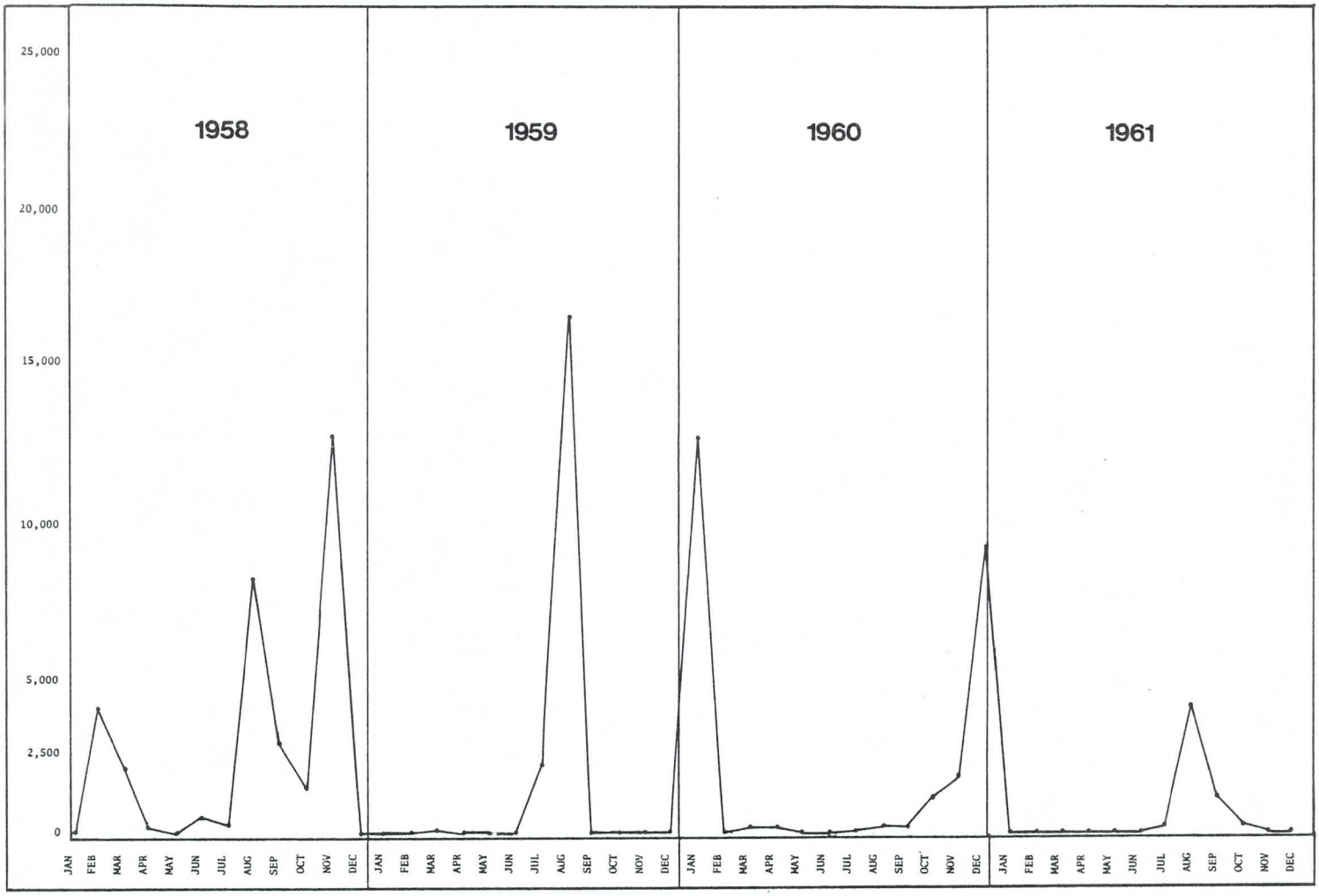


Figure A-2 Gila River
USGS Data - 36 Years; 1941-1978
monthly flows




25,000
20,000
15,000
10,000
5,000
2,500
0
37,160
44,580
1951
1952
1953
1954
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


25,000
20,000
15,000
10,000
5,000
2,500
0
91,960
1955
1956
1957
1958
See next graph
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC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25,000
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15,000
10,000
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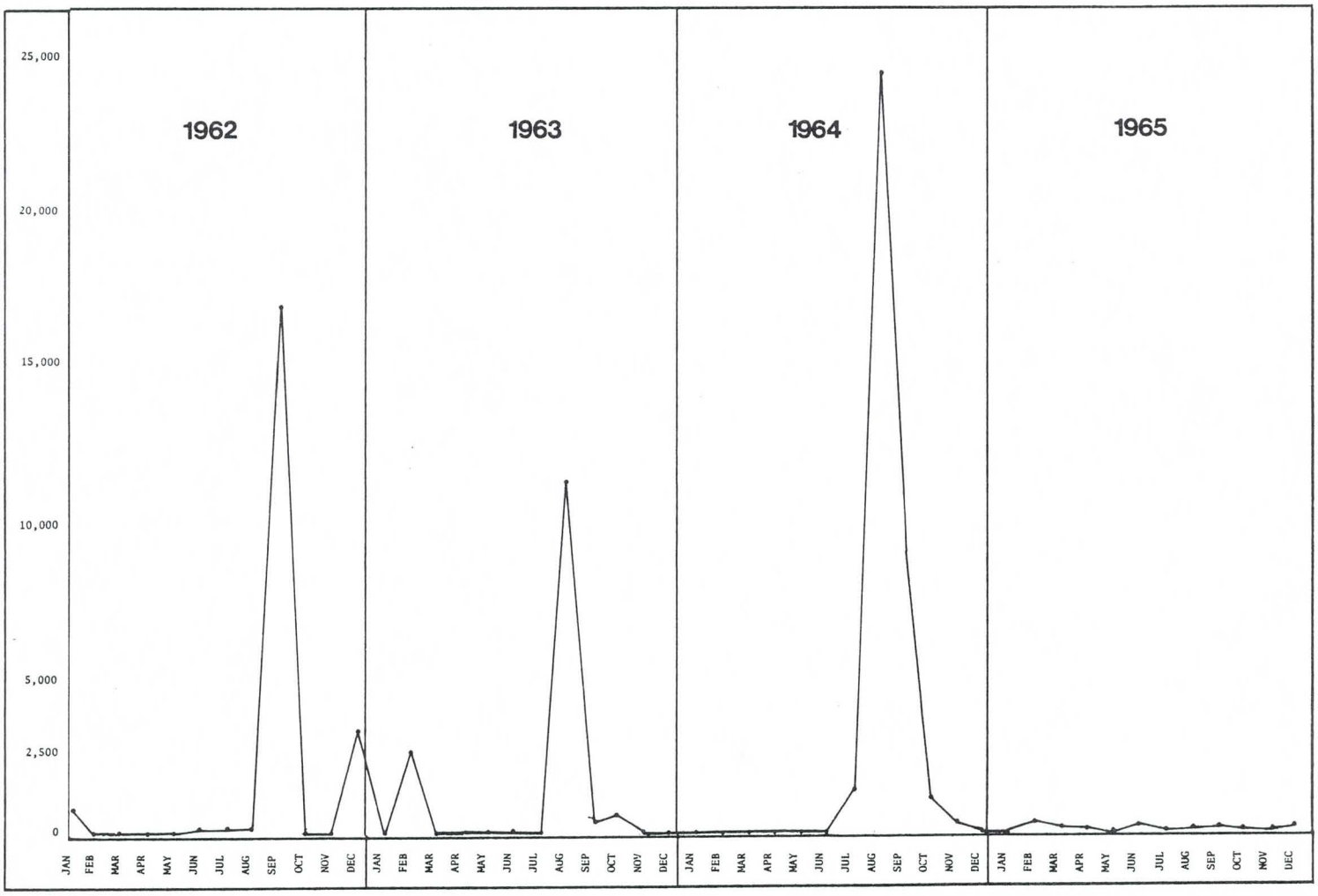
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


1962
1963
1964
1965
25,000
20,000
15,000
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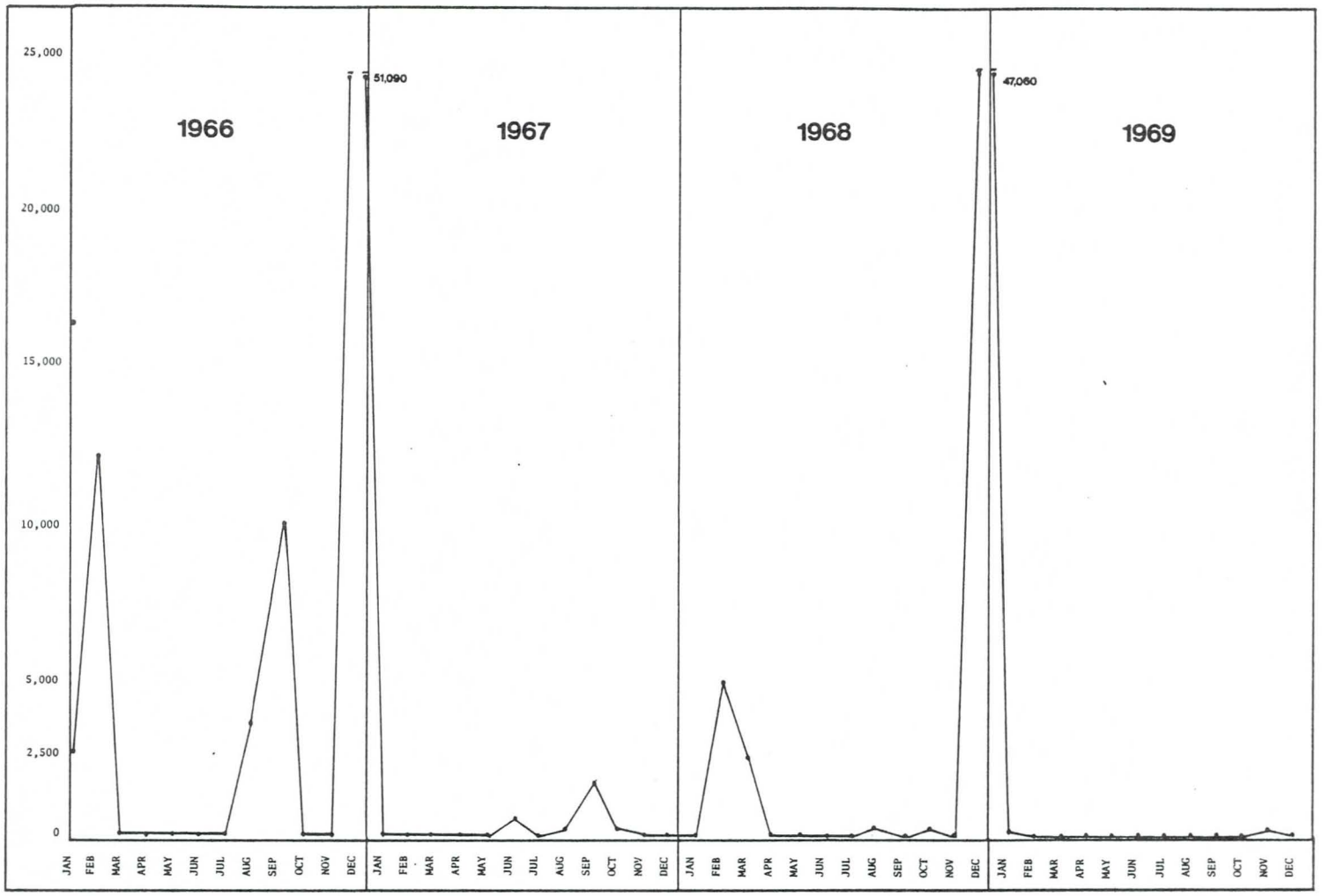
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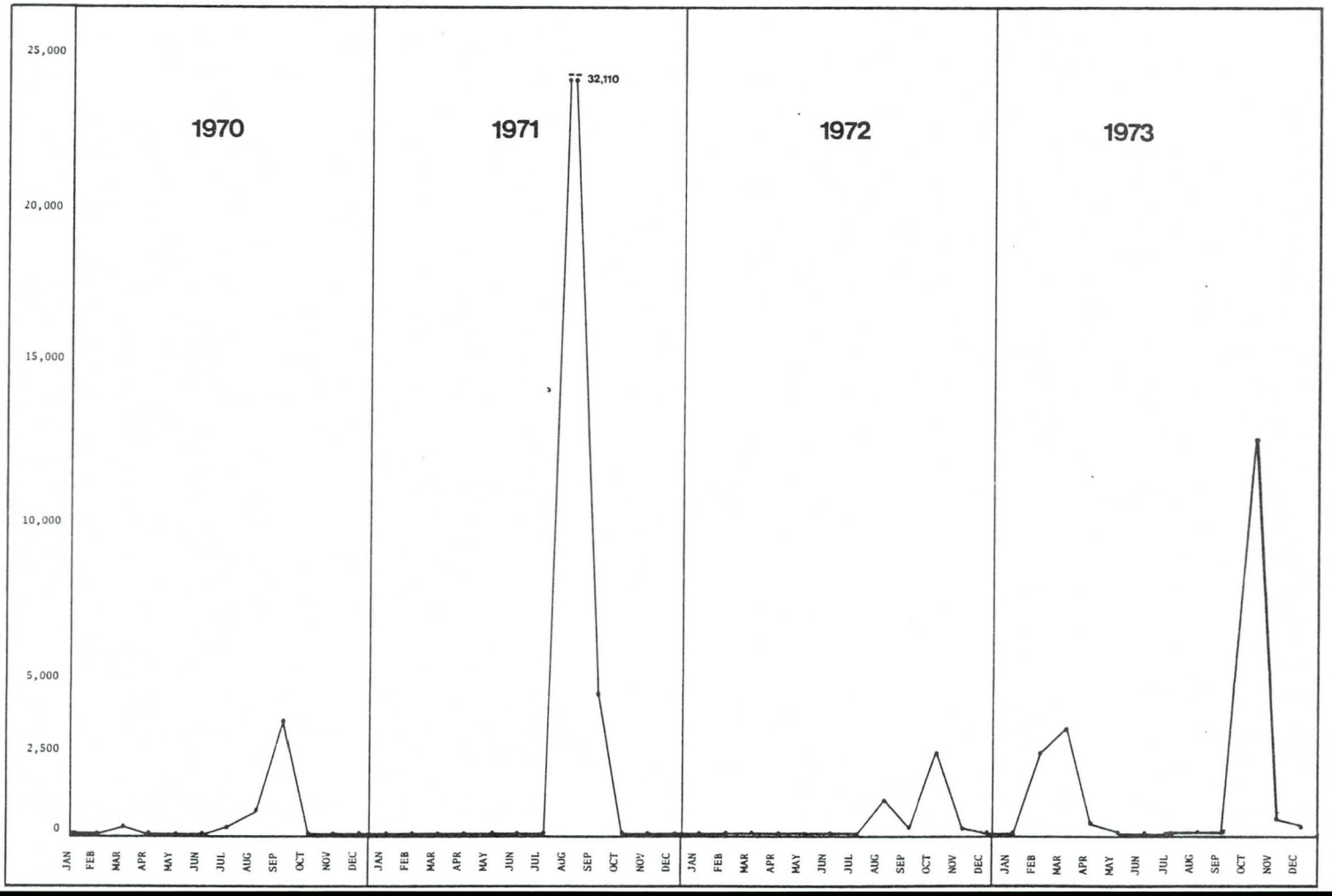
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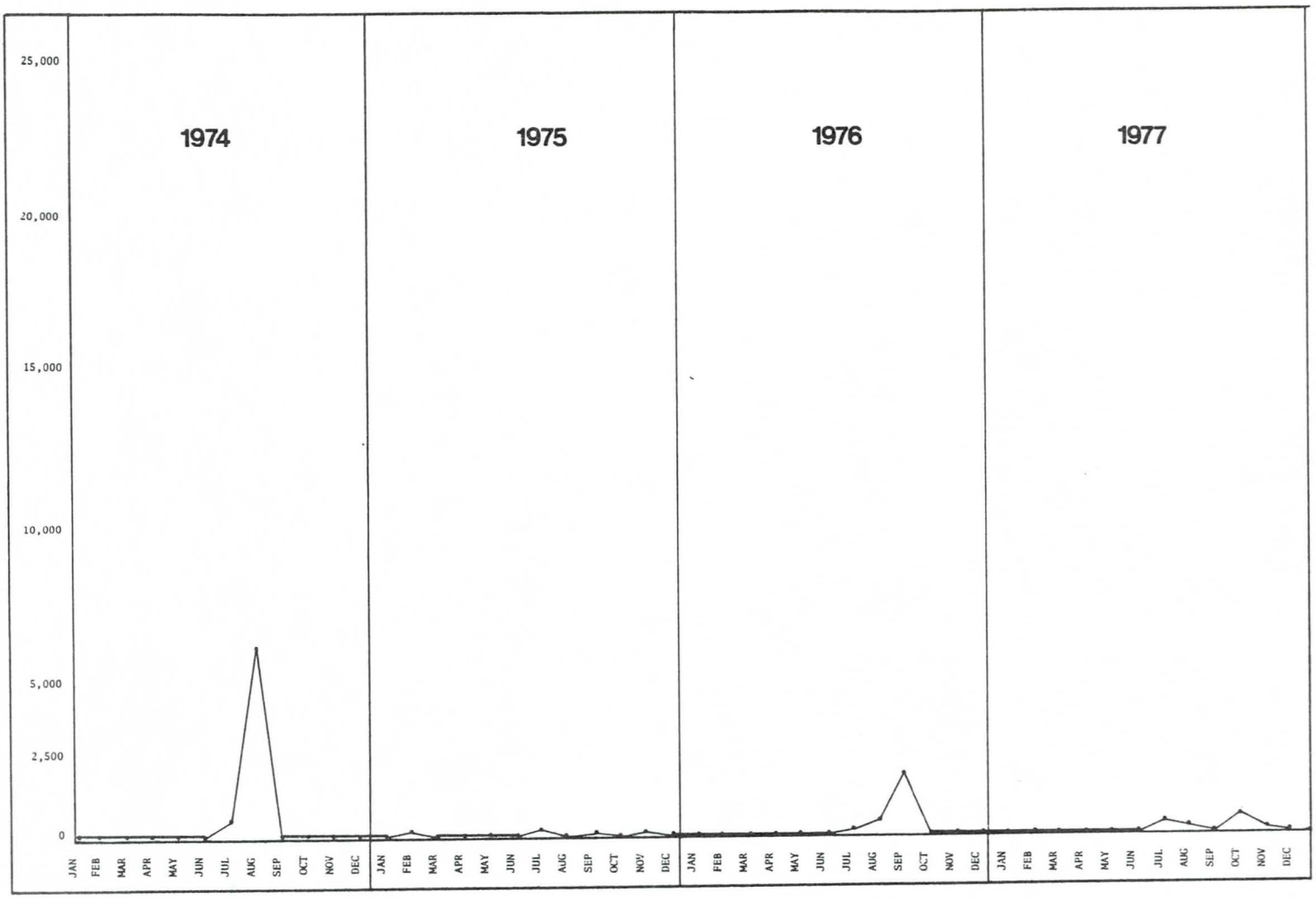
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EXHIBIT B
MEETING SUMMARIES

