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City of Tempe

Rio Salado Town Lake Preliminary Design Report

CH2M HILL
September 1994

Phoenix, AZ 85009

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The CH2M HILL design team wishes to express our gratitude to the staff of the City of Tempe Public Works Department and the Community Development Department for their ongoing support and cooperation in the preparation of this design. The cooperation and teamwork demonstrated by all the City departments exemplifies the attitude responsible for Tempe's success in projects like Rio Salado.

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Introduction

This report presents the results of the preliminary design activities for Tempe's Rio Salado Town Lake project. CH2M HILL was retained by the City of Tempe to provide preliminary and final design, and permitting support for the lake and its infrastructure (see Figure1-1). The design includes:

- Impoundment dams with foundations, control systems, and maintenance buildings.
- An edge treatment to provide an interface between the development features and the existing bank protection.
- Infiltration control and management facilities.
- Water supply and conveyance features.
- Stormwater management.
- Masterplan concepts for park developments within the lake terraces including trail systems, access, lighting, landscaping, and aesthetic architectural concepts.

In addition to the design of the project structural elements and their costs, this document describes the operating plan for the lake, construction sequence and phasing, and major operation and maintenance requirements. (A more detailed document presenting cost estimates for operation and maintenance of the lake will be submitted under separate cover). Finally, this report describes the permitting activities being conducted in support of Rio Salado Town Lake.

The objectives of this report are to briefly summarize the previous work which provided the foundation for the design, describe the design requirements and constraints for the project, and provide documentation for the design criteria and decisions upon which the design is based.

The report is organized in three parts. The first two parts, the Preliminary Design Report and the 30% design plan set, are bound together for ease of review. The third part is the appendixes, found in a 3-ring binder. These appendixes contain design computations, Technical Design Memorandums, vendor-supplied information, and detailed information for technical review. The Technical Design Memorandums (TMs) were documents prepared as interim review deliverables submitted to the City during the preliminary design effort. These memorandums were not produced in final form. However, changes made in response to the City's review comments have been incorporated into the Preliminary Design Report. Therefore, some inconsistencies between the TMs and the report may occur.

Project Background and Overview

Eighty years ago the Salt River was a perennial stream providing water to the Phoenix area. Then dams were constructed that captured the river water for irrigation and electricity, and soon the river became a dry riverbed, flowing only in response to large rainfall events. Over the years, sand and gravel extraction and the addition of several landfills altered the environment and habitat of the Salt River, creating an eyesore where a riparian oasis once existed.

The City of Tempe's plan is to renovate the dry riverbed and create a lake-oriented focal point for public amenities along the Salt River corridor. The challenges associated with creating a major lake (200-acre surface area) include providing a technically sound basis for lake construction within reasonable financial constraints that could also be environmentally acceptable from the perspective of the public and permitting agencies. Water conservation issues mandate that the quantity of water used to supply the lakebed be carefully considered and managed. The challenge of using as little water as possible is compounded by the City's interest in achieving a high water quality standard for lake aesthetics.

Additional engineering challenges are related to the large storm flows that occasionally occur in the Salt River. The channel is designed to contain flows on the order of 250,000 cfs. Floods of this magnitude result in a powerfully destructive force for any manmade structures built within the river channel.

Previous Studies

This report follows the results and conclusions of the *Rio Salado Town Lake Feasibility Study* (CH2M HILL, April 1992) and the *Rio Salado Engineering Report* (CH2M HILL, August 1992). Engineering feasibility studies included evaluation of alternative types of dam structures suitable for the Salt River hydraulic conditions; evaluation of alternative sources of water supply including costs and resulting lake water quality; evaluation of stormwater diversions and control methods to protect the water quality of the lake; and co-ordination with county, state, and federal agencies having environmental permitting jurisdiction over the project. These agencies include the Maricopa County Health Department, the Flood Control District of Maricopa County, the Arizona Department of Water Resources, the Arizona Department of Environmental Quality, the Arizona Game and Fish Department, the U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency. Most of these agencies have unique requirements or permitting conditions that affect the engineering design criteria and subsequent construction and operations cost of the lake structures, water supply, and groundwater protection.

CH2M HILL's role was to develop alternative lake sizes (dam locations), alternative water supply sources and lake water quality conditions, and alternative groundwater protection schemes consistent with the environmental permitting conditions.

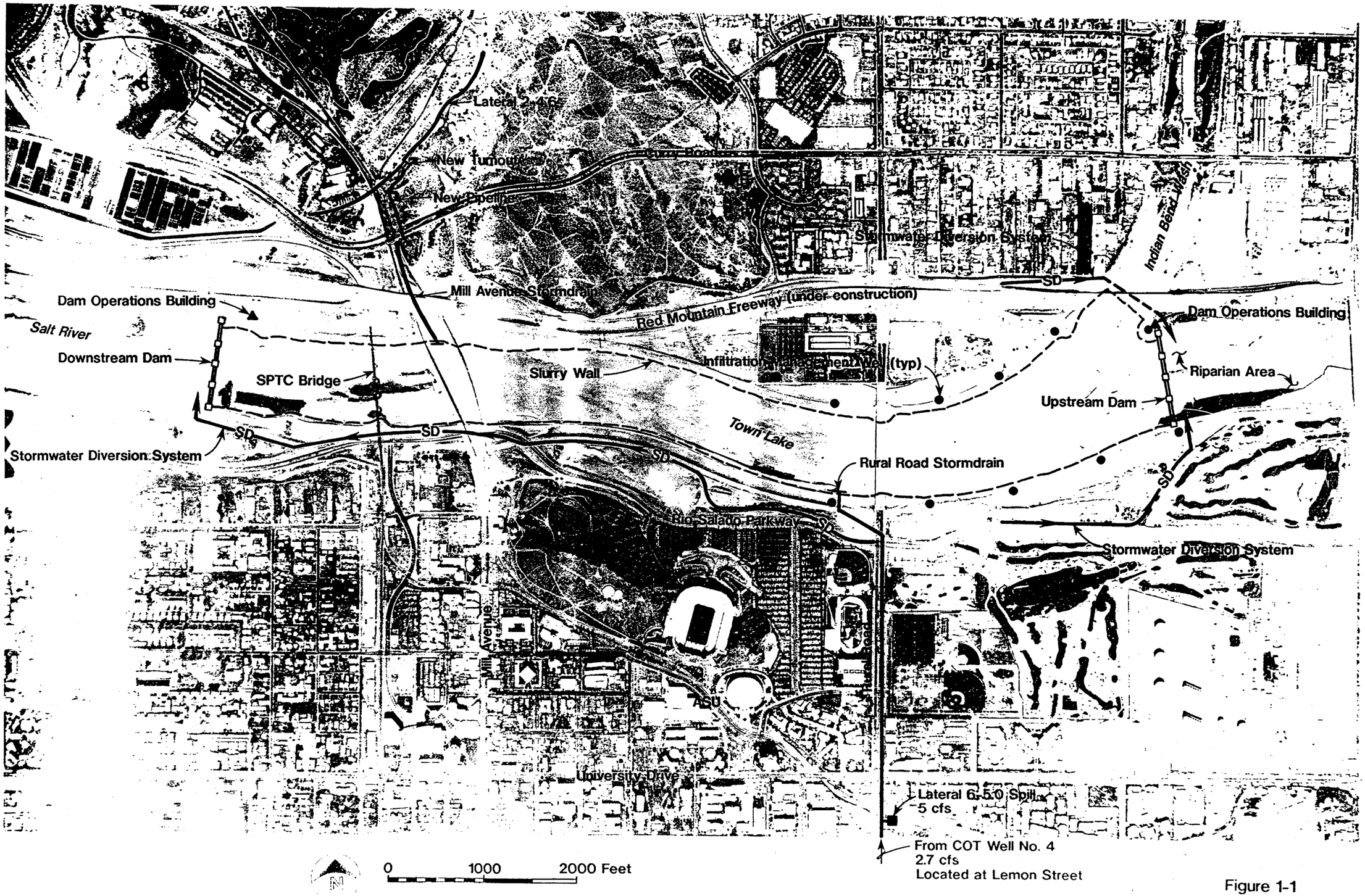
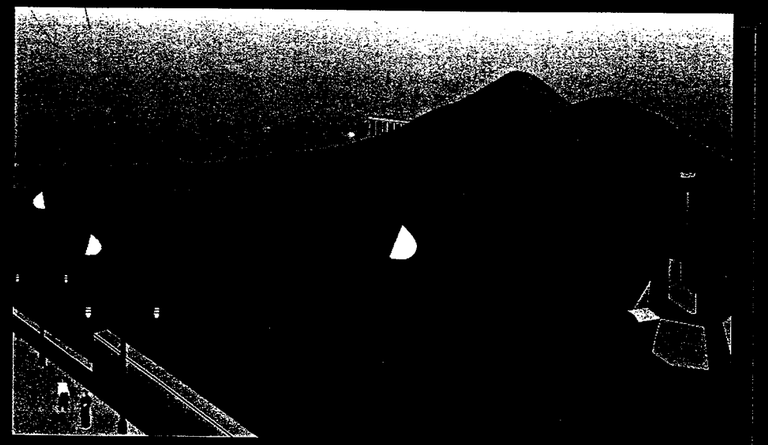


Figure 1-1
Major Project Features

CH2M HILL

SECTION 1
Introduction and Background Information



Project Components

Dams

The most important structural components of the lake are the inflatable rubber dams used to impound the lake water. These innovative dams should perform well during anticipated flood events. During seasonal flooding, the inflatable rubber dams can be lowered to allow flood waters to pass downstream. When flooding ceases, the rubber dams can be raised to impound water for the lake once again. The two dams defining both the upstream and downstream edges of the lake are 6-foot-high and 10-foot-high, respectively.

The dams will be constructed in segments separated by concrete piers and will be founded on roller compacted concrete foundations designed for the accepted Standard Project Flood (SPF) of 250,000 cfs. A downstream dam (16 feet high) located west of Mill Avenue will create the impoundment. A smaller, 6-foot-high dam located just above the confluence of Indian Bend Wash will provide the upstream boundary. This upstream dam will provide retention of small nuisance flows from upstream, enhancing lake water quality and creating a riparian enhancement area upstream of Town Lake.

Water Supply

The Rio Salado Town Lake has two separate supply needs. The first is the water needed to replace consumptive losses such as evaporation. The second is a source for initially filling the lake. The first demand is a relatively small but steady supply of about 1 to 3 mgd. The initial filling, however, will require a large enough flowrate (200 to 300 cfs) to exceed the infiltration capacity of the riverbed.

The basic supply available to Tempe is reclaimed effluent. Through an agreement made with the Salt River Project (SRP), effluent recharged by Tempe will be traded for supplies of surface and groundwater that can be delivered to the lake. The filling supply will be supplied from SRP's Grand Canal, delivered through the Indian Bend Wash or from Tempe Canal via the Salt River. The maintenance supply will be delivered from either the existing SRP facilities on each side of the river to the lake through existing connections with stormdrain pipelines and new water delivery pipelines.

Infiltration Management

Since this facility will be built in the desert, one of the key issues affecting feasibility is the quantity of water required to sustain the lake. The lake will require a continuous supply of water to meet two principal demands: evaporation and infiltration. Evaporation losses are directly related to the size of the lake. A greater surface area causes greater evaporation. The high potential rates of infiltration into the subsurface represents both a challenge and an opportunity. The challenge is to manage the water supply available for the project and prevent unacceptable impacts to local groundwater conditions. The opportunity is the potential *recharge and recovery* possibilities that the project represents for the Phoenix area. A major objective is to provide a project that has the flexibility to offer both infiltration management and recharge and recovery opportunities. Three general infiltration control methods were considered in the study:

- Lining the lake
- Placing cutoff walls along the lake boundary
- Collecting the seepage with wells and returning the water to the lake

Infiltration will be controlled by a state-of-the-art combination of slurry walls and controlled extraction/recovery. Approximately 10 wells will be used to collect an estimated 40 mgd of infiltrated water. The pumped water will be used to circulate the lake water, thus enhancing water quality. This option is significantly less expensive than liners or cutoff walls, it is not susceptible to flood damage. and it offers the ability to provide the community with a high capacity recharge and recovery facility.

Stormwater Management

Offsite stormwater will be managed by diverting first flush runoff around the lake or into detention/retention facilities. Best management practices will be used for onsite stormwater prior to entering the lake.

Shoreline Modifications

To provide a uniform interface between shoreline developments and the lake, and provide a means of emergency egress from the lake, the existing concrete stabilized alluvium (CSA) bank protection will be modified. A varied, hardscaped edge treatment will be integrated into the CSA.

Lakeside Developments

The terraced area between the water's edge and the top of the flood control levee will be developed as a City park. This terrace will include amenities such as trail systems, lighting, landscaping, and water features. While this contract does not include final design of these features, masterplan level concepts were developed to facilitate the integration of these features into the lake infrastructure.

Introduction

The success of the Town Lake project depends on the ability to create and maintain an aesthetically pleasing lake that provides a range of recreational uses. The objective is to maximize the City's benefits as well as the public's benefits--while minimizing the City's costs and liability.

The range of beneficial uses for the lake is subject to several constraints. Access to the facilities, public preference and acceptance, and economic development requirements all affect the types of activities that the project will support. One of the most significant sets of constraints on the potential lake uses are regulatory constraints, and more specifically, water quality. The current designated use for this section of the Salt River in the state of Arizona is A&We (Aquatic and Wildlife--Ephemeral) and Partial Body Contact (PBC). it is anticipated that, when completed, Town Lake will be designated as a warm water fishery, A&Ww (Aquatic and Wildlife, warmwater).

As an initial design criterion, the City elected not to allow swimming in this managed area. Other possible uses for the lake include:

- **Boating (Partial Body Contact).** Boats on the Town Lake will be primarily sponsored by private concessions, and limited to manually operated and electric trolling motors only. The City will limit the size of boats allowed on the lake, for instance, no boats larger than 12 feet long. In addition, boats must be hand-launchable, since there are no public boat ramps. Sailing, if allowed, will be limited by mast height in certain lake areas, and may be restricted by buoys.

- **Sailboarding (Full Body Contact)** requires a higher level of ambient water quality, and therefore may result in a Full Body Contact (FBC) water quality requirement. (The distinction between the PBC and FBC designations is that FBC implies the likelihood of complete submergence and ingestion of water.) An FBC designation is preferred, from the standpoint of recreational enhancement, to allow the City maximum flexibility in providing recreational opportunities.

- **Fishing (Fish Consumption)** is an important recreational component of the planned uses for the lake. Fishing activities can be established for consumption or limited to catch-and-release. Water quality requirements for fish consumption are more stringent. While the source water quality should meet fish consumption requirements, long-term accumulation of metals and other non-volatile constituents in the lake will require active monitoring and management .

- **Passive Recreation (Shoreline Activities)** is the lowest level of water quality risk and management. Water quality issues are primarily aesthetic, for instance, the appearance of the water, floating debris, and weed control. There should be no displeasing odor, floatable debris, algal or other vegetative mats, sheening, etc.

- **Potable Water Storage Reservoir** is not currently a planned use for the lake. Specific requirements for potable water quality are not addressed here.

- **Recharge and Recovery Requirements** depend on the source water. At this time, only Salt River Project or Colorado River water are proposed for recharge.

Table 2-1, below, summarizes the factors affecting the range of possible recreational uses.

Table 2-1

Lake Use Considerations

Use	Water Quality Regulations	Maintenance	Risk Management Issue
Boating. No (internal combustion engine) motorized boats. Electric trolling motors may be allowed. Limited to less than 12-foot boats, and/or hand-launchable boats.	PBC	Docks Access Police needs	Rescue
Sailboarding	FBC	Rescue Access	Higher risk
Fishing	Fish Consumption, A+Ww (Aquatic and Wildlife warm)	Permitting Fish cleaning areas Stocking	Catch & Release Low Risk Consumption Higher Risk
Passive recreation			Access control

Boating

Sailboats/Sailboards. Limiting factors for sailboats/sailboards are size and mast height. Available clearance between the planned water level and the bridge low chord varies at each of the bridges, as shown below.

- SPTC Bridge. Clearance above the normal water surface appears to vary up to 12 feet.
- Mill Avenue Bridge. Clearance appears to vary up to 21 feet above the normal water surface.
- New Mill Avenue Bridge. Clearance up to 25 feet is provided.
- Scottsdale Road Bridge. Clearance varies from 16 to 24 feet.

Concession Boating. Primary boating resources will probably be from private concessions.

Lake Segmentation. One possible solution to conflicts between uses is to allow different uses in different lake areas.

Barriers will be needed to prevent boating accidents at the dams and bridges. Boating uses will require some form of barriers at each dam, such as floating buoy/net barriers, located about 25 feet from each dam and surrounding bridge piers.

Fishing

Types of fish stocked must be coordinated with the City's Parks and Recreation division as well as with the Arizona Game and Fish Department. Coordination with the agencies is ongoing. The selected species must tolerate heat well and be resistant to conditions anticipated in Town Lake. The current practice is to stock City of Tempe lakes every 2 weeks. The cost will be approximately $560/acre/year. It is recommended that the City test selected fish species on a regular basis to evaluate bioaccumulation of contaminants.

Fishing designations can be either catch-and-release or fish consumption. It is recommended that fishing initially be catch-and-release only until longer-term water quality and bioaccumulation data are available.

The City can offer either daily or longer-term **licensing.** Procedures have been established at other City lakes.

Introduction

This chapter describes existing facilities in the project site, and notes which facilities, if any, may either need to be relocated or protected to accommodate the Town Lake project. (See design drawings for locations of these facilities.) In general, relocation of utilities is not required, but some bridge work is required to protect the utilities from continuous submergence. Repairs and maintenance may be more difficult. Impacts on the frequency of vandalism are unknown.

Utilities

Stormwater

There are 15 existing stormwater outfalls discharging into Town Lake, ranging in size from 24" to two 8' x 8' box culverts. (See the chapter "Stormwater Management" for details on the location and modifications to the existing stormdrains.) Though modifications to the stormdrains may be necessary, the Rio Salado project will not significantly alter the ability of these structures to operate as planned.

The largest single source of stormwater to the Town Lake (other than the Salt River) is Indian Bend Wash (IBW), which drains a major portion of Scottsdale north of Rio Salado. Modifications are required to divert IBW nuisance flows away from Town Lake. (See the chapter entitled "Stormwater Management" for details.) Flows down the IBW enter the Salt River through a multi-tiered roller-compacted concrete drop structure. The Town Lake will inundate much of this structure. Modifications are also required to the existing ADOT drainage structure located just north of the Red Mountain Freeway and east of IBW.

Power

Various APS and SRP overhead transmission lines (12 to 230 kV) cross the site. Additional power conduits cross the river attached to the underside of the bridges in the project site. No relocation of these overhead facilities is believed to be required as part of the Town Lake project except for the 12 kV power line located downstream of the SPTC bridge. However, maintenance and repair of these facilities could be more difficult with construction of the lake.

Two APS 230 kV transmission lines cross Indian Bend Wash on the north side of the river. These lines may affect the location of the Town Lake upstream dam operations building, the Miller bypass stormwater diversion pipe, and an infiltration management well.

Water

A 72-inch water line, owned by the City of Phoenix, runs east/west south of the Rio Salado Parkway. A 36-inch City of Tempe water line crosses the river just east of Rural Road at elevation 1125, a depth of 15 feet below the lake bottom. Neither of these water lines need to be relocated for the Town Lake project, but repair/replacement of an inundated Tempe line will be more difficult because direct access to the pipes would be hindered by the lake. While some maintenance repairs could be made by slip lining the existing pipelines, major repairs or replacement would require rerouting or draining of the lake.

SRP water facilities are located on both sides of the river, but well away from any direct contact with the lake. Modifications to several of the facilities will be required to provide make-up water to the Town Lake.

Sanitary Sewer

A 51/54-inch City of Phoenix sanitary sewer (buried at El. 1126) runs east/west on the north side of the lake between Priest Drive and Rural Road. An 18- and 21-inch City of Tempe sanitary sewer crosses the river west of Rural Road Bridge at el. 1130. Neither of these sewer lines need to be relocated for the Town Lake project, however, as noted above, repairs would be more difficult, and may require draining the lake.

Natural Gas/Nitrogen

A Southwest Gas pipeline is located west of Mill Avenue. The pipeline crosses the Salt River attached to the Old Mill Avenue Bridge superstructure. An abandoned 6-inch gas line that used to provide service to the SRP steam plant north of the river crosses the far western section of the lake. Construction of the downstream dam foundation would affect this pipeline. It is recommended that the section of pipeline affected by the dam should be removed and the remainder abandoned in place.

An Air Products nitrogen line crosses the river attached to the Old Mill Avenue Bridge. Under lake conditions, repair and maintenance activities would require a barge (rather than a crane, as required under dry riverbed conditions) and therefore may be more difficult.

Telephone

An MCI telephone line is attached to the SPTC Bridge. The line will not need to be relocated but repair and maintenance may be affected. AT&T does not serve the project area.

Utility Corridor

A utility corridor will need to be constructed to serve the Town Lake project. The selected location is at the base of the levee, outside the 100-year floodplain and may overlap with FCDMC's existing 10-foot Type B easement. The final location of this corridor will depend upon the final landscaping concept. The 20-foot-wide corridor will contain power, water, sewer and telephone lines.

Roads

The **Red Mountain Freeway,** currently under construction, is located north of the Salt River and crosses Indian Bend Wash. The Town Lake project will not affect the construction or operation of the freeway.

The **Rio Salado Parkway,** located south of the Salt River, will be the main access road to the south side of the Town Lake. The City is currently revising the alignment of the parkway.

Bridges

The steel **Southern Pacific Transportation Company (SPTC) Bridge** was built in 1905. The bridge, which was built on a layer of bedrock, was recently strengthened by the City of Tempe during river channelization. The bridge foundation will not be affected by the Rio Salado Town Lake project.

Corrosion of the SPTC Bridge. The proposed maximum water elevation of Town Lake (1150.0 feet) will result in submergence of approximately 8 to 14 feet of the steel columns in the railroad bridge piers. The railroad columns should be protected by construction of concrete encasement with at least 2½" of clear cover over the steel, as shown in Figure 3-1. The concrete encasement should be carried the full length of the steel columns below the bottom chords of the bridge. The bracing between the columns should be included in the encasement.

The affect of the lake water on the steel superstructure of the bridge is unknown. Creating the Town Lake beneath the SPTC bridge will cause an increase in the site's relative humidity due to evaporation of the lake water. While the bottom of the superstructure will be more than 12 feet above water at the maximum lake elevation of 1150.0 feet, the relative humidity would be expected to be less than 50 percent but may exceed the relative humidity of ambient air.

One possible effect of the increase in relative humidity is an increase in the corrosion rate of exposed (unpainted) steel. Another effect of increased relative humidity is the rate of deterioration of the protective coating, in this case, a lead-based paint. Because all bridge paint deteriorates over time, bridges are usually repainted before corrosion damages the steel to the point that repairs are needed. However, it is not possible to predict when the SPTC bridge might be repainted, under existing conditions, for two reasons:

1. In the Arizona desert climate, corrosion rates are low, so steel damage from coating deterioration would likely be slow to occur.

2. The handling and disposal of lead-based paint wastes is complicated and expensive due to recent changes in environmental and worker protection laws, so there is considerable incentive **not** to repaint the bridge until absolutely necessary. However, some agencies are moving to avoid lead disposal projects by carefully painting over existing coatings ("encapsulation") with suitable materials before the coating deteriorates to the point that the surface must be sandblasted to remove the old coating before the new coating is applied.

The SPTC bridge will eventually need to be repainted, and the Town Lake project may reduce the time for repainting. A cooperative discussion and planning session is needed between the City of Tempe and Southern Pacific Transportation Company.

Other Bridges

The following bridges are founded on bedrock; no problems are anticipated from hydraulic forces or from corrosion.

Old Mill Avenue Bridge. Inspection by CH2M HILL identified several cracks in the Old Mill Avenue Bridge piers. In a memorandum dated July 29, 1994, the City indicated it will seal the cracks and resurface the bridge in the latter half of 1994. A structural investigation has been completed by the City of Tempe.

New Mill Avenue Bridge. No problems are anticipated for either hydraulic or corrosion forces.

Scottsdale Road Bridge. No problems are anticipated for either hydraulic or corrosion forces.

Bank Protection

Channelization of the riverbed was recently completed by constructing bank protection consisting of both cement stabilized alluvium and gabions. Modifications to the bank protection will be required and are discussed in the chapter entitled "Shoreline."

Landfills

Landfills are known to have been located in the Rio Beach area at the southwest end of the lake. Excavation required for the construction of the south abutment for the downstream dam and the South Bank Interceptor may encounter landfill materials. Special excavation techniques will be needed if landfill materials are identified. See CH2M HILL's *Geotechnical/Hydrogeological Data Report* (1994) for more details.

Costs

For costs associated with this chapter, see the chapter entitled "Costs."

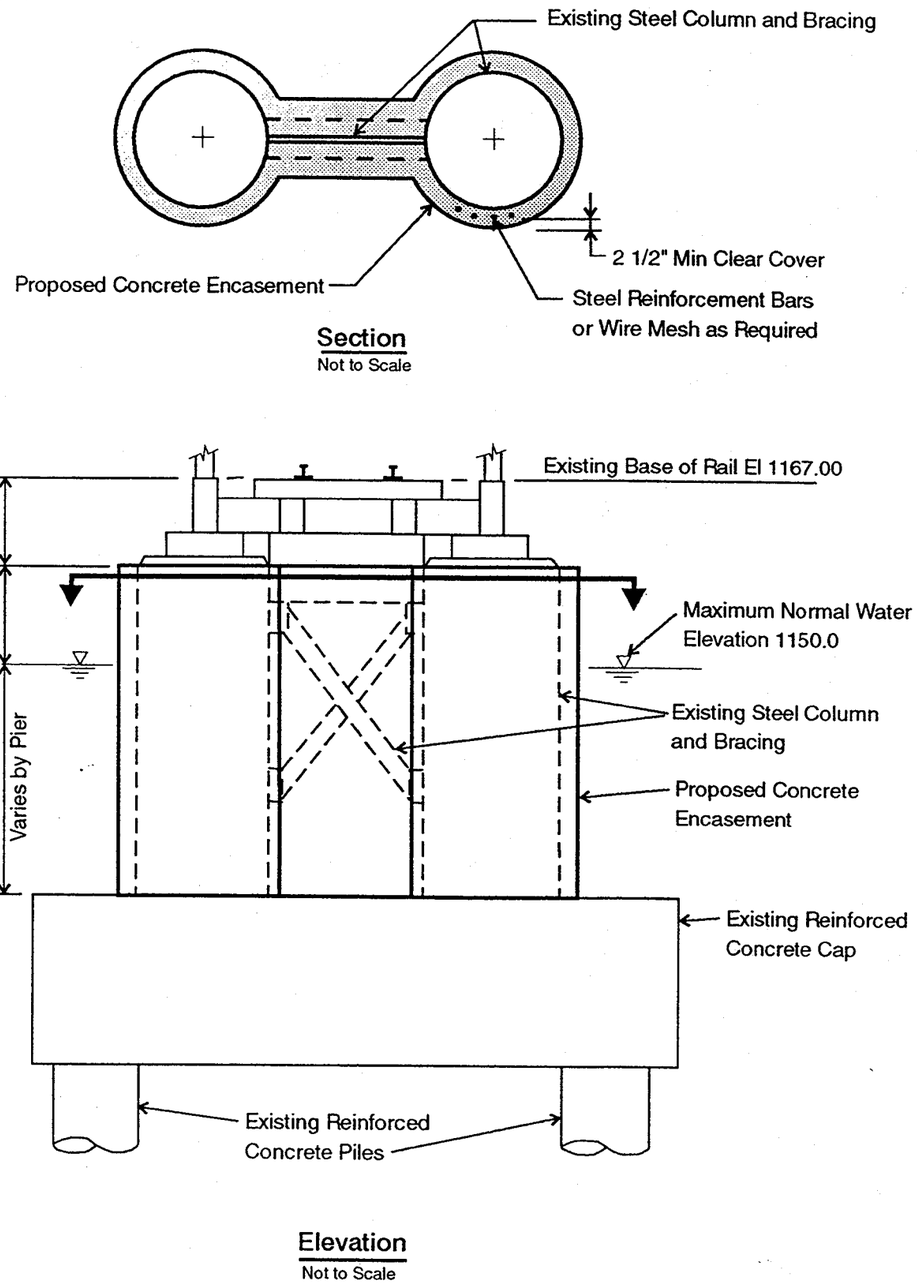


Figure 3-1
Proposed Modifications to
SPTC Bridge Piers

Introduction

This section details the hydraulic assumptions, computations, and criteria used as a basis for design of the dams and other channel modifications. This material expands on the analysis performed during the *Rio Salado Town Lake Feasibility Study* (CH2M HILL, 1992). The objectives of this section are to summarize the hydrology, hydraulics, and scour criteria for the project.

Existing Salt River Conditions in Vicinity of Town Lake

Hydrology

The Rio Salado Town Lake hydrology is based on a revised analysis of Central Arizona Project features ("Gila River and Tributaries, Central Arizona Water Control Study, Hydrology, " U.S. Army Corps of Engineers, Los Angeles District, May 1982) and on information supplied by the Salt River Project (SRP). The Flood Control District of Maricopa County (FCDMC) is currently preparing a restudy of the Salt River hydraulics . The schedule for this project is not certain. This restudy will incorporate the effects of channelization and upstream impoundments on the Salt River and its tributaries. Therefore, the flood data used for the Rio Salado project may be subject to revision upon completion of the FCDMC study or change in reservoir operation procedures by SRP and the U.S. Bureau of Reclamation (USBR).

The Corps' revised hydrologic analysis examined the impacts on Salt River flooding of eliminating the proposed Cliff Dam on the Verde River, and of significantly increasing water storage behind Roosevelt Dam. The Rio Salado project hydrology is based primarily on the Corps' analysis. Discharge frequency results for existing conditions without Roosevelt Dam improvements are shown in Table 4-1. Actual hydrological changes will not be known until 1996.

Modifications to Roosevelt Dam will, when completed, change the operating plan for the river system. According to information provided by the USBR, all of the proposed scenarios will significantly reduce the discharges for higher return period flows. However, because the final operating plan is not scheduled for completion until 1996, the currently accepted, more conservative discharges were used for this design. These design discharges have been approved by the Flood Control District of Maricopa County, USCOE, Arizona Department of Water Resources (Dam Safety Section), Arizona Department of Transportation, and the local cities for design of flood control and transportation facilities on the Salt River. Table 4-1, below, lists the amount and design discharge frequency value for the Salt River used for this project.

Table 4-1
Discharge Frequency Values
Salt River at Mill Avenue Bridge

Return Period (years)	Q (cfs)
5	40,000
10	93,000
20	135,000
50	160,000
100	215,000
SPF	250,000

The accepted maximum design discharge for this reach of the Salt River is the USCOE Standard Project Flood (SPF). Through negotiated agreement reached by the various agencies during the planning and permitting of the Salt River channelization, design discharge varies somewhat from section to section based, in part, on the capacities of existing bridges. Within the project reach, the accepted maximum discharge is 250,000 cfs. The bank protection/channelization facilities on the river are designed to provide 100-year flood capacity with 3 to 4 feet of freeboard and contain the SPF with 1 foot of freeboard.

The Probable Maximum Flood (PMF) is estimated to be about 925,000 cfs (USCOE, 1982). The PMF would inundate a significant portion of the metropolitan Phoenix area, and is not used as a design criteria for Salt River facilities.

Indian Bend Wash will discharge stormwater into Town Lake. The volume, flow rate, and frequency of these discharges will affect the management of Town Lake. Discharge frequency values for Indian Bend Wash are based on a U.S. Army Corps of Engineers Design Memorandum for improvements to Indian Bend Wash and are shown in Table 4-2, below. Flood peaks on Indian Bend Wash and the Salt River were assumed to be independent.

Table 4-2
Discharge Frequency Values
Indian Bend Wash at Salt River

Return Period (years)	Q (cfs)
10	8,000
25	14,000
50	21,000
100	30,000

Channel Bed Characteristics

Figure 4-1 illustrates a typical channel cross-section.

Features of the channel bed through the project area include:

- Design channel slope = approximately 0.11%
- Manning's "n" roughness factor for the main channel = 0.035
- Grade Control Structures. Previous studies (CRSS, 1993) have indicated that the Salt River channel is in a degradational mode. A series of grade control structures (both natural and constructed) stabilize the channel profile. Structures and features in the vicinity of Town Lake are:

  -Bedrock outcrop just upstream of Priest Road Bridge

  -Grade Control Structure No. 4, located approximately 2,100 feet downstream of Mill Avenue

Bridges

Four bridges (see Figure 1-1) affect the channel hydraulics:

-Southern Pacific Transportation Company Railroad Bridge
-Old Mill Avenue Bridge
-New Mill Avenue Bridge
-Scottsdale Road Bridge

Hydraulics

- The design 100-year discharge for the reach is 215,000 cfs. Upstream of Mill Avenue, the SPF design discharge is 250,000 cfs.
- The 10-year storm is generally contained within limits of the CSA.

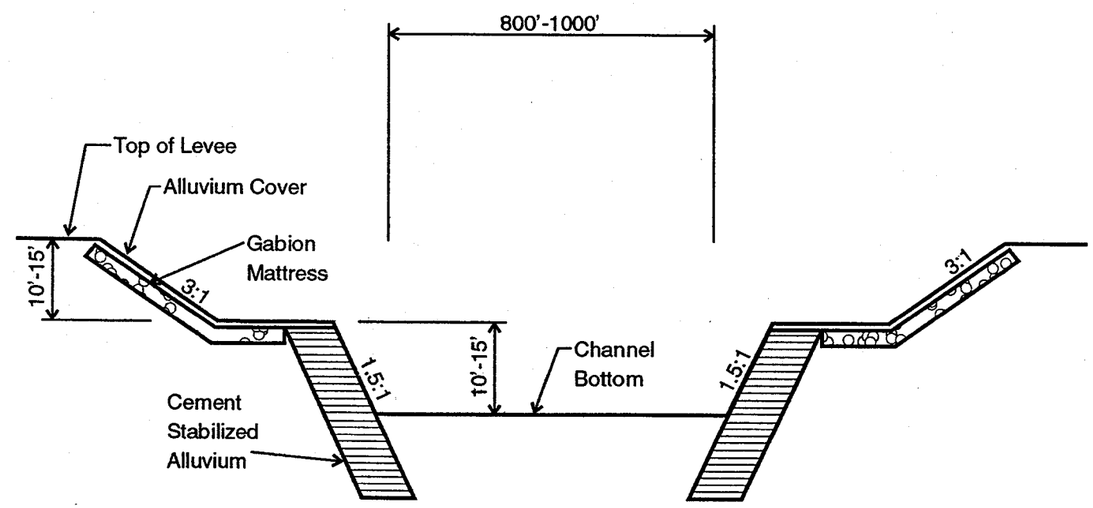


Figure 4-1
Typical Channel Cross-Section

Criteria and Constraints

The Salt River is the primary conveyance facility for flood water from the Salt and Verde River watersheds through the Phoenix valley. During coordination meetings with USCOE, FCDMC, and ADWR specific design criteria were defined for maintaining the flood control function of the Salt River. The following criteria are based on our understanding gained from those meetings and include:

- The ability of the channel, grade control, and bridge structures to pass the design event must not be compromised.
- Changes to the river channel must not cause adverse impacts downstream of the project or adjacent to the channel.
- The general scour downstream of the lake must not significantly increase. New dam facilities cannot increase single-event local scour at the grade control structure 4 to below the design depth. Single-event local scour at the new dam facilities cannot undermine the existing CSA.

In addition to these general criteria, agencies have specific criteria that should be met, as specified below.

FCDMC

The FCDMC has regulatory authority and maintenance responsibility for the Salt River in the project area. The District has stipulated several design requirements, as follows:

- Any changes to the channel cannot negatively affect the primary function of the river channelization, which is flood control.
- The Rio Salado project channel improvements and proposed dams should not reduce the capacity of the channel to less than 250,000 cfs with one foot of freeboard and 215,000 cfs (100-year flow) with 3 feet of freeboard (one foot less than the current design).
- The project should not affect the capacity or maintenance requirements of the Indian Bend outfall structure.
- Any changes to the river channel cannot affect the District's ability to inspect and maintain the flood control structures in the channel. (The District has an Intergovernmental Agreement with the City of Tempe to maintain flood control features within the river channel, such as the CSA.)

ADWR

ADWR has permitting and regulatory authority over all dams in the state that meet or exceed certain size criteria.

- The project must comply with dam safety regulations. ADWR's Division of Dam Safety has jurisdiction over dams that are either 25 feet or more in height or that store more than 50 acre-feet. Though the tallest proposed Town Lake dam is only 16 feet high, the amount of water stored will be 2,400 acre-feet, therefore it will be a jurisdictional dam. Under ADWR's hazard classification system, it will be considered a small, low hazard dam.
- The project must not increase downstream flood hazards due to dam failure-related flooding. Flow depths and velocities that would result from a "sunny day" failure of a dam structure should not increase the potential risks to in-channel structures, bank protection, etc.

COE

- The Rio Salado Town Lake project must obtain an individual 404 permit and conform to the requirements of the permit. Conditions and requirements of the permit will describe activities needed to comply with relevant laws and regulations.

City of Tempe

- Flooding should be minimized on terraces as much as feasible, consistent with the anticipated uses of the terraces and acknowledging their flood control function.
- The lake must include provisions for safety measures to reduce risk to the public. These provisions may include fencing, signing, policing, as well as structural features such as emergency egress in the shoreline, docks, and other waterside hardscaping.

ADOT

- Any changes to the channel shall not adversely affect the stability of the bridges.

Inflatable Dam Characteristics

Dam Configurations

During the initial studies for the Rio Salado project (CH2M HILL,1993), several dam configurations were considered for Town Lake. The Rio Salado advisory committee recommended air-inflatable dams. Schematics of the dams proposed for this project are shown in Figures 4-2 and 4-3. Details of their configurations are given in Table 4-3. Each dam segment will be independently operable to allow flexibility for low flow and sediment passage, and to be able to exercise each segment for maintenance checks. Cross-sections of the dams are illustrated in Figures 4-4 and 4-5.

Table 4-3
Dam Configurations

Cross-Section Geometry

Dam Location		Bed Elev., ft	Dam Foundation Elev., ft	Dam Height, H, ft	Lake Water Surface and Dam Crest Elev., ft.	Channel Width at Top of Dam, ft.	No. of Bays
Downstream		1128.9	1132.0	16	1148	907	4
Upstream		1140.4	1142.0	6	1148	966	4

Piers

Dam Location	No. of Piers	Pier Height , ft.	Top-of-Pier Elev., ft.		Top-of-Pier Width, ft.	Side Slopes	Base Width, ft.
Downstream	3	21	1153		6	½:1	27
Upstream	3	12	1154		6	½:1	18

*For modeling, 10 feet was added to the pier height to accommodate architectural details that may be added.

Downstream Dam

The downstream dam, located 2,380 feet west of Mill Avenue Bridge, will impound the lake on the lake's west side. The rubber dam will be set on a sill about 3 feet above the channel design elevation.

Sill Height. The original channelization design for this reach of the Salt River assumed a channel elevation at Grade Control Structure 4 of about 1132. The hydraulic modeling, river mechanics, and sediment transport studies that formed the basis of the design were based on this invert elevation (personal communication, G. Cotton). During the subsequent construction, as a result of the presence of a shallow "bedrock" layer in the vicinity of Grade Control Structure 4 and the need for borrow material, the design was modified and the invert was lowered to about 1129.5.

To reduce the cost of the dam segments, they will be founded on a concrete/roller-compacted concrete sill whose top elevation of 1132 matches the original channel design elevation. This sill will have no significant adverse affect on the design flood water surface elevation.

Upstream Dam

The upstream dam, located about 3,150 feet east of Rural Road, will impound the lake on the lake's east side.

Water may pond on both sides of the upstream dam. The lake is on the dam's west side. On the dam's east side, water can pond due to either (1) periodic Salt River flows (from east to west) that stop at the dam, and/or (2) IBW flows that flow directly into the lake from the north, then spill over the dam to the east and flow into the riparian detention area.

Dam Hydraulics

Dam Hydraulics/Operations

The dam operation is designed to prevent the lake level from exceeding elevation 1150 during most storm flows. The crests of the dams are at elevation 1148. When storm flows cause the lake level to exceed 1150, the downstream dam will partially deflate to maintain water surface elevations of 1150. If the lake elevation of 1150 cannot be maintained without lowering the downstream dam below 1145, the dam will instead be completely deflated. The upstream dam will only be operated in a fully inflated or deflated position, and will automatically deflate if the river elevation exceeds 1153. Details of the operating plan are presented in "Dam Operations." (See Figure 4-6.)

Rating curves for the flow over the dams were developed using a discharge relationship provided by Bridgestone in their technical notebook, *Questions and Answers about the Bridgestone Rubber Dam*, August 1989. The equation resembles that of a broad-crested weir. The discharge coefficient is a function of the ratio of depth of flow over the dam to dam height, and increases as the ratio increases. Additional information may be found in the "Dam Operations" chapter.

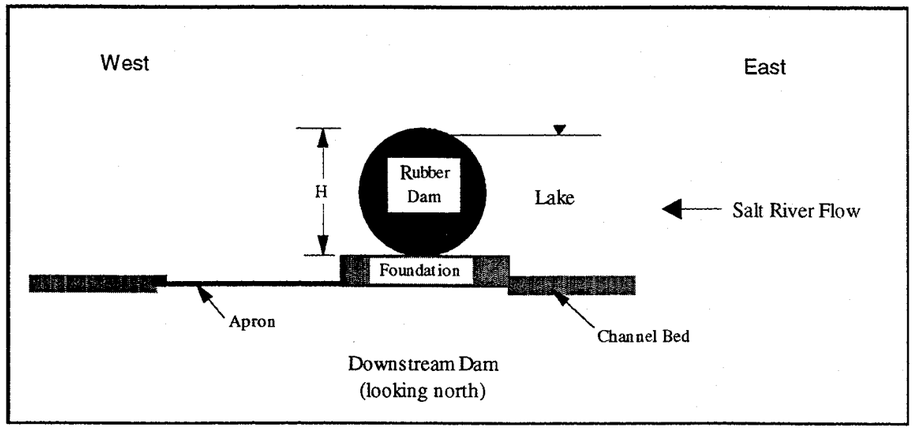


Figure 4-2. Downstream Dam Schematic

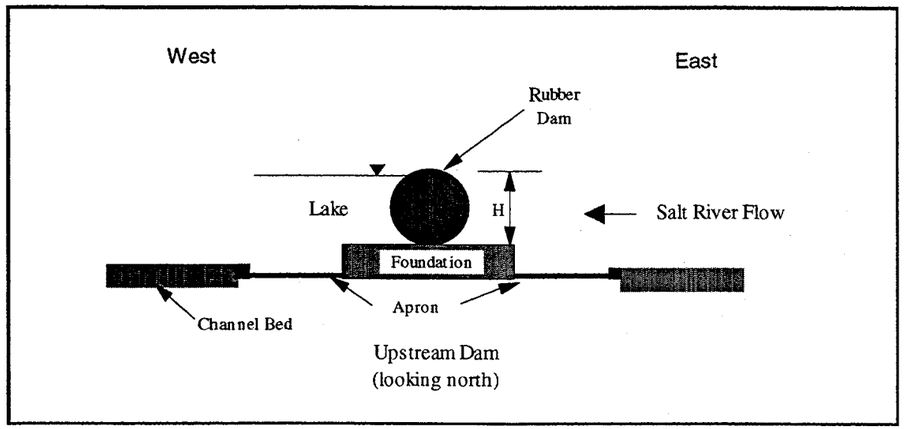


Figure 4-3 Upstream Dam Schematic

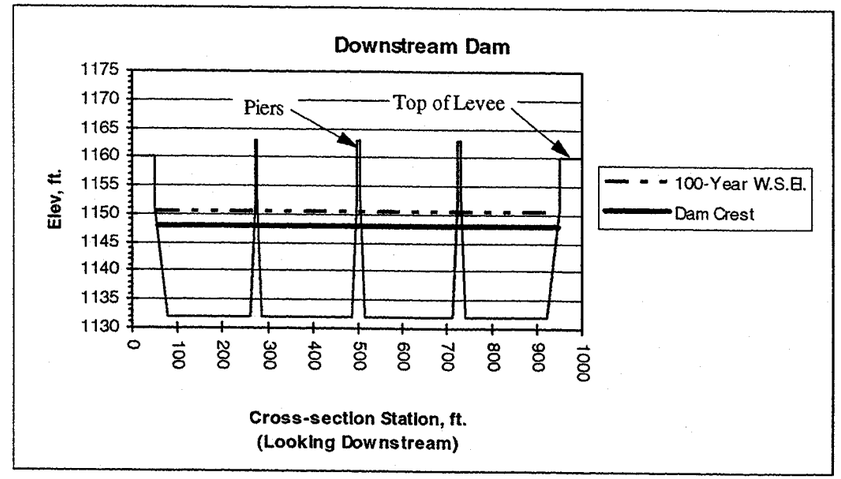


Figure 4-4. Cross-Section of Downstream Dam

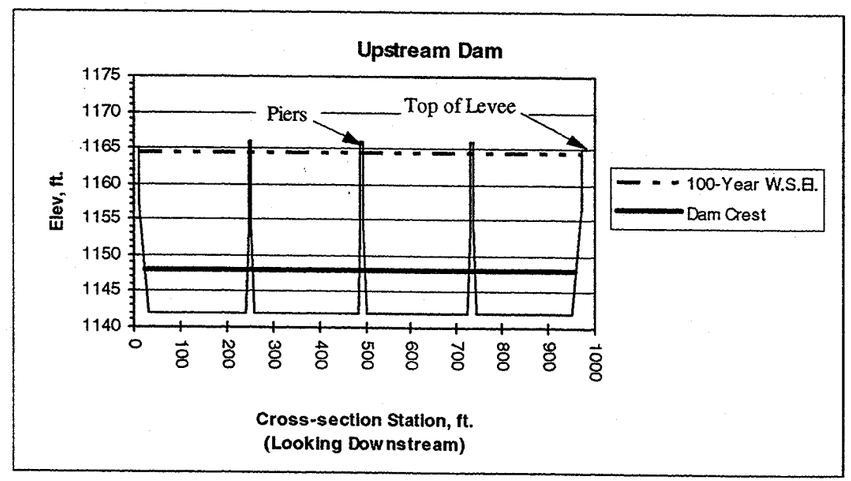


Figure 4-5. Cross-Section of Upstream Dam

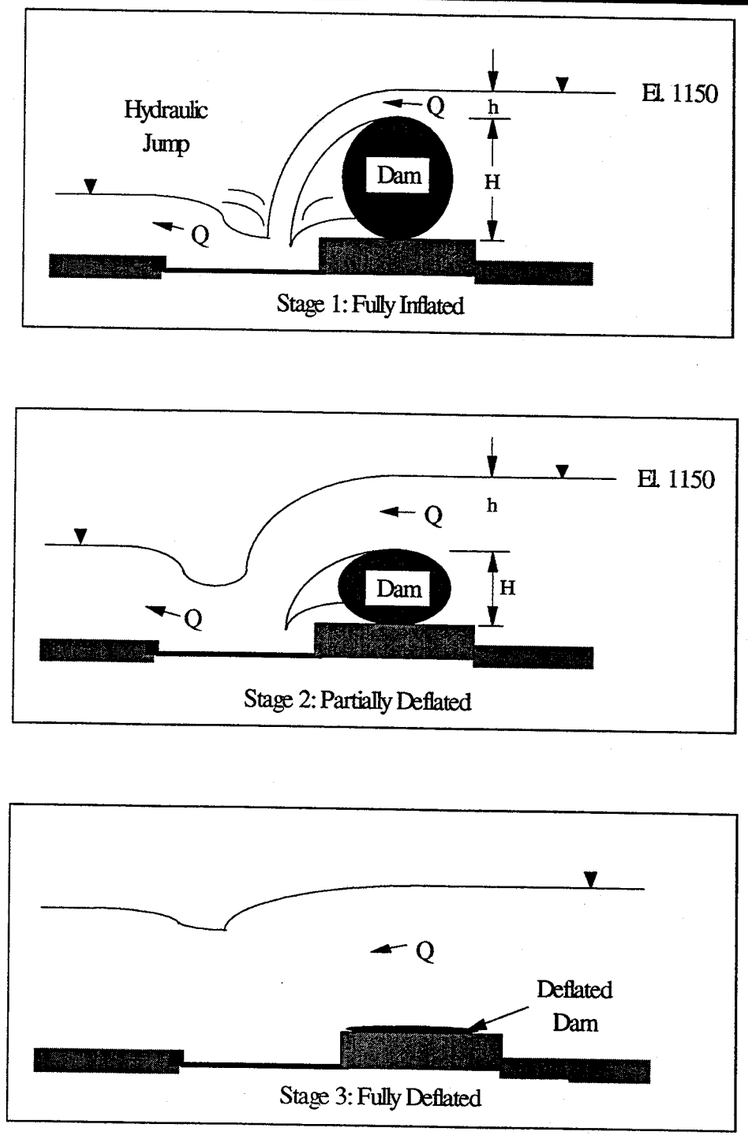


Figure 4-6 Dam Operations Schematics

Energy Dissipator Apron Length Rating Curve

Energy dissipator aprons will reduce scour over the dams and drop structures. In addition, the aprons will help diffuse floodwaves formed by rapid deflation of rubber dams.

Rating curves used to estimate the lengths of the energy dissipator aprons were developed using equations found in *Open Channel Hydraulics* by V.T. Chow, 1959 and *Drainage Design Manual for Maricopa County*, Vol. 2: Hydraulics (see appendix). The ratings included a safety factor of 1.6, as suggested by the FCDMC.

The length of an energy dissipator apron is a function of the overfall height and unit discharge. The equations assume that the nappe is aerated. For an unaerated nappe, the length would be slightly less.

Recommended design lengths are as follows:

- Downstream dam, 95 feet
- Upstream dam, 35 feet

Table 4-4 summarizes overflow discharges and energy dissipator apron lengths for the critical flow scenarios.

Table 4-4
Overflow Discharges and Energy Dissipator Apron Lengths

Location	Dam Inflation	Lake Level, ft.	Crest Elev., ft.	Flow Depth Over Dam, ft.	Dam Height, ft.	Discharge, cfs	Energy Dissipator Apron Length, ft.
Downstream	Fully Inflated	1150	1148	2	16	6,250	39
	Partially Deflated	1150	1145	5	13	33,600	93
Upstream	Fully Inflated	1150	1148	2	6	7,800	35

Hydraulic Evaluations

HEC-2 Model Set-up

The hydraulic impacts of the project were estimated by modifying and combining two HEC-2 models originally created in support of revised Federal Emergency Management Agency (FEMA) floodplain delineation. These Letters of Map Revisions (LOMRs) establish the regulatory flood hazard areas for the Salt River and were prepared after the current Salt River channelization was constructed. Detailed descriptions of the two models and the revisions to them are shown in the appendix.

The following changes were made to the existing conditions models to reflect proposed design conditions:

- The dams were modeled using the Normal Bridge routine because they will not be subject to weir or pressure flow effects
- The upstream dam is about 3,150 feet upstream of Rural Road. The dam's foundation will be about 1½ feet above the channel bed as shown on the channel design plans for this reach of the Salt River channelization project.
- The downstream dam is about 222 feet downstream of Grade Control Structure No. 4 (2,380 feet west of Mill Avenue). The dam's foundation acts as a grade control structure. The invert of the structure is about 3 feet above the design channel invert .
- As requested by FCDMC, the area upstream of the sills was assumed to be ineffective to model sediment deposition to the elevation of the sills.
- Overbank development was assumed to be represented by the concept design prepared for this study. Upstream of the downstream dam, left and right encroachment stations and elevations were added to model the overbank development. Elevations were taken from the most current landscape architect concept plans. To include the effects of the development, the Manning's "n" for the landscaped portions of the terraces was assumed to be 0.045. Bike, pedestrian and equestrian trails were modeled as 0.025
- Discharges modeled were Q_{100} = 215,000 cfs., and SPF =250,000

Results

Design Conditions

The water surface profile is shown in Figure 4-7. The line titled "TOP OF LEVEE" shows the elevation of the lower of the left or right bank levees. The "3 FT. FREEBOARD" (based on FCDMC design criteria) line is 3 feet below the Top of Levee. "CWSEL" is the water surface line and "ELMIN" is the bottom of the channel bed. The resultant water surface complies with the freeboard limit. The minimum freeboard of 3.03 occurs just upstream of the SPTC Bridge.

At the downstream dam, the reduction in cross-section area due to the piers causes the water surface elevation to drop by about ½ foot. At the upstream dam, the piers are significantly smaller, and have almost no effect on the water surface.

Existing vs. Design Conditions

There is an overall slight decrease in the velocity, possibly due to the flattening of the channel grade caused by sediment deposition upstream of the downstream dam. The maximum increase in velocity is about 3.5 ft/s, but this occurs within the hardened dam structure area itself, not in the alluvial river channel. The maximum increase of the water surface, which occurs upstream of the downstream dam, equals 1.02 feet due to backwater, but this increase quickly diminishes upstream.

Conclusions

The effect of the dam and overbank development on hydraulics is minimal, and therefore the ability of the existing channelization to pass the design discharge and control flooding is not diminished. The conclusion is, therefore, that the project does not adversely affect channel hydraulics.

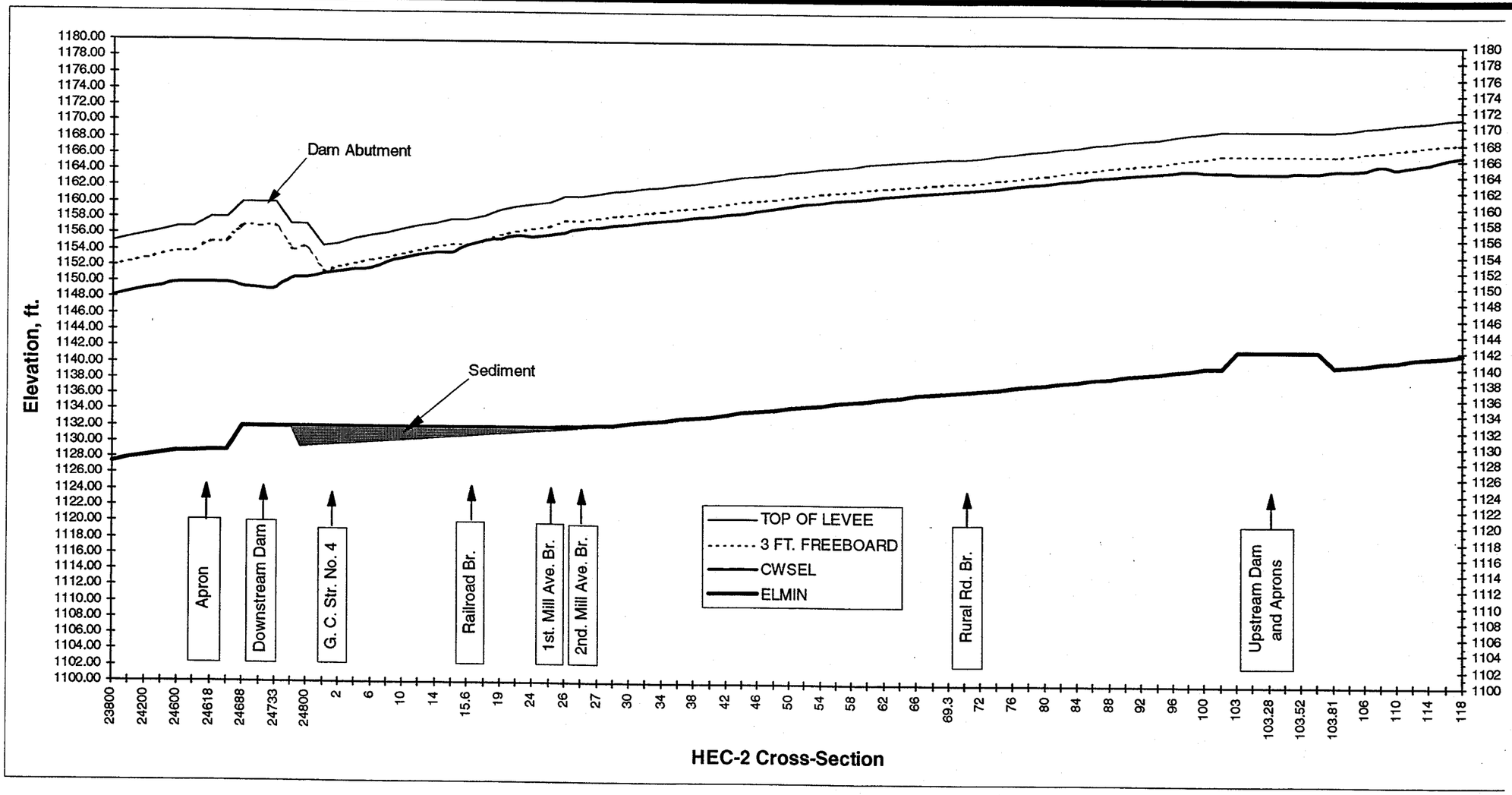


Figure 4-7 Water Surface Profile

Sedimentation and Channel Geomorphology Characteristics

In November 1993, CRSS produced the *Salt River Channelization Floodplain Delineation Study, Southern Pacific Railroad Salt River Bridge to McClintock Drive Bridge.* In that study, CRSS offered the following conclusion:

> The possibility of significant sediment deposition in the Tempe reach is low because of the large volume of sand and gravel production in the upper reaches of the Salt River at this time. Also there is a substantial storage of sediments in the series of upper basin dams on the Salt and Verde Rivers. Given the present condition of sediment supply on the Salt River, the channel is actually sediment-deficient, and the river reach has generally degraded during recent floods. Reduction of the river grade in this reach will therefore arrest the scouring process and provide a more stable river reach...The long-term stability of the Salt River channel occurs due to the eventual armoring of the channel bed by the coarse fraction of the sediment gradation.

The Salt River in Tempe has undergone significant and rapid change during the past 30 years. The bed elevation has dropped 10 to 15 feet. Recent channelization has narrowed the floodplain and increased conveyance. Because of this degradation the bed has become armored with cobble-sized sediment. However, recent grading of the river downstream of the Mill Avenue bridges and in the vicinity of the upstream dam has disturbed the armoring. Construction of numerous bridges and grade control structures has also altered the natural regime of the river. Natural habitat and vegetation has largely been eliminated in the riverbed.

Sand and gravel mining has drastically altered sediment supply in the project reach and is responsible for much of the channel change. An estimated 20 million tons of sediment have been removed from the riverbed by in-channel sand and gravel mining. As a result, the river flows at a sediment deficit condition. The Rio Salado channelization will decrease downstream sediment supply by an additional 1 million tons over the life of the project. Several grade control structures are included in the channelization plans to mitigate the effects of the sediment deficit on adjacent reaches.

The upstream dam will act as a sediment trap for the bed material load during frequent flows. During flows exceeding the 5-year event, the dams will be deflated and the accumulated channel sediments will be removed as part of the naturally occurring channel scour. In the short term, as a result of in-channel grading activities that have disturbed or removed part of the armor layer, sediment deposition rates will be relatively high. However, the sediment transport capacities of the low flows (less than 5-year) are small due to the relatively low depths and velocities which characterize these events.

The actual rate of sediment deposition depends on the flow rates, duration types of in-channel activities, and other factors. Therefore, a definitive volume estimate is not possible. Once an equilibrium armored condition is re-established in the upstream "supply" reach, the volume of sediment deposited will decrease. Monitoring of the sediment deposited at the east dam will be required. Removal of accumulated material may be necessary as a regular maintenance activity.

Finer suspended or wash load sediments will pass over the east dam. A portion of this material will remain suspended and flow over the west dam. The trap efficiency of a reservoir, and the percentage of the suspended sediment load captured, are typically calculated as functions of the storage volume of the reservoir compared to the volume of water passing through it. Based on these relationships, the trap efficiency of the Town Lake is estimated to be very small, indicating that most of the suspended sediment will pass through the lake. As with the upstream dam, monitoring of long-term sediment deposition is recommended.

The Rio Salado project will have a minimal impact on downstream reaches. The dam will be designed to pass sediment for at least the lower recurrence interval floods, i.e., more frequent events. Any potential deficit caused by the dam would be small compared to the sediment deficit created by in-stream mining and channelization. Furthermore, grade control structures, in addition to the grade control provided by the dam itself, will mitigate slope changes initiated by the project.

General Scour

To determine the amount of general scour, the depth of scour occurring until the bed becomes armored is added to the scour due to the formation of low-flow channels.

Procedure

Methods and equations were obtained from the following documents:

- *Computing Degradation and Local Scour*, U.S. Bureau of Reclamation report, 1984
- *Technical Data Notebook* (TDN) for Salt River Channelization Floodplain Delineation Study, SPRR Bridge to McClintock Dr. Bridge, CRSS, November 1993
- *Design Manual for Engineering Analysis of Fluvial Systems*, prepared for ADOT by Simons, Li and Associates, Project No. AZ-DWR-05, 1985

Armor Depth. To estimate the **armor depth**, first the diameter of the smallest particle that won't be moved during a given flow is calculated. Then, how much of the soil column must be removed to accumulate one or more layers of this particle is estimated. The amount of material to be removed determines the armor depth. This approach is consistent with generally accepted practice for gravel or cobble bed streams and represents a limiting scour depth. The current channel stabilization design for the Salt River was based on the same approach.

Degradation depth to armoring is a function of:

- Hydraulic parameters (values obtained from a HEC-2 model of channel):

  -Flow depth
  -Energy Grade Line slope

- Grain-size distribution of bed material. Figure 4-8 illustrates the fine size envelope curve for the data points of sieve analyses for about 30 test pits throughout the project reach of the Salt River.

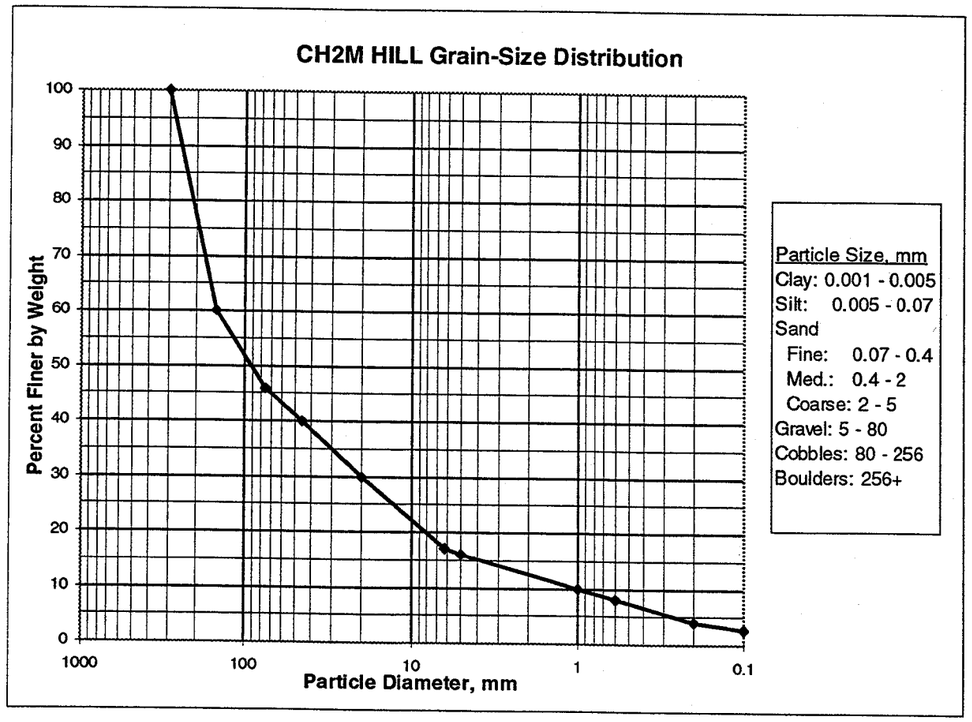


Figure 4-8. Grain-size Distribution

- Manning's "n" for channel
- Bed material roughness
- Safety factor (SF=1.5)

The calculations were performed for cross-sections extending from just downstream of the downstream dam to just upstream of the upstream dam. Figure 4-9 shows the calculated armor depths for the design discharge and the standard project flood.

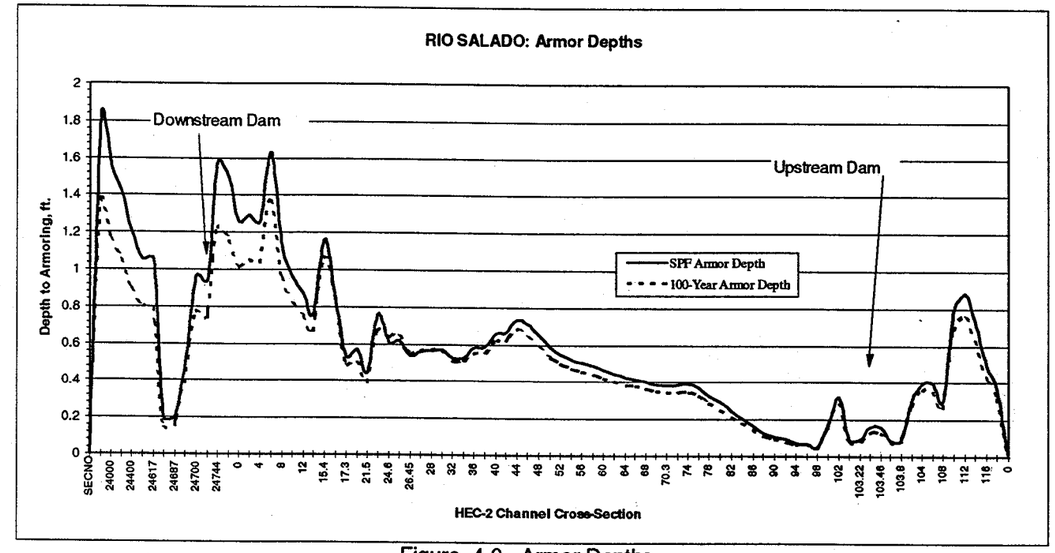


Figure 4-9. Armor Depths

Bedforms. Degradation from bedforms is a function of:

- Shear stress on the channel bed due to the flow
- Critical shear stress of the bed material
- Depth of flow

Depth of bedforms was obtained from the Technical Data Notebook (TDN) for the *Salt River Channelization Floodplain Delineation Study, SPRR Bridge to McClintock Dr. Bridge,* Nov. 1993.

Low Flow Channels. In channels where large width-depth ratios occur, low-flow discharges may initially be conveyed as sheet flow. In this situation, the channel may develop a low-flow channel to more efficiently convey these discharges.

For low-flow channels, Simons, Li and Associates recommend that a reasonable incisement depth of one to two feet. Two feet should be added to the values estimated above to obtain the maximum general degradation.

The following table summarizes the general scour in the Town Lake area.

Table 4-5 Depth of Degradation, Design Discharge			
Location	Armor Depth, ft.	Low-flow Channel Depth, ft.	Total Degradation, ft.
Downstream	1.4	2	3.4
Upstream	0.4	2	2.4
Standard Project Flood			
Downstream	1.6	2	3.6
Upstream	0.4	2	2.4

Local Scour

Local Scour at Piers

Scour is not anticipated at the piers since the piers will be constructed on the dam foundation (see Figure 4-10). The foundation will mitigate the sediment-removal action of vortices formed by the flow accelerating around the pier noses.

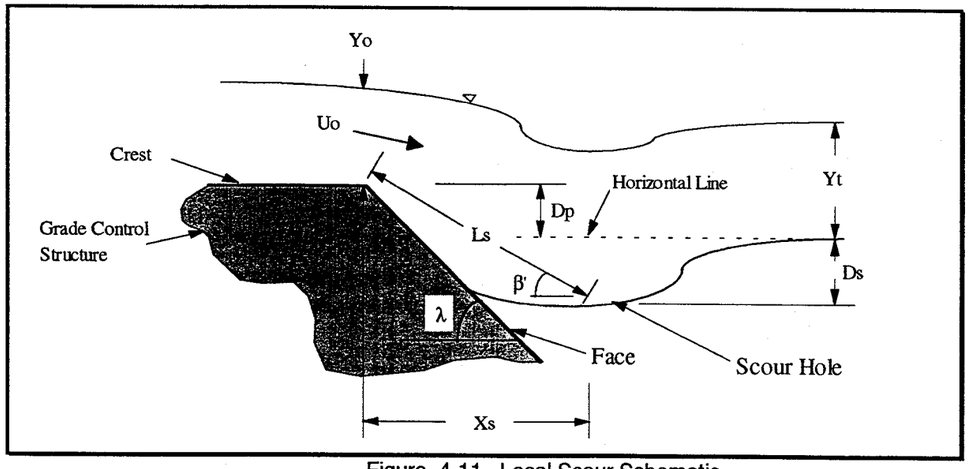


Figure 4-11. Local Scour Schematic

Local Scour Below Energy Dissipator Aprons

Due to channel degradation, a drop forms downstream of the energy dissipator aprons. As the water flows over the brink of the apron and the jet impinges on the channel bed, material is removed. Procedures and equations for estimating the depth of scour were obtained from the document titled "*Scour Downstream of Grade Control Structures*", by N. E. Bormann and P. Y. Julien, J. of Hydraulic Engineering, Vol. 117, No. 5. Some input data were obtained from the TDN.

Depth of scouring is a function of:

- Hydraulic Parameters
  - Upstream jet thickness and velocity
  - Tailwater depth
- Channel Material
  - Specific gravity
  - Submerged angle of repose
  - Effective grain diameter, ds
- Structure Geometry
  - Drop height
  - Downstream face angle
- Applied safety factors

Results

The following table summarizes the results of the scour calculations below the energy dissipator aprons:

Table 4-6 Local Scour Below Energy Dissipator Aprons		
Location	Scour Depth, Ds, ft.	Design Scour Depth, ft.
Design Flood		
Downstream	10	13
Upstream	4	5
Standard Project Flood		
Downstream	12	16
Upstream	5	7

Total Scour Depths

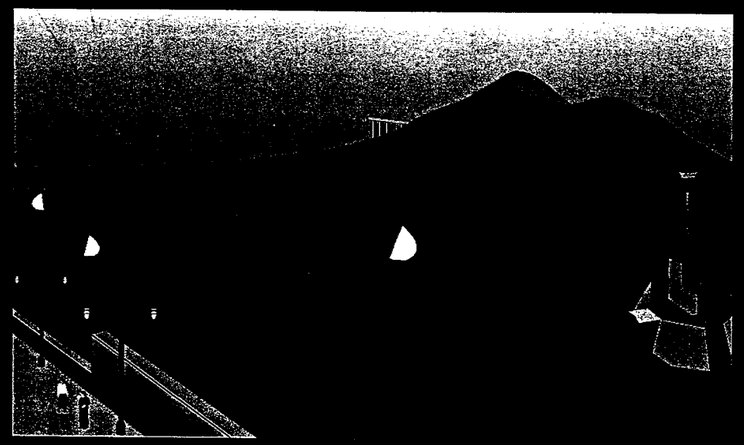
Except for areas downstream of the energy dissipator aprons, the total scour that controls design conditions for the channel is equal to general scour.

At the energy dissipator aprons, the channel will experience local scouring as well as general. The total scour depth is the sum of the two as shown in the following table.

Table 4-7
Total Scour Below Energy Dissipator Aprons

Location	General Scour, ft.	Local Scour, ft.	Total Scour, ft.
Design Flood			
Downstream	4	13	17
Upstream	3	5	8
Standard Project Flood			
Downstream	4	16	20
Upstream	3	7	10

SECTION 2
Lake Operations and Design



Introduction

The Town Lake dams must operate through a range of flow scenarios, while considering the dual objectives of minimizing the loss of stored water, and minimizing impacts to the lakeside development and upstream and downstream structures. This chapter describes the assumed operating scenarios for the lake during a range of Salt River and Indian Bend Wash flow events.

The basic lake operation objectives are to:

- Maximize depth, circulation and mixing characteristics of the lake to enhance water quality and minimize the economic impacts of an empty lake
- Maximize conservation of resources, including water, fisheries, and energy
- Minimize flooding-related damage to overbank park features, docks, Rio Salado Parkway, and other amenities
- Create as stable a water surface as possible given the hydrologic characteristics of the river

Operating criteria and assumptions, described in detail in the "River Hydraulics" chapter, are summarized below:

- Q_{des} = 250,000 (Salt) SPF
  = 215,000 (Salt) 100-year
  = 32,000 (IBW) 100-year
- Water surface elevation (normal) = 1147.75
- Water surface elevation (max. operating) = 1150
- SRP can provide approximately 12-hour notice prior to significant release
- Dams can operate partially inflated (allowing up to 6 feet of overtopping)
- Downstream dam operating range is at least 13-16 feet (el 1145 to el 1148)
- Dam sections can be raised/lowered independently

Salt River Releases

The normal operating static water level for the lake will be 1147.75. When there is inflow down the Salt River that exceeds the infiltration rate of the river, water initially will pond behind the upstream dam (unless that space is already filled with water) before rising to the crest of the dam (el. 1148.0) and spilling into Town Lake. A minimum 2 feet of freeboard will be provided for shoreline treatments and lakeside developments. The normal operating range for the lake, during most flow conditions, will be between elevations 1147.75 and 1150.

At elevation 1150, the spill capacity of the fully inflated upstream dam is 7,800 cfs. The downstream dam spill capacity is 6,250 cfs, therefore, during Salt River discharges between 0 and 6,250 cfs, both dams will remain inflated. If the inflows reach about 6,200 cfs, the lake level will rise to 1150, which is the maximum desirable water surface elevation. If the water surface continues to rise, the controls on the downstream dam would be set to automatically maintain a constant pool elevation of 1150 plus or minus 0.25 feet by deflating one or more of the dam segments. A V-notch will form when the downstream dam is deflated to 10 to 35 percent (varies depending upon the vendor) of the full height. As flow rates exceed 6,250 cfs, dam sections will be sequentially lowered 3 feet to an elevation of 1145, beginning with the center sections and proceeding to the two outer sections. When all of the downstream dam segments have been lowered to 1145, the maximum flow rate at water surface elevation 1150 is about 36,000 cfs. (This is approximately a 5-year flood event on the Salt River and greater than a 100-year event on the IBW.) At a flow rate of 36,000 cfs, there is approximately 5 feet overtopping of the upstream dam, which corresponds to a water surface of 1153 immediately upstream of the dam. The upstream dams will be designed to remain fully inflated until the flow rate reaches 36,000 cfs.

If flows continue to increase to greater than 36,000 cfs (downstream dam water surface elevation greater than 1150.0), then the operation mode should be changed to manual and a signal would be given to:

- First, completely deflate each of the dam segments of the upstream dam since this dam is most sensitive to instability because of the high head/dam height ratio (5'/6').
- Second, completely deflate each of the dam segments of the downstream dam. With the dams fully deflated, the channel now has the capacity to convey the 100-year storm event of 215,000 cfs and have 3 feet of freeboard available below the levee.

When fully deflated, the flow rate at water surface elevation 1150 is approximately 190,000 cfs. As flow rates decrease, re-inflation will begin when the flow rate elevation at the upstream dam has been reduced to 2,000 cfs. The downstream dam segments will be inflated first. Once they have fully inflated, the operation would correspond to the filling of the lake.

Indian Bend Wash Discharges

Except for during the most extreme storms, the anticipated discharges from Indian Bend Wash will not require active management of the dams. For discharges that exceed 6,200 cfs, the operating scenario will be the same as that for Salt River flows, except that the upstream dam will not be lowered. Only the downstream dam will be controlled. For the anticipated 100-year discharge on Indian Bend Wash, the downstream dams would be lowered to a minimum elevation of 1,145 feet.

