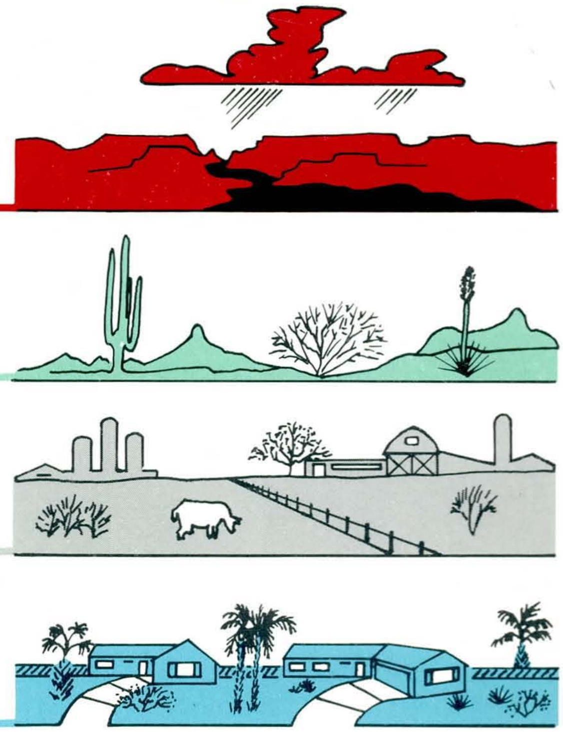

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

LAVEEN
AREA DRAINAGE MASTER STUDY
EVALUATION

By David Russe

FLOOD CONTROL DISTRICT OF MARICOPA

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LAVEEN
AREA DRAINAGE MASTER STUDY
EVALUATION

By David Wiss
Amir Motamedi
1993

(1994)

EXECUTIVE SUMMARY

The objective of the "Re-evaluation of the Laveen ADMS" was to answer the question, "is there REALLY enough (greater than 1′ depth) storm water runoff in the South Phoenix/Laveen area to generate a floodplain?"

Several steps were taken to reflect local conditions in the technical analysis (using non-FEMA criteria for analyzing the hydrology and hydraulics):

-Recent, though relatively small (less than 10 year return frequency), local rainstorms were used to calibrate the hydrology model. The recent rainstorms demonstrated that for a given amount of rain, there was less runoff than predicted by regional and national averages.

-Local irrigation delivery schedules and crop watering patterns were used to generate specific soil moisture values. The irrigation schedules indicated that soil moisture values were less than the original assumptions, i.e., more rainfall would infiltrate the soil and less would run off as flood flows.

-Irrigation channels were used in the hydraulics model as storm water drainage channels. The channels are able to carry substantial volumes of water, assuming they are not carrying any irrigation water.

In summary, using non-FEMA criteria, the storm water runoff is reduced by 50%. The existing irrigation channels can carry less than half of that water. There is enough water that won't "fit" in the irrigation channels to generate a floodplain, i.e., water more than 1 foot in depth.

Laveen Area Drainage Master Study
Re-Evaluation of the 100-Year Floodplain Delineation

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Laveen Area Drainage Master Study
Re-Evaluation of the 100-Year Floodplain Delineation

Purpose

This analysis was conducted in response to comments from residents in the study area that the study done in accordance with Federal Emergency Management Agency (FEMA) criteria did not reflect all of the physical features in the watershed, e.g. the network of irrigation channels and the elevated arterial road prisms. Residents asked if perhaps the FEMA study guidelines were not applicable to the southwest.

The question was asked, "is there REALLY a floodplain in this area?" The answer, as a result of this analysis, is "yes."

Methodology & Assumptions

The analysis uses new data and different assumptions for the hydrology and the hydraulics, relative to the study conducted using FEMA guidelines.

First, the hydrology model was re-evaluated and calibrated to take into account storms in the local area over the last few years, along with a VERY liberal interpretation of the various technical parameters.

Second, the hydraulics model was re-evaluated to take into account the floodwater conveyance capacity of the Maricopa Drain, the capacity of the culverts compared to the capacity of the channel, and whether enlarging the channel would accommodate the 100-year flow.

Introduction and Background

The Laveen Area Drainage Master Study (ADMS) was completed by a consultant for the Flood Control District of Maricopa County in September, 1991. The initial portion of the study consisted of a computerized **rainfall/runoff model** [Note: items denoted in **BOLD** are defined in a glossary at the end of the report] which determined the 100-year peak runoff discharges in the study area. The second portion of the study was a hydraulic analysis of the drainage network to determine the flow pathways and areas of inundation that would be expected to occur during the 100-year rainfall event. The 100-year rainfall is defined as the rainfall event that has a one percent chance of occurrence in any year and is determined from a statistical analysis of historical rainfall events.

The entire study area encompasses approximately 39 square miles. It extends from the ridge of South Mountain north to the Salt River, and from Central Avenue west to the boundary of the Gila River Indian Community (Figure 1). The area is subdivided into three major watershed units, which were analyzed independently. The watershed of concern is the 28.5 square-mile Maricopa Drain Watershed, named for the irrigation tailwater channel, the major drainage feature of the area.

The Maricopa Drain is a tailwater channel, currently operating under a two jurisdiction maintenance plan. The alignment of the Maricopa Drain is shown on Figure 2. The Maricopa County Department of Transportation (MCDOT) provides maintenance between 47th Avenue and 65th Avenue where the channel alignment follows Baseline Road. The Salt River Project is responsible for maintenance of the ditch from 65th Avenue to its outfall in the Salt River near 81st Avenue.

The Maricopa Drain Watershed consists of three distinct topographical units:

1. Steep desert mountain slopes of the South Mountains.

2. Transitional foothills with residential development of moderate slope.

3. Flat agricultural fields between Dobbins Road and the Salt River.

Another notable drainage feature of the area is the Salt River Project (SRP) Western Canal, which enters the area near the intersection of 7th Avenue and Baseline Road, and flows southwesterly to 43rd Avenue and Estrella Drive. The Western Canal has a design capacity of 150 cubic feet per second (cfs), and is provided with numerous, wide flood overchutes to pass stormwater runoff. The Western Canal does not provide a significant barrier to the passage of stormwater during the 100-year event.

The area has some history of shallow flooding during short-duration high-intensity storms, such as occur in the July to September summer monsoon season. Road closure information from the Maricopa County Department of Transportation (MCDOT) documents flooding in the following locations in August, 1990 due to brief, intense thunderstorms:

1. 35th Avenue at Southern Avenue and Baseline Road,
2. 43rd Avenue and Burgess
3. 51st Avenue at Southern Avenue and Dobbins Road,
4. 59th Avenue at Dobbins Road, and
5. Carver Avenue between 43rd and 35th Avenues.

