engineering report

rehabilitate valley water system
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YOSEMITE

NATIONAL PARK / CALIFORNIA

ENGINEERING REPORT

REHABILITATE VALLEY WATER SYSTEM

PACKAGE 249

YOSEMITE NATIONAL PARK

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INTRODUCTION

PURPOSE

The present surface water treatment program for Yosemite Valley, in Yosemite National Park, does not meet the treatment capability requirements of the California State Board of Health Services. If deficiencies are not corrected, the use of this water source could be terminated.

The purpose of this engineering report is to recommend the preferred engineering method for supplying potable water to the entire valley. The report also recommends locations for the construction of two water storage reservoirs and a new distribution line. Before final selection of a course of action, an assessment of the environmental consequences of the various engineering options will be prepared.

SCOPE

This report analyzes the capacity and condition of the existing distribution system. It also analyzes and recommends the required fire flows in each of the developed areas, the best source of water, the sizes and locations of water storage reservoirs, and modifications to the existing distribution system. The analysis includes all of the aspects of life cycle costing (appendix G) and engineering.

Potential water sources were studied in 1970 (Metcalf and Eddy); this report provides greater cost and engineering detail for the water source reservoir and distribution line alternatives identified at that time.

Numerous other reports and studies, developed over the last 20 years by various private and governmental organizations, describe water quality and availability in Yosemite Valley and problems with the valley's potable water system. They are listed in the bibliography; pertinent information from them has been analyzed and incorporated into this study.

SUMMARY AND RECOMMENDATIONS

The conclusions and recommendations for the water source, storage reservoir location, and distribution system are summarized as follows.

WATER SOURCE

Surface water and groundwater were the two water sources analyzed. The surface source option would utilize the Merced River. The groundwater option would obtain water from three deep wells located in the valley floor. The groundwater system is recommended.

The groundwater option would require that one or two new wells be drilled to produce a minimum capacity of 850 GPM. These new wells would be located in areas which have already been impacted (see appendix I). The first well site would be in Upper River campground. Should this well not produce 850 GPM, then a second well would be drilled in Lower River campground. Preliminary tests indicate that the aquifer from which the wells would draw their water would not affect the perched water table (United States Department of the Interior, Geological Survey 1972). There are two existing wells. All the wells would be used a portion of each day, with the capability of having the largest well out of production with the rest of the wells supplying the demand. Well number 1 would require some modifications and well number 2 would need a new pumphouse and distribution line.

While this option would have a low labor requirement, the electrical operating costs would be quite high. New building construction would be minimal. New aerial control wiring and short runs of new piping would be required.

The groundwater system is recommended for the following reasons:

It has the lowest initial investment and the lowest life cycle cost (for the first 25-year life period, operating and maintenance costs would be lowest)

Total yearly additional manpower requirements could be satisfied with the existing labor force.

The source of water is more constant and dependable.

No treated waste would be produced or need to be handled.

Less physical construction would be required in comparison to utilizing the river, which would require a treatment plant.

The amount of new electrical service required would be minimal in comparison to the requirements of a treatment plant.

More river water would be available to the various ecosystems associated with the river and all downstream users.

Physical construction would be in already impacted areas.

The existing sedimentation basin and intake structures could be removed, reducing the physical impact of facilities on the river and the upper end of the valley.

RESERVOIR SITE

Two options for locating the water reservoirs were analyzed. The first would require that two reservoirs (elevated and ground-level) be located at two different sites in the valley. The second alternative would locate two ground-level reservoirs at the same site. The single site option is recommended.

The single reservoir site option would feature two concrete ground-level tanks near Illouette Creek. They would be 90 feet and 74 feet in diameter, 32 feet high, and with respective capacities of 1,500,000 and 1,000,000 gallons. The site next to the existing sedimentation basin was evaluated, but the additional elevation at the Illouette site made it more attractive. Two reservoirs are proposed for maintenance reasons.

This option is recommended for the following reasons:

More pressure available during fire demand conditions.

Location is away from high visitor use area and reservoirs would be well hidden from the majority of the visitors.

Ground-level reservoirs would be easier to maintain and operate.

Implementation would require minimal new pipeline construction and cause minimal impact on developed areas.

Both reservoirs could be equipped with pump control devices, which would give the flexibility of having one reservoir control the pumps when the other is down.

Minimal maintenance would be required on the concrete reservoirs.

DISTRIBUTION SYSTEM

The distribution system has been analyzed. Regardless of reservoir locations, the existing mains should be cleaned and flushed and several interties should be built. The existing system can provide adequate service pressures to all locations for domestic and irrigation demands but is not adequate to meet fire demands anywhere in the valley. To adequately supply all the domestic, irrigation, and fire flow needs, a new 16-inch water main from the superintendent's house to the Happy Isles nature center should be built.

In providing adequate flow and pressure to the Upper Tecoya housing area, the system would also provide adequate pressure to the top floor of the Ahwahnee Hotel (which is approximately 12 feet higher than the elevation of the highest house in Upper Tecoya). The existing supply line to the the hotel is not adequate to supply water to the complex when the irrigation demand is placed on the system. This line would have to be replaced. Otherwise, no other special considerations need be given to supplying adequate fire flow to the hotel complex.

A summer 1982 report recorded flows and pressures for a 5-day test period (August 18-22). During this time the maximum domestic and irrigation demand was 1,967,000 GPD, with a maximum peak demand rate of 2,533 GPM (Walter Long and Associates 1982). This compares to 1,628,000 GPD water demand for the same period in 1981.

A small portion of the valley users are now metered.

The burial depth of the existing distribution system varies. Before the final design is made, verification of the burial depths should be made.

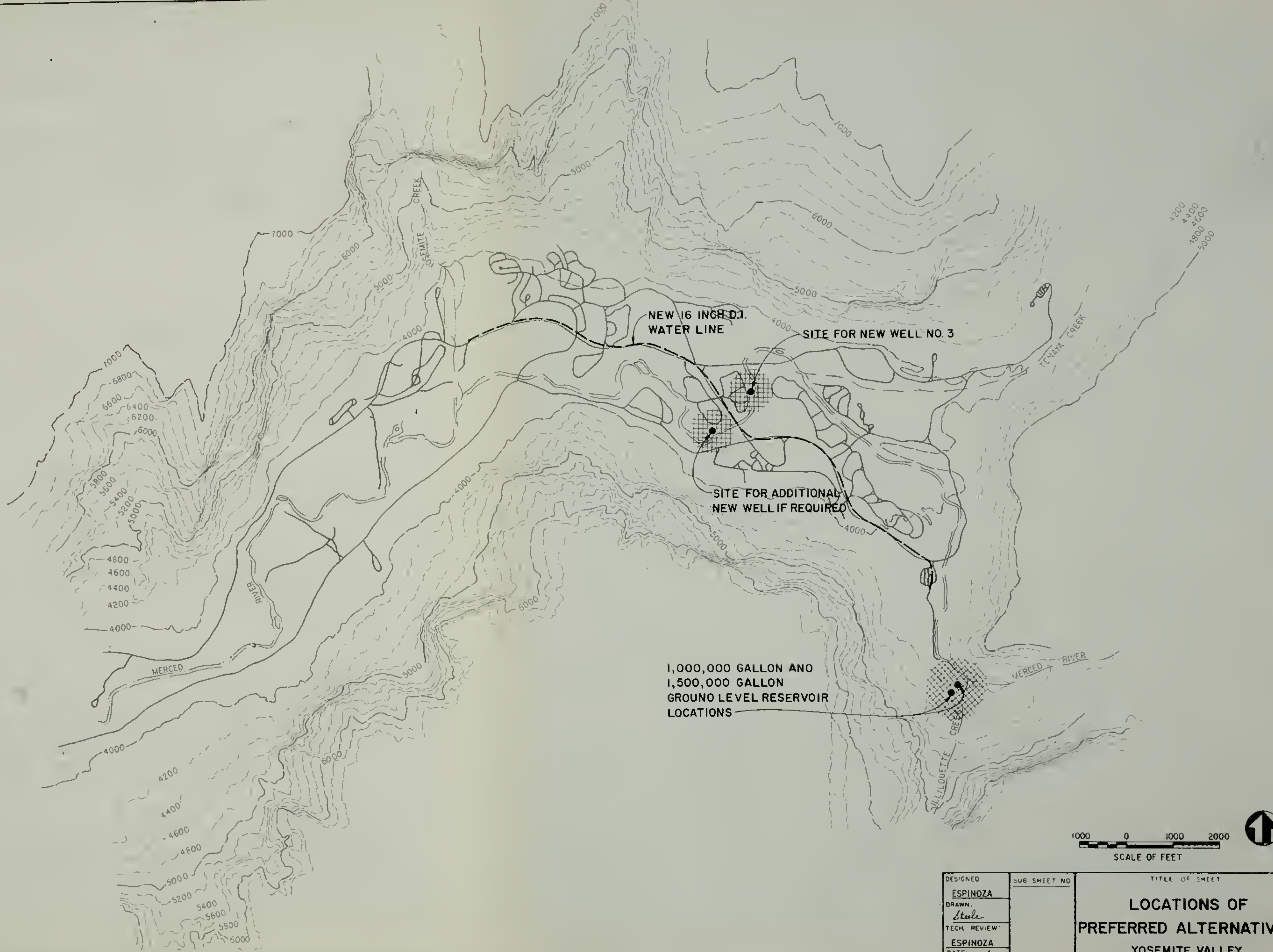
The following recommendations are made:

> All of the existing 8-inch CI water mains should be cleaned of all the accumulated rust, sand and other debris.
>
> The existing lines to the Ahwahnee Hotel and well number 1 should be replaced with 16- and 24-inch lines, respectively.
>
> Several new interties between the existing water mains should be constructed to improve flow patterns and service pressures.
>
> All defective fire hydrants should be replaced and new fire hydrants should be installed where required (requirements to be better defined during preliminary design phase).
>
> New metering should be installed for all users and additional valving should be installed to better isolate the distribution system into sections. This would help in performing maintenance operations without disrupting service to the valley (extent of valving and metering to be defined during the preliminary design phase).
>
> A new 16-inch water main should be built to serve the valley for domestic, irrigation, and fire flows (interties and exact location to be better defined during preliminary design phase).

CONSTRUCTION COSTS

Well No. 1	$ 120,000
Well No. 2	282,000
Well No. 3	457,000
Reservoirs	647,000
Distribution System	1,422,000
	2,928,000

DESIGNED ESPINOZA	SUB SHEET NO	TITLE OF SHEET	DRAWING NO 104 / 41,159
DRAWN: Steele		**LOCATIONS OF PREFERRED ALTERNATIVES**	PKG. NO.
TECH. REVIEW: ESPINOZA		YOSEMITE VALLEY	SHEET 1
DATE: 4/83			OF 8



DESIGNED	SUB SHEET NO	TITLE OF SHEET	DRAWING NO
ESPINOZA		LOCATIONS OF PREFERRED ALTERNATIVES	104
DRAWN. Steele		YOSEMITE VALLEY	41,159
TECH. REVIEW: ESPINOZA			PKG NO — SHEET 1
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EXISTING WATER SYSTEM

The existing water supply and distribution system for Yosemite Valley consists of a water intake structure on the Merced River, an 80,000 gallon sedimentation basin, approximately 2½ miles of 12-inch AC pipe and 6½ miles of 8-inch cast-iron pipe watermains, one 850 GPM well, one 550 GPM well, and two abandoned springs with a pumphouse. Until recently the 850 GPM well was only used during periods of inadequate river flows; however, it is presently being used in the system. The other well does not have a pump or a pumphouse.

INTAKE STRUCTURE

The existing water intake structure, constructed in 1911, consists of a concrete diversion dam, shear gate, metal screen, concrete diversion channel, and a bar screen at the headworks (see appendix J). It is located on the Merced River below its confluence with Illouette Creek. The intake structure is located in a narrow portion of the gorge, however, the river itself is relatively wide near the intake structure. Upstream and downstream the river is strewn with large boulders and rocks that have been moved by the water during periods of extreme runoff. The profile is steep all along this portion of the river.

The access road from Happy Isles to the intake structure is rough and steep. Winter access is difficult because the road is not plowed. The road does not have any wearing surface other than the native material. If the existing structure is retained or a new treatment plant is built, the road will have to be reconstructed.

The intake structure has been totally inundated during periods of extreme runoff, when the water level rises above the bar rack and renders it useless. During the spring runoff the water carries large amounts of silt and debris and the bar screen, which is not mechanically cleaned, has to be manually cleaned many times a day. A large portion of the concrete around the bar screen has deteriorated badly.

The concrete inlet channel between the bar screen and grid plate is rough and badly deteriorated. It is constructed so that all water not used by the system bypasses the grid plate. The grid plate, which has 1-1/4-inch diameter holes to catch some of the smaller debris, must be hand cleaned. The grid plate allows passage of floating matter which is 3/8-inch diameter or less. During periods of extreme surface runoff, the river and creek carry large amounts of suspended solids which enter the sedimentation tank. A gate valve behind the grid plate adjusts the flow going into the sedimentation tank (see sheet 4 of appendix I).

A concrete dike or apron across a portion of the river encourages ponding of the water and directs the flow of water to the bar screen during periods of low flow (see appendix J). During periods of extreme low flow (less than 3 CFS), additional sandbagging is required to direct the river water into the bar screen.

During the winter season, frazil ice builds up behind and in front of the bar screen and grid plate, preventing flow through them. When this condition is allowed to persist, a portion of the 16-inch line feeding the sedimentation tank becomes plugged, a condition extremely difficult to correct. When water ceases to enter the sedimentation basin due to these ice blockages, well number 1 is the only water source available to supply valley water needs. The present method of preventing these ice blockages is to daily monitor the conditions of the bar screen and grid plate and manually prevent ice buildups.

SEDIMENTATION BASIN

The sedimentation basin is a two-celled concrete tank, entirely above ground and with a wooden cover. The structure is more than 40 years old, has been patched and repaired, and has various cracks. Two flow-measuring devices are located in the sedimentation basin to measure use for domestic, irrigation, and fire purposes; one is located at the pipe entrance into the structure, the other is on the discharge side. These flow-measuring devices are calibrated weirs which measure the amount of flow coming in and going out, but their accuracy is not known. An overflow pipe in the second chamber wastes any water not used by the system, thus the second weir measures the amount of water used by the system while the first one also measures the wastewater.

A mechanical bar screen in the second chamber takes out any smaller floating debris that might have passed through the grid plate. During periods of runoff and severe precipitation, the water becomes turbid with sand and silt, the sedimentation tank does not provide sufficient detention time, and a large amount of the suspended matter does not settle out. The capacity of the entire sedimentation basin is approximately 80,000 gallons.

Chlorine is the disinfectant that is used to treat the water. Gas chlorination is injected upstream of the sedimentation basin. No other form of treatment is given to the water. Using the sedimentation basin and the 18-inch distribution main as storage, the approximate chlorine contact time before the first user (Happy Isles) is 28 minutes with a flow rate of 3500 GPM.

A Fisher-Porter magnetic flow meter downstream of the sedimentation tank records all of the flow to the valley. Because it is approximately 20 years old, its accuracy and reliability are questionable. However, the meter and the second weir record approximately the same flow rates.

According to Metcalf and Eddy (1970), the sedimentation basin has a theoretical settling rate of about 1 mm/second at a flow rate of 2,500,000 gallons per day. Under this settling rate all particles .03 mm in diameter and larger should be removed. In actuality it is reported that the tank removes only the large sand particles (.05 mm to 2.0 mm).