Flows down Indian Bend Wash will enter the lake and flow both upstream and downstream. The upstream flows will spill over the upstream dam until the space behind the dam is filled (water will back up as far as the grade control structure at McClintock Road) and then most of the flows will be in the downstream direction. If the inflow exceeds the seepage and evaporation losses in the lake, the excess water will spill over the downstream dam crest. The upstream dam will have a dual connection system which will allow it to accommodate flows in both directions, up to at least 5 feet over the dam crest (el. 1153). However, the dam should not be deflated when the flow is in the upstream direction, since the tube will not stow properly in a flattened position. The operator will need to wait until the flow reverses to the downstream direction with a minimum velocity of 2 to 3 fps.

Dam Operations

Water for the initial filling of the lake will either be conveyed via the Salt River or the Indian Bend Wash. If the Indian Bend Wash is the sole source, and the water begins to approach the bottom of the sill of the downstream dam (el. 1132), the dam should be completely inflated to begin impounding water. As the water level rises and begins approaching the sill elevation of the upstream dam (el. 1142), the upstream dam should be completely inflated, thus forming the lake. The water would continue to rise until it reaches the design water surface of 1147.75 ±.

If the Salt River is the sole source, the scenario will be the same as above except that after filling to the sill elevation of the upstream dam, the dam will be inflated. Inflating the upstream dam would result in water ponding behind the structure until it spills over into the lake. As the water level rises, and begins approaching the normal design surface of 1147.75, the inflow should be shut off. This would create a pool of water above the upstream dam. The life-span of this pool depends upon whether the inflows (stormwater and nuisance flows) exceed the outflows of evaporation, seepage, and/or pumping. A bypass pumping capability is included in the design.

Flood Impacts and Operations

Up to about the 20-year flood event, flooding in the terrace areas (between the CSA bank stabilization and the levees) will be limited to wave run-up and minor overtopping. Rio Salado Parkway at Ash will be inundated by water overtopping the CSA bank at a discharge of approximately 135,000 cfs. This is equal to about a 20-year flood. Currently, the Parkway will be inundated at about the 10-year flood event. Inundation of the Rio Salado Parkway would temporarily affect transportation, and traffic would need to be detoured to alternate routes. No significant structural damage has occurred as a result of inundation from past flood events.

Terrace Park Developments

All features in the park development must be removable, sacrificial, or designed to withstand flooding. During floods of less than the 10-year event, little terrace flooding will occur. In floods greater than the 10-year flood, flows in the terrace will increase with increasing flood discharge. During a 100-year event, the overbank flows may be up to 10 feet per day and flow at up to 5 feet per second.

Flood Warning and Instrumentation

Currently SRP, which operates the Salt River dams, notifies the Tempe police commander 24 hours prior to a major change in flow rate. The Salt River travel time between Granite Reef Road and Mill Avenue varies with the flow rate and antecedent moisture condition of the channel. Recent flow events have ranged from 17 hours for a 3,500 cfs flow to less than 7 hours for a 10,000 cfs release. Therefore, Tempe will have a minimum response time of around 30 hours to prepare for a significant Salt River flow event. There is less response time for IBW events, because there is no formal warning system. During this period, boaters and others must be evacuated from the lake and terraces; docks, vendor equipment, and any in-channel maintenance equipment must be removed. A full response plan will be needed, outlining the responsibilities of an emergency response team consisting of the police, fire, and parks departments.

Dam Failure Analysis

According to both dam manufacturers, Sumigate and Bridgestone, no rubber dam has had a rapid "breach-type" failure in several hundred installations. However, such a failure must be anticipated and evaluated.

The worst-case dam failure scenario is a "sunny day" instant failure. Carter & Burgess, Inc., (August 19, 1994; see appendix) performed an analysis of a sudden gate failure opening failure mode, using a diffusion wave routing model. Results of the analysis indicate that a gate failure leading to a sudden water release would create severe in-channel conditions for about 2½ hours. The release of water from Town Lake would essentially end within 4 hours. The flood wave would travel down the Salt River channel at a maximum rate of about 19 fps, and an average rate of about 11 fps. As the result of in-channel storage, the wave would gradually attenuate to the level generally considered to be fordable, that is, when the depth (ft) times the velocity (fps) is less than 10.

If a rapid gate release occurs, channel-bed users would be at risk for many miles downstream of the project. The rate of rise at the wave front would be rapid, with flow depths increasing from near zero depth to a 5- to 6-foot depth in about 2 minutes. This rapid rise rate would give channel-bed users with no previous warning very little time to exit the channel safely. Such a release would not be a hazard to users located on in-channel terraces that are more than 8 feet above the channel bed elevation, or to users outside of the channel area. From this analysis, it can be concluded that flood warning systems may not reduce significant hazards. While dam failure is an extremely low probability, there could be high risk to anyone within the channel.

Based on this analysis, aggressive and active measures must be taken to prevent danger to life and property. Minimum recommendations may include:

1. Do not allow recreational uses in the channel downstream of the dam
2. Allow very limited channel uses with appropriate signage.

Introduction

This chapter describes, in general terms, the design criteria for the dams and foundations. Additional detailed design requirements are described in the Geotechnical/Hydrogeological Report submitted under separate cover. Basic design criteria are:

- Maintain 3 feet of freeboard below the top of the flood control levee during the 100-year event (as required by FCDMC).
- No increase in impacts to surrounding areas during flood events up to and including the SPF (Standard Project Flood).
- Integrity maintained in design (that is, the dam and the foundations will withstand the SPF with minimal damage).
- Maintain "full lake" condition through a reasonable range of flow events, thus minimizing the economic impacts of an empty lake.
- Maximize the City's opportunities to respond to the widest possible range of development and recreational options.

The intent is to provide a design for the dam and other appurtenances that will sustain little damage during most river flow events. The 100-year design event of 215,000 cfs, however, is an extremely destructive event with high velocities, and could potentially transport large amount of debris. While the structural elements of the project such as the foundations, abutments, and piers are designed to survive not only the 100-year flood but also the SPF, some damage to the dam and the terrace development features should be expected.

The most important structural components of the lake are the dams. During the first phase of the Rio Salado project, dam types were evaluated in detail using specific project criteria, such as hydraulic and sediment transport related flood control impacts, life cycle costs, aesthetics, reliability, safety, and operational flexibility (see Rio Salado Technical Memorandum 4, *Salt River Hydraulics*, CH2M HILL, July 1991).

The potential dam and gate alternatives that were considered for the Town Lake project included three basic configurations: channel gates, fixed weirs, and fuse plugs. A series of alternatives were developed from this list, including tainter gates; both water- and air-filled dams; ogee crest weirs; and labyrinth weirs.

Several alternatives were eliminated after preliminary evaluation. Tainter gates did not meet flood control criteria. Water-filled inflatable dams were eliminated from further consideration for safety and operational constraints. (Specifically, they take much longer to fill and empty than air inflatable dams, reducing the operational flexibility. A water-filled dam also creates a more significant risk from vandalism and is much more difficult to repair in place.) Labyrinth weirs were eliminated because of hydraulic and sediment transport constraints. The Rio Salado advisory committee, comprised of City staff from the engineering, planning, and legal departments, and representatives of the City Manager's staff, selected air-inflatable rubber dams. Details of these evaluations were presented in the Rio Salado *Feasibility Study* and *Engineering Report* (CH2M HILL,1992)

Background

Rubber dams have been available since the mid 1960's. The earliest applications were composed of various types of fabric, possibly rubber coated, and generally filled with water. Today water-filled dams are still available, however most applications are now air-filled structures. The composition is typically a multi-ply synthetic rubber compound with fabric reinforcing similar to automobile tires. These structures have been applied to a range of impoundment uses. Among the uses are flashboard-type extensions on dams of other materials, channel diversions for irrigation and recharge uses, and tidal barriers.

According to the dam vendors, there are approximately 1,500 worldwide installations of air-inflatable dams ranging in size from 3 to 2,000 feet in length. From information provided by the vendors, owners, and dam safety officials, a listing of all known failures of this type of structure was attempted. While it is not known whether the list obtained is complete, the number of reported incidences of failures is small. No failures of foundations or mounting systems were found. The few failures or problems reported were generally related to punctures from flood debris or vandalism. There was also a report of abrasion of the rubber material at an abutment/pier as a result of turbulent flow. In most cases, repairs were made in place but may have required complete deflation of the dam. More serious repairs have required the removal of the dam for permanent repair at the factory.

Currently, two primary vendors of inflatable dams(operating in the U.S.) sell the type of dams envisioned for Rio Salado Town Lake. Town Lake will be the largest application to date in the U.S., although both vendors have produced higher and longer applications outside the U.S. Neither vendor has an installation that is both higher *and* longer.

Much of the information presented in this report was supplied by the vendors described below. The intent of the dam design criteria presented in this report is to provide, to the extent possible, a dam design that can be met by either vendor.

Manufacturers of Inflatable Dams

A number of vendors were contacted; only two vendors offered a product that met the design criteria: Bridgestone USA and Sumigate, a division of Sumitomo Electric.

Bridgestone USA. Bridgestone has been building rubber dams since 1978. They have provided dams for 28 U.S. installations and over 300 worldwide installations.

The local contact is:

Roger Busch
P.O. Box 6147
Huntington Beach, California 92615-6147
714/962-1666

Sumigate. Sumigate has been building rubber dams since 1966. The company has provided dams for 2 U.S. installations and over 1,200 worldwide installations. The local representative is Rodney Hunt and Company; the local contact is:

Bob Henderson
c/o Rodney Hunt
48 Mill Street
Orange, Massachusetts 01364
508/544-2511

Field Visits

The CH2M HILL design team visited three representative dams in California: two Bridgestone installations in Alameda County Flood Control District and Orange County Flood Control District and one Sumigate installation in the Orange County Flood Control District. Contractors, owners, and suppliers were interviewed.

General Characteristics of the Inflatable Dams

Table 6-1 on the following page summarizes the general characteristics of the two dams.

Dam Design

Detailed design information on the dams, foundations, piers, and abutments will be provided in the Geotechnical/Hydrogeological Design Report, provided under separate cover. The recommended design is summarized below. Design criteria are summarized in Table 6-2.

Table 6-2
Design Criteria

	Upstream Dam	Downstream Dam
Max. Height	6 feet	16 feet
Max Q When Inflated	40,000 cfs	40,000 cfs
Dam Height at 40,000 cfs	6 feet	12 feet
Upstream Flow Depth at 40,000 cfs	12 feet	18 feet
Tailwater at 40,000 cfs	6 feet	6 feet
Maximum Flow Depth (SPF) (dam deflated)	26 ft	24 ft
Average Velocity (SPF) (dam deflated)	10 ft/s	12 ft/s

Sill Height

The original channelization design for this reach of the Salt River assumed a channel elevation at Grade Control Structure No. 4 of about 1132. The hydraulic modeling, river mechanics, and sediment transport studies that formed the basis of the design were based on this invert elevation (personal communication, G. Cotton). During the subsequent construction, as a result of the presence of a shallow "bedrock" layer in the vicinity of Grade Control Structure No. 4 and the need for borrow material, the design was modified and the invert was lowered to about 1129.5.

To reduce the cost of the dam segments, the dams will be founded on a concrete/roller-compacted concrete sill. The sill's top elevation (1132) matches the original channel design elevation. As described in the "River Hydraulics" chapter, this sill will have no significant adverse affect on the design flood water surface elevation.

Table 6-1
Comparison of Bridgestone and Sumigate Rubber Dams

	Bridgestone USA	Sumigate
Material Properties		
Rubber	6-ply Nylon Reinforced Rubber	Rubber-coated nylon (thickness & plies determined by height, overflow and stress)
Thickness	Upstream Dam=0.50" Downstream Dam=0.89"	Upstream dam = .31"; downstream dam = .50"
Ultraviolet protection	0.20" thick EPDM cover	Hypalon
Tensile break strength	7800 lbs/in circ. 5500 lbs/in longit.	
Tongue tear strength	300 lbs/in	
Adhesion between nylon & rubber (ASTM D751)	Min. 34 lbs/in^2 new; 22 lbs/in^2 aged at 158 degrees for 96 hours	Min. 6 Kg/CM^2 ; Aged at 70 degrees C 96 hours
Ozone Test	110 mPa/104 degrees F; at 96 hours and 50% elong.	30-year design life for UV exposures. (40 years probable)
Abrasion (ASTM C501 modified)	< 0.03 in ^{3} Tabor Test	
Armor Protection	Ceramic Beads	Ceramic or (now testing) Kevlar
Design Factor of Safety	8 for fabric, 3 for anchor line Japanese Industrial Standard (JIS)	8.0 JIS STD
Color	Black. Other colors recently made available	Blue, Green, Orange, or a Combination
Embedded Steel	Galv. (s.s. available)	Normally stainless (s.s.) when exposed
Project Experience		
Years producing inflatable dams	16 years	28 years
No. dams installed with present materials	300	1,200
Largest dam height/length	15' x 220' (highest) 8' x 291' (longest)	19.7 ' x 113.2' highest; 7' x 320' longest
Oldest dam in service	1980 Japan; 1984 USA	1966 Japan; 1992 USA
References	Provided	Provided

	Bridgestone Inc.	Sumigate
Manuals	Yes	Yes
Vibration	Fin enhances stability	Dependent on design (no fin) and operation
Inflate with sediment load	Yes- up to 1 to 2 feet of silt	Yes, up to 5 feet of silt
Warranty	Fabric - 2 years; Equipment - 1 year. 10 year pro-rated warranty available	1 year normal warranty, extended warranty available
Construction assistance at project site	Provided	Provided
Personnel at jobsite, submittals	Provided	Provided
Design assistance	Provided	Provided
Engineer's stamp on vendor design	Provided	Can be arranged
Support equipment	I&C design by RW Beck	Design by Sumigate (air supply and controls)
Delivery schedule (assuming normal backlog)	12 months for downstream dam; 6 months for upstream dam	8 months for downstream dam; 4 months for upstream dam
Fan noise		80 DBA, Silencers can be added
Geometric Criteria		
Height to Span (Max.)	16' x 259'	16' x 263' (15.75" x 262') or 5.2 x 50 (m) (17.06 x 164')
Pier Side Slopes	Vertical ok 1:1 preferred	Vertical ok Slope preferred
Position of Deflated Dam Body	Flat	Flat
Anchor line	1 line on downstream dam/2 lines upstream dam	2 lines both upstream and downstream dams
Other Considerations		
Vandal resistance	Ceramic chips	Ceramic beads; Kevlar belts
Construction time	15 days per segment (7 days after delivery of rubber dam)	45 days per segment
Material Cost		Downstream dam: $4.43 million ($4.9 million w/ Kevlar armoring) Upstream dam: $1.47 million ($1.6 million w/ Kevlar armoring)
Special characteristics	Fin. Lays flat.	Internal cushioning. Lays flat.
Anchoring system	Upstream dual; downstream single	Upstream dual; downstream dual.

Foundation

Downstream and Upstream Dams

The downstream and upstream dams that will contain Town Lake will be inflatable rubber dams. The dams will be attached to a concrete foundation in the river bed with an anchoring system designed by the vendor. The anchoring systems are bolted to the foundation structure as shown in Figures 6-1 and 6-2 on the next page. Differing foundation conditions at the two locations have led to different dam foundation types. The dams will be inflated with low-pressure compressed air and will retain water in the lake. The dams are designed to fully deflate when overtopping flows exceed a depth of 6 feet. As the air pressure is decreased, the deflated dams will be pressed against the bottom of the river by the force of the flowing water, increasing the flow area for the increased flow in the river. When the higher flow begins to subside the dams will be reinflated, capturing the water between the dams to maintain a full lake.

Downstream Dam

The downstream dam will be located on the Salt River approximately 3,400 feet east of Priest Drive and about 220 feet west of Grade Control Structure No. 4. The downstream dam will consist of 4 spans of rubber dams, each 16 feet in diameter (which equals the dam height) separated by three center concrete piers and two abutments. Each section of the rubber dam will be approximately 190 feet long as measured along the foundation. (See Sheet 5 and Sheets 15 through 19 of the drawings.)

To provide a foundation for the downstream dam, a concrete slab will be constructed. Anchor bolts will be used to secure the dam to the base slab. The dam is designed to operate in both a fully inflated position with up to 2 feet of overtopping and a partially inflated position with up to 5 feet of overtopping, as well as a fully deflated position. An energy dissipation slab will be provided downstream of the dam. It will be designed for preventing erosion and dissipating the energy of the flow over the rubber dam. During high river flows, the rubber dam will be deflated and the water will flow over the slab. When the flows have subsided, the dam will be reinflated.

Foundation Conditions

The subsurface conditions consist of 10 to 20 feet of naturally deposited alluvial materials underlain by 0 to 40 feet of clayey gravel. The recent alluvial materials are 18-inch minus boulders, cobbles, gravel, sand, and a small amount of silt. Beneath the clayey gravel at varying depths, granitic bedrock was encountered. The contact occurred approximately 30 to 40 feet below the channel invert. Groundwater was encountered at a depth of approximately 12 feet below the channel invert which corresponds to approximately Elevation 1117. Some fluctuations can be expected in the depth to groundwater, with high levels corresponding to periods of rainfall or flows in the river. Groundwater is anticipated to be present during the construction of the downstream dam and while it is operating.

Downstream Dam Stability

The rubber dam will be subject to horizontal and overturning forces from the water retained in the lake. The foundation system must be able to provide stability for the dam under a variety of operating conditions. This includes a normal full lake and the overtopping condition where up to 2 feet of water will pass over the top of the dam before the dam is partially deflated. Short duration earthquake forces can also act on the dam. The dam was found to be stable under all these conditions.

To prevent erosion of the alluvial materials under the concrete slab, a cutoff wall or other foundation system must be provided. A cutoff to erosion and water infiltration must be provided at the clayey gravel level. The water cutoff is needed to minimize lake infiltration but also to prevent uplift water pressure from acting on the concrete slab downstream of the rubber dam.

Acceptable factors of safety were achieved with the RCC foundation block beneath the rubber dam and rip-rap downstream of the dam. Details of the stability analysis are included in the Geotechnical/Hydrogeological Design Report, submitted under separate cover. The alluvial material adjacent to the RCC block must be well compacted and the rip-rap downstream of the downstream cutoff wall must remain in place to maintain a stable structure.

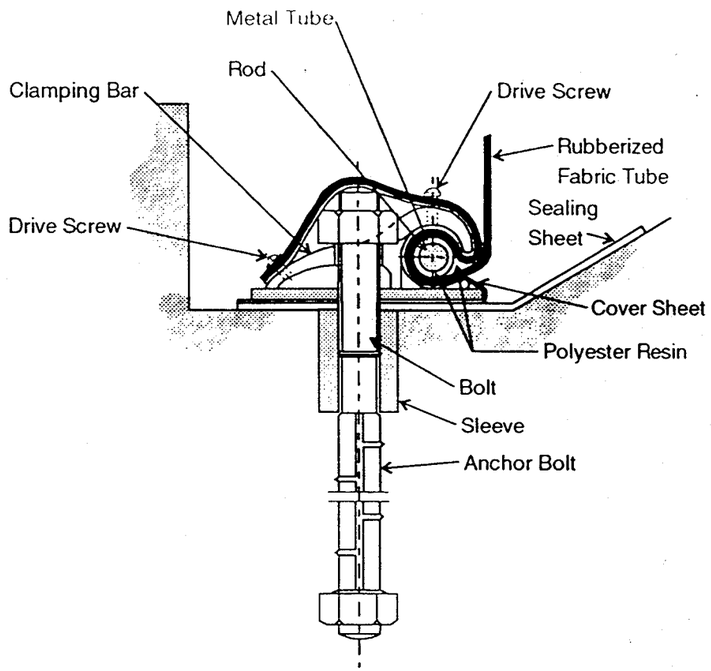
Abutment and Pier Requirements

The abutments currently consist of cement stabilized alluvium (CSA) placed (at a slope of 1.5 horizontal to 1 vertical) in horizontal layers at least 8 feet wide to a depth approximately 10 feet below the channel bottom. Constructing the RCC foundation for the dam and the concrete slab for the abutments will require removal of a panel of the CSA. RCC and /or concrete will be placed in this zone to provide a stable foundation for the dam abutment and to reduce infiltration around the dam. The piers will also be constructed on a RCC foundation.

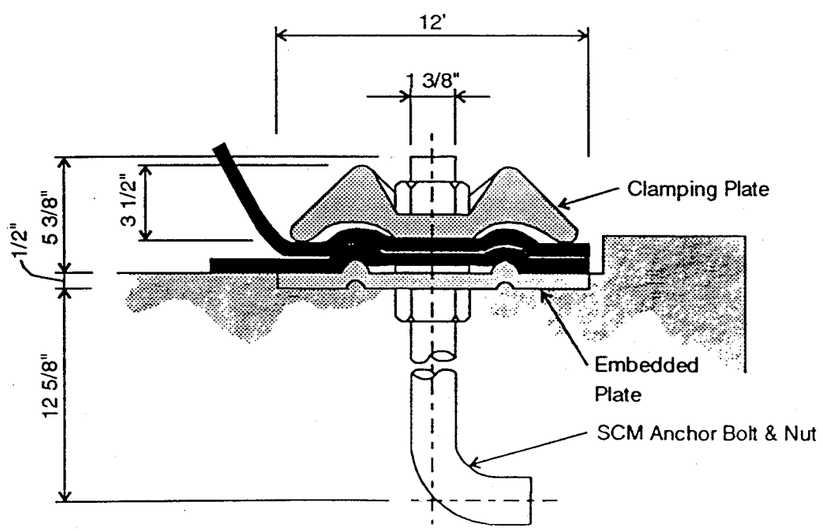
Upstream Dam

The upstream dam will be located approximately 200 feet upstream of the confluence of North Indian Bend Wash with the Salt River. The dam will consist of 4 spans each approximately 200 feet long. The rubber dam segments will be 6 feet in diameter. Three concrete piers and two abutments will support the end of each rubber dam segment. The foundation slab for the dam is anticipated to be approximately 80 feet wide from the upstream to the downstream edge, with the rubber dam in the center. See Sheet. 9 and Sheets. 20 through 24 of the drawings.

As opposed to the downstream dam, the upstream dam is designed to operate in only a fully inflated or deflated position. The upstream dam will remain inflated with up to 6 feet of water spilling over it

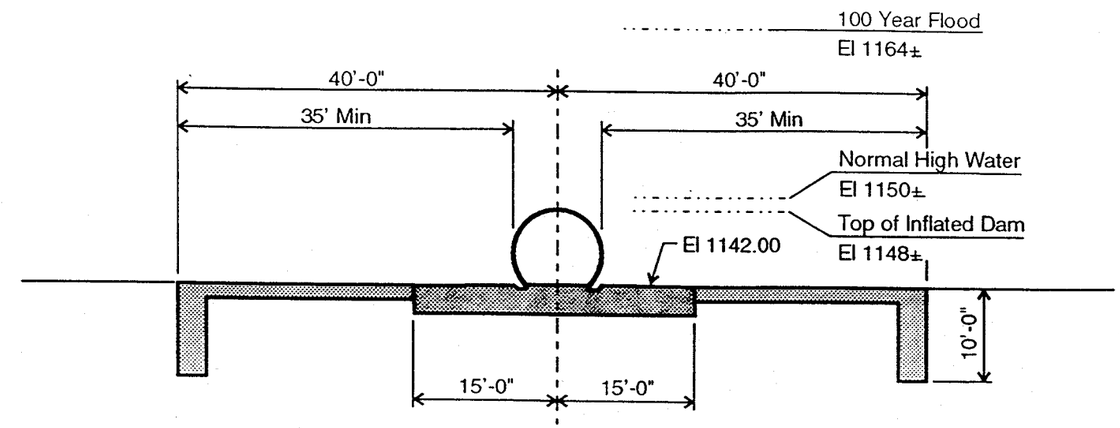


Sumigate Dam

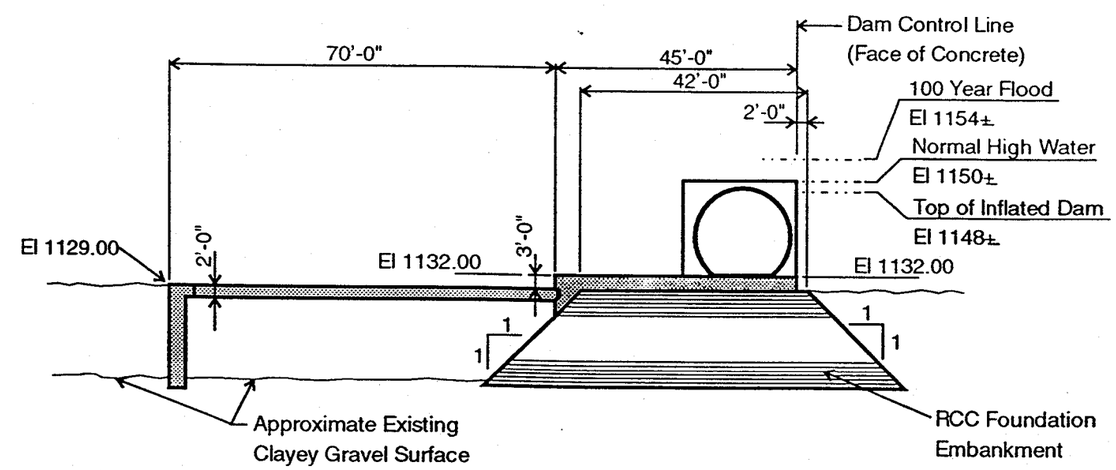


Bridgestone Dam

Figure 6-1
Dam Anchoring Systems



Upstream Dam



Downstream Dam

Figure 6-2
Dam Cross-Sections

(12 feet total head) in either direction, as long as there is 6 feet of tailwater on the other side. Operationally, the upstream dam will be inflated as the lake is being filled. Under normal operating conditions the dam will not be overtopped in the upstream direction except when Indian Bend Wash flows and the Salt River is not flowing at a rate that would prevent flow in the upstream direction. Water from the lake will then spill over the crest of both the upstream and downstream dams. Therefore the dam can be overtopped either from high flow from Indian Bend Wash or other local rainfall events, or from flows in the Salt River upstream of the site. Energy dissipation slabs will be provided both upstream and downstream of the dam.

Foundation Conditions

Based on the information obtained from the field exploration and observation of the site and surrounding construction, the alluvial materials in the channel extend to depths of over 200 feet. The upper alluvial unit is approximately 30 feet thick and consists of loose cobbles/boulders to silt size particles.

Upstream Dam Stability

The general cross-section for the upstream dam is shown in Figure 6-2. The rubber dam will be subject to horizontal and overturning forces from the water retained in the lake. The foundation system must be able to provide stability for the dam under a variety of operating conditions. This includes a normal full lake and the overtopping condition where up to 6 feet of water will pass over the top of the dam in either direction before the dam is deflated. Short duration earthquake forces can also act on the dam. The dam was found to be stable under all these conditions. Details of the stability analysis are included in the Geotechnical/Hydrogeological Design Report.

To provide a stable dam, the foundation must be capable of resisting horizontal forces from either the upstream or downstream direction. Since the depth to bedrock is very great it will not be possible to eliminate water infiltration beneath the dam. The infiltration will be reduced by the presence of a slurry wall and well system.

Two reinforced concrete walls will be constructed at the upstream and downstream edges of the foundation slab. These walls could be constructed either using the slurry trench method or cast in place. If cast in place methods are used, the site would have to be excavated to a depth of 10 feet and after the walls are constructed the backfill would have to be placed and compacted. To provide a 30-foot-deep cutoff wall along the alignment of the upstream dam for the purposes of lake infiltration management, a separate slurry wall would need to be constructed. To avoid a separate wall we recommend the foundation would be constructed using the slurry method of wall construction and the downstream wall extend to the 30-foot depth.

Abutment and Pier Requirements

The abutments currently consist of CSA which extends to a depth of about 12 feet below the channel bottom. To provide a base on which to set the concrete abutments the CSA will have to be removed. The piers in the river will be structurally connected to the foundation slab. This will provide a uniform base on which to construct the foundation slab.

Piers/Abutments

The piers between the dam segments will be made of structural concrete, as shown on the Plan Sheets. The top width will be 6 feet and the side slopes will be .5V to 1H. The sections will be configured to reduce hydraulic pier losses and withstand the hydrodynamic forces during the SPF (see appendix).

Energy Dissipator

To control scour of the dams, energy dissipator aprons will be constructed at both dam locations. The energy dissipator aprons, which generally consist of a 3-foot drop at the base of the dam to a concrete splash pad, will be constructed at both dam locations. The length of the stilling basin was calculated using data supplied by Bridgestone and the methodology outlined in the Maricopa County Drainage Design Manual (1992). Dumped rip-rap will be placed downstream of the downstream dam stilling basin for a distance of 30 feet. Computations are included in the appendix (under separate cover).

At the upstream dam, energy dissipator aprons will be constructed on both the upstream and downstream sides to accommodate flow in either direction. The basins will be 35 feet long.

The stilling basin at the downstream dam will be 95 feet in length.

Access Control

Access to both dams will be controlled by 8-foot-high concrete walls built into each abutment. The wall extends for the full length of the erosion apron.

Instrumentation and Control

Independent blowers will control each dam segment. (See Sheets. 43 and 44 of the drawings.) These controls are cross-connected by a manifold so any blower can operate any dam segment. The

I&C connects to the City's SCADA system for monitoring only; actual control of the dams is from the dam operations buildings. The sensor automatically raises and lowers the dam for river flow of less than 40,000 cfs to maintain the lake depth. For flows greater than 40,000 cfs, a manual system will be used. The decision to lower one or more segments will be based on release information coupled with a gage at McClintock Bridge and pressure sensors near Grade Control Structure No. 5. When SRP notifies the City of a release in excess of 40,000 cfs, staff will prepare to lower one or more dam segments. When the higher flow rate reaches the McClintock Bridge gage, an alarm is sent to the dam operations building and the dams will be lowered. The refilling sequence will be conducted in a similar manner.

Upstream/Downstream Bypasses

Downstream Bypass

To provide low flow control for fine-tuning lake elevation, flow rates, evacuation of lake water, etc., without lowering the dams, a low flow bypass will be built at the downstream end of the lake. (See Sheets. 15 and 17 of the drawings.) The low flow bypass will be:

- Located in north abutment.
- 48-inch-diameter reinforced concrete pipe.
- Remote-controlled gate valve.
- Q_{cap} = 110-115 cfs

Upstream Bypass

Dewatering the riparian area, if necessary for upstream water level control or maintenance, will be possible through a pump bypass system. (See Sheet 21 of the drawings.)

The upstream bypass will be:

- Located in south abutment
- 24-inch PVC perforated collection pipe
- 5-mgd pump capable of dewatering the area within 10 days
- 24-inch discharge pressure pipe

Introduction

The purpose of this chapter is to present the configuration and function of the dam operations buildings. Two dam operations buildings will be constructed. From these buildings, the dam operations will be monitored and controlled.

The preliminary design of the buildings is not yet complete. The following information is based on a concept developed by the project landscape architects. The City will develop and finalize the concept with building scope, dimensional drawings, preliminary elevations, and material choices. After the City finalizes the concept, the preliminary design will be described in a technical memorandum.

Building Function

The purpose of the dam operations buildings is to provide space and shelter for required dam operations equipment and lake aeration equipment. The dam operations equipment layout (which dictates the minimum size of the building) will be provided by the dam supplier. Space will also be set aside for installation of the lake aeration equipment, if required. The dam operations buildings may be a convenient central hook-up point to connect the dam operations, seepage control, wells, water supply, and stormwater diversion facilities to the existing City SCADA system.

The roof of the dam operations building will, according to the landscape architect's concept drawings, be a viewing center for visitors to the Rio Salado recreational area. The building at the upstream dam may have a lighthouse motif.

The buildings are intended for periodic inspections only, and are not designed to be inhabitable on a full-time basis (there are no staff support facilities, such as air conditioning, or bathroom sanitary facilities). The dam operations buildings will house no equipment other than equipment directly related to the operation of the dam.

Location and Access

Both dam operations buildings are located on the north side of the lake; one building is located 200 feet east of the downstream dam, and the other building is on a promontory above the upstream dam. (See Sheets 5 and 9 of the drawings.) The exact location of the upstream dam operations building depends on the required clearance of the proposed architectural icon from the overhead power lines, and obtaining permission from either ADOT or SRP to construct within their right-of-ways. The buildings need to be located close to the dams to efficiently provide the required air for dam inflation and to provide necessary monitoring of dam functions. The chosen locations place the buildings within easy access of City staff based at the Papago Water Treatment Plant.

The dam operations buildings will be built on the levee, out of the floodplain, which will protect them from the 100-year flood event. Downstream, the building will be 12 feet above the lake water surface; at the upstream end, 20 feet above the normal design water surface elevation. Site plans for the buildings will be provided in a preliminary design technical memorandum.

Operators/Equipment Access. For both operators and equipment, the main access to the buildings will be through a double-wide door. No roof access for heavy equipment is required. Vehicle and pedestrian access to both buildings will be via a gated trail.

There will be no public access to the building interior. As noted previously, the roof of the downstream building will serve as an observation deck. To reach the observation deck, a retaining wall will be required for the upper trail. (For concept details, see attached landscape architect drawings.)

Structural Requirements

The downstream building is designed to accommodate the following loads:

- Live loads: 300 psf
- Traffic loads: 32 kips/axle (AASHTO HS20)
- Wind: Base wind speed = 75 mph; I = 1.0
- Seismic: Zone 1

Architecture

Building Exterior

The concept for the Dam Operations Building must be developed and finalized by the City's architect and approved by the City of Tempe. (See drawings.) The building, as currently envisioned, has the following parameters:

- Shape--Circular "pillbox". Downstream building features parapet at the observation deck.
- Size--40-foot-diameter buildings, approximately 16 feet tall.
- Materials--Concrete.
  - -No windows on lower level
  - -Openings in parapet for viewing dam
  - -Stone veneer base
  - -Glass block around door
- Finishing--Patterned concrete with cementitious coating finish.

- Art and special features:
  -Water feature incorporated in downstream building. (See drawings.)

  -Fish sculpture or lighthouse icon. (See drawings)

Building Interior

Since the building is intended to house only dam operations and aeration equipment for periodic maintenance checks, and not intended for habitation, the interior of the building will be strictly utilitarian.

Dam Operating Equipment/Layout

A preliminary layout for the dam operating equipment is shown in Figure 7-1. The final layout will be determined by the needs of the selected equipment supplier.

A stilling well beneath the building (see Figure 7-2) will be used to monitor the lake water surface to determine when the dams need to be lowered. Operation of the dams will only be possible at the respective buildings, and will not be connected. The City will be able to only monitor (not control) both dam operations remotely using the SCADA system. Remote control of the dams was not deemed desirable by City staff because proper control required direct observation of the dam and lake characteristics during deflation and inflation. The nerve center of the City's existing SCADA system is located in the Papago Water Treatment Plant approximately ¼ mile from the lake. Process and Instrumentation diagrams for the dam operation buildings are shown on Sheets 43 and 44 of the drawings.

Telephone service will be provided in each building. If normal electrical service is disrupted, the City will also have the capability to transport a portable generator to the site and use it to operate the dams.

Floor Plan

The building will consist of one room, with no bathrooms and no office.

Materials

The floor will be made of concrete. Other materials will depend on the approved concept.

Furnishings

The building will contain no furnishings.

Utilities

Electrical

APS will supply 3-phase electrical power to the dam operations buildings to serve the equipment, lighting, and ventilation. Stand-by power generation will be provided by portable diesel generators.

Telephone

A telephone will be installed and serviced by U.S. West.

HVAC

Ventilation is required to provide air to blowers. The HVAC system (ventilation/evaporative cooling) will be designed to control the maximum temperature to 90° F.

Water

An exterior hose bib will provide potable water for cleaning the buildings and other miscellaneous purposes.

Sanitary Sewer

No sanitary sewer is needed for the dam operations buildings. A floor drain, which connects to the proposed onsite drainage system, will be provided to collect washdown water.

Security Requirements

Dam

A surveillance system (CCTV) will be installed at the dam, which will be connected to the City's water treatment plant. Deterrence of public access to the dam is provided by high abutment walls. Refer to the chapter "Downstream and Upstream Dams."

Dam Buildings

The dam operations buildings will be equipped with secure (steel) doors and alarm systems to warn against intruders.

Costs

For information about dam operations buildings costs, refer to the chapter entitled "Costs."

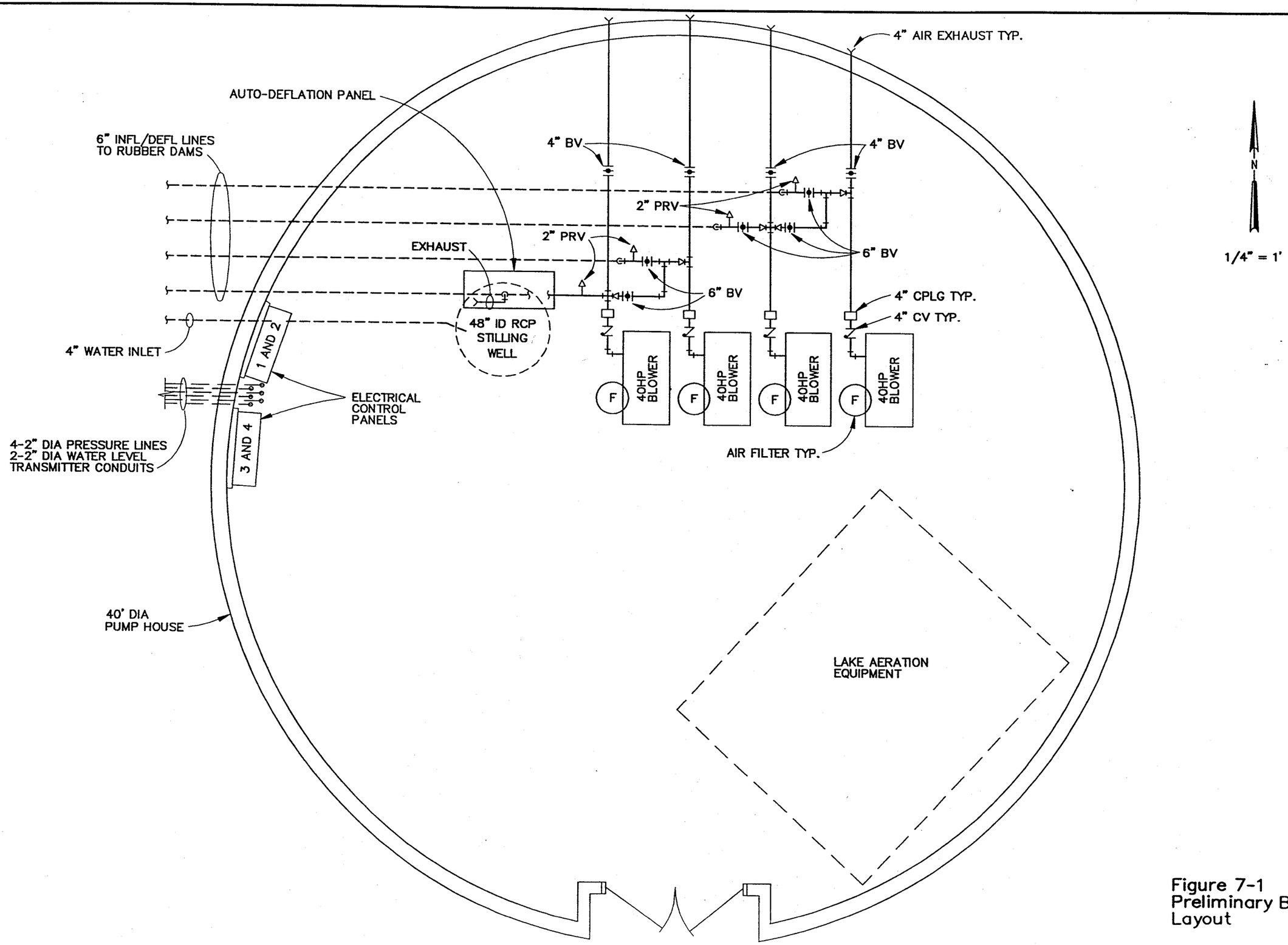
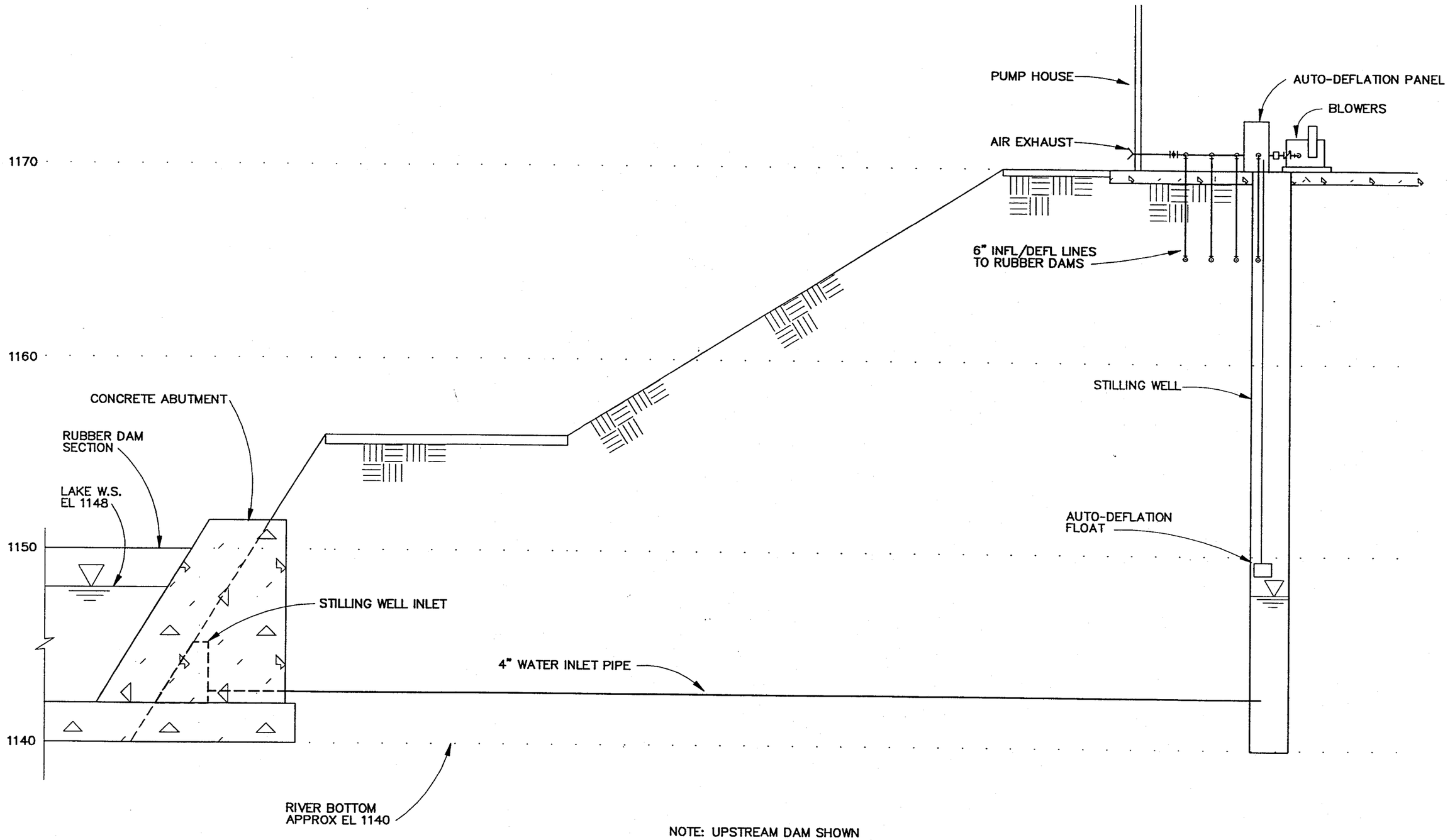


Figure 7-1
Preliminary Building
Layout

CH2M HILL



NOTE: UPSTREAM DAM SHOWN

SCALE: 1"=10'

Figure 7-2
Stilling Well

CH2M HILL

Introduction

The shoreline of the Town Lake must provide a balance between safety and aesthetics. In this chapter, typical shoreline sections are presented along with modifications for desired lake features.

Design Criteria

The design criteria for the shoreline of Town Lake include the following:

- **Infiltration Management.** The shoreline must aid in the prevention of lateral infiltration from the lake.
- **Flood Protection.** The shoreline should protect against flood water overtopping and damaging adjacent landscaping up to the required design level of protection (at least the 20-year recurrence interval).
- **Durability.** It must be strong enough to resist damage from either wave action or storm rubble, pedestrian loads, traffic (HS-20) loads, and vegetation.
- **Safety.** The shoreline will provide a ledge for emergency egress from the lake.
- **Access Control.** It should be constructed to discourage pedestrians from entering the lake and walking on the dams, yet allow for boat tie-ups (boat beaches and marinas). This will also require maintenance of the existing FCDMC access ramps, when possible.
- **Aesthetics.** The shoreline should present an aesthetically pleasing interface of the lake and shore.

Typical Sections

Modifications to the existing bank protection are required to construct the proposed shoreline. (See Sheets 25 through 27 of the drawings.) There are two typical edge types, depending on the height relationship between the existing cement stabilized alluvium (CSA) and the water surface:

Type A Edge. A reinforced concrete wall will be required if the existing CSA is too low, that is, below the proposed water surface elevation.

Type B Edge. Modifications to the face of the CSA will be required if the existing CSA is equal to or above the proposed water surface. Proposed modifications include replacing the face of the CSA with reinforced concrete, presenting an exposed aggregate finish. The concrete face will extend from the safety ledge to the top of the existing CSA (a distance which varies from 5 to 13 feet). The new concrete wall will be anchored into the exiting CSA with reinforcing steel dowels.

At some locations, the existing gravel overburden over the CSA will need to be removed prior to shoreline construction.

Modifications to Typical Sections

At some locations, modifications to the typical sections will be needed to allow for desired features:

- **Boat Beach.** Stairs to water level with a 12-foot-wide sandy beach. Provides easy access to/from beached boats.
- **Marinas (M-4 Edge).** Stairs to water level and access to floating docks.
- **Maintenance Ramps.** Slopes will be modified as required to maintain access to the river bottom.

Infiltration Management

Any modifications to the shoreline must provide equal to or better protection than existing CSA. Concrete will provide at least 10^{-5} cm/sec hydraulic conductivity.

Flood Protection

Normal water surface elevation is 1147.75. Normal maximum water surface is 1150. Top of shoreline is at 1151min, providing at least one foot of freeboard. The shoreline will protect structures behind the wall from damage due to at least a 20-year storm event.

Durability vs. Aesthetics

The shoreline must be both durable and aesthetically appropriate for the Town Lake park setting. It should be able to withstand:

- **Velocity.** 12.5 fps during storm events.
- **Impact of Boulders/Debris.** Minimum concrete strength of 3,000 psi will reduce the damage during large floods.

Shoreline facing options considered include dryset pavers, patterned (stamped) concrete, sand-blasted exposed aggregate, and stone or brick veneer. The City selected a sand-blasted exposed aggregate finish because of its durability and relatively low cost.

Safety

A 1½-foot-wide safety ledge located 2 feet below the water surface is provided for the full length of the shoreline. City staff indicate that handrails are not required.

Access Control

Stairs, descending to a level 2 feet below the normal water surface at desired access points, will allow visitors easy access to boats at marinas and boat beaches. The lack of stairs in other locations discourages access to the lake. Normal lake water surface will be at least 3 feet below the top of the wall.

Restricted access to the riverbed via the existing FCDMC ramps will be maintained wherever possible. However, the deflated dams will be impassable barriers to any maintenance vehicles in the riverbed.

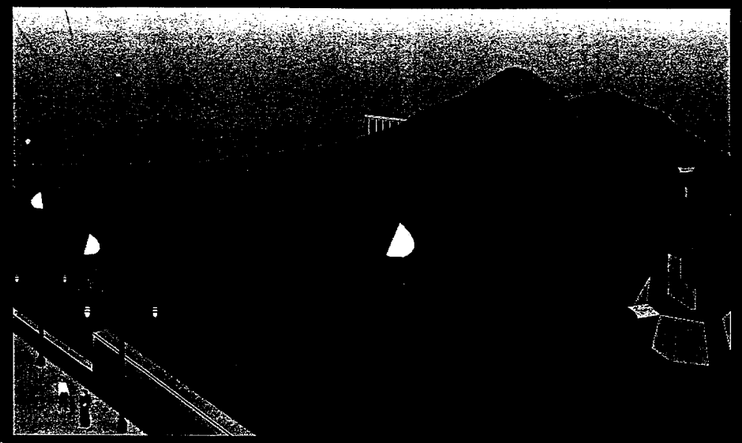
Public access to the dams must be controlled for both safety and security reasons. A wall extending at least 8 feet above the proposed trail elevation and 70 feet beyond the downstream dam will discourage access to the dry side of the dam. However, it will be possible for pedestrians to walk around the western end of the dam and enter the riverbed. A sacrificial fence with appropriate signage is recommended along the western end of the scour apron to further discourage access.

Access to the upstream dam is more difficult because the trail elevation is at least 8 feet above the top of the dam, and access to the dam via the river bottom is more difficult because water is expected to pond on both sides of the dam. Eight-foot-high walls will be built for the total width of the aprons to discourage access.

Costs

For information on shoreline costs, see the chapter called "Costs."

SECTION 3
Water Supply and Quality



Introduction

This chapter describes the selected water supply sources and how the water will be conveyed to Town Lake.

Previous Investigations

Beneficial Uses of Lake

As discussed previously, Town Lake will be used primarily as a boating lake with adequate water quality for use as partial body contact water. Consideration may be given to fishing on the basis of catch-and-release or for food consumption, but fishing is not currently a high priority beneficial use. Swimming in Town Lake will not be allowed due to safety considerations and the high cost of consistently maintaining a highly transparent water quality suitable for full body contact.

Potential Water Sources

The potential sources of water for the Rio Salado Town Lake are:

- **Salt River**. Runoff in the Salt River has a high degree of annual and seasonal variability. Occasional, beneficial flows may be expected during winter months, but excess runoff is unusual during the summer. Flows in the Salt River only occur when releases are made from the reservoir upstream.

  These spills, considered "run of the river" water, are appropriable surface water supplies under the water laws of the state of Arizona. They may be passed through the lake system during floodwater releases. Capturing the water for consumptive use is subject to the appropriation process. This water source is not viable for initial filling of the lake, due to water rights requirements and uncertainty of spill events, but it is viable for refilling the lake after a storm event.

- **Salt River Project (SRP) water**. This is a viable source if it is obtained for use on non-project lands by exchanging recharge credits associated with reclaimed water. However, the canals are dried up for several weeks each year for maintenance purposes, thus a supplementary source may be required.

- **Central Arizona Project (CAP) water** is considered a long-term, high quality potential source of water for Town Lake when used for water exchanges with SRP water. The City's CAP allocation equates to a monthly supply of 475 ac-ft.

- **Groundwater** pumped from wells is a viable source of water. Constructing new deep wells near the lake is infeasible due to poor hydrogeologic conditions on the west and adverse impacts on existing groundwater contamination at the IBW Superfund sites to the east. Some production wells operated by Tempe lie within one mile of the Salt River channel and could be considered for use. Direct use of groundwater is not viable due to conservation constraints, but indirect use could be achieved through exchanges for recharge credits.

- **Urban stormwater** is a nuisance water source. The timing and volume of runoff is not easily controlled, and the water quality is poor. The "first flush" stormwater flow, therefore, will be diverted through stormwater management facilities around the lake, where feasible. The stormwater management plan is described in detail in the "Stormwater Management" chapter of this report.

- **Reclaimed water** can have high nutrient levels (primarily nitrogen and phosphorous) that would promote algae and aquatic weed growth in the lake. Advanced treatment for direct use of reclaimed water is considered to be too expensive. An alternative would be to recharge and use credits for exchange.

SRP water and remote groundwater sources were determined to be the most viable sources for filling Town Lake.

Water Quality Issues

The success of the Town Lake project depends on the ability to create and maintain an aesthetically pleasing lake that provides a range of recreational opportunities. One of the challenges to the development of such a lake is the source water quality. Nutrients in the source water, primarily nitrogen and phosphorus, are the primary constituents of concern to meet aesthetic goals. The desired public uses of the lake result in water quality requirements to meet health and environmental protection based standards. Water quality criteria for various uses are promulgated by the Arizona Department of Environmental Quality and the Maricopa County Health Department. Through a comprehensive review of applicable regulatory standards and water quality analyses for the various potential sources of water, it was determined that groundwater and SRP water meet all applicable regulatory requirements.

An analysis of probable impacts of nutrients contained in the source waters on lake transparency determined that the key parameter of concern is phosphorous concentrations. To achieve optimum transparency, a target concentration for total phosphorus of 0.02 mg/l was recommended. Water quality modeling indicates that phosphorus concentrations above 0.05 mg/l will have an adverse impact on lake water clarity.

Water Exchanges

The designated water supply for Town Lake is reclaimed water from Tempe's wastewater treatment facilities. Since it is not practical to use reclaimed water directly, the plan is to recharge reclaimed water and use the recharge credits to exchange for the directly delivered water source.

Water trade agreements are currently being negotiated between Tempe and SRP, with a separate agreement needed for the Town Lake water supply. For initial filling, groundwater is the most favorable source of supply for exchange purposes. Since SRP regularly pumps groundwater to supplement their surface water supplies, the recharge credits could be applied to pumping at SRP wells. The actual water delivered to the lake would be a combination of surface water and groundwater.

Feasibility studies to construct and operate reclaimed water recharge facilities are ongoing. If the required amount of reclaimed water recharge credits are not available during the early stages of operating Town Lake, the City has recharge credits from other sources which could be used on an interim basis.

Specific Water Sources

The specific water sources selected for detailed investigations include the City's existing production wells and deliveries from the SRP canal system. Based on the City's potable water needs, some of the existing wells could be dedicated to Town Lake water supply. These facilities are located close to the lake, as shown on Figure 9-1.

Existing Production Wells

- **COT Well No. 1**
  --Constructed in 1949.
  --Located at College and 15th Street.
  --Pumping capacity is 785 gpm (1.7 cfs).

- **COT Well No. 3**
  --Constructed in 1951.
  --Located on ASU campus at Stadium Drive and 8th Street.
  --Pumping capacity is 750 gpm (1.7 cfs).

- **COT Well No. 4**
  --Constructed in 1956.
  --Located at Rural Road and Lemon.
  --Pumping capacity of 1,200 gpm (2.7 cfs).

- **COT Well No. 6**
  --Construction date unknown
  --Located at McKellips Road and Indian Bend Wash
  --Pumping capacity of 2,400 gpm (5.3 cfs).

- **COT Well No. 7**
  --Constructed in 1961.
  --Located at 10th Street and Smith Road.
  --Pumping capacity of 1,240 gpm (2.8 cfs).

SRP Canal Deliveries

SRP canals operate year-round except for an annual dry-up period to perform canal maintenance. Facilities north of the river dry up during the month of January and the southside dry-up occurs between mid-October and mid-November each year. Deliveries to Town Lake would be subject to available capacity in the canal system, which will vary seasonally and according to demands and hydraulic capacity of the system at a given location.

- **Tempe Canal.** The reach of the main canal that runs south from Alma School Road and the Salt River to Baseline and Price Roads has a capacity of about 500 cfs. Tempe's South Water Treatment Plant takes water from the canal near Guadalupe and Price. Laterals run west as far as 48th Street, delivering water for urban irrigation.

- **Arizona Canal.** The main canal runs west at Indian Bend Road approximately 7miles north of the Salt River with a capacity of 1,600 cfs. SRP has drain gates off this canal capable of discharging 500 cfs into Indian Bend Wash.

- **Cross-Cut Canal.** This canal branches off the Arizona Canal near 64th Street and runs south to the Grand Canal Forebay near College and Marigold Lane with a capacity of 625 cfs. Tempe's Papago Water Treatment Plant takes water near the terminus. Flows from the forebay are used to generate electricity and discharge into the Grand Canal near Mill and Washington Avenues.

- **Grand Canal.** This canal originates near Mill Avenue and runs along the north side of the Salt River with a capacity of 650 cfs.

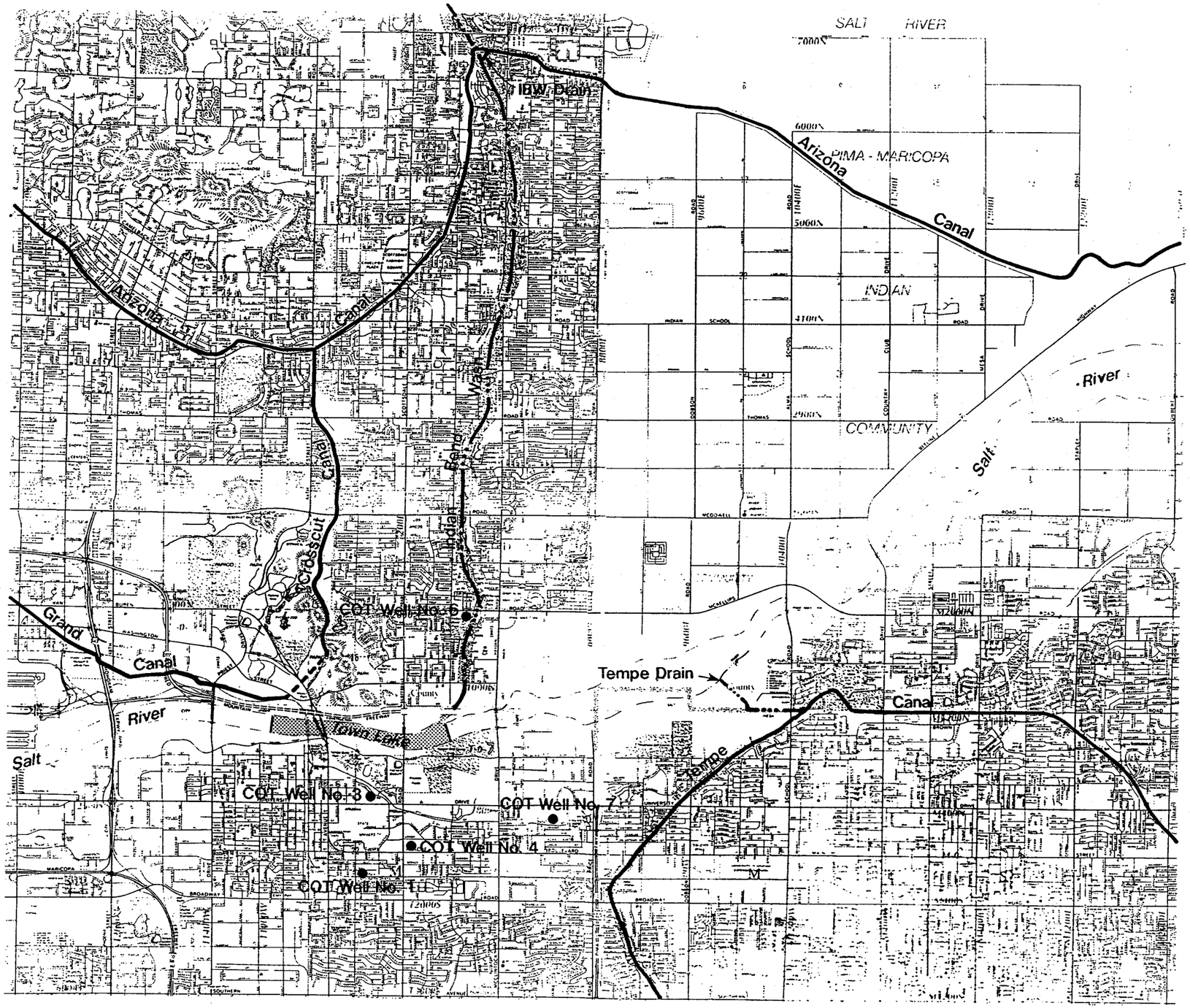


Figure 9-1
Potential Water Sources

Water Quality Investigation

Since phosphorus was identified as the critical parameter in the source water affecting lake transparency, a phosphorous-specific water quality investigation was undertaken. Water samples were collected at Tempe wells and surface water at the intakes of the Papago and South Water Treatment Plants on March 21, 1994, and analyzed for Total Phosphorus and Orthophosphate concentrations. The results are shown in the following table.

Table 9-1
Phosphorous Concentration of Specific Source Waters (samples collected 3/21/94)

Sample Location	Total P (mg/l)	Ortho P (mg/l)
Papago WTP (Cross-cut Canal)	0.10	<0.01
South WTP (Tempe Canal)	0.05	<0.01
COT Well No.1	0.04	0.02
COT Well No.3	0.04	0.04
COT Well No.4	0.06	0.02

All projections of water quality, based on estimates of average growing season conditions for the Town Lake, show that the lake will exhibit eutrophic conditions with either groundwater or SRP source water. There appears to be little difference between the source waters. Water clarity may be as great as 4 to 5 feet at times, however algae blooms are expected and water quality will vary over time. SRP water will produce lower quality on the average, with reduced water clarity and greater algae densities as compared to the use of groundwater as the major source of lake water.

Water Demands and Conveyance

Water Demands

There are two principal water demands for Town Lake: filling and maintenance (see Table 9-2).

- **Filling.** Filling the lake requires:
  --water for the **lake volume**

  --filling the pore spaces in the **vadose zone** immediately beneath the lake

  --sufficient flowrate to keep up with **initial infiltration** losses in the range of 100 to 200 cfs expected to occur at the east end of the lake. This exceeds the capacity of the well recovery system by 40 to 140 cfs. These infiltration losses are expected to decrease with time due to clogging. It may be a matter of days or weeks before the well recovery system is able to fully keep up with the infiltration losses

  --**infiltration losses in the conveyance channel** between the delivery point and the lake

- **Maintenance.** Consumptive water demands that affect Town Lake include lake evaporation, infiltration losses, and pumpage from the lake for landscape irrigation.

  --**Evaporation.** Estimated annual evaporation from an open water body in this climate is 72.4 inches. Monthly evaporation rates vary from 2.2 inches in December and January to a peak of 9.9 inches in June and July. The total volume of evaporated water from the 220 acres of lake surface is expected to range from 37 ac-ft per month in the winter to 165 ac-ft per month in mid-summer.

  --**Infiltration.** With an adequate well recovery system (described in Chapter 10, Infiltration Management), the resulting losses to infiltration will be, essentially, zero. This will occur after infiltration rate drops off and the well recovery capacity exceeds the infiltration losses.

  --**Irrigation.** Irrigation needs will be finalized as the landscape architect's concepts are reviewed and approved by the City. Irrigation is expected to be needed for establishing plants; as the plants become established, less irrigation water will be needed.

Table 9-2
Town Lake Water Demands

	High	Average	Low
Initial Filling			
Lake Volume and Vadose Zone	3,500 ac-ft	3,500 ac-ft	3,500 ac-ft
Initial Infiltration at the east end less recovery well pumping[1]	140 cfs	90 cfs	40 cfs
Conveyance Losses	20 cfs	15 cfs	10 cfs
Time for Initial Filling[2]	14 days	9 days	7 days
Transition Losses[4]	Losses during this period will vary depending upon the actual infiltration rate of the lake bed and bank protection. These losses are only temporary and are expected to decrease with time due to clogging. However, these losses will need to be made up with filling water for days or weeks after the initial filling of the lake. Demands could range up to 140 cfs for several weeks. Losses could be reduced by installing a temporary bed liner prior to filling. Refer to the "Infiltration Management" chapter of this report for details.		
Maintenance			
Evaporation Losses	3.4 cfs	1.7 cfs	0.6 cfs
Infiltration Losses[3]	0.0 cfs	0.0 cfs	0.0 cfs
Irrigation Use	0.5 cfs	0.3 cfs	0.2 cfs
Maintenance Totals	3.9 cfs	2.0 cfs	0.8 cfs

[1] These losses are only temporary and are expected to decrease with time due to clogging.
[2] Assumes 300 cfs discharge from SRP Canal
[3] Assumes the well recovery system captures all infiltration losses during long-term operations
[4] **Between initial filling and maintenance**

Filling Conveyance Alternatives

There are three options for conveying filling water to the lake (see Figure 9-2):

1. Discharge at a wasteway on the Arizona Canal. The Arizona Canal can convey a flow of 300 cfs into the wasteway at the upstream end of IBW about 7 miles north of the lake. The disadvantage is that the flow down the IBW would disrupt any activity in the wash, and require closing certain road crossings during filling. Portions of the parks and golf course located along the wash will be unusable during filling at 300 cfs, but no permanent damage should occur.

Of the nine roads that cross Indian Bend Wash, the three crossings which could be closed are:

- Jackrabbit Road
- Pecos Lane
- Driveway leading into Chaparral Plaza from Hayden Road

Crossings at Osborn Road and Murray Lane would be marginally affected and may need to be closed. Both will have water flowing over the roadway at less than 1-foot depth, but the velocity will be in excess of 2 feet per second. The wooden golf cart bridge located 25 yards upstream from Murray Lane will need to be removed or reinforced to prevent damage.

Road closures will need to be coordinated with the City of Scottsdale. Construction of a low flow channel between Curry Road and the IBW drop structure would be required for conveyance. This alternative would allow filling of the lake to its maximum water surface elevation in the shortest time period.

2. Use of the Tempe Canal drain. Located about 2½ miles upstream of the east end of the lake, the Tempe Canal can discharge about 300 cfs into the Salt River, which would then be conveyed within a low flow channel constructed in the river channel to Town Lake. With this alternative, the water will be backed into the 35-acre riparian/detention area during filling, which will increase the infiltration losses until the upstream dam is raised. Filling with this alternative may not be able to reach the maximum water surface elevation. In that case pumping from the riparian/detention area after raising the dam could finish filling the lake.

3. Use of the Price Road drain. Discharge travels from the Tempe Canal into the stormdrain system of the City of Mesa, draining into Price Road stormdrain. Eventually discharging into the Salt River, the capacity of this discharge is limited to about 50 cfs, which makes this alternative unreasonable for filling the lake.

Maintenance Conveyance Alternatives

The alternatives for conveying maintenance water are shown in Figure 9-2.

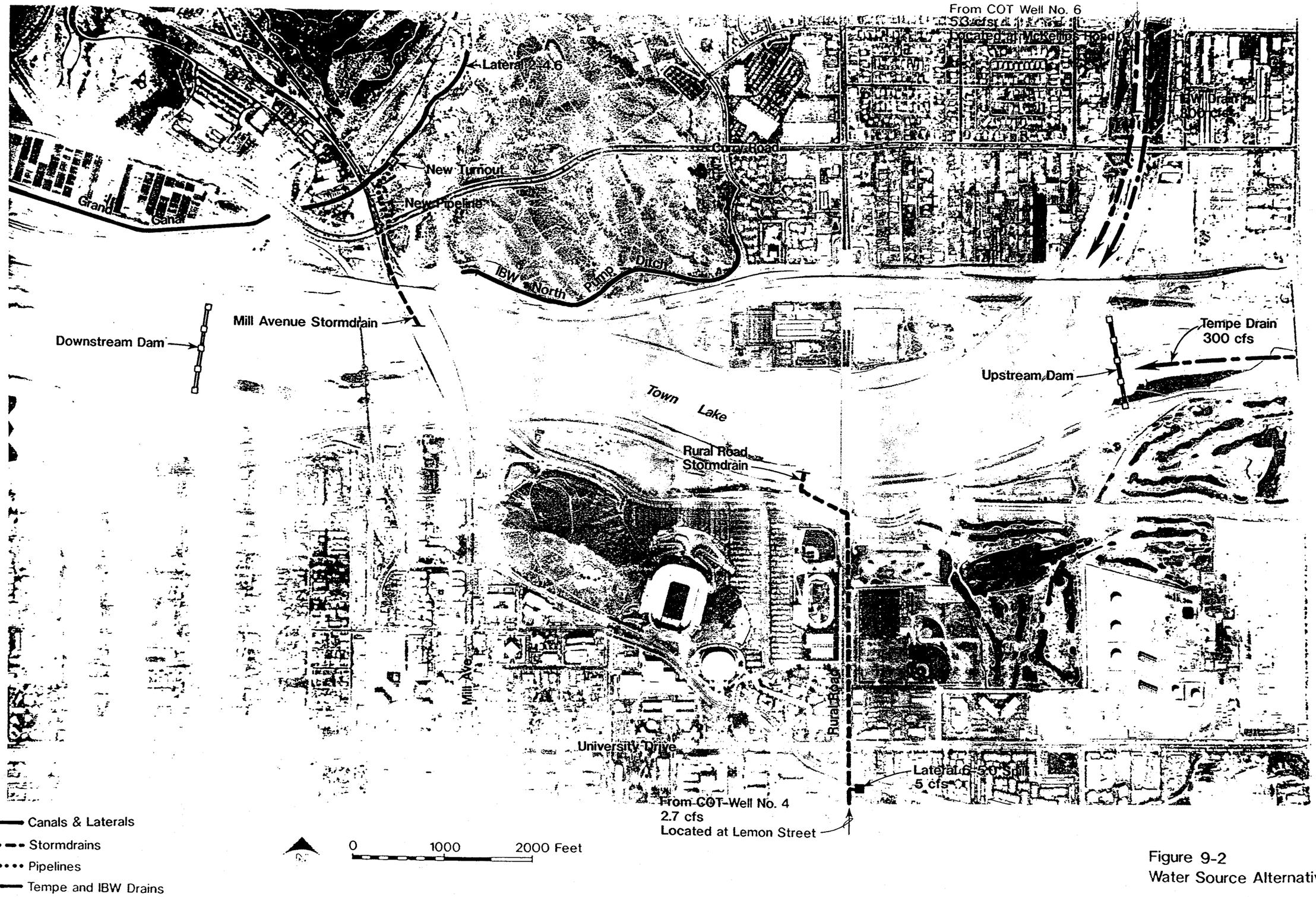


Figure 9-2
Water Source Alternatives

Tempe Wells

Well No. 1. The City of Tempe's Well No. 1 is located at the northeast corner of the intersection of College Avenue and the SPTC railroad tracks. There are two alternatives to connect this well to an existing stormdrain that would discharge into the lake. An alignment along the SPTC right-of-way would require 2,250 feet of 12-inch-diameter pipe. An alternative alignment along College Avenue and Apache Boulevard would require 3,950 feet of pipe. The most direct pipeline alignment would require permission from SPTC, which is not likely to be obtained. The uncertainty of SPTC permission and the long pipeline routings makes this the least favorable of the feasible alternatives.

Well No. 3. Review of the status of this well determined that it is dedicated to the irrigation of ASU facilities and is not available for maintaining the Town Lake project.

Well No. 4. City of Tempe Well No. 4 lies east of Rural Road and south of Lemon Street. This conveyance alternative would require either (1) approximately 300 feet of 12-inch pipe through a parking lot, across Rural Road, to connect with the existing stormdrain, or (2) approximately 520 feet of 12-inch pipe constructed through an alley behind McDonalds to Lemon Street, then west on Lemon to Rural Road. In comparison to the other alternatives, this source is less favorable due to low well capacity and higher construction costs.

Well No. 6 City crews recently constructed a pipeline connection between Well No. 6 and an existing stormdrain that discharges into IBW. Conveyance within IBW will require construction of a lined conveyance channel about 1.5 miles long to reduce conveyance losses . Routine water quality testing shows TCE concentrations typically ranging from 12 to 17 ug/l, however, recent testing indicates that after 24 hours of pumping, this level drops to between 5 and 6 ug/l. TCE levels above 5 ug/l discharged into IBW would require an NPDES permit for surface water and an Aquifer Protection Permit (APP) for groundwater. The most stringent standard that could be applied for NPDES permitting is 78 ug/l. For an APP, the standard is 5 ug/l in the aquifer.

Preliminary results from a 3-day pumping test conducted in August 1994, indicate that TCE levels dropped below 5 ug/l after two days of pumping. It was also determined that the cascading discharge into the stormdrain acts as an effective air stripper and has reduced a concentration of 5 ug/l to 4 ug/l before the water enters IBW. These test results indicate that an NPDES permit or an APP would not be needed to use this source. This source appears to be a feasible alternative.

Well No. 7. It was determined that the use of the City's Well No. 7 would not be feasible. The well lies within a Superfund site, and the use of the well could have negative affects on EPA's cleanup activities in the area. Also, conveyance from this well would require more than 1/2-mile of new pipeline.

SRP Canal System

Tempe Lateral 6-5.0 to Rural Rd. - South Stormdrain. The existing Lateral 5.0 spill at 8th Street and Rural Road is connected to the Rural Road South stormdrain. Spills up to 20 cfs are routinely made into the stormdrain for operational purposes. SRP is able to deliver up to 5.0 cfs into the stormdrain for lake maintenance. The City could order water at this delivery point and still get the benefit of the operational spills as an incidental supply of water to the lake.

According to SRP, in order to make the 5 cfs delivery option available at any time, Tempe would need to be responsible for replacing 1,100 feet of ditch upstream with a new pipeline (about 42-inch diameter).

The stormwater diversion structure to be constructed downstream on the Rural Road stormdrain would need to be modified to convey flows for lake maintenance. A motor-operated gate would need to be added to the diversion structure along with a flow meter in the pipeline to sense rapid changes in flow. An instrumentation system would be needed to open the diversion gate for a set time interval based on exceedance of a specified flowrate in the stromdrain that would be indicative of a stormwater flow event.

Cross-cut Lateral 2-4.6 to Mill Ave. - North Stormdrain. Delivery from Lateral 4.6 will involve re-establishing a previously abandoned turnout near the ASU Sanitorium. The maximum delivery rate will be 10 cfs. SRP has agreed to construct the necessary check structure and turnout facilities. Tempe will provide the design criteria (that is, the location and water surface elevation) for the new delivery. A new pipeline will be constructed parallel to the lateral ditch and through Moeur Park to convey flows from the lateral turnout to connect with the existing Mill Avenue-North stormdrain at the southeast corner of Mill Avenue and Curry Road.

Grand Canal. This canal is located on the west end of the project site. The water surface elevation is lower than the lake and would require a pump station to lift water out of the canal to transport it to the lake. The pipeline routing past the freeway and SPTC tracks would be difficult. SRP staff indicate that during summer months, the canal has little or no excess capacity. This alternative is considered infeasible.

IBW North Pump Ditch. The unlined Indian Bend Wash-North Pump Ditch is located parallel to the Town Lake, from about Mill Avenue east to College Avenue. This unlined ditch has a capacity of about 35 cfs. Excess flows spill over a wasteway provision at the end of the ditch east of Mill Avenue. The water is conveyed down near the freeway overpass structures, where it enters the stormdrain system off Mill Avenue and enters the lake. A diversion and delivery structure constructed near the wasteway would be all that is required to deliver water to the lake. The problems with this alternative are two-fold: 1) the ditch is being used at capacity during summer months and is already a maintenance headache due to its unlined condition, and 2) poor water quality due to inflows from stormwater runoff and chemicals added upstream to control weed and algae problems. Considered an infeasible alternative due to the under capacity and poor water quality.

Recommended Design Concepts

The water supply improvements for both filling and maintenance water supply may be seen in Figure 9-3.

Filling

Either of the two options, Arizona or Tempe canals, appears feasible at this point in time. A discussion with the involved entities (including the City of Scottsdale and Salt River Project) will be needed prior to making a final decision. The time required for filling will be of critical importance for obtaining approval of road closures along IBW.

Low flow channels will be required for either option. For the Arizona Canal option, a half-mile channel would be needed to convey a minimum of 300 cfs from Curry Road to the IBW drop structure at the freeway overpass. Constructing a low flow channel will decrease the conveyance losses over that stretch which is currently several hundred feet wide.