MINUTES OF THE

MULTI-CITY SUBREGIONAL OPERATING GROUP

MEETING

MARCH 28, 1980

This meeting was held in Room 103 of the League of Arizona Cities and Towns Building and was called to order at 10:15 a.m. by Chairman Robert Brunton. The following were in attendance:

MULTI-CITY SROG MEMBERS	REPRESENTING
Robert L. Brunton	City of Phoenix
Richard Brown	City of Scottsdale
George Britton	City of Scottsdale
Ed Wohlenberg	Town of Gilbert
O. A. Hartzell	Town of Youngtown
Jerry Geiger	City of Tempe
Martin Vanacour	City of Glendale
Dean Sloan	City of Mesa

OTHERS PRESENT	
Art Moyer	SROG
Ken Dusenberry	City of Scottsdale
Moe Wakefield	Arizona Dept. of Health Serv.
Allen Davis	Camp, Dresser & McKee
Gerald Bastian	Greeley & Hansen
Madeline Fong	Greeley & Hansen
Walt Howard	John Carollo Engineers
John Puzauskas	John Carollo Engineers
Lindy Cook	MAG 208
Susan Mitchell	Public Participation Coord.
Mark Frank	MAG 208
Bob Owens	Brown & Caldwell
Bob Steytler	City of Phoenix
Jesse Sears	City of Phoenix
Alan Burns	City of Mesa
Mike Brennan	City of Mesa

I. MINUTES OF MARCH 14, 1980 MEETING

George Britton moved approval of the minutes of the March 14 meeting. The motion was seconded by Dean Sloan and approved unanimously.

II. EFFLUENT DISCHARGE ASSESSMENT

Copies of the Effluent Discharge summary prepared for the WQPAC meeting on March 27 were distributed. Bob Steytler reviewed the discussion of the WQPAC meeting indicating that action was deferred until April 24. The major concern of the WQPAC was that once the study is approved it becomes a legitimate reference document.

III. 91ST AVENUE PLANT EXPANSION DRAFT FACILITY PLAN

The March 27 action of the WQPAC recommending approval was described. Dean Sloan moved acceptance of the WQPAC recommendation concerning approval of the Facility Plan and recommend approval to the SROG City Councils. Jerry Geiger seconded the motion.

The motion was modified by Dean Sloan to indicate serious concern over the ability to finance the plant expansion project. The motion was approved unanimously.

IV. SCUM, SCREENINGS AND GRIT PROCESSING

Robert Steytler reviewed the present situation and that it is hoped that a buyer can be found for the scum in the future. Presently are burning screenings and landfilling the grit. There are expectations that the State will relax their standards permitting continuation of present practice.

Robert Brunton stated there are some upcoming problems related to the disposal of septic wastes.

V. GRANT SITUATION

Nothing new to report on grant situation or the freeze.

VI. 99TH AVENUE INTERCEPTOR/TOLLESON PLANT STATUS

It appears that the bid on the 99th Avenue Line can be awarded within the grant offer.

Robert Brunton discussed the letter from Mayor Ridge of Glendale urging support for SROG participation in the Tolleson Plant expansion project. Dean Sloan asked if the SROG participated in this project would the percent of ownership be allocated. Robert Brunton indicated that the capital costs would be reimbursed and the SROG would only be helping in front-ending the costs.

The Plant expansion could be completed by July, 1981.

VII. APRIL 18 MEETING TO REVIEW MULTI-CITY AGREEMENT

The meeting will be a work session only. It will be in Room 910 of the Phoenix Municipal Building.

VIII. INFORMATION ITEMS

Robert Brunton reviewed the provisions of the Holly Acres Flood Control Bill and suggested that the Phoenix representative should be a Multi-City representative.

Mark Frank reviewed the User Charge situation indicating the Consultant's contract is to implement by December, 1980 based on facility start-up date for disinfection at 91st Avenue. If this is not an accurate date, then it should

be adjusted. Mark expressed concern about coordinaiton of starting dates in all of the Cities.

The meeting was adjourned at 11:40 a.m.

Respectfully submitted,

Jim Webb

James R. Webb
SROG Administrator

JRW:sp

WATER QUALITY POLICY ADVISORY COMMITTEE

Meeting Summary
February 28, 1980 - 10:00 AM
League of Cities and Towns Building
1820 West Washington Street
Phoenix, Arizona 85007

Advisory Committee

Helen Cornell	City of Glendale
Michael Goodman	South Phoenix Planning Committee
Ken Hanks	Game and Fish Department
Jack Hinchey	Motorola
Sue Lofgren	League of Women Voters
Dean Moss	Arizona Department of Health Services
Jack Muir	City of Tolleson
Adron W. Reichert	Holly Acres Flood Control
Felix Schmidt	Gila River Indian Community
Laura Watson	Citizen
Don Womack	Salt River Project

Others Present

J. L. Carpenter	Phoenix Gazette
Lindy Cook	MAG 208
Al Davis	Camp Dresser and McKee
Madeline Fong	Greeley and Hansen
Mark Frank	MAG 208
Dale Gutenson	Gila River Indian Community
Will LeGrande	MAG 208
Susan Mitchell	Public Participation Coordinator
Carolyn Slatt	Consultant
Bob Steytler	City of Phoenix
Moe Wakefield	Arizona Department of Health Services

Sue Lofgren, Chairperson, opened the meeting. The purpose of the meeting was to 1) present the Tolleson-Peoria Facility Plan, and 2) discuss short-term solutions to the effluent problems downstream of 91st Avenue (Effluent Reuse Study).

TOLLESON FACILITY PLAN

The meeting was turned over to Al Sevilla, Brown and Caldwell, to discuss the Tolleson-Peoria Facility Plan. Mr. Sevilla provided background on the study, including a description of the study area, scope of work, design criteria, methodology, and alternative development, evaluation and selection. The selected liquid treatment process for expansion of the plant is rock filters followed by activated sludge. The selected sludge disposal/reuse alternative was agricultural reuse. The plan recommends continued exploration of downstream effluent reuse; other reuses will require further detailed study. Total project cost is $10.7 million.

COMMENTS ON EFFLUENT DISCHARGE REPORT

The meeting was then turned over to Adron Reichert, Holly Acres, to discuss his concerns regarding the effluent discharge assessment issued as part of the Multi-cities residuals management facility plan.

Mr. Reichert stated that he felt the report contained false information. He stated that the report seemed to be trying to convince the reader that introduction of effluent into the river bed never made a difference or that if all the effluent were removed from the river bed there would still be vegetative growth in the floodway, especially in the area between 115th Avenue and Bullard Avenue.

Citing specific excerpts from the report, Mr. Reichert stated that it led one to believe that "the whole project area is saturated with irrigation tailwaters." He recommended that consultants reconsider the tailwater project area base flow line.

Based on his discussions with experts, Mr. Reichert questioned the findings of the report regarding the relationship of groundwater and runoff to vegetations growth. He said that in the period up to 1941 there was water in the area and the description of the salt cedar growth as presented in the report was false. He stated there was vegetative growth but not like it is today. Other than along the surface water there was no salt cedar growth. It was not until 1966, when the City changed the main effluent channel to a high flow channel to the north, that salt cedars began to grow there. In the same year the Arizona Game and Fish Department built an earthen dam for 1) water fowl resting area and 2) encouraging vegetative growth, according to the Game and Fish Department.

Mr. Reichert stated that groundwater will maintain the growth after it is germinated but that it was the effluent that caused the salt cedar to grow.

Ken Hanks, Game and Fish Department, stated that the salt cedar was not the cause of the flooding problems. Some feel it was mismanagement by Salt River Project Project on the channel itself. The responsiblity lies with builders and government for allowing development in the floodplain.

Mr. Reichert stated that Holly Acres discovered that they were in the floodplain in 1976 when they discovered that they could no longer build in the area.

Mr. Steytler stated for the record that the City has never instructed consultants to make certain findings. Al Davis, Camp Dresser and McKee will come back to the advisory committee with data sources, etc. to respond to Mr. Reichert's comments at the next advisory committee meeting.

Don Womack, Salt River Project, explained in response to the reference to Salt River Project that the Salt River Project system was not designed for flood control and there is no space dedicated for flood storage.

Laura Watson, citizen, asked Mr. Richert what his recommendation was to correct the problem. Mr. Reichert stated it would be a reuse program that would get effluent out of the stream.

EFFLUENT REUSE STUDY - SHORT TERM SOLUTIONS

The meeting was turned over to Jim Fulton, consultant, to discuss short-term solutions to the problems downstream of 91st Avenue.

Mr. Fulton stated that the question before the committee was, "What can be done about the effluent?" He asked the committee for suggestions.

Mr. Reichert suggested getting the effluent back into the main channel and providing some protection for those with land just west of the plant (e.g. levees, dikes) and maintenance of the channel.

Dean Moss, Bureau of Water Quality Control, suggested that alternatives should be divided into two categories: effluent out of the river, effluent in the river. He asked whether the problem really wasn't solving the flooding problems.

Ms. Lofgren stated that the concern of this study was the effluent.

Mr. Moss stated that the short-term problem was flooding and the long-range problem was finding a way to dispose of the effluent from 91st Avenue and get it out of the river.

Ms. Watson asked if there was any way to kill the vegetation.

Mr. Fulton stated that the Corps is studying alternatives to control salt cedar, e.g. pumping water down.

Regarding channel modifications, Mr. Moss stated that any construction in the channel would require a permit from the Corps and therefore an environmental impact statement, which could take 1-2 years.

Mr. Moss asked the purpose of the low flow channel.

Mr. Fulton replied that the main purpose was flood control, to handle flows up to a certain point and for flows greater, it gives better direction for the main discharge of water.

Mr. Reichert suggested percolation ponds and water for the St. John's Irrigation District. He also stated that there were farmers who would take the effluent as it is. Assurance of contract was a concern.

Mr. Moss again stated that the study needs more structure, i.e., need to define problems and array solutions to see how they impact the problems.

Mr. Fulton stated that would be considered in the next phase of the study (evaluation): what's the alternative do, is it implementable, and what's the time frame.