The Merced River gets significant use by swimmers and sunbathers upstream of the intake structure. A hiking and horseback trail parallels the river, as does a sewer line from Vernal Falls to Happy Isles. With all this use and development along the river, the potential for water contamination is great.

DISTRIBUTION SYSTEM

All of Yosemite Valley is fed by a combination of one 18-inch cast-iron line which branches into three separate mains (one 12-inch asbestos cement, two 8-inch cast iron). These three lines run most of the length of the developed areas in the valley (see appendix I). The existing 12-inch asbestos main is in relatively good condition, but the cast iron mains have tuberculated with age and their flow carry capacities have been reduced between 50 and 60 percent (Koloseus 1968 and Metcalf and Eddy 1970). Specimens are now being taken to determine the actual condition of the pipes. Because of the inadequate sedimentation time in the basin, there are probably large amounts of sand and silt deposits in all of the mains. Along with these deposits and the tuberculation in the pipe, large flow rates in the system could cause the quality of the water to deteriorate.

As shown in column 4 of appendix F, the existing distribution system is not adequate to serve portions of the valley. The top floors of the Ahwahnee Hotel and certain houses in the Upper Tecoya residential area do not receive adequate water pressure during most types of water demand.

The layout of the three mains is such that each is quite isolated from the others and few interties exist. Existing valving and metering are inadequate to isolate small portions of the system for maintenance purposes and to properly monitor the flows within the system. While this piping system layout does supply water, it does not adequately alleviate the low pressure problems.

According to Metcalf and Eddy, the estimated leakage in the system amounted to roughly 8 percent of the average summer supply rate.

MERCED RIVER

The Merced River and Illouette Creek supply most all of the flow available for Yosemite Valley domestic water needs, and published reports state that Yosemite National Park is the only major development that takes its drinking water upplies directly from the Merced. In addition, the Merced provides water to other downstream users (mostly for irrigation purposes). The flow of the Merced has been monitored for many years; the U.S.G.S. has a flow measuring station approximately one mile below the intake structure at the Happy Isles bridge.

The Merced River watershed above Happy Isles is approximately 1,280 square miles according to the USGS. The average gradient of the river, upstream of the Happy Isles bridge, is approximately 327 feet per mile.

On the average, the river experiences its highest flows during May and June due to the melting snowpack in the upper elevations. The low flows generally occur during September and October after snowmelt and before winter rains begin. Appendix A shows some of the lowest flows that the Merced River has experienced during the past 60 years, giving a general feeling for the frequency and the amounts of low flow. It also depicts the mean flow of the river for each month for the past 15 years, indicating the trend of discharges. On the average, river flows have far exceeded the valley's water demand.

Presently, the U.S. Fish and Wildlife Service is studying the effects of various flow levels on the surrounding ecosystems, thus no figure has yet been established regarding required river flows for sustaining downstream ecosystems. This will affect this report only if the treatment plant option is selected. In viewing the past flow records, sufficient water for all of the water system demands is available most years. In the past, the availability of water to the system from the Merced River has ceased for about three weeks each year due to ice and silt.

Demand flow records for valley water consumption have been kept for 20 years. Appendix C shows the usage figures for 1981. For that year, daily usage figures fluctuated from a low of 301,600 gallons per day (GPD) to a high of 3,909,600 GPD. The total usage figure for 1981 was approximately 400,000,000 gallons. As an average, the daily usage figure for the summer months was a little less than 2,000,000 GPD and approximately 800,000 GPD for the winter months.

Valley water requirements are shown in appendix E. Consumption rates are divided into three categories. The domestic rate is developed on a fixture unit basis, which takes into account the number and different types of water fixtures in the valley. The irrigation rate is developed based on the amount of lawn and gardens to be watered and on the number and types of sprinklers used. No information is available as to what type of actual irrigation practices occur in the valley. The design is based on accepted irrigation practices that could reasonably meet the irrigation needs of the valley. The third category is fire flow. As recommended by the Denver Service Center the fire flows were developed based on the flows recommended by the Insurance Services Office of California, fire fighting capabilities in the park and surrounding area, and the nature of the structures requiring fire protection. Although the valley fire fighting capability is limited to a little over 1500 GPM, a fire of a long duration would enable other fire fighting vehicles with additional pumping capacity to arrive.

WELLS

Three major wells have been drilled in Yosemite Valley.

The first, Ledig Meadow (2S/22E-19Q1), was drilled in December 1970 to a depth of 260 feet with an 18-inch diameter hole. The well hole was lined to a depth of approximately 30 feet with a 20-inch solid casing and with perforated casing to a total depth of 55 feet. The balance of the drill hole was filled with gravel (see appendix D). The well was sucessfully developed to deliver 65 GPM. According to the USGS, the principal source of recharge for the well is the Merced River. The water produced by the well was of excellent quality. The well was abandoned because of its low production rate after later wells were drilled. This well has not been assigned a number.

The second well (2S/22E-19J1) was drilled just southeast of Yosemite Lodge near the confluence of Yosemite Creek and the Merced River. This well will be called well number 1 (as referenced by the Yosemite National Park maintenance staff), and is artesian in nature. It was completed during the summer of 1971, drilled to a depth of 1015 feet, and was cased with a 10-inch diameter casing down to 6-inch diameter stainless steel screen. The deepest screen was installed at a depth of approximately 520 feet. The rest of the drill hole was filled with gravel and plugged with concrete below the deepest screen. The capacity of the vertical turbine pump installed in the well is approximately 850 GPM. The screen in the well is designed to operate efficiently at about 750 GPM. This well was originally used as a backup water source to the surface water intake system when the surface source was not obtainable due to ice blockage of the intake structure, polluted surface waters, breakdowns, and/or low flows. However, since October 1982 this well has been used in conjunction with the Merced River water. The water is pumped directly into the distribution system and at times in the past it has overflowed the sedimentaton basin. The pumphouse was constructed to be protected against flooding (see appendix J). The chlorine contact time on this well is estimated at 11 minutes.

The third well (2S/22E-19H1) was drilled in March 1975. This well will be called well number 2 (as referenced by the Yosemite National Park maintenance staff), and is located next to the superintendent's house. It was drilled to a depth of approximately 970 feet with a 12-inch diameter pilot hole, and was cased with a 10-inch diameter casing to a depth of 707 feet. Four screens have been installed from a depth of 500 feet to 700 feet. The rest of the pilot hole was filled in with pea gravel. No distribution line to the system nor pumphouse has been constructed. The well is artesian and the pressure on it seems to be just over 8 PSI. The capacity of the well due to the aquifer and well screens is approximately 550 GPM. The well was actually tested at 637 GPM for one hour with a stabilized water level. The well is not currently being used and is capped.

Both wells 1 and 2 obtain their water from deep lying aquifers that do not seem to be hydraulically connected to the perched water table. No specific data is available on the recharge rate or the origin of the water that supplies the aquifer. The physical information such as well discharge curves and soil types encountered during well drilling operations can be found in U.S. Department of the Interior, Geological Survey 1973.

If both were operating, wells number 1 and 2 would have a joint production capacity of approximately 2,000,000 GPD, pumping 24 hours a day.

The valley seems to have a perched water table and a lower water-bearing aquifer. The last two wells have been drilled into the lower aquifer, and several studies have reported that sufficient water is available in the lower aquifer to satisfy the valley water needs.

When well number 2 was drilled, satellite wells (11 feet deep, 30 feet from well number 2, 180° apart) were drilled around the well to observe how the perched water table was affected when the well was pumped down during the testing period. No difference was observed in the water levels of these satellite wells, which, though not conclusive, strongly indicates that there is a confining layer of silt that prevents any fluctuation of the perched water table because of pumping operations in the lower aquifer.

SPRINGS

A spring system once provided water, but has not been used for many years. The springs are encased in two concrete cisterns with overflow pipes and collection lines tied into an old 8-inch distribution main (see appendix J). A check valve is located at the junction of the line from the springs and one of the 8-inch distribution mains. A pumphouse was constructed to pump the spring water into the distribution system (the springs are at a lower elevation than the sedimentation basin). The check valve allowed the spring water to gravity feed into the distribution system at a certain line pressure (this occurred when water from the sedimentation basin ceased flowing). The pumps were used whenever spring water was needed to augment the water from the river.

The source of the springs is uncertain. Abandoned water lines from the river cross the area, and one of these old underground lines may be broken and the seepage is what is evidenced as springs. Or, the source of the water could be an exposed aquifer discharging its water on the surface. Whatever the source, the reliable flow has not been quantified. The flow fluctuates seasonly and the springs seem to be the principal water sources for a meadow immediately downslope.

The condition of the springs and collection systems seem to be adequate for possible reuse. Only minor rehabilitation, such as cleaning and patching, would be needed. The pumphouse is empty and should be torn down for safety reasons. The check valve and the distribution line to it from the springs were not inspected and their condition is unknown.

STORAGE

There is no dedicated water storage either for domestic or fire use. The capacity of the sedimentation tank is approximately 80,000 gallons. The current design of the distribution system and sedimentation basin is such that the basin cannot be considered as any type of storage.

Due to the lack of adequate domestic water storage, several different problematical situations arise during the year. During periods of heavy runoff, the water becomes turbid with suspended solids. During this time, when large water use demands are made, the water does not have sufficient detention time in the sedimentation basin to have all of its solids fall out of suspension. This creates problems with deterioration of piping and fittings, odor, taste, and maintenance of hot water systems and refrigeration units. These situations usually last three to four days. This also creates the need for excessive flushing, which results in large volumes of wasted water and high instantaneous surge flow conditions in the sedimentation basin.

With the present distribution system, the lack of water storage contributes to pressure and flow problems in the distribution system. Since the water source is located at one end of the distribution system, large pressure drops occur along the distribution system when water demand is satisfied at the far end from the water source. Storage reservoirs would provide an emergency source of water and help provide adequate pressure for the system.

The lack of water storage prevents the system from having an emergency water supply for either domestic or fire use. During periods of maintenance on the intake structure or the sedimentation basin, the current standby or emergency water supply is limited to the capacity of the one existing well and pump, which at the present time does not have emergency standby power generation.

FIRE FLOWS

Appendix E contains a report (by the Insurance Services Office of California) regarding the available fire flows at each of the major areas of Yosemite Valley and indicating that the required fire flows are inadequate according to their standard rating system.

The amount, location, and size of some of the fire hydrants in the Yosemite Valley are not adequate. Placement of some of the hydrants is such that access to them with fire equipment is a problem. The fire hydrants are used for periodic flushing of the water mains. The current water sources (well and river) along with the existing distribution system do not supply adequate volumes or pressures.

The current system has no provisions for storage and relies on the Merced River or well number 1 as the total source for its fire fighting capability. Well number 1 can only produce 850 GPM and ice and low summer flows can limit or prevent the amount of surface water available to supply the fire fighting activity.

QUALITY

Although the river water is slightly corrosive, it is generally of good quality for most of the beneficial uses defined by the California State Water Resources Control Board (USDI, Geological Survey 1982). The lab reports on the water analysis done on the Merced River confirm this (see appendix K).

Little documentation is available on the quality of the spring water or the water from well number 1 (only one analysis each, 1968 and 1979 respectively). The March 1979 analysis of the well water indicates a high level of iron concentration. The actual iron level of .63 PPM compared to the secondary standard of the Primary Drinking Water Regulations of .3 PPM. This analysis was not conclusive as to whether iron has present in the water or whether the well casing or piping had contaminated the water sample. Instances of rust-colored water are currently noted in the park. This could be attributed to the corrosive nature of the river water. No other certified chemical analysis has been performed on the well water since 1979; however, an unofficial test performed by the park staff in March 1983 found no measurable levels of iron. Although iron concentration is a secondary standard that does not require consideration by the U.S. Public Health Service, certified tests should be performed on the well water so that it can be determined whether iron is present. The current cost analysis does not include an iron removal system.

The spring water seems of good quality, but since this source will not be used, no further consideration of its quality will be given.

VISITATION

Visitation to Yosemite Valley increases each year. Not all visitor accommodations are open during the fall and winter months, but winter visitation is growing. The visitation figures for 1981 are reported in appendix B.

The 1980 General Management Plan (GMP) projects relocation of some National Park Service and concessioner activities from Yosemite Valley to outside the park in the El Portal area. The plan also states that some of the existing guest lodging will be replaced and that the total amount of lodging facilities available the valley will be reduced from its present level. Measures restricting visitor entry into the park could be instigated in the future; day use visitation of the valley is currently limited and influenced by the amount of available parking and overnight use is capped at the current level. It is estimated that when the current approved GMP is implemented, the total visitation to the valley will be approximately 6,675 people per day, which is lower than the current use. Based on all of the foregoing information, it is believed that the current maximum daily water usage figures in the valley will not be exceeded to any significant amount.

FLOODPLAIN

The summary of discharges for the 10-year to 500-year floods is in appendix H, as are the flood hazard study maps. When the flood hazard study maps were developed by the Department of the Army in 1981, the proposed sites for the water treatment plant and the upper reservoirs were not included.

The areas where the upper reservoirs and water treatment plants would be located are steep and the river level is lower than the sites. An effort should be made (during the preliminary design stage) to develop high water elevation projections for the various flood periods for the treatment plant and reservoir sites so that the extent of flood protection required can be determined.

WATER SOURCE OPTIONS

GROUNDWATER (Recommended)

This method would supply all of the potable water needs of Yosemite Valley from the two existing wells and one additional well. The capacity of well number 1 is approximately 850 GPM and well number 2 is rated at 550 GPM. If the new well does not yield at least 850 GPM, another new well would have to be drilled to attain the yield required.

The average required summer flow to supply the valley is approximately 1400 GPM; with the three wells, the total water production capability would be approximately 2250 GPM. This would allow all three wells to be used part of each day with the capability of having the largest well down for maintenance and still have the average required summer flow supplied by the remaining wells.

Well number 1 is the only well currently tied into the existing distribution system. In order to provide adequate chlorine contact time, the discharge line to the distribution system will have to be replaced. Well number 2, which has no pump or pumphouse and has been cased and capped, would have to be connected to the distribution system.

The water from the wells would be transmitted to the water storage tanks via the existing distribution lines. No separate line from the wells to the reservoir would be built because of the high construction cost. This would cause the water to either go directly to a user or the storage reservoir, meaning the chlorine contact time would need to be established prior to the first user. The control wiring from the wells to the reservoirs would be via telephone, microwave, or electrical control lines. Emergency standby power generation would be installed at each well site.

The existing and proposed new well sites are in Upper River and Lower River campgrounds, developed areas which are already impacted, easily accessable by vehicle, and would be little impacted by the new construction.

The aquifer for these wells seems adequate to provide for all the future valley water. The use of well water would enable surrounding ecosystems and downstream users to utilize surface water now used by the park. This study does not address legal considerations on future water rights issues.

Advantages:

- Minimal manpower required to operate the system.
- Minimal chemical and operating supplies.
- Water cleaner and less subject to contamination.
- Little physical construction.

Low maintenance required on pumping units.

Capital outlay lower than surface water alternative.

Water source not subject to seasonal fluctuations.

No impact on the perched water table.

Could be easily expanded if future demands increase.

Disadvantages:

Large power consumption.

Large amount of standby power generation equipment required.

Wells located closer to public view than surface water alternative.

Water pumped directly into the storage reservoirs, causing a chlorine residual maintenance problem.

System dependent on electrical service.

Capacity and recharge of acquifer unknown.

SURFACE WATER

This method would utilize the Merced River to supply most of Yosemite Valley's water needs.