The consultant's study of the area's hydrology estimated the 100-year rainfall event to produce in excess of 3000 cfs of stormwater at the 47th Avenue alignment, north of Baseline Road. The 100-year flood would be expected to flow westerly along Baseline Road, from about 43rd Avenue to the Salt River, inundating wide stretches of farmland and homes. The results of this study were made public at a monthly meeting (September, 1992) of the Laveen Planning Committee. Residents of the area expressed considerable incredulity at the findings, and called for a re-examination of the study's methods and findings.

An in-house re-examination of the Laveen ADMS report was initiated in February 1993, in which all of the assumptions of the original FEMA study were considered in terms of how a less stringent floodplain management philosophy (non-FEMA approved) might impact the Laveen area. This report presents the finding of this re-examination.

Mapping Data

A topographic map was made of the entire study area. The map scale is 1" = 400′ with a 2′ contour interval. The western part of the study area is very flat. The existing United States Geological Survey (USGS) maps (with a 10′ contour interval) were judged inadequate for this type of analysis - the subtleties of the drainage patterns would not be seen on the USGS quadrangle sheets.

Hydrology Model Re-Evaluation

The hydrologic assumptions of the consultant to be re-evaluated included the following:

1. Antecedent Moisture Conditions,
2. 100-year design storm characteristics,
3. Possibility of local ponding not previously identified,
4. Effects of slope adjustments on mountainous sub-basins runoff,
5. Routing of peak flows through irrigation channels,
6. Effects of cropped agricultural lands on runoff, and
7. Tailwater conditions in the Maricopa Drain.

Antecedent Moisture

Antecedent moisture refers to the amount of water in the soil when the rainfall event begins. Obviously, a wet soil will not be able to accept infiltration of as much water as a dry soil, and rain falling on already wet soil will produce more runoff than if the soil were initially dry.

The following assumptions were made in the original model: For undeveloped lands (which in Laveen are almost exclusively mountainous) the starting moisture was assumed "dry." For areas of residential development with irrigated lawns or parks with irrigated turf, the land was assumed to be "normal" - a condition in which irrigation had occurred between one and three days prior. For agricultural lands, the ground was assumed to be saturated, as if recently irrigated.

The assumed moisture conditions for desert and irrigated turf seemed reasonable, but the assumption of all agricultural land being saturated simultaneously seemed unlikely. When the starting moisture condition for the agricultural lands was changed from "saturated" to "normal", the stormwater runoff rates were reduced by about 40 percent. By dividing the soil antecedent moisture into four groups ranging from near the wilting point of crops to near saturation, and randomly assigning these conditions to each of the agricultural areas, the model predicted somewhat less than a forty percent reduction of runoff.

Design Storm

The 100-year 6-hour storm (an accumulated depth of 3.50 inches) was used by the consultant for the study. Upon re-examination of the National Oceanic and Atmospheric Association (NOAA) Rainfall Atlas No. 2, a rainfall depth of 3.4 inches was determined to be a better representation (more uniform depth) of the 100-year storm for this watershed. When the depth of rainfall was changed from 3.5 inches to 3.4 inches, the estimates of peak runoff were also reduced by about 10 percent.

Local Ponding

A re-examination of the 2-foot contour study maps revealed the presence of approximately 345 acre-feet of depressed area where ponding could occur. When these effects were added to the model, the peak flows were reduced by amounts generally less than ten percent.

Slope Adjustments

Slope adjustments were made to the mountainous **sub-basins** (or **hydrologic sub-basins**) which have slopes in excess of 200 feet per mile. The original model had not incorporated slope adjustment. Adding the slope adjustments had a negligible effect on the peak flow results in the Maricopa Drain. The adjustments had only a small effect on individual sub-basins. By the time stormwater peaks from the mountains are routed to the Maricopa Drain, all discernable effects of slope adjustments have disappeared, due to the long distances separating the mountains from the Maricopa Drain.

Channel Routing

Channel routing reaches in the HEC-1 model used a cross section and routings were **normal depth.** There was no change made to this arrangement. The only changes made in routing involved the addition of the **storage routing reaches** in areas where new depressions were identified from the contour maps.

Cropped Agricultural Areas

Leveled agricultural fields may contain ponded rain water that may or may not contribute to runoff. While this is probably true for small storms, or during the first part of larger storms, it is not expected to be a significant factor in the 100-year rainfall. Agricultural fields are bermed to contain irrigation waters. These berms will contain up to several inches of standing water. However, if the field receives runoff from upstream sub-basins, as would occur in the 100-year storm, the water depth in the field is expected to reach a height sufficient to overtop and eventually breach the agricultural berms, releasing the stored water. Thus, while runoff may be delayed, it is expected to occur and contribute to flooding problems.

Conventional hydrologic modeling techniques produce a reasonable approximation of the sub-basin runoff peak flows and volumes in the agricultural area. Agricultural fields are given a higher **initial abstraction** than other land types in hydrologic modeling. In the Laveen study, one-half inch was used. This amount of rainfall is assumed not to contribute to runoff.

Tailwater in the Maricopa Drain

Since the Maricopa Drain is not a designated stormwater channel, it was not included in the FEMA hydraulic analysis (FEMA requirement). To determine the typical tailwater flows in the channel, data from a stream gauge operated by SRP was studied. The historical data showed that a typical discharge in the channel from agricultural tailwater is around 25 cfs - far less than the actual capacity of the Maricopa Drain.

Verification of Model with Actual Storm

To test the ability of the HEC-1 model to accurately simulate a real rainfall event, the rainfall data from the storm of August 14-15, 1990 was input to the model. The results were compared with SRP's gauging data in the Maricopa Drain. This comparison showed that the "saturated" moisture condition was not appropriate for use in the simulation, since it produced an unrealistically high discharge. The best agreement between the actual and computer-generated data was obtained when the moisture condition was distributed into four categories ranging from near wilting point to near saturation. This calibrated model was subsequently used for the 100-year flow.

Results of Modified Model Predicting the 100-Year Flood

The other modifications to the model, such as slope adjustment, and the addition of storage routing reaches in ponding areas, were retained. The model was also supplied with the 100-year design rainfall depth of 3.4 inches, spread over a 6-hour period. The resulting flows were much less than those obtained in the original model. Figure 3 shows the results as compared to the original study results. These flow rates were about one-half the rates generated in the original study.