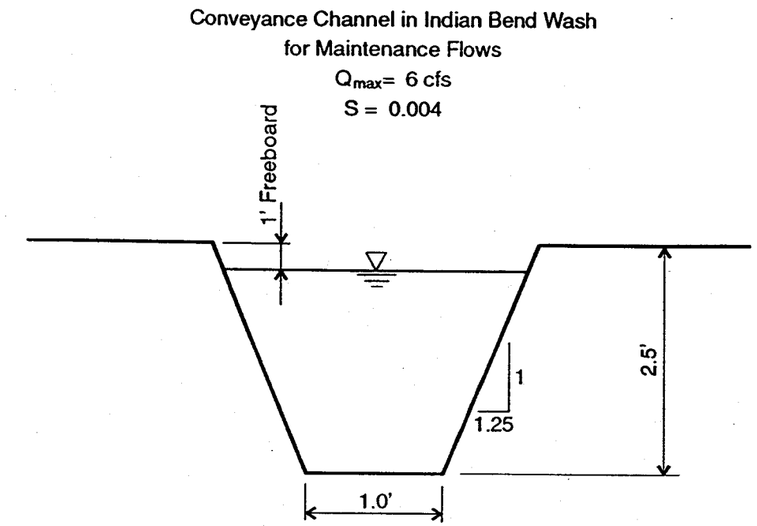
For the Tempe Canal option, a low flow channel would be needed in the Salt River channel to convey a 300 cfs discharge from the Tempe drain wasteway to the grade control structure west of McClintock. A typical cross-section for either low flow channel is shown on Figure 9-4.

Maintenance

The recommended delivery options for maintenance flows are Northside Lateral 2-4.6, Southside Lateral 6-5.0, and COT Well No. 6.

Northside Lateral 2-4.6. Design and construction of the diversion structure and turnout will be performed by SRP. The maximum delivery rate is 10 cfs. The preliminary design for 900 feet of 18-inch-diameter pipeline is shown on Sheets 39 through 41 of the drawings. A new manhole structure will be needed at the northeast corner of Curry and Mill. The crossing of Curry is likely to require a bore and jack operation. The pipeline will be connected at the existing catch basin to an 18-inch drain with a capacity of 14 cfs. The catch basin inlet has a capacity of 4 cfs so it appears that the drain piping will have capacity for 10 cfs even during storm events.

Southside Lateral 6-5.0. No construction features for water supply are shown at this time for this delivery. Sufficient capacity is available since the design flow of 5 cfs is a fraction of the 110 cfs capacity of the 54-inch diameter stormdrain. The modifications to the stormwater diversion structure on the Rural Road stormdrain will be accomplished under the design and construction of the stormwater diversion facilities. (See Sheet 44 of the drawings.) The possible construction of 1,100 feet of new pipeline on the SRP lateral upstream is under discussion by City staff.



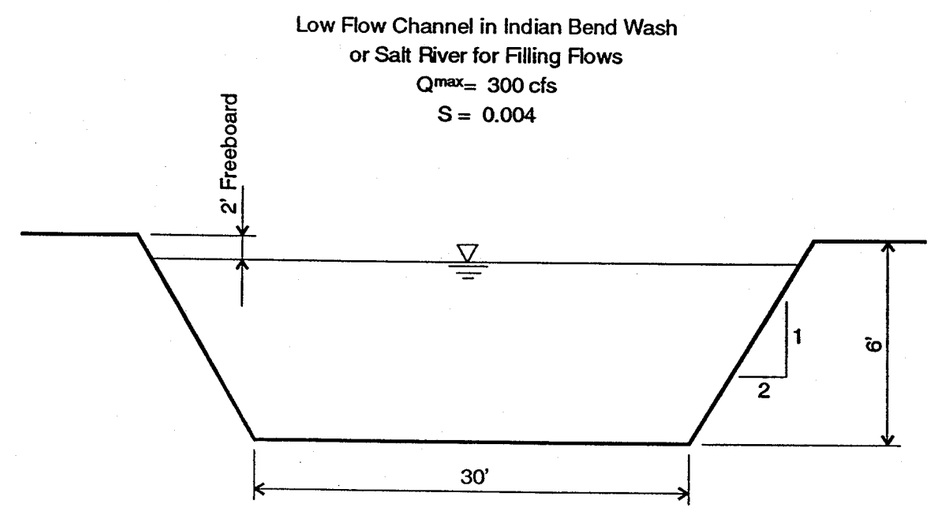


Figure 9-4
Typical Water Supply
Channel Cross-Sections

Figure 9-3
Water Supply Plan Improvements

COT Well No. 6. City staff have connected piping to the stormdrain which discharges into IBW. The feasibility of using Well No. 6 for Town Lake water supply is still being investigated. Data from hydrologic testing and issues surrounding the TCE contamination in the well are being evaluated. Design of the conveyance channel from McKellips Road to the IBW drop structure will proceed when the final decision to use Well No. 6 is made. A typical cross-section of the IBW conveyance channel is shown on Figure 9-4.

Operational Flexibility. Three sources of water for lake maintenance needs provide operational flexibility and redundancy for water security assuming reasonable availability of water. Operating more than one source at a time provides additional capacity for peaking or urgent filling requirements. Multiple delivery points provide continued deliveries when other delivery points are not operable.

Deliveries from both the Northside and Southside canal systems allow for continuous delivery to the lake during dry-up periods for canal maintenance. The Northside lateral 2-4.6 would be available year-round except during the month of January, during Northside dry-up. An additional constraint would occur every 3 years when the pond at the head of the lateral would have to be drained for repairs. The Southside lateral, 6-5.0, would be available year-round except during the Southside dry-up which occurs from mid-October to mid-November.

Introduction

Due to its location in a river channel with very permeable riverbed deposits, and because the natural groundwater table is located at some depth below the riverbed, the constructed Town Lake is expected to lose water through infiltration through the lake bottom. Therefore, an infiltration management system will be needed to maintain the lake level at its targeted elevation.

The information provided in this chapter represents our best estimates of: (1) the likely effects of the operations of the Town Lake on nearby areas and (2) the type and extent of the infiltration management system that will be needed to maintain targeted lake levels. However, due to inherent uncertainties dealing with predictions of future subsurface conditions, the actual effects of the Town Lake, and the ability of the recommended infiltration management system to achieve its goals cannot be known until the lake is constructed and under operation for some time.

This chapter briefly describes the work performed to arrive at the recommended lake infiltration management system. A more detailed discussion of this chapter's contents is presented in a companion document (*Geotechnical/Hydrogeological Report*).

Five *general* types of infiltration management systems were modeled for the Town Lake. The features of the recommended infiltration management system are:

- Slurry walls (or their equivalent) will completely surround the lake perimeter to an average depth of about 30 feet below the lake bottom.
- A slurry wall (tied to consolidated rock) will run in a generally north-south direction across the lake about 1,000 feet west of Rural Road
- Initially, 10 high-capacity wells will be located within about 100 feet of the lake to capture the infiltrating lake water and return it to the lake to maintain normal water elevation. Additional wells may be required if infiltration rates are greater than expected.

Existing Conditions

Data Sources

The following sources contributed to development of a current hydrogeological description of the project site:

Previous Drillings. From November 1991 to January 1992, 36 piezometers (2-inch-diameter wells) were drilled and installed (to a maximum depth of about 100 feet) in the Salt River channel and adjacent areas outside the channel as part of the investigations performed for the Rio Salado Town Lake Feasibility Study. The drilling program was stopped short of the planned total number of piezometers by SRP's releases of water into the Salt River.

Recent Drillings. Between April and May 1994, 11 additional piezometers and 5 test wells (6-inch-diameter wells) were drilled and installed (to a maximum depth of about 260 feet), primarily to investigate the hydrogeological conditions in the upstream portion of the lake area. Approximately 11 soil borings and 35 test pits were also sampled in geotechnical investigations. (See Figure 10-1 for locations of all piezometers and test wells.)

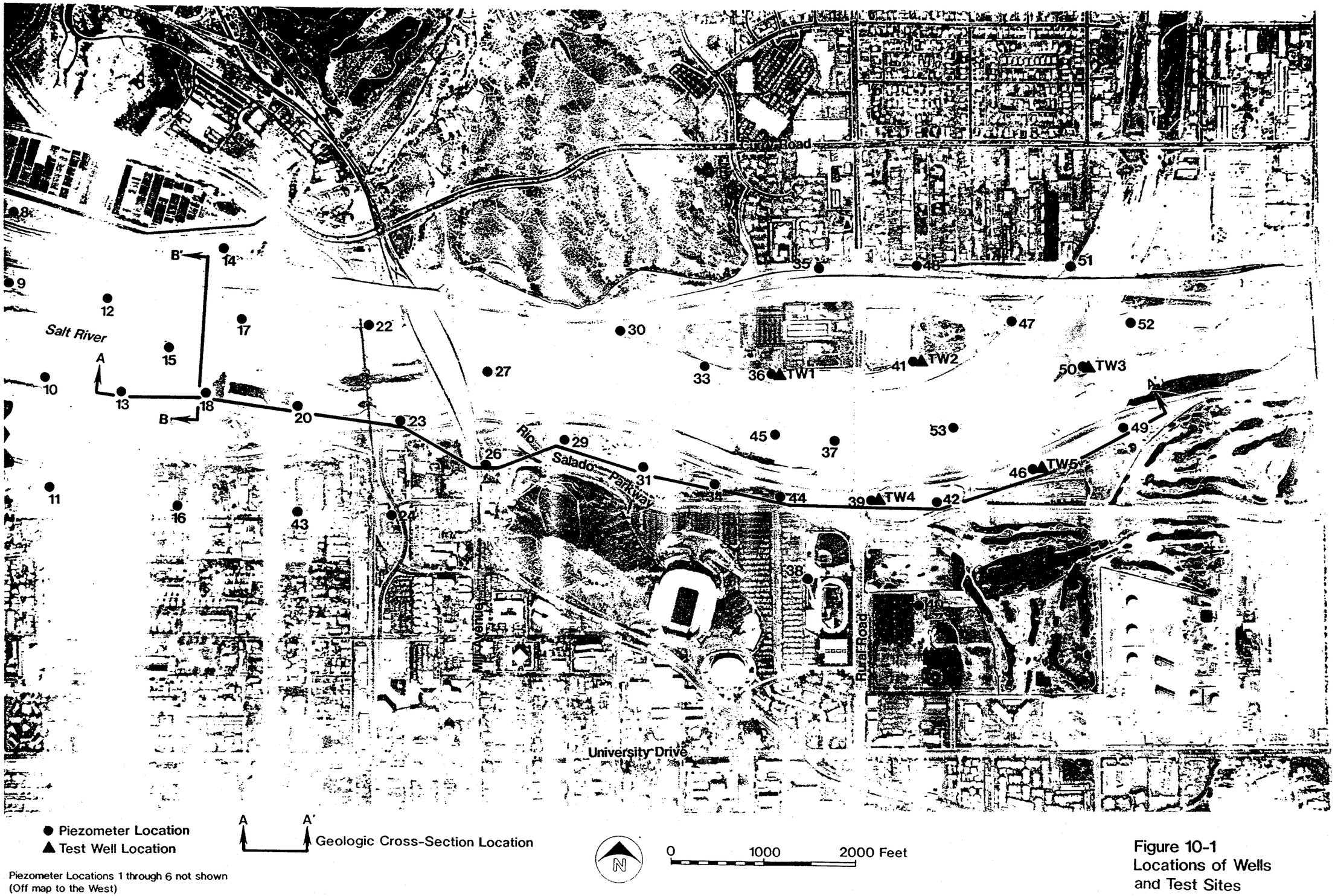
Periodic Water Level Measurements. Since the installations, water levels have been measured periodically to estimate flow directions and gradients, and how the groundwater flow conditions changed under varying surface water flow conditions.

Published Reports. Several publications provided additional insight into the local hydrogeological conditions. A few of the more relevant publications include:

- U.S. Environmental Protection Agency. *Remedial Activities at Selected Uncontrolled Hazardous Waste Sites in the Zone of Regions IX and X.* Public Comment Draft: North Indian Bend Wash RI/FS Report. 1991. (Contract No. 68-W9-0031)
- U.S. Environmental Protection Agency. *Remedial Activities at Selected Uncontrolled Hazardous Waste Sites in the Zone of Regions IX and X.* South Indian Bend Wash Interim RI. 1992. (Contract No. 68-W9-0031)
- Péwé, Troy L., Cathy S. Wellendorf, and James T. Bales. 1986. Environmental Geology of the Tempe Quadrangle, Maricopa County. (Geologic Maps.) Arizona Bureau of Geology and Mineral Technology.
- Laney, R.L., and Mary Ellen Hahn. 1986.Hydrogeology of the Eastern Part of the Salt River Valley Area, Maricopa and Pinal Counties, Arizona. U.S. Geological Survey, Water-Resources Investigations Report 86-4147. Tucson, Arizona.
- Challenges of the 1990s. Papers presented as part of the Fifth Biennial Symposium on Artificial Recharge of Groundwater. Tucson, Arizona. May 29-31, 1991.
- Dames & Moore. 1991. Bedrock Data Report, Motorola, Inc. 52nd Street Facility Final Remedy RI/FS for Motorola Inc. (Contract No. 09948-139-033). February 1991.

Hydrology

Water Level. Figure 10-2 shows interpreted recent groundwater level elevations in the project area under normal conditions of a receding groundwater mound created from past river releases. In the eastern portion of the Town Lake site, the groundwater flows away from the riverbed to the north and



Piezometer Locations 1 through 6 not shown
(Off map to the West)

Figure 10-1
Locations of Wells
and Test Sites

CH2M HILL

to the south. In the western portion of the site, groundwater flows mostly in a west to southwest direction. The Indian Bend Wash (IBW) Superfund site consists of two study areas, a north site (Indian Bend Wash--North) and a south site (Indian Bend Wash--South). The two areas are divided at the north side of the Salt River. On Figure 10-2, these areas encompass the entire area east of Rural Road. As Figure 10-2 shows, localized groundwater flows primarily to the north at the IBW-North site and to the south at the IBW-South site.

Geology

Figure 10-3 is an east-west geologic cross-section along the south bank of the Salt River (Section A-A'). Figure 10-4 is a north-south geologic cross-section across the downstream dam area (Section B-B').

A north-south trending high-angle fault is inferred through the project area about 1,000 feet west of Rural Road. West of this inferred fault, the geology consists of a thin sand and gravel layer above consolidated rock (which was encountered at an average depth of about 30 feet). East of the inferred fault, the geology consists of relatively thick sand and gravel layers with some interspersed finer-grained materials. East of the inferred fault, consolidated rock was not encountered until a depth of about 200 feet in the two borings (TW-1 and TW-4) that went deep enough to encounter cemented geologic materials.

The upper three units of geologic materials east of the inferred fault appear to be hydraulically connected. That is, these three different geologic units are not considered to be distinct aquifers separated by impermeable geologic units, but rather are hydraulically connected geologic units with different permeabilities. Measured responses of the water table to river releases demonstrate that this is the case. However, Units 3 and 4 appear to be less hydraulically connected than overlying units. This was demonstrated during pumping tests in wells completed in the lower clayey gravel unit. During these tests, groundwater elevations were measured in adjacent wells completed in the overlying sand and gravel unit and only a small drawdown was noted.

Groundwater Modeling Methodology

CH2M HILL used a computer code called "Micro-Fem" to support the design of the infiltration management system for the lake. This multi-layer, steady state, finite element groundwater flow modeling code, by C.J. Hemker and H. Van Elburg, was written for personal computers. The model, as configured for this project, has almost 6,000 nodes, and approximately 12,000 model elements in each of 4 layers (five layers, including the lake).

Figure 10-5 shows the finite element grid used for this modeling effort. See Figure 10-2 for the geographic extents of the model. The extent of the model was chosen to include only enough area surrounding the lake to facilitate the engineering design purpose of the modeling effort, and as such, the boundary does not represent a hydrologic boundary.

General Assumptions

The following information was used to develop the conceptual model of the site:

- Subsurface conditions at 47 piezometers and 5 test wells in the project area
- 5 aquifer tests and recovery tests
- Work performed at nearby Superfund sites
- Research conducted by the U.S. Geological Survey and ASU

Figure 10-6 is a block diagram showing how the subsurface geology was conceptualized in numerical modeling. Figure 10-6 also shows the values for horizontal hydraulic conductivity (K_H) and vertical hydraulic conductivity (K_V) used in the base case modeling scenarios. Modeling assumptions included:

- **Slurry walls:** K_H = 0.003 ft/day.
- K_H values for **layers 3 and 4** (east of the fault) came from an analysis of aquifer tests performed in Spring 1994. Other K_H and K_V values were estimated based on professional judgment and data from similar nearby sites.
- **Unconsolidated materials:** K_H/K_V ratio =10.
- **Consolidated materials:** K_H/K_V ratio =1.
- **Lakebed K_V:** Based on estimates from actual measurements made during spring 1992 river releases and from data at other nearby Salt River recharge sites.

Limitations

The numerical model is a mathematical formulation that, in this case, solves a series of mass balance and Darcy's Law equations to predict resulting groundwater elevations. Its purpose is to assist with the engineering design for an appropriate infiltration management system for the Rio Salado Town Lake. *It is not intended to be a regional groundwater model.*

A steady-state groundwater model requires steady-state groundwater elevations at model boundaries. Even without a lake, groundwater elevations in the project area vary, moving upward in response to river flows and downward during periods without river flows. For this modeling effort, groundwater elevations set at the model boundaries represent a reasonable compromise between low-level (extended drought) and high-level (extended river flow) conditions.

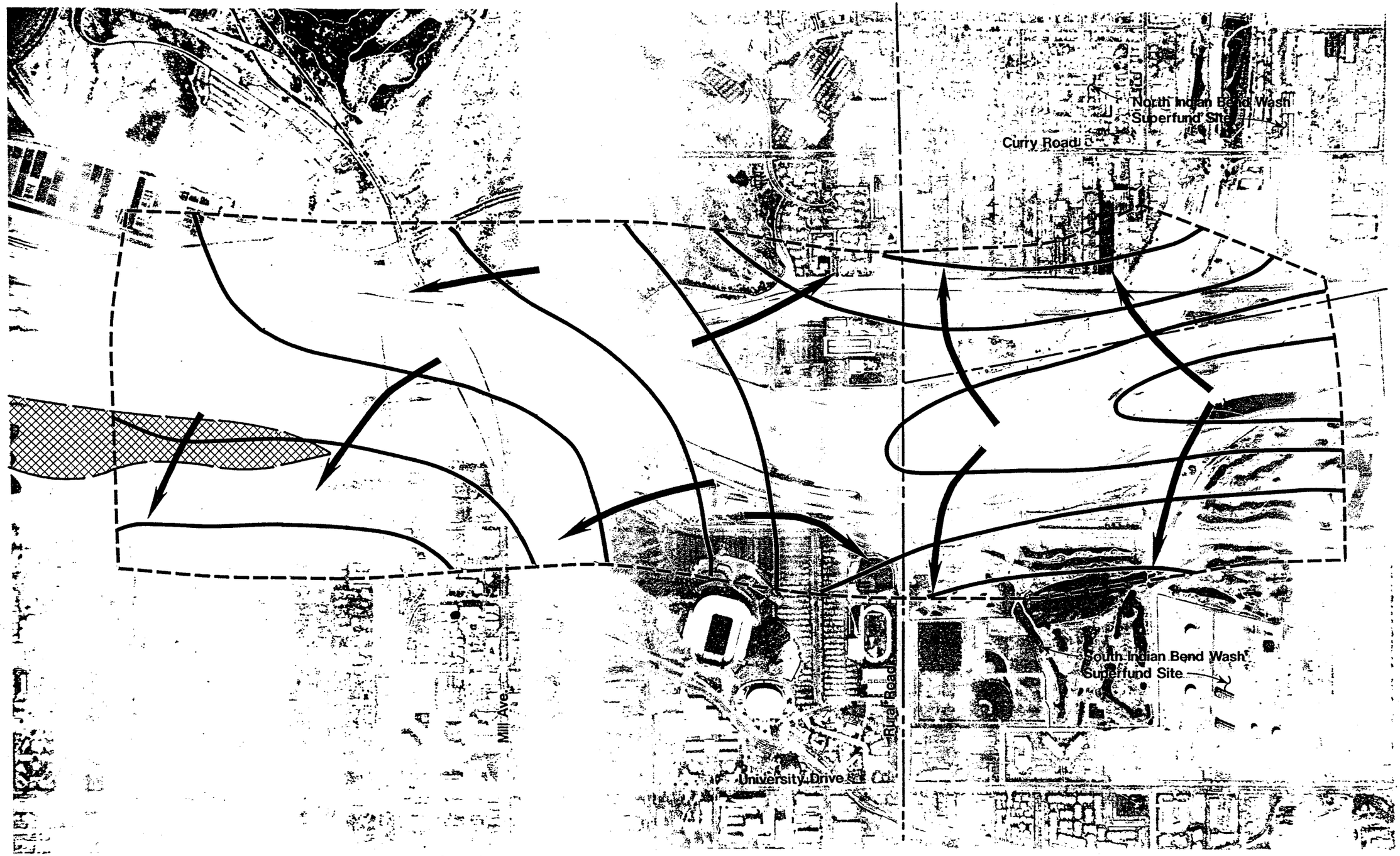
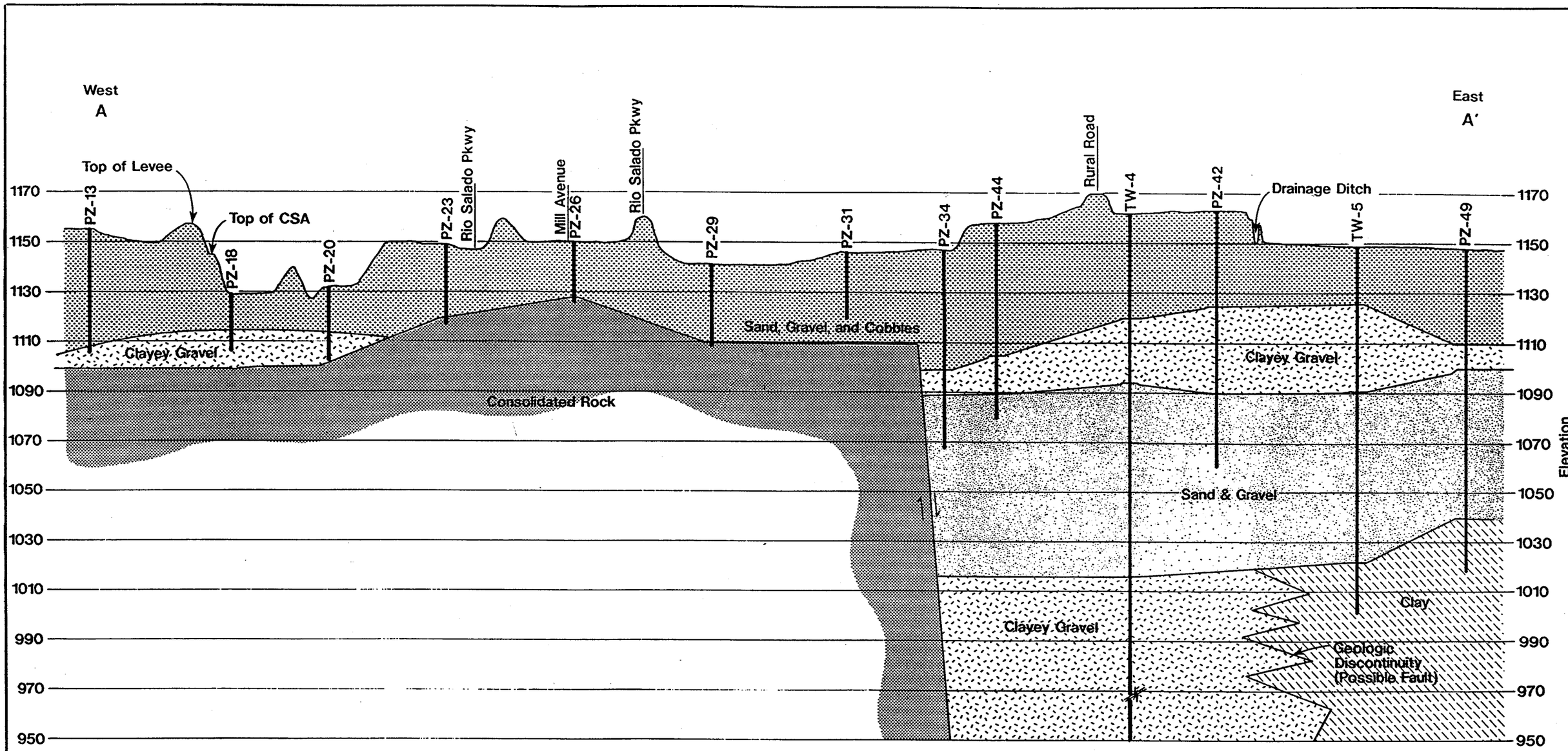


Figure 10-2
Recent Groundwater
Level Elevation



Section A-A'

Scale:
Horiz. 1" = 800'
Vert. 1" = 40'

Legend

Inferred Fault Showing Relative Movement

Note:
See location of cross-section on figure 10-1

The depth and thickness of the subsurface strata indicated on the section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions exists only at the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated locations. Also, the passage of time may result in a change in the conditions at these locations.

Figure 10-3
East-West Geologic Cross-Section

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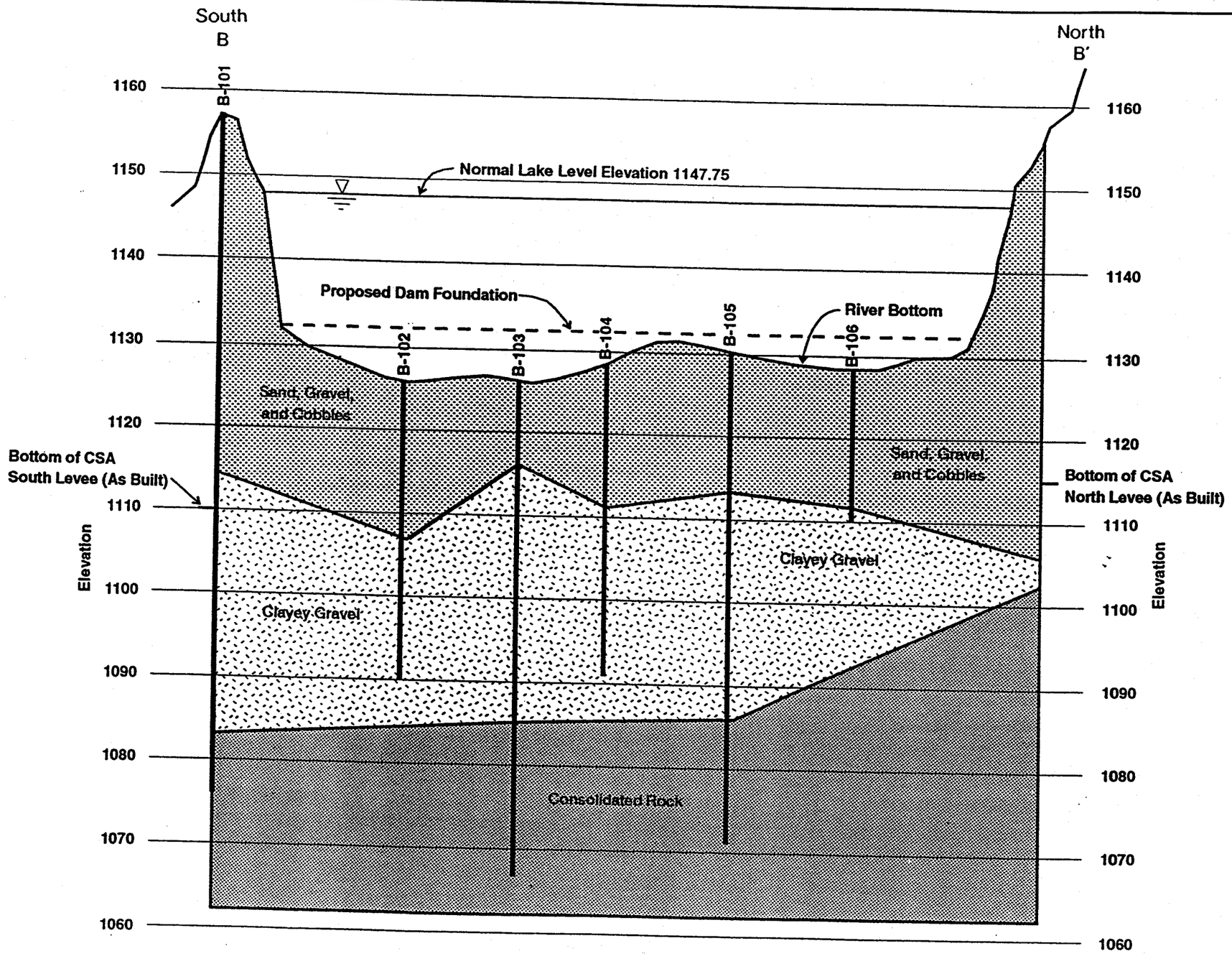
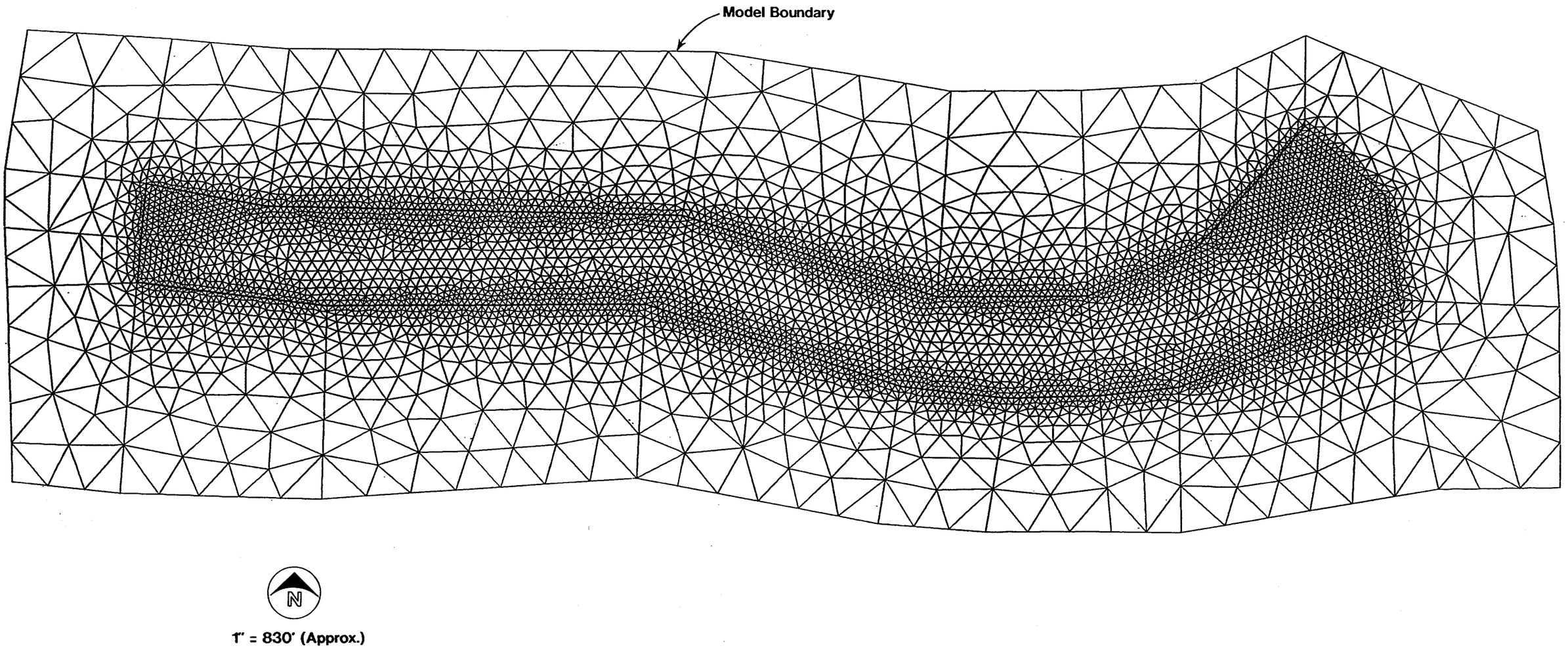


Section B-B'
Horiz. Scale:
1"≈110'

The depth and thickness of the subsurface strata indicated on the section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions exists only at the specific locations and dates indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated locations. Also, the passage of time may result in a change in the conditions at these locations.

Note:
See location of cross-section on figure 10-1

Figure 10-4
North-South Geologic Cross-Section



Note:
See figure 10-2 for Geographic Location of Model Extent

Figure 10-5
Finite Element Grid

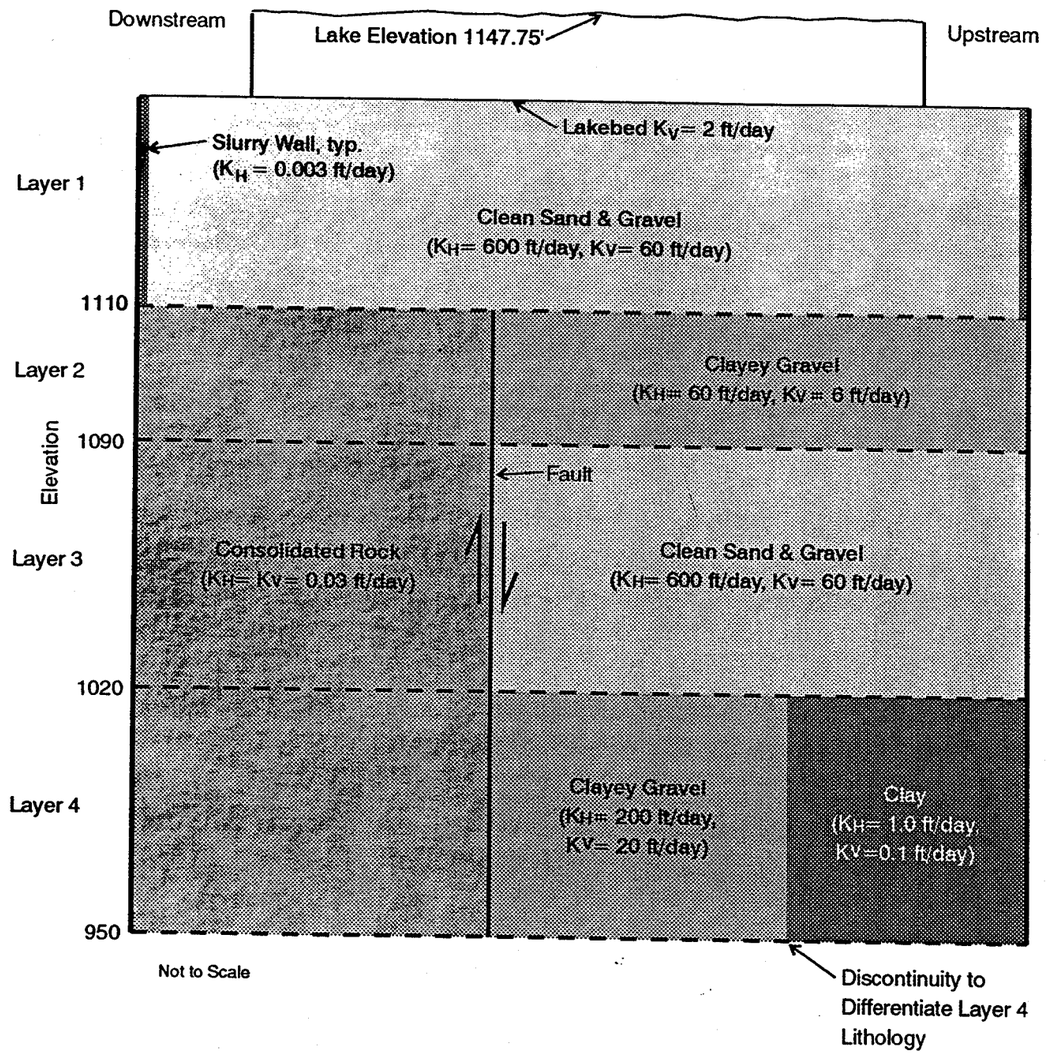


Figure 10-6
Modeled Geology Concept

Modeling Simulations

Modeling simulated the following potential infiltration management features:

- **Slurry Walls.** These are narrow (3' to 4'), vertical, low permeability barriers to groundwater flow. The slurry walls consist of a clay-rich slurry.
- **High-Capacity Wells.** These wells capture lake infiltration and return well discharge to the lake to maintain normal water elevation.
- **Liners.** These are thin (0.25" to 2') horizontal, low permeability barriers to groundwater flow. Liners can be made of a variety of natural or man-made materials.

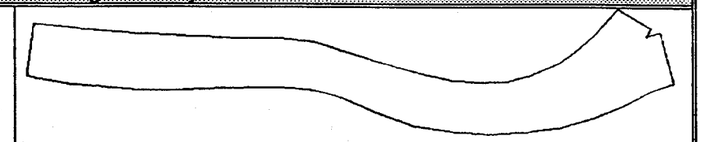
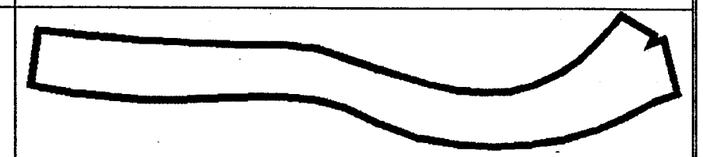
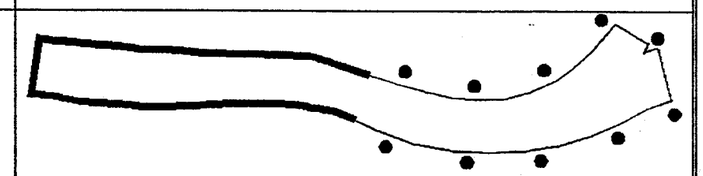
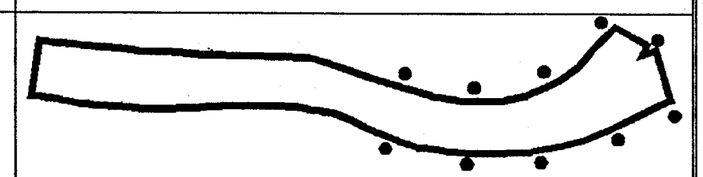
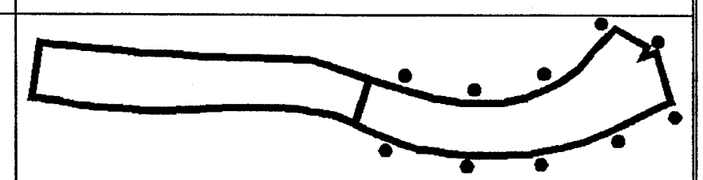
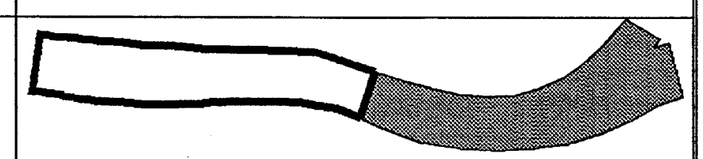
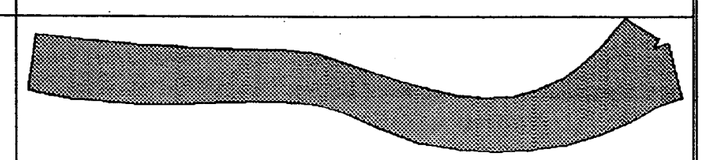
Alternatives Modeled

Infiltration management alternatives modeled for the Town Lake fall into one of five *general* types: :

- **No infiltration management system.** An estimate of infiltration at the expected lakebed infiltration rate, without a clogging or infiltration management system.
- **Infiltration management system using slurry walls only.** An estimate of long-term infiltration if slurry walls were constructed around the lake to tie into deeper and lower permeability materials.
- **Infiltration management system using slurry walls and wells.** An estimate of the long-term infiltration using various combinations of slurry walls and pumping wells.
- **Infiltration management system using partial slurry wall and a partial liner.** An estimate of the long-term infiltration using a combination of slurry walls in the western end of the lake and a liner in the eastern portion.
- **Infiltration management system using full liner.** An estimate of the long-term infiltration using a liner within the entire lake bed.

Table 10-1 describes and illustrates the different arrangements of simulated potential infiltration management features. A total of 24 computer runs were made which simulated alternative configurations of these general types of infiltration management systems. Eighteen of the runs used a consistent set of hydrogeologic input parameters, while varying the types and extent of infiltration management systems (for example, different arrangements and pumping rates for wells, placement and depths of slurry walls, etc.). Six of the runs were sensitivity analyses which were performed to observe the effects of changes to input parameters.

Table 10-1
Infiltration Management System Simulations

Type 1	No infiltration management system.	
Type 2	Slurry walls only.	
Type 3	Slurry walls west of fault only. Wells east of fault.	
Type 4	Slurry walls surrounding lake. Wells east of fault.	
Type 5	Slurry walls surrounding lake and across lake. Wells east of fault.	
Type 6	Slurry walls west of fault only. Liner east of fault.	
Type 7	Full liner only.	

Recommended Infiltration Management System

Description

The features of the recommended infiltration management system are:

- Slurry walls will completely surround the lake perimeter (extending into consolidated rock west of the fault and tied into clayey sands and gravels east of the fault). Across the Salt River at the upstream end of the lake, the concrete dam foundation will take the place of a slurry wall at that location. Similarly, the existing IBW drop structure will take the place of a slurry wall at that location.

- A slurry wall (extending into consolidated rock) will run in a generally north-south direction across the lake just west of the fault.

- About 10 high capacity wells (each capable of pumping about 3,000 gallons per minute continuously) will be located within 100 feet of the lake to capture infiltration and return it to the lake to maintain normal water elevation.

The advantages of the recommended alternative include:

- Cost-effectiveness. The capital costs are lower than the liner alternative.

- Ability to withstand flood scour (no recovery or down time after flood event) due to possible loss of a liner.

- Flexibility for water management options (a liner eliminates possibility of recharge, if desired).

- Circulation of water (from infiltration management well pumping), which may enhance water quality through infiltration and return of "filtered' water.

The infiltration management system is expected to operate as follows:

- Modeling assumed a steady-state lakebed infiltration rate of about 2 feet/day. To maintain normal lake depths, the infiltration management well capacity would need to pump about 40 million gallons per day. Based on test drilling and aquifer testing, it is estimated that 10 wells (each pumping an average of 4.0 mgd) will be needed to keep the lake full. (See discussion of recommended well locations later in this chapter.)

- Initially, the lakebed infiltration rate may be greater than the estimated steady-state rate of 2 feet/day. The estimated upper limit for initial infiltration may be as much as 10 feet/day. In any case, a large, sustained river release prior to filling the lake would fill subsurface pore spaces, reduce gradients, and therefore enhance the initial infiltration rate. If the initial infiltration rate is much higher than 2 feet/day, and in the absence of a river release, the City may need to use temporary measures (described later in this chapter under "Infiltration Rate Reduction Materials") to limit infiltration during lake filling with the currently available water source(s). See the "Water Supply, Quality, and Conveyance" chapter of this report for a discussion of lake filling and lake maintenance water sources, filling rates, etc.

- Once filled, the infiltration rate is expected to fall due to the settling of silt-sized materials and the formation of biological material with lake bottom sediments. When this occurs, infiltration management wells are expected to keep up with lake infiltration and keep the lake full. If the long-term infiltration rate is much greater than 2 feet/day, the City may need to drill a second phase of infiltration management wells (see discussion of recommended well locations).

- The requirement for temporary measures to limit infiltration during filling the lake may apply to the initial filling and any subsequent fillings when it is not possible to take advantage of the end of a river release.

- The recommended slurry walls will inhibit groundwater flow from moving away from the lake in the uppermost sand and gravel unit and will instead force water to move vertically downward where its infiltration rate will be impeded by finer-grained unconsolidated materials east of the inferred fault and by consolidated rock west of the fault.

Infiltration Management System Effects

Infiltrating water from a lake constructed without an infiltration management system would saturate a large area well below the ground surface and raise groundwater levels significantly for some distance away from the lake. Figure 10-7 is a detail of a typical infiltration management well showing groundwater flow lines. Almost all water pumped by the well comes from lake water that has infiltrated since the lake is the "easiest" source of water for a nearby well. Under existing conditions (without a lake), groundwater in the eastern portion of the project site naturally flows north and south, away from the riverbed and toward the North and South Indian Bend Wash Superfund sites. This pattern is due to the mound of groundwater created by infiltrating water from river flows. With the proposed infiltration management system, the Town Lake project must avoid both (1) increasing the groundwater gradient (steepness of the water table), which would increase the rate of groundwater movement and (2) changing flow directions. Either of which may negatively impact planned or

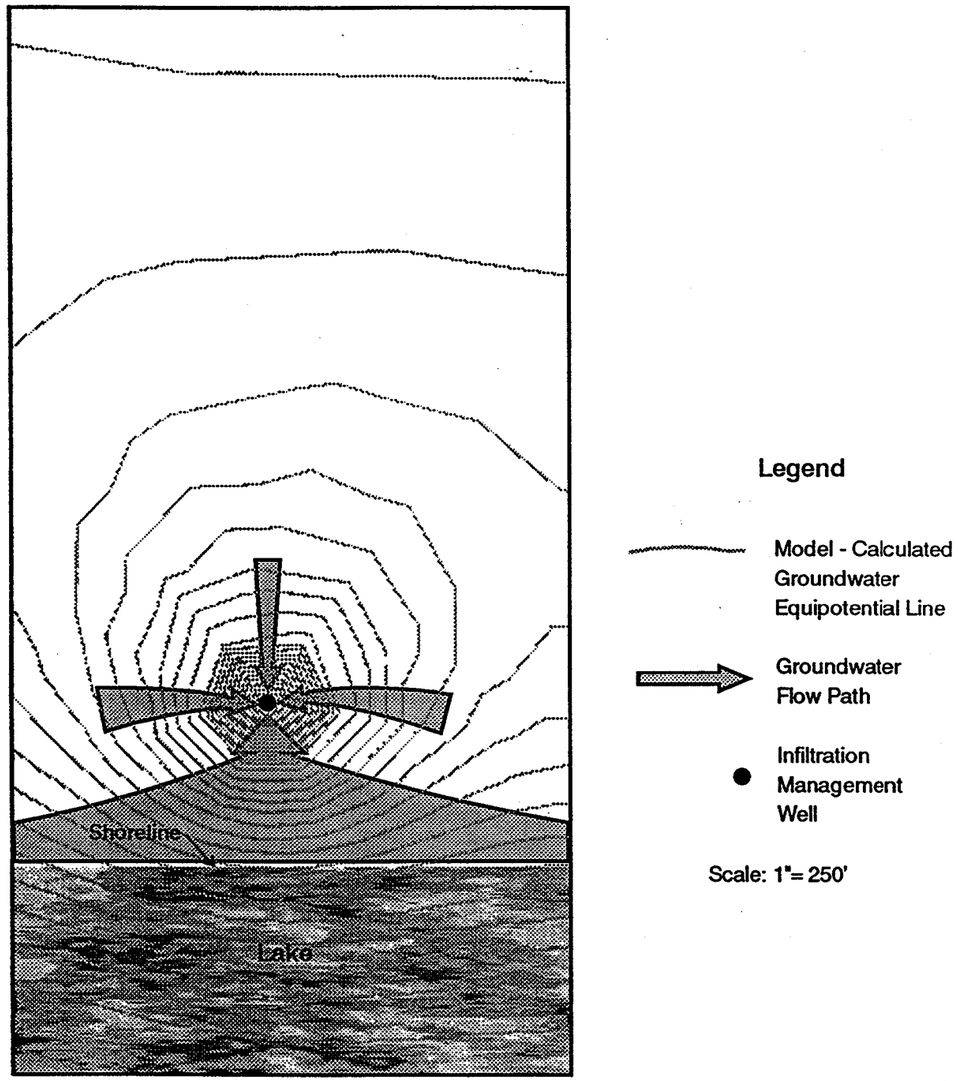


Figure 10-7
Typical Infiltration Management Well

existing groundwater remediation systems by altering the rate or direction of a contaminant plume's migration.

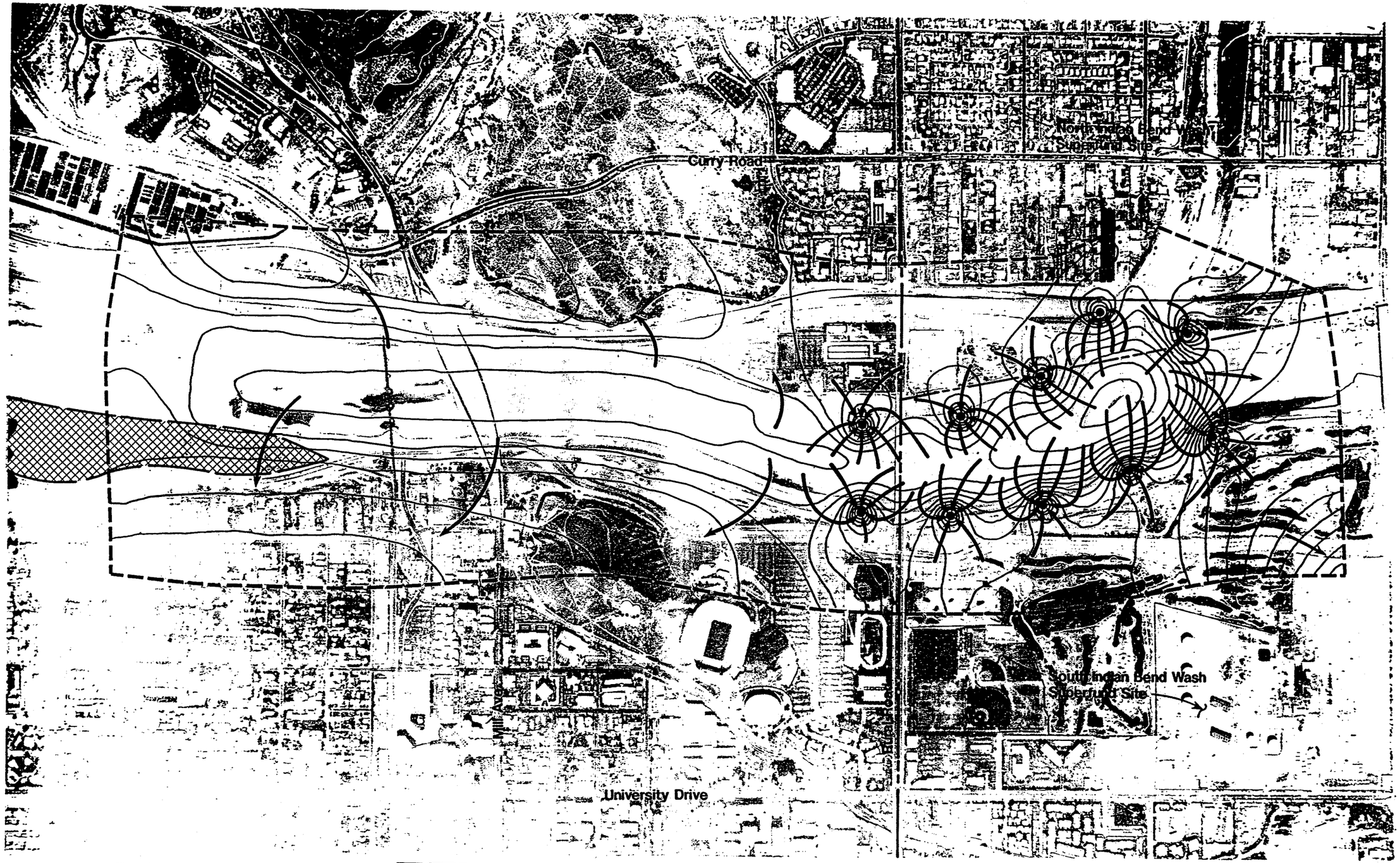
Modeling indicates that an effective infiltration management system will effectively capture the infiltrating lake water and form a "barrier" that will prevent the lake from negatively affecting nearby Superfund sites. To monitor this, groundwater elevations in existing and new piezometers will be regularly measured. Ringing the lake with infiltration management wells (upstream of the inferred fault in thick sand and gravel units) is expected to effectively contain the mound of groundwater created by infiltration of lake water. Figure 10-8 shows the estimated groundwater flow patterns during operation of the recommended infiltration management system. The modeling indicates that the infiltration management wells can function so as to create essentially no net flow effect at the model boundaries (that is, the amount of water leaving through boundaries is balanced by the amount entering the boundaries and the gross boundary flux is very small compared to the amount infiltrating out of the lake and being captured by infiltration management wells).

Figure 10-9 is a north-south cross-section showing the estimated position of the water table under various scenarios. The figure shows graphically that the effects of the lake at the model boundaries will be minimal with the recommended infiltration management systems in place. For example, under a simulation using the recommended infiltration management system, the model predicts about 0.2 million gallons per day will leave through the model boundaries west of the inferred fault, which should be balanced by about 0.2 million gallons per day entering the model boundaries east of the inferred fault.

The predicted operational effects of the recommended infiltration management system on nearby areas (as shown in Figure 10-9) are based on the assumption that the infiltration management wells can operate as needed to maintain an effective hydraulic barrier. This means that electric power must be available at all times to power the infiltration management wells to prevent undesirable subsurface conditions that could develop should the system be shut down for an extended time period. Because of this, CH2M HILL recommends that the City make arrangements for having the highest reliability electric power source available and provide for a backup source of electric power.

A formerly used, municipal solid waste landfill is known to exist in the southwestern part of the project site (see Figure 10-2). Several environmental investigations have been performed on the site. CH2M HILL's scope of work for the Town Lake project did not include conducting a thorough review of previous studies at the landfill site. However, we have performed a brief review of investigation findings because of the proximity of the landfill materials (immediately adjacent to the lake levee) to the future lake water and because of the possible effects of the landfill materials on lake construction. Infiltration of lake water through the slurry walls and cement stabilized alluvium and upward hydraulic gradients within the underlying consolidated rock may cause groundwater levels to rise into the landfill materials. The potential environmental effects of this possible occurrence are difficult to predict.

It is recommended that the City further evaluate the most appropriate actions for this landfill. One potential remedy would be to excavate and move the landfilled materials prior to or during lake construction. Remedial actions at other landfills have included excavation and removal, containment, stabilization, in situ bioremediation, and other actions.



Infiltration Management Well
Example Groundwater Equipotential Line
Numerical Model Boundary
Estimated Groundwater Flow Paths
Superfund Boundary

Known Landfill (others may exist)

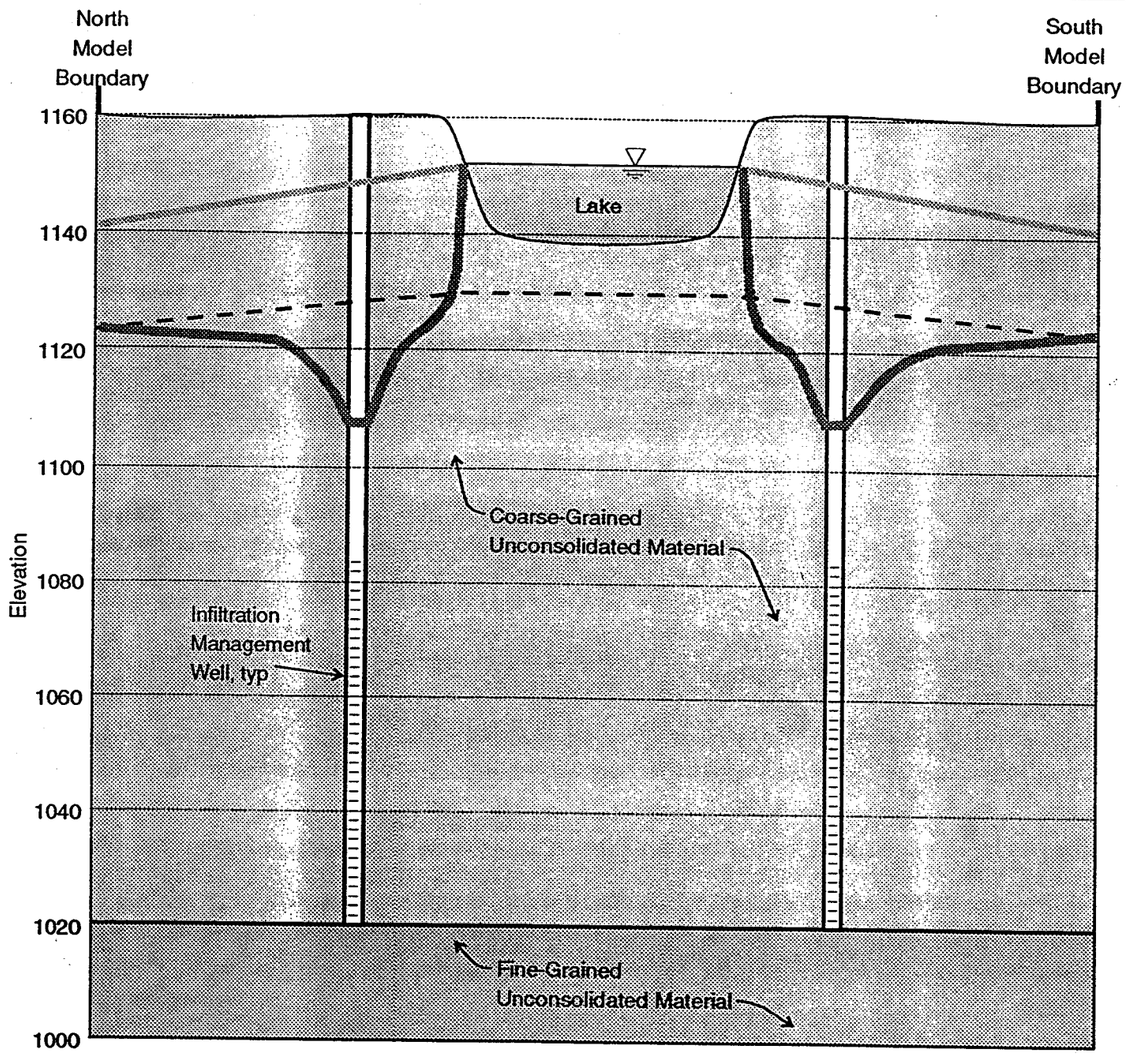
* Slurry Wall Not Shown

0 1000 2000 Feet

N

Figure 10-8
Estimated Groundwater Flow Patterns

CH2M HILL



Legend

- - - Approximate position of water table under non-lake conditions.

Approximate position of water table under lake conditions without an infiltration management system.

Approximate position of water table under lake conditions with recommended Infiltration management system in place (slurry wall not shown).

Figure 10-9
Estimated Positions of Water Table
Under Different Scenarios

Other measures to ensure the protection of the local groundwater are as follows:

- Regularly measure groundwater elevations in the existing network of piezometers to observe and monitor effects of the lake on groundwater elevations, gradients, and flow directions. As appropriate, adjust infiltration management well pumping rates to maintain the desired groundwater elevations.

- Prior to constructing and filling the lake, existing piezometers and test wells located in the riverbed (those that would be under water when the lake is filled) will be properly abandoned (plugged) per state requirements.

Description of Infiltration Management Features

Slurry Walls

Slurry walls are vertical subsurface barriers constructed to reduce the horizontal permeability of the material into which they are placed. They are constructed of low hydraulic conductivity material (approx. 0.003 feet/day) which creates a hydraulic barrier to horizontal groundwater flow. For the Rio Salado project, a vertical slurry wall (Figure 10-10) will be constructed around the lake perimeter and across the lake, just downstream (west) of the fault. Additional geophysical logging would be useful for refining our interpretation of the fault's location and orientation to assist in the proper placement of the slurry wall going across the lake. (Geophysical logging may be needed because the slurry wall going across the lake would function better if it is constructed slightly downstream of the inferred fault where it can tie into consolidated rock and thus be more effective in cutting off horizontal subsurface flow.)

The vertical slurry wall will be constructed down to consolidated rock west of the fault and down to the clayey gravel layer east of the fault. The expected depth of the slurry wall ranges from 15 to 50 feet below the riverbed (with an average of about 30 feet). For this project, about 600,000 square feet of slurry wall (the typical measure of slurry wall quantity, regardless of wall width) is expected to be constructed. The slurry walls will be constructed close to the top of the CSA, but because it is not practical to excavate through the CSA, they cannot be constructed *through* the CSA. To limit the amount of water infiltration loss between the slurry wall and the CSA, a geosynthetic clay liner/rock blanket detail will be constructed (see Figure 10-10).

Figure 10-11 illustrates the approximate locations of slurry walls recommended as part of the infiltration management system. Location and details of the slurry walls are also shown in Sheets 10 through 14 and Sheet 28 of the drawings.

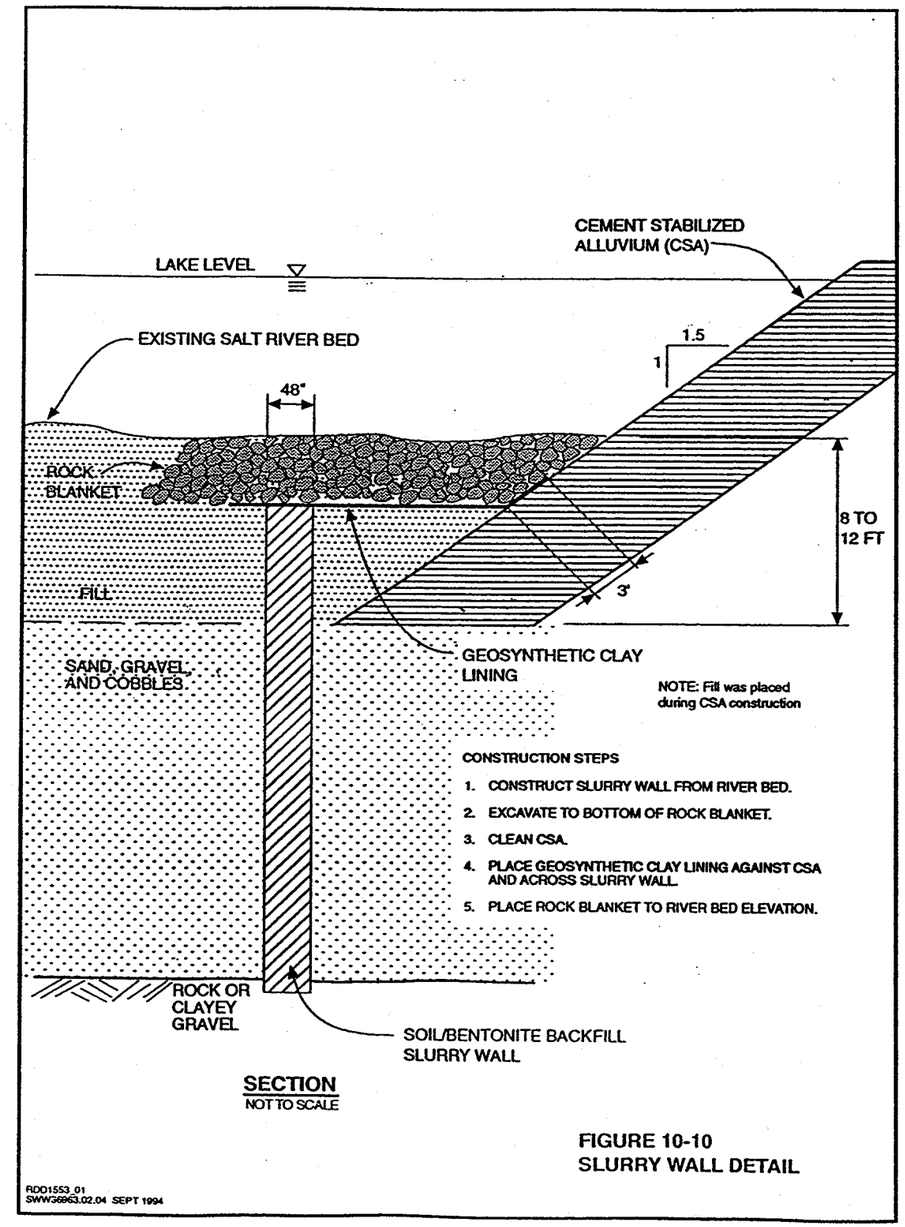


FIGURE 10-10
SLURRY WALL DETAIL

Construction Method

As the trench is excavated, bentonite slurry stabilizes the trench walls, and backfill is placed into the trench. Typical density of the slurry ranges from 70 to 75 pounds per cubic foot. While the trench is open, the slurry level is maintained within 1 or 2 feet of the ground surface, and at least 4 feet above the groundwater level. Because of the coarse particle size characteristic of soil at the Rio Salado Town Lake site, soil will have to be imported and blended with processed onsite soil to create the soil/bentonite backfill slurry wall. It is recommended the slurry trench be keyed 2 feet into consolidated rock. The recommended trench width is a minimum of 48 inches.

High-Capacity Infiltration Management Wells

- **Number.** It is estimated that 10 wells will be needed to maintain lake water depth. Spaces for an additional 11 sites will be reserved so that a second phase of wells could be efficiently installed should they be needed to keep the lake full.

- **Locations.** (See Figure 10-11.) Phase 1 wells will be installed and used as needed for infiltration management. If, under operating conditions, it is determined that additional infiltration management wells are needed, Phase 2 wells can be installed as needed.

- **Approximate pumping rate.** Wells are expected to pump between 2,000 and 3,000 gpm (2.9 to 4.3 mgd) each but the well design should allow individual well pumping rates of up to 3,700 gpm (5.3 mgd) to 4,000 gpm (5.8 mgd) depending on the screen slot size that can be used.

The plan for each location is to drill a borehole, install the well casing and screen, and develop the well. The contractor will then test pump the well to determine the optimum pumping rate for each well. An appropriately sized pump and motor will be selected and installed in each well.

General Design Details

The amount of water the infiltration management wells will need to pump is only an estimate based on a variety of data and technical considerations. Therefore, the initial 10 wells have been designed to provide some excess capacity, to avoid, as much as possible, the need to add the second phase of wells.

Sheet 29 of the drawings shows typical infiltration management well design details. Significant design details include:

- 36" diameter surface casing to stabilize the upper portion of the borehole (to prevent collapse). The size of the borehole for the surface casing is dictated by the casing diameter.

- 24" outside diameter well screen and casing, which is the recommended size for anticipated pump rates (up to 4,000 gpm).

- 34" borehole to total depth; provides recommended annulus for well construction.

- Type 304 stainless steel, which provides a design life of at least 50 years for the potentially corrosive conditions expected at the project site:

  --High total dissolved solids concentrations
  --High dissolved oxygen concentrations
  --High chloride concentrations
  --Low pH

- Pump/motor. The recommended pumps/motors are **submersible pumps and motors** (up to 150 hp motor) for the Town Lake project. This alternative was selected primarily for aesthetic and noise control reasons. The motor is located down the well, therefore the installations are quiet. In addition, the pumps can be constructed in underground vaults, thereby eliminating above-ground well houses.

Infiltration Rate Reduction Materials

If the initial lakebed infiltration rate is too rapid to allow the lake to fill and/or retain water, a temporary infiltration rate reduction material will be applied.

- **Extent.** This temporary material would probably be needed only in the upstream portion of the lake (that is, east of the inferred fault). It would slightly overlap the slurry wall that will be constructed across the lake (see Figure 10-11).

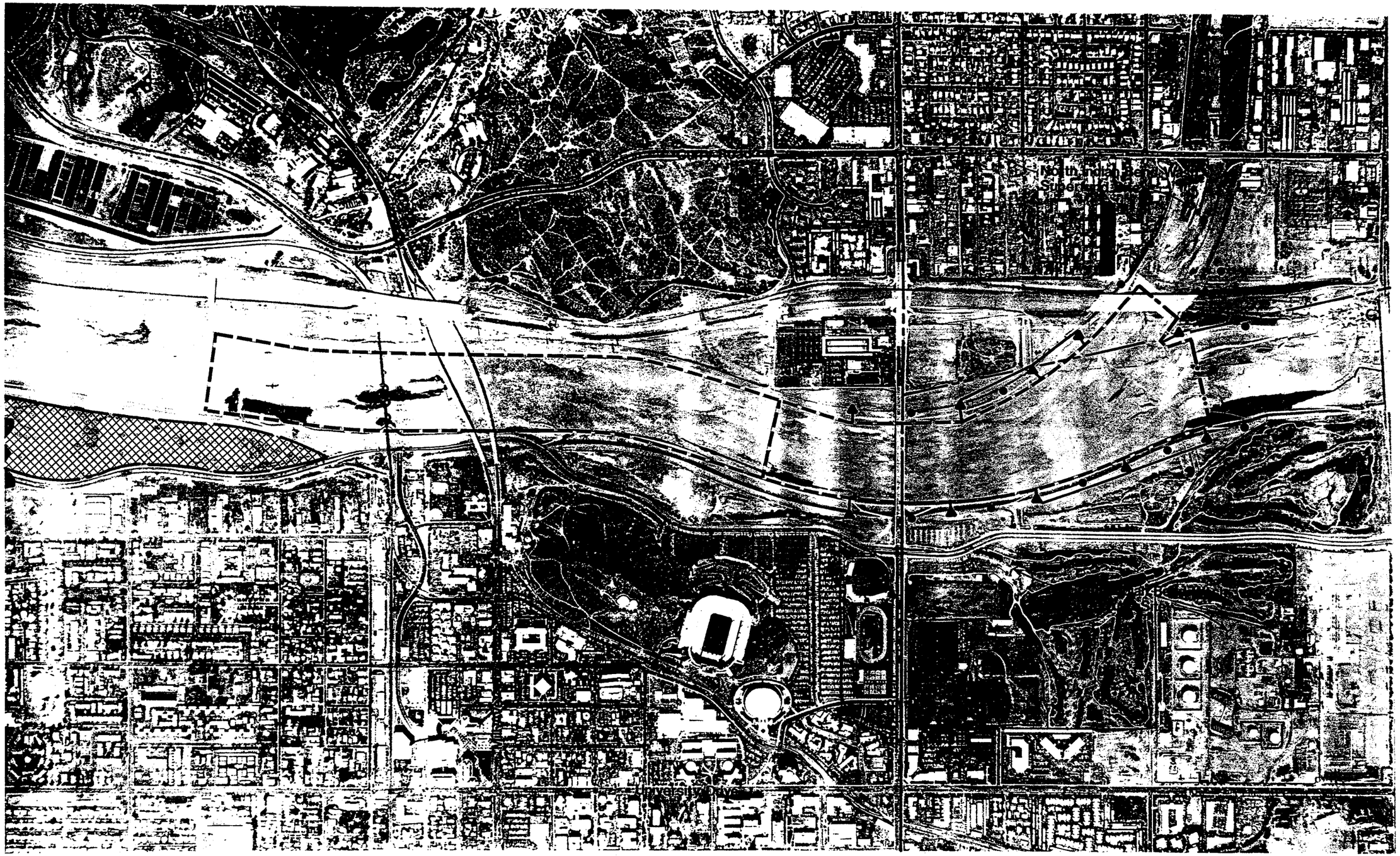
- **Burial depth.** This temporary material will probably be placed on the lakebed surface or buried, at most, at about one foot (depends on the selected material and its characteristics.)

- **Physical characteristics.** Possible materials include a geotextile, bentonite admixture, a geosynthetic clay liner, or roller compacted concrete.

- **Method of construction.** The method will vary, depending on the material selected.

Costs for temporary infiltration reduction methods are discussed in the "Costs" chapter.

As discussed in the beginning of this chapter, it is not possible to know exactly what will be required to fill and maintain the Town Lake, until it is constructed and in operation. Prior to construction, CH2M HILL will develop a detailed "decision tree" that will outline the steps to be taken (and alternatives based on findings from the prior steps) to fill and maintain the lake at its targeted elevation. This "Observational Approach" is the preferred method because it allows flexibility that may be required in the design given the magnitude of the technical issues of this project.



▲ Phase 1 Wells

● Phase 2 Wells

Manifold and Discharge Piping

Soil/Bentonite Backfill Slurry Wall

Grade Control Structure Cutoff Wall

Dam Foundation Cutoff Wall

Superfund Boundary

Known Landfill (others may exist)

N

0 1000 2000 Feet

Figure 10-11
Infiltration Management System

Introduction

This chapter describes design recommendations for the management of stormwater affecting ambient water quality in the Town Lake. It is based on the findings of three previous documents that addressed stormwater issues:

- Technical Memorandum 5 (June 1991)
- Rio Salado Engineering Report (August 1992)
- Technical memorandum dated June 28, 1994

For further details on the stormwater management information presented here, refer to these documents.

Stormwater represents both a potential resource and a potential threat to water quality in the Rio Salado project. Stormwater is a source of additional water to the lake, but pollutant loads carried in runoff discharges may result in adverse lake water quality impacts. The implementation of stormwater management practices can enhance the resource value of runoff discharges while minimizing potential impacts to lake water quality.

The term "first flush" describes the tendency for most pollutants in urban areas to be washed off impervious surfaces during the first part of a storm event. This effect causes higher pollutant concentrations in early storm flows, with pollutant concentrations typically diminishing as the storm continues. As a result, a stormwater management facility that captures the first flush will remove a higher fraction of the pollutant load compared to flows later in the storm. This concept is central to the design presented in this document.

Even after the first flush, stormwater flows may have high turbidity and carry pollutants into the lake. The flows will deposit some sediments. They may carry floating debris, such as plastics or glass. Other effects of stormwater flows may include hydraulic impacts on existing drainage systems (flooding and less stormwater capacity), offsite drainage, and onsite drainage.

The information and conclusions presented in this document are based, in part, on existing local data from the study area. Watershed areas and runoff coefficients for Tempe watersheds were provided by the City. These data were used to estimate the flowrates and volumes for each watershed for the average annual storm based on rainfall data for the Phoenix area.

Tempe also provided basic information (size, location and profile data) on some of the stormdrain outfalls that drain City areas. Very little hydrologic design information was available for these systems. ADOT provided information on the Red Mountain Freeway drains. Where no design hydrology was available, it was assumed that the design capacity of the stormdrain was the pipe capacity flowing full under gravity conditions.

Local data include a limited database of stormwater quality tests. No gage information on local runoff rates or the effectiveness of local stormwater management practices were available.. In lieu of local data, estimates of stormwater quantity, quality, and the effectiveness of pollutant removal techniques are based on nationwide data and methods developed by the U.S. Environmental Protection Agency (EPA) and the limited local stormwater quality data. Based on the available national data, it was estimated that capturing or diverting twice the average storm would reduce average stormwater discharges into the lake by about 80 percent. This conclusion provides the general design objective for the stormwater management system.

Existing Outfalls

There are 15 existing stormwater outfalls to the project site. Figure 11-1 lists the outfalls, the estimated discharges and proposed mitigation measures, if required. Mitigation measures include either (1) diversion around the lake or (2) infiltration galleries.

The condition of these stormwater drains is a concern. Field observations have shown that some, if not all, outfalls have flap gates that do not appear to seal completely. The result is that these outfalls could act as conduits for stormwater from the lake to behind the existing levees, either through leaky joints or along bedding material. A testing program should be conducted, and replacement/repair of the pipes initiated, if necessary.

There are insufficient data to characterize the water quality of specific outfalls (see Table 11-1, on the next page).