A new water intake structure would be needed because the existing one is in disrepair, does not channel any river water into the water distribution system during low river flow, and its bar racks and trash screen plug and present constant maintenance problems. Water from well number 1 would still have to be used in times of ice blockages, heavy sedimentation in the water, and low flows.

A new treatment plant would be required because the current sedimentation basin does not meet the Safe Drinking Water Act standards for treating potable water. The new plant would be as shown in appendix I, and would have coagulation flocculation, sedimentation, filtration, and chlorination capabilities. It could also inject other additives such as carbon and polyelectrolytes and would have a bypass from the flash mixer directly to the filtration units. The backwash waste would be stored in a holding tank until the solids settled out and then the supernatant would be recycled back into the head of the plant. This would prevent waste of water. The treated water would be chlorinated and then be pumped into the storage reservoirs for distribution into the valley. The sludge would be pumped into the sewer at times and at a rate which the treatment plant at El Portal could best handle.

The plant would be designed to operate 24 hours a day; using two 8-hour shifts, it would require at least six additional personnel to efficiently operate the system year-round.

The best location for this treatment plant is next to the 80,000-gallon sedimentation basin, as shown on sheet 4 of appendix I. This area would be close to the reservoirs, pumping costs would be minimized, and the filters could be gravity type. The alternative site would be next to Happy Isles, but it is lower in elevation and would require that the treated water be pumped to the reservoirs at a much higher elevation, resulting in a greater pumping cost.

The treatment plant would have an office, a lab to do all water monitoring tests, a supply room, a chemical storage area, and a standby generator to supply power to the entire plant during power outages.

In the valley area the Merced River greatly influences the perched water table. Should additional water be taken out of the river, the perched water table would be lowered and biological systems near the river would be affected.

A new electrical service line from Camp Curry would have to be constructed to adequately supply the electrical needs of the new plant.

Advantages:

Area for construction has been impacted.

Central location for metering to monitor all valley consumption.

All chlorination use and supplies regulated to one central area.

A portion of the plant would operate by gravity and could produce a limited supply of treated water in case of power outages.

Energy consumption would be less than the groundwater alternative.

Disadvantages:

Large capital investment.

Great amount of manpower required to operate the system.

Large structure and improved service road.

Subject to seasonal surface water fluctuations.

Would require wells as backup.

Large operating cost.

The quality of the river water is somewhat difficult to treat and water is aggressive (corrosive), which may require additional treatment.

SPRINGS

The springs would not be used in either option because their source has not been identified. The springs should be disconnected from the present distribution system. Whether the structures should be demolished and the system returned to its former condition is up to park management.

WATER STORAGE OPTIONS

The required water storage capacity is 2,500,000 gallons, which the park staff has determined is sufficient for any type of future emergency. Daily usage figures are shown in appendix C, which indicates that 2,500,000 gallons would provide less than two days use on an average summer day and approximately three and one-half days during average winter use.

Whichever option for supplying water to the system is chosen, the upper reservoir would control the production of water. This would involve new control wiring from the source of water supply; this could be either buried or overhead new control wiring, microwave, or existing overhead telephone lines.

In either option, water storage would be located in two tanks, desirable when maintenance on one of them is required.

DUAL SITE

This option would divide the total storage capacity between two locations.

One elevated steel storage tank with approximately 500,000 gallons capacity would be placed behind the concessioner's warehouse in Yosemite Village. It would be elevated to a height of 90 feet with a diameter of approximately 63 feet. The tank would be supported by metal leg supports and the color would be either black or a brown-green camoflauge. The piping required for this location is shown on the second sheet of appendix I. It would require approximately 1800 feet of new 16-inch main through the National Park Service maintenance and administrative areas. This location would be very visable from several popular tourist areas, including Glacier Point, the Yosemite Falls trail, and various locations on the valley floor.

The other steel reservoir would be adjacent to the existing sedimentation basin, shown on the fourth sheet of appendix I. In the treatment plant option, all of the water would be pumped into this tank, then into the distribution system, and then into the elevated reservoir behind the concessioner's warehouse. In the well option, the sequence would be the opposite. This reservoir would be a ground-level tank with an approximate height of 32 feet and a diameter of 104 feet. A protective wall or berm would have to be constructed in order to protect it from occasional flooding on Illouette Creek. It would be painted the same coloring scheme as the elevated reservoir. Relatively little new piping would be required. This location is well hidden from all the popular tourist locations.

In engineering terms, this dual site option is best because it would provide a better balanced system. The flow to any one location within the system would be delivered from two directions, which is desirable because it would tend to reduce line loss and thus maintain higher pressures. Another advantage is that certain portions of the existing distribution system could be isolated for maintenance and not disrupt the water service to other parts of the system.

A summary of predicted pressures for different flow conditions is in appendix F. The pressures that would be experienced with a dual site - situation are adequate for domestic and irrigation uses. Pressures for fire flows are generally inadequate but could be improved by the addition of a few inter-connecting lines between the three mains, which would reduce line friction losses. Raising the elevated reservoir and the replacement of several of the service lines would also increase the pressures.

The elevated reservoir would have a lower waterline elevation than the ground-level reservoir. The difference in reservoir water elevations would be less than the line loss in the inter-connecting main when the demand is greater than 2,100 GPM, causing the water to flow out of the elevated reservoir. If the demand flow were to drop below 2,100 GPM, the elevated reservoir would become isolated and all of the water would be supplied out of the ground-level reservoir and wells or treatment plant. If a smaller minimum flow were desired the elevated reservoir could be raised higher.

Advantages:

Better pressure balance in the system.

Not dependent on one main for water from reservoirs.

Two emergency water sources.

Disadvantages:

Higher construction cost.

One reservoir highly visible to public.

More new line construction to supply reservoirs.

Higher maintenance required on elevated tank.

Below certain flow demand, elevated reservoir would become isolated.

SINGLE SITE (Recommended)

Two ground-level concrete reservoirs would be constructed at either of the sites shown on the fourth sheet of appendix I. The difference in elevation of these two sites is approximately 30 feet.

If it is in adequate condition, an abandoned 16-inch waterline from the abandoned intake structure on Illouette Creek could be used in supplying water from the reservoir(s) located nearest the creek to the distribution system. A new 10-inch supply line from the treatment plant to the reservoirs would be necessary if the surface water source is adopted; if well water is used, the 16-inch line could supply water to and from the tanks.

Both sites are subject to flooding from Illouette, so a dike or berm would be constructed to prevent damage to the structures. Both sites are reasonably clear, but a few trees would probably have to be cut. The reservoirs would be visible from a few sites along the Vernal Falls trail in the fall and winter months.

Both steel and concrete reservoirs were analyzed in the 25-year life cycle cost analysis. Although steel was more economical over the 25-year period, in actuality the reservoirs would be used much longer than that and in the long-run, concrete would be the better investment due to lower maintenance costs. Thus, concrete is recommended.

Appendix F summarizes pressures for the different reservoir locations and piping conditions. Using the existing piping, the majority of the flow pressures for domestic and irrigation uses were found to be sufficient. When the reservoir location was changed from the lower dual sites to the upper single reservoir site, the fire flow pressures were, on the average, unacceptable. When the existing 12-inch main was replaced with a 16-inch line, the pressure was better. The best pressures were obtained when a new 16-inch line augmented the flow of the three existing mains. Thus a new 16-inch water line should be constructed from near the superintendent's house, along the shoulder of the existing roadway, to the Happy Isles nature center so that all demand flows can be met.

Advantages:

- Less conspicuous to visitors.
- Less cost.
- Easier to maintain.
- Better control of storage volume.
- Less new line construction.
- No stagnant storage.

Disadvantages:

- More susceptible to flood damage.
- Break in main would isolate storage reservoirs.
- More development in the eastern end of valley.
- Less pressure balance to system.

WATER DISTRIBUTION SYSTEM RECOMMENDATION

Because the condition of the existing cast-iron pipe seems to be relatively good (appendix D), rehabilitation rather than replacement is recommended.

Rust deposits and tuberculation require that the cast-iron lines be cleaned and all the mains be flushed out (due to the cleaning operations and possible sand accumulations). More pipe samples are currently being taken to better analyze the existing pipe conditions.

The distribution system needs new metering and valving so that flows can be better monitored, leakage more easily detected, and repairs made more easily (thus lessening adverse effects on valley water usage during emergency pipe repairs).

All individual users (not metered) should have meters installed so that water usage can be more effectively monitored and everyone charged equitable use fees.

Appendix I shows the existing water distribution system for Yosemite Valley and all of the potential construction sites for reservoirs, wells, treatment plants, and waterline construction. The drawings also show how the system was modeled for a computer analysis. The system has node points showing change of pipe diameter, meetings of two or more pipes, pressure point locations, and where flow either enters or leaves the system. For simplification, the water demands of several users were grouped together at one node point. Many different types of reservoirs, flows, and piping situations were analyzed to determine the capacity of the different systems (see appendix F).

The domestic, irrigation, and fire flows that have been developed in the report are values that are reasonable. Based on the analysis done on the system, the only feasible way to provide adequate domestic, irrigation, and fire flows is to provide a new 16-inch water main since the current three mains cannot supply all of the required flows and pressures. For environmental reasons it would be better to construct a new 16-inch main along the existing road shoulder. This would prevent construction activity in the meadow areas which would be needed if the existing 12-inch or any of the 8-inch lines were to be replaced. Further study and analysis is recommended for the exact placement of the new 16-inch main and its exact points of connections to the other water mains.

The existing distribution system should have more fire hydrants installed so that better fire protection can be attained throughout the valley. Additional hydrants would also allow more portions of the existing distribution system to be periodically flushed and cleaned, thus maintaining the carrying capacity of the mains and other lines.

Construction of some new waterlines will be necessary to increase the flows and pressures in certain locations. Examples include the line to the Ahwahnee Hotel, the line to well number 1, and the three new inter-connections between the 8- and 12-inch water mains. The locations would be as shown in appendix I; this does not take into consideration new lines that would be required for the new wells and reservoirs.

APPENDIX A: DISCHARGE TABLES OF THE MERCED RIVER

MEAN DISCHARGE OF MERCED RIVER - CFS
(1 CFS = 448.83 GPM)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1965										19.2	91.9	80.5
1966	69.6	65.1	225	819	1,198	440	118	63.6	8.44	4.86	49.5	234
1967	94.3	143	273	213	1,452	2,331	1,745	396	108	27.9	19.9	40.9
1968	40.6	110	138	433	785	453	84.8	26.5	6.76	11.5	109	61.2
1969	194	127	177	781	2,675	2,270	1,096	238	54.7	265	92	304
1970	680	171	436	680	2,040	1,760	595	104	26	3.85	43.5	105
1971	135	145	165	383	900	1,367	442	85.2	24.3	11.9	40.3	58.1
1972	67.1	76.1	351	355	1,065	896	145	27.8	129	51.7	64.6	105
1973	110	116	121	524	2,086	1,513	386	146	13.2	24.9	274	150
1974	191	115	246	453	1,775	1,621	407	154	21.2	11.3	19	29.4
1975	49.5	70.8	124	173	1,516	2,053	519	82.4	41.5	118	86.4	41.2
1976	21.4	33.8	84.4	209	679	169	58.8	38.7	79.3	29.7	9.72	4.49
1977	6.7	13.5	25.2	218	231	419	53.9	7.79	3.18	2.61	7.48	62.6
1978	101	106	277	428	1,677	2,407	1,135	331	360	30.8	25.4	38.4
1979	139	94.4	197	425	1,789	1,139	277	59.7	13.2	41.3	56.6	59.7
1980	366	270	286	667	1,366	1,867	1,175	218	51.1			
Avg. Mean MGD	97.6	71.1	134.4	291.5	915.2	891.9	359	86	41	28.4	43	60
Avg. Mean CFS	151	110	208	451	1,416	1,380	549	132	63	44	66	92

MINIMUM DISCHARGE OF THE MERCED RIVER - CFS
(Minimum Daily Flow for Month)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1923	60	60	85	230	850	500	270	60	50	35	24	14
1924	18	26	40	60	97	50	20	7	2.4	2.4	40	40
1925	45	60	150	280	700	700	150	40	12	22	35	30
1926	16	28	100	290	500	170	30	6	1.4	2	3.6	45
1955	250	140	140	360	700	1,000	700	115	35	2.6	4.4	30
1961	17	30	40	150	335	360	30	20	11	5.4	6.8	30
1962	18	45	65	300	500	990	200	35	8.6	20	12	10
1963	4	140	100	160	700	900	290	35	16	20	28	55
1964	30	40	40	120	240	300	80	18	3.6	1.8	30	65
1965	190	140	160	200	700	800	370	100	30	13	11	50
1966	50	55	70	900	800	250	80	25	4.6	3.2	3.5	180
1967	60	110	120	170	170	900	800	180	50	12	12	20
1968	25	40	80	220	800	150	40	10				
1971	63	95	84	245	416	554	188	30	15	7.7	10	37
1972	57	53	108	214	461	319	44	12	16	15	34	53
1973	60	99	104	110	720	735	137	26	8.4	6.8	29	113
1974	126	96	174	279	735	735	249	43	11	7	15	16
1975	20	47	96	115	274	738	169	36	19	15	38	23
1976	18	19	46	100	321	82	30	17	14	11	6.9	2.8
1977	3.5	7.5	16	28	112	192	10	4.9	1.5	2	2.6	12
1978	87	82	122	239	504	1,260	720	97	70	14	16	26
1979	34	70	93	184	570	489	118	22	7.4	8	35	36
1980	71	142	173	213	649	945	844	67	25			
Lowest Flow												
CFS	4	7.5	16	28	112	50	10	6	1.4	2	2.6	10
MGD	2.6	4.9	10.5	18.3	73.3	32.7	6.5	3.9	.9	1.3	1.7	1.5

APPENDIX B: VISITATION FIGURES - 1981

VISITATION FIGURES
1981 - YOSEMITE NATIONAL PARK

Month	Total Park Visitation	Yosemite Valley Visitation
January	63,171	48,010
February	93,994	71,435
March	86,500	65,740
April	158,727	120,632
May	292,853	222,568
June	349,877	265,906
July	419,003	318,442
August	460,091	349,669
September	325,252	247,191
October	197,445	150,058
November	99,442	75,576
December	70,353	53,468