The flows shown in Figure 3 were subsequently used in the hydraulics analysis to determine the areas which would be inundated by floodwaters during the 100 year storm.

Hydraulic Analysis

Methodology

The water surface elevations for the 100-year flood recurrence interval were computed using the U.S. Army Corps of Engineers (COE) HEC-2 step-backwater computer program. The previous hydrologic analysis provided peak discharges rated at concentration points. The rating curve method was used to define the break-out areas using weir flows over streets, and where culverts crossings are overtopped, notably along Baseline Road at 51st, 63rd and 75th Avenues. Starting water surface elevations were determined using the slope area method.

FEMA Criteria

In order for the study to qualify as a FEMA floodplain delineation, the structures found in the study area must meet the following criteria:

1) Is there bank stabilization along each side of the Maricopa Drain?

2) Are there any design calculations for the bank protection?

3) Was a seepage analysis of the embankment performed?

4) Is there adequate **freeboard** from the design water surface elevation in the Maricopa Drain to the top of the channel bank?

5) Is there an engineering plan & profile for the full length of the Maricopa Drain?

6) Is there an officially-adopted (funded) plan for regular inspection and maintenance, based on the hydraulic design calculations?

Based on these criteria, the Maricopa Drain does not qualify a FEMA flood control structure. It was therefore, not included in the earlier FEMA floodplain delineation. The Maricopa Drain was, however, used in this re-evaluation. It is a large channel in the study area which collects stormwater, though it is not a structure dedicated for that use.

N values - Field verification

On March 22 and July 2, 1993, field trips were made to collect data on the Maricopa Drain dimensions, culvert sizes, their relative elevations, and the appropriateness of the N values (see Table 1). Mannings N values were selected based on visual observations for the channel and over-banks using the "Mannings Roughness Coefficient for Stream Channels and Floodplains in Maricopa County, Arizona" by the United States Geological Survey (USGS) as a guide.

A slightly different modeling technique was used in the Corps of Engineer's HEC-2 software model to better reflect the roughness coefficient in the Maricopa Drain to the cash crop fields and residential areas. The N values were assigned in accordance with the values shown in Table 1:

TABLE 1: MANNINGS N VALUES

	FCD	FEMA
	n	n
Maricopa Drain (in channel)	0.025	0.035
Cash Crops	0.045	0.04-0.07
Drain Overbanks	0.05	0.07
Residential Areas	0.05	0.07

There are 5 culverts in the Maricopa Drain between 43rd Avenue and 75th Avenue on Baseline Road: one double barrel 10′ x 5′ concrete box culvert at 51st Avenue; the remainder are circular pipes varying in size from 36" to 72" in diameter. These culverts were modeled in the study with no clogging factors considered. It was determined that the water is in a **subcritical flow regime** for the culverts meaning no turbulence. These culverts are undersized for the 100-year event, resulting in a significant backwater effect with weir flow over the road.

Current flooding problems include shallow flooding associated with ponding behind the Maricopa Drain and behind Baseline Road. The Maricopa Drain is the single structure that most impacts the floodplain between 43rd Avenue and the Salt River. Undersized culverts along Baseline Road also affect the floodplain to a great extent.

The Maricopa Drain at 75th Avenue and Baseline Road. is approximately 36 feet wide at the top and 8 feet deep with 2:1 side slopes. The channel at this location is about 75% full most of the time, due to the impoundment caused by the dam at the border of the Gila River Indian Community. This drop structure is to maintain the head for an SRP irrigation pump. For the purpose of this study, the average tailwater flow in the Maricopa Drain was calculated, to determine the remaining capacity of the channel available for stormwater..

Floodplain Evaluation

Table 2 indicates the results of the three different floodplain analyses in comparison to the FEMA study. In this study, the ponding that is behind the (elevated) Baseline Road, and behind the Maricopa Drain levee, in most cases has no way of getting back into the Maricopa Drain. This ponding results in a higher water surface elevation (WSEL). Figure 4 illustrates the original FEMA floodplain and the Maricopa Drain without culverts.

The three floodplain analyses considered are the following:

1. Laveen ADMS with all culverts in place. This is referred to in Table 2 as "Maricopa Drain with culverts". This analysis assumes that all the existing structures, including the Maricopa Drain, the culverts, the Salt River Project drop structure, and the dirt roads that impact the Laveen ADMS Floodplain are in place. As shown in Table 2, even though the FCD 100-year peak flow is greatly reduced in some areas, and the Maricopa Drain is able to convey some of the flow, the undersized culverts block the flow and cause significant ponding.

2. Remove (in the model) the Salt River Project drop structure and all of the culverts. This is referred to in Table 2 as "Maricopa Drain w/o culverts." In this option, the floodplain shows a slight reduction in topwidth and in depth as the bottleneck caused by the undersized culverts is eliminated from the model.

3. Champion Drain improvements required to eliminate the floodplain are referred to in Table 2 as "Maricopa Drain enlarged." Several trial runs were made in an attempt to identify the channel dimensions required to convey the 100-year flow, with one foot of freeboard. The

HEC-2 model indicated that a Maricopa Drain, enlarged to 60 feet bottom width with 2:1 side slopes, would contain the 100-year flow. One notable problem is getting the water into the channel: ponded water behind Baseline Road and the Maricopa Drain around 63rd Avenue has no way of getting back into the channel due to the berms on both sides of the Drain (the berms are "leftover" piles of material from channel cleanout). The berms were not used to calculate the capacity of the Drain. If the berms were removed, the Maricopa Drain could still convey the 100-year flow.