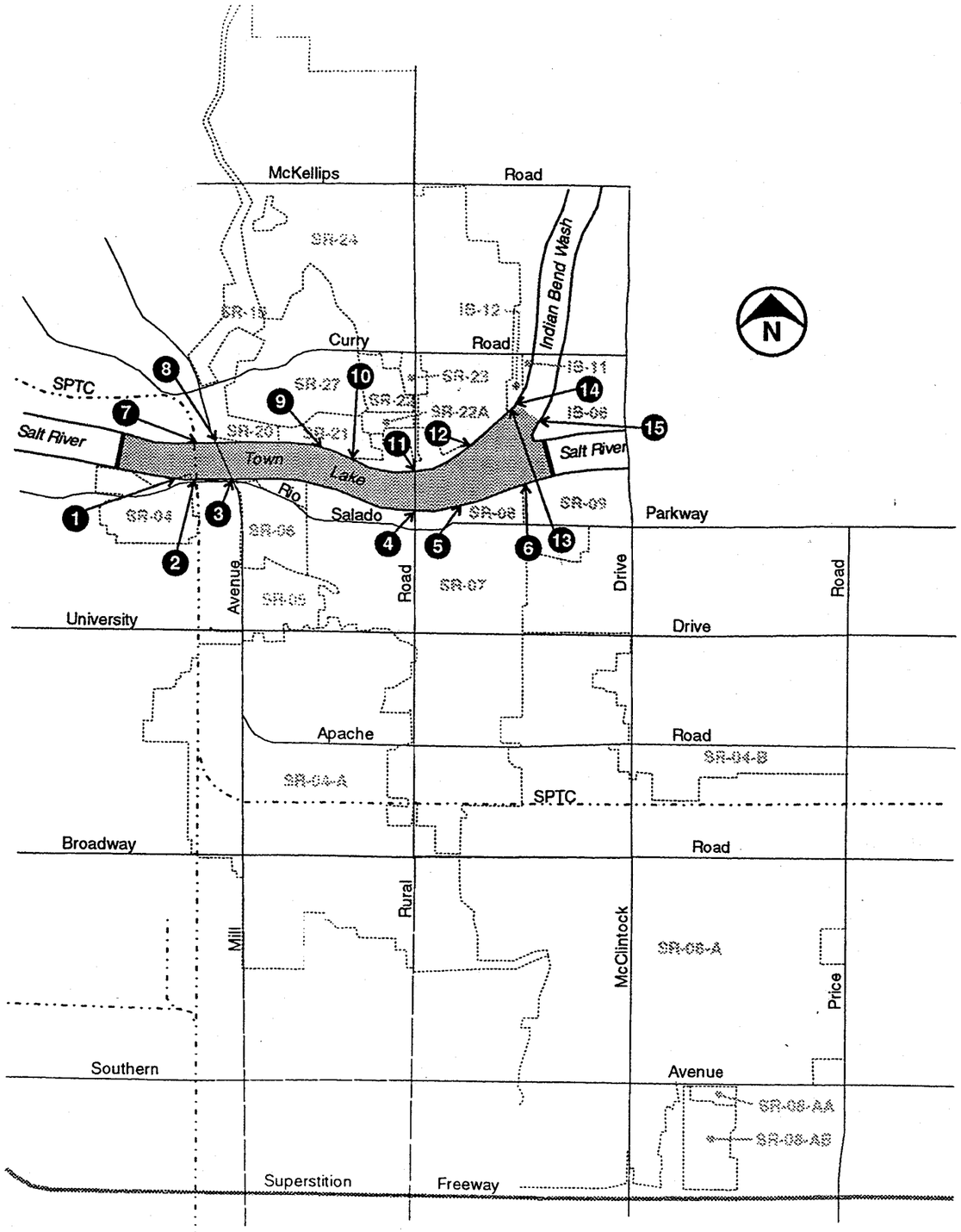
The average annual stormwater discharge to Rio Salado is estimated at 11,000 ac-ft, excluding Salt River and IBW flows. The average storm is expected to produce about 600 ac-ft of direct runoff.

Indian Bend Wash

The largest single source of stormwater runoff to the proposed Town Lake is the Indian Bend Wash (IBW) watershed, which drains north Tempe, Scottsdale, and Paradise Valley. The average storm event generates about 400 ac-ft of runoff with a flow of 1,000 cfs, but much of this flow infiltrates into the golf courses and upstream lakes, resulting in little or no runoff reaching the Town Lake. Typically, at least one storm event per year results in flow to the river. The estimated flow for the 100-year event is 30,000 cfs. Average annual runoff is 7,500 ac-ft.

Salt River Flows

In the 100-year event, the design flow for the Salt River is 215,000 cfs. For detailed information, see the chapter entitled "River Hydraulics."



Legend							
ID	Outfall Name	Size	Drainage Basin(s)	Basin Area (ac.)	Est. Peak Discharge (cfs)	First Flush (cfs)	Comment
1	Farmer	72"	SR-04 SR-04-A	79 948 1,027	280	52	Divert Fill Flow
2	Ash	54"	SR-05	155	155	36	Divert Fill Flow
3	Mill South	24"	SR-06	66	12	12	Divert Fill Flow
4	Rural South	66"	SR-07 SR-07-B	663 107 770	114	52	Divert First Flush
5	Dorsey	66"	SR-08 SR-08-A SR-08-AA SR-08-AB	34 1,731 11 60 1,836	210	88	Divert First Flush
6	Karsten	30"	SR-09	78	13	-	Divert Fill Flow
7	SPTC	66"	SR-19	67	99	6	No Diversion
8	Mill North	48"	SR-20	55	-	20	No Diversion
9	Curry	2-8'x8' CBC	SR-21	38	-	12	No Diversion
10	College	2-48"	SR-22	28	60	10	Divert First Flush
11	Rural North	42"	SR-23	23	56	8	No Diversion
12	Miller	2-8'x8' CBC	SR-24	903	709	66	Divert First Flush
13	Gilbert	48"	IB-12	6		2	No Diversion
14	South Curry	36"	IB-11	4		2	Divert First Flush
15	ADOT	48"	IB-06	53		6	Divert First Flush

Figure 11-1
Outfalls, Estimated Discharges, and Proposed Mitigation Measures

Table 11-1
Tempe Area Average Stormwater Quality

Parameter[a]	Technical Memorandum 5	New Data (1989 to 1993)
Total suspended solids	278	216
Total dissolved solids	--	315
Biochemical oxygen demand	47	54
Total phosphorous	0.35	0.59
Dissolved phosphorous	0.24	0.29
Ammonia nitrogen	1.60	1.87
Dissolved organic nitrogen	3.46	4.07
Nitrate nitrogen	1.58	1.62
Total nitrogen	6.65	7.93
Fecal coliform	8177	5418
pH	7.72	--
Oil/Grease	<5	<5
Arsenic	<0.02	<0.02Phenols<0.005-
Cadmium	<0.005	<0.005
Chromium	<0.05	0.02
Copper	0.06	0.01
Lead	0.05	0.02
Mercury	<0.001	<0.001[b]
Selenium	<0.005	<0.0008
Silver	<0.02	<0.002
Zinc	0.26	0.31

[a]All units in mg/l, except fecal coliform in cfu/100 ml.
[b]Mean excludes high mercury concentrations from Dorsey Lane storm drain.

Design Criteria

The first design criterion was to design a cost-effective system to minimize inflow of pollutants to the lake. To achieve a cost-effective stormwater management system, CH2M HILL only considered outfalls that drain watersheds that are suspected major contributors of pollutants, such as commercial or industrial areas or the Red Mountain Freeway. These outfalls were identified as the Miller, Dorsey, College, and Rural South outfalls. The recommended stormwater management system diverts 80% of the pollutants from the lake by diverting the "first flush." Impacts from other, minor, sources will be mitigated through lake management practices.

A second design criterion was to divert the stormwater flows that would otherwise reduce the capacity of the pipe to manage typical flows. For instance, when the lake level exceeds the ground elevation behind the levee, water backs up. Lake water may also back up into the pipes, again reducing capacity to handle stormwater flows. Unless some of these flows are diverted, the stormwater potentially could cause flooding in the levee or around the lake developments.

Other design criteria include:

- Select alignments that minimize impacts on existing properties, so the need to obtain easements is reduced or eliminated.
- Produce no significant adverse hydraulic impacts to existing stormwater system.
- When possible, use gravity as a means to divert stormwater. However, pumping may be necessary when dictated by hydraulics.

Diversion Facilities

The proposed stormwater management system is shown in Figure 11-2.

South Bank Interceptor

The South Bank Interceptor (SBI) will generally parallel the Salt River and the existing alignment of the Rio Salado Parkway, from Rural Road to the downstream dam (see drawings). Until recently, the concept was that Kaminski-Hubbard would design the portion of the SBI between Rural Road and Farmer Avenue as part of the realignment of the Rio Salado Parkway. CH2M HILL would design the section between Farmer Avenue and the downstream dam. The design drawings reflect this concept (see Sheets 31 and 32). Recent events have resulted in the realignment of both the parkway and the SBI. The current concept is that Kaminski-Hubbard would design the pipeline between Rural and Ash with CH2M HILL designing the remainder. Kaminski-Hubbard is currently evaluating several alignments for their section of the SBI.

The SBI mitigates potential flooding at the Farmer, Ash, and Miller outfalls by diverting the full flow (calculated based on the capacity of the pipe) from each outfall to below the downstream dam. It will also capture the first flush from the Rural South outfall. The SBI has been designed to have enough capacity to handle the onsite drainage for the proposed realignment of the Rio Salado Parkway between Rural and Farmer. Capacity of the drain is based on a downstream water elevation in the lake of 1138.

Flows greater than the capacity of the existing pipes will initially cause surcharging, and if large enough, back up into the adjacent roads and facilities. Flows greater than the first flush from Rural Road will discharge into the lake.

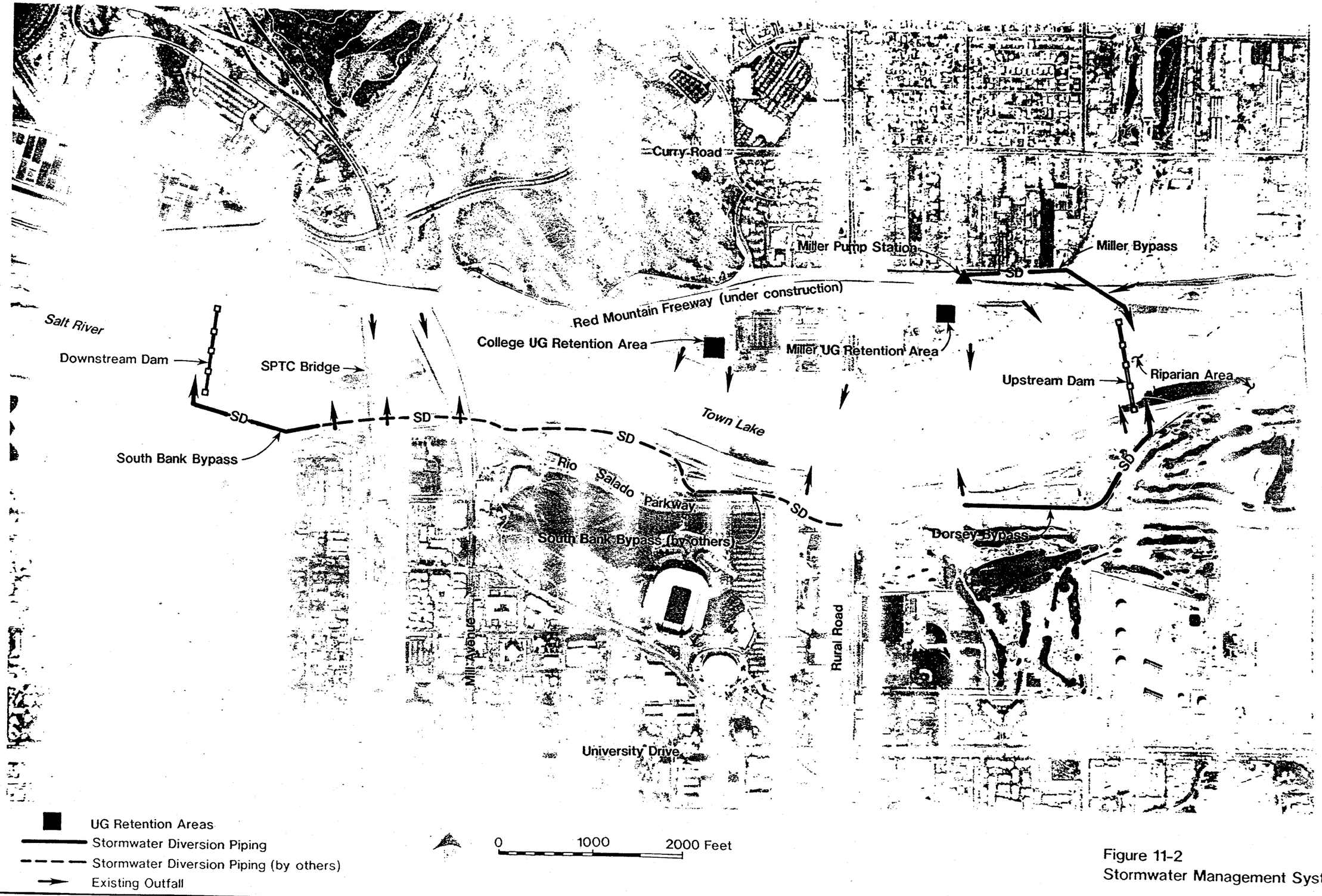


Figure 11-2
Stormwater Management System

The SBI is located on City right-of-way, therefore no easements are needed. The alignment poses no known utility conflicts. The following construction issues have been identified:

- Levee crossings will require replacement of existing gabions.
- A flap gate will be used to minimize or eliminate floodwaters from entering the SBI.
- Penetration of the CSA will require watertight seal.

A new first flush diversion structure will be required at Rural Road. (See drawings.) The Rural Road diversion structure also will be used as part of the water supply system to the lake (for make-up water) (see chapter entitled Water Supply and Conveyance). Instrumentation and control facilities will be required at the Rural Road diversion structure and just upstream of the SRP spill structure to correctly operate and monitor the diversion of stormwater. During dry periods, the motor-operated gate on the SBI will be closed, allowing make-up water to enter the lake. When the sensor on the Rural Drain just upstream of the SRP spill indicates that there is storm flow, the slide gate to the SBI will be opened for a given time duration to pass the first flush. When the first flush has been diverted, any additional flow will be directed into the lake as normal. The City will be able to remotely operate the gate, monitor its status, and measure the stormwater flow.

Dorsey Bypass

The Dorsey Bypass is approximately 1,600 feet long. It diverts first flush flows from the Dorsey Drain and the design flow from the Karsten Golf Course drain to upstream of the upstream dam, thus reducing stormwater quality impacts on Town Lake. (See Sheets 33 and 34 of the drawings.) To construct the Dorsey Bypass, an easement/right-of-way will be required from Tempo Investments. However, there are no known utility conflicts. The bypass has been designed to operate assuming the riparian area in the Salt River channel upstream of Town Lake is full (at elevation 1148).

Other construction issues are similar to the SBI:

- Flap gate.
- Penetration of CSA will require watertight seal.
- Levee crossing will require replacement of gabions.

Miller Bypass

The Miller Bypass, which is approximately 2,200 feet long (excluding the IBW drop structure), diverts:

- First flush from the Miller drain
- Full design flow from ADOT drain on east side of IBW
- Low flows (less than 72 cfs) from IBW to the Salt River

The IBW drop structure will divert the flow from nearby storm drains, across the wash, to the proposed Town Lake. Because these are smaller, local storm drains, flows are assumed to peak earlier than IBW flows. Flows from the IBW are assumed to take longer to reach the river because of the greater time of concentration. Therefore, these estimations are based on the assumption that IBW discharges do not coincide with discharges from the local outfalls. Significant discharges from the local outfalls also empty into the IBW drop structure and would reduce its capacity.

The IBW drop structure (see Sheet 37 of the drawings) needs the following modifications:

- Fill in the low flow notch with a gated pipe and concrete to make it a water tight diversion structure. Bore and jack construction may be required between the IBW and the Salt River because of the depth of cut and concern over disruption to levee construction.
- Modify the east end of the stormwater bypass by constructing an inlet structure.

A pump station (consisting of three 40-hp pumps and one 20-hp pump) located at the existing ADOT stormdrain structure will need to be modified to keep the first flush out of the lake (see Sheets 38 and 44 of the drawings). The ADOT structure needs similar modifications. Flow will be diverted by pipe to the IBW, then across the IBW drop structure, then again by pipe to the Salt River upstream of the dam. Instrumentation and control will be used for the following:

- Measure flow rate through each pump
- Measure water elevation in the pump
- Select the lag pump sequence
- Remotely/locally start and stop pumps
- Remotely/locally determine status of pumps
- Remotely indicate intrusion alarm

The bypass has been designed assuming the riparian area water surface elevation is at 1148. Flap gates will be needed at the IBW and Salt River outlets. Again, penetration of the CSA requires a watertight seal. Construction of the Miller Bypass will encroach upon the existing ADOT and SRP right-of-way. Any power outage would result in the stormwater flowing directly into the lake.

College and Miller Underground Retention Basins

Drainage for the Red Mountain Freeway currently enters the river through the Miller and College outfalls. This drainage will be directed into underground retention basins located adjacent to the drains (see Sheets 7 and 9 of the drawings). Construction of the retention basins should not inhibit

construction of any future above-ground facilities. If significant underground facilities, such as a basement or parking structure, are required in these areas, the drainage system may require revision. Failure of the retention basins would result in the freeway runoff flowing directly into the lake.

Salt River Flows

Low flows will pond behind the upstream dam. This area, then, acts as a detention pond, and can reduce pollutant loading. The riparian area has a capacity of up to approximately 50 million gallons or about 6.5 million cubic feet. Flows in excess of this amount would overflow the upstream dam. A pump station has been included to pump water from the riparian area into the lake, if necessary, for upstream water level control or maintenance.

Onsite Drainage

The area between the levee and the CSA currently drains by way of a sheetflow directly to the river. Construction of the proposed shoreline facilities would interrupt this drainage pattern and potentially result in some ponding behind the shoreline wall.

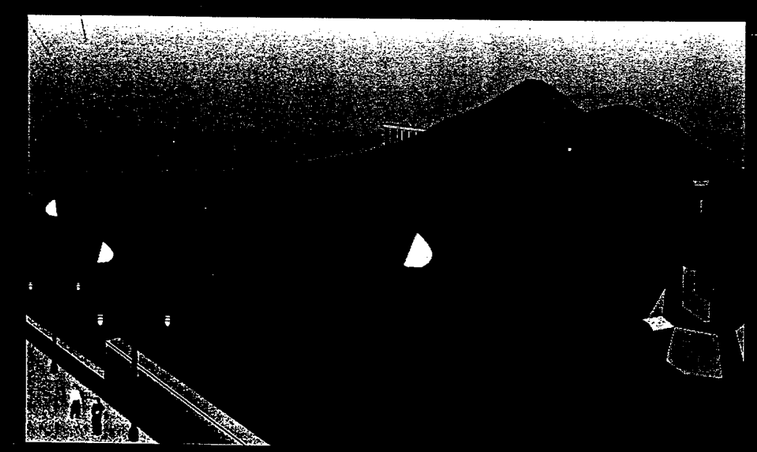
The proposed drainage concept is to place catch basins at various locations spaced along the shoreline, so as to allow a maximum of 6" ponding (see Sheets 5 through 9). The catch basins would be located in the landscaped areas just outside the proposed shoreline trail (T-2). Final grading between the CSA and the levee should be sloped to allow overland runoff to flow along the shoreline and empty into the basins. On the north shore, the catch basins are located adjacent to each existing outfall and will drain into the lake through the outfall. On the south shore, the catch basins are spaced accordingly and will direct the flow either into the nearest outfall or to the SBI. Best management practices will be included to minimize the adverse impacts on lake water quality.

The design is based on the proposed landscape concept. If the landscaping concept is changed or not constructed at the same time as the lake facilities, the drainage patterns may change and the proposed drainage design may not apply.

Costs

For cost information, please refer to the chapter entitled "Costs."

SECTION 4
Lakeside Landscaping Concepts



Introduction

Since the Town Lake will be a major valleywide attraction, access points have been developed to link the lake with the community and the adjacent sites. To serve a variety of recreational visitors, access routes include freeways, roads, and a variety of recreational trails.

Town Lake Visitors

The Rio Salado Town Lake area will attract a variety of recreational visitors, including but not limited to pedestrians, equestrians, boaters, bicyclists, roller bladers, and fishers. Some of these potential visitors are described below.

Pedestrian users include:

- Recreational visitors (including bikers, joggers, walkers, picnickers)
- Local downtown Tempe residents and University students
- Future users from adjacent private/commercial developments (for example, Rio Beach, Hayden's Landing, Tempo Investments, and Boardwalk sites.)
- Valleywide visitors
- Tourists

Equestrian Use. Horses may be rented from an existing local ranch, to be ridden on the equestrian trails. Trails may be developed for horseback riding between the S.C.E.N.E. (Southwest Center for Education and the Natural Environment) site north of the lake, and the Red Mountain Freeway between the Mill Avenue and College Avenue underpasses.

Boating. Small *non-motorized recreational boats* may be acceptable, as long as they can be carried in by the people using them. (No boat trailers would be allowed, nor are landing facilities provided.) It has not yet been determined by the City what percentage of lake use will be for recreational boating. *Ferry boats* may provide transit access for park users between key park nodes (see drawings). *Paddle boats* may be available for use and may be part of the marina concession docks. *Kayaks and canoes* could be carried into hand launch sites (see M-4 sites on drawings). *Small sailboats* could be sailed in the center of the lake area between Mill and Rural Roads. *"Homemade" floating craft* could be permitted during special events. Rules and regulations of the homemade floating craft will vary by event, and will be disclosed before the event occurs.

Police/emergency boats would be the only motorized boats allowed on the lake. A floating dock would be provided on the north side of the lake, with access to the police building. Both land and water vehicles are required to patrol and supervise the park and lake areas.

Other Uses. Bicyclists would have a choice of using either the top of the bank levee trail (T-1b) or the concrete link trail (T-3). This system will link with the regional bike network. There will be many roller bladers using the trails, and the hard-surfaced trails will be designated for their use. Fishing may also be a popular lake sport. Fishers may use the floating docks. They may also, possibly, use the shoreline promenade trail (T-2).

Maintenance. Flood control maintenance staff will use the levee trail (T-1a) when their presence is required. Tempe Parks maintenance personnel will have access to all other areas on the lake terraces. Because of the stature of this project, a high level of maintenance will be required throughout the lake area.

Access Routes

Access routes to the park area include:

Red Mountain Freeway. Access ramps for the Red Mountain Freeway from Center Parkway will provide visual and physical access to the lake. The Rural Road ramp access provides a physical access to link Rural/Scottsdale Road.

Rio Salado Parkway. Local access will be provided to parking areas at private development sites and the ASU parking lot at Sun Devil Stadium. If the Rio Salado Parkway is realigned to 1st Street, further study is required to develop additional access from the Parkway.

Mill Avenue. Pedestrian access is provided from the pedestrian walk on the northbound bridge to link with two stairways.

Rural Road. Local access from the bridge to the park system includes improved bicycle trail connections on the north side of the lake and pedestrian improvements at the south bridge abutment.

Curry Road. This would provide local access to Moeur Park and a new Park Loop road under Mill Avenue bridge. This connects to additional parking for lake visitors arriving from the north.

Hotel. Hotels will provide visitors access from hotel sites to the lake.

Trails. The various trails to be developed will provide non-automated access to the lake

Indian Bend Wash trail system connection will provide access at several points along the lake.

College Avenue underpass north of the lake will link with Papago Park.

Grand Canal trail system to connect with the lake near the rail line on the north shore.

There will be several connections from the lake to **ASU**.

Access Points to Town Lake

Since the lake will be a major attraction, pedestrian access points were developed to link the community and the adjacent development sites. Thus, the drawings show gateway plazas, which are points of entry spaced approximately 1,000 feet apart on the levee. Gateway plazas will provide aesthetically pleasing places and physical nodes to link the lake with adjacent development sites, the ASU population, and the Tempe community. These gateway plazas may have restrooms, drinking fountains, or other attractions such as benches to provide a central gathering point. A right-of-way space should be defined through adjacent development sites at each gateway plaza, to link with the Rio Salado Parkway, thus providing linkages for pedestrians to connect with future transit stops/points along the Rio Salado Parkway and with the lake.

Access To and From Developments

Hayden's Ferry Development would provide private access at each gateway plaza to Parkway. **Rio Beach** will provide public access through the site through the use of the gateway plazas described earlier. **Tempo Development** site (privately owned land) would provide future private access through the site at gateway plazas. The potential **Ash Avenue Park** will provide future access, parking, and a major entrance gateway.

Handicapped Access. All trails would be handicapped accessible, using T-3 link trails, with a 5 percent gradient. Except for two upstream docks, all marina docks would also be handicapped accessible. A safety ledge would be provided at the perimeter of the lake, providing egress from the lake for people who fall into the lake, or for the recovery of persons in the water. Continuous public access along the water's edge would be provided all along the boardwalk sites.

Flood Control. For flood control purposes, there would be minimal changes to existing ramps from the levees into the lake on both the north and south shores.

Management of Access Routes

Management of the access routes will be addressed both on a daily/typical basis and for emergencies.

Daily/Typical Management

Because the Rio Salado Town Lake is a 24-hour facility, it may require a high level of maintenance for local and tourist activities. A detailed management plan will need to be developed.

Signs will provide visitors with information, directions, regulations, and interpretations. The park's **lighting** philosophy and management would match the park's operational and management choices.

Some areas of the project site, such as docks, would be **gated** for private concessionaire management, safety, and maintenance. The Indian Bend Wash drop structure would also be gated, allowing only limited use for management and maintenance activities.

Controlled access to dams. The downstream dam operations building provides an observation deck for visitors. Access to this visitor site would be controlled by hours of operation. A fence located on the downstream side of the downstream dam will prohibit non-authorized access to the face of the dam, thus helping to eliminate vandalism and accidents. Concrete walls (at least 8 feet high) will also be constructed on the dam abutments to discourage access to the dams.

Emergency/Storm Events

Again, because this is a 24-hour facility, emergency signs warning of flood dangers would be posted at gateway plazas and points around the lake. During a major storm event, all docks and boats will be removed. There would be gated access (road/trail) across the IBW drop structure. The areas around the dams would be fenced and planted to restrict public access.

For efficient management and evacuation of the park area in an emergency, procedures and contingencies need to be adopted. A standby work force should also be available. An emergency action plan would be required for evacuation of areas downstream of the lake.

Introduction

Trail system users will be a mix of local and out-of-town people visiting the site for daily, weekend, and special events. As described in the chapter "Access to Rio Salado Area," the Town Lake park can expect to host daily joggers, hikers, walkers, bikers, and horses; maintenance and security people; special event participants; 10k running events, joggers; boating regattas; 4th of July celebrations; and other special events.

Trail linkages will be developed for river crossings between the north shore and south shore, across upstream and downstream locations. The levee trails will extend beyond the lake area to link the north and south shores, east to McClintock Drive, and west to Priest Drive.

Trail System

The 15-foot-wide **levee trail** (see drawings T-1a) will be surfaced with decomposed granite. The **levee walk** will consist of a 12-foot-wide concrete surface (see drawings 1-1b). The 20-foot-wide **shoreline trail** (see drawings T-2) will also be surfaced with decomposed granite. The connecting trail (see drawings T-3) is a 12-foot-wide concrete/hard surface.

A **river crossing** will be possible via a path in the river channel located 100 feet ± downstream of the downstream dam. Crossing of the river upstream of the lake will not be possible except at McClintock Road because of the riparian area. During storm events, the river crossings will be closed to public use until the flow subsides. For information on trail lighting, see chapter entitled "Lighting."

Gateways

Gateway plazas provide visual access and physical linkage access from the levee to the trail system, lake terraces, and lake edges. Approximately 12 gateway plazas will be placed at locations about 1,000 feet apart around the lake. Where trails converge, the gateway plazas will be placed on top of the levee. From the urban park, gateway plazas provide right-of-way access through adjacent sites to public roadways. For more information on gateway plazas, see the "Access to Rio Salado Area" chapter.

Public Access

Public parking on the north bank will provide access for valleywide visitors (Moeur Park at Mill Avenue). The lake area is centrally located, and access on the south bank will be linked (and within walking distance) with downtown Tempe, the community, and ASU.

Costs

Order-of-magnitude costs are provided in the "Costs" chapter.

Introduction

Landscape vegetation for the Rio Salado Town Lake project will attempt to replicate the natural, Sonoran environment typical of the area.

Design Criteria

The design criteria for the Town Lake landscape vegetation focuses on maintaining an environment typical of the Sonoran desert. The river environment will replicate natural fauna patterns. The design criteria are:

- **Hydraulics (plant to river).** If the plants slow down the flow of the river, the capacity of the river channel will be decreased. Trees and plants must be modeled correctly to confirm that there are no adverse affects on hydraulic characteristics.
- **Visibility/Security.** Trees will be trimmed to allow clear visibility below branches. Shrubs and low vegetation will be minimized to low-height ground cover on slopes, and to allow better visibility and security.
- **Levee Stability/Erosion.** Low, native ground covers will be used for slope stability on the levee slope. The CSA restricts planting within 10 to 20 feet of the water edge. Fill material may be required for erosion control until final landscaping is completed.
- **Water Conservation.** An irrigation system will be needed to establish landscape vegetation. Once the plants are established, irrigation can be reduced to conserve water.
- **Shading.** Appropriate desert shade trees will provide a comfortable park atmosphere for Town Lake visitors. Recommended tree species are listed below.
- **Vehicle Clearance.** The minimum clearance under the railway bridge is 9' 8".
- **Maintenance.** Vegetation has been designed to minimize maintenance, however, establishing new vegetation will require some start-up maintenance.

Representative Plants

The types of plants that have been selected for the landscape vegetation include native and hybrid mesquites, Blue Palo Verde, and Sweet Acacia. These plants will be used throughout the lake area, establishing the Sonoran desert atmosphere described earlier.

Trails

Each trail will have unique types of trees. For instance, Mesquite trees will be prevalent along the promenade walk (T-2) near the river edge, and Palo Verde and Sweet Acacia will be represented along link trails (T-3). The following table shows the types of vegetation to be used, their location in the lake area, and irrigation requirements.

Table 14-1

Plant Types

Types of Vegetation	Location	Irrigation Requirements
Native Trees	Floodplain, levee sides, and levee tops*	Low to extremely low
Native Habitat	River side of levee bank	Low to extremely low
Turf Areas	Flat public areas	Extremely high

* Gabion excavation required. Where trees are planted on gabion slopes, holes can be punched for each tree.

Irrigation

The following facilities are required for irrigation of the selected landscape vegetation:

- City water for top of levee planting
- Lake water for planting and turf inside levee channel
- Filter and pumping system for lake water usage; quick couplers
- Temporary irrigation system and initial hand watering until established

Irrigation Options

Irrigation options may include:

- Drip irrigation. Permanent underground automatic piped system.
- Flood irrigation on terraces.
- Temporary watering systems that use the lake as a water source, including spray pumper water barge.
- Combination of permanent and temporary systems to establish plants.

Costs

Order-of-magnitude costs are provided in the "Costs" chapter.

Introduction

The purpose of this chapter is to identify the needs for signing adjacent to the Town Lake development area. It presents general guidance toward establishing uniformity and standardization of signing, and is offered for the City's consideration in development of a master signing plan.

Signs developed for the Town Lake site will be the property of the City of Tempe.

Signing Needs

Adequate signing along the lakefront and on adjacent streets is essential for communicating information to visitors. From information on park hours to restrictions of motor vehicles, signs are needed to maintain order, and to provide direction and information. They should be uniform in appearance, size, color, material, and location so that they will be unobtrusive yet convenient for public use.

Types of Signs

Signing for this project can be classified into three general types: pedestrian, vehicular, and informative.

- **Pedestrian signs** provide directions, regulation, and information immediately adjacent to and along the lakefront. Directional signing (such as trail identifiers and directional arrows to concessions) assists in determining the pedestrian's location and destination. Regulatory signs for pedestrians identify requirements to maintain order in the use of the facilities. Examples of these signs are park hours, pet restrictions, swimming/fishing restrictions, boating, and use of motorized vehicles on trails.

- **Vehicular signs** should be provided in and adjacent to the lakefront area to give motorists the necessary directional, warning, and regulatory information to safely and efficiently access the park facilities. *Directional signs* guide motorists to parking, boat access, and street arterials. *Warning signs* are used to inform motorists of unseen conditions, such as pedestrian crossings. *Regulatory signs* are generally used to control the speed and flow of traffic. These signs include speed limit, parking restrictions, and boat access.

- **Informative signs** provide cultural and educational information for the general public. They may include such signs as historical markers, plant descriptions, and facts about the lake.

Standards

The City does not have a set of sign standards specifically intended for their parks. From discussion with City staff, signs for parks (for instance, Kiwanis Park) were developed on a project-by-project basis, and any signing for the Rio Salado Town Lake would be handled in a similar fashion.

The Manual on Uniform Traffic Control Devices (MUTCD) is prepared by the U.S. Department of Transportation, and provides industry standards for vehicular and vehicular/pedestrian interface signing. Essentially, it will become the basis for designing all signs for vehicular traffic.

Other sources could be explored for developing signing design guidelines, including contacting other metropolitan areas.

Considerations for Developing Design Criteria

The following list of considerations applies to all types of signs, but more particularly to those not already covered in the MUTCD:

- Signing should be unobtrusive and blend with the park setting, yet command attention where appropriate (traffic control and regulatory signs).
- Advertising is not recommended and is, in fact, discouraged.
- Signs may consist of universal symbols, or have English/Spanish wording.
- The use of handicap signing for facilities will be necessary, and should comply with American Disabilities Act (ADA) requirements.
- Sizes, colors, reflectivity, and appearance should be uniform.
- Some signing may have the potential to be integrated with sculptures or monuments.
- Sign lighting considerations may include which signs need to be lit, types of luminaires to use, and whether they are lit by direct or back lighting.
- Sign mounting heights, sign materials, and post types could be standardized to give the park a unique appearance. However, it is not advisable to deviate far from good practices or use of proven materials, since the signs will be owned by the City and will need to be maintained. Use of materials such as Plexiglas or wood will be costly to maintain. Similarly, caution should be taken when considering the placement of signs at heights that may invite vandalism or graffiti.

Introduction

Careful use of small, linked water features may be appropriate features to aid in developing the Sonoran desert character of the Town Lake. Water features selected for the lake will use water sparingly in concert with the desert environment. Concepts may include ideas such as the historic use of water in Arabic gardens.

Water sources for these features, including infiltration wells, should coordinate water sources with gateway plaza locations. The plazas can introduce water into the landscape and create fountains and channels to direct water to flow into the lake.

Water features could be an important component of managing the lake water quality, by providing a means for lake circulation and aeration.

Sources

Infiltration Management Wells. This source may be temporary or intermittent depending upon the lake infiltration rate. It is anticipated that infiltration will be high shortly after construction, thus, supplying large amounts of water to the wells. However, over time, the infiltration rate will drop due to siltation and the presence of organics. This would result in less infiltrated water and, thus, require less pumping. This would mean that an alternative source may have to be used for supplying the water features.

Lake Water Supply. These well sites may be linked to gateway plazas, allowing a constant source of water to flow to the water features.

Types of Water Features

Types of fountains to consider using include:

- **Off-shore.** Aerator spray-type water features in the lake.
- **On shore.** Small water fountains, bubblers, water channels, and water chaddars.

The following are additional water features also under consideration:

- **Bridge-mounted Jets** would spray water into the lake from the bridge.
- **Aqueducts** could be constructed from the pump house and park maintenance buildings, dropping water into the lake.
- **Waterfall Over Rubber Dam.** (Flow through lake if additional water sources are available.)
- **Water Cannon.** The water cannon is a special water feature, shown at the amphitheater location, which includes a water channel conveying water down the levee to the lake terrace and down the hardbank edge into the lake.
- **Stream.** This would simulate a natural water course with natural planting, possibly on the north side of lake.
- **Architectural Plaza** would include water features from gateway plazas on the south side of the lake.
- **"Water Barge"** for irrigation of turf and to add supplemental water to trees, and habitat plants.

Introduction

One of the first decisions in the design of a lighting system is the choice of a light source. There are a number of light sources available, each with its own combination of operating characteristics. The lamp characteristics that should be considered when selecting a light source include efficacy, color, lamp life, and lamp depreciation. Efficacy is the amount of light (lumens) emitted from a light source per watt of power, and is sometimes thought of as the light's "efficiency." The color of the light emitted is important under certain conditions where true color rendition is necessary. Lamp life generally ranges from 7,500 hours to 24,000 hours, depending on the type of luminaire. Finally, lamp depreciation is a factor to consider since it defines percentage of light output a lamp loses over its life.

There are three basic groups of lamps: incandescent, fluorescent, and High Intensity Discharge (HID) lamps.

- **Incandescent.** This is the light source most commonly used in residential lighting. The short life and efficacy (lumens per watt) of this source limits its use to residential and decorative commercial lighting. Halogen lamps are a type of incandescent lamp. It emits twice the light as a normal incandescent bulb.

- **Fluorescent.** The advantages of the fluorescent lamp over the incandescent light source include improved efficacy and longer life. Approximately 3 to 4 times more light per watt is produced with a fluorescent lamp. Fluorescent lights are used to luminate the street signs (back lit) mounted on the Tempe signal pole standard.

- **High Intensity Discharge (HID) Lighting.** The major advantages of HID sources are their high efficacy, long lamp life, and point source characteristics for good light control. Disadvantages include the need for a ballast to regulate lamp current and voltage. Ballasts are needed as a starting aid, but have a delay time in restriking after a momentary power interruption.

There are four classes of high intensity lighting:

- **High Pressure Sodium (HPS).** With efficacy ranging from 80 to 140 lumens per watt, these lamps provide about 7 times as much light per watt as incandescent and about twice as much as some mercury or fluorescent, it also offers the longest life and the best lumen maintenance characteristics of all HID sources. They are more commonly used in commercial areas since the improved color versions are available.

- **Low Pressure Sodium (LPS).** Offers the highest initial efficacy of all lamps on the market today, ranging form 100 lumens to 180 lumens per watt. The yellow light produced, however, results in poor, unattractive color rendition.

- **Mercury Vapor (MV).** This efficient, compact, high output lamp offers a deluxe white lamp, which is now commonly used. Efficacy ranges from 30 to 60 lumens and takes about 4-7 minutes to achieve maximum output.

- **Metal Halide** lights are white in color, have a low average life, and high initial cost. They are normally used for lighting sporting events and parking areas where illumination and color are important. The height of the luminaire is important for reducing glare.

Town Lake Lighting

Lighting will enhance the appearance of the park as well as provide:

- **Safety.** Since the park will be used at night, appropriate levels of lighting will be necessary to provide the Town Lake park area with the level of safety desired by the City. Boating and park activities require lighting along the lake to increase the safety of the public.

- **Security.** To maintain effective security, the park needs to be well lit. Well lit areas discourage vandalism and other crimes. Appropriate lighting design will be able to minimize shadows and offer good color rendition to aide in visual perception.

- **Convenience.** The public should be able to easily recognize park features and locations at night. Parking lots and boat docks should be well lit to accommodate night activities. Considerations for glare will be important in design to allow for comfortable vision.

- **Attraction.** Lighting may be designed to enhance features for nighttime enjoyment of park facilities.

In the initial consideration of lighting needs for the concept landscape plan, three types of lights were considered:

- **Type A.** Located at special gateway light towers, about 100' high, with standard white color metal halide light. Provides "area lighting," that is, fixtures to flood a large area. Special bases and "light capitols" are part of a public art project.

- **Type B.** Located between the levee trail and walk T-1A/T-1B. Standard lighting along the levee trail, using special character fixtures with an efficient high pressure sodium light source.

- **Type C.** Located along promenade walk T-2 and link trail T-3. Specially designed light poles with decorative reflector tops, using reflected halogen light sources to direct light within the lake terrace park areas. See drawings for detailed locations and spacing for each light type shown on trails.

Because of the location and intended use of the Town Lake park, lighting is appropriate for many of the features and facilities surrounding the lake. The following list identifies areas where lighting should be considered:

- **Trails.** Types A, B, and C as described above and shown on the concept landscape plan.
- **Parking/Access.** Parking areas and access points should be well lit for security, safety, and user convenience. Metal halide lamps emit white light providing true color. They are commonly used in parking areas where identification of color is important. Cutoffs can be used to control spill lighting and reduce glare. Access drives within the park should also be lit to aide motorists in sight distance and driver recognition. Use of HPS or metal halide lamps would be appropriate, depending on economics and overall appearance being achieved.
- **Docks.** Lighting as needed primarily for safety. HPS or Metal Halide would work well, and could be supplemented with incandescent lamps to achieve aesthetics if desired.
- **Dams/Bridges.** These facilities may require navigation lighting (red/green) for boater safety. Additional lighting of the dams should be considered for security measures. Such lighting could be incorporated into a master lighting plan.
- **Water Features, Monuments and Sculptures.** Lighting type will vary. Submerged, spot, and flood lighting on water features and/or monuments will depend on the feature's architectural needs. Lighting of features would be primarily for aesthetics, but would also serve as a location identifier, which offers convenience to the public.
- **Signing.** Sign lighting should be considered depending on night use. The types of signs and how they would be lit are functions of the activities intended for the lake park. Major signs, such as entrances could have dedicated spot lighting, and minor signs could be placed to receive incidental lighting. Color rendition needed for signing would depend on the type of sign.
- **Dam Operations and Miscellaneous Buildings.** Lighting of the dam operations buildings or other types of buildings such as restrooms or maintenance buildings, may require only minimal lighting outside the structure for identification purposes.

Considerations for Design

Following is a list of items to be considered for the development of standards, and for a comprehensive lighting plan.

Poles and Appurtenances

- **Cutoffs.** Provide a shield from uplighting and also control spill lighting, which will focus the light.
- **Pole heights** play a significant role in achieving uniformity of lighting levels. Types should be determined in conjunction with the landscape design.

Design Criteria

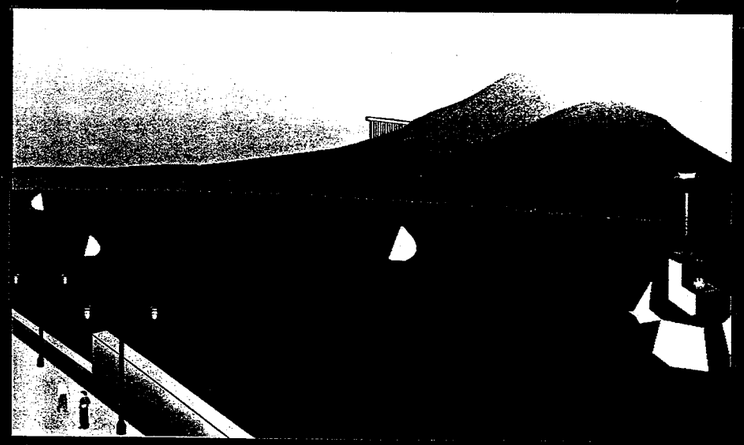
- Average illuminance requirements should be established for the various areas. Trails, open areas, parking lots, and drives may have different requirements. The City currently requires a minimum average of 1.2 foot-candles for city streets, however, their standard does not appear appropriate for a park setting. The lighting concept provides a minimum average of 0.4 foot candles.

Average to minimum luminance is a measure of the light uniformity. It may have importance for certain features such as trails and parking. The City requirements for streets is 4:1 ratio.

Costs

Order-of-magnitude cost opinions for lighting may be found in the "Costs" chapter of this report.

SECTION 5
Lake Management



Introduction

This chapter describes some of the operations and maintenance activities that will be required for the management of Town Lake.

Utilities

A utility corridor (at least 20 feet wide) is proposed to be located at the outside toe of the levee. Location of the levee toe will depend upon the final landscaping design and may not correspond to the current location. Anticipated utilities to be run in this corridor are:

- Power to the dam operation buildings, infiltration management wells, pump stations, and shoreline lighting
- Potable water to the dam operations buildings
- Telephone to the dam operations buildings
- Return water from the infiltration management system to the water features before entering the lake
- Some stormwater diversion pipe

In addition, the shoreline facilities may require sewer for the bathrooms, power to the lights, floating docks, etc., and potable water to the bathrooms and drinking fountains. Natural gas may also be required.

Power Distribution

The Arizona Public Service will be providing most of the electrical power for the project facilities. A small part of the project is in the Salt River Project service jurisdiction.

Primary System

The electrical utility will distribute primary voltage at 12kV along the inland side of the levees. Pad-mounted transformers with looped-feed primary connections will be located on the inland side near the top of the levee at various locations to provide 480-volt secondary distribution and utilization circuits. The primary (12 kV) distribution will consist of a double-ended circuit for the north shore and a double-ended circuit for the south shore. The double-ended circuit will allow maintenance staff to isolate any section while the remaining portions remain energized. Metering is anticipated to be at 480 volts at the transformer locations.

Secondary System

Permanent facilities such as the dam operations buildings, pump station, and wells, will be supplied power from local pad-mounted transformers. *Removable facilities* such as marinas, ferry landings, and other lakeside facilities requiring electrical supply will be supplied from pad-mounted transformers with secondary panelboards located on the levee. The 480-volt service cables from the levee area to the facilities will be permanently installed but have separable connectors at the facility end. The facility's local distribution can be locally transformed to 208Y/120 volts for utilization. This local distribution system could be portable, that is, each removable section could be disconnected, including the local 208Y/120-volt transformer and panelboard. Underground cabling with watertight separable connectors would remain in place; it can be de-energized at the pad-mounted transformer on the levee.

Electrical distribution to site lighting will be permanently installed in underground wire and conduit and/or direct buried cable. The advantage of wire and conduit is the ease of replacing the cable in the event of failure or system changes. This advantage could be lost in areas subject to flooding where silt can fill up the raceway and prevent cable removal. In such areas, direct buried underground cable may be more appropriate. It is recommended that wire and conduit be used for the lights on the levee, but direct burial cable may be used for the lights on the connecting and shoreline trails.

Water Supply

Water will be required at the dam operation buildings for equipment washdown. A hose bib outside the building should be the extent of the facilities. These facilities will be out of the floodplain and not subject to flood damage.

Telephone

Telephone service will be required at the dam operations buildings to provide direct communications between the two buildings and the City offices. Telephone facilities will be out of the floodplain.

Lake Maintenance

The maintenance requirements for Rio Salado Town Lake could be significant. A preliminary projection of the anticipated costs is currently being completed and will be submitted under separate cover. Prior to initial lake filling, a detailed operations and maintenance plan (O&M) will be needed. This chapter outlines some of the items that will require operation or maintenance resources and activities.

Dam Maintenance

The air-inflated segments of the rubber dams have few moving parts and mechanical features, and require relatively modest day-to-day attention for O&M. The air supply facilities, in comparison with equipment routinely found in water and wastewater treatment plants, is relatively common. Life span of the dams is estimated by the vendors to be 30 to 50 years. Replacement costs are based on a life span of 30 years. Significant O&M activities associated with the dams are:

- Weekly visual inspection of dams, piers, abutments, and equipment during normal circumstances.
- Occasional lowering (partial or complete) and raising due to Salt River and IBW flow levels, and sediment clearing following a major river flow event.
- Frequency of inspection/testing (equipment). May be required as part of Dam Safety Permit.
- Daily visual inspection of dam facilities during unusual circumstances (flow events).
- Building maintenance.
- Prior to reinflating a dam segment after a storm event, it may be necessary to remove any sediment greater than 2 feet thick or any large boulders that have settled on the dam foundation.
- Repairs.

Repairs of the rubber dam may consist of the following:

- **Puncture holes 1-inch in diameter and smaller** can be permanently repaired using rubber plugs. This process is similar to the process of repairing a tire but on a larger scale. The dam manufacturers supply the plugs.
- **Larger puncture holes and cuts up to 4-inches long** can be temporarily repaired using metal clamps, a process similar to steel tank repair. A permanent repair would require deflation and drying of the dam when it is convenient for the City.
- **Very large cuts** may not be able to be temporarily repaired and thus the dam will lose more air than the blowers can provide. In this case, the permanent repair will require that the dam be deflated so that repairs can be undertaken in a dry environment. Some repairs may require that the dam be shipped back to Japan or completely replaced.

The dam manufacturer will either provide training and support to City staff for more significant repairs or will enter into a service contract with City.

Repairs of the dam foundation, piers and abutments may be required after a large storm event due to damage from rubble and debris.

Lake Bed and Banks Maintenance

Access

The lake is accessible using the FCDMC access roads, which have been built into the trail system.

Sediment

Maintenance of the lake bed will be required to ensure that the channel capacity continues to accommodate the design flood event. In addition, maintenance of the lake edge is necessary to provide a pleasing appearance and to reduce water loss through infiltration. Based on previous studies (CRSS, 1991), the Salt River channel is in a degradational mode (see chapter on "River Hydraulics"). The upstream dam will act as a sediment basin, therefore accumulations in the lake are primarily wash or suspended load. Annual volumes are expected to be small.

- **Quantity Accumulated.** Quantities will vary with frequency and severity of storm events. Larger floods (greater than 34,000 cfs) will remove most accumulations.
- **Monitoring.** Depth soundings and water quality sampling will be part of the lake quality management.
- **Removal.** The lake can be dredged as needed to remove accumulated sediments. Removed material should be analyzed for the presence of hazardous materials prior to handling and disposal.

Repair of the CSA on the banks may be required after large storm events due to damage from rubble and debris.

Water Supply Maintenance

It is desirable to limit the variation of the lake water surface to plus or minus 6 inches. Maintaining the lake level will require close monitoring of the water supply systems and infiltration management system.

- **Water Level.** Pan evaporation rates will be monitored and replacement water ordered from SRP.

- **Infiltration.** An infiltration management system will require regular inspection and maintenance of at least 10 submersible wells. Wells will be started and tested 4 times per year if not continuously used.

- A **weather monitoring station** will be constructed to measure temperature, humidity, wind velocity and direction and solar insolation rates.

- **Primary water supply**. No significant maintenance should be required to maintain the water quality of source water.

Water Quality Maintenance

Meeting Tempe's objectives for the project requires that the lake water quality meet state standards for the lake's designated uses, and be aesthetically pleasing, without significant accumulations of floatables, algal mats, odors, or sheening. The morphometric characteristics of the lake (long, narrow shape, relatively shallow depth, steep banks, etc.) is unusual. The physiological setting including warm temperatures, abundant sunlight with few overcast days, and bank levees reducing wind exposure, combined with the uncertainties associated with the quality of the source water [very low turnover (flushing) rate and potential stormwater inputs] make this lake unique from the standpoint of predicting long-term water quality.

Water quality modeling performed during the feasibility study and updated for this study indicates that the lake quality would be sensitive due to (1) nitrogen and phosphorus levels in the source water, and (2) the balance between algaes and diatoms versus macrophytic vegetation. While the initial water quality of the lake is expected to be quite high, the long-term equilibrium conditions cannot be definitively estimated. Water quality could remain high--requiring only modest maintenance--or over time, it could require aggressive management.

A subconsultant, Aquatic Consulting & Testing, Inc., along with Dr. Robert Kortmann of Ecosystem Consulting Services, Inc., investigated the water quality of the proposed lake. A review of temperature data collected from local lakes suggests that Town Lake may exhibit thermal stratification with thermal density gradients forming at a depth of 2 to 3 feet. These gradients could reduce the natural mixing of the lake and thus reduce the available oxygen in the lower depths.

Review of the water chemistry for the primary water source, SRP canal water, indicates that the potential exists for the following lake water quality conditions:

- High levels of nitrogen and phosphorus in the water column, resulting in a high rate of primary productivity and a eutrophic condition.

- Productivity dominated by planktonic and filamentous algae; rooted macrophytes (plants) are not expected to play a dominant role because of lake basin morphometry.

- High organic loading resulting in a large demand for oxygen to accomplish bacterial respiration.

- High pH as a result of photosynthesis by algae.

- Significant concentrations of ammonia which may be toxic to aquatic organisms under high pH conditions.

- High levels of alkalinity, conductivity, and hardness. The carbonate buffering system is likely to control internal phosphorus rather than iron.

- A significant amount of floatable debris, including litter generated in the urban setting and algal scums from the trophic condition.

Options for managing the lake water quality include chemical and biological treatments, physical aeration and mixing, surface skimming, macrophyte harvesting, and dredging. Because the ultimate level of management cannot be determined, the design of the lake infrastructure includes features that will allow the lake manager a range of flexibility in responding to water quality conditions. These features include:

- Boat ramp access for dredges and weed harvesting equipment.

- Bank penetrations, controlled building space, and connections for future aeration, mixing, and chemical feeding equipment.

- Pipeline connections in the well recovery system to allow the Infiltration management wells to be used for mixing and aeration of the lake.

One of the biggest potential sources of contaminants to the lake is stormwater runoff. Management of the lake water quality will require the installation of a stormwater diversion system for major sources of stormwater as described in Chapter 11, Stormwater Management,

Maintenance of the stormwater diversion system will require inspection/testing of facilities (catch basins, pipelines, mechanized gates, instrumentation and control) at least twice annually. The stormwater diversion pumps should be started and inspected at least 4 times per year.

Even with the stormwater diversion system, management of the lake water quality may require an intensive effort. Under rare conditions, toxic pollutants could still enter the lake through the piped stormwater system.

Both visual inspection and sampling and testing of the water quality of the lake and the water supply sources will be required to determine whether the above conditions will occur. The frequency of the testing will depend on seasonal changes in air temperature, sunlight, rainfall, and the entry (pass

through) of water from IBW and the Salt River. Experience with the lake's water quality will determine the frequency of monitoring, but a reasonable starting point is to assume weekly sampling of some parameters and monthly testing of others. Water quality conditions outside the accepted limits will require corrective action by combinations of increased circulation, mechanical cleaning, biological balance, chemical treatment, and flushing.

Maintenance activities may include:

- **Garbage Removal.** Skimming the lake may be necessary to remove floating debris which will accumulate on the lake surface due to wind-blown floatable solids and litter. The lake surface and windward shores will likely require daily attention. The primary method for removal of these solids is planned to occur from a semi-automatic floating barge, but hand-skimming may also be required in restricted areas along the shoreline or in the immediate vicinity of the dams.

- **Aeration.** Aeration and mixing of the stratified layers of lakes and reservoirs is an established and effective technique for maintaining and improving water quality. The most common method of inducing lake mixing is to pump air to diffusers at the bottom of the lake. Some aeration and mixing of the lake will be provided by the return water from the infiltration management system. Additional aeration/circulation may be necessary sometime in the future to meet water quality demands; thus it is prudent to include in the design the necessary facilities to make later installation of the system easier if needed.

The preliminary concept (proposed by Aquatic Consulting & Testing) is a compressed air system consisting of four 40-HP rotary screw compressors used to drive both an artificial circulation system and pneumatic skimmer/aerator towers (multi-function aerators). Design of any in-channel aeration equipment would require the consideration of the need to remove the equipment during any storm event to prevent damage due to debris and scour. The preliminary concept consists of the following:

- **Space** in the dam operations buildings for installation of the aeration compressors and related equipment.

- **Piping** between the buildings and the proposed locations for the aeration facilities

- **Chemicals.** Application of chemicals (herbicides) will probably be necessary to control the algae an aquatic weeds.

- **Harvesting.** Mechanical harvesting of the aquatic weeds may be required.

Riparian Area Maintenance

Maintenance of the riparian area will require the following:

- Periodic removal of sediment

- Management of the plantings (including providing a water supply during drought conditions)

- Monitoring of water quality

- Maintenance of desired water level

- Maintenance of the pump by starting and testing at least 4 times annually.

- Periodic drainage of the area through use of the 5-mgd pump station located on the south side of the lake near the upstream dam. This pump will drain the 50-million-gallon area in a period of 10 days.

- Repairs required after a major storm may be the removal of large amounts of sediment, regrading of the river bed, and replanting of the vegetation.

Bridge Maintenance

Southern Pacific Transportation Company

- Access for inspection and maintenance/repairs of the bridge may be more difficult due to submergence by the proposed lake.

- Continue with normal inspection frequency

- Repainting of the bridge will probably be required at some time in the foreseeable future, regardless of whether the Town Lake is created.

Other

- Access for inspection and maintenance/repairs of the bridges may be more difficult due to submergence by the proposed lake

- A detailed inspection of the old Bridge at Mill Avenue will be conducted by City staff prior to filling the lake.

Landscape Maintenance

Maintenance of the landscaping (signage, lighting, restrooms, plantings, and trails) will be required to maintain a pleasing appearance. The required activities include:

- Cleaning restrooms
- Mowing turf
- Pruning trees
- Sweeping trails
- Replacing light fixtures and bulbs
- Erasing/painting over graffiti
- Removing debris and garbage

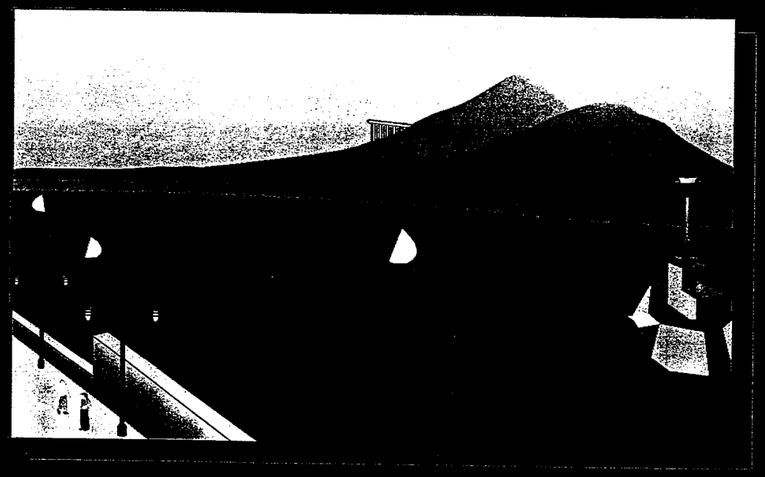
Prior to a large storm event, the following activities would be required:

- Removing the floating boat docks and paddle boats, sail boats etc.
- Removing the police boat and ferry
- Removing of any portable equipment

Repairs and replacement of the landscaping facilities will be required after a major storm (greater than 20-year) event. It is anticipated that the flood waters from such an event will overtop the shoreline wall and inundate, to some extent, the landscaping features between the shoreline and the levee. During the 100-year storm event, the landscaping could be under as much as 6 feet of water moving at 5 fps. Depending upon the severity of the storm, the following could be required:

- Replacement of the light poles and conduits
- Regrading and replacing the decomposed granite that was washed away.
- Replacing the signs
- Replacement of the trees and miscellaneous plantings
- Repair/Replace damaged restrooms

SECTION 6
Project Delivery and Cost



Introduction

Permitting is the critical element controlling timing of construction. Permits are required from several agencies and in many cases, these agencies have incompatible or conflicting objectives. A permitting plan was developed by Tempe for the project that emphasizes cooperation and partnership with the agencies, and flexibility in the design concept to allow the project to provide value for each of the agencies.

Table 19-1, below, summarizes the current status of each of the permits that are needed to complete the Town Lake project.

Table 19-1
Rio Salado Town Lake
Permitting Summary

Responsible Agency	Type of Permit	Purpose of Permit	Status of Permitting	Comments
COE	404	Dredge & fill within waters of the U.S.	Application complete; public notice out for review and comment	Must satisfy review comments from other agencies, i.e. EPA, USFW, AGF, FCDMC
ADEQ	401 certification	Water quality during dredge & fill operations	Application being prepared and submitted	
ADEQ	Aquifer Protection Permit (APP)	Protect groundwater quality	Determination by ADEQ that the project is exempted from APP requirements	Plan modifications that affect water quality may require that this determination be revisited
ADEQ	NPDES	Protect surface water quality	Determination by ADEQ that the project is exempted from NPDES requirements	Plan modifications that affect water quality may require that this determination be revisited
ADWR	Underground Storage Facility	Required to establish an account for recharge and recovery credits	Application being prepared for submittal	Information developed for this application useful for addressing EPA concerns
ADWR	Dam Safety	Public safety from dams	Send agency a copy of Pre-design report for informal review; formal submittal after final design	

Introduction

The City's objective is to have the Town Lake project under construction by January 1996. Additional goals are to:

- Minimize construction time
- Optimize cash flow for final construction sequencing

There are a number of construction options that are yet to be determined, including:

- Number of construction contracts
- How the lake components will be "packaged"
- Will the dam vendor be selected by competitive bid or by qualifications-based selection?

The schedule, therefore, is conceptual; it is based on preliminary assumptions of estimated construction times for each component. This preliminary schedule will help identify sequencing requirements and construction constraints. Current activities (by others) that affect the schedule include the realignment of the Rio Salado Parkway and the undergrounding of overhead electrical wires.

Procurement and Contracting Mechanisms

The City's procedures for procurement and contracting include the following parameters:

- **Competitive bid** is generally required.

- **Time constraints.** Normally the process is time efficient. A project is advertised for 30 days, then the City has 2 weeks to award the contract, and 3 weeks for processing of bonds, etc. The total contracting time is usually between 2 and 3 months.

Other Schedule Constraints

- **Construction schedule for Rio Salado Parkway.** The Parkway is currently under design by Kaminski-Hubbard. The tentative schedule for completion of construction is September 1995. The proposed realignment of the Rio Salado Parkway could change the Town Lake construction schedule.

- **Weather.** To reduce risks from flood events, the dam foundation should be built after the spring runoff season and preferably before the summer monsoon season.

Schedule

On the following page is a tentative construction schedule, illustrating the project milestones and how tasks are keyed together. The following table summarizes the key construction events and constraints.

Assumptions made in the development of this preliminary schedule include:

- 2 or 3 bid packages. Dams will be a separate package.
- No funding limitations.
- No delays in permitting schedule.

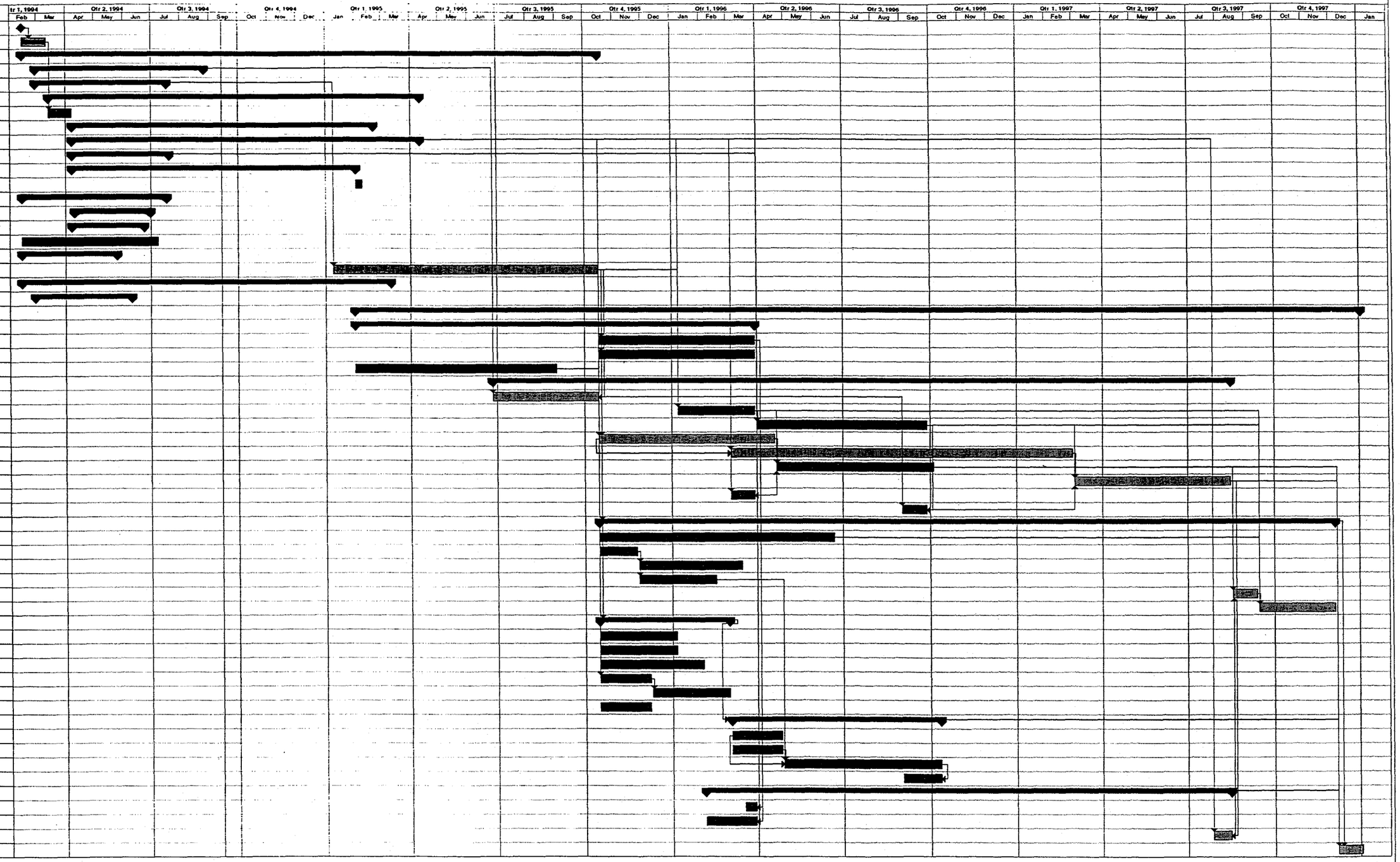
Table 20-1

Summary of Key Construction Components

Element	Construction Time	Constraint
Rubber Dam Procurement	3 months	
Dam Foundations	9 months	Should avoid spring runoff season
Rubber Dam Fabrication and Delivery	12 months downstream dam 6 months upstream dam	Coincident with foundation construction
Rubber Dam Installation	6 weeks (total)	May be shorter depending on vendor
Infiltration Management	12 months	Coordinate with foundations
Stormwater Bypass	5 months	Coordinate with construction of Rio Salado Parkway
Water Delivery	2 months	Coordinate with Salt River Project
Shoreline Modifications	8 months	Coordinate with stormwater bypass and slurry wall construction

Rio Salado Project Schedule

ID	Task Name
1	Project kickoff
2	Data collection
3	**Design and Permitting Services**
4	**TO 1 Preliminary Lake Design**
65	**TO2 Geotech and Hydrogeologic Invest**
76	**TO3 Permitting Coordination Services**
77	Permitting Strategy Planning
78	**ADWR USR**
94	**USCOE Section 404**
101	**ADWR Dam safety**
105	**EPA NPDES**
114	Review Support Services
115	**TO4 Surveying and Mapping**
142	**TO5 Lake Operation and Mgmt Plan**
159	**TO6 Water Supply Plan and Pre-Design**
163	**TO7 Environmental Assessment**
164	**TO8 Water Supply Design**
169	**TO9 Final Lake Design**
170	**TO10 Program Management**
173	**TO11 Landscaping & Access**
189	**Construction activities**
190	**Activities by others**
191	SRP modifications
192	Electric underground
193	RS Parkwy realignment
194	**Dams**
195	Dam Procurement
196	Upstream foundation
197	Downstream foundation
198	Upstream Dam Fabrication
199	downstream Dam Fabrication
200	Upstream Dam Installation
201	Downstream Dam Installation
202	Upstream Dam operation bldg
203	Downstream Dam operation bldg
204	**Infiltration control system**
205	Slurry Walls
206	Well sitework
207	Recovery Wells
208	Recovery pipeline system
209	Pilot testing
210	Temporary Liner
211	**Stormwater Bypass system**
212	Dorsey system
213	Miller/ IBW System
214	South bypass interceptor
215	RS Parkway Drain
216	Town Lake bypass
217	College improvements
218	**Shoreline Modifications**
219	Shoreline drainage
220	CSA Penetrations
221	CSA Modifications
222	Boat docks
223	**Water delivery systems**
224	Rural Rd Modifications
225	Canal 4.6 Pipeline
226	Temporary delivery channel
227	Filing



Project: Rio Salado
Date: 9/14/94

Task | Critical Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress

Introduction

This chapter introduces the cost opinions for the Town Lake project and explains the methodology and the resources used to arrive at the costs.

The opinions of cost shown in this chapter, and any resulting conclusions on project feasibility or budget requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time the opinion was prepared. The final costs of the project and resulting feasibility will depend on actual labor and materials costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary above and below the opinions of cost presented herein. Because of these factors, project feasibility, benefit/costs rations, risks, and funding needs must be carefully reviewed by the City prior to making specific financial decisions or establishing project financial budgets to help ensure adequate funding.

Cost Estimating Methodology

The opinions of cost prepared have been developed from layout sheets and equipment selections. The engineering layouts have, in some facilities such as pump stations, identified the foot-prints of facilities and services required. Until further design development, the methodology for these cost opinions are budget level. The landscaping cost opinion was prepared using conceptual layout sheets and is presented as an order-of-magnitude level.

Explanation of Costs

The summary of cost presented includes overhead, profit, mobilization, bonding, insurance, contingency, and escalation to the mid-point of construction (June 1996). **Overhead** costs are included for Workers' Compensation Insurance, Fixed Overhead (such as federal and state unemployment costs, Social Security Taxes, Builders Risk Insurance, and Public Liability costs), and Variable Overhead (such as engineering and logistical support costs, and staff requirements). **Profit** included for contractor profit. **Mobilization/Bonds/Insurance**, are included for contractors front-end costs for mobilizing equipment, paying for bonding to perform the work, and insurance other than that covered in overhead. **Contingency** is included for unidentified scope of work that is expected to be further developed in the design process. At the Definitive Level Cost Estimate, the scope of work will be at its highest level of design, therefore eliminating the need for a contingency.

Table 21-1
Rio Salado Town Lake
Estimated Construction Cost
All costs shown are escalated to June 1996

	Costs (Budget-level)	
Facilities	**Subtotal**	**Total**
Dams		
Downstream Dam		
Rubber Dam	$ 6,214,000	
Foundation, Piers, Abutments, Misc.	$ 6,846,000	
Subtotal		$ 13,060,000
Upstream Dam		
Rubber Dam	$ 2,290,000	
Foundation, Piers, Abutments, Misc.	$ 4,158,000	
Subtotal		$ 6,448,000
Shoreline		$ 5,323,000
Infiltration Management		
Slurry Walls	$ 11,623,000	
Wells	$ 2,240,000	
Subtotal		$ 13,863,000
Stormwater Management		
Offsite Drainage	$ 1,809,000	
Onsite Drainage	$ 83,000	
Subtotal		$ 1,892,000
Water Supply		$ 680,000
SUBTOTAL LAKE CONSTRUCTION		**$ 41,266,000**
Options		
Armoring Of Rubber Dams		
Downstream	$ 601,000	
Upstream	$ 167,000	
Subtotal		$ 768,000
Aeration	$ 718,000	
Temporary Liner For Filling Lake	$ 1,136,000	
SUBTOTAL LAKE CONSTRUCTION W/ OPTIONS		**$ 43,888,000**
Landscaping (Order-of-Magnitude Cost Estimate)		$ 15,000,000

Escalation of Costs

The escalation to the mid-point of construction was calculated using Engineering News Record (ENR), Construction Cost Index (CCI). The following explains the background to the escalation percentage used in the cost opinions.

The National Average for the CCI between January 1994 and August 1994 indicated the annual percentage increase at 2.3%. Last year's CCI for this period indicated the annual percentage increase at 4.7%. The Los Angeles (regional area index) percent change for the year indicated a 1.1% increase in the CCI. Last years annual percentage change was a 2% increase for the same CCI.

For the cost opinions presented, a 3% per year escalation factor will be used to estimate costs at the mid-point of construction, June 1996.

Spreadsheet Development for Cost Opinions

Excel spreadsheets were developed to calculate and extend the quantities and unit costs prepared for the detailed cost. The costs shown as MARK-UPS are extended at the end of the facility or subfacility of that cost category. Be careful not to assume the mark-ups are included in those costs shown directly below the headings MATERIALS, LABOR, CONSTRUCTION EQUIPMENT, INSTALLATION, or S/C. These costs are **bare costs** and **do not include** the mark-ups.

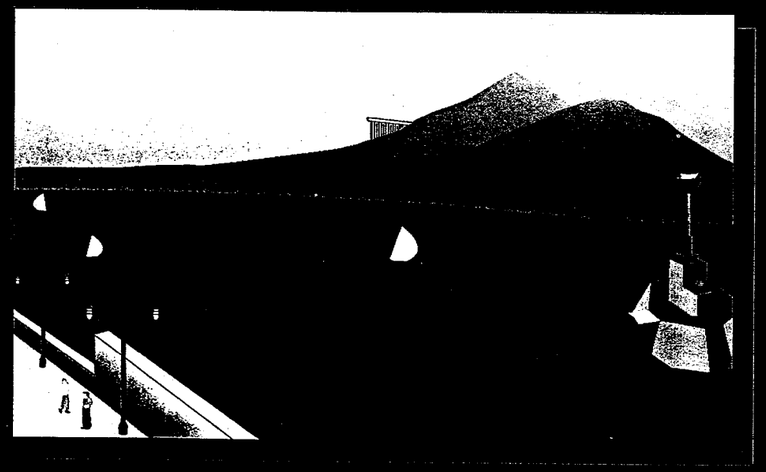
The extension of the mark-ups are as follows:

- *Overhead and profit* are a percentage of the subtotal and added together (5%)
- *Mob/Bond/Insurance* is a percentage of the sum of Overhead/Profit/Subtotal (5%)
- *Contingency* is a percentage of the sum of all the above (10%)
- *Escalation* is a percentage of the sum of all the above (3%)

Resources

The cost opinions were developed using any of the following: Means Construction Cost Data 1994, Richardsons Construction Estimating Standards 1994, ADOT 1993 Construction Costs, and equipment, supplier, and contractor quotes. Area factors were included as needed to adjust costs to the current local market conditions.