APPENDIX C:
WATER DEMAND AND AVERAGE WATER USAGE CHARTS

1981 Water Demand Chart (GPD)

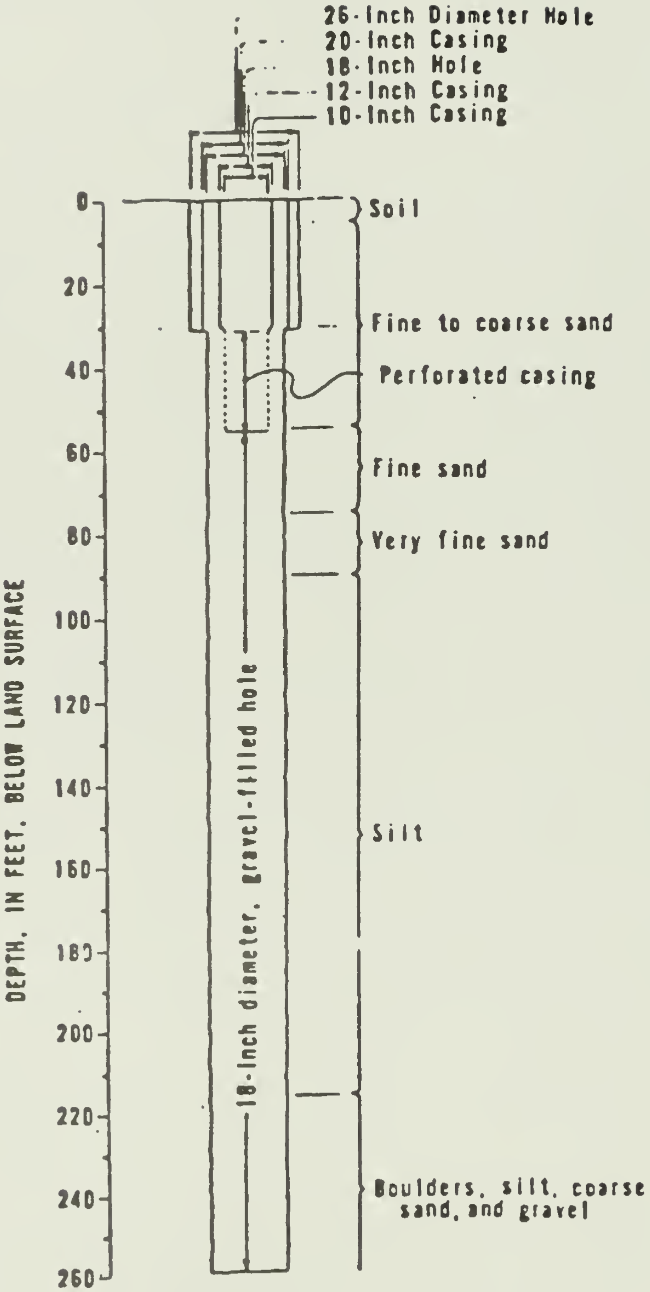
Day	January	February	March	April	May	June	July	August	September	October	November	December
1	769,500	693,300	797,700	892,800	1,017,500	1,177,300	1,588,600	1,639,400	2,115,800	1,137,700	841,900	654,200
2	829,400	615,200	646,100	661,900	1,135,500	1,445,000	1,791,800	1,441,700	1,238,700	1,114,700	804,200	626,400
3	838,500	707,600	712,200	729,200	1,235,300	1,147,200		2,033,400	1,702,200	1,171,400	774,200	646,200
4	889,900	501,300	737,600	725,100	863,400	1,265,100	1,791,800	1,797,500	1,746,700	1,109,900	872,400	628,400
5	712,900	769,400	787,300	846,000	1,118,200	1,346,000	3,896,100	1,868,000	1,842,200	1,093,500	858,200	607,300
6	667,100	487,000	556,200	605,300	1,027,100	1,349,800	2,010,000	1,317,100	1,434,000	1,001,500	676,000	674,800
7	737,400	762,600	806,900	822,400	1,018,300	1,458,400	1,659,800	1,064,700	1,897,000	974,300	831,400	
8	718,400	716,000	657,900	809,600	1,106,100	1,430,000	1,739,900	1,204,500	1,470,400	1,072,700	826,600	643,100
9	631,300	680,800	735,500	755,200	1,325,400	1,377,000	1,617,000	2,239,200	1,634,900	980,000	715,700	620,500
10	814,000	693,700	752,000	741,800	1,328,900	1,530,400	1,630,900	1,967,100	1,480,900	1,187,700	732,300	632,900
11	695,200	593,600	707,800	917,700	1,008,300	1,659,300	1,919,100	1,951,100	1,900,200	732,300	785,000	588,900
12	670,300	626,400	696,200	896,500	1,256,300	1,228,500	1,804,300	1,507,800	1,495,100	915,400	695,200	605,200
13	703,200	613,300	716,000	824,000	1,161,700	1,563,200	1,630,000	1,749,500	1,589,000	938,800	795,700	625,800
14	650,100	784,200	721,700	1,139,500	1,239,700	1,272,700	1,670,000	1,926,500	1,596,500	912,300	669,200	689,500
15	664,200	821,900	878,600	969,500	1,145,900	1,355,200	1,924,700	1,759,200	1,310,000	896,600	697,300	689,100
16	696,400	767,900	706,300	947,900	1,221,100	1,574,000	1,933,300	1,654,200	1,172,300	884,000	892,600	663,300
17	723,500	807,200	846,700	1,013,600	1,285,300	3,288,000	2,360,600	1,716,800	1,357,500	969,700	737,600	681,000
18	714,700	684,600	723,600	1,111,300	1,209,500		1,478,600	1,511,700	1,246,100	1,087,500	771,900	694,700
19	725,900	698,900	720,100	899,100	764,300	1,667,800	1,740,600	1,628,400	1,352,800	793,600	748,900	610,800
20	651,700	728,700	670,200	756,200	836,200	1,550,000	1,534,000	1,540,000	1,408,700	837,400	754,800	640,000
21	621,700	777,800	711,100	949,100	1,035,200	2,061,100	2,021,400	1,598,400	1,343,000	770,400	722,100	660,000
22	661,600	737,500	915,800	799,100	1,035,200	1,374,500	1,273,500	1,585,200	1,314,600	816,900	776,100	701,000
23	656,600	709,800	695,900	877,200	1,035,200	1,641,000	1,828,100	1,491,000	1,188,700	991,900	809,400	
24	838,700	790,000	655,700	769,700	1,140,500	3,909,600	1,270,800	1,488,600	1,438,300	835,900	687,300	
25	639,400	590,300	739,800	301,600	1,174,600	1,114,300	1,850,000	1,382,000	1,331,600	929,800	820,500	732,100
26	645,800	762,100	779,200	907,900	885,500	1,104,300	2,136,700	1,363,100	1,144,000	1,046,500	673,000	725,100
27	686,200	690,500	634,200	819,000	1,009,400	1,400,600	1,876,600	1,466,500	1,246,000	835,100	850,000	746,200
28	1,292,000	725,200	830,400	939,300	1,050,700	1,811,000	1,727,900	1,888,900	1,179,000	818,600	831,700	763,300
29	419,200		836,200	908,600	1,357,500	1,393,700	2,495,200	2,088,100	1,134,000	755,900	872,500	737,500
30			612,400	985,100	1,133,600	1,182,400	2,128,500	1,900,500	1,181,700	839,700	671,800	765,300
31	753,200		771,200		1,204,200		1,738,100	1,924,300		834,500		729,700
Ave.	725,000	698,000	734,000	844,000	1,109,000	1,575,000	1,867,000	1,668,000	1,450,000	938,000	773,000	671,000
High	1,292,000	821,900	915,800	1,139,500	1,357,500	3,909,600	3,896,100	2,239,000	1,900,200	1,187,700	892,600	765,300
Low	419,200	487,000	556,200	301,600	764,300	1,104,300	1,270,800	1,317,100	1,134,000	732,300	671,800	605,200

AVERAGE DAILY WATER USAGE FOR YOSEMITE VALLEY - MGD

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
								1.8	1.3	1.1	1.1
.9	.7	.8	.8	.8	1.5	1.9	1.9	1.5	1.3	.9	.9
.8	.8	.8	.8	1.1	1.3	1.3	.9	.7	.6	.6	.6
.8	.8	.8	.8	.8	.8	.8	.8	.7	.7	.9	.9
.9	.9	.9	.9	.9	.9	.9	1.0	.6	.6	.5	.5
.4	.4	.4	.4	.7	.8	.9	1.0	.8		.5	.4
.4	.4	.4	.55	.7	.9	1.0	1.0	1.2	.9	.2	.8
.7	.7	.7	.8	1.1	1.6	1.9	1.7	1.5	.9	.8	.7
.8	.8	.8	.9								
.7	.7	.7	.7	.9	1.1	1.2	1.2	1.1	.9	.7	.7

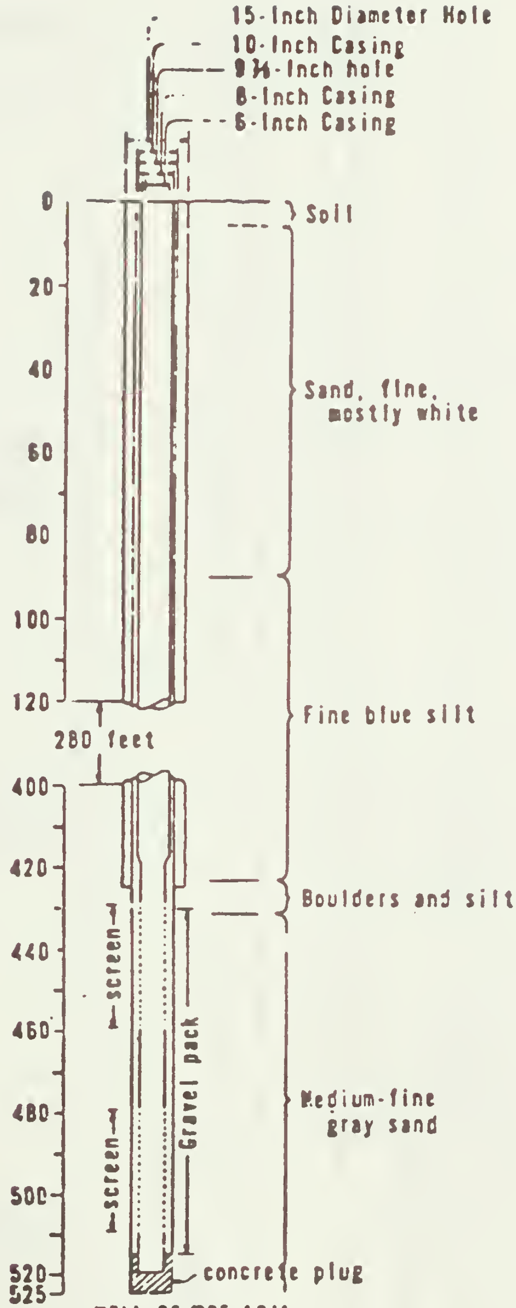
APPENDIX D: EXISTING WELL LOGS

LEDIG MEADOW WELL
NO NUMBER



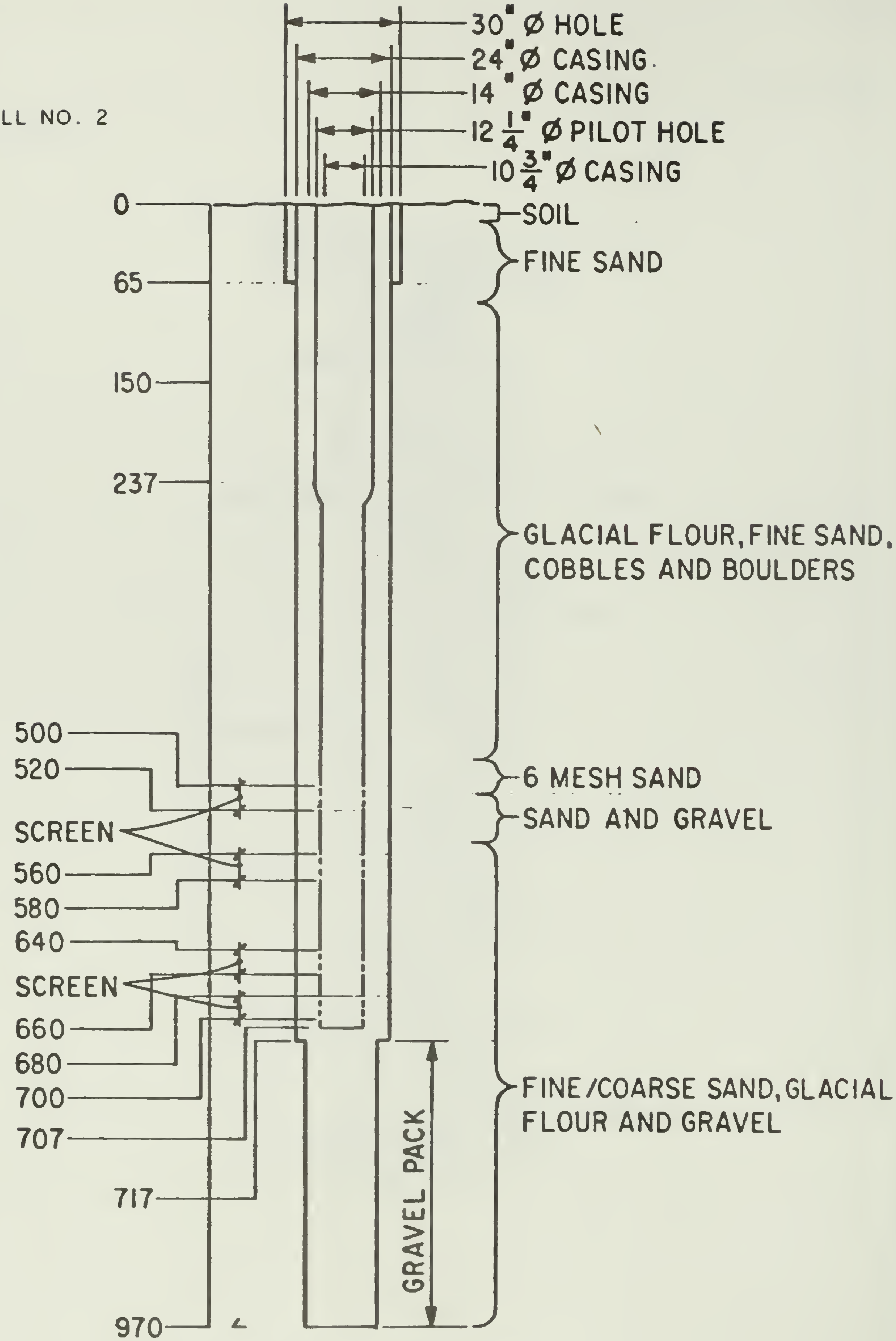
WELL 2S/22E-19D1

WELL NO. 1



WELL 2S/22E-19J1

WELL NO. 2



WELL 25/22E-19H1

APPENDIX E: CALCULATIONS

All flow figures in this section are based on the AWWA Manual No. M22, Sizing Water Service Lines and Meters. A set of figures from that publication is reprinted at the end of this section and should be referred to when notes such as "figure 4.4" appear in the calculations.

TYPICAL COMFORT STATION FLOW ANALYSIS

Typical arrangement for comfort station:

Men's Side	2 water closets
	1 urinal
	2 lavatories
Woman's Side	3 water closets
	2 lavatories

Amount of fixture values per standard comfort station with flushometers installed in water closets and wall type urinals.

WC	= 5 x 35 FV	= 175
UR	= 1 x 12 FV	= 12
LAV	= 4 x 4 FV	= 16
	Total FV	= 202

Because of the different types of fixtures that have been installed in the valley, several of the fixtures have had different fixture values assigned to them. These are urinals, water closets, and service sinks.