TABLE 2: FLOODPLAIN COMPARISON

CROSS-SECTION 4.898 AT BASELINE & 51ST AVENUE					
	OUTPUT	FEMA FLOODPLAIN	FLOODPLAIN for MARICOPA DRAIN WITH CULVERTS	FLOODPLAIN for MARICOPA DRAIN W/O CULVERTS	FLOODPLAIN for MARICOPA DRAIN ENLARGED*
1	Q_{100}	3089	1498	1498	1438
2	CWSEL	1010.6	1012.4	1009.8	1008.8
3	TOPWIDTH	2990.1	3483.2	1444.6	73.4
4	VELOCITY	1.1	.62	5.1	3.4
5	DEPTH	2.4	10.7	8.1	7.1
CROSS-SECTION 3.108 AT THE NORTH SIDE OF BASELINE & 63RD AVENUE (RESIDENTIAL AREA)					
1	Q_{100}	2795	1561	1561	N/A**
2	CWSEL	996.6	996.1	996.1	N/A
3	TOPWIDTH	1428.3	1296.8	1269.2	N/A
4	VELOCITY	1.2	2.0	2.0	N/A
5	DEPTH	2.1	1.9	1.9	N/A
CROSS-SECTION 3.021 AT THE SOUTH OF BASELINE & 63RD AVENUE					
1	Q_{100}	1651	733	733	1561
2	CWSEL	995.2	1001.8	994.3	994
3	TOPWIDTH	1910.7	2121.3	1535.4	79.8
4	VELOCITY	.77	.32	4.1	3.7
5	DEPTH	1.7	12.9	6.5	6.2
CROSS-SECTION 1.156 AT 75TH AVENUE, BASELINE AND MARICOPA DRAIN CROSSING					
1	Q_{100}	2960	1563	1563	1563
2	CWSEL	987.4	985.3	983.4	983.4
3	TOPWIDTH	2045.6	123.4	40	75.9
4	VELOCITY	1.4	4.6	6.0	3.3
5	DEPTH	3.4	9.2	7.3	7.7

*Enlarging the Maricopa Drain to the dimensions noted eliminates the floodplain - the 100 year flow will "fit" in the channel.
** The existing Maricopa Drain is on the south side of Baseline Road at this point. The drainage area and the resulting floodplain are on the north side of Baseline Road, which is relatively high, separating the water from the Maricopa Drain.

Detention

Finally, an evaluation was made of the volume of upstream detention necessary to "stop" the flows of stormwater runoff east of 43rd Avenue, the volume of stormwater runoff originating west of 43rd Avenue, and the hydraulics of that runoff in the Maricopa Drain.

It was determined that approximately 700 acre-feet of detention would be required, with 300 cfs outflow, to "stop" the flow of runoff east of 43rd Avenue. This assumes all of the factors used in this study, NOT the FEMA study.

The volume of stormwater runoff originating from the area west of 43rd Avenue would vary from 750 - 840 cfs, as shown in Table 3. Again, these runoff values assume all of the factors in this study, NOT the FEMA study.

TABLE 3: Stormwater runoff originating West of 43rd Avenue with 700 Acre-feet of detention in place.

47th Ave.	920 cfs
51st Ave.	850 cfs
59th Ave.	750 cfs
63rdAve.	900 cfs
67th Ave.	860 cfs
75th Ave.	860 cfs

Finally, the hydraulics of the Maricopa Drain were evaluated using the aforementioned values: the 700 Acre-feet of detention is assumed in place at 43rd Avenue; the outflow from the basins is 300 cfs; the stormwater runoff from the area west of 43rd Avenue varies from 750 - 840 cfs; all of the culvert obstructions are removed from the existing Maricopa Drain; the existing channel remains with no improvements. Under these assumed conditions, the existing Maricopa Drain has marginal capacity to convey the 100-year flow, i.e., the capacity is within the error of the modeling techniques, meaning there is no safety factor.

Arizona Department of Transportation Analysis

The Arizona Department of Transportation (ADOT), in a hydrologic study for the future freeway along the 55th Avenue alignment, identified a drainage corridor of approximately the same size and location as that delineated by the consultant's FEMA study. ADOT estimated that it would cost $13-$19 million dollars for a bridge to span the FEMA floodplain.

An order-of-magnitude estimate was made of structures necessary to detain the 100-year flow at 43rd Avenue. While the flood control structures were large, the cost was comparable to the ADOT cost estimate of bridging the floodplain for the future freeway in the 55th Avenue corridor. The flood control structures eliminate the flooding problem (for all parties). The money spent on the bridge merely solves the transportation problem but still leaves the floodwaters in place.

Floodplain Management Alternatives

Once a floodplain has been identified, there are several alternatives for managing the floodplain.

No Action Alternative

The first option is to do nothing. The Flood Control District is a technical organization with a focus on public safety, and prevention of loss of life and property damage. The District has been recognized on a national level for having an aggressive floodplain management program, and its administration of the program has earned "discounted" flood insurance premiums for the citizens of Maricopa County under FEMA's Community Rating System (CRS) program.

If the District has identified a floodplain in the Laveen area, using the same technical methods and procedures that are used for all floodplain delineations, and does not distribute that information to the public, the agency is in an awkward position: when development occurs in the area, the owners or their consulting engineers are not aware of the technical information available on the flood hazard, appropriate flood prevention measures are not taken, and if the area floods, the District is liable for the damages which occur, that could have been prevented. On an individual basis, if a developer requests all available technical information of a District staffer, does the staff member give out information only when specifically asked, or should they volunteer any and all technical information of which they are aware? Certainly, individual staff could not deny having knowledge of technical information about a flood hazard, but it is a fine line to ask District staff, who are employed to serve the public, to answer only specific questions and not volunteer additional, relevant information about the same topic. In this situation, doing nothing would not be acceptable.

FEMA Floodplain Alternative

The second option is to regulate the area as a Federal Emergency Management Agency (FEMA) floodplain. After the study is complete, it is sent to FEMA for technical review. Once the review has been completed, the floodplain maps are published and become part of the National Flood Insurance Program (NFIP). Development in the floodplain will be subject to restrictions as set forth in FEMA's guidelines, ARS 48-3609 and the Arizona Department of Water Resources (ADWR) regulations, and the Floodplain Regulations for Maricopa County as administered by the Flood Control District.

Local Floodplain Alternative

The third option is to manage the floodplain using local standards. ARS 48-3609 establishes the Director of ADWR as the state coordinator for the National Flood Insurance Program (NFIP) and 48-3609A gives the Director of ADWR authority to develop criteria for delineating floodplains in compliance with the NFIP. Typically, the NFIP guidelines and ADWR criteria are viewed as minimum regulatory requirements, and local standards, as may be appropriate, are to be more rigorous than those of FEMA or the State. FEMA standards were developed for use nationally, with an emphasis towards areas having 20+ inches of precipitation per year, with stream channels that have water in them virtually all of the time. Maricopa County has arid conditions, with streams that behave much differently than eastern style streams. Stream channels in Maricopa County are dry most of the time. But, when they do flow, the water has substantial energy which can potentially cause a great deal of damage. To safeguard life and property, a higher standard of safety is sometimes appropriate.

Flood Control Project Alternatives

1. The first project alternative is not to build a project, and simply manage the flood hazard area as a floodplain. That would be a good interim solution to safeguard future development against flooding, but in this case, the problem is the 50+ existing structures that experience flooding.