CONSULTANT COSTS

Jack Hinchey, Motorola, stated that he had talked with Mark Frank, MAG, regarding giving the advisory committee an accounting so far on how much had been spent on consultants and how much had been spent on "hard design and work," in order to make some kind of judgment as to whether they were getting their money's worth.

Mr. Frank presented a gross estimate of the 208 costs, funded by a 208 grant from October 1976 to July 1979: over a three year period, an estimated $2.8 million for 208 level studies, some of which was used as direct input to Multi-cities 201 studies. Costs of 201 studies which come out of the 208 will be obtained from the Multi-cities SROG administration, and will be presented at the next advisory committee meeting.

Ms. Lofgren asked how much of the total 208 cost ($2.8 million) was for consultants.

Mr. Frank estimated that of the initial 208 grant ($614,000), about $250,000-$350,000 was for consultants; about 2/3 of the Corps contribution of $1.2 million was consultant-related; and of the Westside analysis portion of $1 million, about 90% was consultant related.

Mr. Hinchey asked how these figures related to the current 201 costs.

Mr. Frank said it was more, but that no figures were available at this time.

Mr. Hinchey asked who so many consultants were needed.

Bob Steytler, City of Phoenix, stated that EPA will not approve grants without scope of work which require all the studies by the consultants.

ANNOUNCEMENTS

Ms. Lofgren announced that Mr. Reichert would give tours of the Holly Acres area to see first hand the problems that effluent has caused. Those interested can contact Susan Mitchell.

Mr. Moss suggested items for the agenda of the next meeting:

1. assessment of the flooding problems and direct impacts on water quality

2. impact of flooding on other facilities (e.g. treatment facilities in the area)

3. address long-term water quality issues and things going on in the area

Ms. Lofgren stated that Mr. Steytler would respond to Mr. Reichert's concerns and Mr. Frank would present the dollar figures on consultant costs. The next meeting is Thursday, March 13, at 10:00 a.m.

Mr. Frank stated that 1) he would clarify the consultants dollar figures at the next meeting, 2) all facility plans will come before the advisory committee for recommendation of consistency with the 208 plan, and 3) Lindy Cook is the MAG public participation coordinator.

Ms. Mitchell announced that the Tolleson Facility Plan Public Hearing would be held Tuesday, March 4 at 7:00 p.m. in Tolleson City Hall.

The 91st Avenue Facility Plan Public Hearing will be held Wednesday, March 5 at 7:30 p.m. at County Supervisors Auditorium.

With no further business, the meeting was adjourned at 12:00 noon.

WATER QUALITY POLICY ADVISORY COMMITTEE

Meeting Summary
March 13, 1980 - 10:00 AM
League of Cities and Towns Building
1820 West Washington Street
Phoenix, Arizona 85007

Advisory Committee

James M. Casey	City of Tempe
Lee Chadwick (for Dick Mettler)	Home Builders Association
Helen Cornell	City of Glendale
Dan Devers	Valley Forward Association
Michael Goodman	South Phoenix Planning Committee
William F. McCarthy (for Dean Sloan)	City of Mesa
Mark Miller (for Bob Yount)	State Land Department
Daril Peterson	St. Johns Irrigation District
William Raymo	Sun City Water & Sewer Companies
Adron W. Reichert	Holly Acres
Rick Santoro	Arizona Public Health Association
Felix Schmidt	Gila River Indian Community
Larry Stephenson (for Dean Moss)	Arizona Department of Health Services
Don Womack	Salt River Project

Others Present

Wally Ambrose	Greeley & Hansen
Veda Barnes	Holly Acres
Joan L. Carpenter	Phoenix Gazette
Lindy Cook	MAG 208
Richard Cote	Camp Dresser and McKee
Jan White Eagle	Salt River Maricopa Indian Community
Renee Farmer	Holly Acres
Mark Frank	MAG 208
Jerry Hill	Holly Acres
Judy Hill	Holly Acres
Susan Mitchell	201 Public Participation Coordinator
Art Moyer	Multi-city SROG
Robert L. Munari	Arizona Department of Health Services
Eileen Pannetier	Camp Dresser and McKee
John Puzanskas	John Carollo Engineers
Ken Schmidt	MAG 208
Carolyn Slatt	Consultant
Jeanie Starkey	Holly Acres
Bob Steytler	City of Phoenix
Robert Villasenor, Jr.	Citizen
Moe Wakefield	Arizona Department of Health Services
Jim Webb	Multi-city SROG

Sue Lofgren, Chairperson, opened the meeting. The purpose of the meeting was: 1) present Multi-cities response to comments on the Effluent Discharge Assessment; 2) present residuals management alternatives for scum, screenings and grit; 3) discuss the Pima Ranch Development Project; 4) report on flood damage to wastewater treatment facilities; and 5) present a 208 status report.

Ms. Lofgren stated the recommendation of the 91st Avenue plant facility plan to the March 27 advisory committee meeting due to the need to respond to comments received at the public hearing.

EFFLUENT DISCHARGE ASSESSMENT

The meeting was turned over to Bob Steytler, City of Phoenix, who provided background on the discussion of the effluent discharge assessment report. It is the contention of Holly Acres that effluent from the 91st Avenue plant cause growth of vegetation, in particular salt cedar, in the river channel; the growth in turn causes flooding damages. The findings of the report to be discussed indicate in effect that the salt cedar growth in the river would be there with or without the effluent. Also, the report sets forth that the floods which have damaged Holly Acres (flows in excess of 100,000 up) would probably do so with or without the salt cedar growth.

The meeting was then turned over to Al Davis, Camp Dresser Mckee, who summarized the background on the study, including discharge conditions, scope and methodology, findings and issues to be resolved

To respond to comments presented by Adron Reichert, Holly Acres, at the last advisory committee meeting, Mr. Davis then turned the meeting over to Rick Cote and Eileen Panateer of Camp Dresser McKee.

Surface and Ground Water Aspects

Mr. Cote stated that the basis of the study was to determine how much water was actually reaching the project area from 91st Plant to Buckeye Heading. In terms of surface water based on previous studies, it was determined that 36,270 acre feet/year of water (32.4 mgd) including rainfall, enter the project area (see handout). There is a peak summer discharge (late July and August) of about 90 acre-feet.

Regarding groundwater, it was determined that the western part of the project area has a high groundwater regime (about 3-5 feet). In the eastern portion, groundwater level is approximately 7-10 feet (low groundwater).

Ms. Panateer then discussed findings of the study regarding the effect of the surface water and groundwater on vegetation.

The history of the vegetation in the area is closely related to the history of the groundwater in the area. Prior to the 1920's the riparian vegetation consisted mainly of cottonwood, willow and mesquite. The groundwater was close to the surface at that time. By 1929, salt cedars had invaded the area and continued to increase through the 1940's. In the late 50's and early 60's groundwater was declining and the riparian vegetation died. The decline in groundwater was caused by a lack of flood flows, increased pumping and decreased stream flows. The 1965-66 flood scoured out much of the remaining vegetation and left ideal conditions for the reestablishment of riparian vegetation (i.e. recharging groundwater, increasing soil moisture), especially salt cedar, which is a highly competitive species. Presently vegetation in eastern and western portions of project area differ because of the difference in groundwater regime; in the easter portion primarily cottonwood and willow are found along the channel near the surface flows and salt cedar both near and away from the surface flows; in the western portion (high groundwater) vegetation is found both away from and near the surface flows.

These factors were used to determine the future conditions in the area with a decreased effluent discharge to the stream bed. With all but 6.5 mgd of effluent discharge removed from the river, no significant change in riparian vegetation is expected west of 115th Avenue. East of 115th, a reduction in soil surface water could be expected to thin and become distributed closer to the surface water channel. With discharges reflecting existing reuse commitments, no significant changes would be expected to the west of 115th; east of 115th, thinning would occur but to a lesser degree than under the first condition.

Terry Hudgins, Arizona Public Service, stated that the EIS prepared by the Nuclear Regulatory Commission and impact reports and assessments prepared for Arizona Public Service regarding the Palo Verde Nuclear Generating Station and the potential impacts of removing effluent from the river basically are in agreement with the findings of the Multi-cities effluent discharge assessment. The same information can be found and the same conclusions have been independently reached by the consultants for the City and those for Arizona Public Service.

Adron Reichert, Holly Acres, stated that regarding the phreatophytes he would like to have people who actually live in the area come to a meeting and respond to statements about the historical vegetative growth.

Mr. Reichert then responded to the baseline flow data presented by the consultants, specifically irrigation tailwaters and Gila River contributions (see handout). He presented graphs and tables depicting discrepancies between USGS data and flows as projected by the consultants. Considerable discussion followed. (Tapes of the meeting are available at MAG; also a paper explaining any discrepancy has been prepared in response.)

Darryl Peterson, Holly Acres, asked if just wells were sampled or if USGS maps were used that showed the geological rock outcroppings.

Mr. Cote stated that Ken Schmidt, consultant, would have to answer that question.

Larry Stephenson, Bureau of Water Quality Control, asked for further discussion of seasonality of vegetation -- is the moisture there when needed?

Felix Schmidt, Gila River Indian Community, asked if the baseflow (34.2 mgd) excluded effluent from 23rd and 91st Avenue plants.

Mr. Cote responded that it included the upstream flow from 23rd and 91st Avenue plants.

Eva Patten, Governor's Commission of the Environment, asked if the work done by the consultants is being coordinated with similar work being completed as part of the Central Arizona Water Control Study.

Mr. Cote said data was not available at this time.

Ms. Lofgren suggested that the discrepancy issue and the questions raised at the meeting be resolved at another meeting.

Ms. Patten, stated that perhaps a non partisan technical expert was needed to aid in resolving the issues.

The meeting was turned over to Bob Steytler, City of Phoenix.

SCUM, SCREENINGS AND GRIT

Mr. Steytler discussed recent developments in the scum, screenings and grit portion of the residuals management facility plan. Because the classification of grit as a hazardous waste may change and because there may be a buyer for the scum, the City is recommending continuing with the existing process for scum screenings and grit at the plants. Mr. Steytler asked that the committee take some formal action on the recommendation.

Ms. Lofgren asked for a motion.

Ms. Patten moved that in light of the new developments, the existing method of scum, screening and grit disposal be continued.

Pam Hart, Arizona Magazine, seconded the motion.

The motion passed unanimously.

The meeting was turned over the Bob Brunton, City of Phoenix.

PIMA RANCH DEVELOPMENT PROJECT

Mr. Brunton discussed the Pima Ranch Development project. The City of Phoenix presently provides water and sewer to Ahwahtukee. Continental Builders is asking for annexation and sewer and water for the Pima Ranch Development south of Ahwahtukee. The City Council is coming to an agreement with them, asking for zero discharge through December 1982, during which time they would provide a sewer system and some temporary form of treatment.

Mr. Schmidt asked if sewage from the development would go to 91st or to Chandler.

Mr. Brunton stated that the present plan calls for additional lift stations to lift sewage to the 91st Avenue plant.

Mike Goodman, South Phoenix Planning Committee, asked if areas outside Pima Ranch would want to hook up.

Mr. Brunton replied that there could be other areas developed.

Mr. Goodman asked if the developments had to demonstrate that they can supply water.

Mr. Brunton said that the 48 inch waterline which is planned by the City of Phoenix, be such a demonstration.

Ms. Patten asked under zero discharge what kind of facilities are being considered.

Mr. Brunton said individual septic tank or area septic system would be considered with future connection to the sewer system.

Ms. Hait asked how additional development could be justified when there are existing problems with obtaining funds for plant expansion.

Mr. Brunton replied that the City Council had so voted.

Ms. Lofgren asked, in light of fact that 91st Avenue plant is a Multi-city facility, what about the impacts and influence on and by the other cities in the Multi-cities SROG.

Mr. Brunton replied that Phoenix does not regulate any other cities.

Don Womack, Salt River Project, added that plant capacity had been allocated and decisions were up to the individual cities regarding use of that capacity.

Mr. Reichert stated that according to the 208 plan, 84 mgd was it until the expansion of the plant. He asked how the city planned to deal with it.

Mr. Brunton replied that there would be zero discharge to 1982, at which point the City hoped to have the plant expanded.

Ms. Hait asked why a sewer system couldn't be put in initially.

Jim Casey, City of Tempe, stated that available studies show it to be least expensive to go to 91st Avenue.

Mr. Womack asked if the Pima Ranch agreement for zero discharge to December 1982 was contingent on having additional plant capacity.

Mr. Brunton replied that that was the case.

The meeting was turned over to Bob Steytler.

FLOOD DAMAGES

Mr. Steytler described the facility damages caused by the February flood.

- No effect on plants
- $200-250,000 damage to effluent channel
- Most damage to pipe in airport area ($400,000)
- Upstream at 43rd Avenue on the south side of river, a leaking pipe was being chlorinated but is back in shape now
- Sewage coming out of pipeline manholes upstream which means there is a blockage somewhere in the pipe. The City is chlorinating (7 tons daily) until the blockage can be removed.

Mr. Reichert asked about the possibility of using the original effluent channel to the south.

Mr. Steytler stated that discussions have taken place with the City attorney and an answer is expected soon. It is a question of discharge on private property and the city's liability for such an action.

The meeting was turned over to Bob Munari, Arizona Department of Health Services, who described flood damage to other facilities in the Valley, namely City of Mesa, City of Tempe, City of Avondale and Town of Wickenburg. He stated that a damage report should be complete next week.

The meeting was turned over to Mark Frank.

Mr. Frank stated that the 208 status report would be postponed until the next meeting. Also, the report on consultant costs as requested by Jack Hinchey, Motorola, would be postponed until Mr. Hinchey's return.

OTHER BUSINESS

Mr. Stephenson stated that impacts of the flood on water quality should also be discussed.

Ms. Lofgren added drinking water impacts as well.

Ms. Lofgren announced that the next advisory committee meeting was scheduled for Thursday, March 27 at 3:00 pm.

With no further business, the meeting was adjourned at 12 noon.