YOSEMITE VALLEY PEAK USAGE FIGURES

Domestic Usage

Area	Fixture Value FV	Flow GPM	Node Number
Upper Pine Campground (No. 11)			
Fig. 4.4			
5 Comfort Stations			
203 FV/CS x 5 CS	1015	65	
5 Drinking Fountains			
2 FV/DF x 5 DF	10	8	
		73 GPM	
		37 GPM	4
		36 GPM	5
North Pine Campground (No. 12)			
Fig. 4.4			
3 Comfort Stations	609	54	
	10	8	
		62 GMP	
		31 GPM	15
		31 GPM	20

Area	Fixture Value FV	Flow GPM	Node Number
Lower Pine Campground (No. 14)			
Fig. 4.5			
7 Comfort Stations	1421	70	
5 Drinking Fountains	10	8	
		78 GPM	13
		39 GPM	13
		39 GPM	19
Upper River Campground (No. 15)			
Fig. 4.4			
5 Comfort Stations	1015	65	
5 Drinking Fountains	10	8	
		73 GPM	35
Organization Campground (No. 9)			
Fig. 4.4			
3 Comfort Stations	609	54	
5 Drinking Fountains	10	8	
		62 GPM	14
Lower River Campground (No. 7)			
Fig. 4.4			
5 Comfort Stations	1015	65	
5 Drinking Fountains	10	8	
		73 GPM	
		37 GPM	37
		36 GPM	36
Camp No. 6			
Fig. 4.4			
3 Comfort Stations	609	54	
5 Drinking Fountains	10	8	
		62 GPM	42
Stables			
Fig. 4.4			
2 Comfort Stations	406	45	10
Sunny Side Campground (No. 4) and Gas Station			
Fig. 4.4			
1 Urinal (flush valve)	35		
2 Water Closets	70		
1 Drinking Fountain	2		
Service Sink	7		
3/4-Inch Hose Bibb	10		
	124 FV	24	90

Area	Fixture Value FV	Flow GPM	Node Number
Camp Curry			
Fig. 4.4			
Typical Residence (2 bath)			
Wash Machine	12		
Dish Washer	10		
Kitchen Sink	7		
2 Lavatories	8		
Shower	4		
2 Water Closets (tank type)	6		
Bath Tub	8		
	55 FV		
14 Residences	770 FV	55	12
Camp Curry			
Fig. 4.5			
Typical Cabin with Bath			
Shower	4		
Water Closet	35		
Lavatory	4		
	43 FV		
99 Cabins	4275 FV	73	23
Camp Curry			
Fig. 4.4			
Typical Lodge Unit			
Lavatory	4		
Water Closet	35		
Shower	4		
	43 FV		
19 Units	817 FV	58	
		29	22
		29	26
Camp Curry			
Fig. 4.4			
Typical Bath House			
9 Water Closets	315		
4 Lavatories	16		
6 Showers	24		
	355 FV		
4 Bath Houses	1420 FV	65	18
Camp Curry			
Fig. 4.4			
Cafeteria and Lounge			
5 Water Closets	175		
5 Lavatories	20		
2 Drinking Fountains	6		
2 Kitchen Sinks	14		
2 Service Sinks	14		
2 Urinals	70		
	299 FV	34 GPM	17

Area	Fixture Value FV	Flow GPM	Node Number
Housekeeping Camp			
Fig. 4.5			
10 Comfort Stations	2030 FV	75 GPM	49
Housekeeping Camp			
Fig. 4.4			
2 Shower Buildings			
16 Showers	64 FV	20 GPM	49
Housekeeping Camp			
Fig. 4.4			
Laundry			
20 Washers	360 FV	40 GPM	49
Ahwanee Hotel			
Fig. 4.5			
Typical Hotel Room			
Lavatory	4		
Shower	4		
Water Closets	35		
	43 FV		
99 Rooms	4356 FV	170 GPM	
		56 GPM	24
		57 GPM	25
		57 GPM	32
Ahwanee Hotel			
Fig 4.4			
Dining Room			
Water Closet	35		
Lavatory	4		
Service Sink	7		
Dish Washer	10		
Hose Connection	25		
3 Kitchen Sinks	21		
	102 FV	22 GPM	27
Ahwanee Hotel			
Fig. 4.4			
Typical Cottage			
Lavatory	4 FV		
Shower	4		
Water Closet	35		
	43 FV		
22 Cottages	968 FV	60 GPM	27

Area	Fixture Value FV	Flow GPM	Node Number
Ahwanee Hotel			
Fig. 4.4			
10-Room Dormitory			
6 Showers	24		
4 Lavatories	16		
6 Water Closets	210		
2 Urinals	70		
	320 FV	35 GPM	27
Yosemite Village			
Fig. 4.5			
Typical Residence			
Kitchen Sink	7		
Dish Washer	10		
2 Lavatories	8		
2 Water Closets	6		
Shower	4		
Bath	8		
Washing Machine	12		
	55 FV		
147 Residences	8085 FV	290 GPM	
Curry Housing (26)		17 GPM	40
		18 GPM	52
Upper Tecoya Housing (34)		32 GPM	38
		35 GPM	37
Government Housing (87)		10 GPM	63
		26 GPM	70
		26 GMP	79
		26 GPM	80
		26 GPM	81
		26 GPM	84
		31 GPM	88
NPS Maintenance Area			
Fig. 4.4			
2 Hose Bibbs	24		
Typical Bathroom			
Water Closet	35		
Lavatory	4		
	39 FV		
12 Bathrooms + 2 Hose Bibbs	492 FV	44 GPM	64

Area	Fixture Value FV	Flow GPM	Node Number
NPS Headquarters Area			
Fig. 4.4			
Typical Bathroom			
3 Water Closets	105		
1 Urinal	35		
2 Lavatories	8		
	148 FV		
6 Bathrooms	888 FV	60 GPM	54
Best Studio			
Fig. 4.4			
Water Closet	35		
Lavatory	4		
	39 FV	18 GPM	46
Post Office			
Fig. 4.4			
2 Water Closets	70		
2 Lavatories	8		
	78 FV	20 GPM	46
Village Store			
Fig. 4.4			
2 Water Closets	70		
2 Lavatories	8		
	78 FV	20 GPM	58
Bank			
Fig. 4.4			
2 Water Closets	70		
2 Lavatories	8		
	78 FV	20 GPM	58
Curry Headquarters			
Fig. 4.4			
2 Water Closets	70		
2 Lavatories	8		
	78 FV	20 GPM	41
Curry Maintenance Area			
Fig. 4.4			
1 Hose	9		
2 Water Closets	70		
2 Lavatories	8		
	87 FV	20 GPM	41

Area	Fixture Value FV	Flow GPM	Node Number
Hospital			
Fig. 4.4			
1 Dishwasher	10		
7 Water Closets	245		
7 Lavatories	28		
Shower	4		
Kitchen Sink	7		
Bed Pan Washers	10		
	304 FV	70 GPM	61
Ranger Club			
Fig. 4.4			
6 Water Closets	210		
6 Lavatories	24		
6 Showers	24		
2 Kitchen Sinks	14		
	272 FV	32 GPM	62
Warehouse Laundry		298 GPM	53
Degnans			
Fig. 4.4			
4 Water Closets	140		
4 Lavatories	16		
Kitchen Sink	14		
Service Sink	7		
	177 FV	28 GPM	45
Yosemite Lodge			
Fig. 4.5			
Typical Room			
Water Closet	35		
Lavatory	4		
Shower	4		
	43 FV		
374 Rooms	16,082 FV	176 GPM	
		44 GPM	74
		44 GPM	75
		44 GPM	82
		44 GPM	89
Yosemite Lodge Area			
Fig. 4.4			
8-Room Dormitory			
4 Water Closets	140		
2 Urinals	70		
4 Lavatories	28		
	238 FV	32 GPM	78

Area	Fixture Value FV	Flow GPM	Node Number
Yosemite Lodge Area			
Fig. 4.4			
6 Washer Laundry	150 FV	27 GPM	77
Yosemite Lodge Area			
Fig. 4.4			
Restaurant, Cafeteria, Lounge			
2 Dish Washers	20		
6 Water Closets	210		
2 Urinals	70		
5 Lavatories	20		
2 Kitchen Sinks	14		
2 Service Sinks	14		
	348 FV	35 GPM	83
Total Usage		2173 GPM	

Irrigation Usage

Because the climatic conditions of Yosemite Valley are more like those of Squaw Valley than the Fresno area, the evapotranspiration factor is taken from the northeast interior basin rather than from San Joaquin drainage.

EF = 5.11 In/Mo
RF = .37 In/Mo
PIFF = 4.74 In/Mo

For a hot and dry climate the irrigation is only 60% efficient. The total water required by irrigation to replace that evaporated:

= 4.74 In/Mo x 1.6
= 7.58 In/Mo

In addition to the amount of water required to replace that which has evaporated, a grass lawn requires an additional 2 inches per week. Increased by 60 percent due to irrigation losses this becomes 3.2 In/Wk. The total amount of water required to grow a lawn is:

7.58 In/Mo + 3.2 In/Wk x 4 Wk/Mo = 20.38 In/Mo
20.38 In/Mo ÷ Mo.30 Day = .679 In/Day
Use = .68 In/Day

For a light sandy soil the maximum precipitation rate of the soil is between .75 to .5 In/Hr (Toro Maximum Precipitation Rates Table.) The total amount of water required per square foot of lawn irrigation equals:

= .68 In/Day x Ft/12 In x 7.48 Gal/CF
= .424 Gal/SF Day

Because the irrigation practices of the valley are not known, the following analysis is based on using rainbird type sprinklers.

Area	Volume GPD	Flow GPM	Node Number
Ahwahnee Hotel			
Lawn 250 Ft x 500 Ft			
= 125,000 SF			
Total amount of water required:			
125,000 SF x .424 Gal/SF Day	53,000 GPD		
Using 10 4-GPM Sprinklers		40 GPM	27
Curry Village			
Lawn 70,00 SF	29,680 GPD		
Using 10 sprinklers		40 GPM	
		20 GPM	22
		20 GPM	17
Yosemite Village			
Lawn 10,000 SF	4,240 GPD		
Using 10 sprinklers		20 GPM	83
		20 GPM	87

Area	Volume GPD	Flow GPM	Node Number
NPS Administrative Area			
Lawn 100,000 SF	42,400 GPD		
Using 10 sprinklers		40 GPM	62
Indian Museum			
Creek (Estimated)		20 GPM	54
Reflecting Pool			
125,000 Gal/Mo		17 GPM	89
Residences (Typical)			
Lawn 10,000 SF	4,240		
Using 2 sprinklers		8 GPM	
Curry Housing (26)		207 GPM	
		69 GPM	40
		69 GPM	51
		69 GPM	52
Upper Tecoya (34)		272 GPM	
		136 GPM	37
		136 GPM	38
Government (87)		696 GPM	
		87 GPM	63
		87 GPM	65
		87 GPM	70
		87 GPM	79
		87 GPM	80
		87 GPM	81
		87 GPM	84
		87 GPM	88
TOTAL		1,372 GPM	

Memo

August 12, 1982

D5039 (DSC-TWE)

Memorandum

To: Regional Director, Western Region

From: Assistant Manager, Alaska/Pacific Northwest/Western Team, Denver Service Center

Reference: Yosemite National Park, Package 249, Rehabilitate Water System, Yosemite Valley

Subject: Fire Flow Requirements

Under separate cover we are sending to the Superintendent of Yosemite National Park the results of fire flow testing done in Yosemite National Park in April of 1981 by the Insurance Services Office (I.S.O.) of California. This report has the needed fire flow as recommended by I.S.O. for full credit conditions in establishing the insurance rates for property loss due to fire.

It is our recommendation that the total fire flows for each area be as follows:

Area	Fire Flow (G.P.M.)
Visitor's Center (Yosemite Village)	3000
Village Store	3000
Ahwahnee Hotel	2500
Camp Curry Village	2500
Yosemite Lodge	3000

We are requesting that the Superintendent analyze the report and our recommendations and make his decision as to what flows are to be used for fire fighting purposes.

(Sgd) Kenneth Raithel, Jr.

Kenneth Raithel, Jr.
Enclosure
cc:
Supt., YOSE, w/enc.

bcc:
DSC-TWE-PIFS, w/enc.
DSC-TWE-Espinoza, w/enc. DSC:TWE:ESPINOZA:lh:8/12/82:4520

City YOSEMITE NATIONAL PARK State CALIFORNIA Zip 95389 Witnessed by J. LEE / L. LYNCH Date APRIL 1981

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW-GPM				PRESSURE PSI		FLOW AT 20 PSI		REMARKS
				INDIVIDUAL HYDRANTS			TOTAL	STATIC	RESID.	NEEDED **	AVAIL.	
1	C	VISITOR'S CENTER (YOSEMITE VILLAGE)		660				77	60	4000	1300	
2	C	VILLAGE STORE		860				81	66	4000	1800	
3	C	AHWAHNEE HOTEL		410				82	20	2500	400	
4	C	CAMP CURRY VILLAGE		1030				82	52	2500	1500	
5	C	YOSEMITE LODGE		920				90	58	5000	1400	

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR INSURANCE RATING PURPOSES ONLY AND ARE NOT INTENDED TO PREDICT THE MAXIM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION. THE AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire Suppressi

11/80

INSURANCE SERVICES OFFICE OF CALIFORNIA

HYDRANT FLOW DATA SUMMARY

City YOSEMITE NATIONAL PARK State CALIF. Zip ______ Witnessed by J LEE Date MAY 1981

HODGDON (Park Service living quarters area)

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW-GPM INDIVIDUAL HYDRANTS			FLOW-GPM TOTAL	PRESSURE PSI STATIC	PRESSURE PSI RESID.	FLOW AT 20 PSI NEEDED **	FLOW AT 20 PSI AVAIL.	REMARKS
1				1140				140	50	1000	1300	

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR INSURANCE RATING PURPOSES ONLY AND ARE NOT INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION. THE AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit

11/80

City EL PORTAL State CALIFORNIA Zip ______ Witnessed by J. LEE & L. LYNCH Date MAY 1981

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW-GPM INDIVIDUAL HYDRANTS			FLOW-GPM TOTAL	PRESSURE PSI STATIC	PRESSURE PSI RESID.	FLOW AT 20 PSI NEEDED **	FLOW AT 20 PSI AVAIL.	REMARKS
1	C	STATE ROUTE 140 REAR OF EL PORTAL INN COFFEE SHOP		890			890	92	58	2000	1300	
2	C / R	RANCHERO FLAT RD. & RED BUD LN		900			900	97	65	1500 / 750	1400	

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR INSURANCE RATING PURPOSES ONLY AND ARE NOT INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION. THE AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire Suppression Rating Schedule.