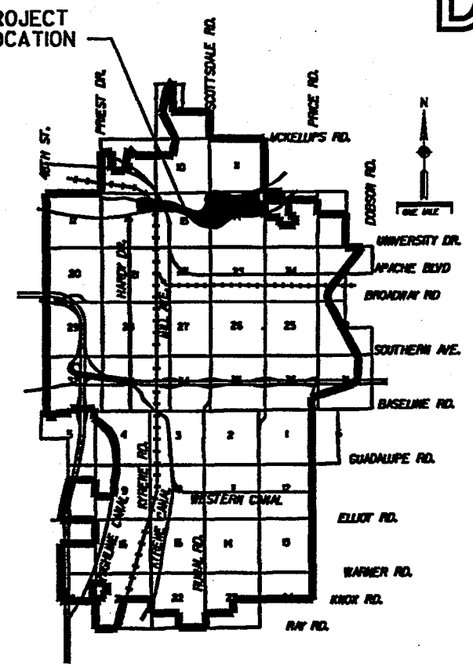
Preliminary Design Plan Set



CITY OF TEMPE
PUBLIC WORKS DEPARTMENT
DIVISION OF ENGINEERING

RIO SALADO TOWN LAKE
PROJECT NO. 946523

PROJECT LOCATION



MAYOR

NEIL G. GIULIANO

CITY COUNCIL

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P. BEN ARREDONDO
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JOSEPH P. SPRACALE
CAROL E. SMITH

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UTILITY INFORMATION

MCI — DATE

AT & T — DATE

US WEST — DATE

ARIZONA PUBLIC SERVICE CO. — DATE

AIR PRODUCTS — DATE

SALT RIVER PROJECT-WATER — DATE

SALT RIVER PROJECT-POWER — DATE

EL PASO NATURAL GAS CO. — DATE

SOUTHWEST GAS CORP. — DATE

CABLE - TV — DATE

APPROVED

CITY ENGINEER — DATE

MARICOPA COUNTY DEPT. OF ENVIRONMENTAL MGMT. — DATE

AS-BUILT INFORMATION IS INCLUDED IN THESE AREAS ON THIS SET OF DRAWINGS		PERMITS REQUIRED FOR THIS SET OF DRAWINGS
___ ☐ SEWER	___ ☐ FIRE LINE	___ DRAINAGE
___ ☐ WATER	___ ☐ CITY RWG.	___ PAVING
___ ☐ WATER-RECLAIMED	___ ☐ BIKE PATH	___ WATER
___ ☐ STORM DRAIN/DRYWELL	___ ☐ LNDSCPE/SPRKLR	___ SEWER
___ ☐ PAVING	___ ☐ STREET LIGHTS	___ STREET LIGHTS
___ ☐ OFFSITE (C,G,SR,DW)	___ ☐ BUILDINGS	___ FLOODPLAIN
___ ☐ GRADING/DRAINAGE	___ ☐ ____	___ OTHER___
AS-BUILT PLANS CHECKED FOR FIELD CHANGES		PARCEL # ____
INSPECTOR: ____	DATE: ____	PROJECT # ____

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ABBREVIATIONS

@	AT
AB	ANCHOR BOLT, AGGREGATE BASE
AC	ASPHALTIC CONCRETE
ACI	AMERICAN CONCRETE INSTITUTE
ACT	ACOUSTICAL TILE
ADD'L	ADDITIONAL
ADH AB	ADHESIVE ANCHOR BOLT
ADJ	ADJACENT, ADJUSTABLE
AFF	ABOVE FINISH FLOOR
AFG	ABOVE FINISH GRADE
AHP	AIR; HIGH PRESSURE
AHR	ANCHOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AL	ALUMINUM
ALP	AIR LOW PRESSURE
ALTN	ALTERNATE
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APVD	APPROVED
ARCH.	ARCHITECTURAL
ARV	AIR RELEASE VALVE
AUTO.	AUTOMATIC
AUX	AUXILIARY
AWG	AMERICAN WIRE GAGE
AWT	ADVANCED WASTE TREATMENT
BC	BEGIN CURVE
BD	BALANCING DAMPER
BF	BLIND FLANGE, BOTTOM FACE
BFD	BUTTERFLY VALVE DAMPER
BFV	BUTTERFLY VALVE
BLDG	BUILDING
BM	BENCH MARK, BEAM
BO	BLOW OFF
BOO	BOTTOM OF OPENING
BOD	BOTTOM OF DUCT
BOP	BOTTOM OF PIPE
BOS	BOTTOM OF STEEL
BOT	BOTTOM
BRG	BEARING
BV	BALL VALVE
BVC	BEGINNING OF VERTICAL CURVE
BYP	BYPASS
C	CHANNEL (BEAM)
CB	CATCH BASIN
CCP	CONCRETE CYLINDER PIPE
CCS	CENTRAL CONTROL SYSTEM
CD	CONDENSATE DRAIN
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHEM	CHEMICAL
CI	CAST IRON
CIGC	CAST IRON GROOVED COUPLING
CIMJ	CAST IRON MECHANICAL JOINT
CIP	CAST IRON PIPE
CIRJ	CAST IRON RESTRAINED JOINT
CISP	CAST IRON SOIL PIPE
CJ	CONSTRUCTION JOINT
CLDIP	CEMENT-LINED DUCTILE IRON PIPE
CLG	CEILING
CLR	CLEAR
℄	CENTERLINE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CONT	CONTINUOUS, CONTINUATION
COORD	COORDINATE
COP.	COPPER
CPLG	COUPLING
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CHLORINE SOLUTION
CSA	CEMENT STABILIZED ALLUVIUM
CTD	CENTERED
CTR	CENTER
C TO C	CENTER TO CENTER
CU	CUBIC
CU FT	CUBIC FOOT
CU IN.	CUBIC INCH
CU YD	CUBIC YARD
CULV	CULVERT
CV	CHECK VALVE

DBA	DEFORMED BAR ANCHOR
D	DRAIN
DD	DIGESTER DRAIN
DBL	DOUBLE
DEC	DECANT
DEMO	DEMOLITION
DET	DETAIL
DG	DECOMPOSED GRANITE
DI	DROP INLET, DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL
DIL	DILUTE
DIMJ	DUCTILE IRON MECHANICAL JOINT
DIP	DUCTILE IRON PIPE
DIPGL	DUCTILE IRON PIPE, FLANGED, GLASS LINED
DIR	DIRECTION
DN	DOWN
DWG	DRAWING
E	EAST
EA	EACH
EWEF	EACH WAY, EACH FACE
EC	END CURVE
ECC	ECCENTRIC
EF	EACH FACE, EXHAUST FAN
EFL	EFFLUENT
EL	ELEVATION
ELB	ELBOW
ELC	ELECTRICAL LOAD CENTER
ELEC	ELECTRIC, ELECTRICAL
ENGR	ENGINEER
EO	EMERGENCY OVERFLOW
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
ERW	EFFLUENT RECYCLE WATER
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EXC	EXCAVATE
EXP	EXPOSED, EXPANSION
EXP JT	EXPANSION JOINT
EXST	EXISTING
FA	FOUL AIR
FB	FLAT BAR
FC	FLEXIBLE COUPLING
FCA	FLANGED COUPLING ADAPTER
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FDA	FLOOR DRAIN W/INTEGRAL TRAP
FDN	FOUNDATION
FES	FLARED END SECTION
FEXT	FIRE EXTINGUISHER
FF	FINISH FLOOR
FG	FINISH GRADE
FHY	FIRE HYDRANT
FIG.	FIGURE
FL	FLOOR
FLG	FLANGE
FLH	FLAT HEAD
FLL	FLOW LINE
FLTR	FILTER
FNSH	FINISH
FOC	FACE OF CONCRETE
FRP	FIBERGLASS REINFORCED PLASTIC
FT	FOOT OR FEET
FTG	FOOTING
FWD	FORWARD
°F	DEGREE FAHRENHEIT
G	GRIT
GA	GAGE
GAL	GALLON
GALV	GALVANIZED
GC	GROOVED COUPLING
GCO	GRADE CLEANOUT
GCF	GROOVED COUPLING FITTING
GE	GROOVED END
GL	GLASS
GLDIP	GLASS LINED DUCTILE IRON PIPE
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GRTG	GRATING
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
GVL	GRAVEL

HAS	HEADED ANCHOR STUD
HD	HUB DRAIN
HDR	HEADER
HDW	HARDWARE
HGT	HEIGHT
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HORSEPOWER
HR	HANDRAIL
HV	HOSE VALVE
I&C	INSTRUMENTATION & CONTROL
ID	INSIDE DIAMETER
IF.	INSIDE FACE
IN.	INCH
INFL	INFLUENT
INSTM	INSTRUMENTATION
INSUL	INSULATE
INV	INVERT
JT	JOINT
KIP	THOUSAND POUNDS
KW	KILOWATT
L	LEFT, ANGLE, LENGTH
LAB	LABORATORY
LAT'L	LATERAL
LAV	LAVATORY
LB	POUNDS
LB/CU FT	POUNDS PER CUBIC FOOT
LF	LINEAR FEET
LG	LONG
LH	LEFT HAND
LONG.	LONGITUDINAL
LR	LONG RADIUS
MAX	MAXIMUM
MB	MACHINE BOLT
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MG/L	MILLIGRAMS PER LITER
MH	MANHOLE
MIN	MINIMUM, MINUTE
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MSNRY	MASONRY
MTL	MATERIAL
MTS	MILL TYPE STEEL PIPE
MTSS	MILL TYPE STEEL PIPE - SPECIAL SERVICE
MO	MASONRY OPENING
MWS	MAXIMUM WATER SURFACE
N	NORTH
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NO.	NUMBER, NUMBERING
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER, OVERFLOW DRAIN
OF.	OUTSIDE FACE, OVERFLOW
OFR	OVERFLOW RETURN
OG	ORIGINAL GROUND
OSD	OPEN SITE DRAIN
O TO O	OUT TO OUT
OPNG	OPENING
OZ	OUNCE
PC	POINT OF CURVE
PE	PLAIN END, PRIMARY EFFLUENT
PENT	PENETRATION
PI	POINT OF INTERSECTION
PJF	PREMOLDED JOINT FILLER
PL	PLATE, PROPERTY LINE
PLYWD	PLYWOOD

PPM	PARTS PER MILLION
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PREFAB	PREFABRICATED
PRESS.	PRESSURE
PRI	PRIMARY
PROP.	PROPERTY
PSF	POUNDS PER SQUARE FOOT
PS	PRIMARY SLUDGE
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PT	POINT OF TANGENCY
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE PLASTIC
PVCGS	POLYVINYL CHLORIDE PLASTIC-GRAVITY SEWER TYPE
PVCW	POLYVINYL CHLORIDE PLASTIC-WATER DISTRIBUTION SERVICE TYPE
PVMT	PAVEMENT
R, RAD	RADIUS
RC	REINFORCED CONCRETE
RCC	ROLLER COMPACTED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RCPP	REINFORCED CONCRETE PRESSURE PIPE
RD	ROAD, ROOF DRAIN
RDCR	REDUCER
REF	REFER OR REFERENCE
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RJ	RESTRAINED JOINT
RLS	RUBBER LINED STEEL
RM	ROOM
RO	ROUGH OPENING
RST	REINFORCING STEEL
RTN	RETURN
RV	ROOF VENT
RW	RAW WATER
R/W	RIGHT-OF-WAY
S	I-BEAM, SOUTH
SA	SAMPLE
SAT	SUSPENDED ACOUSTIC TILE
SM	SCUM
SCFH	STANDARD CUBIC FEET PER HOUR
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SD	STORM DRAIN
SEC	SECONDARY
SECT	SECTION
SH	SHEET
SIM	SIMILAR
SLD	SLUDGE
SLP	SLOPE
SOLN	SOLUTION
SP	SPACE OR SPACES
SPD	SUMP PUMP DISCHARGE
SPEC	SPECIFICATIONS
SPLY	SUPPLY
SQ	SQUARE
SQ FT	SQUARE FOOT
SQ IN	SQUARE INCH
SS	SANITARY SEWER
SSH	SAFETY SHOWER
SST	STAINLESS STEEL
STA	STATION, STARTING AIR
STD	STANDARD
STIF	STIFFENER
STL	STEEL, STEEL PIPE
STLS	STEEL PIPE (SPECIAL)
STR	STRAIGHT
STRL	STRUCTURAL
STRUCT	STRUCTURE
SUBFL	SUBFLOOR
SUSP	SUSPEND
SYMM	SYMMETRICAL

T	TANGENT
TBG	TUBING
T&B	TOP AND BOTTOM
TC	TOP OF CURB
TDH	TOTAL DYNAMIC HEAD
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPERATURE
TF	TOP FACE
T&G	TONGUE AND GROOVE
THD	THREAD
THK	THICK
TOC	TOP OF CONCRETE
TOF	TOP OF FOOTING
TP	TURNING POINT
TRANS	TRANSITION
TRANSV	TRANSVERSE
TST	TOP OF STEEL
TT	THRUST TIE
TW	TOP OF WALL
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UD	UNDERDRAIN
UH	UNIT HEATER
U.P.	UNIT PROCESS
UR	URINAL
V	VENT, VOLT, VALVE
VAC	VACUUM
VAR	VENT ACID RESISTANT
VC	VERTICAL CURVE
VERT	VERTICAL
VPI	VERTICAL POINT OF INTERSECTION
VPS	VENEER PLASTER SYSTEM
VTR	VENT THRU ROOF
W1	WATER (POTABLE)
W2	WATER (NONPOTABLE)
W3	WATER (RECLAIMED)
W3HP	WATER (RECLAIMED)(HIGH PRESSURE)
W4	WATER (UNCHLORINATED FILTERED)
W/	WITH
W	WIDE FLANGE (BEAM), WEST
WC	WATER CLOSET
WD	WOOD
WH	WATER HEATER
WM	WATER METER
WP	WORK POINT
WR	WATER RESISTANT
WS	WATER SURFACE, WATER STOP
W SH ST	WEATHERING SHEET STEEL
WSP	WELDED STEEL PIPE
WTR	WATER
WW	WASHWATER
WWF	WELDED WIRE FABRIC
YD	YARD

NOTES:

1. FOR ELECTRICAL AND INSTRUMENTATION ABBREVIATIONS, SEE ELECTRICAL AND INSTRUMENTATION DRAWINGS.
2. CONTACT THE ENGINEER FOR ABBREVIATIONS NOT LISTED.
3. THIS IS A STANDARD LEGEND SHEET, THEREFORE, SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS SHEET AND MAY NOT BE UTILIZED ON THIS PROJECT.

263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	ABBREVIATIONS	PROJECT NO. 946523
DRAWN: J URIA		
CHECKED: X		
SCALE: NTS		SHT. 2 OF X

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-1994

ARCHITECTURAL LEGEND

SYMBOL	LEGEND
100 A — ROOM NUMBER / DOOR LETTER	DOOR NUMBER
W-1, R-1, L-1	WINDOW, RELIGHT OR LOUVER NUMBER
103	ROOM NUMBER
3 — DIRECTION SHOWN	INTERIOR WALL ELEVATION
A	WALL TYPE
	CONCRETE
	CMU PLAN
	CMU SECTION
	METAL OR WOOD STUD WALL PLAN
	GYPSUM WALLBOARD
	RIGID INSULATION
	BATT INSULATION
	PLYWOOD
	STEEL
	WOOD, ROUGH CONTINUOUS
	WOOD, ROUGH NON-CONTINUOUS
	WOOD, FINISHED
	GROUND SURFACE
WALL — F.EXT-"X"	FIRE EXTINGUISHER "X" = NUMBER IN SPECS

GENERAL NOTES

1. UNLESS OTHERWISE NOTED, PLAN DIMENSIONS ARE TO NOMINAL SURFACE OF MASONRY, FACE OF STUDS AND FACE OF CONCRETE WALLS.
2. "FLOOR LINE" REFERS TO TOP OF CONCRETE SLABS AT EXTERIOR WALL. FINISH FLOORING IS INSTALLED ABOVE THE FLOOR LINE. FOR DEPRESSED FLOORS AND CURBS, SEE STRUCTURAL DRAWINGS.
3. REPETITIVE FEATURES ARE NOT DRAWN IN THEIR ENTIRETY AND SHALL BE COMPLETELY PROVIDED AS IF DRAWN IN FULL.
4. WHERE DOOR IS LOCATED NEAR CORNER OF ROOM AND IS NOT LOCATED BY DIMENSION ON PLAN OR DETAILS, DIMENSION SHALL BE 4-INCHES FROM FACE OF STUD (WALL) AND 8-INCHES FROM FACE OF MASONRY TO FACE OF ROUGH OPENING.
5. LINE OF EXISTING GRADES, AS SHOWN ON THE BUILDING ELEVATIONS AND SECTIONS ARE APPROXIMATE. THEY ARE AT THE BUILDING FACE, OR ON THE SECTION END EXCEPT AS NOTED.
6. VERIFY ALL ROUGH-IN DIMENSIONS FOR EQUIPMENT PROVIDED IN THIS CONTRACT, OR BY OTHERS.
7. VERIFY SIZE AND LOCATION OF, AND PROVIDE: ALL OPENINGS THROUGH FLOORS AND WALLS, ACCESS DOORS, FURRING, CURBS, ANCHORS AND INSERTS. PROVIDE ALL BASES, BLOCKING REQUIRED FOR ACCESSORIES, MECHANICAL, ELECTRICAL AND OTHER EQUIPMENT
8. EXTERIOR LANDINGS AT DOORS SHALL BE MAX 1/4 INCH BELOW BUILDING FLOOR LINE.
9. ALL GLAZING IN OR WITHIN 48 INCH OF DOOR OPENING SHALL BE TEMPERED GLAZING, SEE SPECS.
10. ALL DOOR HARDWARE SHALL BE LEVER OR PANIC TYPE, SEE SPECS.
11. MAXIMUM SLOPE FOR CONCRETE SURFACE OF WALKS AND LANDINGS SHALL BE MAX 1/4 INCH PER FOOT IN ANY DIRECTION FROM EXTERIOR DOORS.
12. EXTERIOR LANDINGS AT DOORS SHALL BE MINIMUM 60 INCHES DEEP WITH MINIMUM 2'-0" DIMENSION PAST THE STRIKE EDGE OF THE DOOR.

NOTE:
"STANDARD DETAILS" AS SHOWN (XXXX) ARE INTENDED TO BE TYPICAL AND SHALL APPLY TO ALL SIMILAR SITUATIONS OCCURING ON THE PROJECT, WHETHER OR NOT THEY ARE KEYED IN EACH LOCATION. CONSULT THE ENGINEER FOR REVIEW PRIOR TO CONSTRUCTION.

CIVIL SYMBOLS

	EXISTING STRUCTURE TO BE REMOVED •
	NEW AC PAVEMENT •
	GRAVEL SURFACE •
	CONCRETE WALK •
4:1	NEW EMBANKMENT SLOPE AS INDICATED
	DRAINAGE DITCH SHOWING DIRECTION OF FLOW
×1000.0	EXISTING GRADE
⊗1000.0	FINISH GRADE
1000	CONTOUR
35.7 △	VPI (VERTICAL POINT OF INTERSECTION) AND FINISH GRADE ELEVATION (NO VERTICAL CURVE)
△	HORIZONTAL OR VERTICAL POINT OF INTERSECTION WITH ELEVATION OF INTERSECTION. (NOT FINISH GRADE)
	ROCKS
	EXISTING TREES AND SHRUBS
	DIRT ROAD
	SIGN
	LIGHT STANDARD
	PROPERTY LINE/RIGHT OF WAY
	FENCE
	EASEMENT LINE
	STREET CENTERLINE
	BENCHMARK
	EXISTING UTILITY OR TELEPHONE POLE
	NEW UTILITY OR TELEPHONE POLE
MH	EXISTING MANHOLE
MH	NEW MANHOLE
	GROUND SURFACE

CURVE DATA

R = RADIUS _ L = LENGTH OF CURVE
Δ = DELTA T = TANGENT LENGTH

_ ALL CURVE RADII MEASURED TO FACE OF CURB

NOTES:

1. • SYMBOL - ONLY WHERE REQUIRED FOR CLARITY.
2. IN GENERAL, EXISTING STRUCTURES AND FACILITIES ARE NOTED AS "EXISTING" AND ARE SHOWN IN LIGHT LINE WEIGHTS, OR AS SCREENED BACKGROUND. NEW STRUCTURES ARE SHOWN IN HEAVY LINE WEIGHTS.

SHEET IDENTIFICATION SYSTEM

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION — A

SHEET NUMBER (REPLACE WITH A LINE IF TAKEN AND SHOWN ON SAME DRAWING) — M-2

ON DRAWING WHERE SECTION OR DETAIL IS TAKEN: SHEET NUMBER WHERE SHOWN

ON DRAWING WHERE SECTION OR DETAIL IS SHOWN: SHEET NUMBER(S) WHERE TAKEN

DETAIL AND SECTION DESIGNATION

STANDARD DETAIL DESIGNATION (NUMERAL) — 15525

SHOWN ON STANDARD DETAIL DRAWING (SEE NOTE)

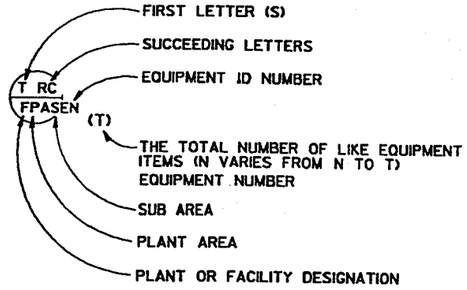
BEFORE YOU DIG CALL FOR THE BLUE STAKES
263-1100
BLUE STAKE, INC.
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	CIVIL AND ARCHITECTURAL LEGEND	PROJECT NO. 946523
DRAWN: J URIA		
CHECKED: X		
SCALE: NTS		SHT. 3 OF X

INSTRUMENTATION IDENTIFICATION

EXAMPLE SYMBOLS



FE — FIELD MOUNTED INSTRUMENT

FY 1/1 — REAR-OF-PANEL MOUNTED INSTRUMENT

FIC — PANEL MOUNTED INSTRUMENT

QL 00 — MOTOR CONTROL CENTER MOUNTED INSTRUMENT

SPECIAL CASES

QL 00 — ON AND OFF EVENT LIGHTS

ZS OC — OPENED AND CLOSED POSITION SWITCHES

HS 00 — ON-OFF HAND SWITCH. MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON A RETURN OF POWER AFTER POWER FAILURE)

HS SS — STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHS (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE)

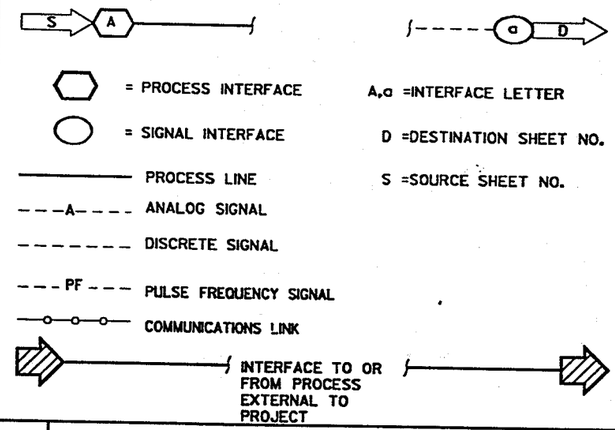
HS 00 MS — DENOTES FIELD MOUNTED MANUAL MOTOR STARTER.

INSTRUMENT SOCIETY OF AMERICA TABLE

LETTER	FIRST LETTER (S): PROCESS OR INITIATING VARIABLE	FIRST LETTER (S): MODIFIER	SUCCEEDING LETTERS: READOUT OR PASSIVE FUNCTION	SUCCEEDING LETTERS: OUTPUT FUNCTION	SUCCEEDING LETTERS: MODIFIER
A	ANALYSIS (+)		ALARM		
B	BURNER FLAME		USERS CHOICE (+)	USERS CHOICE (+)	USERS CHOICE (+)
C	CONDUCTIVITY			CONTROL	
D	DENSITY (S.G)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT		
F	FLOW RATE	RATIO			
G	GAUGE		GLASS	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT		INDICATE		
J	POWER	SCAN			
K	TIME OR SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION				MIDDLE
N	USERS CHOICE (+)		USERS CHOICE (+)	USERS CHOICE (+)	USERS CHOICE (+)
O	USERS CHOICE (+)		ORIFICE		
P	PRESSURE (OR VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY OR EVENT(+)	INTEGRATE	INTEGRATE		
R			RECORD OR PRINT		
S	SPEED OR FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MUTIVARIABLE (+)		MULTIFUNCTION	MULTIFUNCTION (+)	MULTIFUNCTION (+)
V	VISCOSITY			VALVE OR DAMPER	
W	WEIGHT OR FORCE		WELL		
X	UNCLASSIFIED (+)		UNCLASSIFIED (+)	UNCLASSIFIED (+)	UNCLASSIFIED (+)
Y	USERS CHOICE (+)			RELAY OR COMPUTE (+)	
Z	POSITION			DRIVE, ACTUATE OR UNCLASSIFIED FINAL CONTROL ELEMENT	

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS.

INTERFACE SYMBOLS & LINE LEGEND



GENERAL NOTES

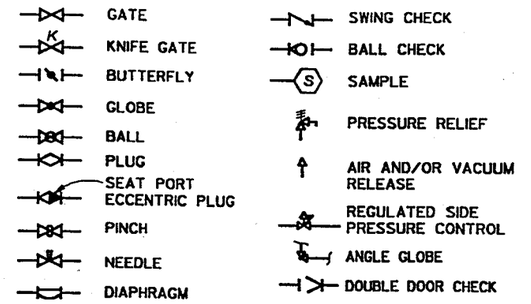
1. COMPONENTS AND PANELS SHOWN WITH A ( ) ARE SPECIFIED UNDER SECTION PROCESS INSTRUMENTATION AND CONTROL SYSTEM.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK ( ) ** ARE PART OF A PACKAGE SYSTEM; SEE EQUIPMENT SPECIFICATIONS.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THIS PROJECT.

SELF CONTAINED VALVE & EQUIPMENT TAG NUMBERS

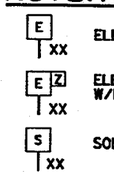
D-ID NUMBER

D: AR = AIR RECEIVER
CHP = CHEMICAL FEED PUMP
G = GATE
M = MECHANICAL EQUIPMENT
RWP = RECLAIMED WATER PUMP
P = PUMP
PSV = PRESSURE RELIEF VALVE
COMP = COMPRESSOR
EMG = EMERGENCY GENERATOR
RSP = RAW SEWAGE PUMP
SMP = SECURITY MONITORING PANEL
SP = SUMP PUMP
T = TANK

VALVE SYMBOLS



ACTUATOR SYMBOLS



ELECTRIC

ELECTRIC W/POSITIONER

SOLENOID

NOTE:

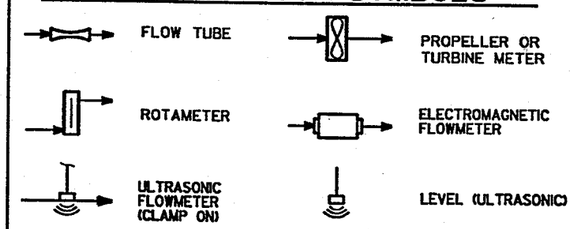
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL OR HYDRAULIC)

XX: FO =FAIL OPEN
FC =FAIL CLOSED
FLP =FAIL TO LAST POSITION

GATE SYMBOLS

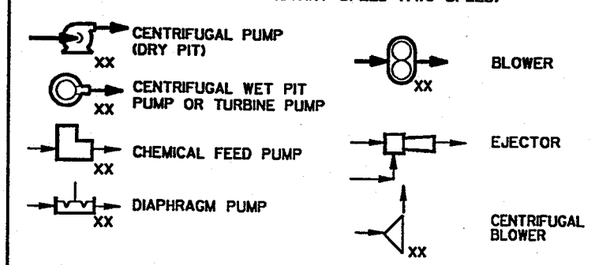
SLUICE

PRIMARY ELEMENT SYMBOLS



PUMP SYMBOLS

NOTE: XX : AS ADJUSTABLE SPEED
CS-1 CONSTANT SPEED (SINGLE SPEED)
CS-2 CONSTANT SPEED (TWO SPEED)



CENTRIFUGAL PUMP (DRY PIT)

CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP

CHEMICAL FEED PUMP

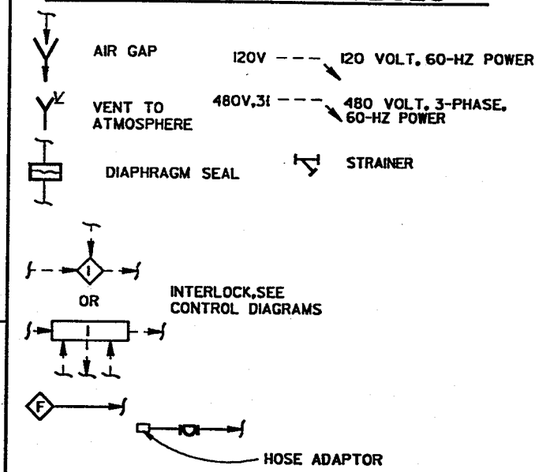
DIAPHRAGM PUMP

BLOWER

EJECTOR

CENTRIFUGAL BLOWER

MISCELLANEOUS SYMBOLS



ABBREVIATIONS

ACK	ACKNOWLEDGE
AFD	ADJUSTABLE FREQUENCY DRIVE
ALP	AIR LOW PRESSURE
BTD	BEARING TEMPERATURE DETECTOR
CS	COMPUTER SYSTEM
DC	DIRECT CURRENT
EMERG	EMERGENCY
FCP	FACILITY CONTROL PANEL
GAL	GALLON
HOA	HAND-OFF-AUTO
I/I	CURRENT TO CURRENT TRANSDUCER
LCP	LOCAL CONTROL PANEL
LOR	LOCAL-OFF-REMOTE
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MCC	MOTOR CONTROL CENTER
MCP	MAIN CONTROL PANEL
MFR	MANUFACTURER
MTD	MOTOR TEMPERATURE DETECTOR
NIC	NOT IN CONTRACT
NO	NUMBER
OC	OPEN-CLOSE (D)
OCR	OPEN-CLOSE-REMOTE
OCA	OPEN-CLOSE-AUTO
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
OSC	OPEN-STOP-CLOSE
PF	PULSE FREQUENCY
PLC	PROGRAMMABLE LOGIC CONTROLLER
REC	RECOVERY
SEQ	SEQUENCE
SS	START-STOP
TURB	TURBIDITY
TYP	TYPICAL
UPS	UNINTERRUPTIBLE POWER SUPPY
VHC	VOLATILE HYDROCARBONS
f(x)	OUTPUT IS FUNCTION OF INPUTS
>	SELECT HIGHEST SIGNAL
X	MULTIPLY
Σ	SUM

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DIVISION OF ENGINEERING
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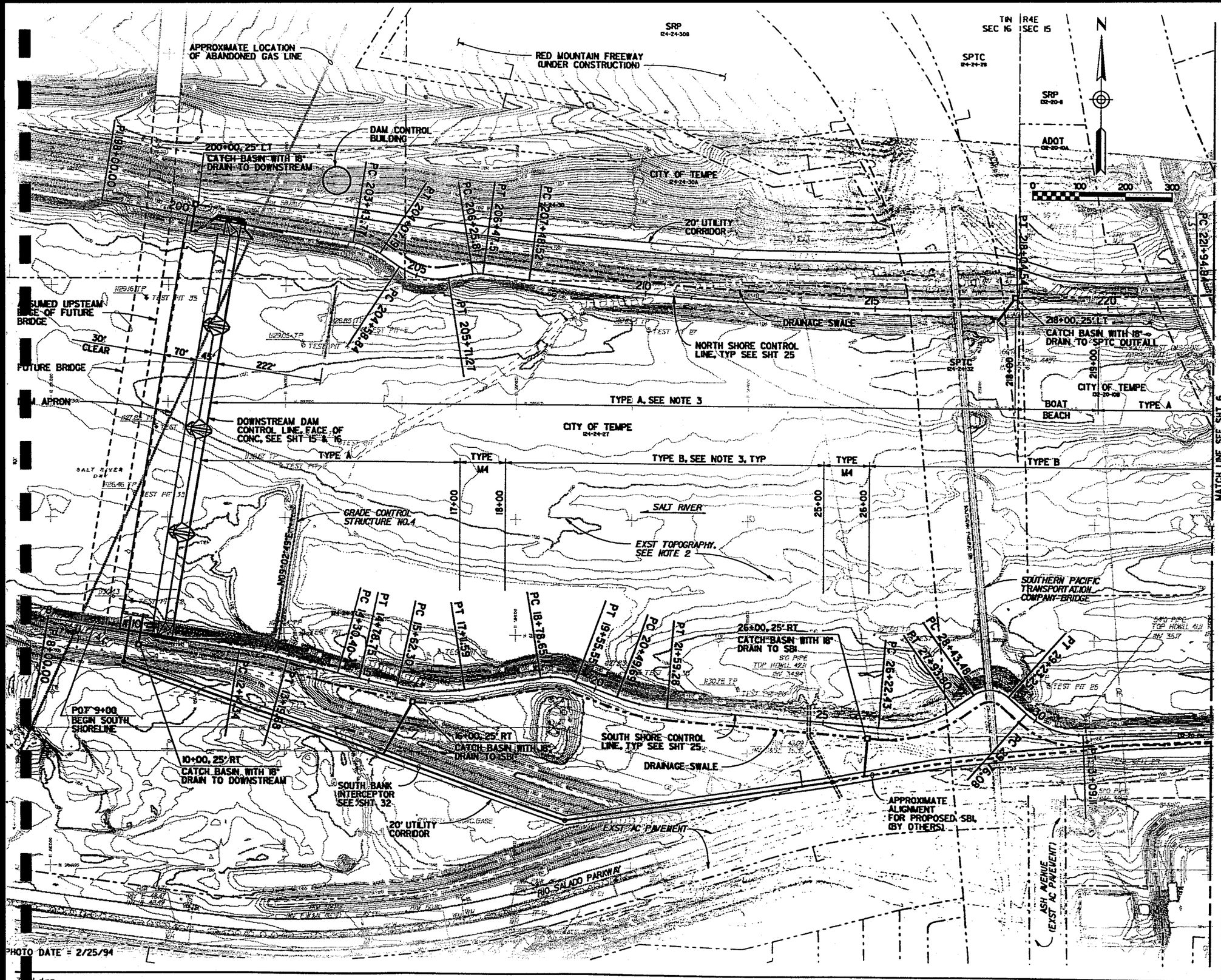
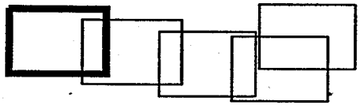
SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	I&C LEGEND	PROJECT NO. 946523
DRAWN: J URIA		
CHECKED: X		
SCALE: NTS		SHT. 4 OF X



CONSTRUCTION NOTES

1. BASIS OF STATIONING IS
2. EXISTING TOPOGRAPHY OF RIVER BED BETWEEN MILL AVENUE GRADE CONTROL STRUCTURE NO. 4 DOES NOT MATCH TOPOGRAPHY AS SHOWN, DUE TO RECENT RIVER GRADING. SEE CONTRACT DWGS
3. DESIGNATION OF SHORELINE EDGE TREATMENT. SEE SHTS 25 AND 26.
4. SHORELINE DRAINAGE DESIGN IS BASED ON CURRENT LANDSCAPING CONCEPT.



KEY PLAN
NTS

THE VERIFIED DATE BEFORE YOU DIG FOR THE BLUE STAKES
263-1100
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CALL COLLECT

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DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE SITE PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 5 OF X

RED MOUNTAIN FREEWAY (UNDER CONSTRUCTION)

TIN R4E SEC 15

224+00, 25' LT CATCH BASIN WITH 18" DRAIN TO MILL NORTH OUTFALL

20' UTILITY CORRIDOR

CITY OF TEMPE

24" DRAIN PIPE

DRAINAGE SWALE

NORTH SHORE CONTROL LINE, TYP SEE SHT 25

238+00, 25' LT CATCH BASIN WITH

MILL AVENUE BRIDGE

EXST CONCRETE

TYPE A

TYPE M4

TYPE B

TYPE B, SEE NOTE 3, TYP

SALT RIVER DRY

FCDMC

SALT RIVER

MATCH LINE SEE SHT 7

SOUTH SHORE CONTROL LINE, TYP SEE SHT 25

37+00, 25' RT CATCH BASIN WITH 18" DRAIN TO SBI

SOUTHWEST P GAS LINE APPROXIMATE LOCATION PER SHT 25

49+00, 25' RT CATCH BASIN WITH 18" DRAIN TO SBI

APPROXIMATE ALIGNMENT FOR PROPOSED SBI (BY OTHERS)

RIO SALADO PARKWAY

EXST AC PAVEMENT

APPROXIMATE LOCATION EQUIP WATER MAIN PER COP WATER MAPS

N

0 100 200 300

PHOTO DATE = 2/25/94

BAY STATE MINING

CONSTRUCTION NOTES

1. BASIS OF STATIONING IS
2. EXISTING TOPOGRAPHY OF RIVER BED BETWEEN MILL AVENUE GRADE CONTROL STRUCTURE NO. 4 DOES NOT MATCH TOPOGRAPHY AS SHOWN. DUE TO RECENT RIVER GRADING. SEE CONTRACT DWGS
3. DESIGNATION OF SHORELINE EDGE TREATMENT. SEE SHTS 25 AND 26.

KEY PLAN
NTS

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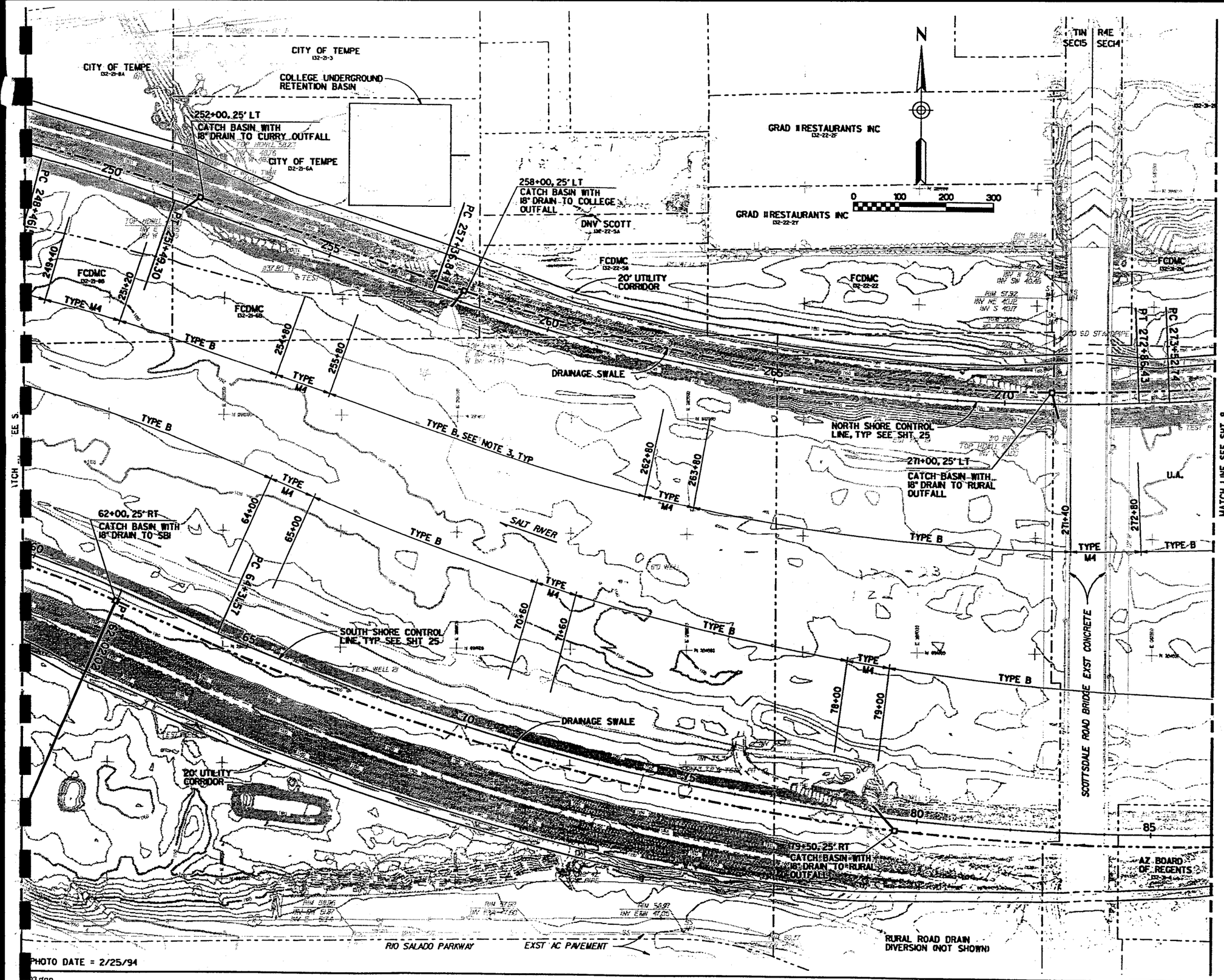
SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE SITE PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 6 OF X

4: 02.dgn
-1994



CONSTRUCTION NOTES

1. BASIS OF STATIONING IS
2. EXISTING TOPOGRAPHY OF RIVER BED BETWEEN MILL AVENUE GRADE CONTROL STRUCTURE NO. 4 DOES NOT MATCH TOPOGRAPHY AS SHOWN, DUE TO RECENT RIVER GRADING. SEE CONTRACT DWGS
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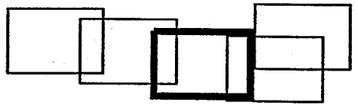

KEY PLAN
NTS

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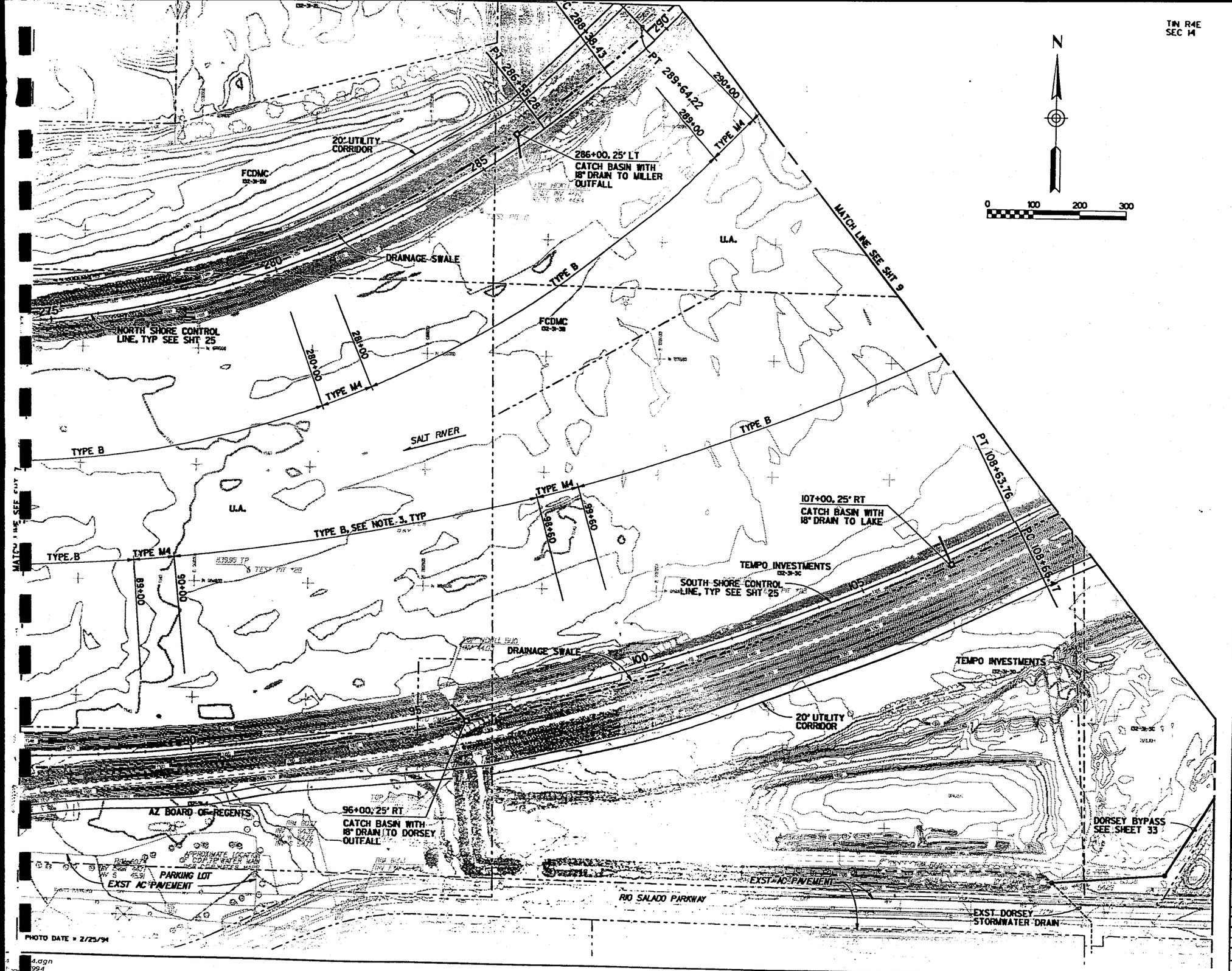
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE SITE PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 7 OF X

03.dgn
SEP-1994
:34:55



CONSTRUCTION NOTES

1. BASIS OF STATIONING IS
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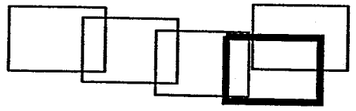

KEY PLAN
NTS

BEFORE YOU DIG
CALL FOR THE BLUE STAKES
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BLUE STAKE, INC.
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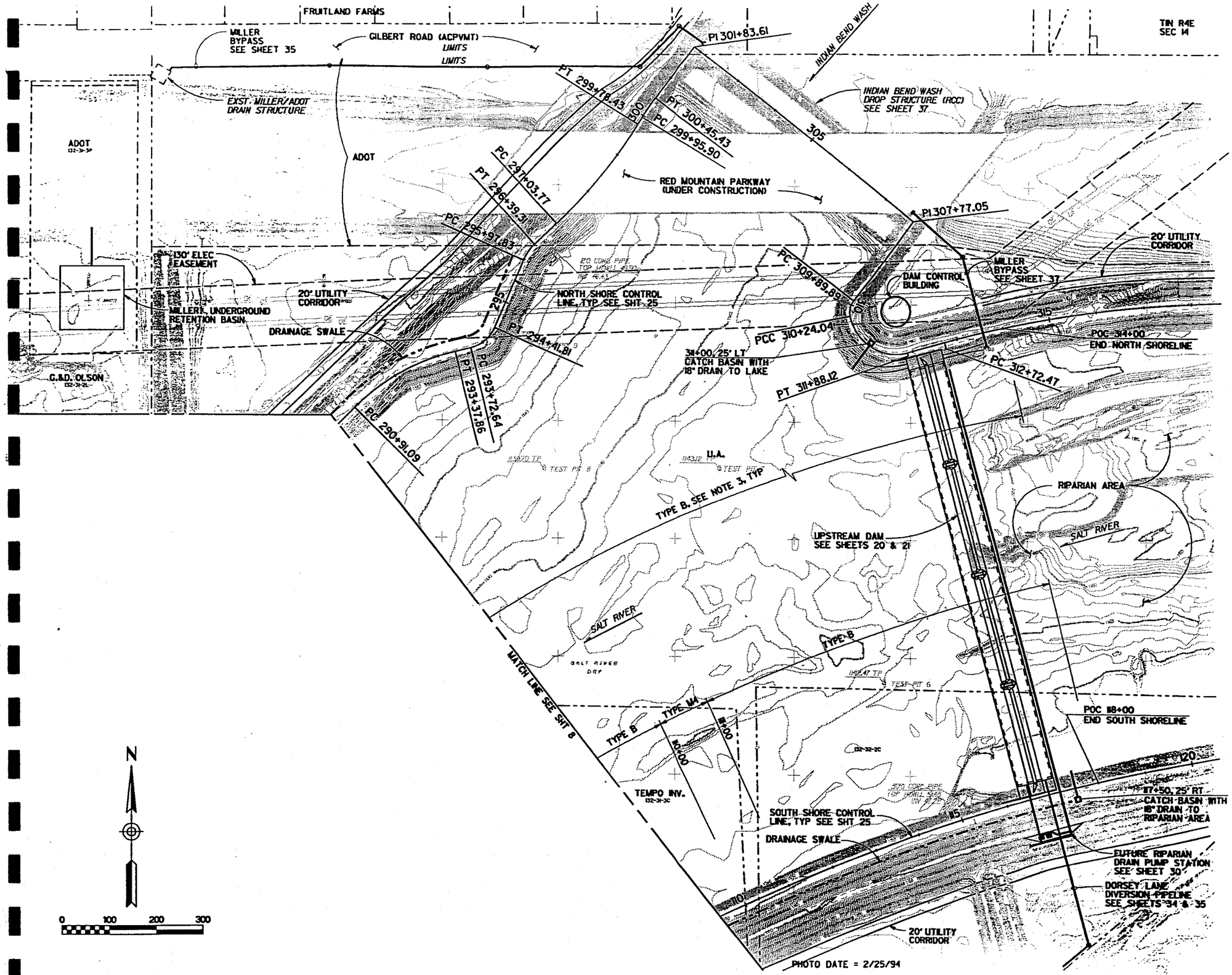
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE SITE PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 8 OF X



CONSTRUCTION NOTES

1. BASIS OF STATIONING IS
2. EXISTING TOPOGRAPHY OF RIVER BED BETWEEN MILL AVENUE GRADE CONTROL STRUCTURE NO. 4 DOES NOT MATCH TOPOGRAPHY AS SHOWN, DUE TO RECENT RIVER GRADING. SEE CONTRACT DWGS
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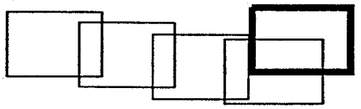

KEY PLAN
NTS

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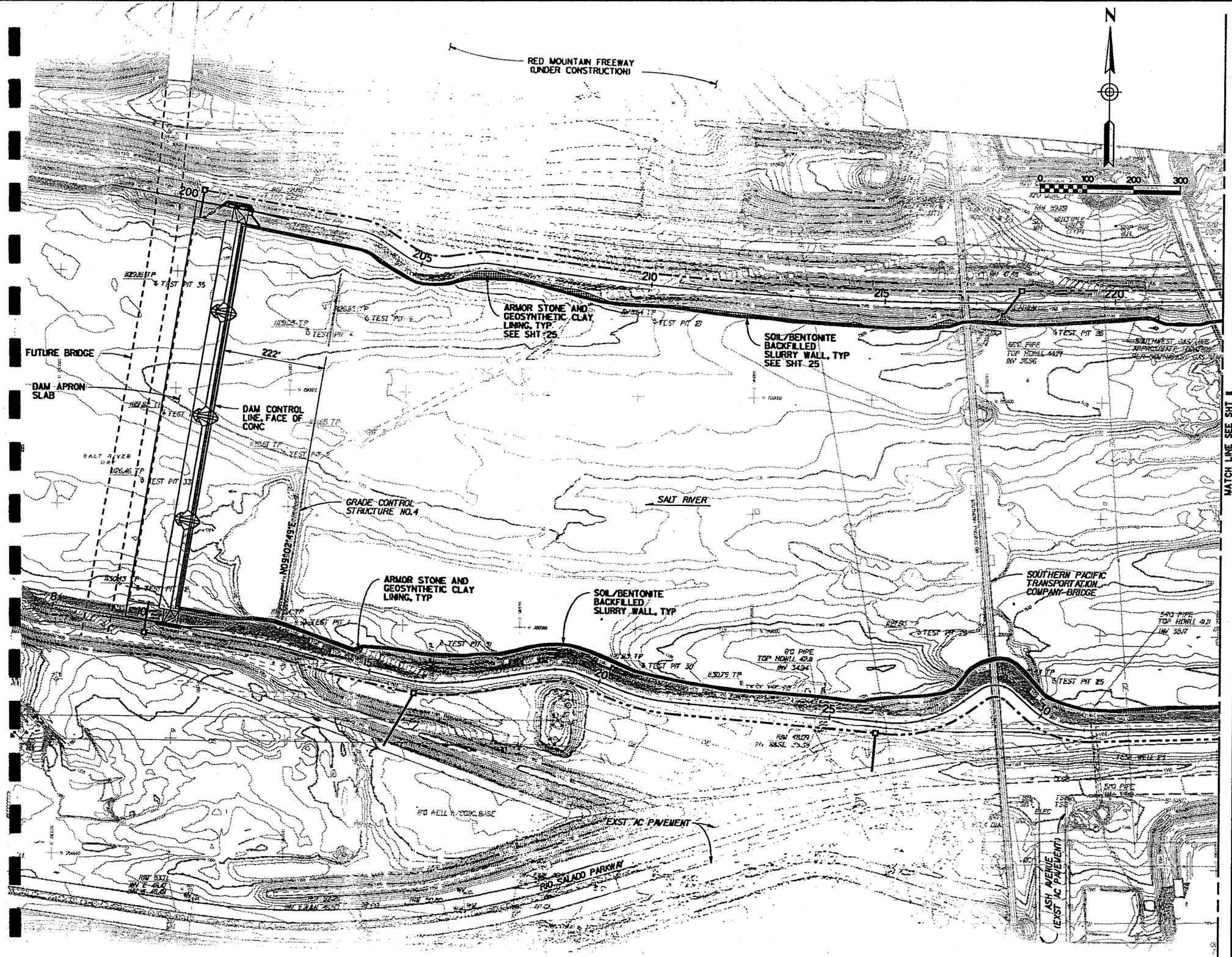
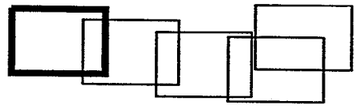
SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE SITE PLAN	PROJECT NO. 946523
DRAWN: C. WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 9 OF X



CONSTRUCTION NOTES



KEY PLAN
NTS

TWO WORKING DAYS BEFORE YOU DIG
CALL FOR THE BLUE STAKES
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BLUE STAKE, INC.
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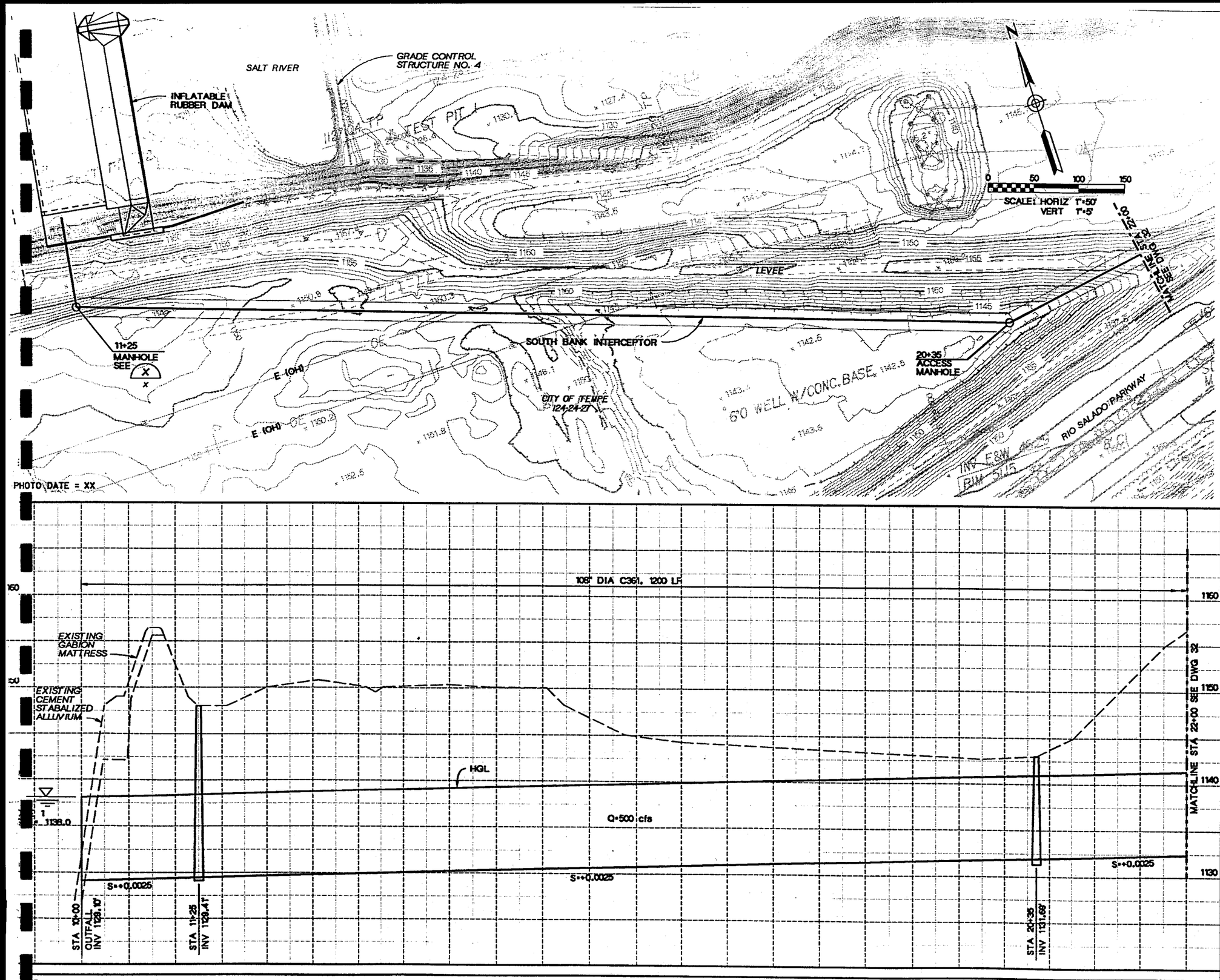
CITY OF TEMPE

DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE INFILTRATION MANAGEMENT PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 10 OF X

21.dgn
1994



CONSTRUCTION NOTES

NOTES:

1. THE COMPUTED OUTFALL HGL IS BASED ON A FREE WATER SURFACE ELEVATION OF 1138.0 IN THE SALT RIVER, Q = 500 cfs.

BEFORE YOU DIG, CALL FOR THE BLUE STAKES
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CITY OF TEMPE

DIVISION OF ENGINEERING

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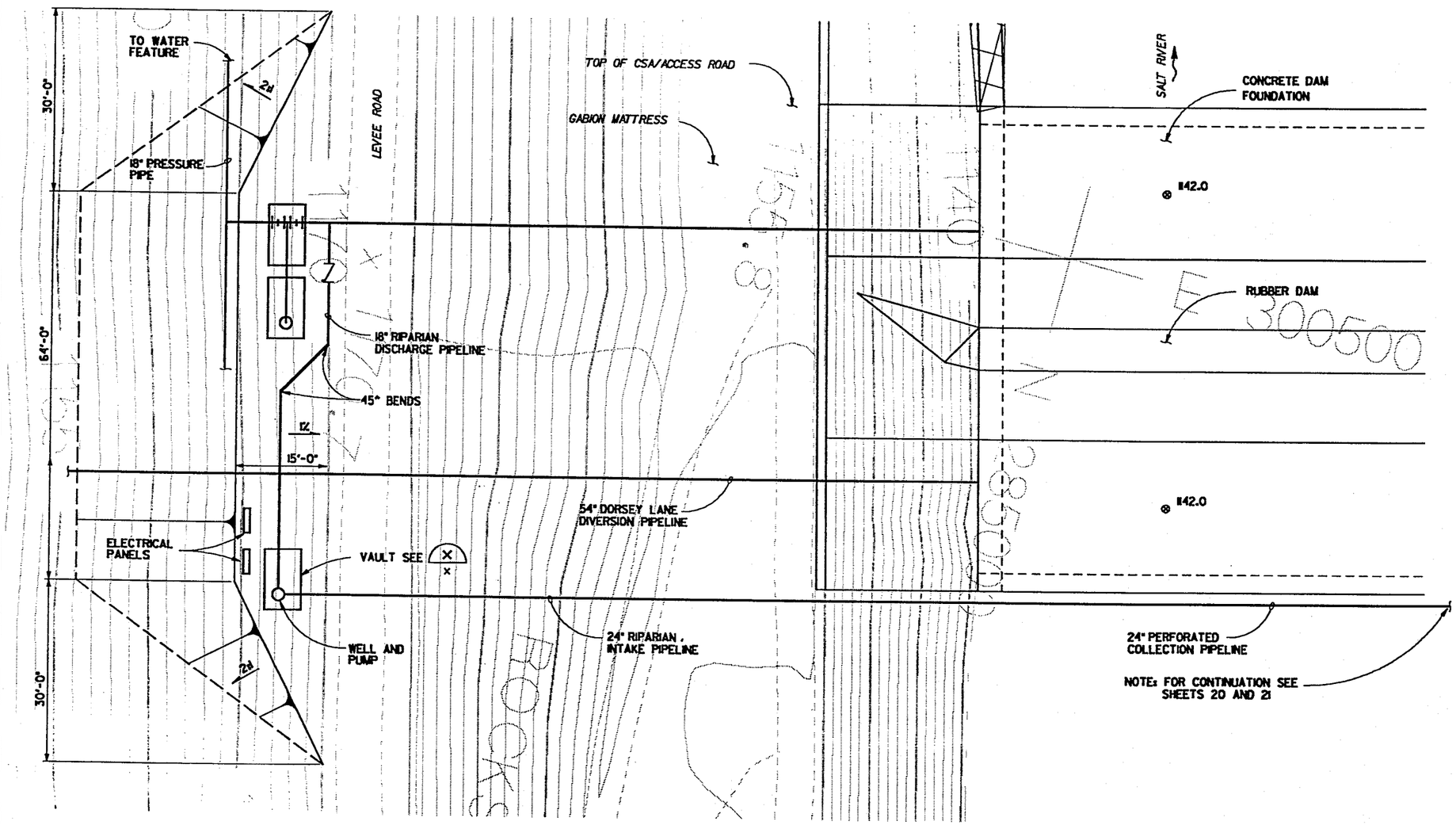
SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	SOUTH BANK INTERCEPTOR	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=50'		SHT. 31 OF X

3103.dgn
SEP-1994



PLAN

1"=10'-0"

N

CONSTRUCTION NOTES

CALL COLLECT 263-1100

DEPARTMENT OF PUBLIC WORKS

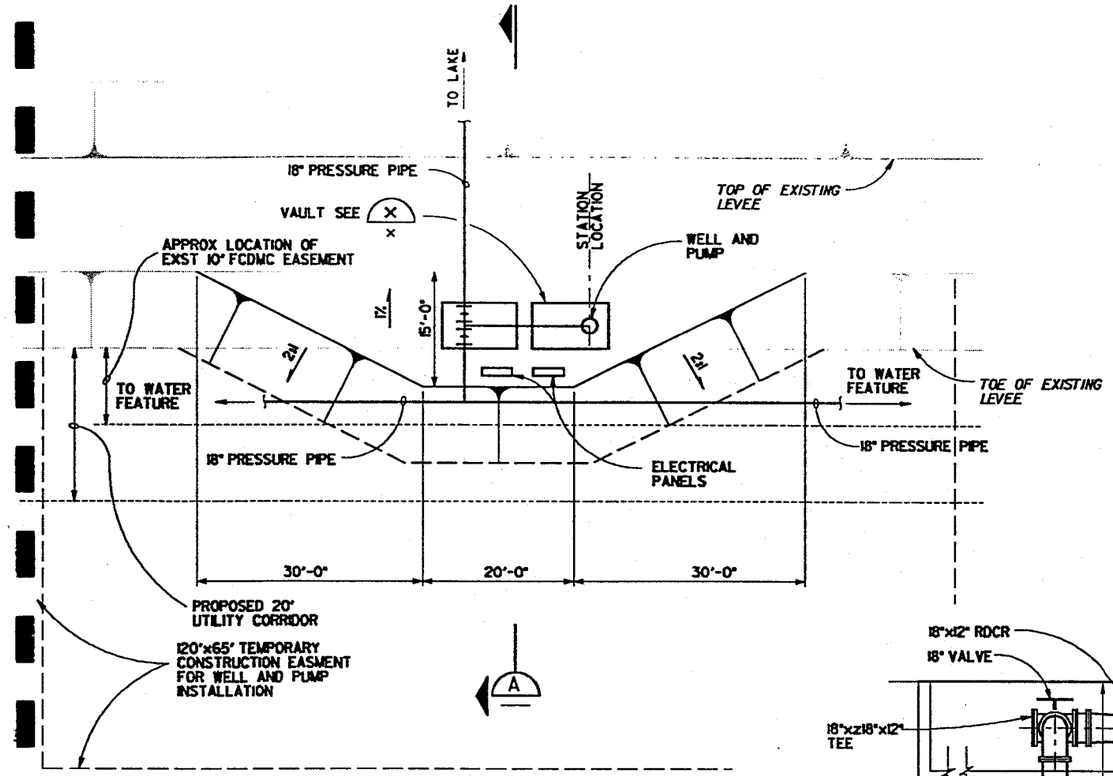
CITY OF TEMPE

DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 199
DESIGNED: X	RIPARIAN DRAIN PUMP STATION	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=10'-0"		SHT. 30 OF X

c15.dgn
-1994



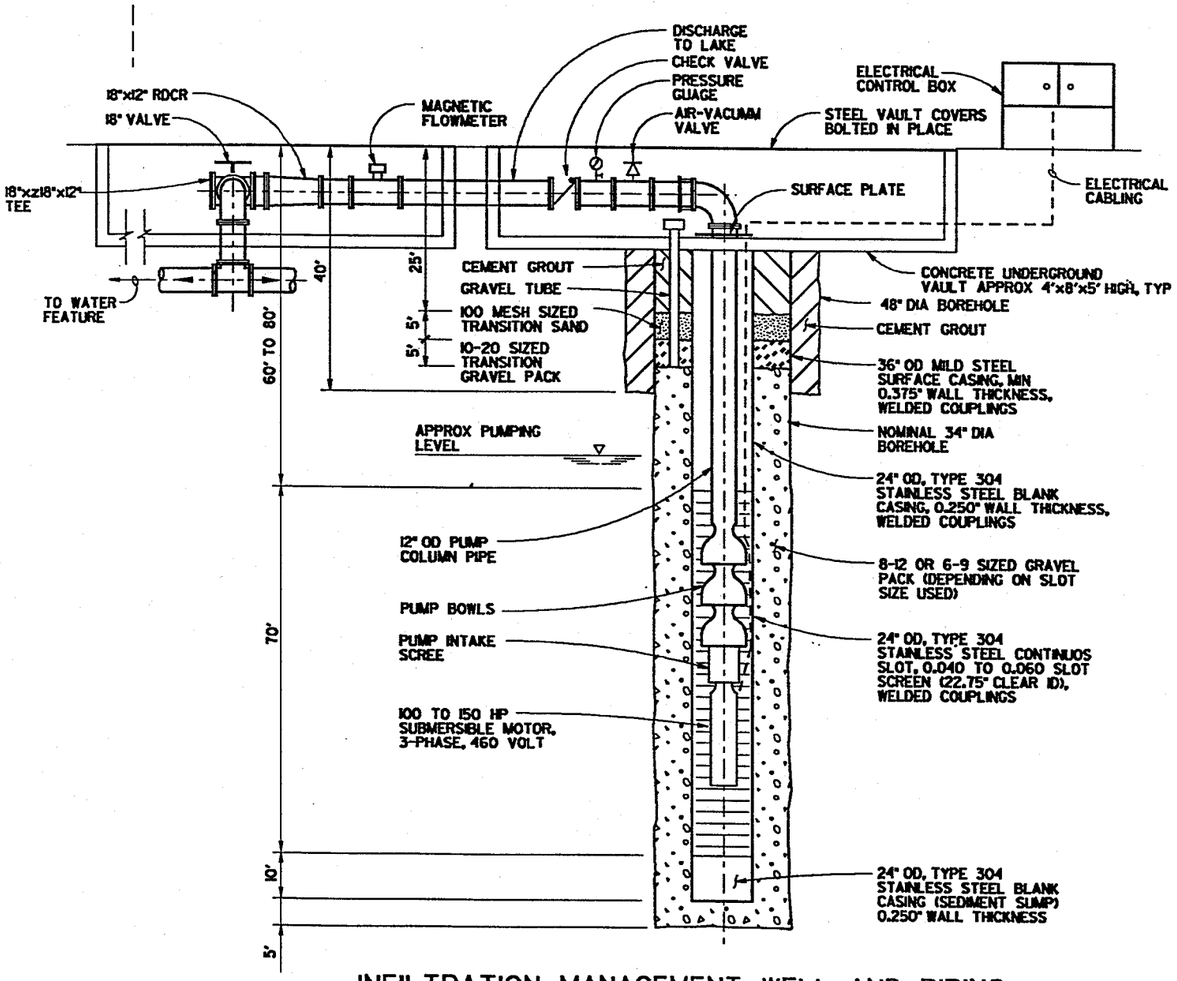
TYPICAL PULL OUT

1"=10'-0"

NOTE: PROPOSED UTILITY CORRIDOR MAY VARY IN LOCATION DEPENDING UPON FINAL LANDSCAPING CONCEPT. THE INTENT IS THAT CORRIDOR WOULD BE LOCATED AT THE TOE OF THE OUTSIDE SLOPE OF THE LEVEE.