WATER QUALITY POLICY ADVISORY COMMITTEE

Meeting Summary
March 27, 1980 - 3:00 PM
League of Cities and Towns Building, Room 101
1820 West Washington Street
Phoenix, Arizona 85007

Advisory Committee

Jack Berton	Phoenix Chamber of Commerce
Bob Bradley	Maricopa Audubon Society
Jim Casey	City of Tempe
Lee Chadwick for Dick Mettler	Home Builders Association
Michael Goodman	South Phoenix Planning Committee
Jack Hinchey	Motorola
Sue Lofgren	League of Women Voters
William F. McCarthy for Dean Sloan	City of Mesa
Paul B. McCleester	Sun City Homeowners Association
Dean Moss	Arizona Department Health Services
Jack H. Muir	City of Tolleson
Eva Patten	Governors Commission on Arizona Environment
William Raymo	Sun City Water & Sewer Companies
Adron W. Reichert	Holly Acres
Felix Schmidt	Gila River Indian Community
Don Womack	Salt River Project
Robert Yount	State Land Department

Others Present

Susan Mitchell	Public Participation Consultant
Carolyn M. Slatt	Consultant
Lindy Cook	MAG 208
Eileen Pannetier	Camp Dresser & McKee, Inc.
Richard Cote	Camp Dresser & McKee, Inc.
Allen Davis	Camp Dresser & McKee
Walt Howard	John Carollo Engineers
Wally Ambrose	Greeley and Hansen
John Puzauskas	John Carollo Engineers
Moe Wakefield	Arizona Department Health Services
Art Moyer	Multi-city SROG
John Schaper	Buckeye Irrigation District
Jim Webb	Multi-city SROG
Robert L. Brunton	City of Phoenix
Roberta Moore	Student
Marianne F. Fettibene	Student
Jeanie Starkey	Holly Acres Association

Sue Lofgren, Chairperson, opened the meeting. The purpose of the meeting was to discuss 1) the Effluent Disinfection Assessment working paper, 2) the 91st Avenue Plant Expansion Facility Plan, and 3) an update on the 208 program.

EFFLUENT DISCHARGE ASSESSMENT

Susan Mitchell, Public Participation Consultant, summarized the purpose of the discussion stating that an attempt was made to clarify points raised at the March 13 advisory committee meeting regarding irrigation tailwaters and Upper Gila flows and how conclusions were drawn in the Effluent Discharge Assessment working paper.

Bob Steytler, City of Phoenix, stated that the handout prepared for committee members was an attempt to put findings of the study in layman's terms. He then restated the conclusions reached by the consultants and Holly Acres, and indicated the flows in question, which show no discrepancy. The discrepancy lies in the conclusions reached using the same data.

Al Davis, Camp Dresser and McKee, qualified Mr. Steytler's remarks, stating that relative to the effect of vegetation on flood water spreading, the report did not quantify the effect of the salt cedars.

Adron Reichert, Holly Acres, then clarified his information relative to upstream flows, specifically figures as shown in the 208 EIS, Salt River Project contribution, and the 7,300 acre feet per year as identified by Halpenny and Clark. He stated that according to his information the Halpenny estimate was derived from a one-time visit. He stated that according to Salt River Project, this would not be a continual flow.

Don Womack, Salt River Project, stated that SRP had reviewed the Halpenny report and that the 7,300 acre feet per year was from a one-time visit and estimated that if it was a continual flow, it would be 7,300 acre feet per year. He further stated that Salt River Project feels the agricultural contribution should be about 1,000-1,500 acre feet per year, and the Upper Gila flows were correct as stated in the report. He stated, however, that the original report gave the impression that the bulk of water in the river would come from irrigation tailwaters and Upper Gila flows, but that actually the bulk of the water one could count on being there would be effluent from the 23rd Avenue plant supplemented by small amounts of additional water.

Rick Cote, Camp Dresser and McKee, then further clarified how the consultants arrived at Upper Gila flows.

Mr. Steytler summarized, stating that 1) the majority of the flow occurs in months critical to salt cedar growth (June - November), 2) salt cedars grow roots to 30 feet in depth and can go deep to groundwater for water supply, and 3) once established there is enough water during these months within 30 feet of the surface to support them.

Mr. Reichert cited data sources which indicate that surface moisture is needed to germinate the salt cedars.

Ms. Lofgren stated that the Corps of Engineers has a study underway to determine the effects of vegetation on flooding and if that report would be going into the subject in depth, perhaps the committee should consider accepting with reservations or rejecting the report at this time.

Mr. Reichert requested additional time to present data.

Paul McCleester, Sun City Homeowners Association, asked if the outcome of this discussion would alter the recommendations of the consultants or the decisions that are going to be made relative to the 91st Avenue plant.

Mr. Steytler replied no.

Considerable discussion followed.

Ms. Lofgren summarized concerns: 1) The report as such does not affect the actual building of the plant; 2) However, the report if accepted as such is then used as data base for future effluent planning; 3) If the report is accepted, Holly Acres is concerned that their contentions will no longer have any validity and it will affect the city's responsibility to Holly Acres in the event of future flooding.

Eva Patten, Governor's Committee of the Environment, moved to table the committee's recommendation on the report until April 24, pending more informtion.

Laura Watson, citizen, seconded the motion.

Discussion followed.

The motion passed with one dissenting vote.

91ST AVENUE TREATMENT PLANT EXPANSION FACILITY PLAN

Comments received at the public hearing on the 91st Avenue plant expansion facility plan and the city's response to them were provided to the advisory committee for review.

Ms. Lofgren stated that the committee was being asked to recommend the facility plan as conforming to the MAG 208 plan.

Bob Yount, State Land Department, suggested that if the response to public comments would be incorporated into the final 201 plan, the advisory committee should only address additional comments.

Jack Hinchey, Motorola, asked if the response to comments were mailed out to everyone at public hearing.

Ms. Lofgren replied yes.

Terry Hudgins, Arizona Public Service Company, questioned the financial aspects of plant expansion (funding the expansion).

Mr. Steytler stated that within the city's ability, the plant will be built with or without federal funds.

Mr. Hudgins moved that the advisory committee recommend the 91st Avenue Expansion Facility Plan as in compliance with the MAG 208 plan.

Felix Schmidt, Gila River Indian Community, seconded the motion.

The motion passed unanimously.

208 STATUS REPORT

Mark Frank, MAG, presented a status report on MAG 208 planning. He discussed:

1. New Contracts
   - Phase IV element of user charge contract -- implementation of user rates.
   - Phase II Groundwater Quality -- Ken Schmidt.
   - Landfill monitoring assistance to the City of Phoenix, to be initiated in three weeks, with a total of 14 monitoring wells at 16th Street, 19th Avenue and 27th Avenue landfills.
2. 208 Plan Compliance -- 201 plan review is underway for Tolleson, Gilbert, Chandler, and Multi-cities.
3. The State Construction Grant Priority System has been revised:
   - easier to understand
   - stronger documentation required to prioritize
   - waste flow reduction required for 1981
4. Procedures to determine the effectiveness of the 208 plan are under development.
5. 208 plan update procedure has been established.
6. Groundwater monitoring is underway.
7. Flow Reduction Program -- MAG will soon come up with a model plumbing code requiring low-flow fixtures.

8. Pima Ranch Development flows were incorporated into the 208 (6000 people). This figure will be revised upward in the 208 update based on the city's analysis.

Regarding consultant costs, as requested by the advisory committee, Mr. Frank stated that there has been a handout prepared for committee discussion at a later date.

OTHER BUSINESS

Ms. Lofgren announced that the next meeting of the advisory committee was April 10. The committee would meet April 24 to discuss the Effluent Discharge Assessment.

With no further business the meeting was adjourned at 5:00 p.m.

WATER QU, ,TY POLICY ADVISORY COMMITTEE M. ,ING

Meeting Summary
April 24, 1980 - 3:00 P.M.
League of Cities and Towns Building, Room 101/102
1820 West Washington Street
Phoenix, Arizona

Advisory Committee

Bob Bradley	Maricopa Audubon Society
Lee Chadwick for Dick Mettler	Home Builders Association
Helen Cornell	City of Glendale
Dan Devers	Valley Forward
Michael Goodman	South Phoenix Planning Committee
Jack Hinchey	Motorola
Terry Hudgins	Arizona Public Service
Sue Lofgren	League of Women Voters
William F. McCarthy	City of Mesa
Paul McCleester	Sun City Homeowners Association
Jack Muir	City of Tolleson
Eva Patten	Governors Commission on Arizona Environment
William Raymo	Sun City Water and Sewer Co.
Adron Reichert	Holly Acres
Felix Schmidt	Gila River Indian Community
Dean Sloan	City of Mesa
Laura Watson	Citizen
Don Womack	Salt River Project

Others Present

Wally Ambrose	Greeley and Hansen
Lindy Cook	MAG 208
Richard Cote'	Camp Dresser McKee
Allen Davis	Camp Dresser McKee
Joe Dixon	U.S. Army Corps of Engineers
Madeline Fong	Greeley and Hansen
Mark Frank	MAG 208
Jim Fulton	Consultant
Dr. Will Graf	Arizona State University
Chuck Lakin	Lakin Cattle Company
Will LeGrande	MAG 208
L.C. Lewis	Maricopa County Flood Control District
Robert Logan	Consultant
Andy Marcus	Arizona Environmental Consultants
Susan Mitchell	Public Participation Consultant
Susan Monroe	Citizen
Eileen Pannettier	Camp Dresser McKee
John Puzauskas	John Carollo Engineers
Dr. Ken Schmidt	Consultant
Carolyn Slatt	Consultant
Stan Smith	Maricopa County Flood Control Association
Ken Spiker	City of Phoenix
Bob Steytler	City of Phoenix
Dr. Ray M. Turner	U.S. Geological Survey
Moe Wakefield	Arizona Department of Health Services
Jim Webb	Multi-city SROG

Sue Lofgren, Chairperson, opened the meeting and reviewed the agenda: 1) panel discussion on effluent discharge assessment, and 2) presentation of the plumbing code revision. She then introduced Susan Mitchell, public participation coordinator, to lead the panel discussion.

EFFLUENT DISCHARGE ASSESSMENT

Ms. Mitchell explained the purpose of the panel discussion and then introduced each of the panel members:

Kenneth Schmidt, PhD	Groundwater Quality Consultant
Ray Turner, PhD	U.S. Geological Survey
Will Graf, PhD	Arizona State University

Before the panel members began, Stan Smith, Maricopa County Flood Control Association, was asked to give a status report of the channel clearing project. He explained that the Gila Rvier Indian Community had given their permission to clear the south side of the channel and that the project will include a low flow channel.

Andy Marcus, Arizona Environmental Consultants, was then asked to give his overall impression of the report. Mr. Marcus said that the methodology appeared sound; both a literature search and primary research were used. The documentation was weak in several areas such as in the area of the BOD and ammonia on the groundwater quality. He felt the public would be able to accept the conclusions if photographic evidence was included. He also felt that the many questions surrounding the invasion of saltcedars into the area were not answered sufficiently. Studies underway right now should provide some of these answers. His last point was a suggestion that the introduction include a description of how this working paper fit into the whole facility plan.

Dr. Schmidt was then introduced. He stressed three points regarding the groundwater conditions in the area downstream of the 91st Avenue plant. First, both flood flows and sewage effluent contribute to the recharge of groundwater. Second, the groundwater level west of 115th Avenue has generally been within five feet of the surface. This is due partially to additional contributions from the Gila and Aqua Fria Rivers and also due to the shallow bedrock in the area.

A third important factor in the high groundwater levels is the very poor quality of the groundwater, virtually the worst in the area. For this reason, there does not seem to be a high concentration of pumping as in other areas.

Dr. Turner then began his presentation by emphasizing the germination and growth process of the saltcedar. Dr. Turner explained that the mature saltcedar plant will produce 500,000 seeds per year and it matures in just one year. This plant also produces seeds over a very long period of time, generally from April until October. Dr. Turner added that the coincidence of seed production with proper growing conditions is extremely important to the establishment of these plants. The proper condition of moisture must combine with the period of seed production or the plant

does not become established. The fact that saltcedar is found primarily in river channels suggests that it has a very high water dependency.

Dr. Graf then explained the historical analysis of the saltcedar in the Salt River. Dr. Graf noted that his study has a couple of purposes. First, the documentation of the historical development of saltcedars was necessary. To accomplish this, Dr. Graf interviewed residents living near the channel. Although everyone seemed to feel that they remembered exactly what it was like in 1932 at a particular crossing, it was quite easy to find individuals with diametrically opposed stories. Because of this, only data which could be documented such as scientific collections or photographs were used.

The factors investigated included local climate, precepitation, surface flows on both the Salt and Gila Rivers, groundwater levels, flood flows, water quality, amount of sewage effluent, and geomorphic characteristics of the channel. After analyzing all of these factors, the conclusions of the study were that none of the factors could be eliminated completely. Some, however, were more significant than others. The groundwater level beneath the channel appears to be the main controlling factor in the growth of phreatophytes. Other factors have important impacts on groundwater levels, such as flooding.

Another major controlling factor was channel morphology. If the channel is wide and shallow, it would be conducive to phreatophyte growth. If it were narrow and deep, great destruction of vegetation during flooding would occur.

Surface flows, especially those from the Gila River, are a third controlling factor in the study. The reason is that this is one way in which the groundwater level is maintained.

Fluctuations in vegetation in the area downstream of the 91st Avenue plant closely parallel the fluctuation in groundwater levels.

Ms. Mitchell then asked if there were any questions of the panel.

Adron Reichert, Holly Acres Association, stated that we should have seen saltcedar growing all over because the groundwater table was high, yet all that we have seen has been growing within 3 to 4 feet of the channel. Why?

Dr. Turner repsonded that it is no surprise that saltcedar is growing along the banks of the effluent channel. He does not know whether flooding caused surface flow at the right time of year for germination in 1966.

Dr. Graf added that the 1966 flooding was in January.

An advisory committee member stated that the summertime flooding was in 1973. The Game and Fish Department dam, backwaters in low areas, construction of a four-lane road, caused the water to spread out over areas. The culprit is the surface flow, not the groundwater.

Dr. Graf responded that the data suggests that vegetation was reestablished after the flood of 1966 in a "fingerling" kind of pattern, not clear across the channel. It grew along lines of seepage and the effluent canal with flowing water. Tempe was similar, but the saltcedar disappeared because depth to groundwater was greater. The groundwater in the area we are discussing was high enough that once the saltcedar was established, it was able to survive effectively. There is no one reason; they are intertwined.

An advisory committee member asked if the phreatophytes are the result of the effluent from the treatment plants?

Dr. Graf responded no.

An advisory committee member asked if the phreatophytes would be there if the effluent was not there?

Dr. Graf stated that he believed that they would.

An advisory committee member stated that because they need the right climate and water supply for germination, doesn't it make sense that probabilities would be in favor of their survival in places whwere there was continuous flowing water.

Dr. Graf agreed.

An advisory committee member asked if anything would ever displace the saltcedar in the channel.

Dr. Turner responded that he did not think there is anything around right now.

An advisory committee member asked if cottonwood and willow would always be displaced by saltcedar.

Dr. Turner responded that saltcedar requires less water, so when things get rough, cottonwood and willow would give up and saltcedar would survive. It depends on conditions. In the middle east, with similar climate to here, tamarisk is viewed as a valuable resource for wood and cattle grazing of seedlings.

An advisory committee member asked if the nutrient load of effluent makes the saltcedar grow faster.