SUMMARY OF FLOW REQUIREMENTS

Node Number	D Flow GPM	D & I Flow GPM	D, I & FF Visitor Center GPM	D, I & FF Village Store GPM	D, I & FF Ahwahnee Hotel GPM	D, I & FF Curry Village GPM	D, I & FF Yosemite Lodge GPM
4	37	37	37	37	37	37	37
5	36	36	36	36	36	36	36
10	45	45	45	45	45	45	45
12	55	55	55	55	55	55	55
13	39	39	39	39	39	39	39
14	62	62	62	62	62	62	62
15	31	31	31	31	31	31	31
17	34	54	54	54	54	500	54
18	65	65	65	65	65	500	65
19	39	39	39	39	39	39	39
20	31	31	31	31	31	31	31
22	29	49	49	49	49	1,000	49
23	73	73	73	73	73	500	73
24	56	56	56	56	56	56	56
25	57	57	57	57	500	57	57
26	29	29	29	29	29	29	29
27	117	157	157	157	1,500	157	157
32	57	57	57	57	500	57	57
33	37	37	37	37	37	37	37
34	36	36	36	36	36	36	36
35	73	73	73	73	73	73	73
37	35	171	171	171	171	171	171
38	32	168	168	168	168	168	168
40	17	86	86	86	86	86	86
41	40	40	40	40	40	40	40
42	62	62	62	62	62	62	62
45	28	28	1,000	1,000	28	28	28
46	40	40	40	40	40	40	40
49	135	135	135	135	135	135	135
51	17	86	86	86	86	86	86
52	18	87	87	87	87	87	87
53	298	298	298	298	298	298	298
54	60	80	1,000	80	80	80	80
56	0	0	0	1,000	0	0	0
58	40	40	40	1,000	40	40	40
61	70	70	70	70	70	70	70
62	32	72	1,000	72	72	72	72
63	10	97	97	97	97	97	97
64	44	44	44	44	44	44	44
65	0	87	87	87	87	87	87
70	26	113	113	113	113	113	113
74	44	44	44	44	44	44	1,000
75	44	44	44	44	44	44	44
77	27	47	47	47	47	47	47
78	32	32	32	32	32	32	32
79	26	113	113	113	113	113	113

Node Number	D Flow GPM	D & I Flow GPM	D,I & FF Visitor Center GPM	D,I & FF Village Store GPM	D,I & FF Ahwahnee Hotel GPM	D,I & FF Curry Village GPM	D,I & FF Yosemite Lodge GPM
80	26	113	113	113	113	113	113
81	26	113	113	113	113	113	113
82	44	44	44	44	44	44	44
83	35	55	55	55	55	55	1,000
84	26	113	113	113	113	113	113
88	31	118	118	118	118	118	118
89	44	61	61	61	61	61	1,000
90	24	24	24	24	24	24	24
Total	2,471	3,843	6,933	6,775	6,072	6,102	6,683

TABLE 4.2

Multiplication Factors to Adjust Demand Lead as Obtained from the Curves in Figs. 4.4 or 4.5 to Various Utility Delivery Pressures at the Meter Outlet

Design Pressure *psi*	Factor
20	0.74
30	0.92
35 Base	1.00
40	1.07
50	1.22
60	1.34
70	1.46
80	1.57
90	1.68
100	1.78

TABLE 4.3
Plumbing Fixture Value

Fixture Type	Fixture Value Based on 35 psi at Meter Outlet
Bathtub	8
Bedpan washers	10
Combination sink and tray	3
Dental unit	1
Dental lavatory	2
Drinking fountain (cooler)	1
Drinking fountain (public)	2
Kitchen sink: 1/2-in. connection	3
3/4-in. connection	7
Lavatory: 3/8-in. connection	2
1/2-in. connection	4
Laundry tray: 1/2-in. connection	3
3/4-in. connection	7
Shower head (shower only)	4
Service sink: 1/2-in. connection	3
3/4-in. connection	7
Urinal: Pedestal flush valve	35
Wall or stall	12
Trough (2-ft unit)	2
Wash sink (each set of faucets)	4
Water closet: Flush valve	35
Tank type	3
Dishwasher: 1/2-in. connection	4
3/4-in. connection	10
Washing machine: 1/2-in. connection	5
3/4-in. connection	12
1-in. connection	25
Hose connections (wash down): 1/2-in.	6
3/4-in.	10
Hose (50-ft length–wash down): 1/2-in.	6
5/8 in.	9
3/4 in.	12

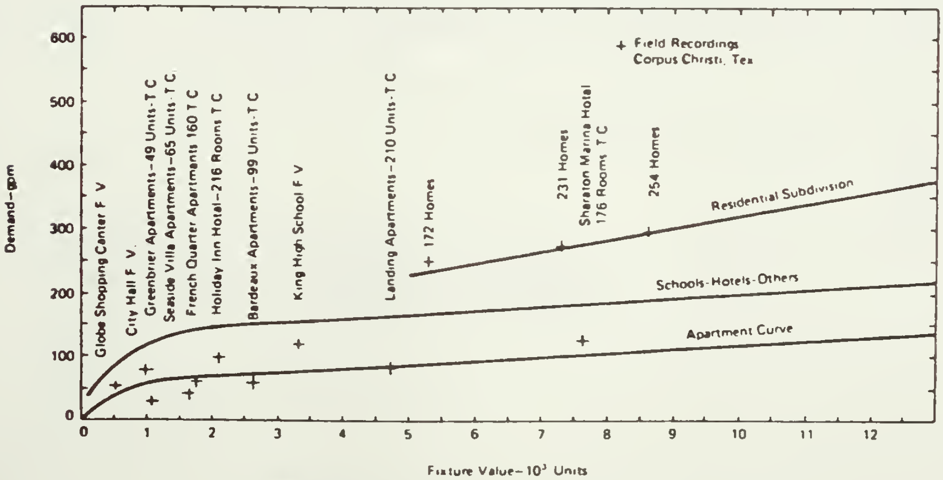


Fig. 4.3. Peak Flow Demand of Typical Utility Customers

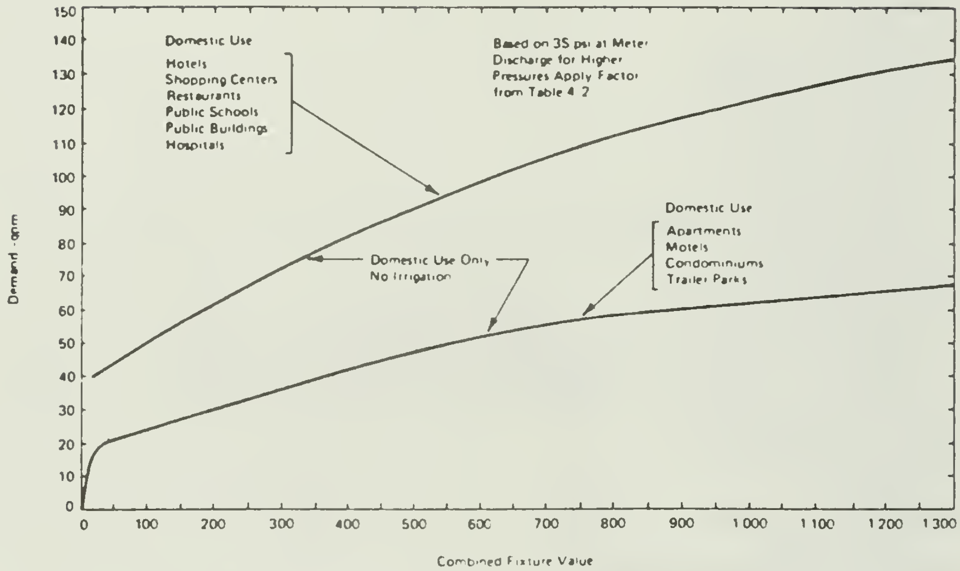


Fig. 4.4. Water-Flow Demand per Fixture Value—Low Range

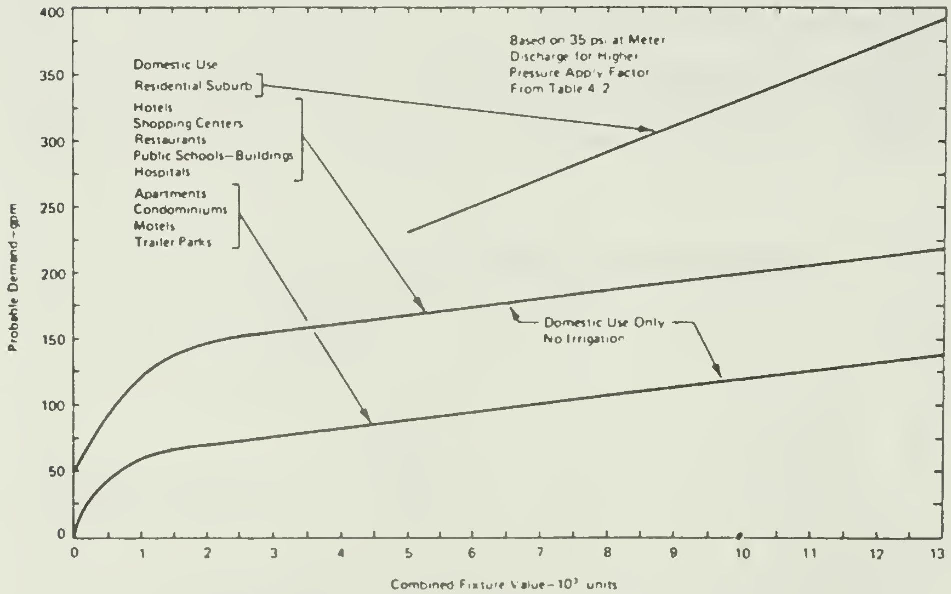


Fig. 4.5. Water-Flow Demand per Fixture Value—High Range

WATER TREATMENT PLANT CAPACITY

Water Usage

Using 1981 figures (appendix C), it seems that the lowest flows and highest daily flows are:

Low Low	301,600	GPD
Peak High	3,909,600	GPD
Average Low	638,000	GPD
Average High	1,916,500	GPD

The treatment plant will be sized for is 2,000,000 GPD flow, which reduces to a flow of 1,400 GPM.

Storage

It has been recommended by the park that the storage for system be rated at 2,400,000 gallons. The capacity of the two reservoirs will follow Metcalf and Eddy's recommendation that one be sized at 900,000 gallons and the other at 1,500,000 gallons. (The location of each reservoir will be addressed in each of the alternatives.)

Assuming the demand occurs from 6 am to 10 pm, usage can be spread over 16 hours. This leaves eight hours for the reservoirs to be refilled. In the groundwater option the total production capacity is approximately 1,080,000 gallons in eight hours and 3,240,000 gallons for every 24 hours. Depending on the daily water demand and the amount of reservoir resupply, water rationing measures may have to be implemented. In the surface water option the total amount of emergency water production (short term, 5 GPM/SF treatment rate) is limited to 1,920,400 gallons for eight hours and 5,760,000 gallons for 24 hours. This option could supply demand quantities at all times if sufficient water is available in the Merced River for treatment. The fire storage requirement will be sized at 500,000 gallons, which leaves 1,900,000 gallons for domestic storage. The fire storage will provide approximately 2-3/4 hours of fire protection at a withdrawal rate of 3,000 GPM.

Filter Bed Capacity

Filtration Rate = 2 GPM/SF

Size of Total Filter Bed/SF Required

$$= \frac{2{,}000{,}000\ \text{Gal.}}{24\ \text{HRS}} \times \frac{\text{Min. - SF}}{2\ \text{GAL}} \times \frac{\text{HR}}{60\ \text{MIN}}$$

= 694 SF

or Four Beds at 174 SF each

or 10' x 17.4'

use 10' x 20'

Filtration Rate

No. of Beds	2 GPM/SF	2.5 GPM/SF	3 GPM/SF
1	576,000 GPD	720,000 GPD	864,000 GPD
2	1,152,000 GPD	1,440,000 GPD	1,728,000 GPD
3	1,728,000 GPD	2,160,000 GPD	2,590,200 GPD
4	2,304,000 GPD	2,880,000 GPD	3,456,000 GPD

Filtration Rate

No. of Beds	3.5 GPM/SF	4.0 GPM/SF	4.5 GPM/SF	5 GPM/SF
1	1,008,000	1,152,000	1,296,000	1,440,000
2	2,016,000	2,304,000	2,592,000	2,880,000
3	3,024,000	3,456,000	3,888,000	4,320,000
4	4,302,000	4,608,000	5,184,000	5,760,000

In filtration plants where coagulant is used, sand filters should produce a satisfactory quality of water at a 4 GPM/SF operating rate.

For short periods of time, such as during maintenance and emergencies, the capacity of the filters can be increased to a maximum of 5 gallons per square foot. As the filter is designed, the plant can handle a variety of flows with a number of filter combinations.

Flocculation Tank

Detention time in flocculation tanks must be no less than 30 minutes (Great Lakes 1976). The tank will be sized for this time even though the state of California approves of direct filtration with no flocculation time. The flow rate used will be 1,400 GPM.

$$\text{Vol} = 1{,}400\ \frac{\text{GAL}}{\text{MIN}} \times 30\ \text{MIN}$$
$$= 42{,}000\ \text{GAL}$$
$$= 5{,}544\ \text{CF (two cell)}$$

Clear Well Tank

Chlorine solution will be injected in the clear well tank prior to distribution and using a 30-minute contact time and a 1,400 GPM flow rate into the clear well, the tank volume is the same as the flocculation tank = 5,544 CF.

By adding an additional 1,400 feet of 18-inch diameter main, an additional 13 minutes of chlorine contact time is achieved at a flow rate of 1,400 GPM. An additional 18 hours of contact time is achieved at the reservoir. With these contact times the system can experience a flow rate in excess of 6,500 GPM and still provide a contact time in excess of four hours.

Backwash Holding Tank

Using a rate of 15 gallons per minute per square foot and a backwash time of 15 minutes the total volume of the tank would be:

= 15 MIN x 10 feet x 20 feet x 15 GPM/SF
= 45,000 GAL
= 5,940 CF

Spring runoff conditions may require two filters to be backwashed in quick succession. The capacity of the holding tank should be increased for this situation, and therefore would be:

= 11,880 CF

WELL CAPABILITIES

The existing valley demand requires 2,000,000 GPD average. This number reduces down to 1,400 GPM. The existing wells in the valley will produce the following:

Well No. 1 = 850 GPM
Well No. 2 = 550 GPM

Using well number 1 as a stand by for emergencies, the required new well capacity is:

1,400 550 = 850 GPM

It is assumed that one new well will produce the required flow. Should flow from the new well No. 3 be less than 850 GPM, a fourth well will have to be drilled. These two well sites have been identified in appendix I.

With well number 1 being used during extreme demand periods, the total capacity of the three wells would be 2,250 GPM or 3,240,000 gallons per day production.

The site of the proposed third well is more than one mile from either well number 1 or 2. The USGS (1973) noted that when well Number 2 was drilled, the satellite wells that were drilled next to it did not show any measurable drop in the level of the water surface when the well was developed and tested. The areas opposite the Ahwanhee and Curry Village have been identified as good potential well locations.

APPENDIX F: SUMMARY OF FLOWS AND PRESSURES

Following is a short summary of the different distribution system conditions and of the pressure results as modeled by the computer. Not all locations or different types of analysis are contained in this report.

Columns 1 and 2 denote the locations in the existing distribution where the demand flows were modeled.

Colume 3 lists the pressure conditions as the distribution system now exists, using just the valley's domestic demand. Adequate pressures are available throughout most of the system when the domestic demand is placed on the system. The top floor of the Ahwahnee shows a low service pressure.

Column 4 lists pressure conditions as the distribution system now exists with domestic and irrigation demands being placed on it. On the average the pressures are adequate except for the top floor of the Ahwahnee, the residential housing area, the Curry housing area, and the hospital.

Column 5 shows that with the existing cast iron mains cleaned and two new reservoirs placed on the system (one elevated and the other located above the sedimentation basin) the pressures rise to higher levels. When the domestic and irrigation flows are met, all the pressures are adequate.

For the next five computer runs, the village store location was chosen because of its central location.

Column 6 shows that with clean piping, new interties, two reservoirs (one elevated and one ground level), and with domestic, irrigation and fire flows being placed on the system, the residential and Curry housing areas are the two locations that do not provide adequate pressures.

Column 7 shows that with clean piping, new interties, two ground level reservoirs (one reservoir site), and with domestic and irrigation flows being placed on the system, the pressures are adequate in all locations except Curry housing.

Column 8 shows that with clean piping, new interties, two ground-level reservoirs (one reservoir site), and with domestic, irrigation and fire flows, the pressures in half the system are inadequate.

Column 9 shows that with clean piping, new interties, two ground-level reservoirs (one reservoir site), replacement of the 12-inch line with a 16-inch line, and with domestic, irrigation and fire flows, the pressures are adequate except for the Curry and residential housing areas.

Column 10 shows that with clean piping, new interties, a new 16-inch main, two ground-level reservoirs (one reservoir site), and domestic, irrigation, and fire flows, all of the pressures are adequate except for the Curry housing.

Additional analyses were done (not as part of this report) at all of the other lcoations and generally the pressures were adequate.