SECTION A

1"=10'-0"



INFILTRATION MANAGEMENT WELL AND PIPING

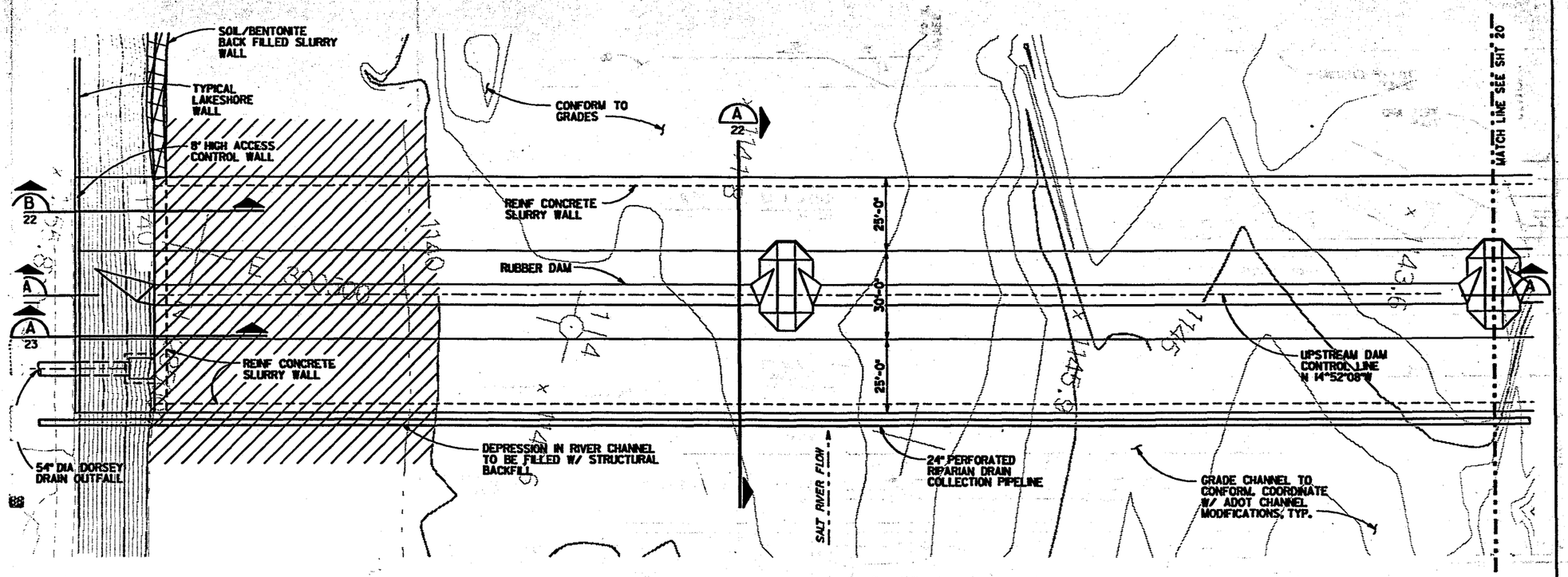
NTS

CONSTRUCTION NOTES

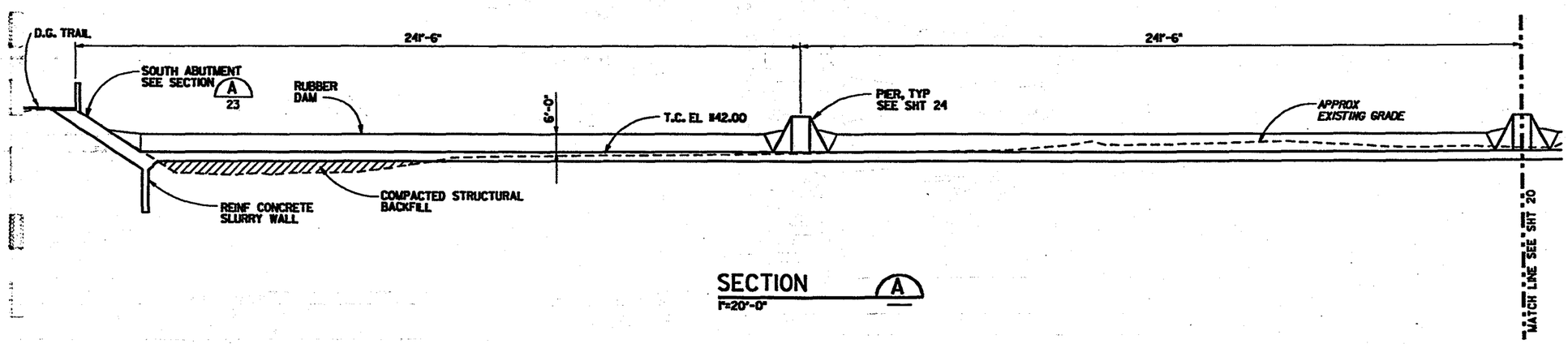
BEFORE YOU DIG CALL FOR THE BLUE STAKES
263-1100
BLUE STAKE, INC.
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	INFILTRATION MANAGEMENT WELL AND PUMP	PROJECT NO. 946523
DRAWN: J URIA		
CHECKED: X		
SCALE: 1"=10'-0"		SHT. 29 OF X



PLAN
1"=20'-0"



SECTION A
1"=20'-0"

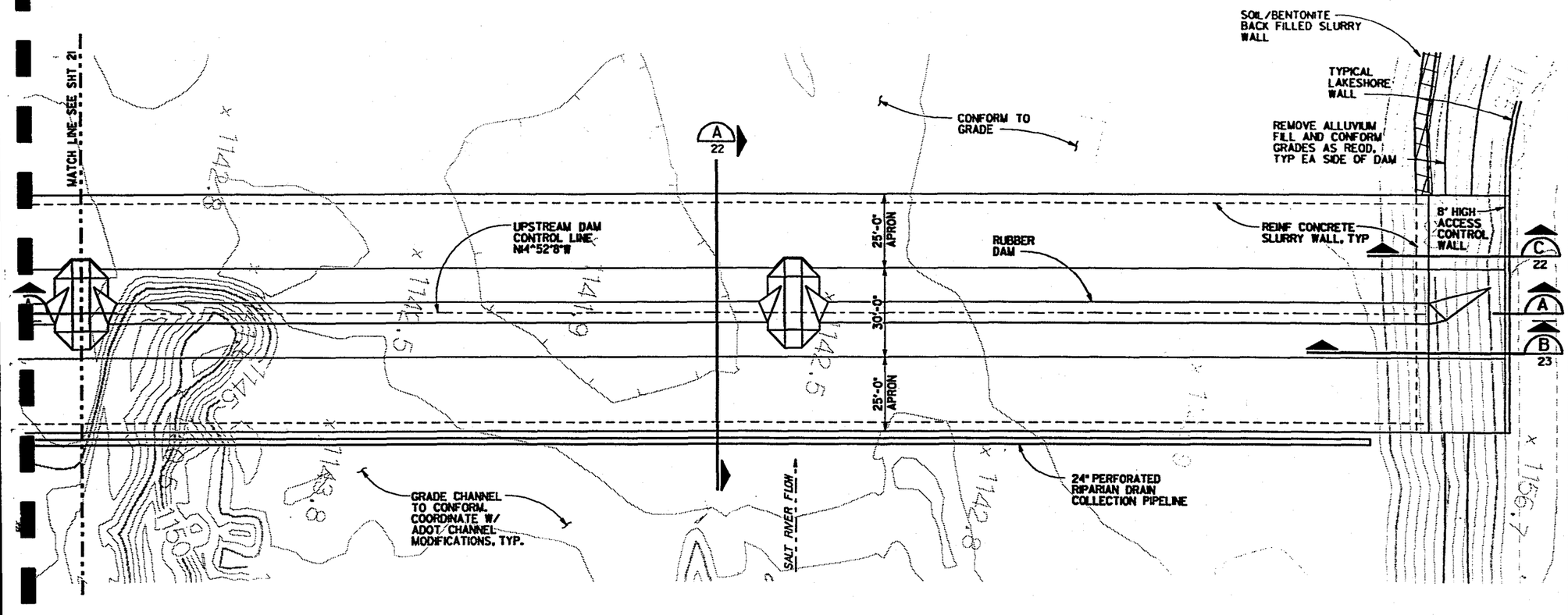
CONSTRUCTION NOTES

263-1100
DIAL 811 BEFORE YOU DIG
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

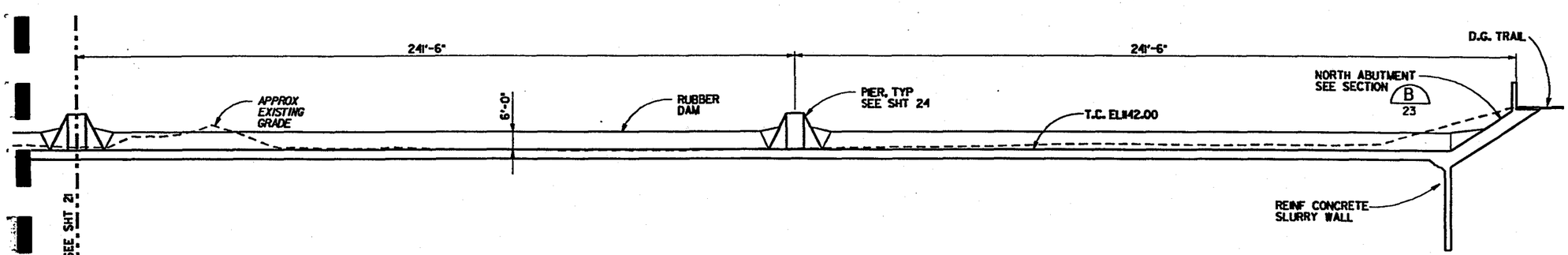
SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	UPSTREAM DAM SOUTH PARTIAL PLAN AND SECTION	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=20'-0"		SHT. 21 OF X

4 3s03.dgn
4-SEP-1994
1:25:54



PLAN

1"=20'-0"



SECTION A

1"=20'-0"

CONSTRUCTION NOTES

CALL COLLECT 263-1100

DEPARTMENT OF PUBLIC WORKS

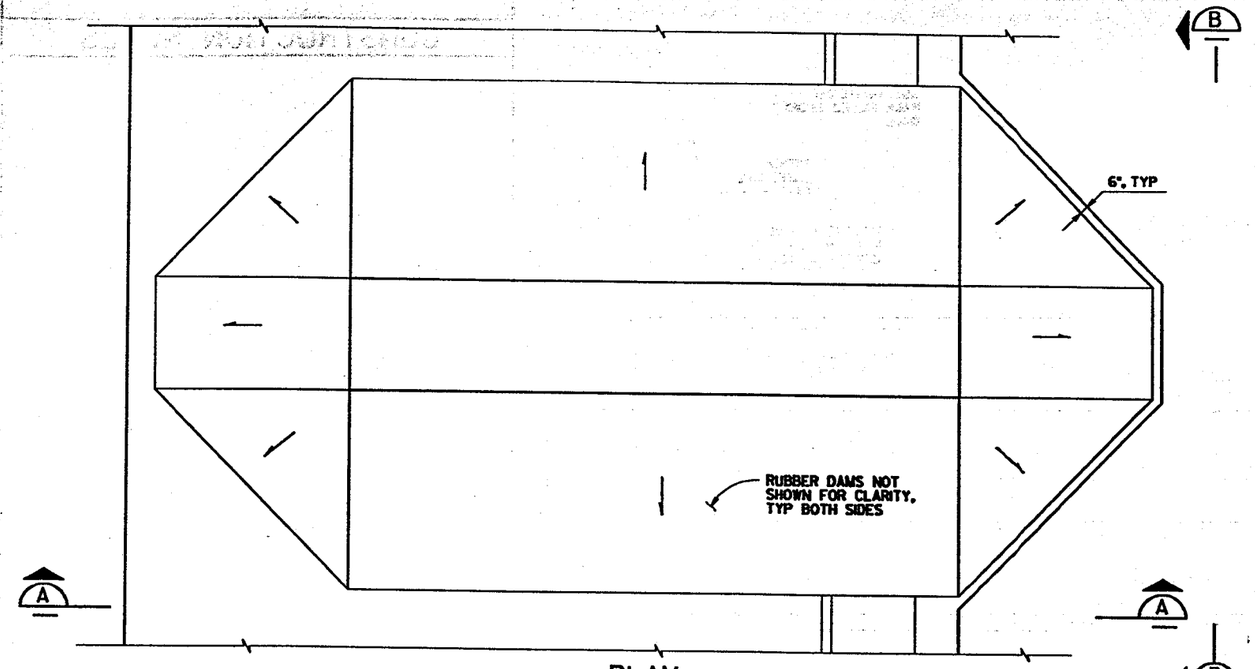
CITY OF TEMPE

DIVISION OF ENGINEERING

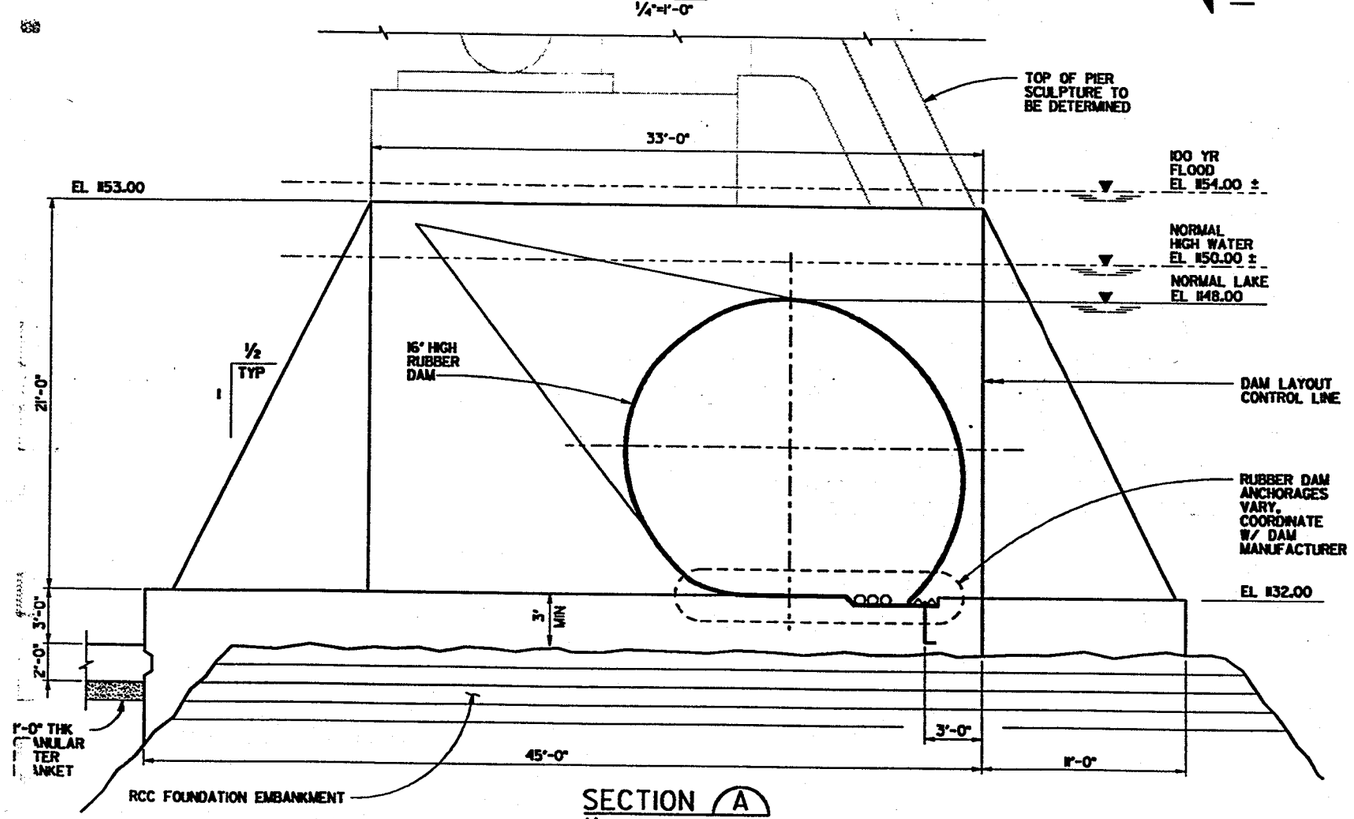
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	UPSTREAM DAM NORTH PARTIAL PLAN AND SECTION	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=20'-0"		SHT. 20 OF X

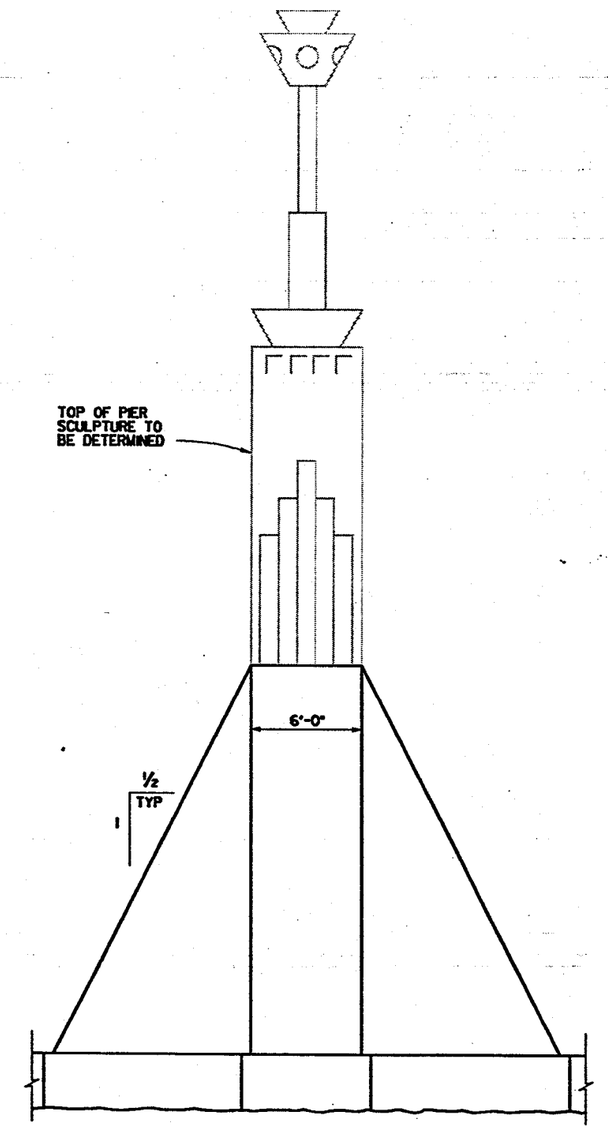
s04.dgn
-1994
:08:08



PLAN
1/4"=1'-0"



SECTION A
1/4"=1'-0"



ELEVATION B
1/4"=1'-0"

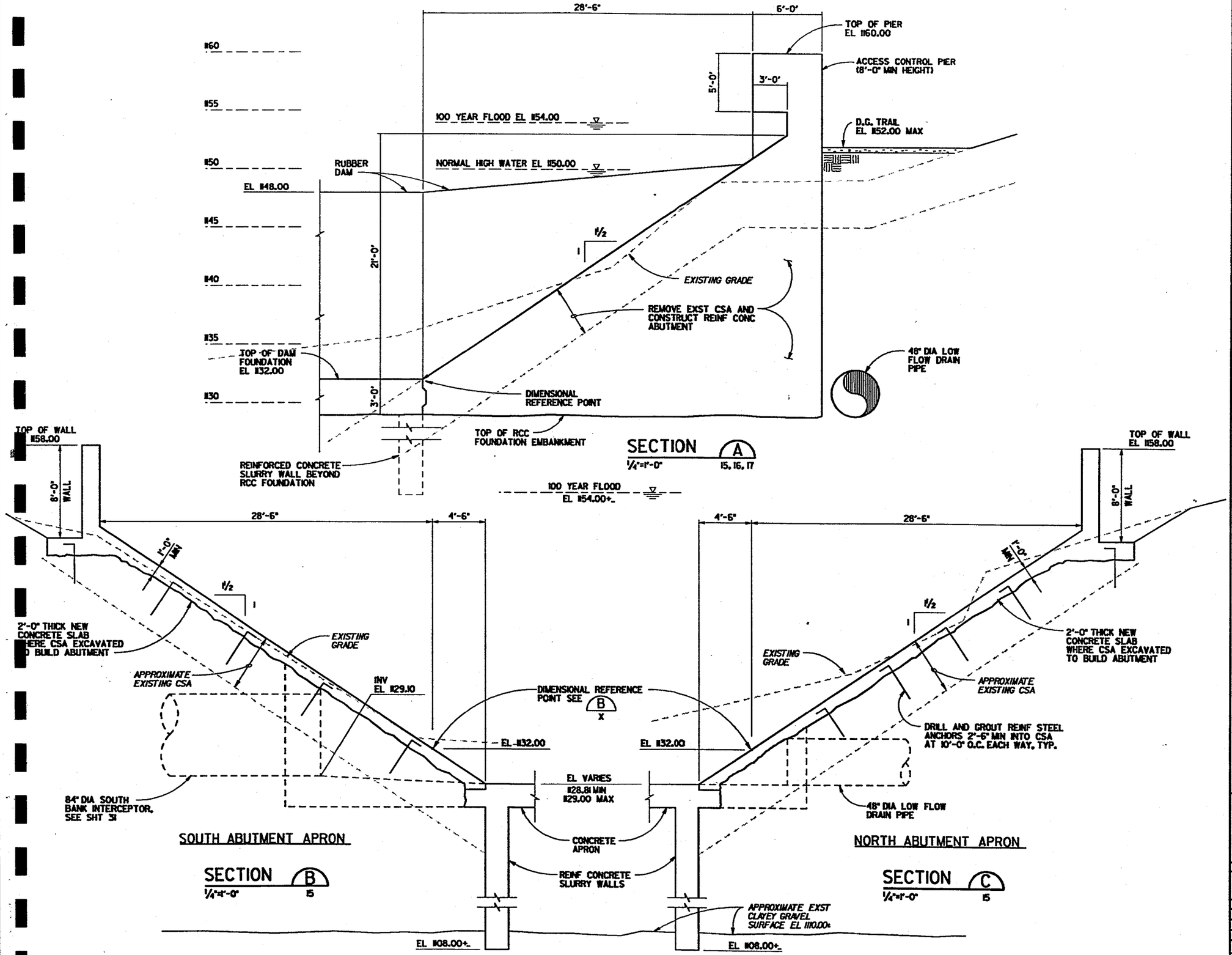
CONSTRUCTION NOTES

NO WORKS SHALL BEGIN UNTIL YOU HAVE CALLED FOR THE BLUE STAKES
263-1100
BLUE STAKE SERVICE
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	DOWNSTREAM DAM PIER PLAN AND SECTIONS	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1/4"=1'-0"		SHT. 19 OF X

4 3s30.dgn
-92P-1994
26:16



CONSTRUCTION NOTES

DEPARTMENT OF PUBLIC WORKS

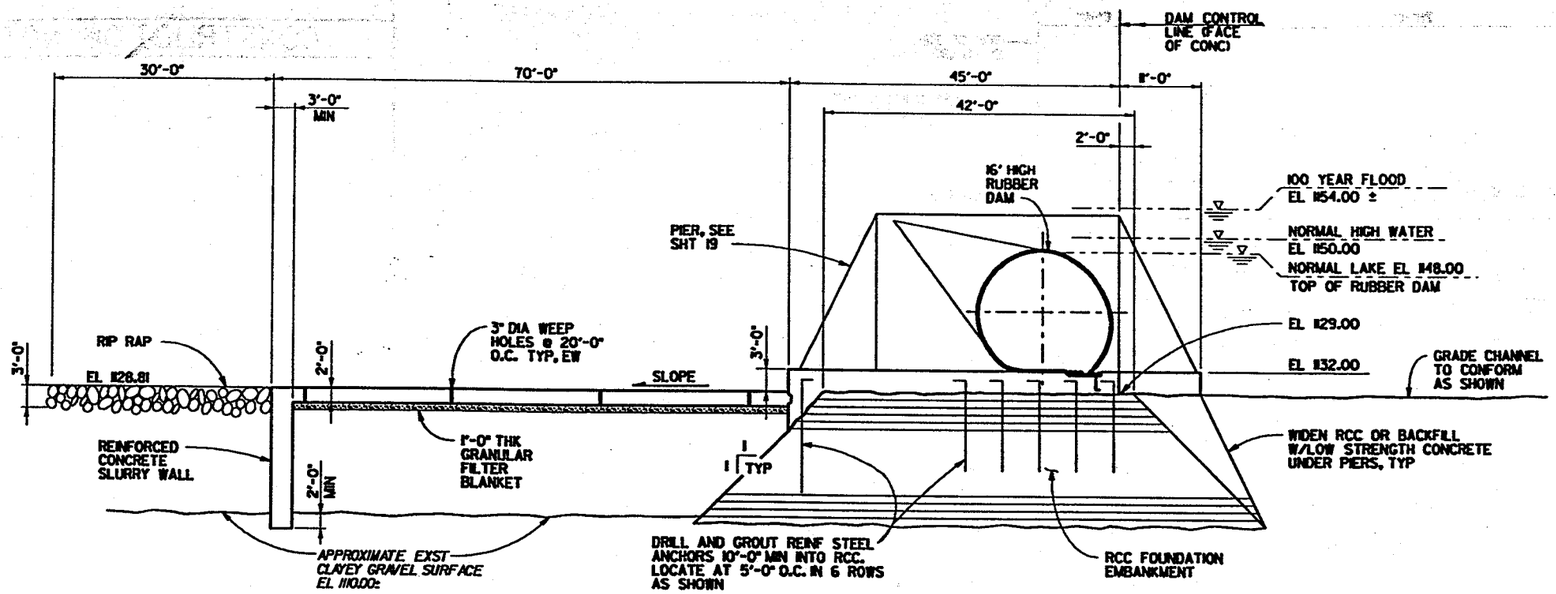
CITY OF TEMPE

DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

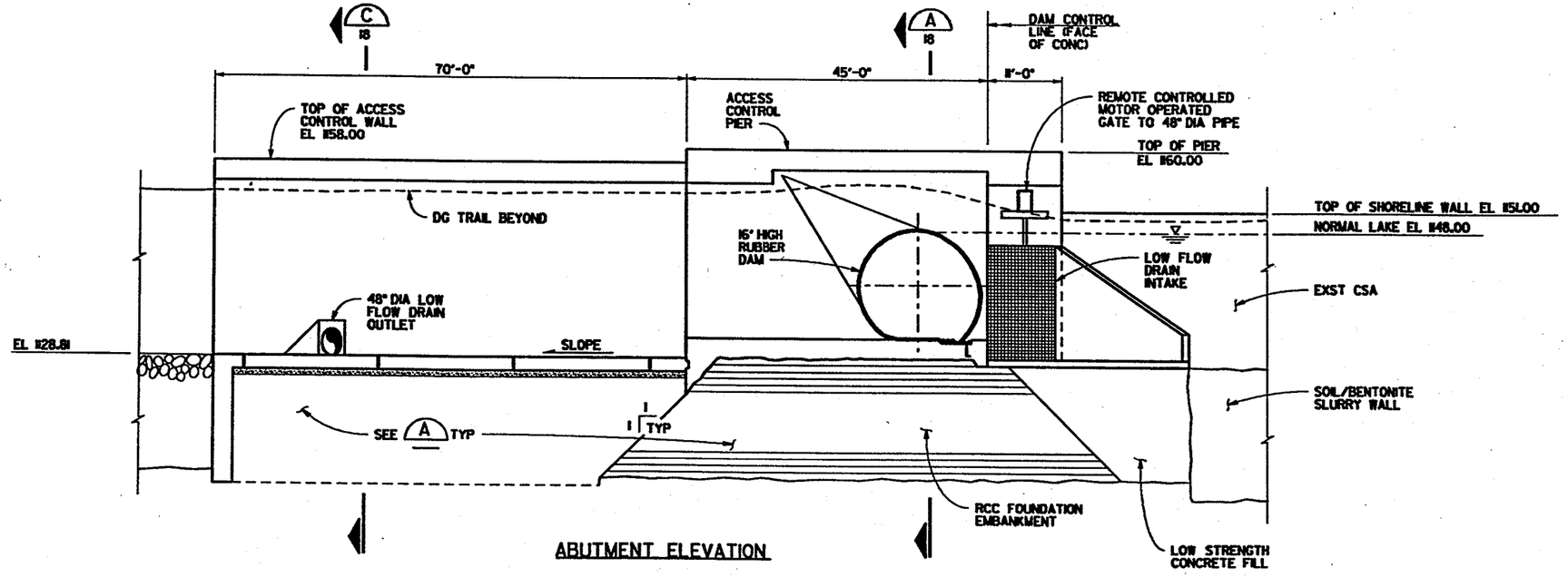
SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	DOWNSTREAM DAM ABUTMENT AND APRON SECTIONS	PROJECT NO. 946523
DRAWN: J LIRIA		
CHECKED: X		
SCALE: ¼"=1'-0"		SHT. 18 OF X

263-1100
CALL COLLECT



DOWNSTREAM DAM AND APRON

SECTION A
1"=10'-0" 15, 16



ABUTMENT ELEVATION

SECTION B
1"=10'-0" 15

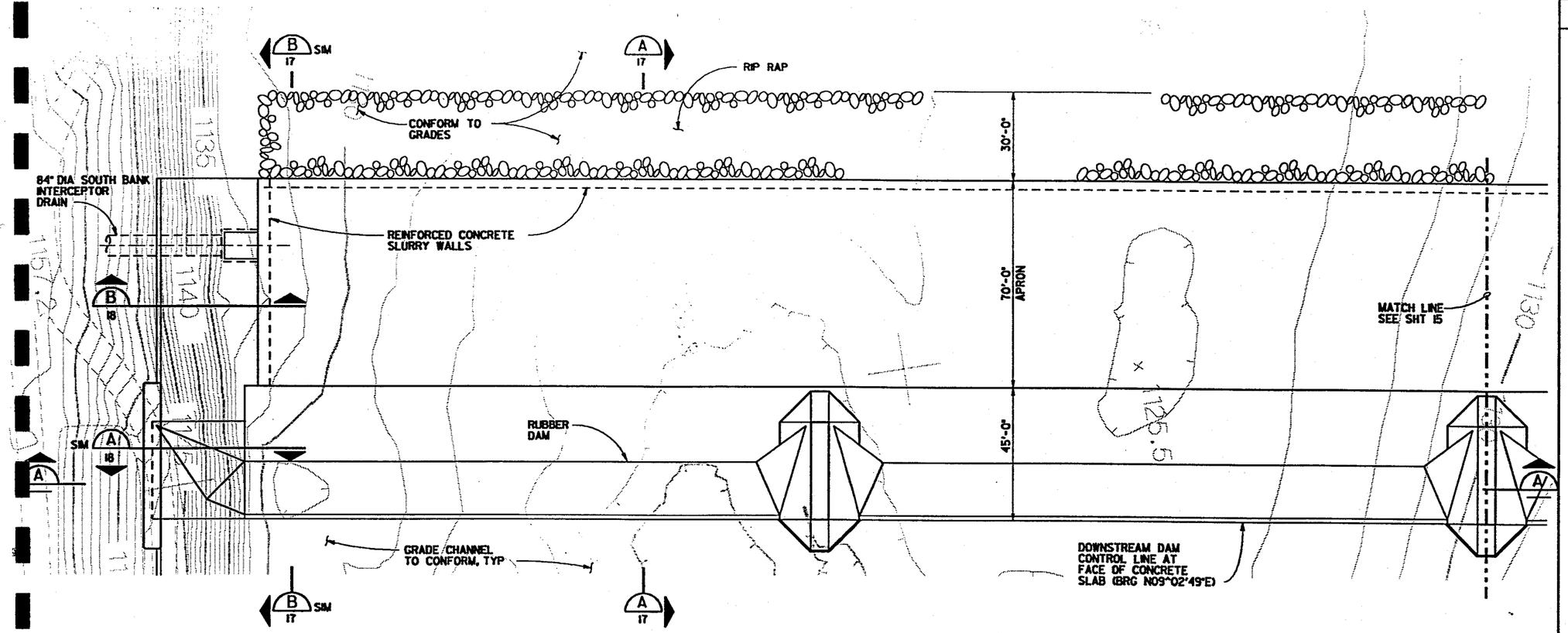
CONSTRUCTION NOTES

CALL COLLECT 263-1100

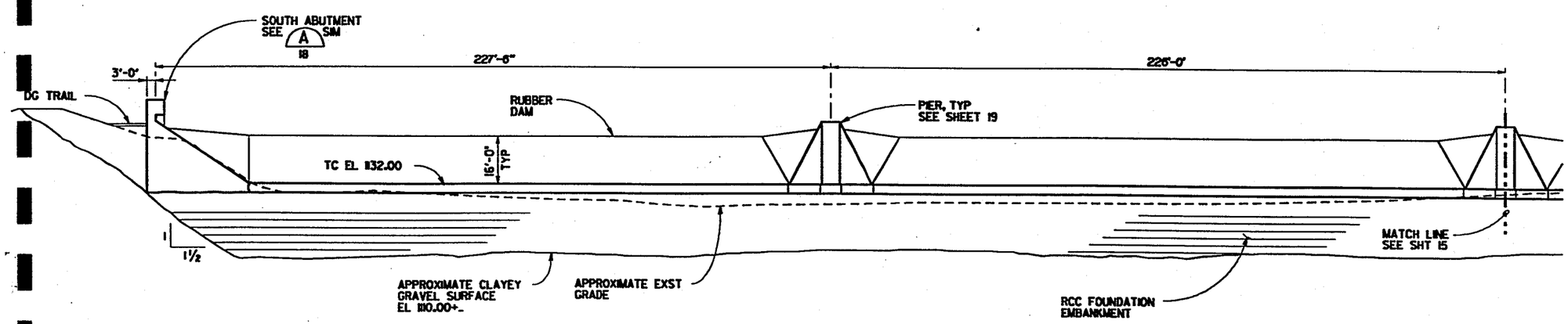
DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	DOWNSTREAM DAM SECTIONS	PROJECT NO. 946523
DRAWN: CW/JEU		
CHECKED: X		
SCALE: 1"=10'		SHT. 17 OF X

4_3s05.dgn
1-SEP-1994
3:35:13



PLAN
1"=20'-0"



SECTION A
1"=20'-0"

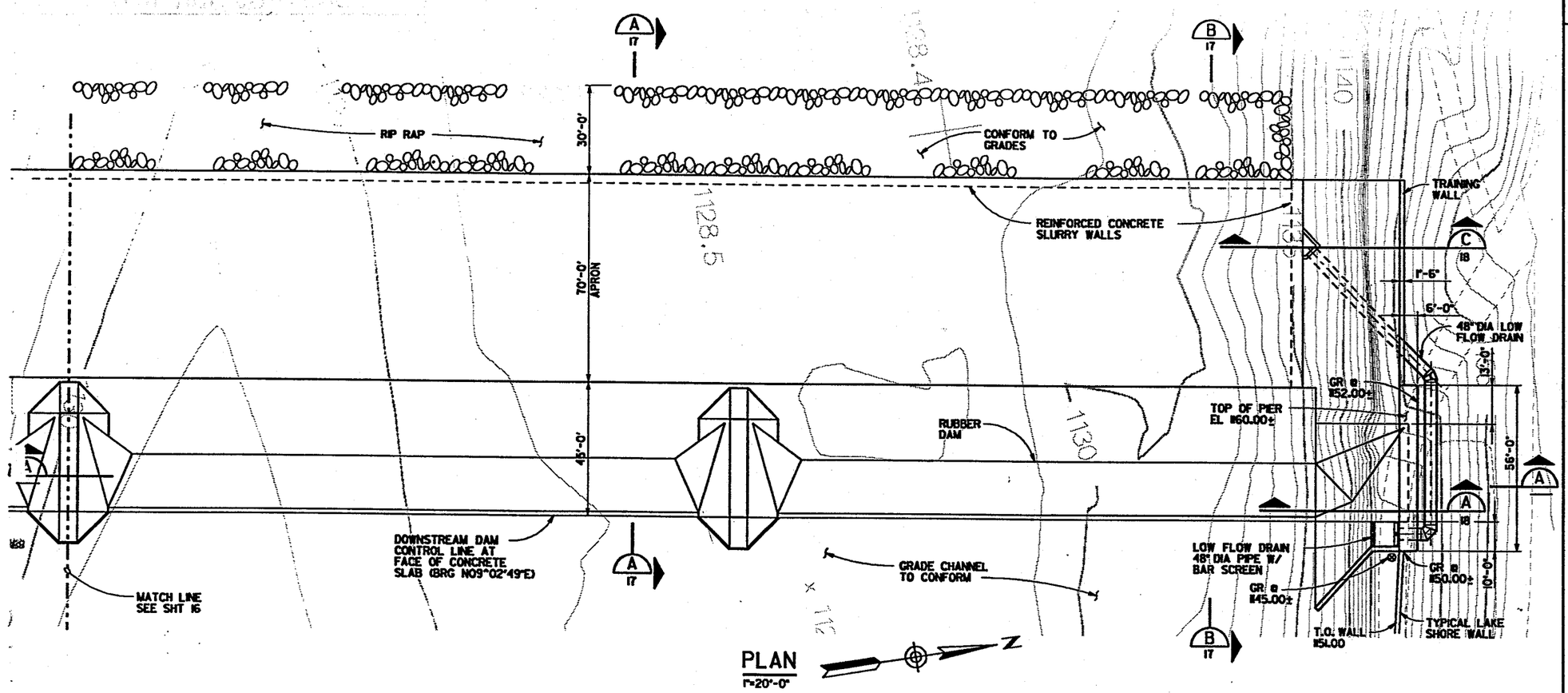
CONSTRUCTION NOTES

263-1100
CALL COLLECT

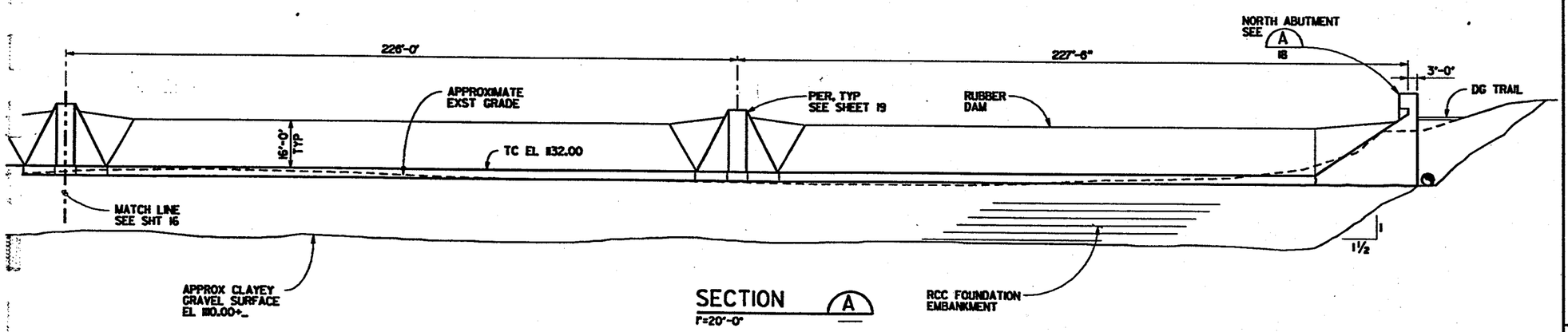
DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	DOWNSTREAM DAM SOUTH PARTIAL PLAN AND SECTION	PROJECT NO. 946523
DRAWN: JEU/CSW		
CHECKED: X		
SCALE: 1"=20'-0"		SHT. 16 OF X

s01.dgn
-SEP-1994
:27:01



PLAN
1"=20'-0"



SECTION A
1"=20'-0"

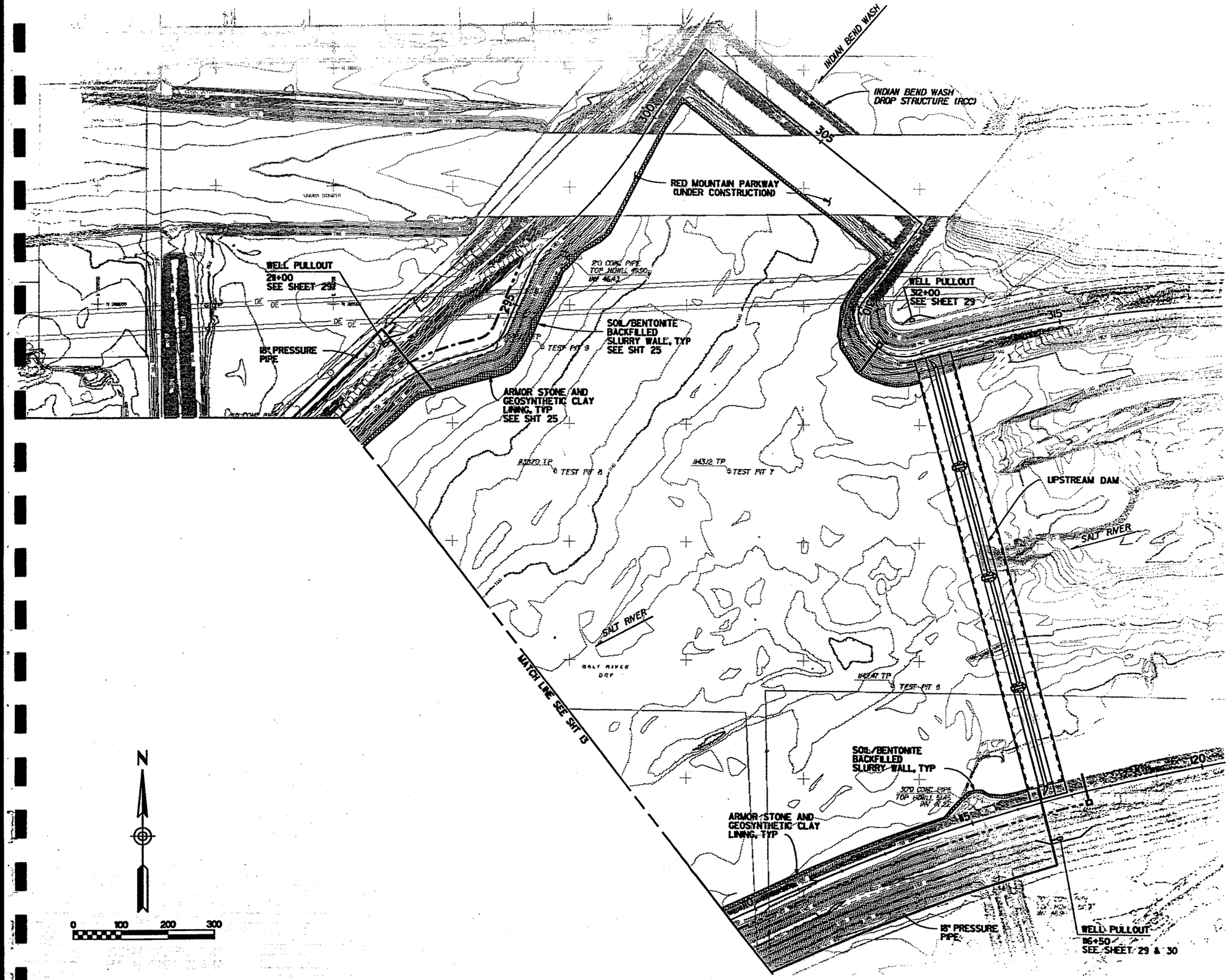
CONSTRUCTION NOTES

263-1100
CALL COLLECT

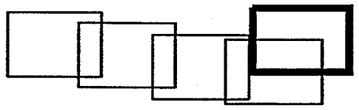
DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	DOWNSTREAM DAM NORTH PARTIAL PLAN AND SECTION	PROJECT NO. 946523
DRAWN: JEU/CSW		
CHECKED: X		
SCALE: 1"=20'-0"		SHT. 15 OF X

3s02.dgn
-SEP-1994
:17:12



CONSTRUCTION NOTES



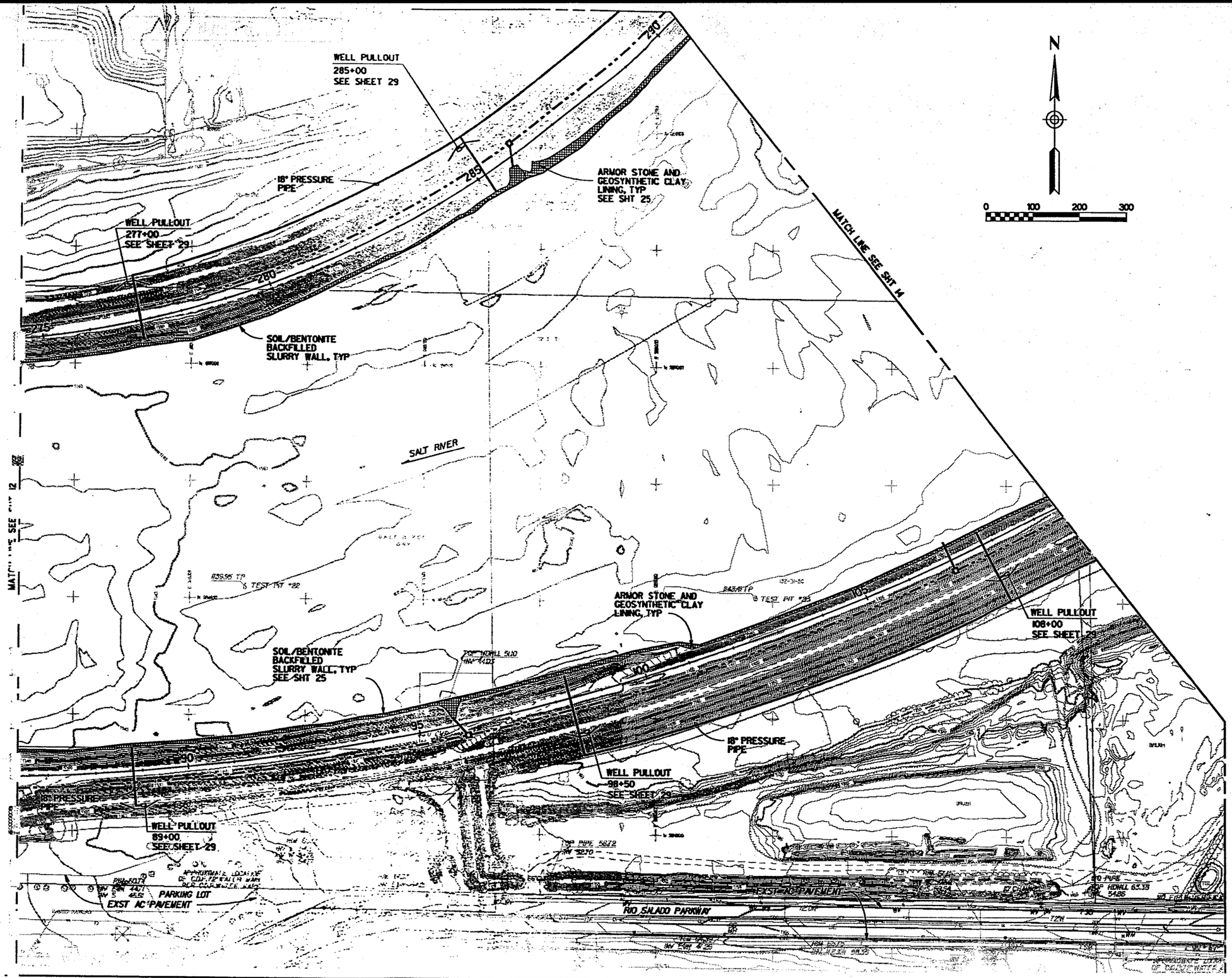
KEY PLAN
NTS

BEFORE YOU DIG, CALL THE ONE CALL CENTER
258-1100
OUTSIDE MARICOPA COUNTY
CALL COLLECT

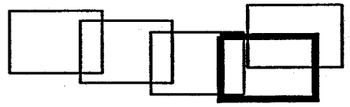
DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE INFILTRATION MANAGEMENT PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 14 OF X

25.dgn
1994



CONSTRUCTION NOTES



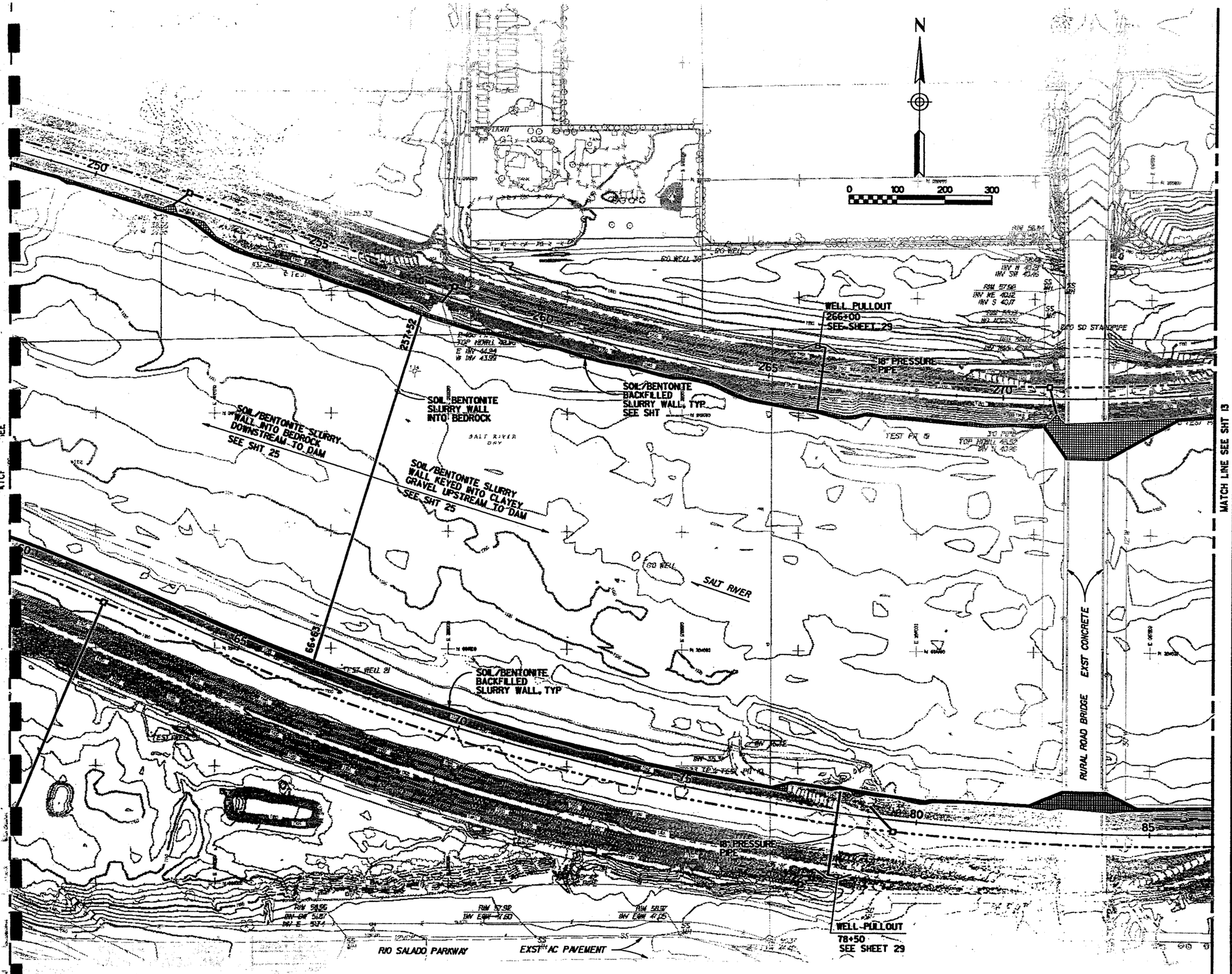
KEY PLAN
NTS

BEFORE YOU DIG
CALL 263-1100
ONE WORK DAY BEFORE YOU DIG
CALL COLLECT

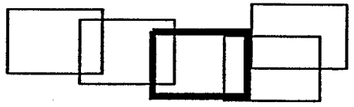
DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE INFILTRATION MANAGEMENT PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 13 OF X

3c24.dgn
SEP-1994
:44:03



CONSTRUCTION NOTES



KEY PLAN
NTS

263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	LAKE INFILTRATION MANAGEMENT PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 12 OF X

RED MOUNTAIN FREEWAY
(UNDER CONSTRUCTION)

225
230
235
240
245

ARMOR STONE AND
GEOSYNTHETIC CLAY
LINING, TYP
SEE SHT 25

SOIL/BENTONITE
BACKFILLED
SLURRY WALL, TYP
SEE SHT 25

MILLER AVENUE BRIDGE

EXST CONCRETE

SALT RIVER

MATCH LINE SEE SHT 10

MATCH LINE SEE SHT 12

ARMOR STONE AND
GEOSYNTHETIC CLAY
LINING, TYP

SOIL/BENTONITE
BACKFILLED
SLURRY WALL, TYP

35
40
45
50
55

SOUTHWEST GAS LINE
APPROXIMATE LOCATION
PER STUDY

RIO SALADO PARKWAY

EXST AC
PAVEMENT

APPROXIMATE LOCATION
OF CORP. WATER MAIN
PER CORP. WATER MAPS

N

0 100 200 300

CONSTRUCTION NOTES

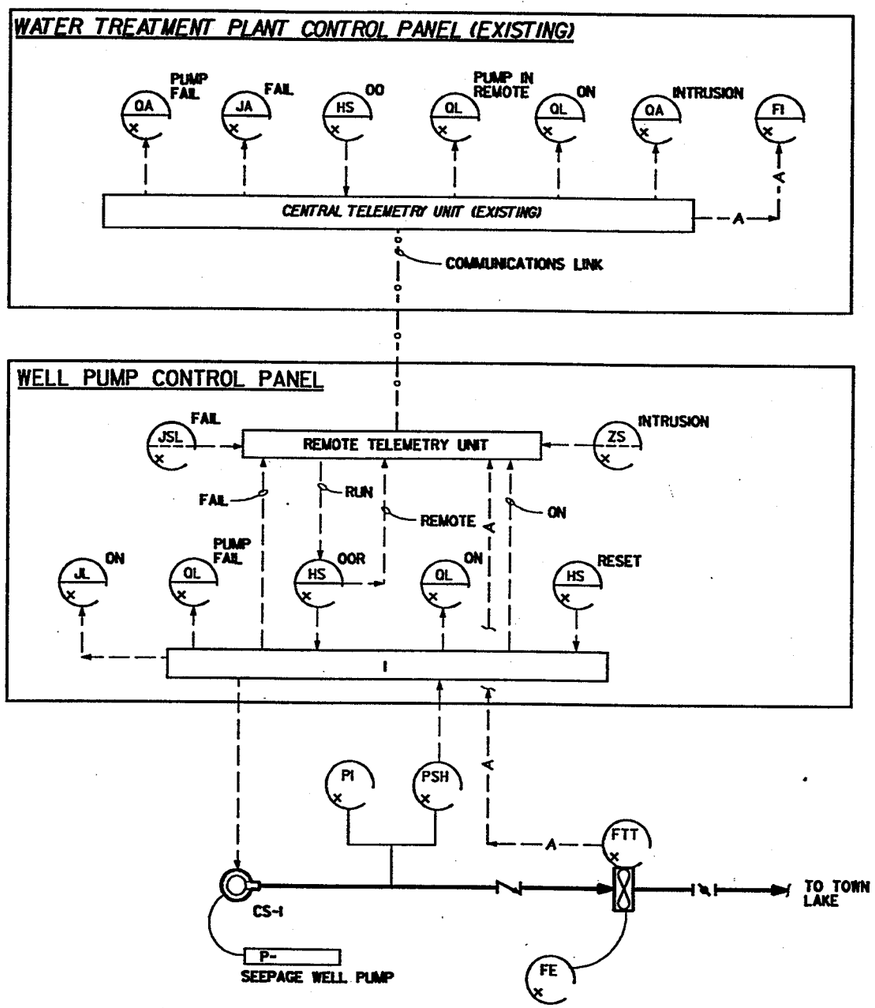
KEY PLAN
NTS

263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 199
DESIGNED: X	LAKE INFILTRATION MANAGEMENT PLAN	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=100'		SHT. 8 OF 7

3c22.dgn
P-1994
:38:59



TYPICAL SEEPAGE WELL CONTROLS

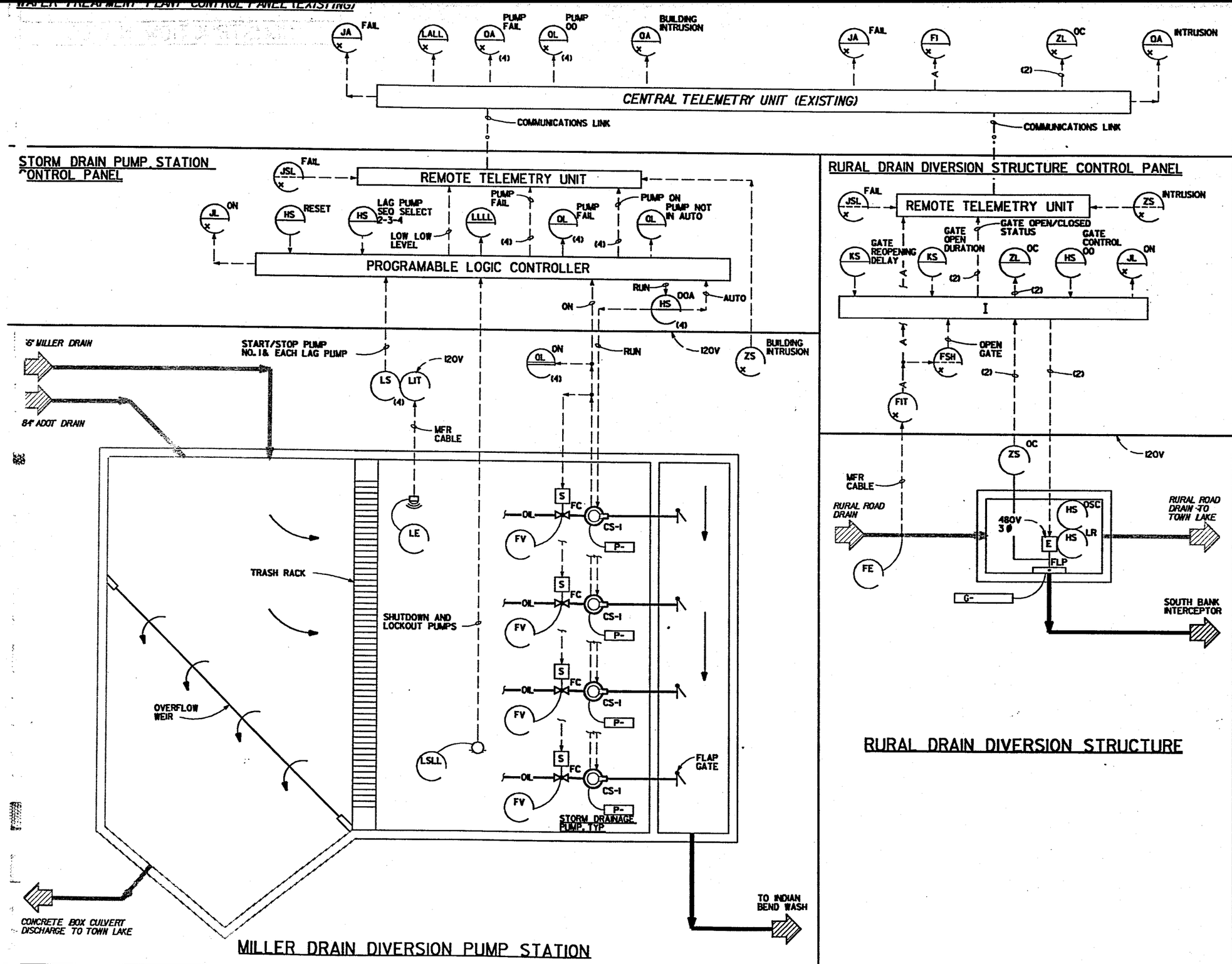
CONSTRUCTION NOTES

263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	P&ID	PROJECT NO. 946523
DRAWN: J URIA	TYPICAL SEEPAGE WELL CONTROLS	
CHECKED: X		
SCALE: NTS		SHT. 45 OF X

WATER TREATMENT PLANT CONTROL PANEL (EXISTING)



CONSTRUCTION NOTES

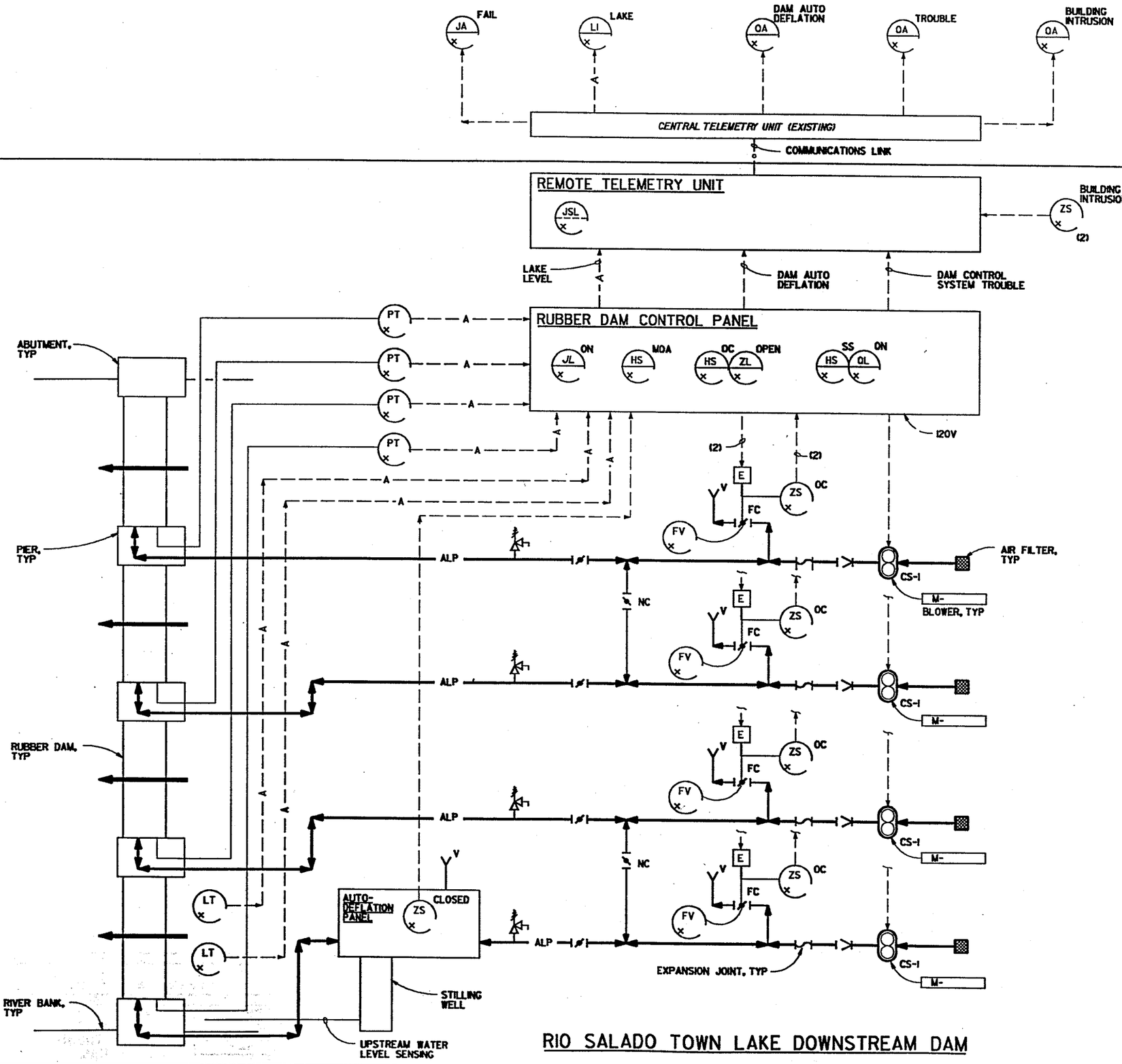
263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	P&ID	PROJECT NO. 946523
DRAWN: H HERRICK	MILLER DRAIN DIVERSION	
CHECKED: X	RURAL DRAIN DIVERSION	
SCALE: NTS		SHT. 44 OF X

4. p03.dgn
1994
12

WATER TREATMENT PLANT CONTROL PANEL (EXISTING)



RIO SALADO TOWN LAKE DOWNSTREAM DAM

CONSTRUCTION NOTES

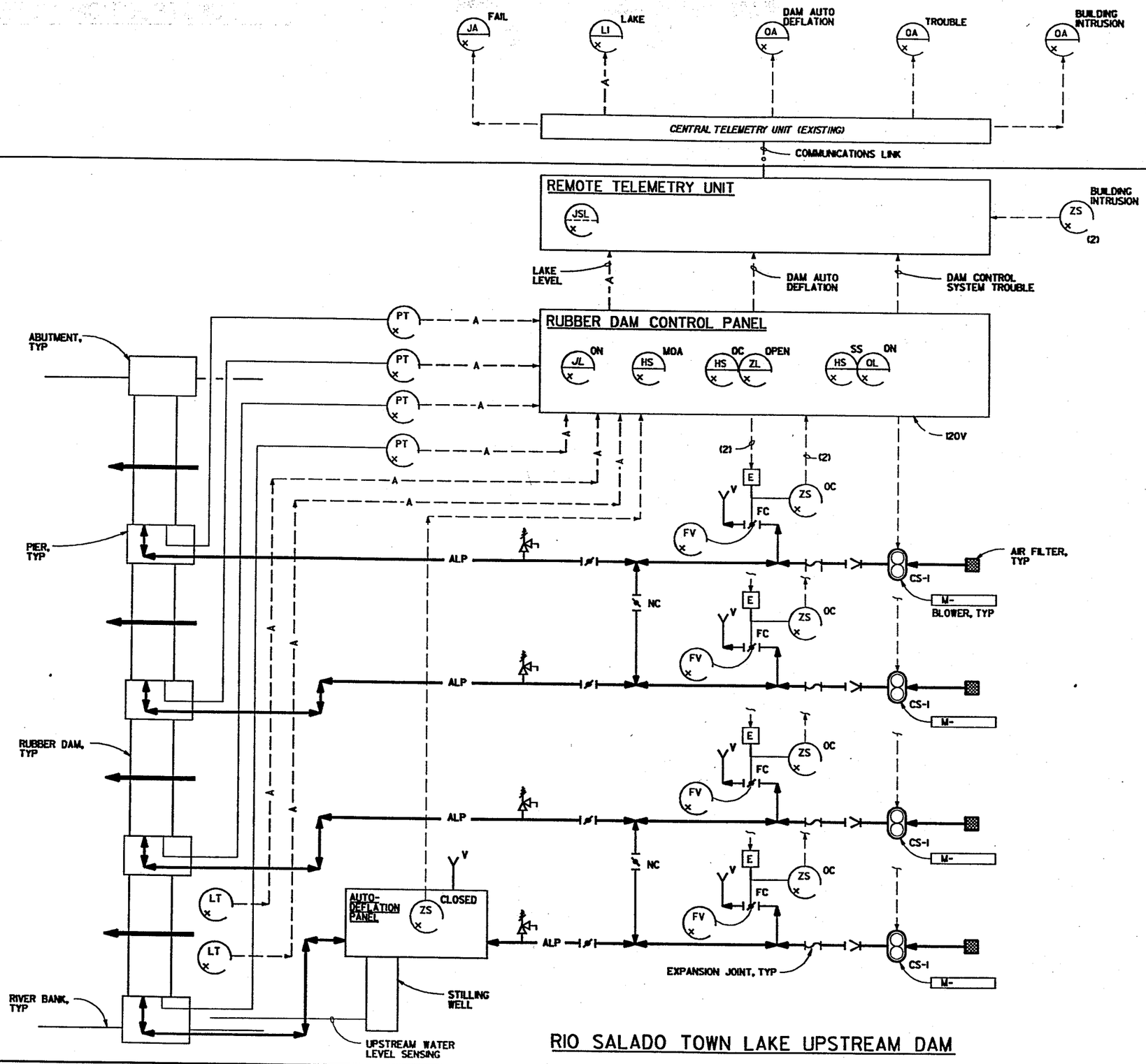
263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	P&ID DOWNSTREAM DAM	PROJECT NO. 946523
DRAWN: J URIA		
CHECKED: X		
SCALE: NTS		SHT. 43 OF X

DL.dgn
1994
25:42

WATER TREATMENT PLANT CONTROL PANEL (EXISTING)



RIO SALADO TOWN LAKE UPSTREAM DAM

CONSTRUCTION NOTES

283-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS

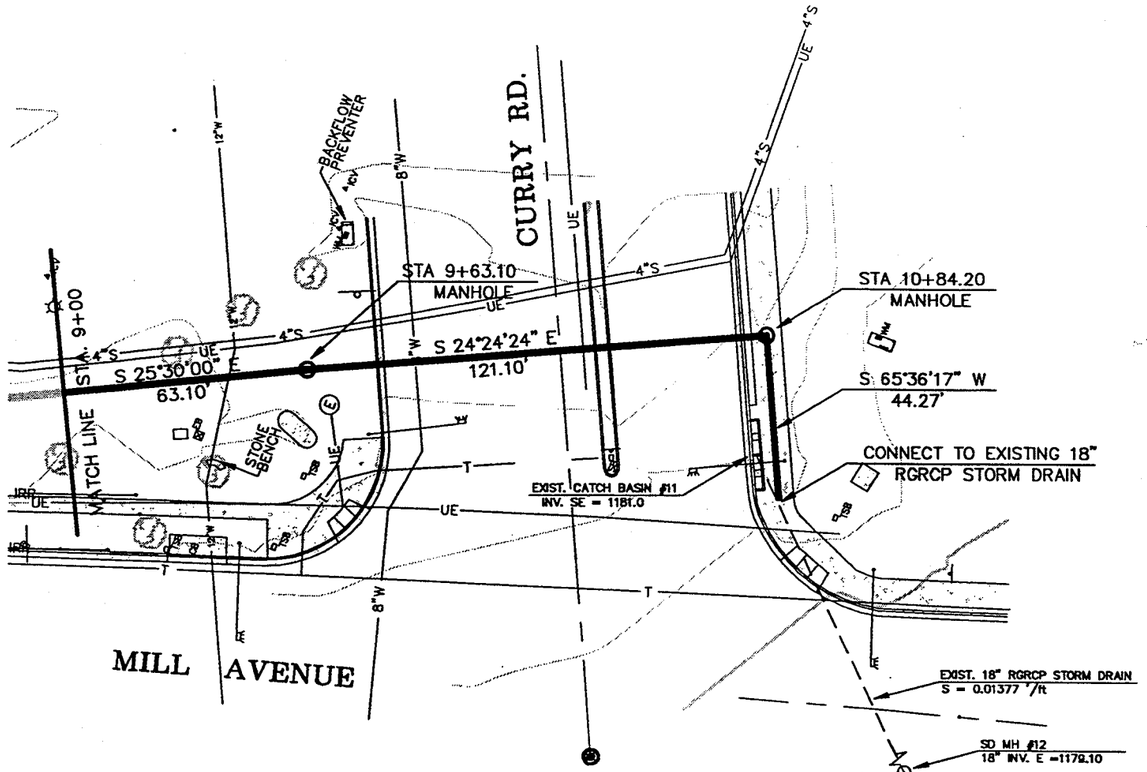
CITY OF TEMPE

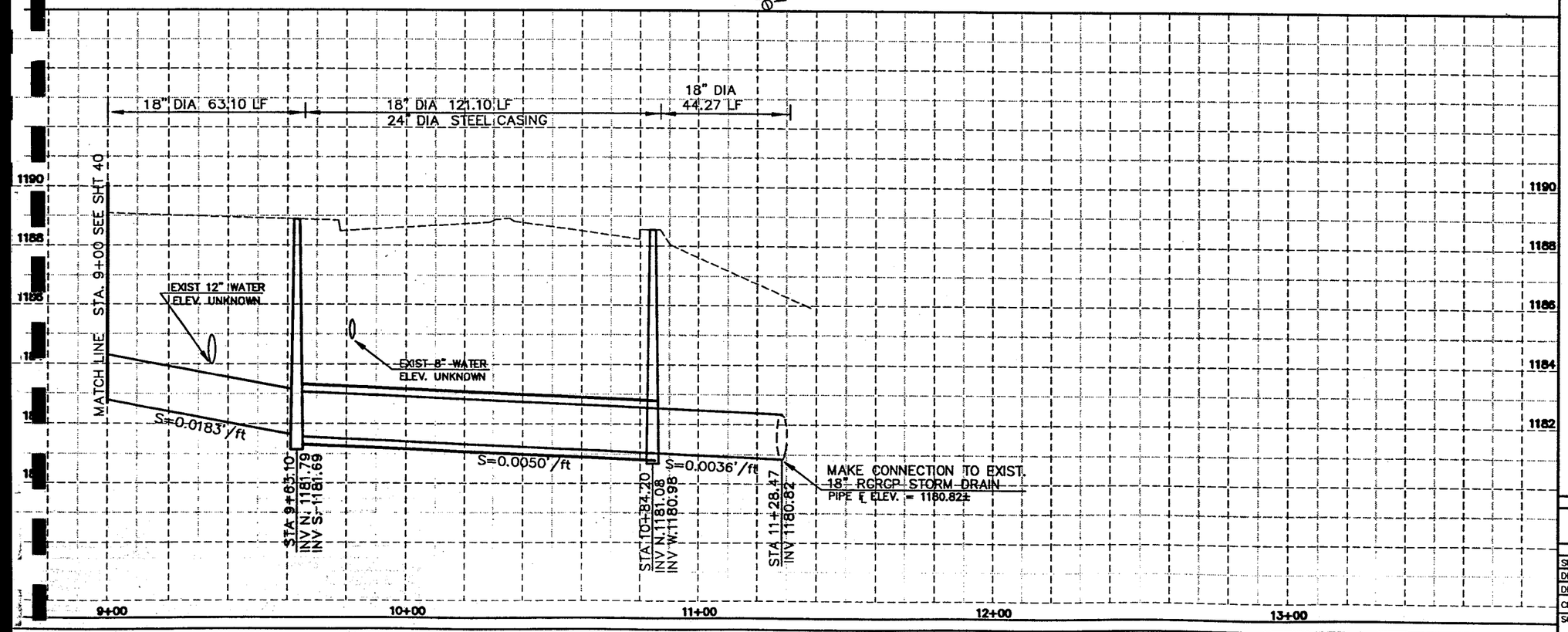
DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	P&ID UPSTREAM DAM	PROJECT NO. 946523
DRAWN: J URIA		
CHECKED: X		
SCALE: NTS		SHT. 42 OF X

4_3p02.dgn
-SEP-1994
:25:07





CONSTRUCTION NOTES

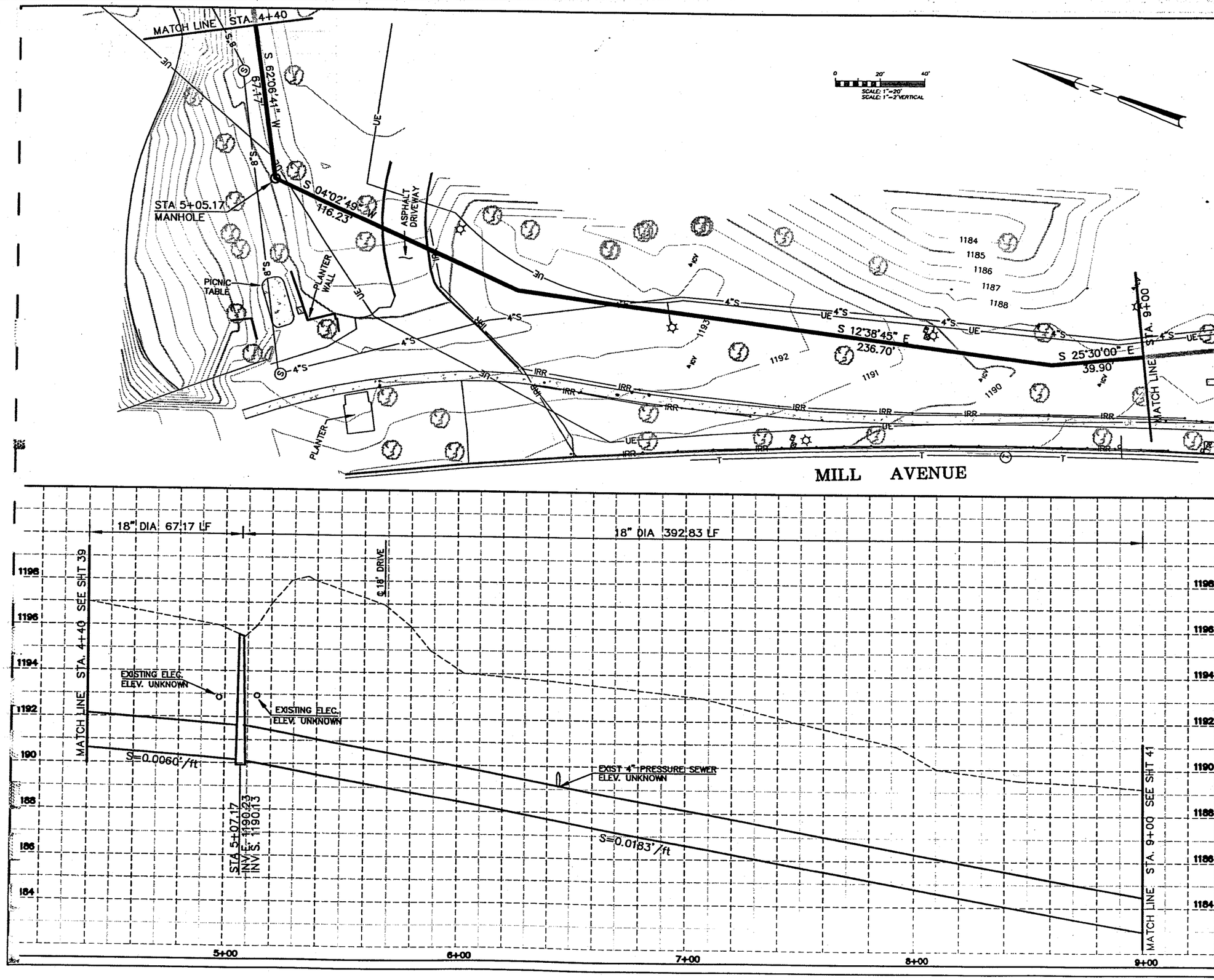
DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE

DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: B-A	DESCRIPTION	DATE SEPT 1994
DESIGNED: R.R.	LAT. 2-4.6 TO MILL PIPELINE	PROJECT NO. 946523
DRAWN: M.C.		
CHECKED:		
SCALE: 1"=20'		SHEET 41 OF X



CONSTRUCTION NOTES

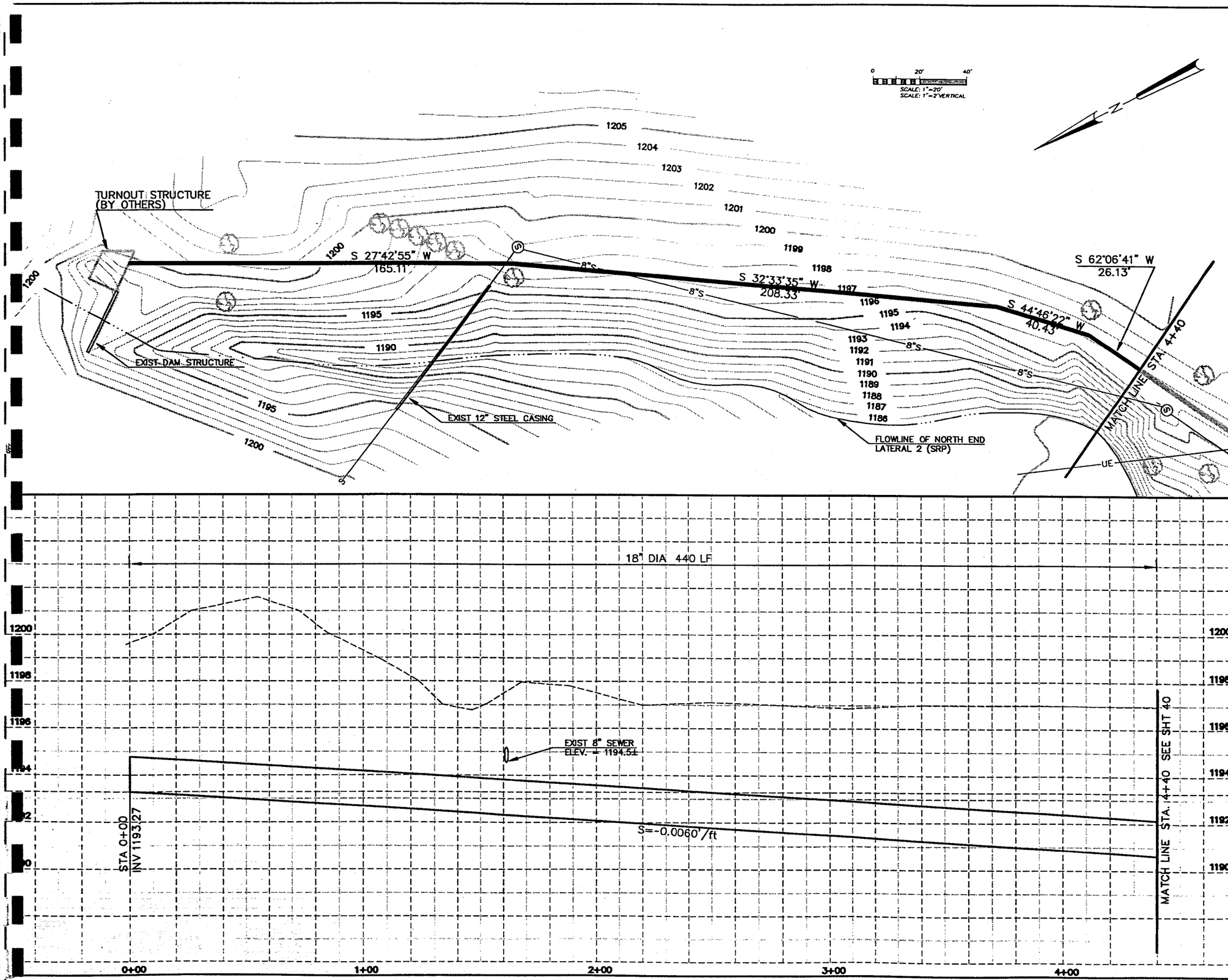
DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE

DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: B-A	DESCRIPTION	DATE SEPT 1994
DESIGNED: R.R.	LAT. 2-4.6 TO MILL PIPELINE	PROJECT NO. 946523
DRAWN: M.C.		
CHECKED:		
SCALE: 1"=20'		SHEET 40 OF X



CONSTRUCTION NOTES

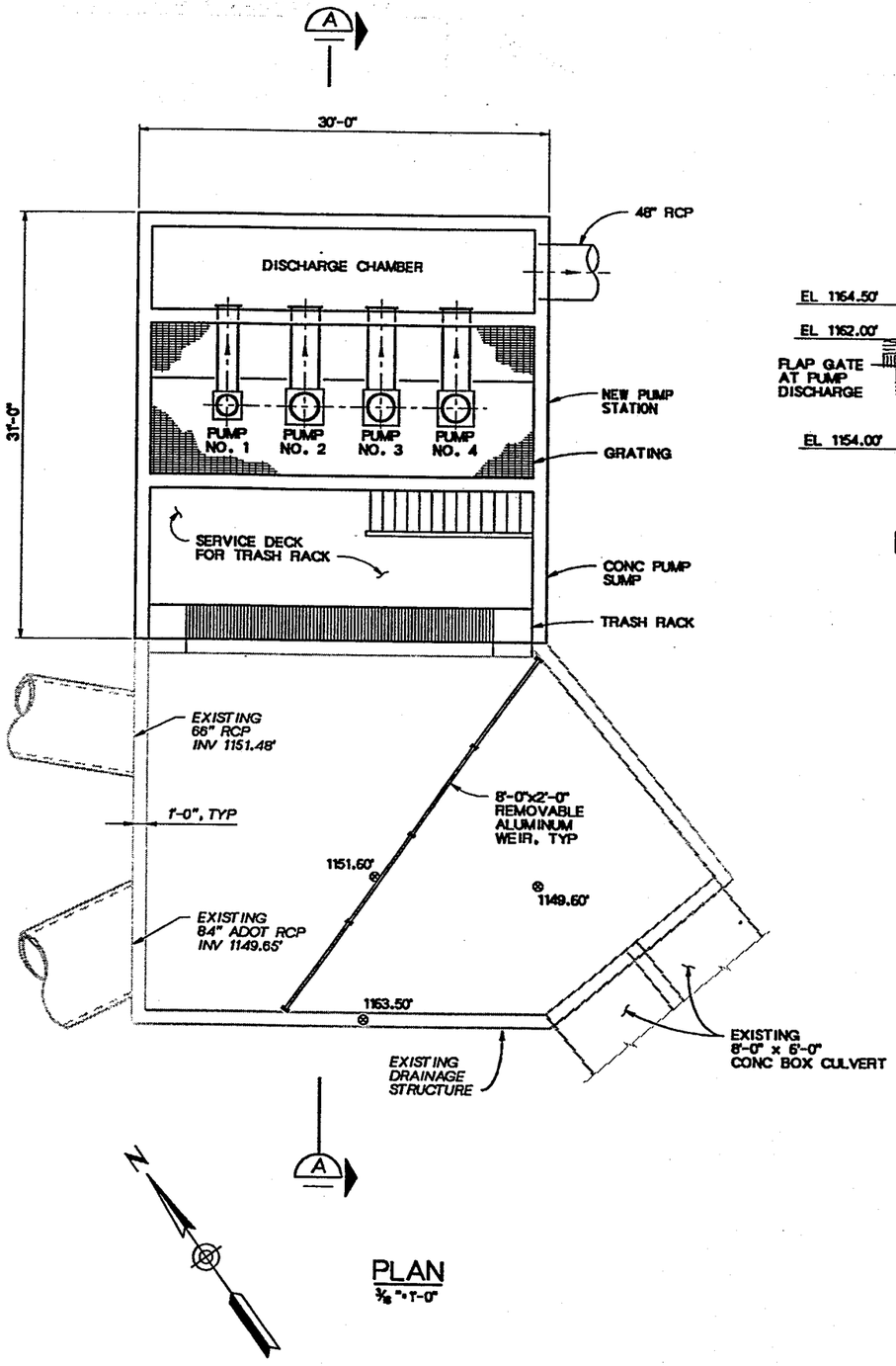
DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE

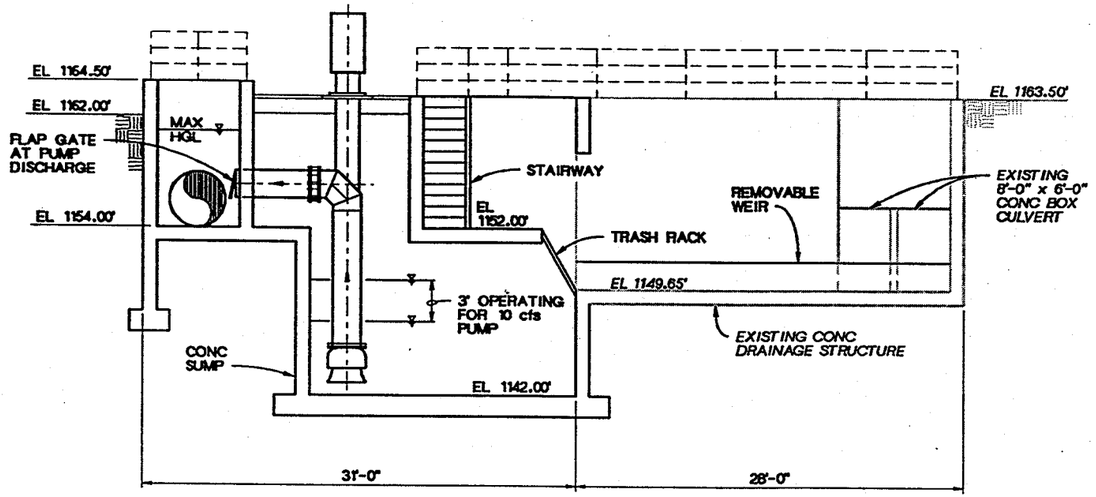
DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: B-A	DESCRIPTION	DATE SEPT 1994
DESIGNED: R.R.	LAT. 2-4.6 TO MILL PIPELINE	PROJECT NO. 946523
DRAWN: M.C.		
CHECKED:		
SCALE: 1"=20'		SHEET 39 OF X



PLAN
3/16"=1'-0"



SECTION A
3/16"=1'-0"

CONSTRUCTION NOTES

NOTES:

PUMPS:
NO. 1 - 10 cfs PROPELLER PUMP 20 hp
NO. 2-4 - 18 cfs PROPELLER PUMP 40 hp

263-1100
CALL COLLECT

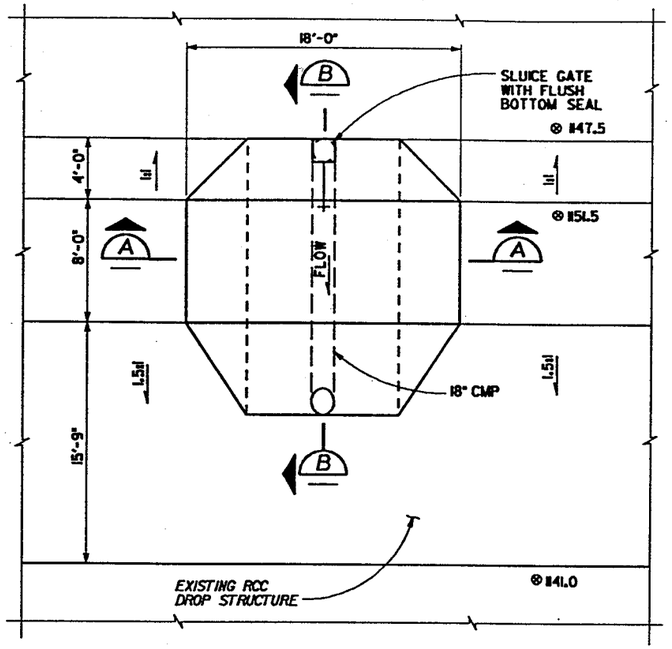
DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 19
DESIGNED: X	MILLER DRAIN PUMP STATION	PROJECT NO. 946523
DRAWN: W WORRALL		
CHECKED: X		
SCALE: 3/16"=1'-0"		SHT. 38 OF

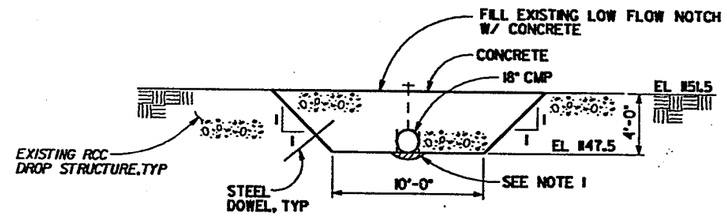
3la2.dgn
-SEP-1994
:23:21

NOTES:

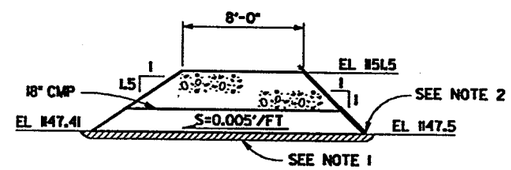
1. CHISEL A 24" WIDE BY 6" DEEP SLOT OUT OF EXISTING RCC AND REPLACE WITH GROUT IMMEDIATELY PRIOR TO PLACING 18" CMP TO PROVIDE ADEQUATE SUPPORT FOR PIPE.
2. COORDINATE PLACEMENT OF SLURRY WITH SLUICE GATE MANUFACTURER'S SPECIFICATIONS FOR A FLUSH BOTTOM WATER TIGHT SEAL.