Mr. Marcus replied that Las Vegas has a twelve mile stretch of tamarisk near the treatment plant, and they have found almost no effect. Phosphates were not changed; some ammonium was taken out, but they thought that was from the clay soil; nitrates remained the same.

An advisory committee member then asked if the saltcedar would grow well in sterile circumstances.

Dr. Graf responded that he has encountered extremely dense thickets in the Colorado River area of Utah, 400 miles from the nearest sewage treatment plant, out in the wilderness. It is a demanding environment, yet

the plants were growing very healthily. Rigorous scientific studies to answer your specific question have not been done, as far as he knew.

An advisory committee member asked why is the groundwater closer to the surface in the western end of this reach.

Dr. Schmidt responded that depth to groundwater increases as you go eastward into the Phoenix area. The greater concentration of wells (and thus pumpage) and much thicker alluvium make a difference. There are also sources of recharge to the western part that are not recharge sources in the eastern part. These include groundwater underflow and seepage of streamflow from the Gila and Agua Fria. Salinity is high and thus less water is pumped. Halpenny has pointed out that pumpage caused water levels to decline in much of the Buckeye Irrigation District, but not under the stream channel. The shallow bedrock may prevent locating wells in that area and pumping near the channel is thus minimal.

An advisory committee member asked if there is a bedrock situation near Wickenburg, where water has to flow up over the bedrock constrictions.

Dr. Schmidt responded that the bedrock in this area is not that shallow. Drillers' logs for wells south of the river indicate that wells penetrate 100 or 200 feet of alluvium before they hit hard rock. East of Monument Hill the alluvium is thick and has an almost infinite areal extent. As one goes west, there are more hydrological boundaries which can result in shallow groundwater levels.

An advisory committee member asked that if the saltcedar were cleared and the effluent removed from the channel, would it grow back in the same place.

Dr. Graf replied that it grew there in 1937 before sewage effluent was ever present.

An advisory committee member asked what would happen if you drilled some wells down at the other end of the channel and lowered the water table.

Dr. Schmidt replied that we could pump a lot of groundwater from this area, but the water that is pumped would be replaced by recharge from the floodflows or the sewage effluent. An intentional dewatering project would be difficult, because recharge would occur from water coming down the channel. When the groundwater basin is full, there is very little percolation of streamflow. However, if the water level is lowered fifty feet, for example, there is going to be substantial percolation of streamflow. Thus the more we pump, the more recharge that will result to counter-balance this. If streamflow in the channel from all sources was stopped, then the water level could be lowered substantially by pumping.

Don Womack, Salt River Project, noted that the methodology has changed. Before, the baseline flow was primarily irrigation tailwater and the Upper Gila flow, with 15,000 to 30,000 acre-feet per year agricultural return water. This figure has been changed to 9100 acre-feet. The Upper Gila River contribution of 13,400 acre-feet is a mean figure, and most of it comes in a few heavy flows. With this new information, would the conclusions be the same as they were originally.

Dr. Schmidt answered that his evaluation of level changes would not be substantially altered by reducing the amount of tailwater to this extent. He originally studied the groundwater independently from the evaluation of surface flow. However, he later reviewed the values for surface water components and has considered this in his report. The floodflows will continue as a source of recharge unless the flood control is altered. If 20 or 30 years pass with no releases, then the water levels will decline.

Dr. Graf added that Halpenny and Greene say 30 percent or more of the water that came over Granite Reef Dam did not make it down to the western end of the valley. This water recharged the groundwater (several hundred thousand acre-feet).

An advisory committee member asked if no effluent was allowed to go down the cleared channel, would there be a parallel channel.

Mr. Smith responded that the clearing project does not pretend to change the present flow characteristics of the river. They plan to provide a clear area for floodflows, not to channelize existing flows. They did not plan on bringing effluent into the clear area or to provide new low flow channels.

Chuck Lakin, citizen, stated that he has about 20 acres of farmland along the north bank of the Salt River. He took great exception to the methodology regarding tailwater contribution to the river. The use of a percentage of the amount of acreage that contributes to the tailwater inflow as the only factor and to use eleven irrigation districts in California as the basis for this is unscientific. In the first place, there was no mention of the facilities for reuse of this tailwater. It assumes that one percent of all the water used on this ends up as tailwater and ends up in the Salt River. This is incorrect. First, virtually every bit of it from the major part of the Salr River Project that services this area is collected in this southwest corner of the district and enters the Buckeye feeder canal on 115th Avenue. It ultimately reaches the Agua Fria and then is diverted at Bullard Road into the Buckeye Irrigation District. His company has used in the past five years an average of 5180 acre-feet of that water in the contract that has existed since 1921. Ten thousand to twelve thousand acre-feet annually of that same water is used by the Buckeye Irrigation District, so about 17,000 acre-feet per year between Buckeye Irrigation District and Lincoln Cattle Company is used from that tailwater. This exceeds the minimum estimate mentioned in this report. The report indicates that the points of inflow have been identified, but it does not identify them. There are no measurements taken to back the figures they come up with. He believes that it is not a valid figure.

Rick Cote, Camp Dresser and Mckee responded that because of the discrepancies which were mentioned, Camp Dresser and Mckee went back through and used only documented flows in the upcoming report. Halpenny's figures were used, along with Salt River Project amounts.

Mr. Reichert stated that the Agua Fria discharges water, the Gila and Salt discharge water, but from Bullard Road downstream, there is not the growth that there is before Bullard.

Dr. Graft stated that he would like to check his maps and get back with Mr. Reichert on that.

Ms. Mitchell then turned the meeting over to Chairperson Lofgren who asked for a motion. Terry Hudgins, Arizona Public Service, moved that the advisory committee accept the Effluent Discharge working paper with revisions. Jack Hinchey, Motorola, seconded the motion. The motion passed with one dissenting vote.

The meeting was then turned over to Mr. Mark Frank, MAG 208 Program Manager.

PLUMBING CODE REVISION AND WASTEWATER FLOW REDUCTION REPORT

Mr. Frank began the discussion by describing the rationale for preparing the report:

1) A 9.5 percent wastewater flow reduction factor for the design of wastewater systems, interceptors, and treatment plants to the year 2000 is contained within the 208 Plan - Point Source Element. The reduction breakdown is 4 percent reduction in flows for existing homes and 15 percent reduction in flows for new homes built from 1980 to 2000.

2) The recent revisions to the State Construction Grants Priority System require an active flow reduction program for any community applying for a federal wastewater construction grant. This requirement becomes effective for FY 1981.

3) The Phoenix/EPA Consent Order on the 91st and 23rd Avenue Treatment Plants contains a requirement for flow reduction.

4) The MAG Management Committee directed the 208 staff to begin work on a revision to valley plumbing codes designed to achieve the 9.5 percent overall reduction in wastewater flows.

The purpose of the study and resultant scope of work was to determine the advisability of the revision on valley plumbing codes. The study effort involved examining the advisability of three low-flow fixtures: shower heads, faucet aerators, and toilets.

Mr. Frank then discussed the perceived role of the committees involved in the study process. The advisory committee has indicated in the past year that they prefer not to be involved in the technical aspect of wastewater systems. Based upon this preference, the Flow Reduction

Committee and Plumbing Code Revision Steering Committee were established to provide the necessary technical input for the development of the code revision. The technical information generated by these committees has now been forwarded to the Water Quality Policy Advisory Committee in the form of a draft working paper for review and consideration. The primary role of the advisory committee would then be to determine the consistency of the code revision with the aforementioned flow reduction recommendations of the 208 Plan.

The primary data collection and analysis was completed by the 208 staff under the direction of Mr. Will LeGrande. The Plumbing Code Revision Steering Committee provided technical information from the perspective of the homebuilding industry, plumbing fixture manufacturers, plumbing contractors, enforcement agencies, etc. The Flow Reduction Committee, composed of intergovernmental coordinators from the cities and towns, provided input on municipal interests.

Ms. Laura Watson, Citizen, asked if it were possible to make items such as garbage disposals request items rather than standard. The disposals are high water users and sludge creating devices.

Mr. Frank indicated that the loading factor in wastewater systems is impacted by garbage disposal systems. However, they were not included in the study since they would necessitate examining the impact of removing their contribution to the wastewater systems and solid waste disposal systems.

Mr. Frank then introduced Mr. Will LeGrande, Project Manager for the study.

Mr. LeGrande stated that the purpose of his presentation was to discuss the following items: formation of the technical committees, working paper, model plumbing code revision, and corresponding review process.

A chart indicating the composition of the Plumbing Code Revision Steering Committee was presented. The committee was instrumental in determining the types of information necessary for the study, developing the code revision and identifying areas for further investigation.

Comprehensive in scope, the study included a summary of ordinances utilized in other cities, availability and acceptance of low volume fixtures and devices, costs, impact of reduced flow on wastewater collection and treatment, and impacts upon the implementing city.

The examination of ordinances utilized in other cities revealed two basic types of flow reduction programs: voluntary and mandatory programs. The primary reasons that communities want to reduce flows are due to drought conditions, lack of quality surface and groundwater, and lack of capacity in wastewater collection and treatment facilities.

This research also indicated that voluntary programs were ineffective in reducing flow. Only a one or two percent flow reduction is achieved with a voluntary program. Mandatory programs comprised of low-flow toilets, faucets, and shower heads have reduced flow by ten to twenty-five percent and are effective in maintaining that reduction. Of all ordinances reviewed, ninety-nine percent utilized these three basic low-flow devices.

Originally, there was a problem with the availability of low-flow fixtures because of low demand. In order to determine current availability, one hundred manufacturers were contacted. Three of the major manufacturers (Kohler, American Standard, and Crane) have indicated that there is no problem with availability now.

Acceptance of low-flow fixtures was also a problem initially. The toilet bowl was not yet redesigned to accommodate a low-flush tank. Consequently, solids were not flushing out of the bowl with the first flush. Manufacturers have indicated that this is no longer a problem because the entire toilet unit has been completely redesigned.

Early low-flow fixtures were more expensive than standard fixtures due to low demand. Because demand has increased, low-flow fixtures are now the same price as standard fixtures.

It was difficult to determine the impact of reduced flows on wastewater collection and treatment because there are a limited number of studies in this area. Therefore, it was necessary to rely on theoretical studies from engineers and university professors. The experts have indicated that while there should be little impact on wastewater collection, there could be problems with the clogging of laterals and house connections and wastewater turning septic in the pipes. These problems are unlikely to occur unless the area has less than five hundred people contributing to the system itself.

The experts have further indicated that a ten to twenty-five percent reduction would have very little impact on the treatment plant. If problems do occur, the plant operator can easily adjust the treatment process accordingly.

Mr. LeGrande then discussed the impact of flow reduction measures on an implementing city. Reducing the amount of water used should extend the existing water supply and life of the wastewater system. Costs due to plant expansions and construction of new facilities should also be reduced. There may be a need, however, to increase water rates slightly; this would amount to only pennies per household.

It is recommended by the Plumbing Code Revision Steering Committee that the Plumbing Code Revisions become effective by January 1, 1981 for three reasons:

1) It will enable suppliers in the area to deplete their stock of standard fixtures.

2) It will provide time for homebuilders and their contractors to comply with the revisions.

3) It will provide adequate time for the Cities and Towns to adopt the code in part or in entirety.

The Plumbing Code Revision contains the following recommendations:

- A toilet flush is not to exceed four gallons.
- The flow rate for shower heads is not to exceed a maximum of three gallons per minute.
- The flow rate for faucets is not to exceed 3.5 gallons per minute.
- The flow rate for faucets in public restrooms is not to exceed 3.5 gallons per minute.
- Standard fixtures are permitted under special health and safety conditions.

A chart delineating the review process necessary for adoption of the code revision was presented. It included the following committees and groups: MAG Staff, Plumbing Code Revision Steering Committee, Flow Reduction Committee, Arizona Groundwater Management Study Commission and State 208 Program (information provision only), MAG Public Works Committee, MAG Building Codes Committee, and MAG Regional Council.

Ms. Lofgren asked if the steering committees have already provided their input.

Mr. LeGrande indicated that the committees have been well informed and provided input throughout the study process.

Helen Cornell, City of Glendale, stated that the Building Inspection Supervisor for Glendale recommends including a policy on the repair of leaky faucets and shower heads.

Mr. LeGrande replied that repairs are voluntary and not mandatory. They will be included, however, as part of the overall flow reduction program.

Paul McCleester, Sun City Homeowners Association, asked if there were a County-wide or State Plumbing Code in existence.

Mr. Frank stated that the County and State do not have codes. County jurisdiction is only in the unincorporated areas.

Eva Patten, Governor's Commission on the Arizona Environment, stated that Mr. LeGrande had done an outstanding job on the report. The technique of utilizing technical task forces exemplified in this study should be considered for other studies in the future. The advisory committee should strongly recommend the continuation of the water conservation effort and the code revision is needed right away.

Bill Raymo, Sun City Water and Sewers Company, stated that if there is a fifteen percent reduction in flow, the solids are going to remain in the pipes. He again asked if the County and State would specify new design

criteria for sewer lines. Certain design criteria for sewer systems is currently specified. For example, for an eight inch line, it is necessary to have a .32 percent minimum slope. This will produce a two feet per second cleansing velocity when flowing full, not when flowing three-fourths full.

Ms. Lofgren stated that these questions would be answered at the next meeting and a decision would be deferred until that time. The meeting was adjourned.

APRIL 24, 1980 WATER QUALITY POLICY ADVISORY COMMITTEE MEETING

PANEL OF EXPERTS

Ken Schmidt:

I'd like to first make some comments on the report. I believe that the groundwater work that I performed was used correctly in this report in the text. However, one figure in the final report could be clarified (Figure 2-4). This is a hydrograph for a well near 91st Avenue. It is meant to show the historical changes in groundwater levels and these are not solely due to floodflows. The title of this would be a lot better if either floodflows were not mentioned or floodflows and sewage effluent were used, because the change in water levels is showing the effects of both of these.

For the groundwater study, we collected information on the subsurface materials from the drillers' logs available from the Arizona Water Commission, the U.S. Geological Survey, irrigation districts, and others. We collected the historical water-level information from the same places. Information on the chemical quality is also available from the State Health Department and County Health Department. There has not been a program in existence in the past to specifically measure the depth to water beneath the river channel. We don't have special piezometers or numerous wells to determine this. At the end of my report, I recommended that this be done. I feel that if this is not done, then we're going to be here in 20 years arguing the same thing all over again. So there is a need to have special monitor wells and to implement a monitoring program, if we're to draw conclusions based on solid data. In the absence of such data, we've used records for nearby wells. There's a Salt River Project well near 91st Avenue and the Salt River, there are records from Herman Bouwer's Flushing Meadows Project, which is west of that area, and there are records for wells at some distance from the river to the west, including the Buckeye I.D. wells near the western boundary of the area.