   There are numerous structural projects that will solve the flooding problems in the Laveen ADMS area. The next step in the process would be a feasibility study to explore the details of all of the alternatives with the emphasis on handling the flooding east of 43rd Avenue in Phoenix, and to eliminate the floodplain.

Other project alternatives include:

2. Construct detention basins near 43rd Avenue and Southern (SE and SW quadrants) along with a detention basin in the southwest quadrant of Baseline Road and 51st Avenue. Basins at these locations would intercept two of the major flowpaths conveying water east and north, respectively, to the Maricopa Drain.

3. Use the existing gravel pit located on Roeser Road between 27th Avenue and 35th Avenue as a stormwater detention basin. The water could then be pumped out of the pit. Alternatively, a pipe might be used to drain the pit, depending on the elevation of the water relative to the channel invert elevation of the Salt River.

4. There is another gravel pit, located between 39th and 41st Avenues, north of Pecan Road, that could be used as a detention basin. Again, the pit could be drained with pumps and/or a gravity system. A gravity system might be used to drain the water from the "top" of the detention basin, in combination with a pump to drain the bottom of the basin.

5. A channel and/or pipe along 35th Avenue would intercept water from the upper parts of the watershed (South Mountain) before it became a flooding problem, and convey the water to the Salt River. A channel extending from Dobbins Road north to the River would provide the most flooding protection but would also cost the most. A shorter channel (Baseline Road or Southern Avenue north to the river) would provide less flooding protection but would also cost less. Starting at South Mountain, the land slopes downward to the north until about 1/4 mile north of Southern Avenue (location of the Maricopa Drain). From that point, the land slopes upward, north to the river (the rise is about six feet). A channel (less expensive than a pipe) might be used for the southern leg of this system, emptying to a detention basin at the low point. The basin could then drained by a (relatively small) pipe because a channel running against grade results in a large (expensive) cross section.

6. A channel and or pipe along 43rd Avenue, similar in design to the previous. Depending on real estate costs and other constraints, two small system could be consructed, one each along 35th and along 43rd Avenues, or one, larger system could be constructed along 43rd Avenue. The topography is similar, but the low point is one-half mile to the south (south of Southern Avenue) on 43rd Avenue. The ground surface rises eight feet from the Maricopa Drain to the river.

7. Enlarge the lake in the City Park located at Baseline Road and 35th Avenue to provide for stormwater detention. A larger body of water would enhance the recreational aspect of the lake.

8. Construct a detention basin in the City park located on 19th Avenue between Baseline Road and Southern Avenue. The basin could potentially expand the recreational component of the park. The advantage to using parks as detention basins are the multi-use opportunities - for the money spent on one parcel of real estate, the residents enjoy a recreational facility along with flood protection.

9. Floodproofing individual homes can be a cost effective way to reduce flood damages, particularly for smaller (2 year, 5 year) flood events. The subdivision east of 43rd Avenue, between Baseline Road and Southern Avenue would be a prime candidate, because it is an area that is flooded by even the smaller, more frequent events. Floodproofing includes constructing small walls around the lot or the house with ramps or gates for the driveway; sealing the house (block construction) against moisture and installing structures with gates at the doorways, etc...

10. The Flood Control District's 1963 Comprehensive Plan proposed an interceptor channel along the toe of South Mountain, extending from 24th Street west to the Gila River. Such a channel would intercept much of the water before flooding residences, business or roads. The first section of that proposed channel, from 24th Street to about Central Avenue, is uphill (pumps were proposed). The reach from Central Avenue west to the Gila River is downhill-a gravity system was proposed.

11. Enlarge the existing irrigation wastewater channel (the Maricopa Drain) to convey the 100-year flow and upsize the culverts to the same capacity. The channel would be unlined, as is the existing channel. The enlarged culverts would be constructed of concrete. The structures would be below ground level. A detention basin may be a component of the system. It would be unlined and seeded with natural vegetation to minimize dust. More elaborate vegetation and recreation amenities could be added by other agencies or private developers if desired.

12. Master plan or acquire a green belt corridor along the topographic low in the Maricopa Drain area. The corridor could be slightly regraded to convey flow. Landowners would donate the ROW in return for relaxation of the retention requirements for future development, or property purchased.

Both alternatives eleven and twelve would include a dip section in 43rd Avenue between Southern and Baseline. 43rd Avenue currently acts as a dam causing water to pond in the subdivision east of 43rd Avenue. There are approximately 50 houses which are flooded. A dip section in 43rd Avenue would allow the water to flow downstream to the west, into the Maricopa Drain or a greenbelt corridor.

13. Line the existing channel to improve the hydraulic efficiency, and improve the culverts to match the capacity of the channel.

14. Extend the existing channel from 75th Avenue, due west to the Gila River, eliminating the dog-leg to the northwest.

15. Extend the existing channel west along Baseline Road (eliminating the dog-leg to the southwest), then use the existing alignment to the northwest. Both option #'s 5 & 6 would have the effect of shortening the channel length, effectively increasing the channel slope. The end result in both case is to increase the water velocity in the channel, thereby increasing the capacity, for a given channel footprint (cross-sectional geometry).

16. Construct a detention basin as part of the second 18 holes of the Pohlcat Golf Course (detention basin serves a dual function: stormwater basin and a water feature of the golf course) located on Baseline Road, west of 51st Avenue.

Conclusions

1. A flood hazard area exists in the Laveen Study area. The original consultant study conducted in accordance with nationally accepted FEMA floodplain delineation criteria and methodology determined that there is a floodplain having a Q_{100}= 2960 cfs, being 2,045 feet wide at the 75th Avenue alignment and 3.4 feet deep moving at an average of 1.4 feet per second.

2. The existence of this floodplain was confirmed by an independent ADOT study in conjunction with planning for the outer loop freeway.

3. A re-evaluation of the consultant's FEMA study using less rigorous criteria confirmed the existence of the flood hazard. The one-hundred year discharge is reduced by 47% to 1563 cfs, resulting in a floodplain 1563 feet wide by 2.1 feet deep, moving at 4.6 feet per second.

Recommendations

Floodplain Management/Flood Control Project Alternatives:

Build a project or projects to eliminate the potential flood hazard and delineated floodplain. The suggested timetable would be to begin immediately: submit a proposal to the Flood Control District's Citizen's Advisory Board and to the Board of Directors; initiate a feasibility study following Board approval; simultaneously advertise and initiate the process to select a design consultant.