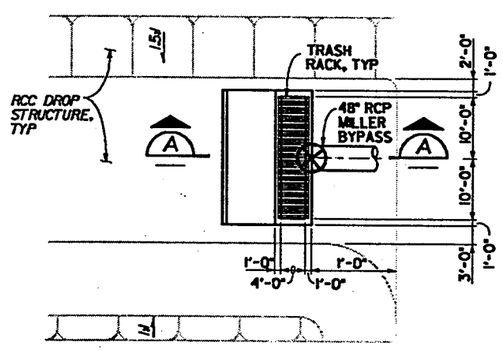
PLAN
1"=5'-0"



SECTION A
1"=5'-0"



SECTION B
1"=5'-0"



PLAN
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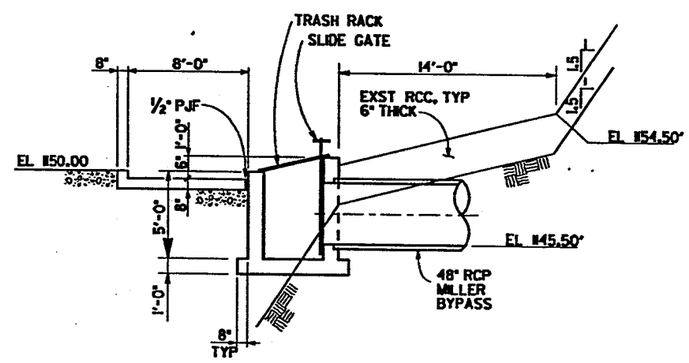


SECTION A
¼"=1'-0"

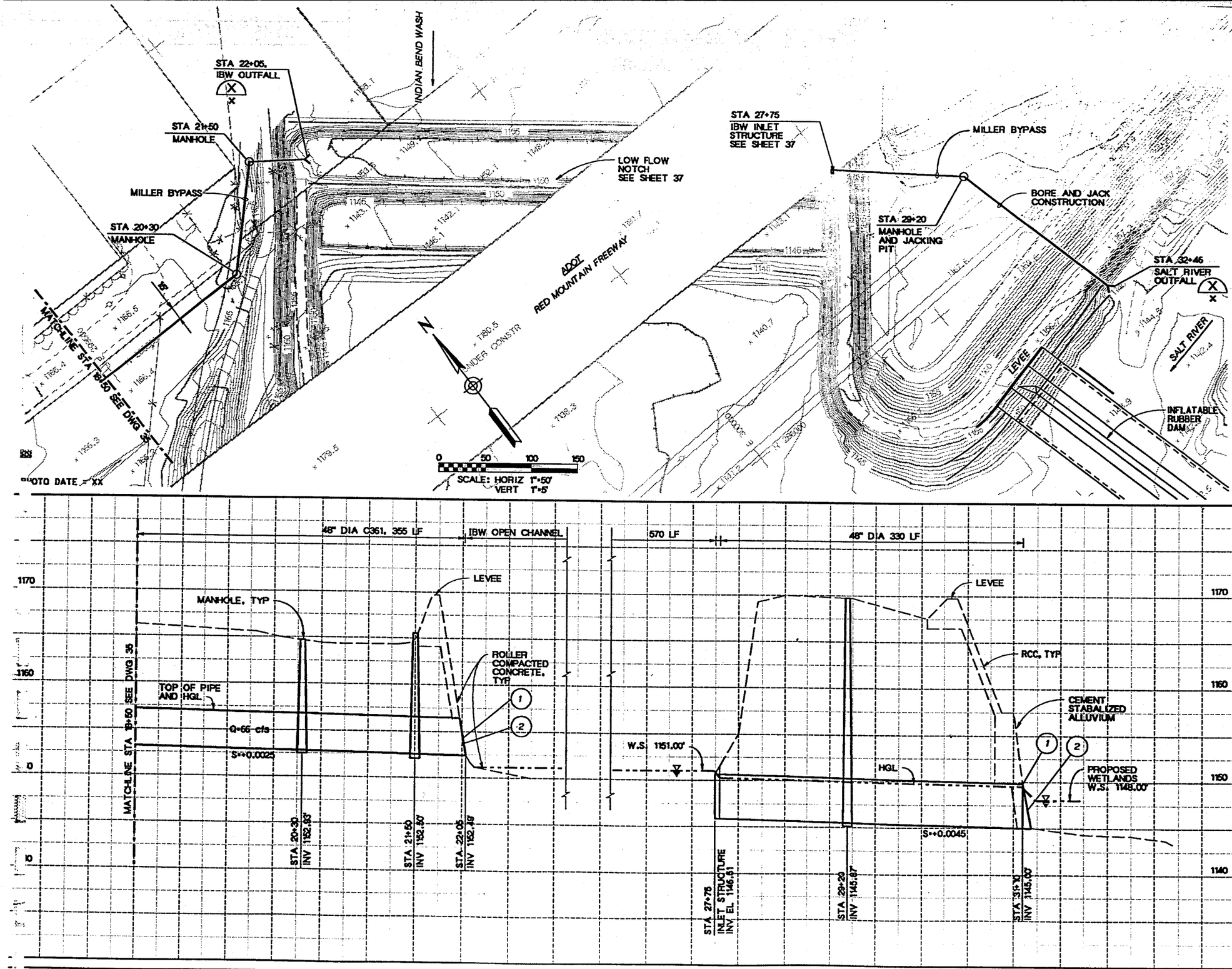
CONSTRUCTION NOTES

263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	IBW DROP STRUCTURE MODIFICATIONS	PROJECT NO. 946523
DRAWN: J URIA		
CHECKED: X		
SCALE: 1"=5'-0"		SHT. 37 OF X

3 d.dgn
SEP 1994
0:42



CONSTRUCTION NOTES

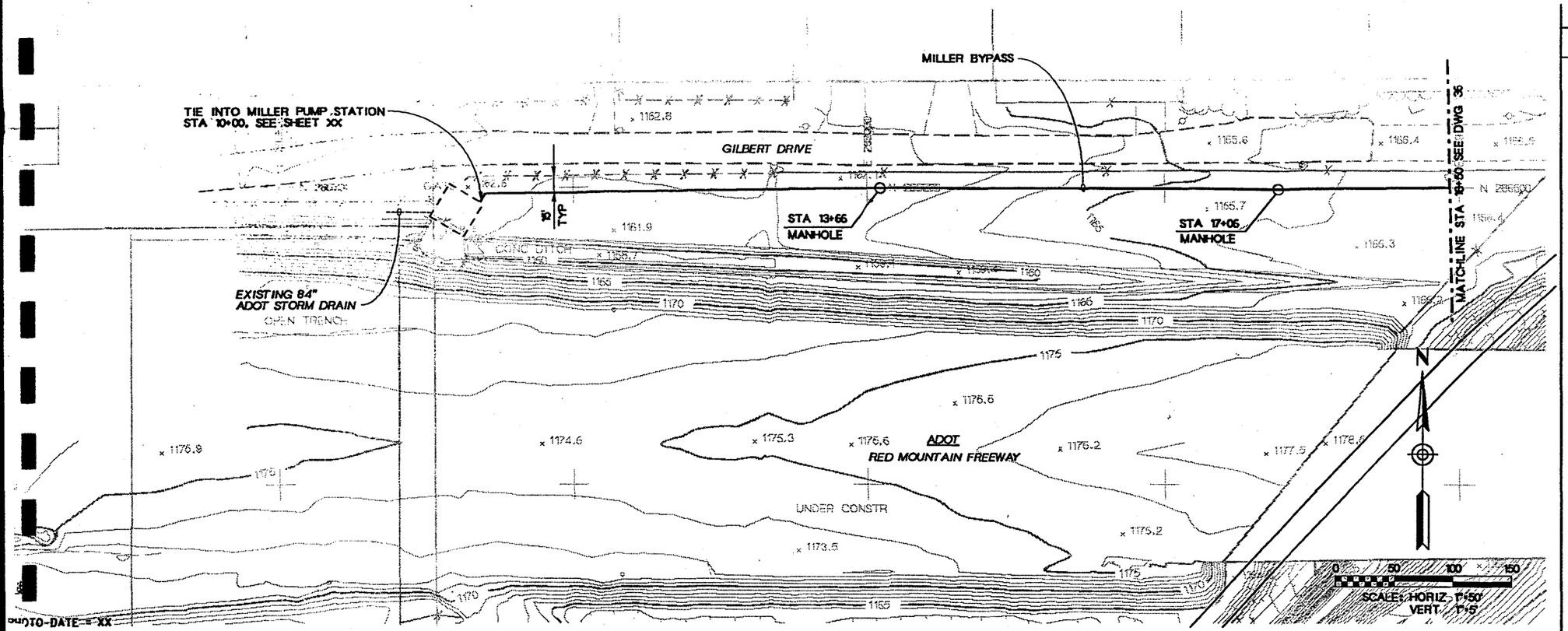
1. WATERMAN 48" FLAPGATE.
2. HDWL PER MAG 501-4.

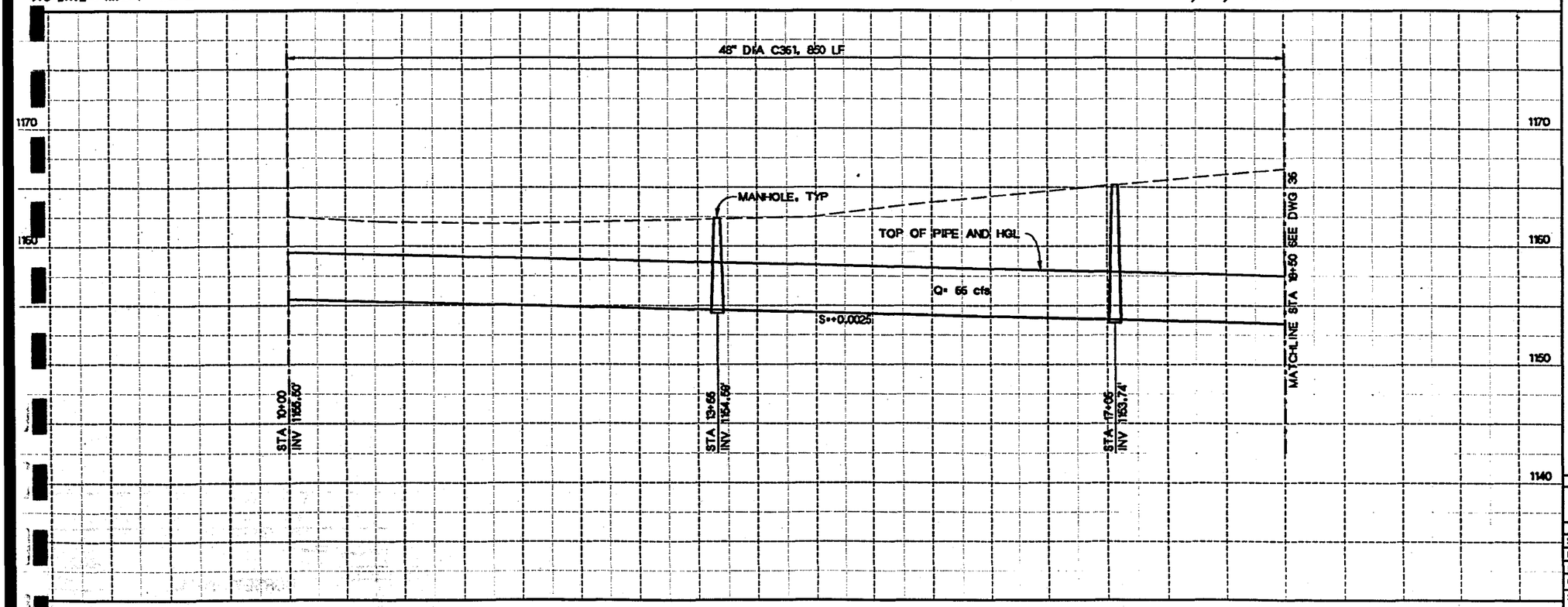
263-1100
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	MILLER BYPASS	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=50'		SHT. 36 OF X

3106.dgn
-SEP-1994





CONSTRUCTION NOTES

DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE

DIVISION OF ENGINEERING

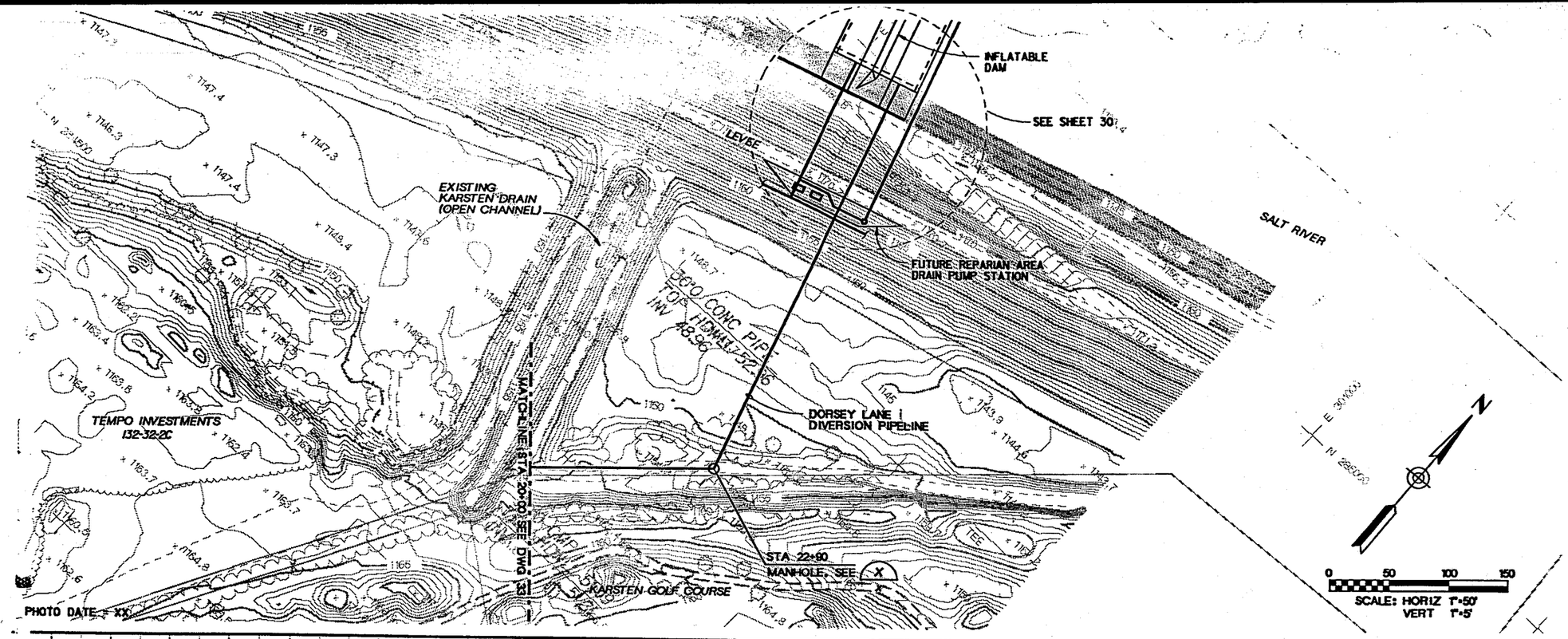
P.O. BOX 5002 TEMPE, ARIZONA 85280

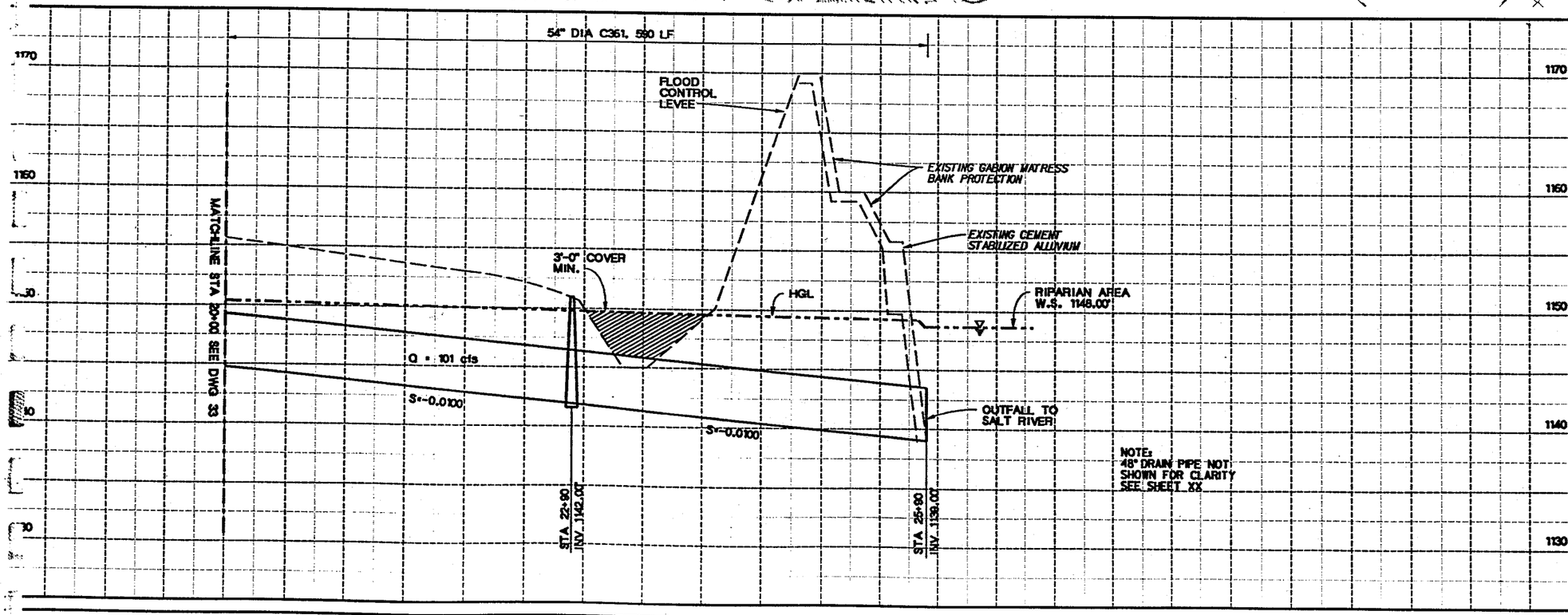
SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	MILLER BYPASS	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=50'		SHT. 35 OF X

263-1100 CALL COLLECT

TO-DATE = XX

05.dgn
SEP-1994





CONSTRUCTION NOTES

NOTES:

1. HGL ASSUMES n = 0.014 AND ½ VELOCITY HEAD LOSS ACROSS MANHOLES.

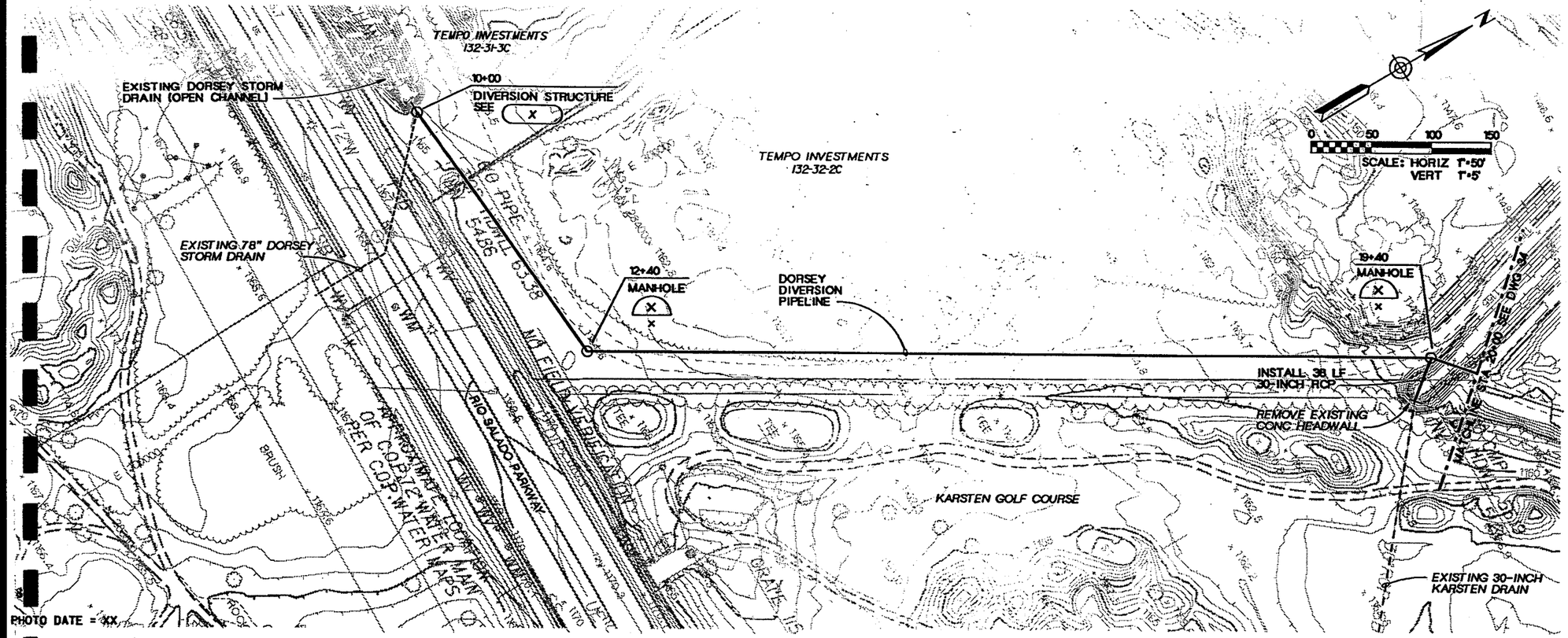
CALL COLLECT 263-1100

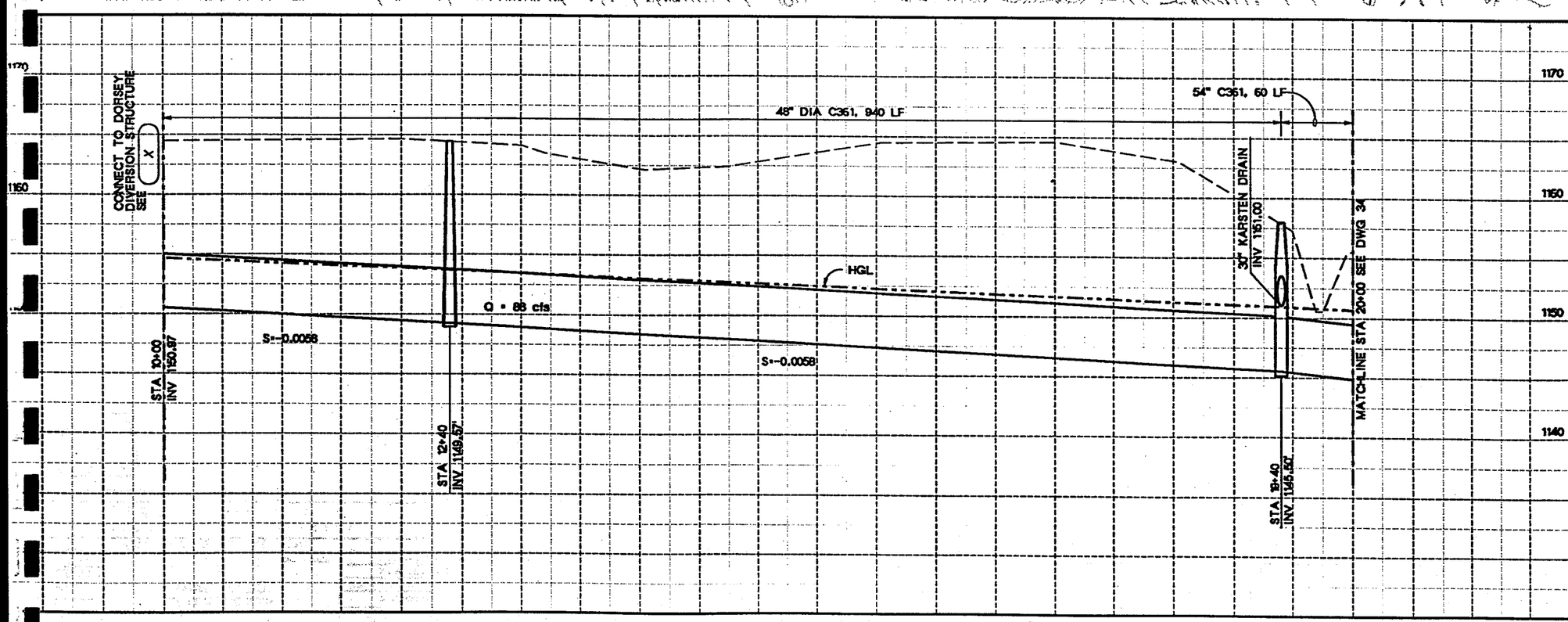
DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 199
DESIGNED: X	DORSEY BYPASS	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=50'		SHT. 34 OF

23102.dgn
1-SEP-1994
8:32:50





CONSTRUCTION NOTES

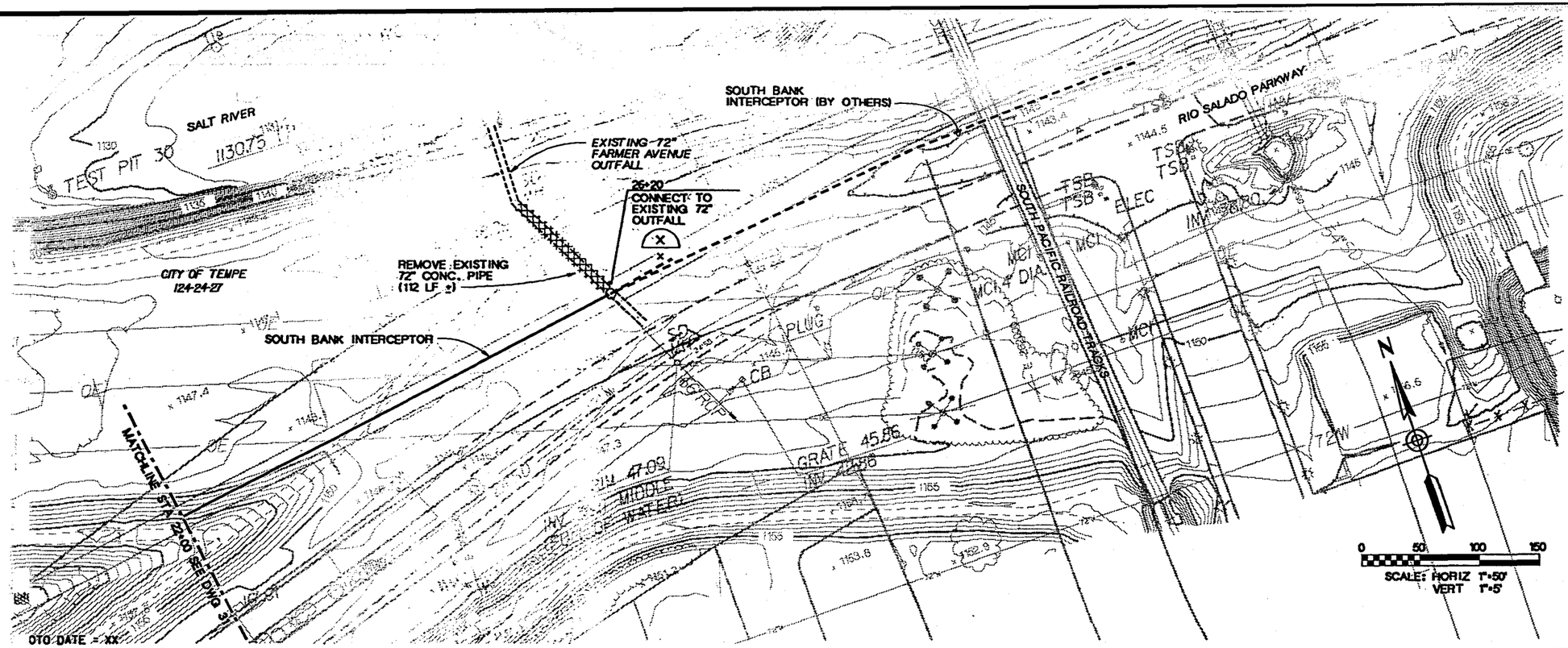
NOTES:

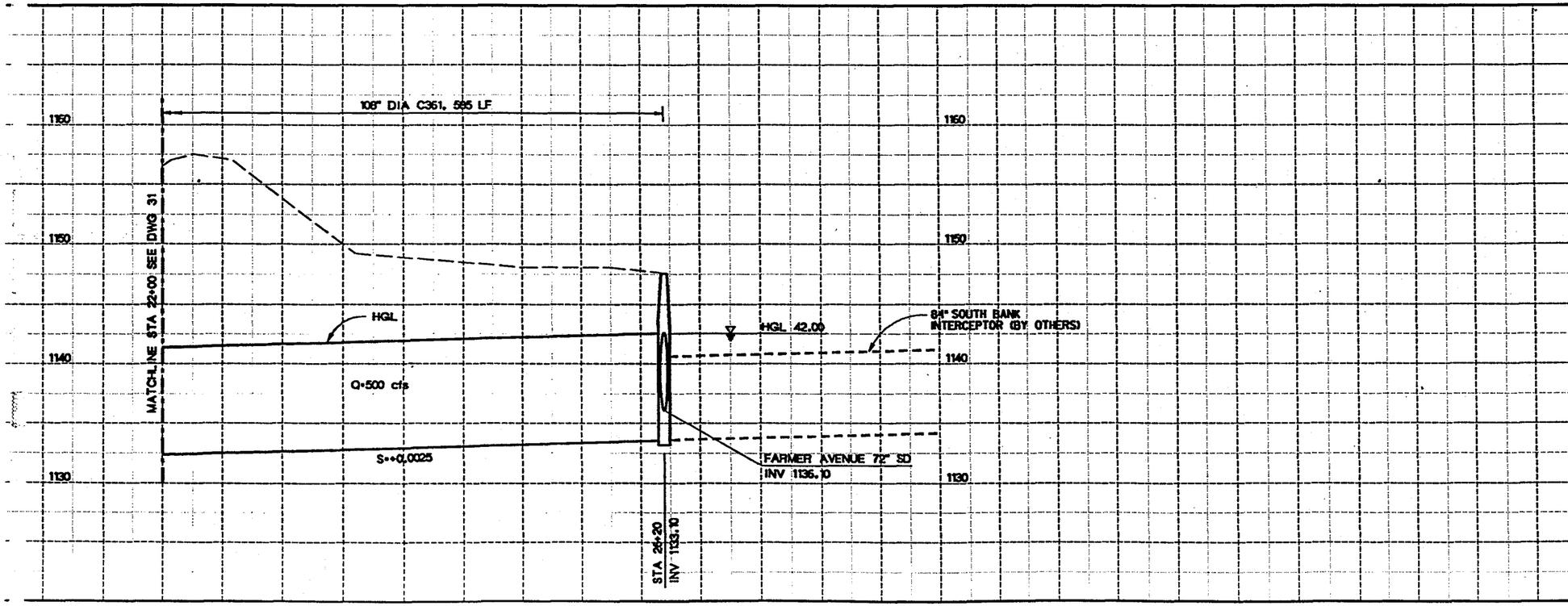
1. HGL ASSUMES n = 0.014 AND ½ VELOCITY HEAD LOSS ACROSS MANHOLES

BEFORE YOU DIG, PLAN AHEAD
263-1100
FROM TEMPE AREA
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X		PROJECT NO. 946523
DRAWN: C WORRALL	DORSEY BYPASS	
CHECKED: X		
SCALE: 1"=50'		SHT. 33 OF X





CONSTRUCTION NOTES

283-1100
ONE CALL CENTER
CALL COLLECT

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION	DATE SEPT 1994
DESIGNED: X	SOUTH BANK INTERCEPTOR	PROJECT NO. 946523
DRAWN: C WORRALL		
CHECKED: X		
SCALE: 1"=50'		SHT. 32 OF X

4-3104.dgn
-SEP-1994

Rio Salado Town lake
Conceptual Landscape Development

Prepared for

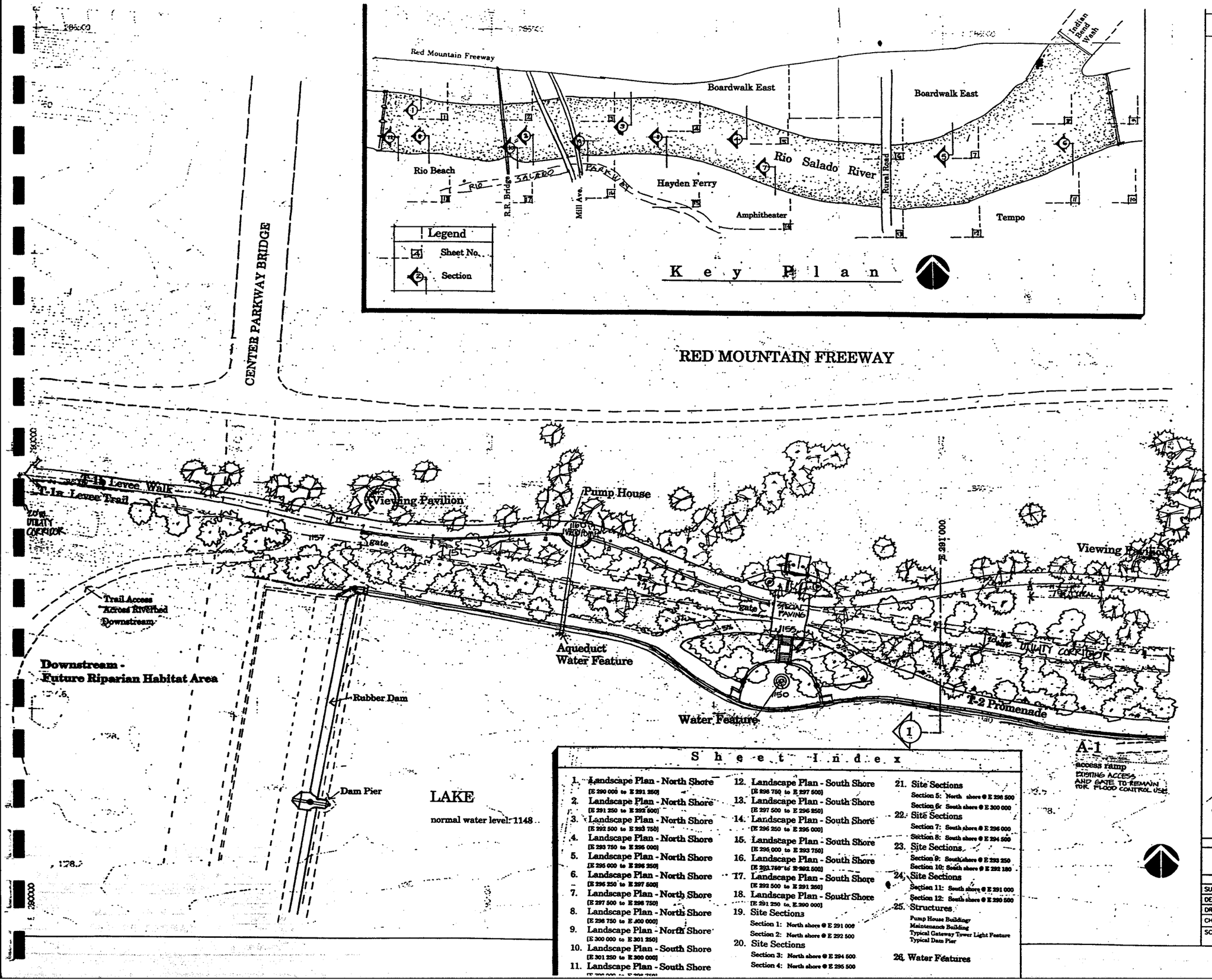
The City of Tempe
Community Development Department

Prepared by

Civil Engineers: CH2M Hill

Landscape Architects: Martino & Tatasciore,

in association with
Wayne Colebank of Logan, Simpson & Dye



CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

- Gateway Plazas (pedestrian access to park)
- Restrooms

TRAILS:

T-1a: Levee Trail (15' wide D.G./Maintenance Route)
T-1b: Levee Walk (12' wide Conc. Bikeway/Walkway)
T-2: Promenade (20' wide D.G. @ Water Edge)
T-3: Connector-Trail (12' wide Conc. w/ 5% max. gradient slope)

LIGHTING:

- Type "A" (Special 100' high Tower area lights, at Gateways)
- Type "B" (Standard 22' high poles along Levee)
- Type "C" (Special 15' high poles along Promenade)

MARINAS:

M-1: Main Dock (80 boat slips) with Ferry landing site
M-2: Central Area (60 boat slips) with Ferry landing site
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with stepped access to water for hand launch/landing site

LANDSCAPE:

- Native & Hybrid Mesquite Trees
- Blue Palo Verde & Ironwood Trees
- Desert Habitat Plants
- Public Turf Areas

Sheet Index

1. Landscape Plan - North Shore [E 290 000 to E 291 250]
2. Landscape Plan - North Shore [E 291 250 to E 292 500]
3. Landscape Plan - North Shore [E 292 500 to E 293 750]
4. Landscape Plan - North Shore [E 293 750 to E 295 000]
5. Landscape Plan - North Shore [E 295 000 to E 296 250]
6. Landscape Plan - North Shore [E 296 250 to E 297 500]
7. Landscape Plan - North Shore [E 297 500 to E 298 750]
8. Landscape Plan - North Shore [E 298 750 to E 300 000]
9. Landscape Plan - North Shore [E 300 000 to E 301 250]
10. Landscape Plan - South Shore [E 301 250 to E 300 000]
11. Landscape Plan - South Shore [E 300 000 to E 298 750]
12. Landscape Plan - South Shore [E 298 750 to E 297 500]
13. Landscape Plan - South Shore [E 297 500 to E 296 250]
14. Landscape Plan - South Shore [E 296 250 to E 295 000]
15. Landscape Plan - South Shore [E 295 000 to E 293 750]
16. Landscape Plan - South Shore [E 293 750 to E 292 500]
17. Landscape Plan - South Shore [E 292 500 to E 291 250]
18. Landscape Plan - South Shore [E 291 250 to E 290 000]
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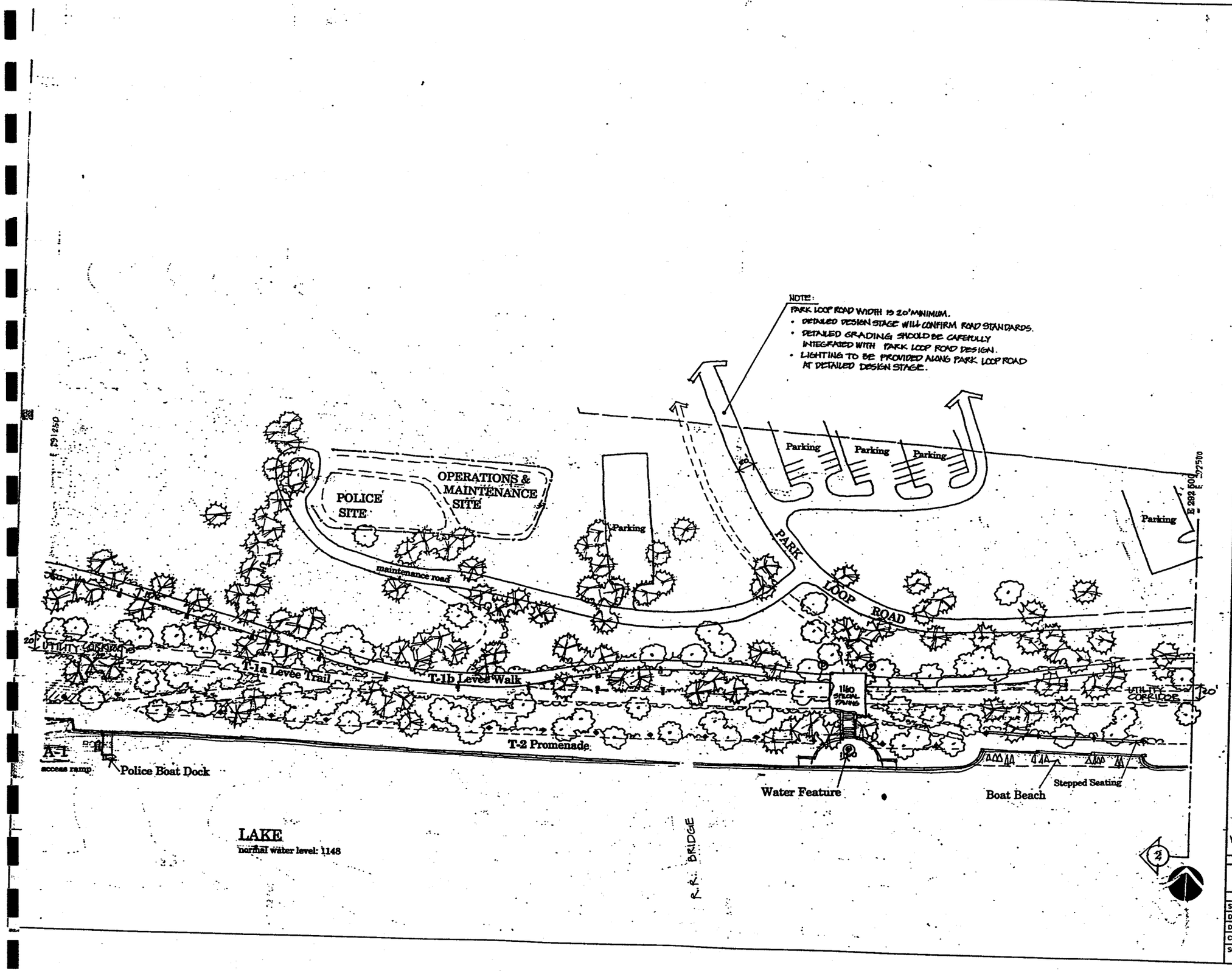
    Section 2: North shore @ E 292 500
20. Site Sections
    Section 3: North shore @ E 294 500
    Section 4: North shore @ E 295 500
21. Site Sections
    Section 5: North shore @ E 296 500
    Section 6: South shore @ E 300 000
22. Site Sections
    Section 7: South shore @ E 296 000
    Section 8: South shore @ E 294 500
23. Site Sections
    Section 9: South shore @ E 293 250
    Section 10: South shore @ E 292 180
24. Site Sections
    Section 11: South shore @ E 291 000
    Section 12: South shore @ E 290 500
25. Structures
    Pump House Building
    Maintenance Building
    Typical Gateway Tower Light Feature
    Typical Dam Pier
26. Water Features

Martino & Tatasciore
Landscape Architecture
Urban Design
Planning

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED:	DESCRIPTION	DATE July 21, 1994
DESIGNED: RJSM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RJSM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT. 1 of 20



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Landscape Architecture
Urban Design
Planning

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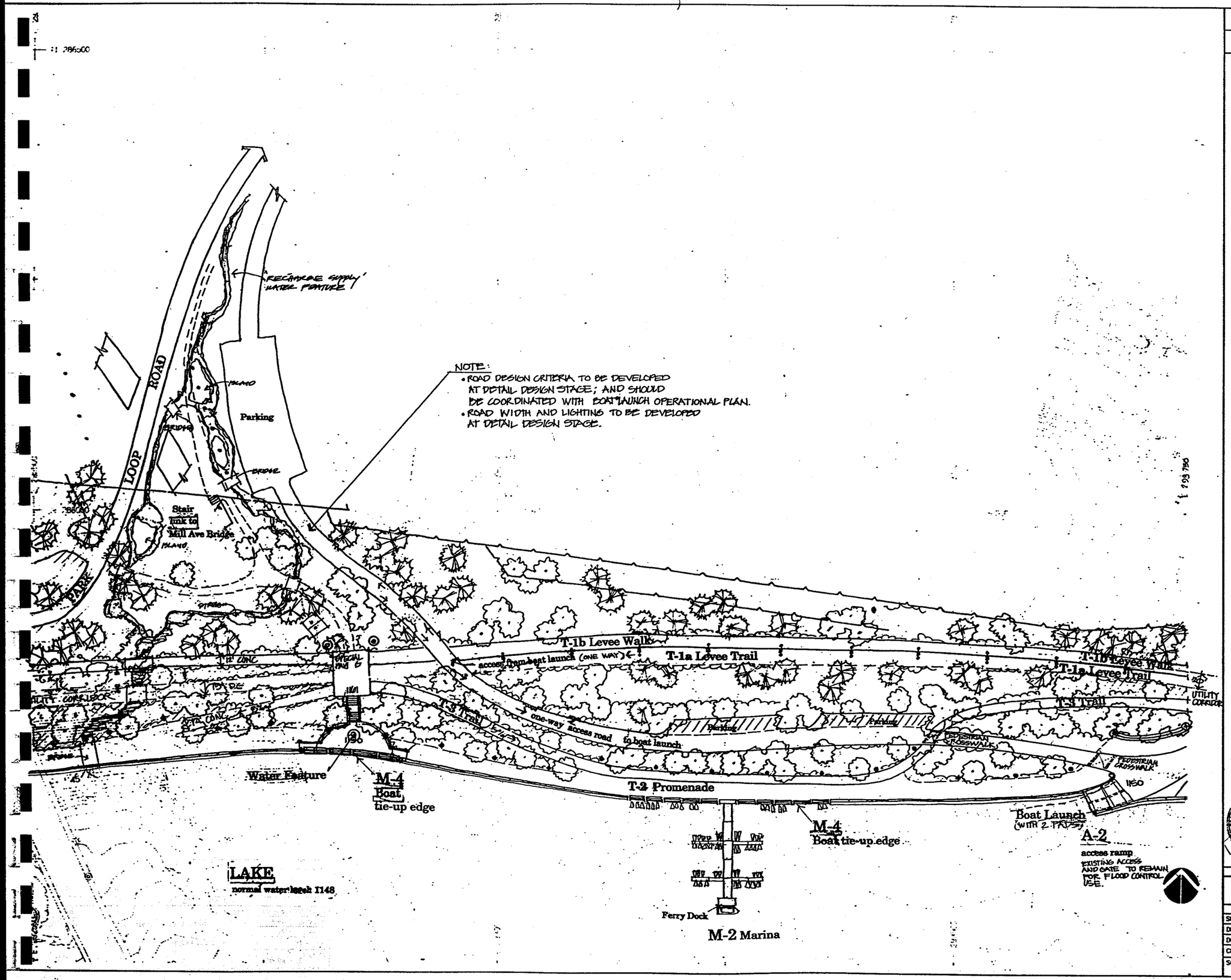
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CREW NO.	DESCRIPTION	DATE July 21
DESIGNED: RT/SM	Rio Salado Town Lake.	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN.	
CHECKED: SM.		
SCALE: 1" = 50'-0"		SHT: 2



NOTE:
- ROAD DESIGN CRITERIA TO BE DEVELOPED AT DETAIL DESIGN STAGE; AND SHOULD BE COORDINATED WITH BOAT LAUNCH OPERATIONAL PLAN.
- ROAD WIDTH AND LIGHTING TO BE DEVELOPED AT DETAIL DESIGN STAGE.

CONSTRUCTION NOTES

LEGEND:

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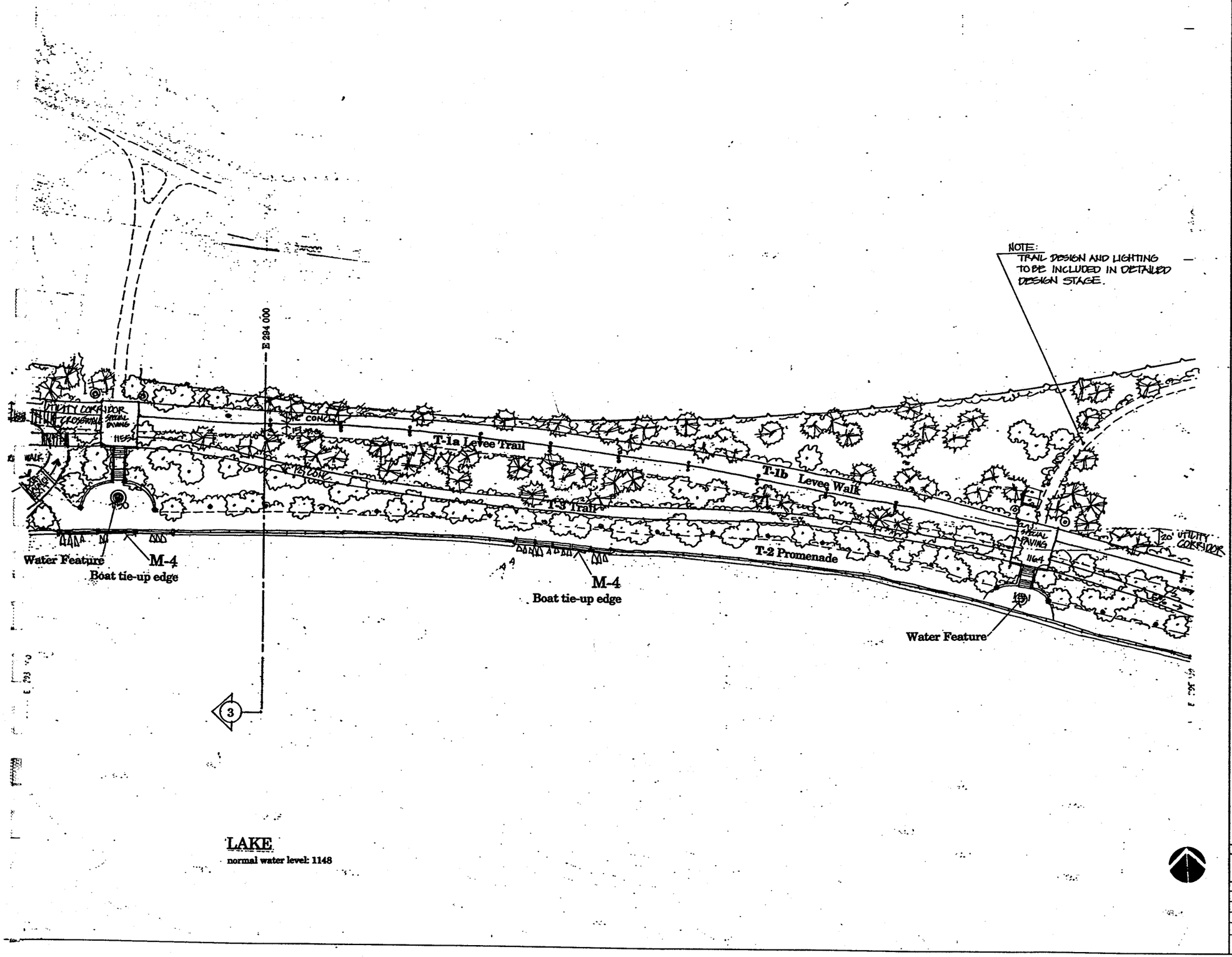
Landscape Architecture
Urban Design
Planning

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED:	DESCRIPTION	DATE July 21, 1994
DESIGNED: KT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: KT/SM	LANDSCAPE PLAN	
CHECKED: SM		SHT. 13 of 26
SCALE: 1" = 50'-0"		



CONSTRUCTION NOTES

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P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: KEM BLL	DESCRIPTION	DATE July 21, 1994
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 60'-0"		SHT. 4 of 2

NOTE:
TRAIL DESIGN AND LIGHTING TO UNDERPASS TO BE INCLUDED IN DETAILED DESIGN AND COORDINATED WITH DEVELOPMENT

BOARDWALK (WEST)
DEVELOPMENT SITE

NOTE:
TRAIL DESIGN AND LIGHTING TO BE INCLUDED IN DETAIL DESIGN STAGE

20' UTILITY CORRIDOR

T-1b Levee Walk

T-1a Levee Trail

E 295 500

M-4 Boat tie-up edge

Ferry Dock

M-1 Marina

A-3
access ramp
EXISTING ACCESS AND GATE TO REMAIN FOR FLOOD CONTROL USE

T-2 Promenade

M-4
Boat tie-up edge

T-3 Trail

Water Feature

NOTE:
EXISTING TRAIL TO BE REMOVED
CITY WILL SALVAGE EXISTING LIGHTING

UTILITY CORRIDOR 20'

LAKE
normal water level: 1148

CONSTRUCTION NOTES

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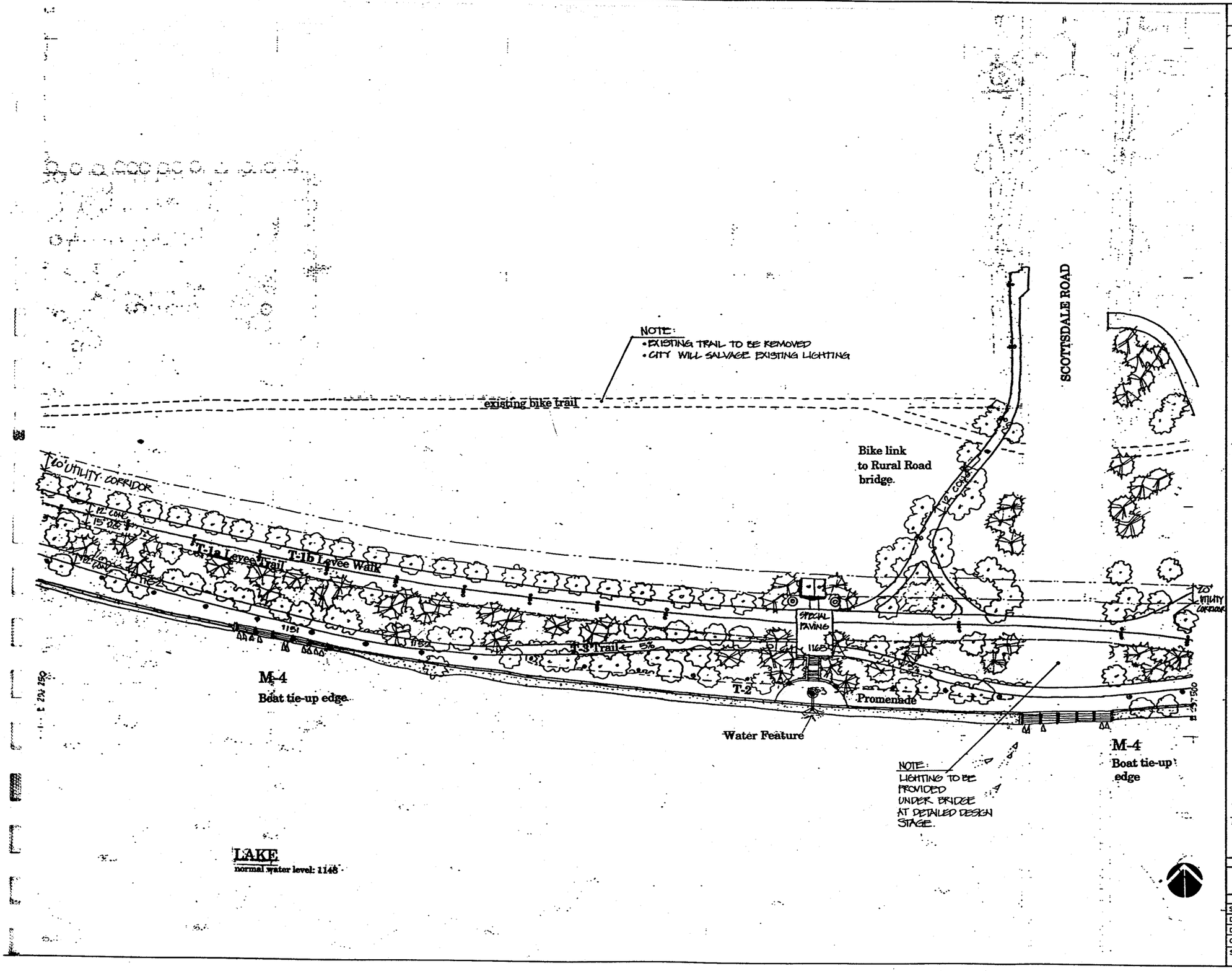
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CHEM HILL	DESCRIPTION	DATE July 21, 1994
DESIGNED: FT/SAC	Rio Salado Town Lake	PROJECT NO.
DRAWN: FT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT 5 of 26



CONSTRUCTION NOTES

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Landscape Architecture
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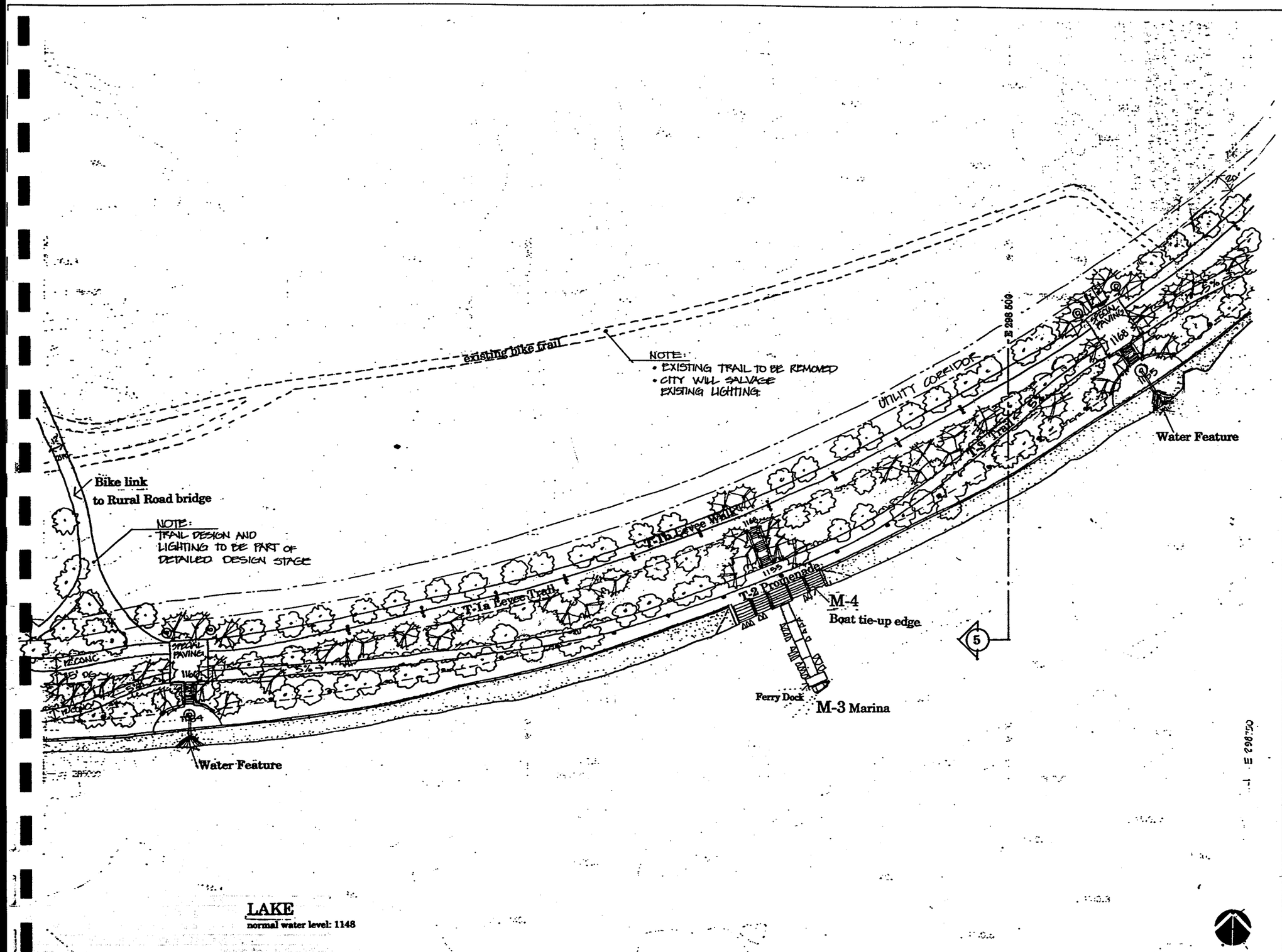
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CREW KILL	DESCRIPTION	DATE July 21, 198
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		SHT. 6
SCALE: 1" = 50'-0"		



CONSTRUCTION NOTES

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Gateway Plazas (pedestrian access to park)
Restrooms

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Desert Habitat Plants
Public Turf Areas

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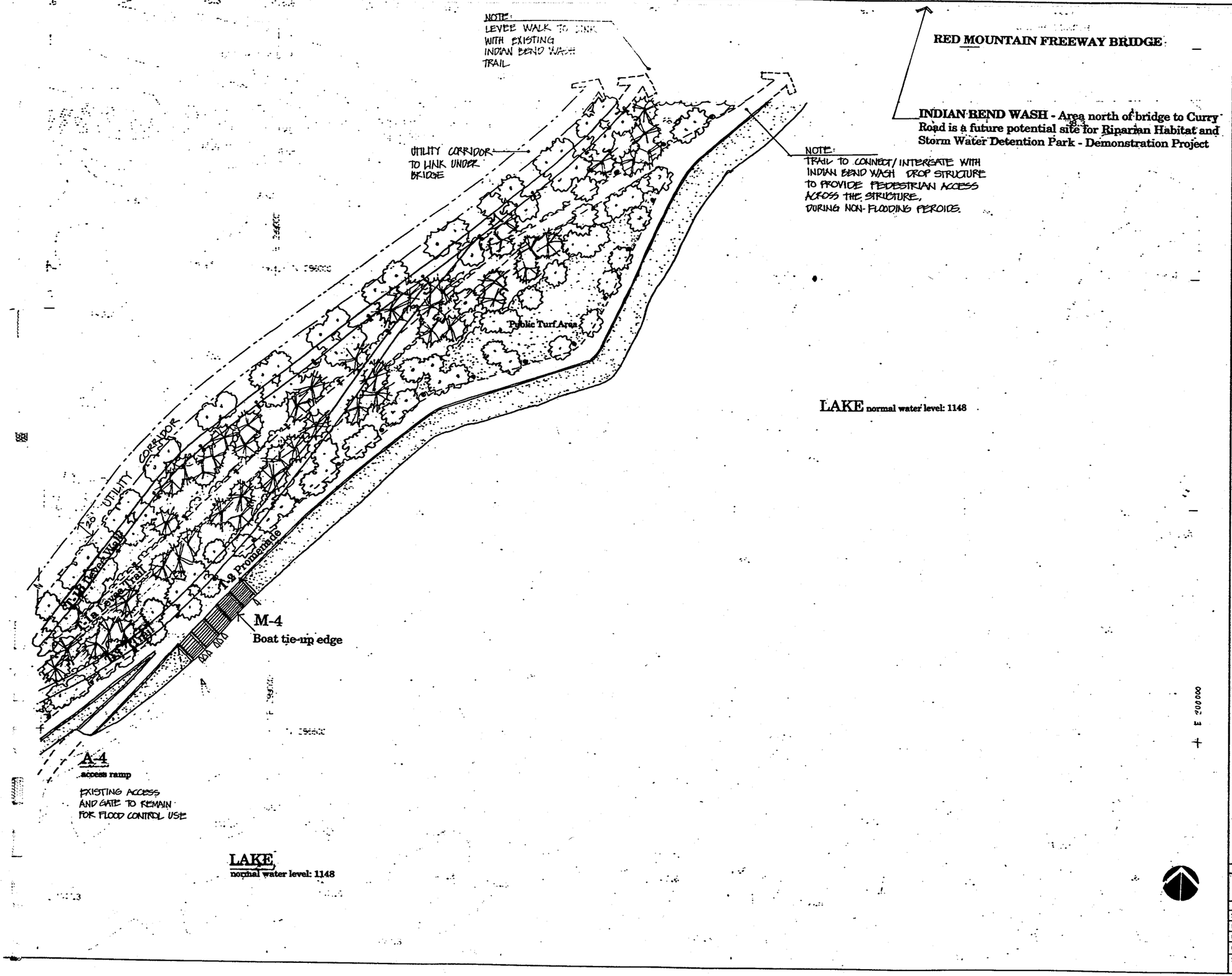
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: QUEM BRL	DESCRIPTION	DATE July 21, 1994
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT. 7 of 9



CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

Gateway Plazas (pedestrian access to park)
Restrooms

TRAILS:

T-1a: Levee Trail (15' wide D.G./Maintenance Route)
T-1b: Levee Walk (12' wide Conc. Bikeway/Walkway)
T-2: Promenade (20' wide D.G. @ Water Edge)
T-3: Connector Trail (12' wide Conc. w/ 5% max. gradient slope)

LIGHTING:

Type "A" (Special 100' high Tower area lights, at Gateways)
Type "B" (Standard 22' high poles along Levee)
Type "C" (Special 15' high poles along Promenade)

MARINAS:

M-1: Main Dock (80 boat slips) with Ferry landing site
M-2: Central Area (60 boat slips) with Ferry landing site
M-3: Lake end (40 boat slips) with Ferry landing site
M-4: Boat Tie-up Edge
with stepped access to water for hand launch/landing site

LANDSCAPE:

Native & Hybrid Mesquite Trees
Blue Palo Verde & Ironwood Trees
Desert Habitat Plants
Public Turf Areas

Martino & Tatasciore
Landscape Architecture
Urban Design
Planning

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CHCM HILL	DESCRIPTION	DATE July 21, 1994
DESIGNED: RJ/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RJ/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT: 8 of 21

RED MOUNTAIN FREEWAY

BRIDGE

NOTE:
TRAIL TO CONNECT / INTEGRATE WITH INDIAN BEND WASH DROP STRUCTURE - TO PROVIDE PEDESTRIAN ACCESS ACROSS THE STRUCTURE, DURING NON-FLOODING PERIODS.