The depth to water in this area when there are flood releases being made down the river is virtually at the channel level throughout this whole reach. In other words, in the presence of such releases and perhaps for months after, the groundwater level is going to be very close to the channel level. It means that the groundwater basin an the area is virtually full. In the absence of flood releases, the water level falls to a lower level. Up until about 1964 or 1965, the groundwater level was at its lowest depth that we know of. This was primarily due to pumping and the fact that floodflows had not been present as a source of recharge for many decades. Since 1965, two things have happened: there's been increased recharge from sewage effluent and there have been large floodflows in some years. Both have contributed to recharge in this area, but I can't quantify the extent of each. They're both extremely important, and one cannot explain water level trends in the area with only one of them. That is, one cannot explain how the water levels have changed if only sewage effluent is considered and one cannot explain how they've changed if only floodflows are considered. Floodflows have produced marked responses in water levels over a short time period. Floodflows also scour the channel and they allow more infiltration of effluent at a later time, when the floodflows are not being released.

Discussions on the depth to water beneath the channel may have been confusing to read in the report because it's one thing to talk about depth to water in the wells and it's another to try to extrapolate it to the channel level. If we were doing this very precisely, we would have special monitor wells and would know the elevation at the top of those. We don't have this kind of information, so we are extrapolating from the measurements we have. For wells like those for

the Salt River Project, we do know the elevation of the measuring point, and thus we know the elevation of the water in such a well. These are virtually the only well s in this whole area for which we know exact water level elevations. Water levels have been deepest in the eastern part of the area near 91st Avenue. The deepest it has been is about 25 feet below the ground surface in this area. This is a depth you would expect when there have not been any flood releases for several years. On the other hand, the basin will be full (right up to the channel level) when floodflows are occurring. The groundwater depth as one goes to the west from the Flushing Meadows Project, to Monument Hill, and to the Buckeye Canal Heading, become progressively shallower. I must admit that we do not have measurements for many wells in the western part of this area near the river channel. There are some wells that have been measured periodically, but continuous measurements are usually not available. The records we do have indicate that the groundwater has been shallow in that area. Of course, as one goes further west near Buckeye, the water level is near the land surface. It has generally been within five feet of the channel level in the western part of the study area. There are some other sources of recharge in this area, for example, streamflow from the Gila River, groundwater inflow from the Gila River floodplain, and streamflow from the Agua Fria River.

Another important factor is that the western part of the area is underlain by poor groundwater quality. Groundwater of high salinity is present in the western part of this area and there doesn't appear to be as much pumping here as there is to the east.

Lastly, the geologic conditions west of Monument Hill, where the bedrock is very shallow south of the Gila River, tend to keep the groundwater level shallower.

Ray Turner:

Unlike the other members of this panel, I don't have experience with this specific area. I began working with the USGS in 1962 on what they call the Gila River Phreatophyte Project on the Gila River upstream from Coolidge Dam. I was reminded of that work by Mr. Smith's remarks earlier today. We cleared approximately 25 miles of the river channel there as part of an experimental design. We have written a report, which I'll be glad to send to Mr. Smith, describing the methods used and we have some cost estimates that were applicable in the late 60's and early 70's. Just give me a call and I'll be glad to send you that report.

Furthermore, there's another thing that comes to mind before I discuss the few points that I want to make. And that is that in a very short time the saltcedar and other plants have come back into the Gila River Phreatophyte Project area. It was not maintained, and I foresee in the channel that you may have here a continuing problem with maintenance, but you probably realize that already.

I'd like to discuss very briefly saltcedar and its introduction into this area and its contribution to what I think is a very major dislocation of the ecology in the streams of Arizona and other southwestern areas. So far as we can tell, it was brought to this continent in the 19th Century as a horticultural plant. It was planted in people's gardens, and it was picked up by botanists and preserved in herbaria in Arizona as early as 1892. Botanists collected it first from the Santa Catalina Mountains outside of Tucson. It was later picked up about 1901 in Tempe; Thatcher in 1905. It appeared in large numbers at Gillespie Dam by 1929. This is probably one of the biggest early sites for it. Subsequent to that, it increased very rapidly during the 40's and 50's and now it's found in many, many places, as you probably know.

What's the reason for this plant's success? There are other phreatophytes here, other riparian species. How does it succeed in shouldering them aside? If it weren't for the saltcedar being here, we'd probably have instead such things as seepwillow and other willows. I'm not sure they'd be less of a problem, but at any rate they have been displaced by this plant. According to work by Jerry Horton and others in the Forest Service, the mature, robust saltcedar plant will produce as many as 500,000 seeds per year. That's a single plant. That's a lot of seeds. Another thing in its favor is that it matures in one year. This is a tree, and it's very unusual for trees to become sexually mature in so short a time as one year. Most of you who plant trees in your yard know you have to wait for a long time before mulberries flower and this sort of thing. This is a rather unusual plant in that regard. The seeds are windborne and disseminate through the air...they pepper the landscape; not many places are missed. To site a rather remarkable example, I think, is a sighting of saltcedar in the bottom of a volcanic crater in the Pinacate Mountain area in the northwestern Sonoran. This is south of Organ Pipe Cactus National Monument. MacDougal Crater is perhaps 10 or 15 miles from the Rio Sonoita, where there is a heavy stand of saltcedar. But in the bottom of this crater in an area that receives perhaps six inches of rainfall a year there is saltcedar growing. The seeds were carried there through the air, presumably. Water accumulates in the bottom of that crater from time to time from rain, and the seed was there at the right time and germinated. Of course, elsewhere in the desert, it's too dry; the plant can't grow just anywhere; it has to have just the right conditions. But once there's a seed source, not necessarily close by, but within a few tens of miles, it's going to get started. The plant is all about us. The seed source is something we can't eliminate.

Another important point about this plant is that it produces seeds over a very long period of time. Each year it begins producing seeds in April or May and doesn't stop producing them until about October. Unlike the cottonwood and the willow, which have very brief seed-producing seasons, just a few weeks in the spring, the saltcedar produces seeds throughout the summer. It's similar in that respect to seepwillow. When you wonder why it has the uppder hand over seepwillow, one of the interesting features of seepwillow that is not in its favor is that it is a bisexual plant. That is, it has certain plants that are pollen producers but not seed producers, and the other plants produce seeds. So roughly half of all the seepwillow plants that you see on the bank of a stream are producing seeds. By contrast, all of the saltcedar plants are producing seeds.

Another very important feature of saltcedar, willow and cottonwood seed ecology is that the seeds are very short-lived; they only last a few weeks, at least under the high temperatures that we experience here in the desert. If refrigerated, they'll last for a very long time.

Combining what I have just said about duration of seed production and length of seed viability, we can easily see that the coincidence of seed production with proper growing conditions is extremely important to the establishment of these riparian species. Summer stream flow will be of no benefit to species such as willow and cottonwood, both of which have spring periods of seed production.

It's equally important for saltcedar and seepwillow that the proper conditions of moisture coincide with the period of seed production or the plant does not become established. This means then that if the channel which is open for establishment is moist in the wintertime, saltcedar does not make use of it.

Saltcedar does not germinate during the winter. Seepwillow does. Seepwillow seeds remain viable for a longer period of time and even though they're not being produced during the wintertime, seeds left over from summer production do produce seedlings. We've seen this around reservoirs as we've followed the history throughout a year of the water level decline on the reservoir bank: seepwillow will come in during the winter, but as soon as the saltcedar seeds start to fly, saltcedar takes over. There's a very definite seasonal rhythm to the establishment of these plants.

The fact that saltcedar is found primarily in river channels suggests that it has a very high water dependence. I've seen it in some rather unlikely places, however. It's found growing on a roadcut beside a highway between Winkelman and Mammoth; I know that highway was sprinkled as a means of settling the bed just before paving. I just think that the sprinklers watered the vertical banks sufficiently so the saltcedar became established, and sprinklers were undoubtedly operating during the critical summer season. It's right by the San Pedro River with a very good source of seeds nearby. So you do find it in surprising places, but virtually anywhere you find it, it's in a place that is very well watered.

William Graf:

My interest in saltcedar or tamarisk or whatever you wish to call it stems from my work in the geomorphology of stream channels, that is, the mechanics of how flowing water changes the channel. In working in the American Southwest it quickly becomes very obvious that you can't understand much about what happens with a river channel unless you understand what happens with the vegetation that grows within the river channel. Hence my interest in saltcedar.

Most of what I have to say today is the direct outgrowth of a project on which I am working in conjunction with the Corps of Engineers and our major interest in this project really is not sewage effluent or groundwater levels but is in the question of flood control: what potential impacts flood control efforts might have on the stream channel and the vegetation that grows in it. Also, I have a problem with the scale of analysis because most of my work concerns the entire reach of the channel from Granite Reef Dam on the east to Gillespie Dam on the west. And so the photographs that occupy several feet of the wall over here occupy all of about three inches on the maps that I work with. So I tend to be analyzing the question of growth of saltcedar from a bit more regional-scaled analysis than what is discussed in the report that you're considering.

In the work that we've done so far, we've attempted to accomplish a couple of things. First of all, we wanted to document very clearly the historical development of the growth of phreatophytes in general and of tamarisk (saltcedar) in particular in this reach between the two dams. Discussions with local residents, people who live and work in the areas near the channel, showed very quickly that

although everyone seemed to feel that they remembered exactly what it was like in 1932 at a particular road crossing, it was quite easy to find several individuals who had stories that were diametrically opposed to each other. So we very quickly went away from this sort of interviewing process and resolved the question into accepting only that data which we could document, either from scientific collections such as Dr. Turner mentioned, or from photographs, where although we might disagree about the interpretation of that evidence, we could agree that the evidence was there.

In using evidence of this type, we attempted to build a history of the invasion of the river from Gillespie upstream to Granite Reef and then we wanted to use that history to test a variety of hypotheses about what controls the growth of this plant. We tried to build a chronology of the growth of the plant. Then we tried to document changes that took place in a variety of potential control mechanisms. And then we tried to see if there were any matc-ups. For example, if the groundwater levels increased in a particular area, did we see a concommitant increase in the growth of phreatophytes in the area? The factors that we investigated included such things as local climate, the amount of precipitation that was available (as we've just heard, the amount of precipitation that is available in the form of soil water might be significant; we didn't know). So we went back to the historical climatological records all the way back to the 1890's and tried to document the changes in the precipitation regimes in the areas along the river. We wanted to compare it with the extent of the growth of phreatophytes.

Other control factors that we investigated in our research included such things as surface flows on both the Salt and the Gila Rivers; groundwater levels,

which have already been mentioned; floodflows, both in terms of their magnitude and duration; we were concerned about water quality because saltcedar in particular has the ability to survive very effectively in highly saline environments, where many of its competitors would not, so we felt that might be a consideration. We also wanted to examine such things as groundwater, particularly the well levels. As was mentioned earlier, we had some difficulty in determining the depth to groundwater. We also investigated such things as the amount of sewage effluent that was available in the channel as it fluctuated from one time to the next. We examined the geomorphic characteristics of the channel itself, that is, its shape (Was it wide and shallow or narrow and deep?). Does that have an effect on the growth of the plants? We investigated the gradient of the channel, sedimentation processes in the channel, sediment sizes to determine whether or not those had changed over time and perhaps had influenced the growth of the plant, and finally we looked at land use and land management.

After a rather exhausting analysis of the trends of all these variables and comparing them with the changes in growth of phreatophytes in four major sections of the channel, which I can discuss in a moment, we came to the conclusion that of all of these potential control factors, we really couldn't eliminate completely any of them, but we could define which ones were most significant and which ones were most important. Our evidence, we feel, shows rather conclusively that the level of the groundwater beneath the channel is the main controlling factor in growth of phreatophytes. Now if you recall the list of controlling factors, some of those other things had something to do with groundwater levels. The floods, for example, have an important impact on groundwater levels and therefore,

through groundwater, they have an effect on the growth of phreatophytes. But at any rate, groundwater turned out to be the major controlling factor from the study.

Also a major controlling factor was channel morphology. In other words, if the channel was in fact wide and shallow, this was very conducive to the growth of many of the phreatophytes. On the other hand, if the channel were narrow and restrictive, we found that during flood periods, great destruction of the vegetation near the channel occurred. So, of the floods were frequent enough, the vegetation did not have an adequate opportunity to grow and develop effectively.

A third major and most important control factor in our study we found was surface water, specifically, the surface flows that occasionally do issue from the Gila River area. The reason for this apparently is that that is one way in which the level of groundwater is maintained in that area, so those surface flows do, in fact, become very critical in the support of phreatophytes, especially in the study area that you're working with here.

These conclusions are drawn from the analysis of changes that took place in the area immediately behind Gillespie Dam, in the area that we're working with here, in the area just upstream from the Tempe bridge crossing, and in an area near northeast Mesa. All these areas showed similar trends in the growth of phreatophytes and changes in the control factors. If you look at these areas today, I think you can see how these control factors operate. Behind Gillespie Dam we have extremely high water tables, and we have very dense growth of phreatophytes on available surfaces. Obviously, surfaces that are inundated continuously do not have dense growth, but if there are suitable surface conditions for the

growth of phreatophytes, they do in fact survive there and have survived there since at least 1929. As Dr. Turner mentioned, that was one of the early areas where tamarisk or saltcedar did appear in this area. Our evidence indicates that the area behind Granite Reef Dam was also a similar heart-zone, if you want to call it that, for the very dense growth of these plants. In the area that we're working with here today, we've noticed in our analysis fluctuations from one time to the next in terms of density and growth of phreatophytes. We've found that the fluctuations very closely parallel the fluctuation in groundwater level. There may be other factors that control groundwater levels, but we found that if you examine the fluctuation of those levels you can find that it correlates reasonably well with the extent of growth of phreatophytes. In the Tempe bridge crossing area immediately upstream we had, in the 1940's, growth that was just as dense as what we see here now. Those of you that crossed the Tempe bridge this morning might have looked upstream and seen a totally barren channel. We found that in the 40's and early 50's, the dense growth of phreatophytes in that area disappeared over a relatively gradual sort of time period, but nonetheless a change did occur. It coincided with the withdrawal of groundwater by the local municipalities in that area, and it was closely correlated with that. In northeast Mesa we have exactly the opposite end of the spectrum of what we had behind Gillespie Dam. Apparently phreatophytes have never grown densely there, and it is also apparent the groundwater levels have never been very close to the surface in that region. In the 1930;s, the water levels were perhaps within some 20 feet of the surface or so and there were scattered patches of phreatophytes at that time, but once those levels declined, the phreatophytes disappeared. If we

examine the changes that have taken place that we have been able to document, along with the changes that have taken place in groundwater levels, we have found that once the groundwater has dropped below some guess between 20 and 25 feet, that at least in the present environmental conditions, we don't find dense growth of phreatophytes. If the water levels are above this depth, somewhere between 20 and 30 feet, we find that the phreatophytes are able to grow successfully and very densely. In order to do so, the water levels must be maintained at that fairly high level.