Public Involvement

Several public meetings/workshops are planned. The first will present the results of the re-study of the area, along with the concept of the proposed feasibility study. Assuming the Board of Directors authorizes funds for the study, there will be several workshops with residents of the Laveen area to discuss the various project alternatives, along with different aesthetic treatments for the project alternatives and multi-use potential. Flood Control District staff will incorporate the results of the public workshops into the scope of work for the study consultant.

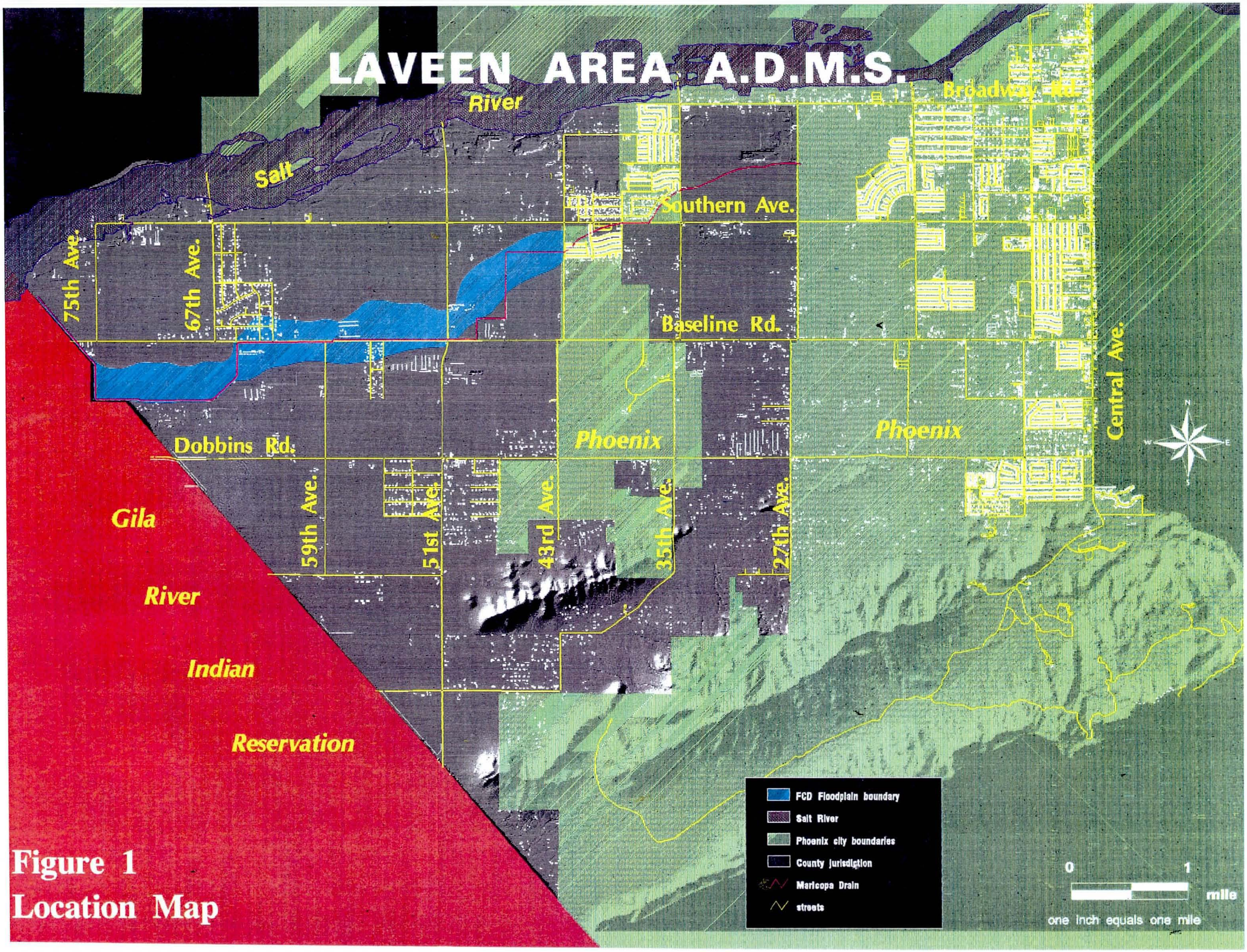


Figure 1
Location Map

Laveen Area A.D.M.S

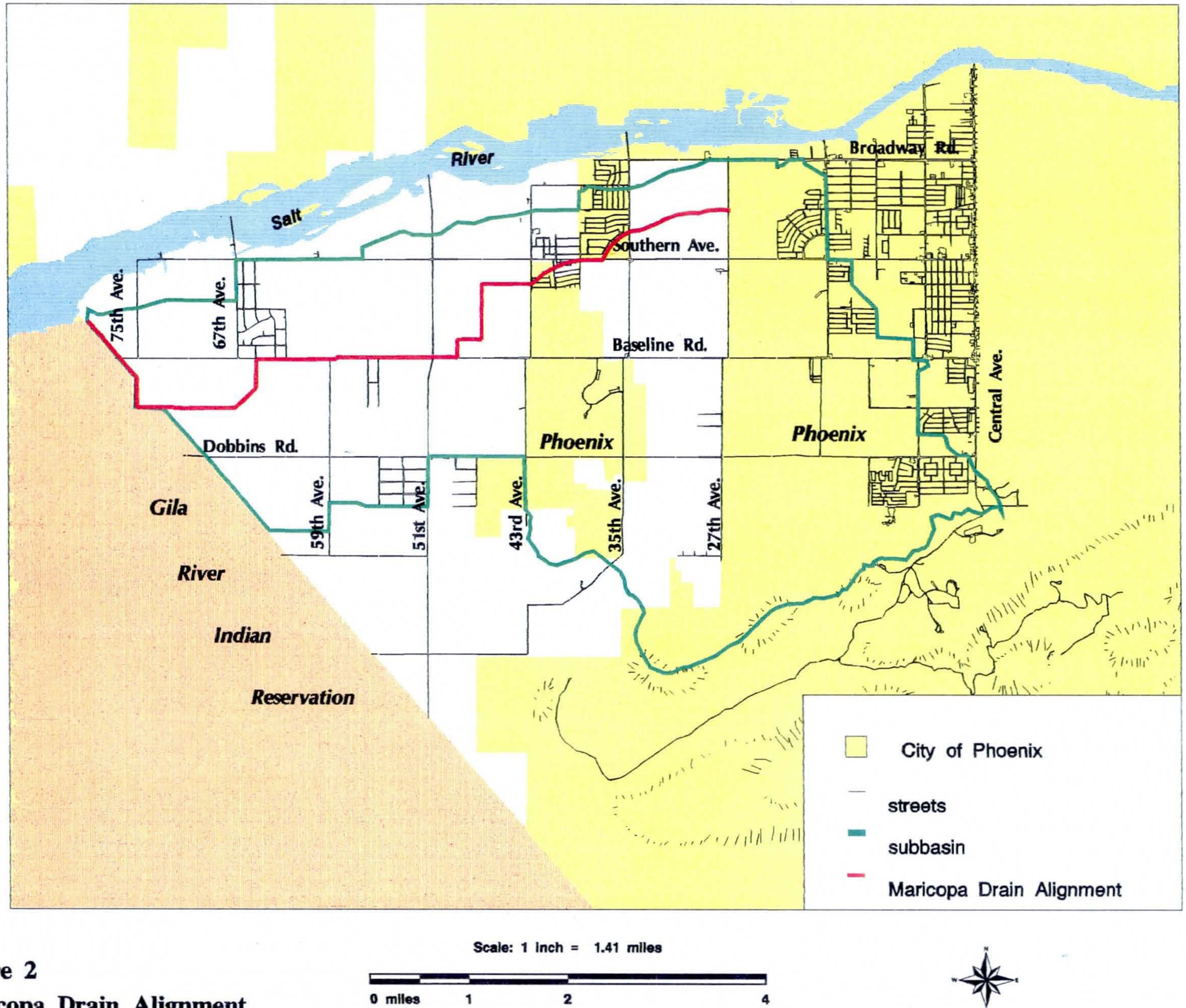
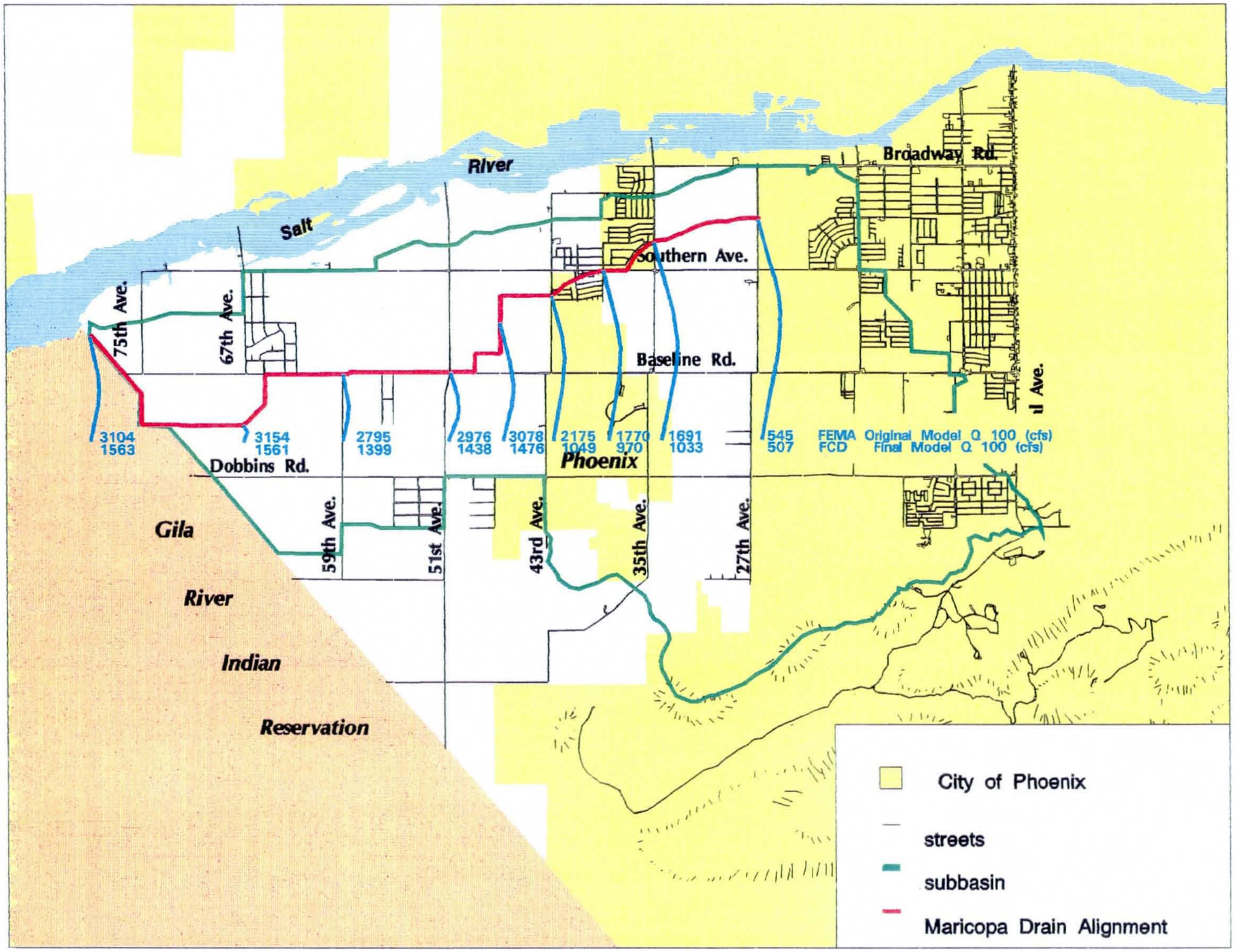


Figure 2
Maricopa Drain Alignment

Laveen Area A.D.M.S



Scale: 1 inch = 1.41 miles

0 miles 1 2 4

Figure 3
Comparitive Discharge Values

Laveen Area A.D.M.S.