NOTE:
LEVEE WALK TO CONNECT WITH McCLINTOCK RD

Pump House

T-3 Trail

T-1a Levee Trail

NOTE:
LEVEE TRAIL TO CONNECT WITH McCLINTOCK RD

EXISTING ACCESS AND GATE TO REMAIN FOR FLOOD CONTROL USE

Upstream - Future Riparian Habitat Area

LAKE
normal water level: 1148

Upstream Dam Pier

LAKE
normal water level: 1148

CONSTRUCTION NOTES

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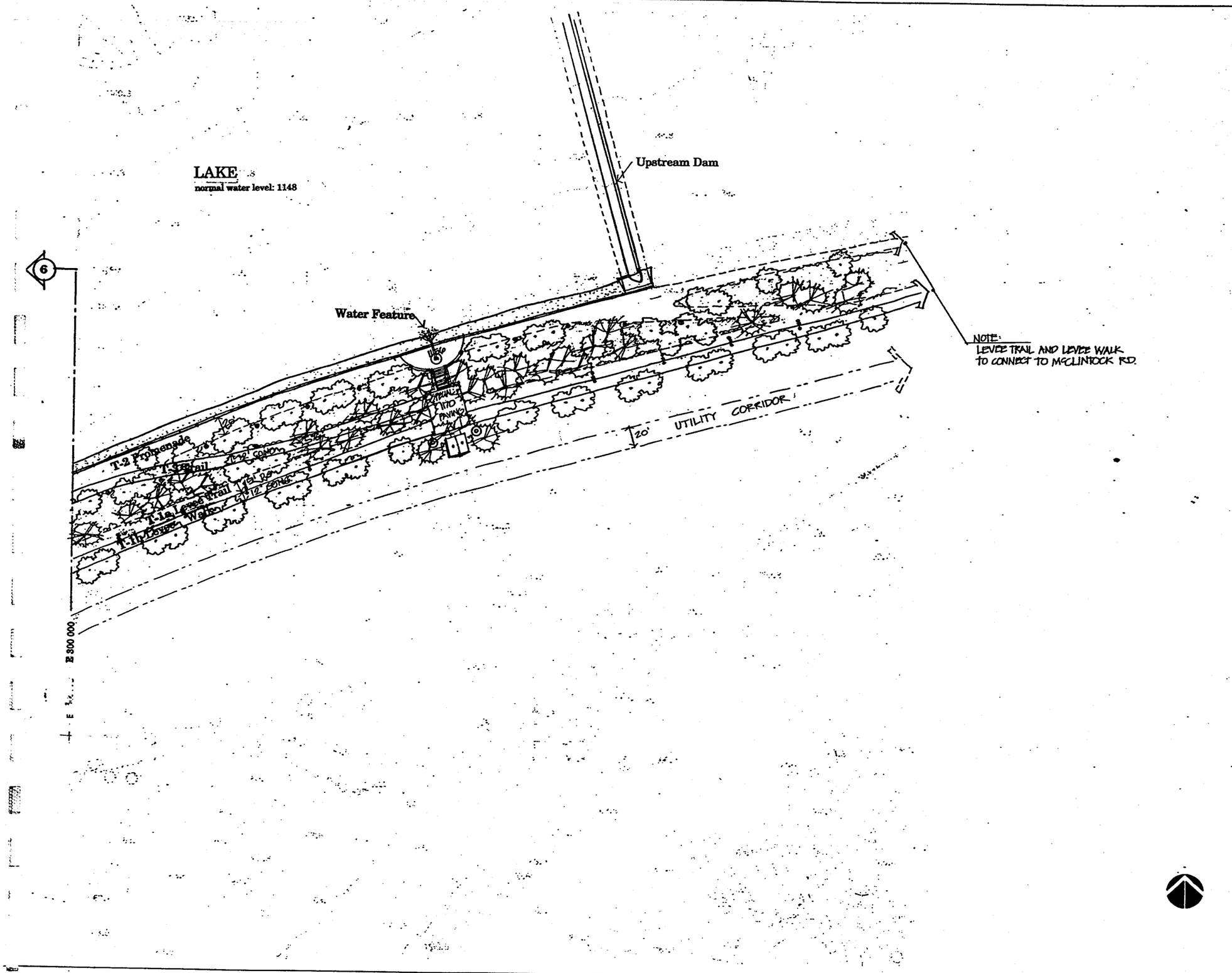
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CREW NILL	DESCRIPTION	DATE
DESIGNED: RI/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RI/SM	LANDSCAPE PLAN	
CHECKED: SM		SHT.
SCALE: 1" = 50'-0"		



CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

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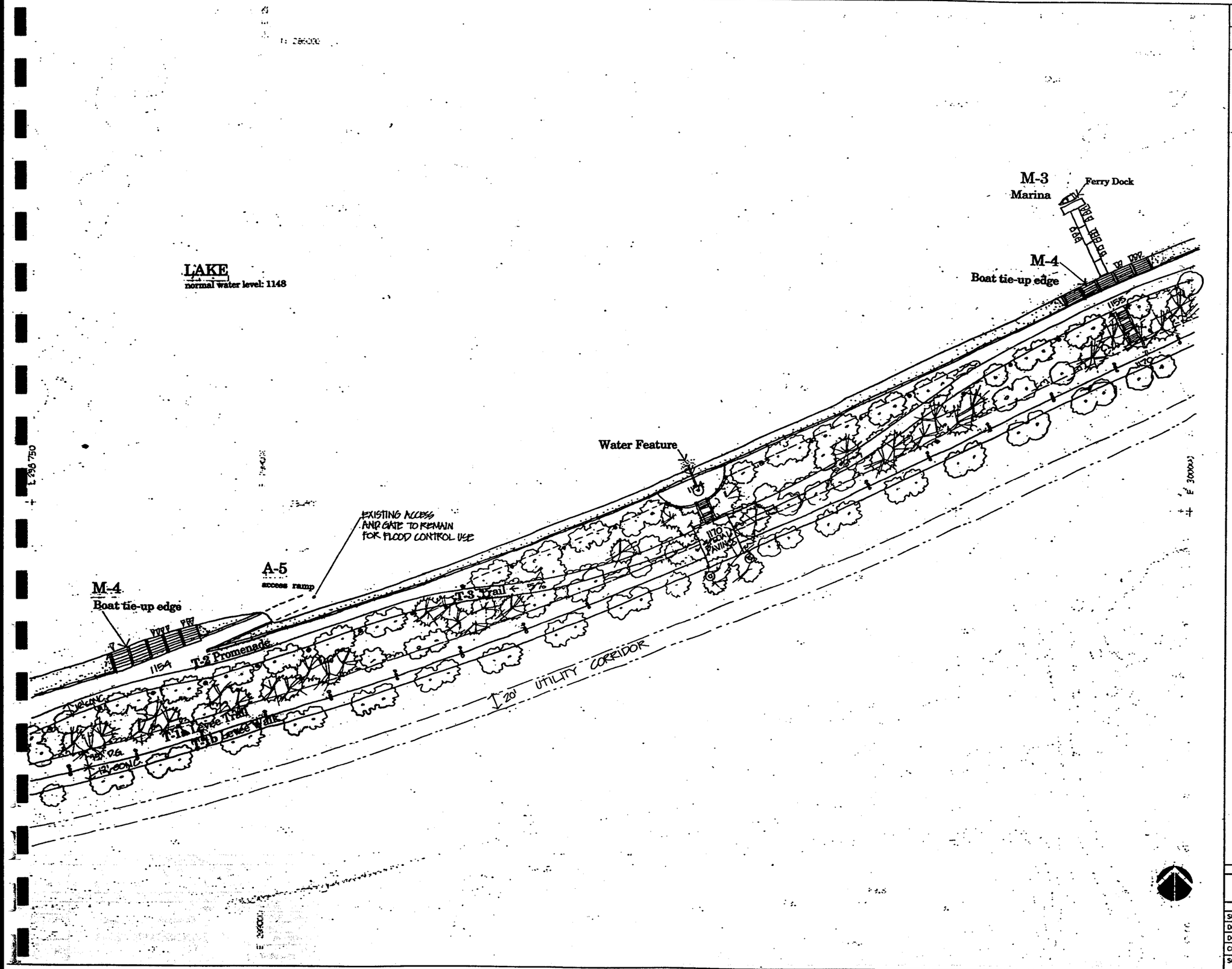
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: DKZM HILL	DESCRIPTION	DATE July 21, 1994
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 60'-0"		SHT. 10 of



CONSTRUCTION NOTES

LEGEND:

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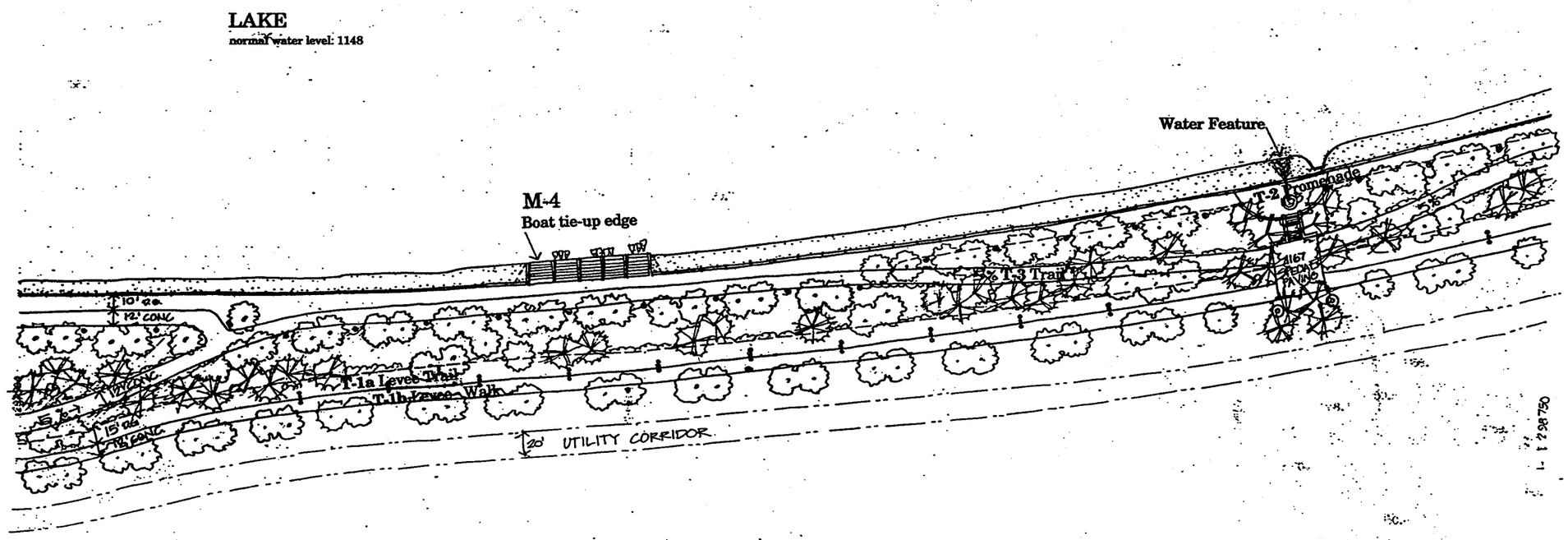
DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: GAE M BAL	DESCRIPTION	DATE July 22, 1994
DESIGNED: KT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: KT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT. 11 of 26



CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

- Gateway Plazas (pedestrian access to park)
- Restrooms

TRAILS:

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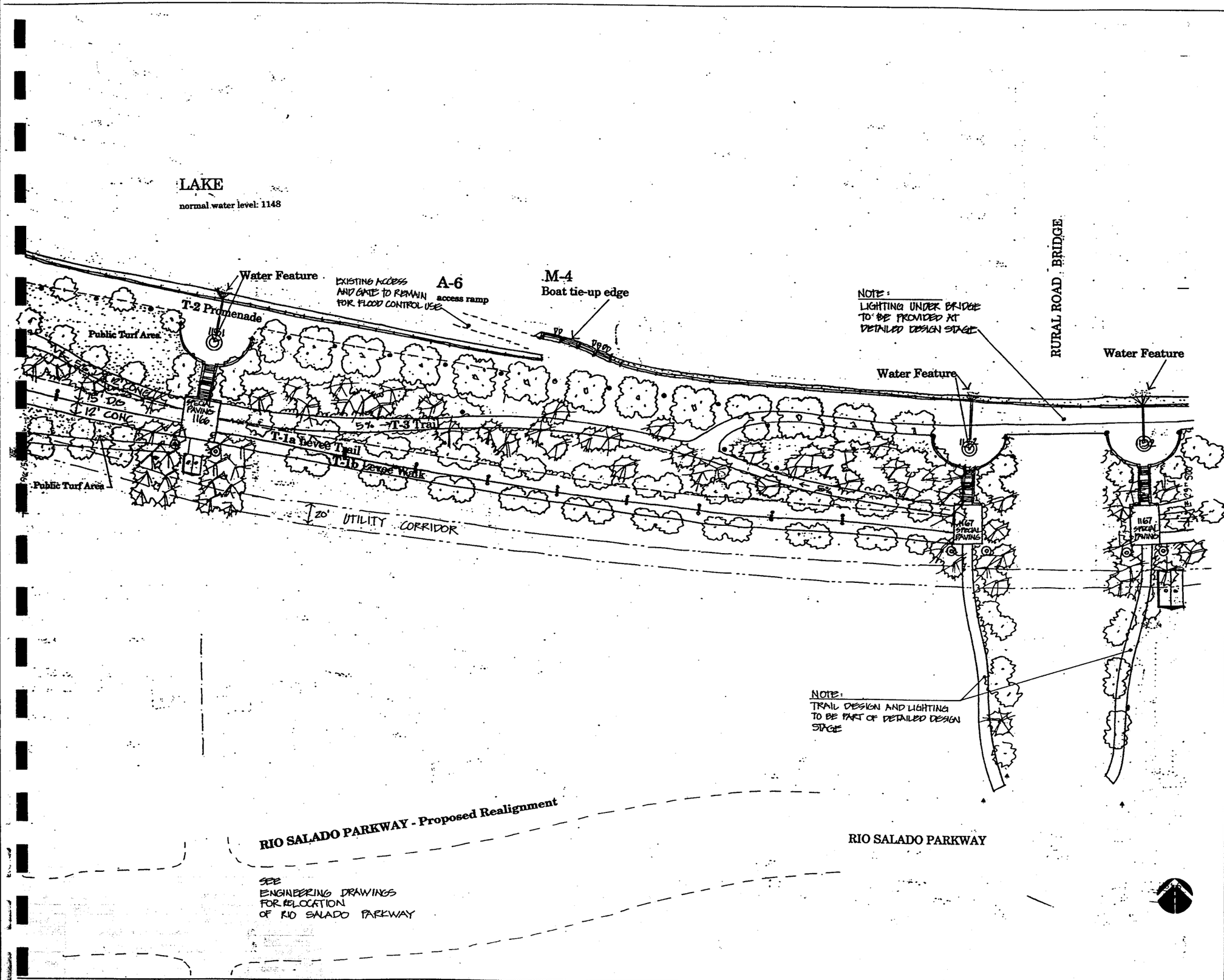
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CREM HILL	DESCRIPTION	DATE July 23, 19
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT. 12



CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

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TRAILS:

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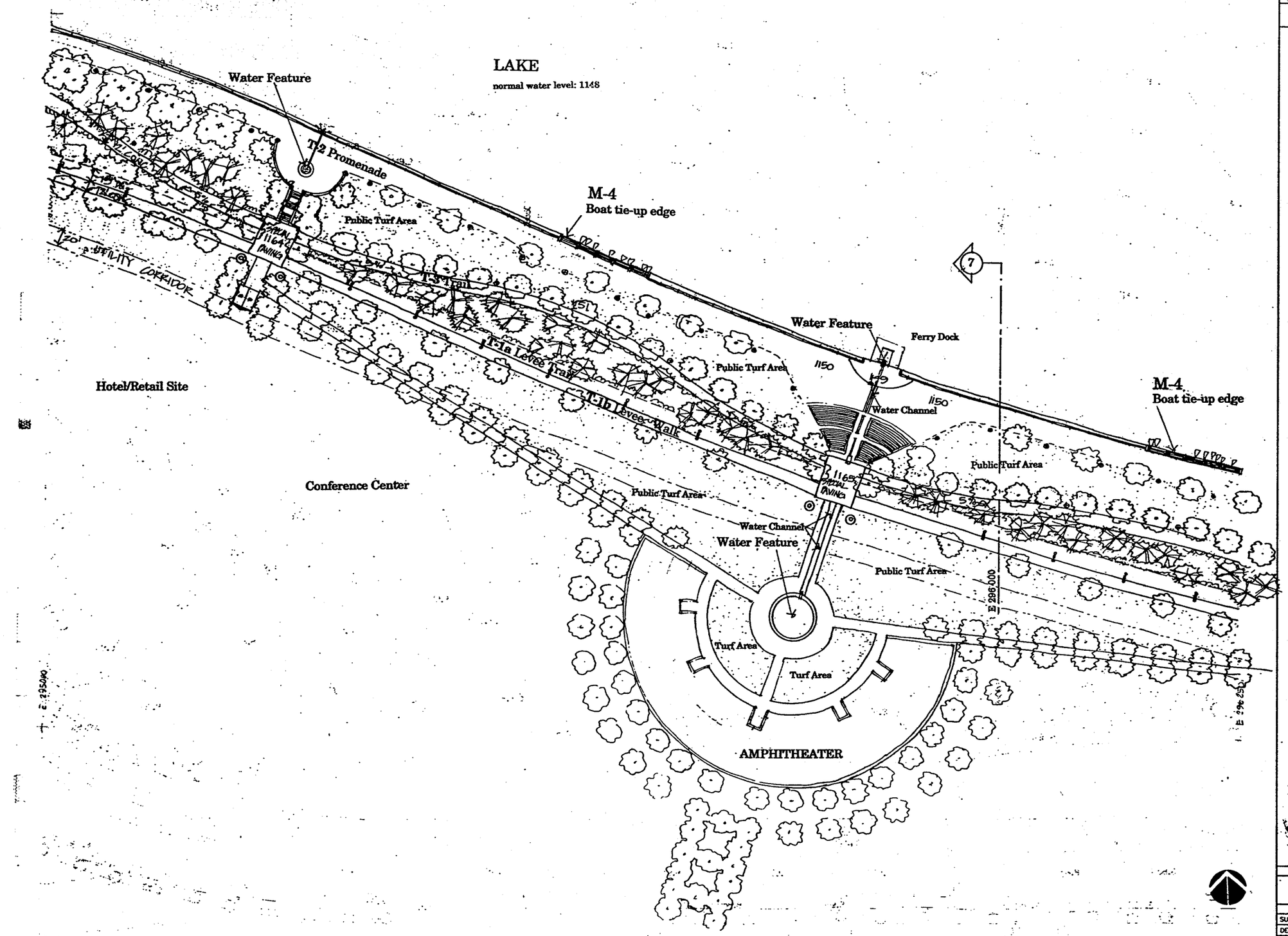
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CH2M HILL	DESCRIPTION	DATE July 21, 1994
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT 13 of 26



CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

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- Restrooms

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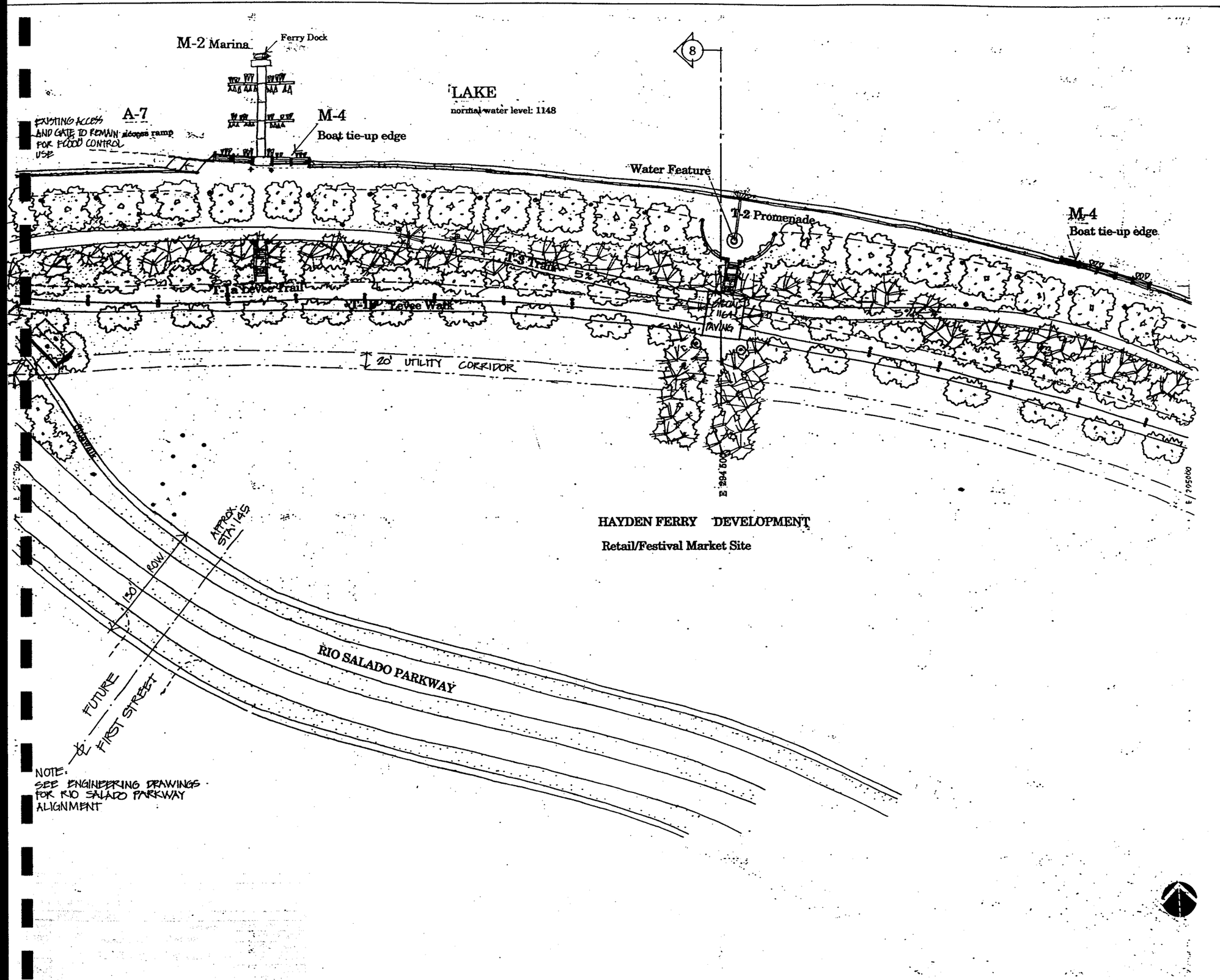
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CHEM HILL	DESCRIPTION	DATE July 21, 19
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 60'-0"		SHT. 4



CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

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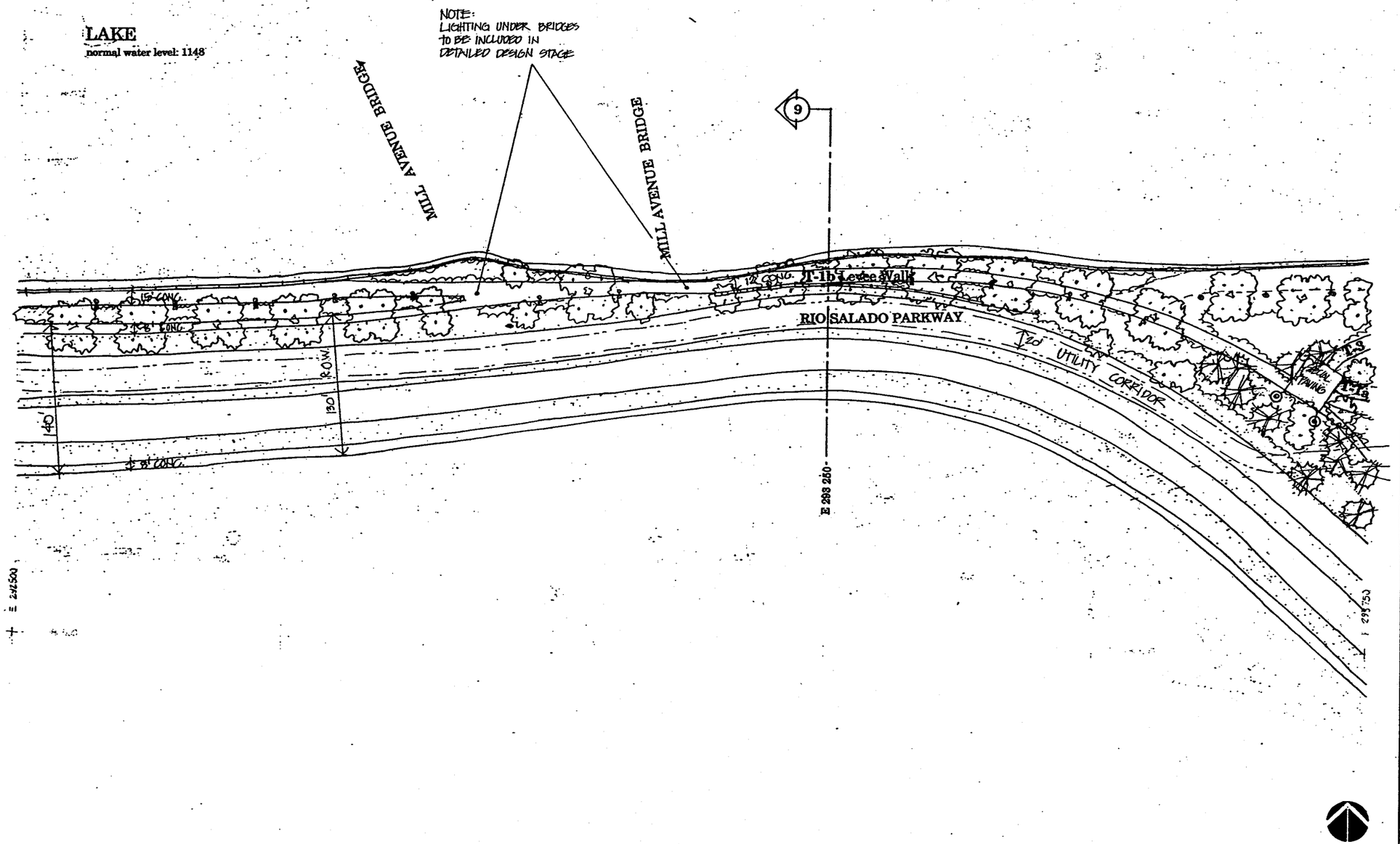
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: GRM HLL	DESCRIPTION	DATE July 21, 1994
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT 16 of 23



CONSTRUCTION NOTES

LEGEND:

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DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
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P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: DUM HILL	DESCRIPTION	DATE July 22, 18
DESIGNED: RT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT. 16

LAKE

normal/water level: 1148

M-3
Marina

Ferry Dock

M-4
Boat tie-up edge

T-2 Promenade

Public Turf Area

Public Turf Area

T-1b Levee Walk

T-1a Levee Trail

20' UTILITY CORRIDOR

130' ROW

1150 STORM DRAINAGE

RAILROAD BRIDGE

10

10

RIO SALADO PARKWAY

ASH AVENUE

NOTE:

- RIO SALADO PARKWAY LIGHTING TO BE COORDINATED WITH PARK LIGHTING AT DETAILED DESIGN STAGE
- BUS BAY LOCATION TO BE COORDINATED WITH STREET IMPROVEMENT PLANS.

CONSTRUCTION NOTES

LEGEND:

ACCESS: A-1 to A-8 (ramped access to lake)

Gateway Plazas (pedestrian access to park)
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P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: GREM HILL	DESCRIPTION	DATE July 21, 1994
DESIGNED: RT/MA	Rio Salado Town Lake	PROJECT NO.
DRAWN: RT/MA	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT. 17 of 24

Downstream -

Future Riparian Habitat Area

LAKE

normal water level: 1148

BRIDGE

12

Aqueduct Water feature

EXISTING ACCESS AND GATE TO REMAIN FOR FLOOD CONTROL USE

A-8 access ramp

11

M-4

Boat tie-up edge

T-2 Promenade

Water Feature

Public Turf Area

20' UTILITY CORRIDOR

Park Maintenance Building

CENTER PARKWAY

E 290 500

T-3

Public Turf Area

T-1a Levee Trail

T-1b Levee Walk

FUTURE

RIO BEACH SITE

E 291 000

RIO SALADO PARKWAY

CONSTRUCTION NOTES

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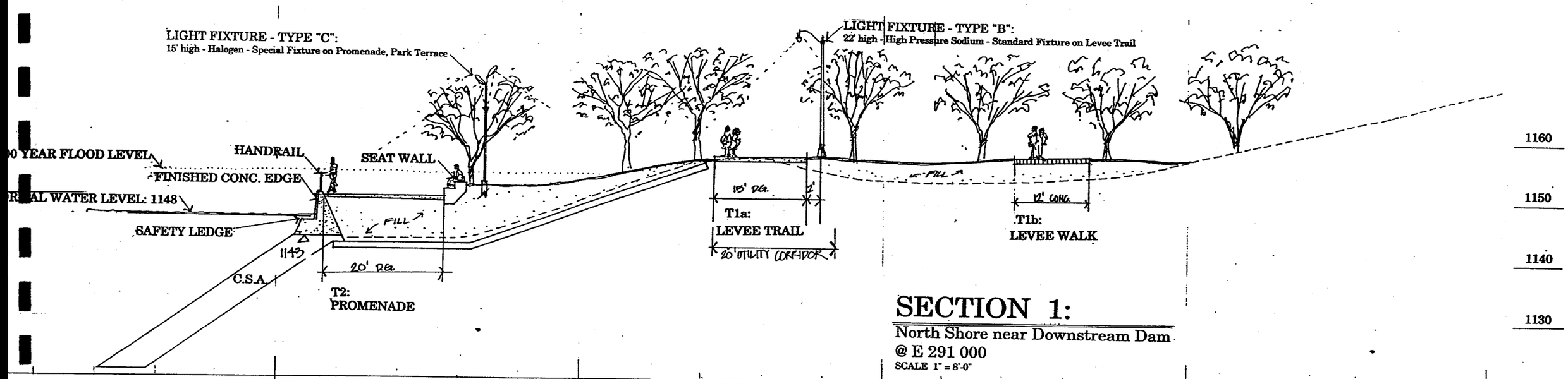
DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE

DIVISION OF ENGINEERING

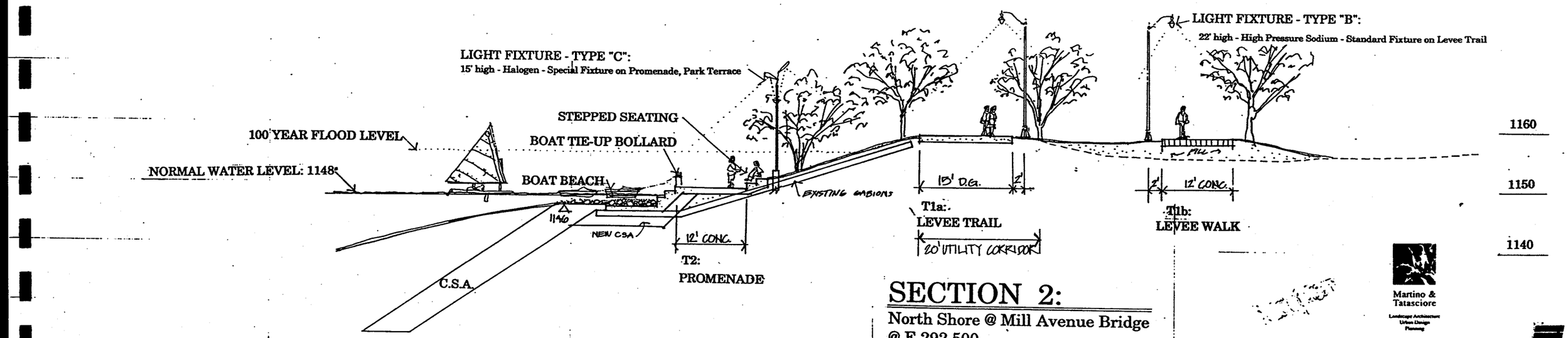
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: CHM WLL	DESCRIPTION	DATE July 31, 199
DESIGNED: KT/SM	Rio Salado Town Lake	PROJECT NO.
DRAWN: KT/SM	LANDSCAPE PLAN	
CHECKED: SM		
SCALE: 1" = 50'-0"		SHT. 18 of



SECTION 1:

North Shore near Downstream Dam
@ E 291 000
SCALE 1" = 8'-0"



SECTION 2:

North Shore @ Mill Avenue Bridge
@ E 292 500
SCALE 1" = 8'-0"

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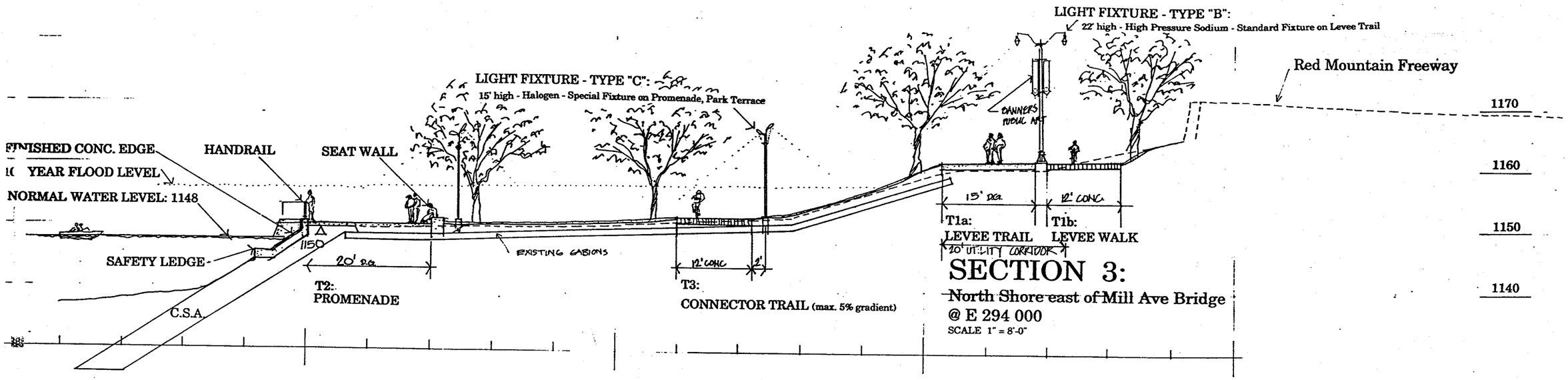
P.O. BOX 5002 TEMPE, ARIZONA 85280

Rio Salado Town Lake
SECTIONS

1" = 8'-0"

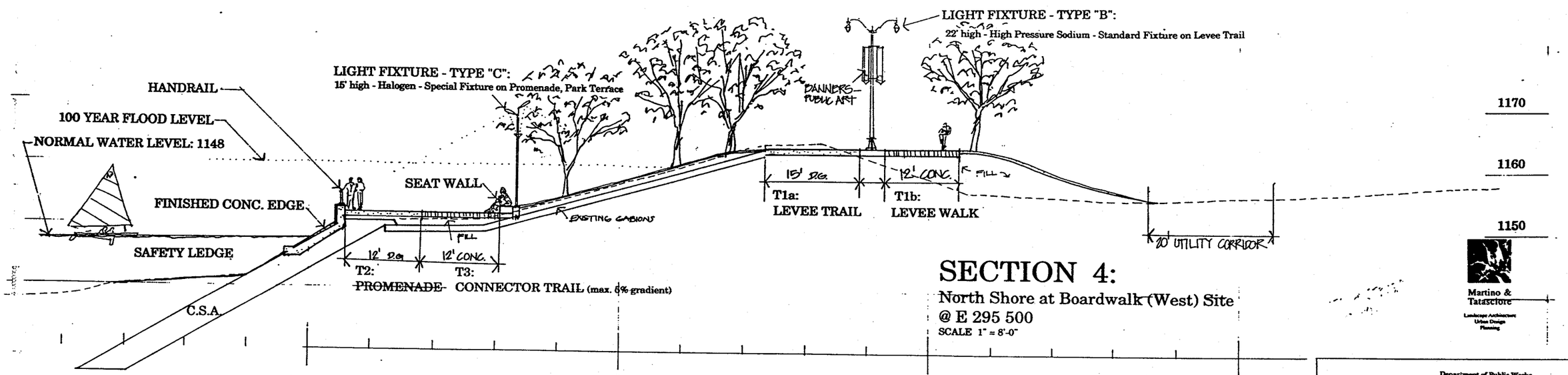
July 21, 1994

SH. 19 of 26



SECTION 3:

North Shore east of Mill Ave Bridge
@ E 294 000
SCALE 1" = 8'-0"



SECTION 4:

North Shore at Boardwalk (West) Site
@ E 295 500
SCALE 1" = 8'-0"

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CMT

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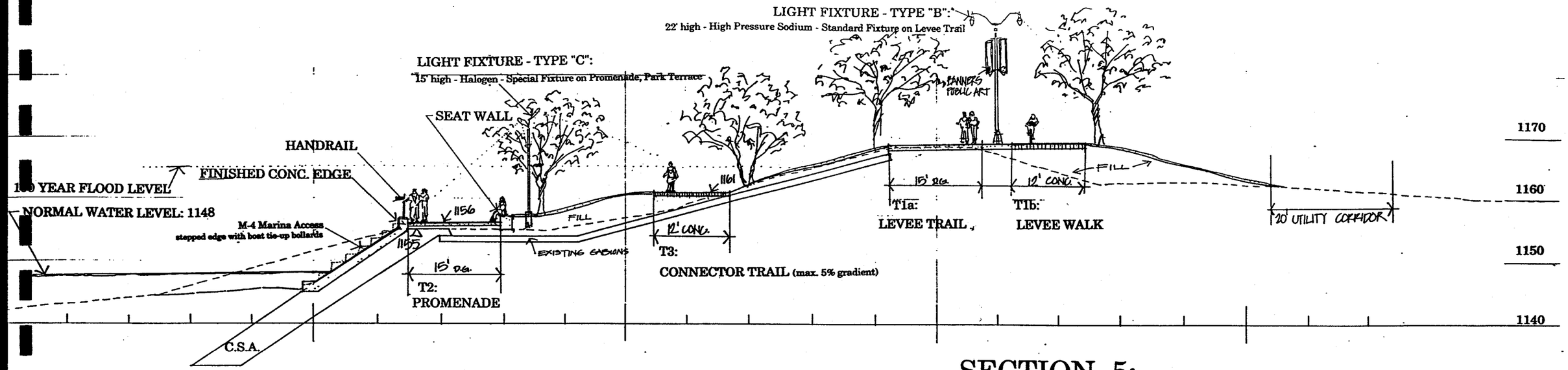
1" = 8'-0"

Rio Salado Town Lake
SECTIONS

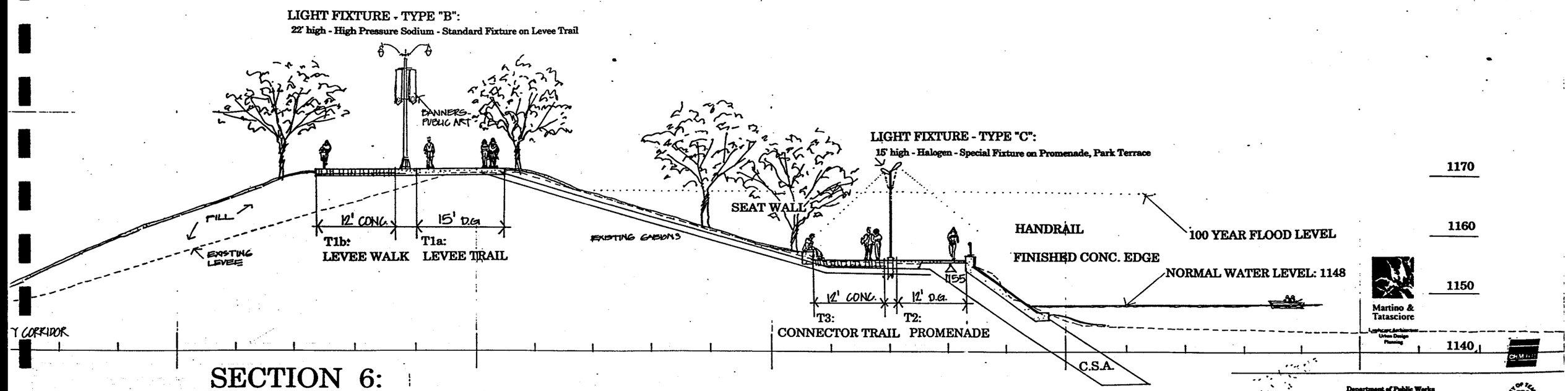
July 21, 19

Sht. 20 of 26



SECTION 5:

North Shore at Boardwalk (East) Site
@ E 298 500
SCALE 1" = 8'-0"



SECTION 6:

South Shore at Tempo Site
@ E 291 000
SCALE 1" = 8'-0"

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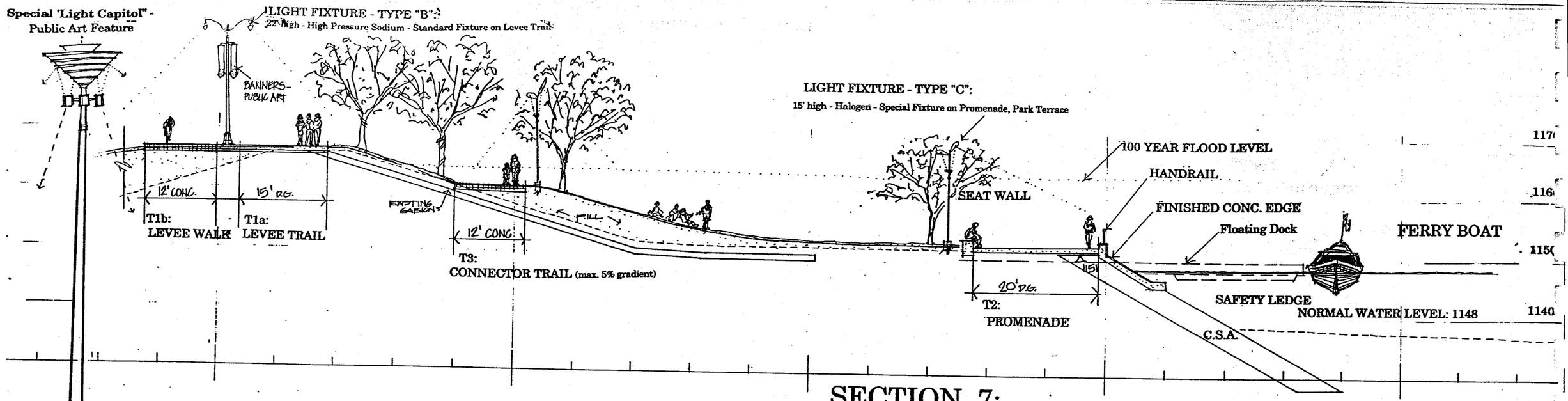
1" = 8'-0"	Rio Salado Town Lake SECTIONS	July 21, 1994 SHT 21 of 26

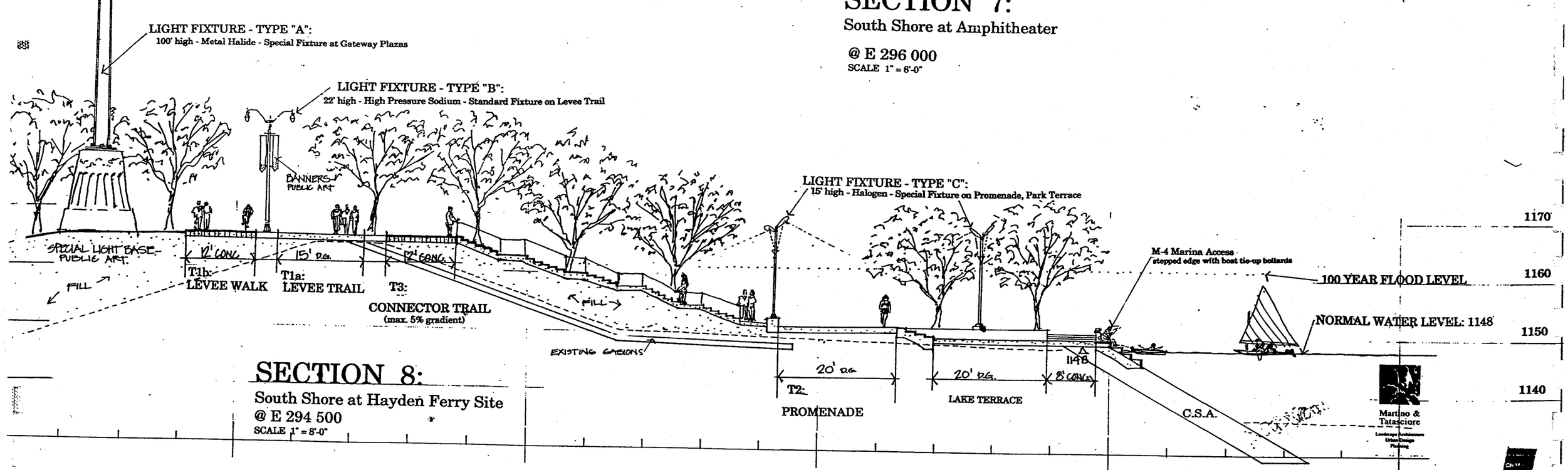


SECTION 7:

South Shore at Amphitheater

@ E 296 000

SCALE 1" = 8'-0"



SECTION 8:

South Shore at Hayden Ferry Site

@ E 294 500

SCALE 1" = 8'-0"

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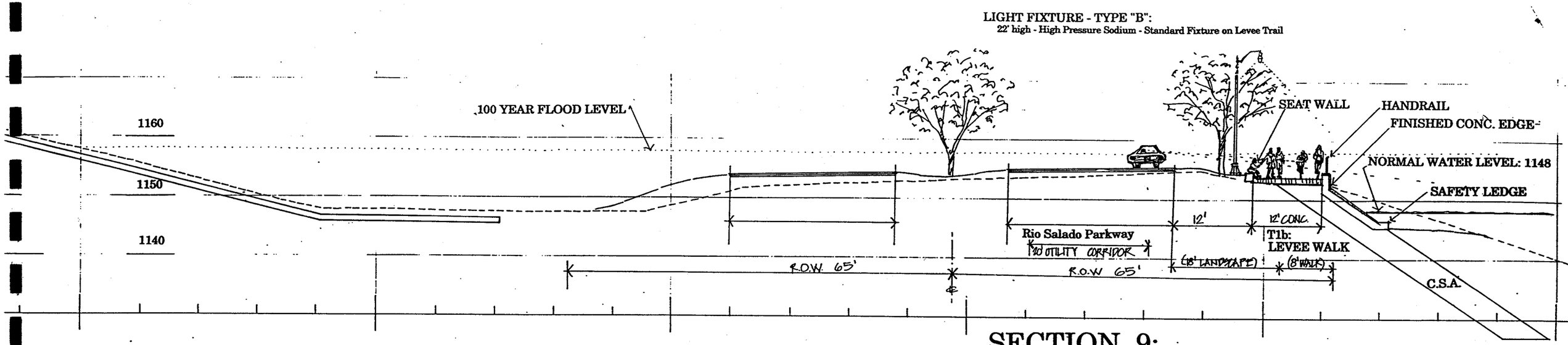
CITY OF TEMPE ARIZONA

July 21, 199-

Rio Salado Town Lake
SECTIONS

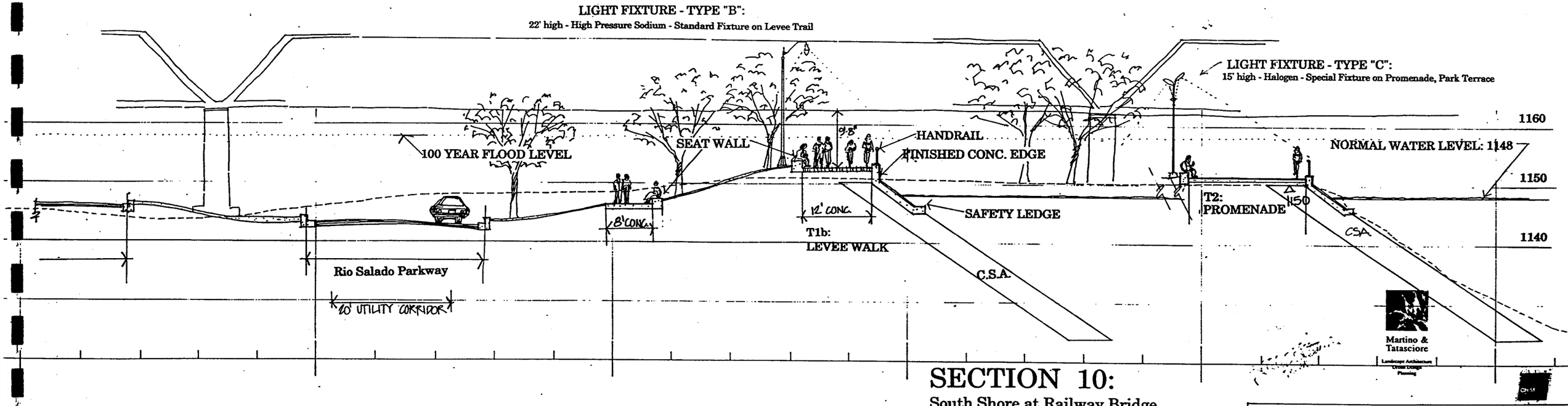
1" = 8'-0"

SHT. 22 of 24



SECTION 9:

South Shore at Rio Salado Parkway
@ E 293 250)
SCALE 1" = 8'-0"



SECTION 10:

South Shore at Railway Bridge
@ E 292 000)
SCALE 1" = 8'-0"

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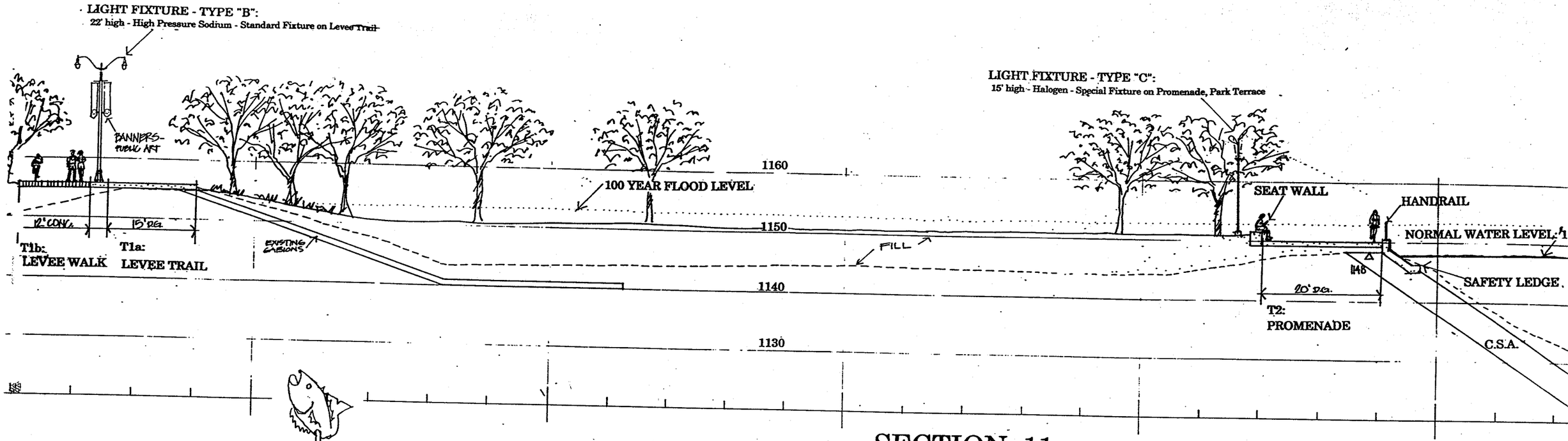
July 21, 1994

Rio Salado Town Lake
SECTIONS

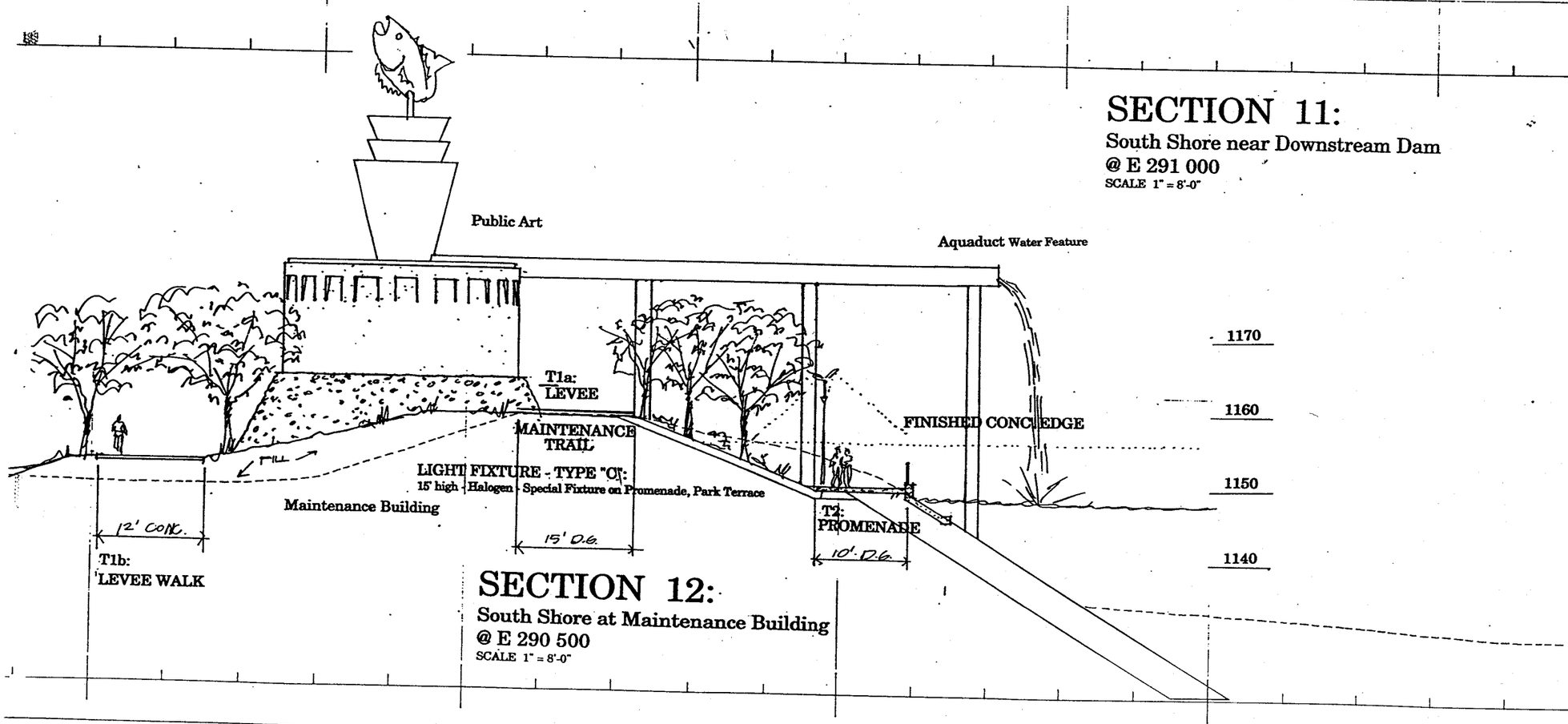
1" = 8'-0"

SHT. 23 of 26



SECTION 11:

South Shore near Downstream Dam
@ E 291 000
SCALE 1" = 8'-0"



SECTION 12:

South Shore at Maintenance Building
@ E 290 500
SCALE 1" = 8'-0"

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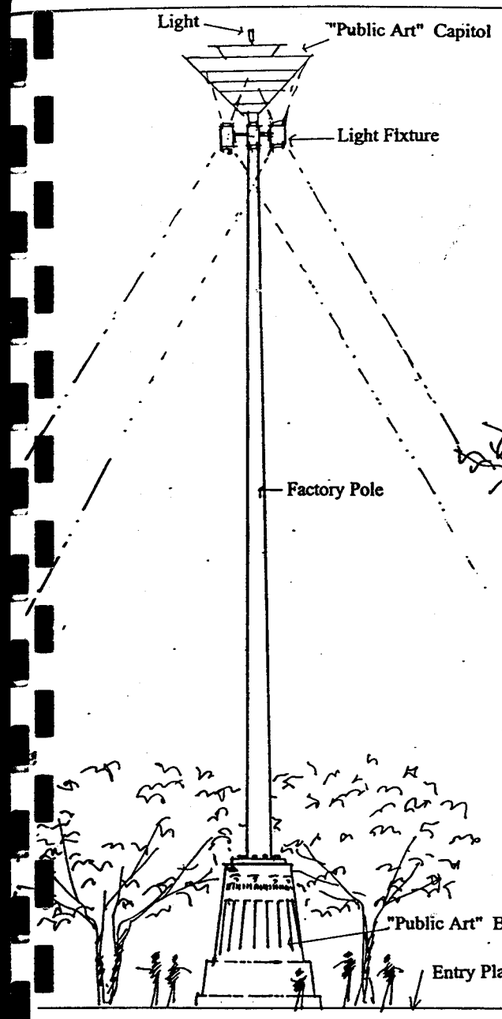
Rio Salado Town Lake
SECTIONS

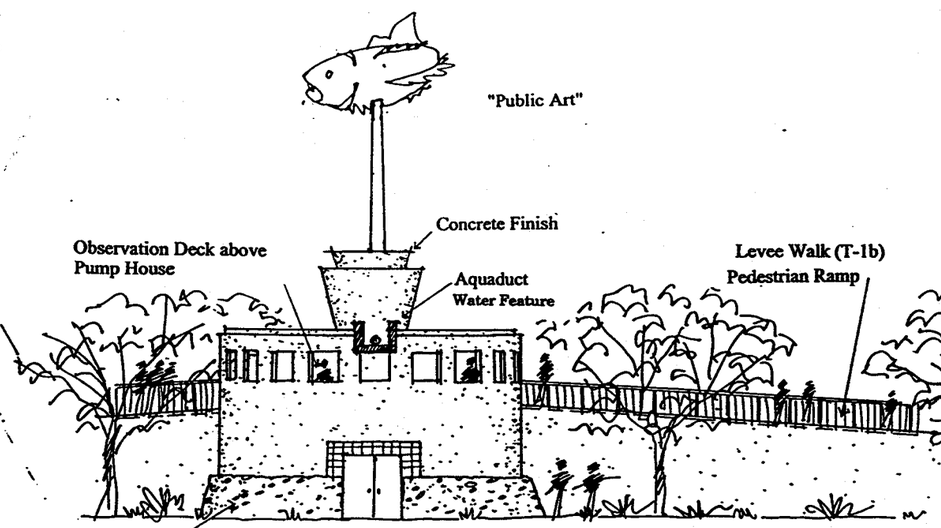
1" = 8'-0"

July 21, 19

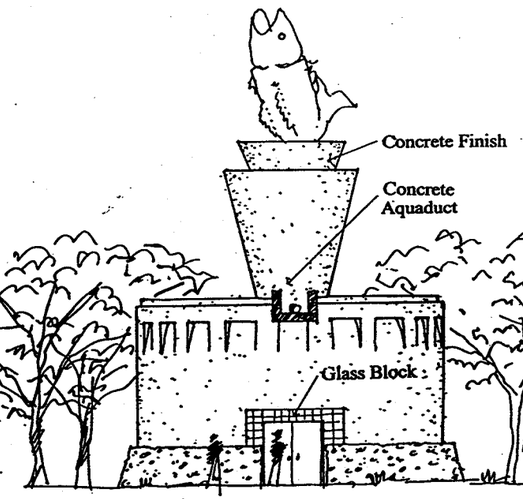
24



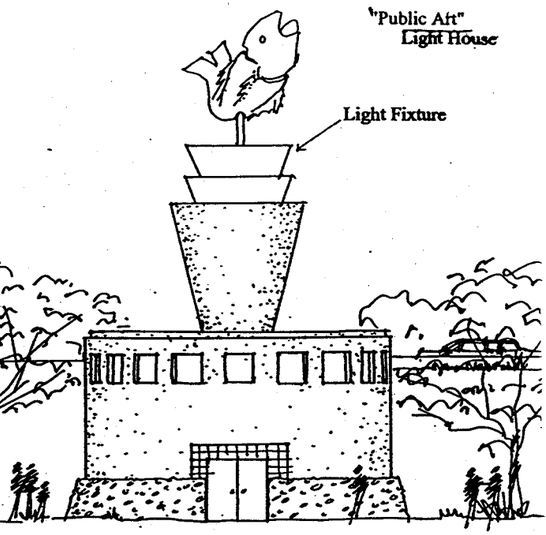
Gateway Light Towers



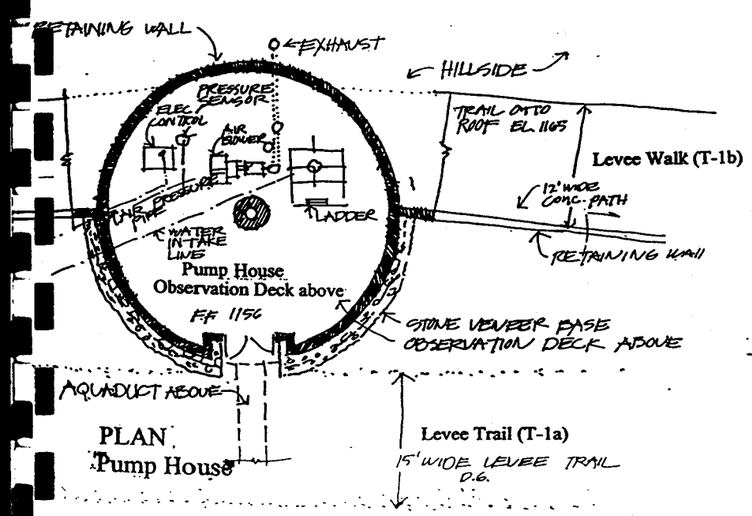
Pump House / Observation Deck above
ELEVATION



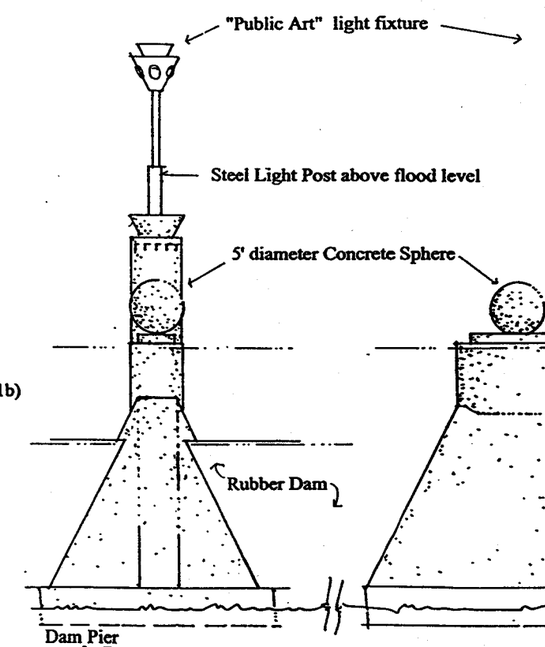
Maintenance Building
ELEVATION



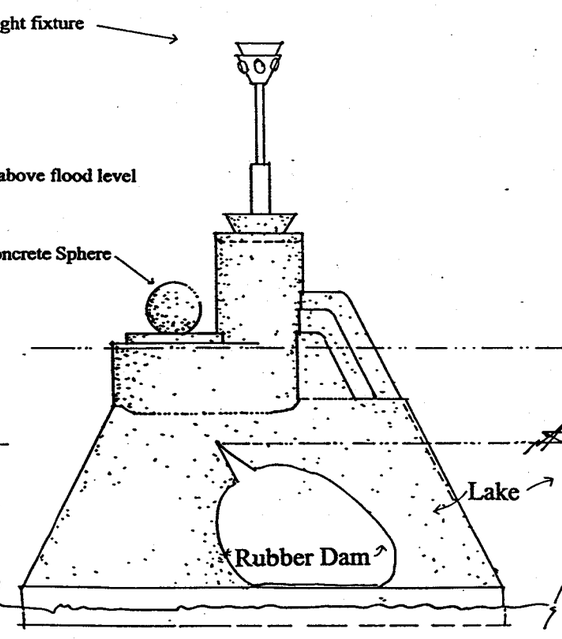
Pump House / "Public Art" Light House
ELEVATION



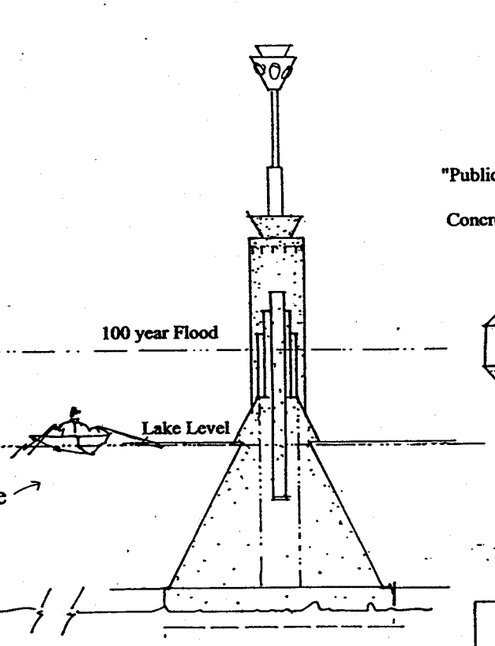
PLAN
Pump House



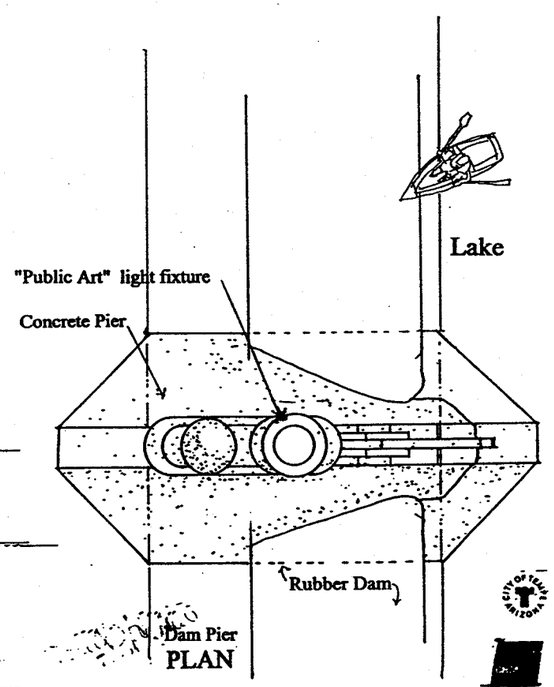
WEST ELEVATION
Concrete Pier



SECTION



EAST ELEVATION



PLAN

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DIVISION OF ENGINEERING
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July 21, 1994

Rio Salado Town Lake
STRUCTURES

Scale 1"=8'-0"

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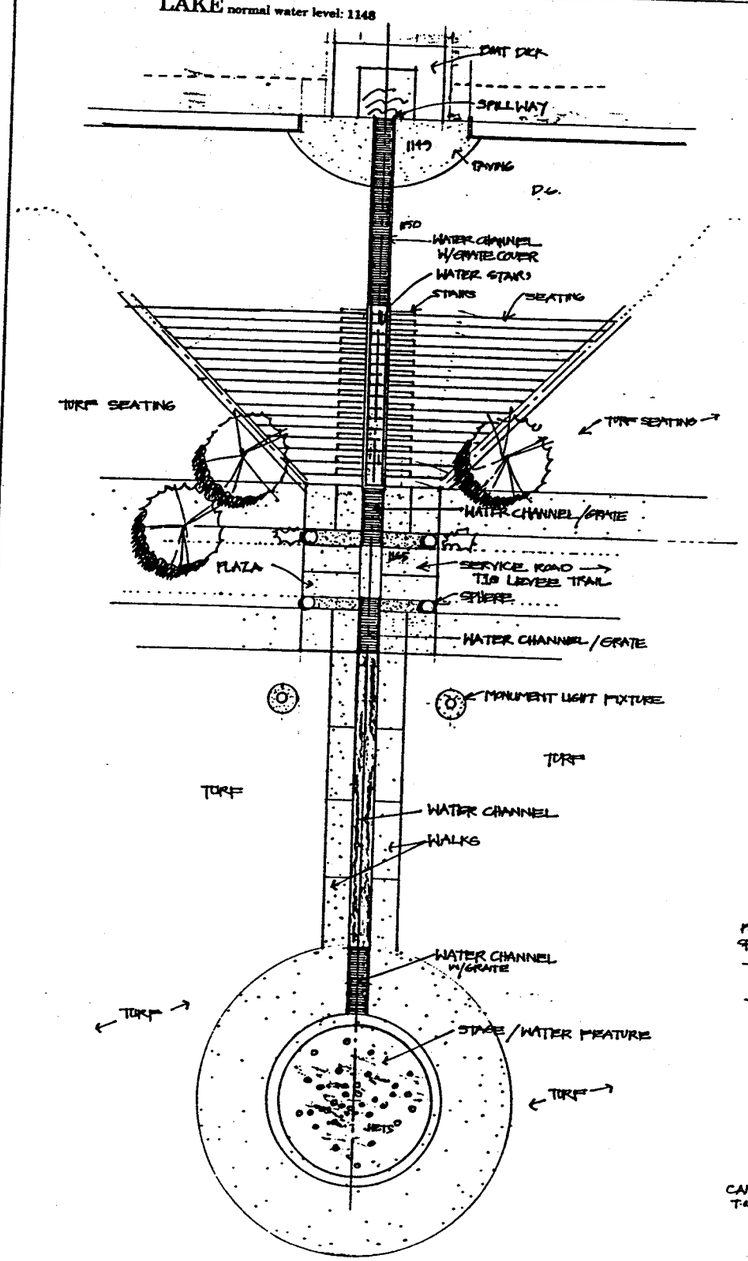
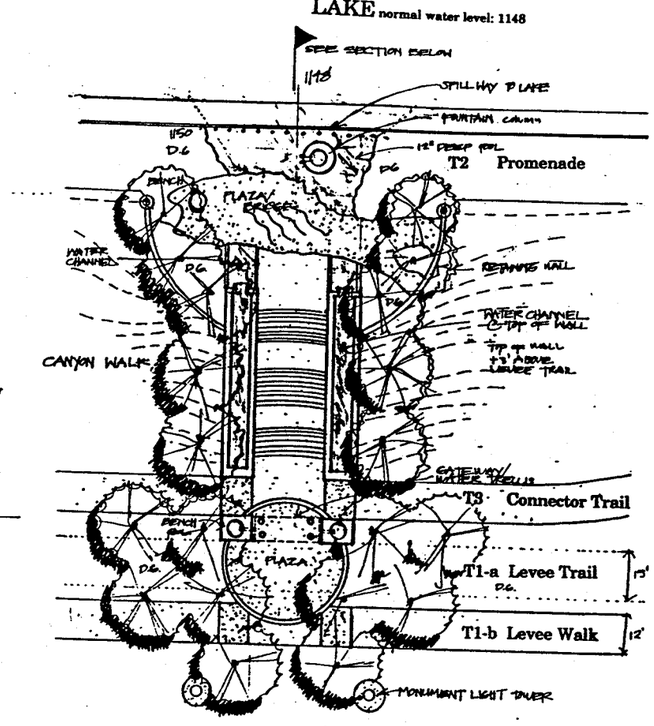
Landscape Architecture
Urban Design



PLAN
WATER FEATURE AT AMPHITHEATRE

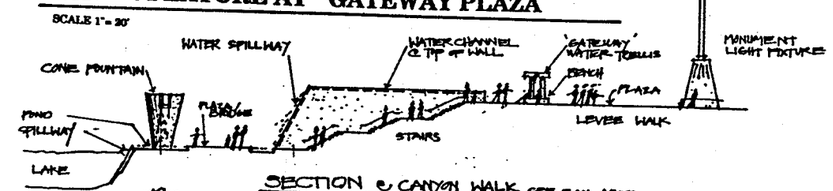
SCALE 1" = 20'

SEE SHEET #4 FOR CONTEXT

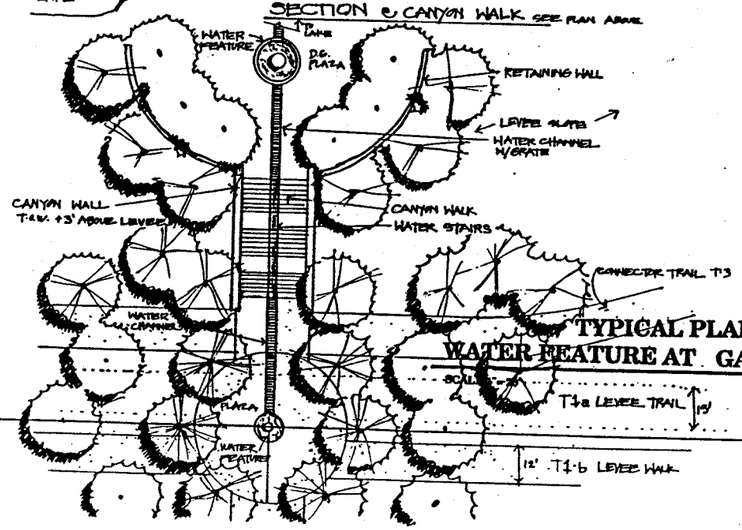


TYPICAL PLAN 'A'
WATER FEATURE AT GATEWAY PLAZA

SCALE 1" = 20'

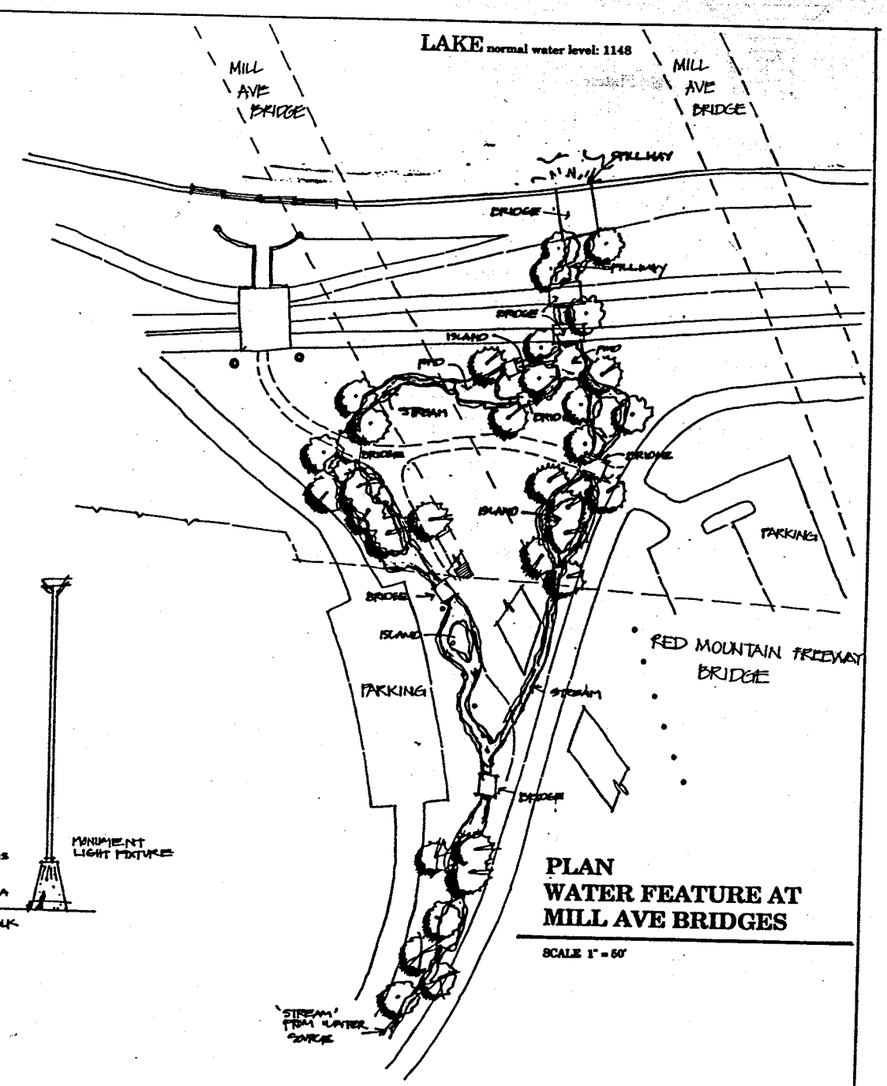


SECTION @ CANYON WALK SEE PLAN ABOVE



TYPICAL PLAN 'B'
WATER FEATURE AT GATEWAY PLAZA

SCALE 1" = 20'



PLAN
WATER FEATURE AT MILL AVE BRIDGES

SCALE 1" = 60'

Martino & Tatasciore
Landscape Architecture Urban Design Planning

CH2M HILL

DEPARTMENT OF PUBLIC WORKS CITY OF TEMPE DIVISION OF ENGINEERING P.O. BOX 5002 TEMPE, ARIZONA 85280		
SURVEYED: CH2MHILL DESIGNED: SM/RT DRAWN: RT/SM CHECKED: SM SCALE:	DESCRIPTION Rio Salado Town Lake WATER FEATURES	DATE Sept. 1994 PROJECT NO. SHT. 26 of 26