The conclusions that we've reached will appear in a report that is now in draft form. Presumably, once it's been through the proverbial wringer, it will be available through the urban study office of the Army Corps of Engineers.

EDITED QUESTION AND ANSWER SESSION RESPONSES

QUESTION FROM CITIZEN: You say we should have seen saltcedar growing all over, because the groundwater table was high, yet all we have seen has been growing within 3 to 4 feet of the surface flow. Why?

TURNER: It's no surprise that saltcedar is growing along the banks of the effluent channel. I don't know whether flooding caused surface flow at the right time of year for germination in 1966.

CITIZEN: The '66 flooding was in January.

CITIZEN: I think the summertime flooding was in 1973. AGFD dam, backwaters in low areas, construction of a four-lane road, etc. caused the water to spread out over areas. What is the culprit is the surface flow, not the groundwater.

GRAF: My data suggests that vegetation was reestablished after the flood of 1966 in a "fingerling" kind of pattern, not clear across the channel. It grew along lines of seepage and the effluent canal with flowing water. Tempe was similar, but the saltcedar disappeared because depth to groundwater was greater. The groundwater in the area we're discussing was high enough that once the saltcedar was established, it was able to survive effectively. There is no <u>one</u> reason; they're intertwined.

QUESTION FROM CITIZEN: Are the phreatophytes the result of the effluent from the treatment plants?

GRAF: No.

CITIZEN: Would the phreatophytes be there if the effluent was not there?

GRAF: I believe they would.

CITIZEN: Because they need the right climate and water supply for germination, doesn't it make sense that probabilities would be in favor of their survival in places where there was continuous flowing water?

GRAF: I believe that's true.

QUESTION FROM CITIZEN: Would anything ever displace the saltcedar in the channel?

TURNER: I don't think there's anything around right now.

CITIZEN: Would cottonwood and willow always be displaced by saltcedar?

TURNER: Saltcedar requires less water, so when things get rough, cottonwood and willow would give up and saltcedar would survive. It depends on conditions. In the middle east, with similar climate to here, tamarisk is veiwed as a valuable resource for wood and cattle grazing of seedlings.

QUESTION FROM CITIZEN: Does the nutrient load of effluent make the saltcedar grow faster?

MARCUS: Las Vegas has a twelve-mile stretch of tamarisk near the treatment plant, and they have found almost no effect. Phosphates weren't changed; some ammonium was taken out, but they thought that was from the clay soil; nitrates remained the same.

CITIZEN: So would saltcedar grow well in sterile circumstances?

GRAF: I've encountered extermely dense thickets in the Colorado River area of Utah, 400 miles from the nearest sewage treatment plant, out in the wilderness. It's a demanding environment, yet the plants were growing very healthily. Rigorous scientific studies to answer your specific question have not been done, as far as I know.

QUESTION FROM CITIZEN: Why is the groundwater closer to the surface in the western end of this reach?

SCHMIDT: Depth to groundwater increases as you go eastward into the Phoenix area. The greater concentration of wells (and thus pumpage) and much thicker alluvium make a difference. There are also sources of reacharge to the western part that are not recharge sources in the eastern part. These include groundwater underflow and seepage of streamflow from the Gila and Agua Fria. Salinity is high and thus less water is pumped. Halpenny has pointed out that pumpage caused water levels to decline in much of the Buckeye I.D., but not under the stream channel. The shallow bedrock may prevent locating wells in that area and pumping near the channel is thus minimal.

CITIZEN: Is there a bedrock situation there like near Wickenburg, where water has to flow up up over the bedrock constrictions?

SCHMIDT: The bedrock in this area is not that shallow. Drillers' logs for wells south of the river indicate that wells penetrate 100 or 200 feet of alluvium before they hit hard rock. East of Monument Hill the alluvium is thick and has an almost infinite areal extent. As one goes west, there are more hydrological boundaries which can result in shallow groundwater levels.

QUESTION FROM CITIZEN: If the saltcedar were cleared and the effluent removed from the channel, would it grow back in the same place?

GRAF: It grew there in 1937 before sewage effluent was ever present.

QUESTION FROM CITIZEN: What would happen if you drilled some wells down at the other end of the channel and lowered the water table?

SCHMIDT: We could pump a lot of groundwater from this area, but the water that is pumped would be replaced by recharge from the floodflows or the sewage effluent. An intentional dewatering project would be difficult, because recharge would occur from water coming down the channel. When the groundwater basin is full, there's very little percolation of streamflow. However, if the water level is lowered fifty feet, for example, there is going to be substantial percolation of streamflow. Thus the more we pump, the more recharge that will result to counter-balance this.

(SCHMIDT, cont'd): If streamflow in the channel from all sources was stopped, then the water level could be lowered substantially be pumping.

QUESTION FROM CITIZEN: The methodology has changed: Before, the baseline flow was primarily irrigation tailwater and the Upper Gila flow, with 15-30 thousand acre-feet per year agricultural return water. That has been changed to 9100 acre-feet. The Upper Gila River contribution of 13,400 acre-feet is a mean figure, and most of that comes in a few heavy flows. With this new information, would the conclusions be the same as they were originally?

SCHMIDT: My evaluation of level changes wouldn't be substantially altered by reducing the amount of tailwater to this extent. I originally studied the groundwater independently from the evaluation of surface flow. However, I later reviewed the values for surface water components and have considered this in my report. The floodflows will continue as a source of recharge unless the flood control is altered. If 20 or 30 years pass with no releases, then the water levels will decline.

GRAF: Halpenny and Greene say 30 percent or more of the water that came over Granite Reef Dam did not make it down to the western end of the valley. That water recharged the groundwater (several hundred thousand acre-feet).

QUESTION FROM CITIZEN: If no effluent is allowed to go down the cleared channel, will there be a parallel channel or what?

SMITH: The clearing project doesn't pretend to change the present flow characteristics of the river. We plan to provide a clear area for floodflows, not to channelize existing flows. We didn't plan on bringing effluent into the clear area or to provide new low flow channels.

QUESTION FROM CITIZEN: I have about 20 acres of farmland along the north bank of the Salt River. I would like to take great exception to the methodology regarding tailwater contribution to the river. The use of a percentage of the amount of acreage that contributes to the tailwater inflow as the only factor and to use eleven irrigation districts in California as the basis for this is unscientific. In the first place, there was no mention of the facilities for reuse of this tailwater. It assumes that one percent of all the water used on this ends up as tailwater and ends up in the Salt River. That is incorrect. First, virtually every bit of it from the major part of the Salt River Project that services this area is collected in this southwest corner of the district and enters the Buckeye feeder canal on 115th Avenue. It ultimately reaches the Agua Fria and then is diverted at Bullard Road into the Buckeye Irrigation District. My company has used in the past five years an average of 5180 acre-feet of that water in the contract that has existed since 1921. Ten thousand to twelve thousand acre-feet anually of that same water is used by the BID, so about 17,000 acre-feet per year between BID and Lincoln Cattle Co. is used from that tailwater. That exceeds the minimum estimate mentioned in this report. The report says that the points of inflow have been identified, but it doesn't identify them. There are no measurements taken to back the figures that they come up with. I believe that it is not a valid figure.

COTE: Because of the discrepancies which you have mentioned, we went back through and used only documented flows in the upcoming report. Halpenny's figures were used, along with Salt River Project amounts.

CITIZEN: You're saying the Agua Fria discharges water, the Gila and Salt discharge water, but what we see is from Bullard Road downstream there's not the growth that there is before Bullard.

GRAF: I'd like to check my maps and get back with you on that.

SUMMARY OF CHANGES BEFORE REPORT IS RESUBMITTED (COTE): Irrigation tailwater flows and Gila River contribution will be expanded and clarified. The conclusions will not change in essence, but sections will be clarified.

CONCLUSION:

The meeting concluded with a vote on whether to accept the Effluent Discharge Assessment with the proposed changes; it was accepted. It was also agreed that the contents of this meeting would be included as an appendix.

EXHIBIT C

EFFLUENT FLOW PROJECTIONS

GREELEY AND HANSEN JANUARY 1980

TABLE C-1

PLANT EFFLUENT FLOW PROJECTIONS

Month	23rd Avenue Plant Effluent Flows, mgd			91st Avenue Plant Effluent Flows, mgd			Combined Effluent Flows, mgd		
	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum
1980									
January	38.3	36.4	18.9	83.4	78.4	36.1	121.7	114.8	55.0
February	37.9	35.6	16.4	86.2	81.0	38.1	124.1	116.6	54.5
March	37.2	36.1	17.7	88.0	81.8	40.9	125.2	117.9	58.6
April	37.2	35.0	17.5	88.0	80.1	38.4	125.2	115.1	55.9
May	36.5	34.2	18.9	88.9	79.1	41.1	125.4	113.4	60.0
June	36.8	34.6	18.7	88.9	78.2	40.7	125.7	112.8	59.4
July	37.2	35.0	21.7	91.6	83.4	49.2	128.8	118.4	70.9
August	36.1	34.3	20.6	93.4	84.1	44.6	129.5	118.4	65.2
September	35.7	33.9	20.7	99.8	92.8	46.4	135.5	126.7	67.1
October	35.0	33.6	21.2	97.0	87.3	44.5	132.0	120.9	65.7
November	33.9	32.2	17.7	92.5	87.0	40.9	126.4	119.2	58.6
December	35.7	33.9	18.0	90.7	85.3	42.7	126.4	119.2	60.7

(Continued)

TABLE C-1 (Continued)

Month	23rd Avenue Plant Effluent Flows, mgd			91st Avenue Plant Effluent Flows, mgd			Combined Effluent Flows, mgd		
	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum
1981									
January	38.3	36.4	18.9	85.6	80.5	37.0	123.9	116.9	55.9
February	37.9	35.6	16.4	88.4	83.1	39.1	126.3	118.7	55.5
March	37.2	36.1	17.7	90.2	83.9	42.0	127.4	120.0	59.7
April	37.2	35.0	17.5	90.2	82.1	39.4	127.4	117.1	56.9
May	36.5	34.2	18.9	91.1	81.1	42.2	127.6	115.3	61.1
June	36.8	34.6	18.7	91.1	80.2	41.7	127.9	114.8	60.4
July	37.2	35.0	21.7	93.9	85.4	50.4	131.1	120.4	72.1
August	36.1	34.3	20.6	95.8	86.2	45.7	131.9	120.5	66.3
September	35.7	33.9	20.7	102.3	95.1	47.6	138.0	129.0	68.3
October	35.0	33.6	21.2	99.5	89.6	45.7	134.5	123.2	66.9
November	33.9	32.2	17.7	94.9	89.2	41.9	128.8	121.4	59.6
December	35.7	33.9	18.0	93.0	87.4	43.7	128.7	121.3	61.7
1982									
January	38.3	36.4	18.9	87.9	82.6	38.0	126.2	119.0	56.9
February	37.9	35.6	16.4	90.7	85.3	40.1	128.6	120.9	56.5
March	37.2	36.1	17.7	92.6	86.1	43.1	129.8	122.2	60.8
April	37.2	35.0	17.5	92.6	84.3	40.5	129.8	119.3	58.0
May	36.5	34.2	18.9	93.6	83.3	43.3	130.1	117.5	62.2
June	36.8	34.6	18.7	93.6	82.4	42.8	130.4	117.0	61.5
July	37.2	35.0	21.7	96.5	87.8	51.8	133.7	122.8	73.5
August	36.1	34.3	20.6	98.4	88.6	47.0	134.5	122.9	67.6
September	35.7	33.9	20.7	105.1	97.7	48.9	140.8	131.6	69.6
October	35.0	33.6	21.2	102.2	92.0	46.9	137.2	125.6	68.1
November	33.9	32.2	17.7	97.4	91.6	43.1	131.3	123.8	60.8
December	35.7	33.9	18.0	95.5	89.8	44.9	131.2	123.7	62.9

(Continued)

TABLE C-1 (Continued)

Month	23rd Avenue Plant Effleunt Flows, mgd			91st Avenue Plant Effluent Flows, mgd			Combined Effluent Flows, mgd		
	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum
1983									
January	38.3	36.4	18.9	90.2	84.8	39.0	128.5	121.2	57.9
February	37.9	35.6	16.4	93.1	87.5	41.1	131.0	123.1	57.5
March	37.2	36.1	17.7	95.1	88.4	44.2	132.3	124.5	61.9
April	37.2	35.0	17.5	95.1	86.5	41.5	132.3	121.5	59.0
May	36.5	34.2	18.9	96.0	85.4	44.4	132.5	119.7	63.3
June	36.8	34.6	18.7	96.0	84.5	43.9	132.8	119.1	62.6
July	37.2	35.0	21.7	99.0	90.1	53.2	136.2	125.1	74.9
August	36.1	34.3	20.6	100.9	90.8	48.1	137.0	125.1	68.7
September	35.7	33.9	20.7	107.8	100.3	50.2	143.5	134.2	70.8
October	35.0	33.6	21.2	104.9	94.4	48.1	139.9	128.0	69.3
Novmeber	33.9	32.2	17.7	100.0	94.0	44.2	133.9	126.2	61.9
December	35.7	33.9	18.0	98.0	92.1	46.1	133.7	126.0	64.1
1984									
January	38.3	36.4	18.9	92.5	87.0	40.0	130.8	123.4	58.9
February	37.9	35.6	16.4	95.5	89.8	42.2	133.4	125.4	58.6
March	37.2	36.1	17.7	97.5	90.7	45.4	134.7	126.8	63.1
April	37.2	35.0	17.5	97.5	88.7	42.6	134.7	123.7	60.1
May	36.5	34.2	18.9	98.5	87.7	45.6	135.0	122.0	64.5
June	36.8	34.6	18.7	98.5	86.7	45.1	135.3	121.3	63.8
July	37.2	35.0	21.7	101.5	92.4	54.5	138.7	127.4	76.2
August	36.1	34.3	20.6	103.5	93.2	49.4	139.6	127.5	70.0
September	35.7	33.9	20.7	110.6	102.9	51.5	146.3	136.8	72.2
October	35.0	33.6	21.2	107.5	96.8	49.4	142.5	130.4	70.6
November	33.9	32.2	17.7	102.5	96.4	45.3	136.4	128.6	63.0
December	35.7	33.9	18.0	100.5	94.5	47.3	136.2	128.4	65.3

(Continued)

TABLE C-1 (Continued)