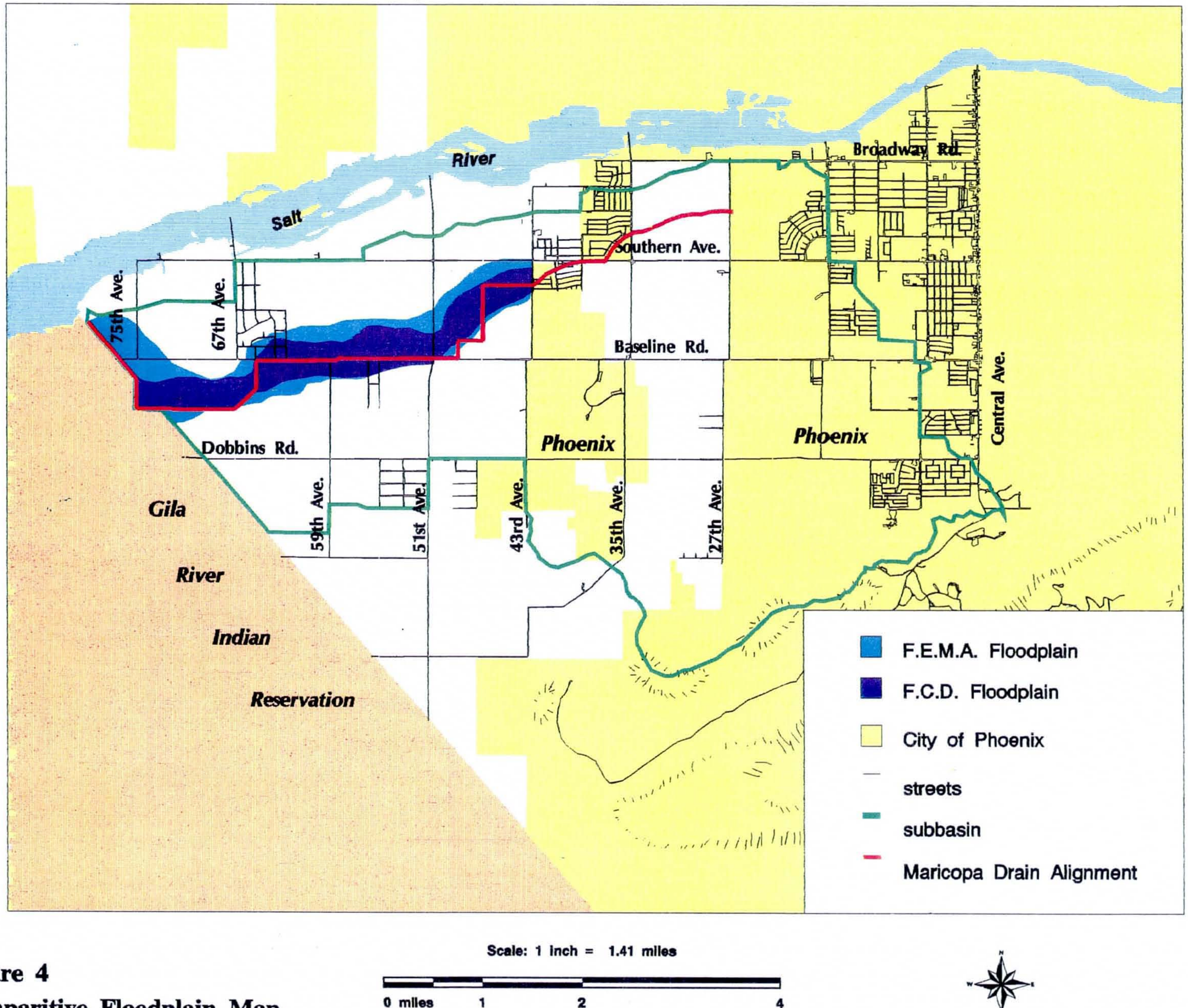


Figure 4
Comparitive Floodplain Map

GLOSSARY

Channel Routing Reaches. A term from the Army Corps of Engineer's HEC-1 software (rainfall runoff model). A reach is a specified length of channel. In a channel routing, water is directed (in the model) along a "channel" or in a linear direction, which has a specified shape and physical characteristics (depth, width, vegetation type in the bottom, smooth, rocky, etc.).

CWSEL-Computed Water Surface Elevation. A term from the Army Corps of Engineer's HEC-2 software (hydraulics). It is the elevation (in feet) of the top of the water in the stream or river channel.

Design Storm. The magnitude or frequency storm to which the flood control structures are being designed, e.g., the 100-year storm. The 100-year storm is NOT the storm that occurs once every 100 years. Rather, there is a 1% chance that, that size storm will occur in any given year.

Freeboard. The vertical distance from the surface of the water to the top of the structure. Typically, a foot or more of freeboard is built-in to the design of a channel or a basin as a safety factor. For example, for a channel sized to convey the 100-year flow, an additional foot, or more, of freeboard would be added to the top of the channel.

Hydrologic Sub-basin or Sub-basin. A "small" area, from several tens of acres to several square miles, depending on the overall size of the watershed. It is the fundamental areal unit of the drainage network having similar physical characteristics: rainfall, geology, soils, slope, vegetation, infiltration, and natural storage. The sub-basins are the building blocks that make up a watershed.

Initial Abstraction. A value used in hydrologic analysis which represents the amount of water that will NOT run off, due to various factors, such as infiltration, ponded storage, and interceptions/diversions. A sandy soil or pure sand would have a high initial abstraction. A clay pan or a soil with a high clay content would have a lower (than the sand) initial abstraction.

N value. A number used in hydraulic analysis which represents the texture of the surface over which water flows, the roughness or smoothness of the surface. N values have been calibrated for various artificial surfaces (concrete, steel) used to convey water. These are available in standardized tables. Representative N values are available for natural channels - the United States Geological Survey (USGS Water Supply Paper #1849) has compiled photographs of channels having various combinations of soil, sand, and rock lined channels with different vegetation, along with their respective, calibrated N values.

Normal Depth. The depth of water in a channel under "uniform" conditions, that is, no flood flows or markedly varied flows caused by channel irregularities.

Q_{100} (cfs). "Q" is the symbol used to denote water discharge, a rate of flow. Units are typically expressed in cubic feet per second (cfs). The "100" refers to the "one hundred-year discharge," or the "one hundred-year flood." Note that the "100-year flood" means the flood that has a 1% chance of occurring in any given year. It is NOT the flood that occurs once every one hundred years.

Rainfall/Runoff Model. A method used to simulate what happens during a rainstorm: as water strikes the ground, some of it sinks into the soil, some of it runs off, and some of the water evaporates. The model attempts to simulate different combinations of physical conditions. Years ago, the calculations were done by hand. The computer has enabled us to automate the process and perform calculations more rapidly. The District uses the U.S. Army Corps of Engineers HEC-1 software package.

Storage Routing Reaches. A term from the Army Corps of Engineer's HEC-1 software package (rainfall-runoff). It refers to runoff which is in a temporary storage mode or "holding pattern," as represented by the HEC-1 model. A detention basin holds water in a "stored" mode.

Subcritical Flow Regime. Flow in which the Froude number has a value of less than one, meaning that the water is in a tranquil flow regime.

Velocity (fps). The speed of the water, typically expressed in units of feet per second.