Summary of Flows and Pressures

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10
Node Number	Location	Existing Conditions D Flow 2471 GPM	Existing Conditions D&I Flows 3843 GPM	Clean Pipe, New Inter-ties 2 Res. Locations, D&I Flows 3843 GPM	Clean Pipe, New Inter-ties, 2 Res. Locations, D,I, and FF Village Store 6775 GPM	Clean Pipe, New Inter-ties, 1 Res. Location, D&I Flows 3843 GPM	Clean Pipe, New Inter-ties, 1 Res. Location, D,I, and FF Village Store 6775 GPM	Clean Pipe, New Inter-ties, Replac-ing 12-in. with 16-in. Main, 1 Res. Location, D,I, and FF Village Store 6775 GPM	Clean Pipe, New Interties and 16-in. main, D,I. and FF 1 Res. Location, Village Store 6775 GPM
5	Upper Pine campground	58.27	42.70	66.56	61.74	80.73	43.91	71.75	69.82
13	Lower Pine campground	59.54	41.64	66.46	60.02	77.93	27.58	68.86	69.91
14	Organization camp	30.16	12.26	41.83	35.39	53.30	2.95	44.23	45.28
15	North Pine campground	48.50	30.60	56.99	50.55	68.46	18.11	59.39	60.44
18	Camp Curry	53.20	29.14	63.59	56.22	73.65	17.97	64.04	66.36
22	Camp Curry	61.81	37.58	72.02	64.51	81.87	25.14	72.11	74.59
24	Top floor, Ahwahnee Hotel	9.47	-21.49	26.61	17.04	32.70	- 43.26	21.37	26.26
27	Ground floor, Ahwahnee Hotel	55.23	24.27	69.98	60.40	76.07	.11	64.73	69.63
36	Residential housing	21.70	-24.82	22.51	3.39	22.59	- 90.20	1.23	15.19
42	Camp 6	54.58	12.93	59.25	39.31	60.40	- 48.67	37.99	49.81
46	Yosemite Village	54.58	11.88	57.83	37.13	57.83	- 57.26	34.79	49.04
51	Curry housing	50.77	-53.11	4.06	-16.29	5.01	-105.89	-17.92	- 5.91
61	Hospital	33.70	- 8.24	37.44	17.00	38.36	- 73.17	15.28	27.34
67	NPS shop area	47.87	2.51	49.94	32.68	49.64	- 62.82	30.23	44.79
75	Yosemite Lodge	49.70	17.98	63.43	51.09	62.86	- 45.69	48.51	60.21
79	Residential housing	44.86	- .52	46.91	29.88	46.61	- 65.71	27.42	41.83
82	Yosemite Lodge	42.79	11.35	57.01	44.68	56.44	- 52.11	42.09	53.79
88	Residential housing	46.29	1.33	49.72	33.57	49.37	- 62.32	31.08	45.02

APPENDIX G: LIFE CYCLE COST ANALYSIS

CONSTRUCTION COSTS AND LIFE CYCLE COST ANALYSES

WELLS

Construction Costs

Existing Well No. 1	
Controls to Reservoir	$ 20,000
Emergency Standby Generator	100,000
TOTAL	$120,000
Connect Well No. 2 Piping to Main (600 Feet)	
Pump, 125 HP and Piping	$ 20,000
Pump Cable	12,000
Motor Controls	10,000
Electrical Service and Transformer	11,000
Install Pump, Piping and Cable	20,000
Pump House	60,000
Emergency Standby Generator	100,000
Controls to Reservoir	10,000
Miscellaneous Equipment and Labor	15,000
Piping to Main (600 Feet)	24,000
TOTAL	$282,000
New Well No. 3	
Drill Well and Casing	$200,000
New Pump 125 HP and Piping	20,000
Install Pump, Piping and Cable	20,000
Motor Controls	10,000
Pump Cable	12,000
Emergency Generator	100,000
Controls to Reservoir	10,000
Pumphouse	40,000
Miscellaneous Equipment and Labor	15,000
Electrical Service and Transformer	12,000
Piping to Main (300 Feet)	18,000
TOTAL	$457,000

Operating Costs

Wells, Using Well No. 1 as a Standby:

Well No. 1, rated at 850 GPM at 75 HP, approximately 60% efficiency.

Well No. 2, rated at 550 GPM 125 HP submersible, 60% efficiency.

Well No. 3, assumed rating at 850 GPM 125 HP submersible, 60% efficiency.

From 1981 demand records total usage is approximately 393,630,000 gallons for the year.

Average Monthly Pumping Time:

JAN. 725,000 GPD

Use Well No. 1 for Source

$$\text{Running Time} = \frac{725{,}000\ \text{Gal}}{\text{Day}} \times 30\ \frac{\text{Day}}{\text{Mo.}} \times \frac{1}{850}\ \frac{\text{Min}}{\text{Gal}} \times \frac{\text{HR}}{60\ \text{min}}$$

= 426 HRS in January

FEB. 698,000 GPD
Use Well No. 1
Running Time = 383 Hours

MAR. 734,000 GPD
Use Well No. 1
Running Time = 446 HRS

APR. 844,000 GPD
Use Wells No. 1 and 3
Running Time (1) = 480 HRS
Running Time (3) = 17 HRS

MAY. 1,109,000 GPD
Use Wells No. 1 and 3
Running Time (1) = 496 HRS
Running Time (3) = 178 HRS

JUN. 1,575,000 GPD
Use Wells No. 1 and 3
Running Time (1) = 480 HRS
Running Time (3) = 446 HRS

JUL. 1,867,000 GPD
Use Wells No. 1, 2, and 3
Running Time (1) = 496 HRS
Running Time (2) = 220 HRS
Running Time (3) = 496 HRS

AUG. 1,668,000 GPD
Use Wells No. 1, 2, and 3
Running Time (1) = 496 HRS
Running Time (2) = 34 HRS
Running Time (3) = 496 HRS

SEP. 1,450,000 GPD
Use Wells No. 1 and 3
Running Time (1) = 480 HRS
Running Time (3) = 373 HRS

OCT. 938,000 GPD
Use Well No. 1 and 3
Running Time (1) = 496 HRS
Running Time (3) = 74 HRS

NOV. 773,000 GPD
Use Well No. 1
Running Time = 455 HRS

DEC. 671,000 GPD
Use Well No. 1
Running Time = 407 HRS

Total Running Time:
Well No. 1 = 5,115 HRS
Well No. 2 = 254 HRS
Well No. 3 = 2,080 HRS

The operating costs would be

$$\text{Well No. 1} = 5115 \text{ HRS} \times 75 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{\$.0611}{\text{KW-HRS}} = \$23{,}439$$

$$\text{Wells No. 2 \& 3} = 2334 \text{ HRS} \times 125 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{\$.0611}{\text{KW-HRS}} = \$17{,}825$$

Total $41,265

Assuming the chlorine booster pumps to be approximately 2 HP each and any other miscellaneous power requirements in the pumphouses add another 1/2 HP. The 1985 operating costs for the wells would be

$$= 9{,}853 \text{ HRS} \times 2.5 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{\$.061}{\text{KW HRS}} = \$1{,}505$$

Labor:

Maintenance of Wells
One WG-9, AVG of 3 HRS per day for maintaining the three wells.

$$\text{Cost} = \frac{3 \text{ HRS}}{\text{day}} \times 365 \frac{\text{days}}{\text{year}} \times \frac{\$10.00}{\text{HR}} = \$10{,}950/\text{year}$$

Pump Repairs:

Repair two submersible pumps at a cost of approximately $10,000 each and two replacements of the chlorine booster pumps at $6,000 each, all after about 15 years of service.

Control Wiring:

Control wiring wiring will probably have to be replaced every five years for each well, at an average cost of $6,000.

Miscellaneous:

Miscellaneous costs such as, fuel, chlorine gas, painting, etc., would be $2,500/year.

Life Cycle Cost Summary for Wells

Construction	1985 - Present Worth Cost
Well No. 1	$ 120,000
Well No. 2	$ 282,000
Well No. 3	$ 457,000
Electrical	
$41,265	
1,505	
$42,770 x 13.51	$ 577,823
Labor	
$10,950 x 11.65	$ 127,568
Pump Repairs	
$10,000	
10,000	
6,000	
6,000	
$32,000 x .36	$ 11,520
Control Wiring	
$ 6,000	
6,000	
6,000	
$18,000 x .71	$ 12,780
Miscellaneous	
$2,500 x 11.65	$ 29,125
TOTAL	$1,617,816

WATER TREATMENT PLANT

Construction Costs (2,000,000, MGD WTP)

Access Road. (Improved and Paved), Approximately 2,000 Ft. x 12 Ft.	
Asphalt	$ 22,500
Base Course	20,250
Subgrade Prep.	30,000
Intake Structure	60,000
Concrete Building	900,000
Flocculation Equipment, Pumping Equipment, and Piping	125,000
Chemical Feed Equipment and Controls	220,000
Motor Controls and Electrical	250,000
Electrical Service at Transformer	10,000
New Electrical, 12,000-Volt Line	70,000
Metering and Chlorination	60,000
Controls to Reservoir	7,000
Filter Media	50,000
Standby Emergency Generator	120,000
Site Grading	80,000
Landscaping	15,000
TOTAL	$2,039,750

Operating Costs

Pumping Costs:

Four reservoir pumps would be required to pump at the treated water to the reservoir.

500 GPM, @ 10 HP, pumps 720,000 GPD
800 GPM @ 15 HP, pumps 1,152,000 GPD
1400 GPM @ 40 HP, pumps 2,016,000 GPD (2 each)

JAN. 725,000 GPD

$$RT = 725{,}000 \text{ GPD} \times 30 \text{ DPM} \times \frac{1}{500} \times \frac{1}{60 \text{ MPH}}$$

= 744 HRS of 10 HP
= 3 HRS of 15 HP

FEB. 698,000 GPD
RT = 651 HRS of 10 HP

MAR. 734,000 GPD
RT = 744 HRS of 10 HP
= 9 HRS of 15 HP

APR. 844,000 GPD
RT = 720 HRS of 10 HP
= 78 HRS of 15 HP

MAY 1,109,000 GPD
RT = 716 HRS of 15 HP

JUN. 1,575,000 GPD
RT = 423 HRS of 10 HP
= 720 HRS of 15 HP

JUL. 1,867,000 GPD
RT = 739 HRS of 10 HP
= 744 HRS of 15 HP

AUG. 1,668,000 GPD
RT = 533 HRS of 10 HP
= 744 HRS of 15 HP

SEP. 1,450,000 GPD
RT = 298 HRS of 10 HP
= 720 HRS of 15 HP

OCT. 938,000 GPD
RT = 744 HRS of 10 HP
= 141 HRS of 15 HP

NOV. 773,000 GPD
RT = 720 HRS of 10 HP
= 33 HRS of 15 HP

DEC. 671,000 GPD
RT = 693 HRS of 10 HP

TOTAL HOURS 7,009 HRS of 10 HP
3,908 HRS of 15 HP
Deduct 3 weeks of 10 HP
Deduct 2 weeks of 15 HP

Because of problems with ice, silt and low flows, the plant would be calculated to be shut down one week in winter and two in summer. Water would then be supplied by the well:

$$\text{Cost} = (6{,}505 \text{ HRS} \times 10 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{.0611)}{\text{KW HRS}} = \$3{,}975$$

$$\text{Cost} = (3{,}572 \text{ HRS} \times 15 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{.0611)}{\text{KW HRS}} = \$3{,}274$$

Well Pump:

$$\text{Cost} = (504 \text{ HRS} \times 75 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{.0611)}{\text{KW HRS}} = \$2{,}310$$

Backwash Pumps: Because of the relatively clean water in the Merced River, backwashing should only be required approximately every six days. A 3,000 GPM, 30-HP pump would be required.

344 days per year/6 day backwash cycle
= 57 Backwashes Per Year Per Filter
RT = 57 x 4 Filters x 1/4 HR/Backwash Per Filter
= 57 HRS of 30 HP/YR

$$= (57 \text{ HRS} \times 30 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{.0611)}{\text{KW HRS}}$$

= $104

Supernatant and Sludge Pump: Approximately 7/8 of all the backwash water would be returned to the front of the plant and the other 1/8 would be pumped into the sewer. A 200 GPM 2 HP pump would be required.

$$\text{RT} = 45{,}000 \text{ Gal} \times 57 \times 4 \times \frac{1}{200 \text{ GPM}} \times \frac{1 \text{ HR}}{60 \text{ Min.}}$$

= 855 HRS of 2 HP/YR

$$= (855 \text{ HRS} \times 2 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{.0611)}{\text{KW HRS}}$$

= $104

Miscellaneous Power Requirements: Miscellaneous pumping, lighting, heating, ventilation, and other electrical costs are estimated at 800 KWH per day.

$$=800 \frac{\text{KWH}}{\text{Day}} \times 365 \text{ Day}$$

= 292,000 KWH

$$= (292{,}000 \text{ KWH} \times \frac{.0611)}{\text{KW HRS}}$$

= $17,841

Mixers: For mixing the chemicals in the flocculation tank, two 5-HP mixers would be required.

RT = 365 Day/Year x 24 HRS/Day x 2
= 16,512 HRS/YR

$$= (16{,}512 \text{ HRS} \times 5 \text{ HP} \times \frac{\text{KW}}{\text{HP}} \times \frac{.0611)}{\text{KW HRS}}$$

= $5,044

TOTAL COST = $32,652/YR

Miscellaneous supplies and maintenance approximately $6,000/YR

Fuel (Emergency Generator):
Assume 6 days per year

$$\text{Costs} = \frac{6 \text{ days}}{\text{Year}} \times \frac{24 \text{ HRS}}{\text{Day}} \times \frac{\$2.00}{\text{GAL}} \times \frac{6 \text{ GAL}}{\text{HR}}$$

= $1,728/YR

Labor Costs: Plant operates 24 hours a day requiring three shifts per day. Two shifts will be manned. Six people would be required.

$$\text{Cost} = 2{,}080\ \frac{\text{HRS}}{\text{Man-YR}} \times 5\ \text{people} \times \frac{\$12}{\text{HR}}$$

= $149,760/YR

Equipment Repair Costs:

Potable Water Pumps

10 HP 500 GPM	7th Year	$3,000
	15th Year	4,500
	20th Year	6,000
20 HP 200 GPM	10th Year	$6,000
	20th Year	8,000
2 HP 200 GPM	7th Year	1,500
	15th Year	3,000
	20th Year	4,000
30 HP 3,000 GPM	10th Year	7,000
	20th Year	10,000

Mixers

5 HP	7th Year	5,000
	10th Year	7,000
	15th Year	9,000
	20th Year	15,000

Chemical Costs:

Alum

Because of the quality of raw water used, use 5 mg/l of alum for coagulation.
Total water Volume Processed
397,876,000 gallons
=3,277,225,000 lbs of water
Alum required @ 5 PPM
= 16,386 lbs
= 8.2 tons @ $150/ton
= $1,230

Chlorine

Using an application rate of 3 P.P.M. for the treatment of 400,000,000 gallons of water per year, the required chlorine would be approximately 9831 lbs.
= 5 tons of chlorine at $300/ton
= $1,500

Use $2,730 for chemical costs.