Month	23rd Avenue Plant Effluent Flows, mgd			91st Avenue Plant Effluent Flows, mgd			Combined Effluent Flows, mgd		
	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum	Monthly Average	Weekly Minimum	Daily Minimum
1985									
January	38.3	36.4	18.9	94.7	89.0	40.9	133.0	125.4	59.8
February	37.9	35.6	16.4	97.8	91.9	43.2	135.7	127.5	59.6
March	37.2	36.1	17.7	99.8	92.8	46.4	137.0	128.9	64.1
April	37.2	35.0	17.5	99.8	90.8	43.6	137.0	125.8	61.1
May	36.4	34.2	18.9	100.8	89.7	46.6	137.2	124.0	65.5
June	36.8	34.6	18.7	100.8	88.7	46.1	137.6	123.3	64.8
July	37.2	35.0	21.7	103.9	94.5	55.8	141.1	129.5	77.5
August	36.1	34.3	20.6	106.0	95.4	50.6	142.1	129.7	71.2
September	35.7	33.9	20.7	113.2	105.3	52.7	148.9	139.2	73.4
October	35.0	33.6	21.2	110.1	99.1	50.5	145.1	132.7	71.7
November	33.9	32.2	17.7	105.0	98.7	46.4	138.9	130.9	64.1
December	35.7	33.9	18.0	102.9	96.7	48.4	138.6	130.6	66.4
1986									
January	38.3	36.4	18.9	96.6	90.8	41.8	134.9	127.2	60.7
February	37.9	35.6	16.4	99.8	93.8	44.1	137.7	129.4	60.5
March	37.2	36.1	17.7	101.9	94.8	47.4	139.1	130.9	65.1
April	37.2	35.0	17.5	101.9	92.7	44.5	139.1	127.7	62.0
May	36.4	34.2	18.9	102.9	91.6	47.6	139.3	125.8	66.5
June	36.8	34.6	18.7	102.9	90.6	47.1	139.7	125.2	65.8
July	37.2	35.0	21.7	106.1	96.6	57.0	143.3	131.6	78.7
August	36.1	34.3	20.6	108.2	97.4	51.6	144.3	131.7	72.2
September	35.7	33.9	20.7	115.5	107.4	53.7	151.2	141.3	74.4
October	35.0	33.6	21.2	112.4	101.2	51.6	147.4	134.8	72.8
November	33.9	32.2	17.7	107.1	100.7	47.3	141.0	132.9	65.0
December	35.7	33.9	18.0	105.0	98.7	49.4	140.7	132.6	67.4

TABLE C-2

EFFLUENT REUSE FLOW PROJECTIONS

Month	Monthly Average Reuse Flow Projections, mgd			
	Arizona Game and Fish Department	Buckeye Irrigation District	Arizona Public Service	Total
1980				
January	6.5	26.8	-	33.3
February	6.5	26.8	-	33.3
March	6.5	26.8	-	33.3
April	6.5	26.8	-	33.3
May	6.5	26.8	-	33.3
June	6.5	26.8	-	33.3
July	6.5	26.8	-	33.3
August	6.5	26.8	-	33.3
September	6.5	26.8	-	33.3
October	6.5	26.8	-	33.3
November	6.5	26.8	-	33.3
December	6.5	26.8	-	33.3
1981				
January	6.5	26.8	-	33.3
February	6.5	26.8	-	33.3
March	6.5	26.8	-	33.3
April	6.5	26.8	-	33.3
May	6.5	26.8	-	33.3
June	6.5	26.8	-	33.3
July	6.5	26.8	-	33.3
August	6.5	26.8	-	33.3
September	6.5	26.8	-	33.3
October	6.5	26.8	-	33.3
November	6.5	26.8	-	33.3
December	6.5	26.8	-	33.3

(Continued)

TABLE C-2 (Continued)

Month	Monthly Average Reuse Flow Projections, mgd			
	Arizona Game and Fish Department	Buckeye Irrigation District	Arizona Public Service	Total
1982				
January	6.5	26.8	-	33.3
February	6.5	26.8	-	33.3
March	6.5	26.8	-	33.3
April	6.5	26.8	-	33.3
May	6.5	26.8	-	33.3
June	6.5	26.8	-	33.3
July	6.5	26.8	-	33.3
August	6.5	26.8	-	33.3
September	6.5	26.8	-	33.3
October	6.5	26.8	-	33.3
November	6.5	26.8	-	33.3
December	6.5	26.8	-	33.3
1983				
January	6.5	26.8	-	33.3
February	6.5	26.8	-	33.3
March	6.5	26.8	-	33.3
April	6.5	26.8	-	33.3
May	6.5	26.8	22.1	55.4
June	6.5	26.8	23.4	56.7
July	6.5	26.8	23.1	56.4
August	6.5	26.8	23.1	56.4
September	6.5	26.8	21.7	55.0
October	6.5	26.8	21.0	54.3
November	6.5	26.8	13.6	46.9
December	6.5	26.8	17.9	51.2
1984				
January	6.5	26.8	13.1	46.4
February	6.5	26.8	13.4	46.7
March	6.5	26.8	19.5	52.8
April	6.5	26.8	20.1	53.4
May	6.5	26.8	44.2	77.5
June	6.5	26.8	46.8	80.1
July	6.5	26.8	46.2	79.5
August	6.5	26.8	46.2	79.5
September	6.5	26.8	43.4	76.7
October	6.5	26.8	42.0	75.3
November	6.5	26.8	27.2	60.5
December	6.5	26.8	35.8	69.1

(Continued)

TABLE C-2 (Continued)

Month	Monthly Average Reuse Flow Projections, mgd				
	Arizona Game and Fish Department	Buckeye Irrigation District	Arizona Public Service		Total
1985					
January	6.5	26.8	26.2		59.5
February	6.5	26.8	25.6		58.9
March	6.5	26.8	39.0		72.3
April	6.5	26.8	40.2		73.5
May	6.5	26.8	44.2		77.5
June	6.5	26.8	46.8		80.1
July	6.5	26.8	46.2		79.5
August	6.5	26.8	46.2		79.5
September	6.5	26.8	43.4		76.7
October	6.5	26.8	42.0		75.3
November	6.5	26.8	27.2		60.5
December	6.5	26.8	35.8		69.1
1986				(1987)	
January	6.5	26.8	26.2	39.5	59.5
February	6.5	26.8	25.6	40.2	58.9
March	6.5	26.8	39.0	58.5	72.3
April	6.5	26.8	40.2	60.3	73.5
May	6.5	26.8	66.3	-	99.6
June	6.5	26.8	70.2	-	103.5
July	6.5	26.8	69.3	-	102.6
August	6.5	26.8	69.3	-	102.6
September	6.5	26.8	65.1	-	98.4
October	6.5	26.8	63.0	-	96.3
November	6.5	26.8	40.8	-	74.1
December	6.5	26.8	53.7	-	87.0

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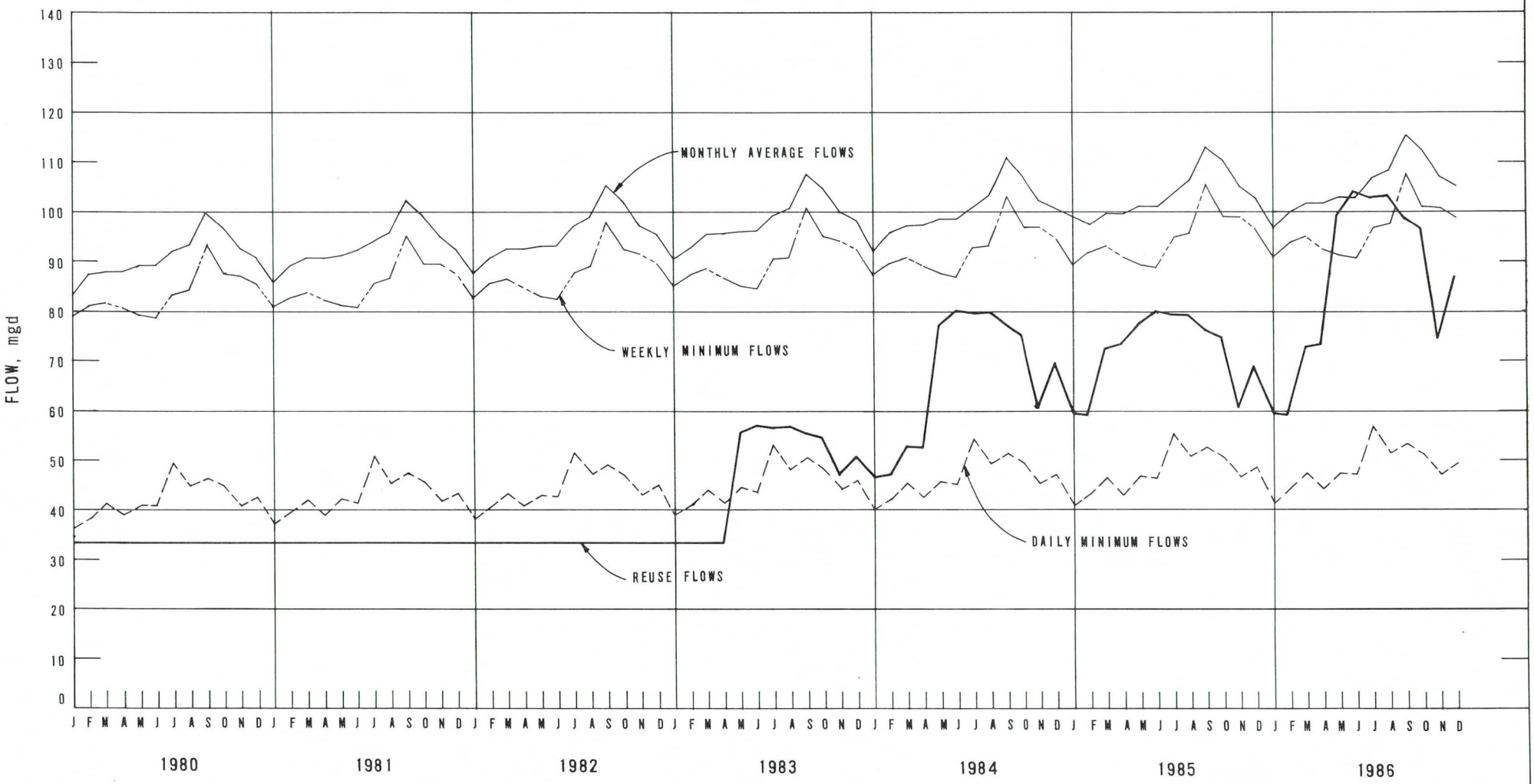
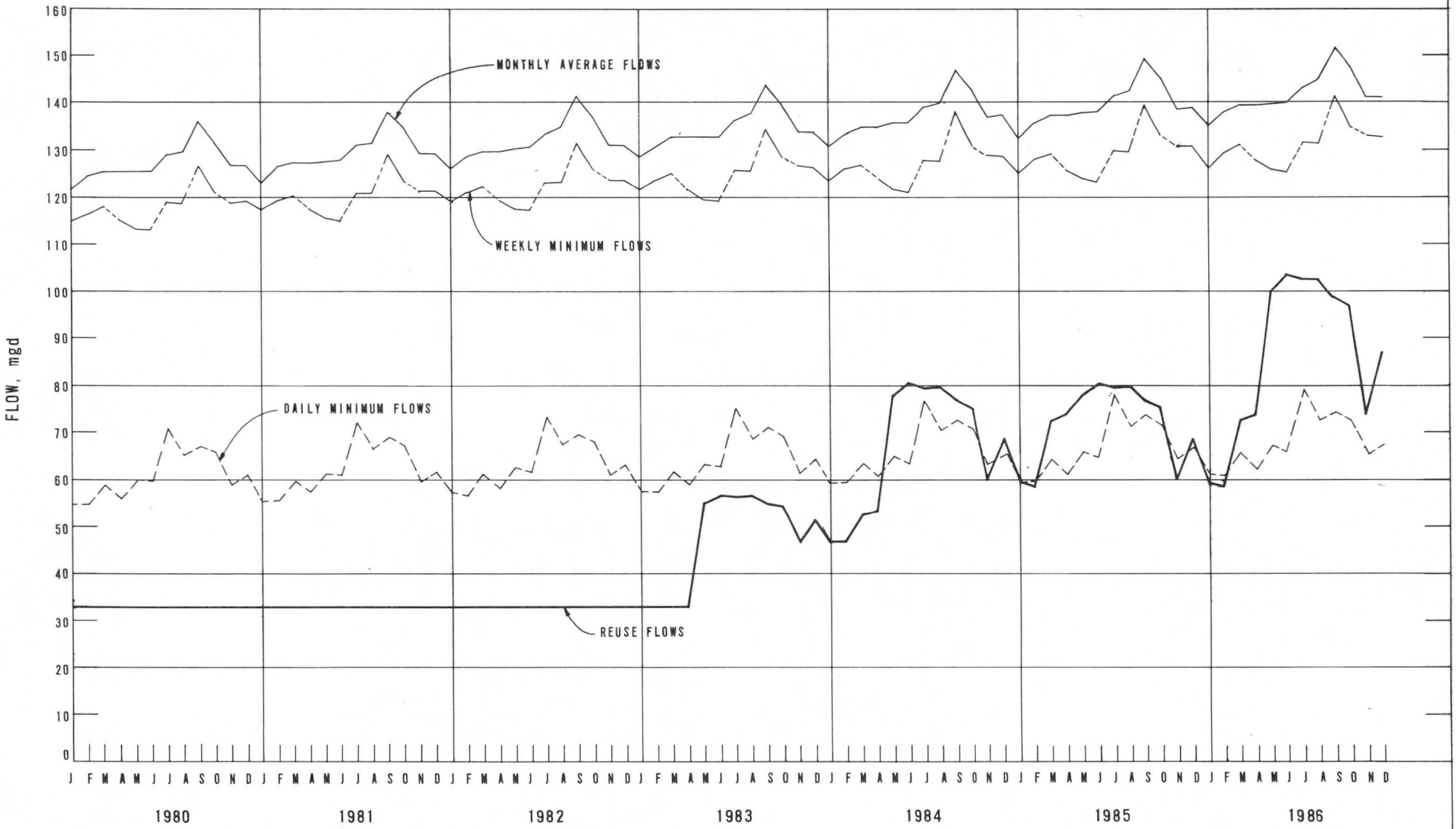


GREELEY AND HANSEN
JOHN CAROLLO ENGINEERS

FLOW DATA FOR 91ST AVENUE PLANT
PLATE C1



COMBINED FLOW DATA FOR
23RD AVE. AND 91ST AVE. PLANTS

GREELEY AND HANSEN
JOHN CAROLLO ENGINEERS

PLATE C2

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