Life Cycle Cost Summary, Water Treatment Plant

25 year life cycle	1985 Present Worth Cost
Construction	$2,039,750
Electrical	
$32,652 x 13.51	$ 441,129
Miscellaneous	
$6,000 x 11.65	$ 69,900
Fuel	
$1,728 x 18.10	$ 31,277
Labor	
$149,760 x 11.65	$1,744,704
Equipment	
7th Year $ 6,503 x .62	$ 4,032
10th Year $20,000 x .51	$ 10,200
15th Year $16,500 x .36	$ 5,940
20th Year $43,000 x .26	$ 11,180
Chemical	
$2,730 x 11.65	$ 31,805
TOTAL	$4,389,917

RESERVOIRS

Dual Reservoir Site (STEEL)

Construction Costs:

Elevated Reservoir (500,000 Gallons)	$ 540,000
Foundation	55,000
Ground-level Reservoir (2,000,000 Gallons)	378,000
Foundation	30,000
Valve Boxes	15,000
Piping (2,000 Feet of 16-Inch CI)	120,000
Berm	30,000
	$1,168,000

Maintenance Costs:

Paint Every 10 Years Inside and Outside	
10 Years	
500,000 Gallons Elevated Reservoir	$ 80,000
2,000,000 Gallons Ground-level Reservoir	91,000
	$ 171,000
20 Years	
500,000 Gallons Elevated Reservoir	$ 168,400
2,000,000 Gallons Ground-level Reservoir	191,500
	$ 359,900

Life Cycle Cost Summary:

	1985 Present Worth Cost
Construction	$1,168,000
Maintenance	
171,000 x .51	87,210
359,900 x .26	93,574
	$1,348,784

<u>Single Reservoir Site</u> (STEEL)

Construction Costs:

Ground-level 1,000,000 Gallons	$ 234,000
Foundation	23,000
Ground-level 1,500,000 Gallons	312,000
Foundation	30,000
Valve Box	8,000
Berm	40,000
	$ 647,000

Maintenance Costs:

Paint Every 10 Years Inside and Out (with sand blasting)	
10 Years	
1,500,000 Gallons	$ 75,000
1,000,000 Gallons	57,500
	$ 132,500
20 Years	
1,500,000	$ 157,700
1,000,000	120,900
	$ 278,600

Life Cycle Cost Summary:

	1985 Present Worth Cost
Construction	$ 647,000
Maintenance	
132.500 x .51	67,575
278,600 x .26	72,436
	$ 787,011

<u>Single Reservoir Site</u> (CONCRETE)

Construction Costs:

Ground-level 1,000,000 gallons	$ 350,000
Ground-level 1,500,000 gallons	435,000
Valve Box	8,000
Berm	40,000
	$ 833,000

DISTRIBUTION SYSTEM

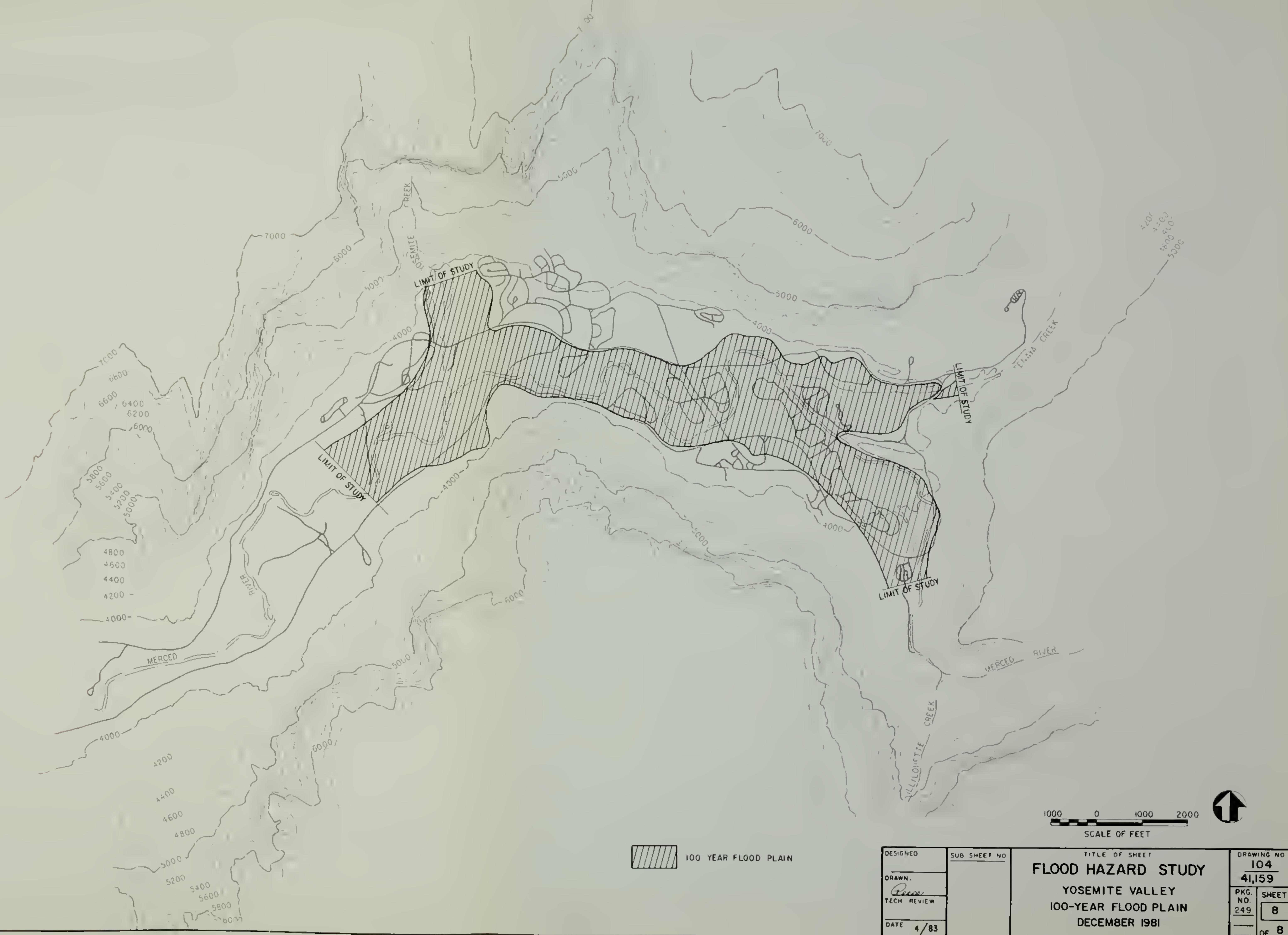
Construction Costs

8-Inch DI Pipe (1600 LF)	$ 46,000
12-inch DI Pipe (1,900 LF)	60,000
16-Inch DI Pipe (14,400 LF)	720,000
24-Inch DI Pipe (600 LF)	42,000
123 Fire Hydrants (estimated)	260,000
Metering and Valving	94,000
Cleaning	200,000
	$1,422,000

Life cycle costing is not appropriate for the distribution system.

APPENDIX H: FLOODPLAIN MAPS

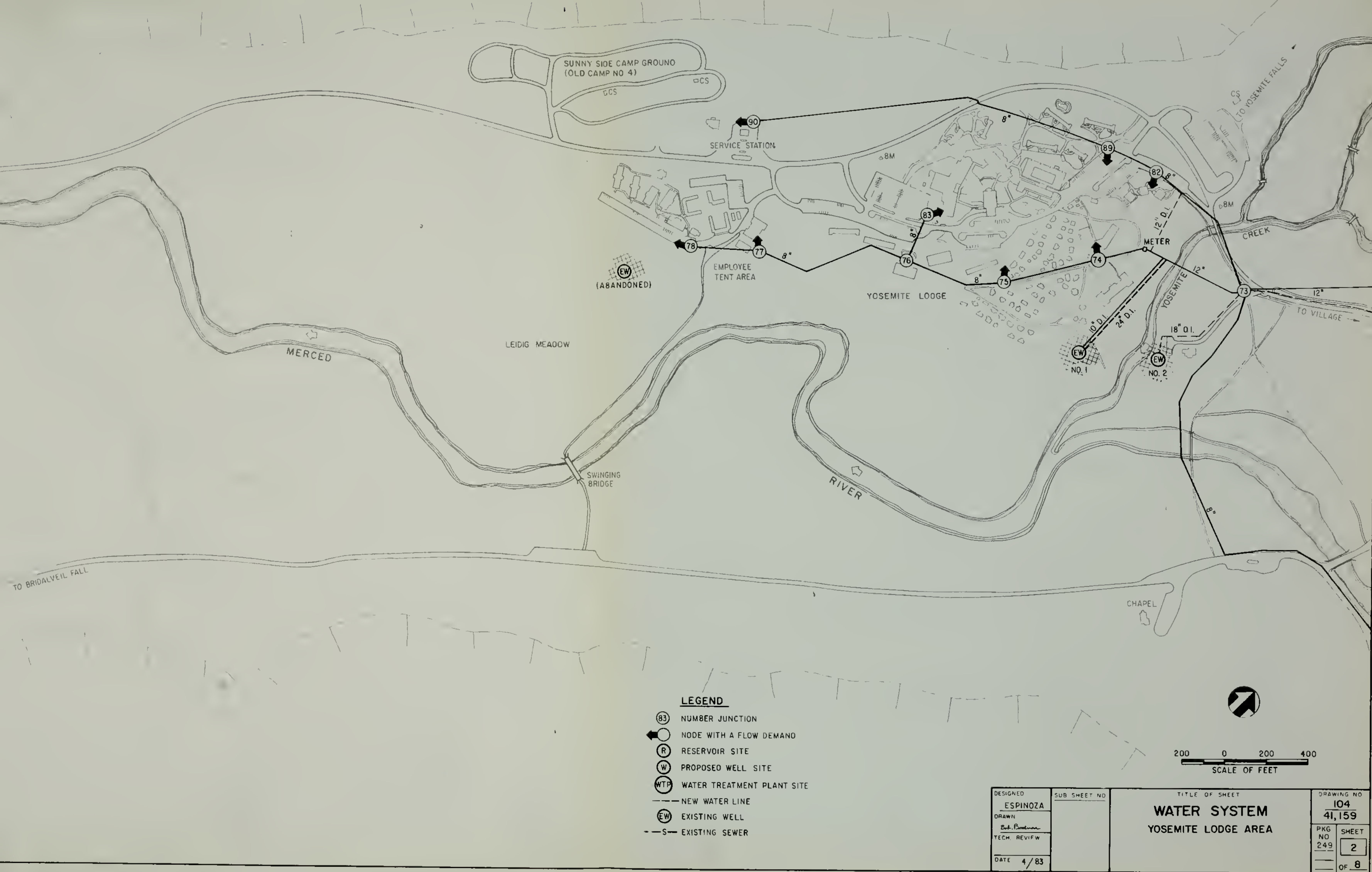
	SUB SHEET NO	TITLE OF SHEET	DRAWING NO
VIEW		**FLOOD HAZARD STUDY**	104 / 41,159
/83		YOSEMITE VALLEY 100-YEAR FLOOD PLAIN DECEMBER 1981	PKG. NO. 249 — SHEET 8 OF 8



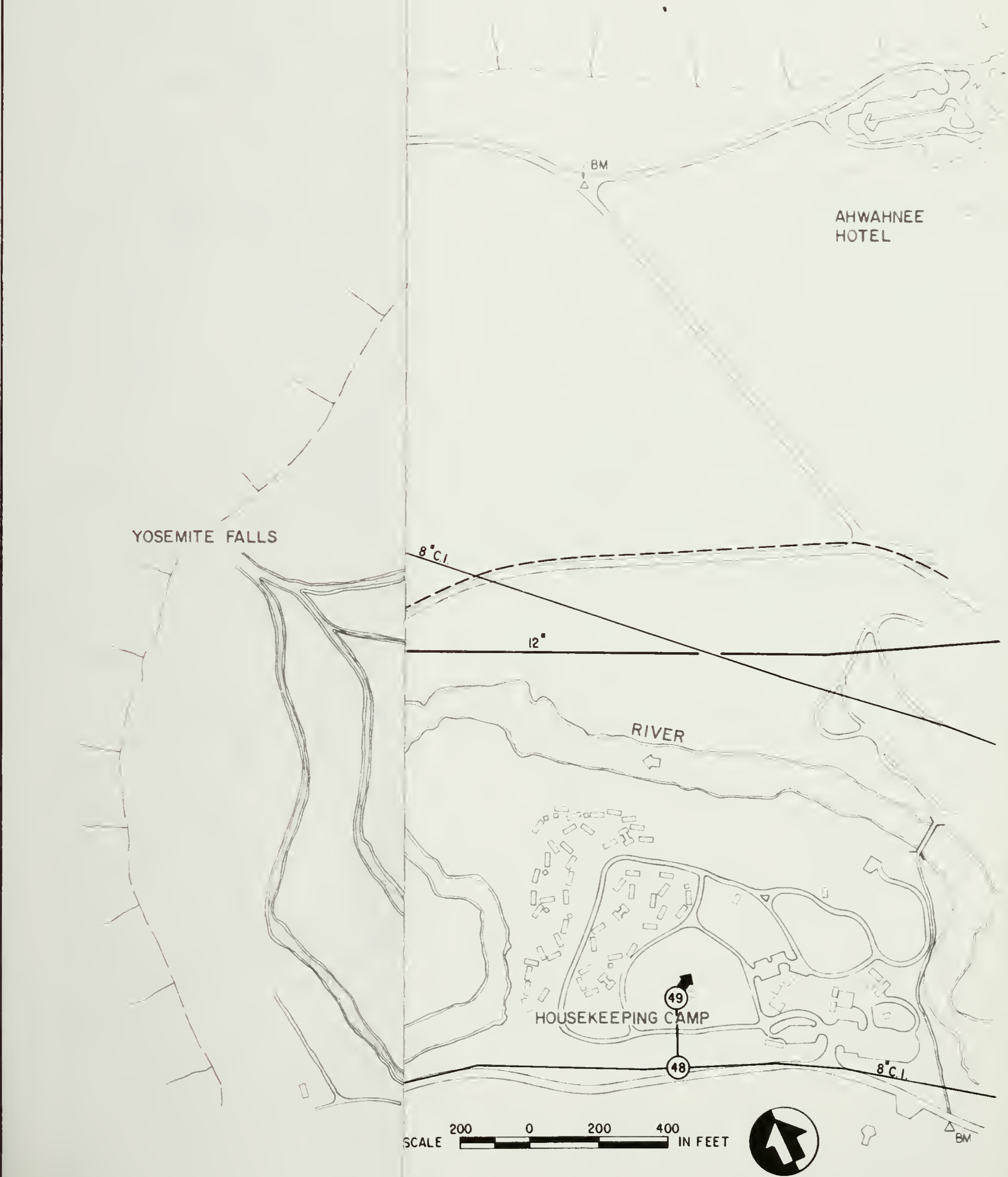
LIMIT OF STUDY
LIMIT OF STUDY
LIMIT OF STUDY
LIMIT OF STUDY
YOSEMITE CREEK
TENAYA CREEK
MERCED RIVER
MERCED RIVER
ILLILOUETTE CREEK
100 YEAR FLOOD PLAIN
1000 0 1000 2000
SCALE OF FEET
DESIGNED
DRAWN.
TECH REVIEW
DATE 4/83
SUB SHEET NO
TITLE OF SHEET
FLOOD HAZARD STUDY
YOSEMITE VALLEY
100-YEAR FLOOD PLAIN
DECEMBER 1981
DRAWING NO
104
41,159
PKG. NO. 249
SHEET 8 OF 8

APPENDIX I: VALLEY WATER SYSTEM AND TREATMENT PLANT DRAWINGS

SIGNED ESPINOZA DRAWN Bob. Bodnar TECH. REVIEW DATE 4/83	SUB SHEET NO	TITLE OF SHEET **WATER SYSTEM** **YOSEMITE LODGE AREA**	DRAWING NO 104 / 41,159 PKG NO 249 SHEET 2 OF 8

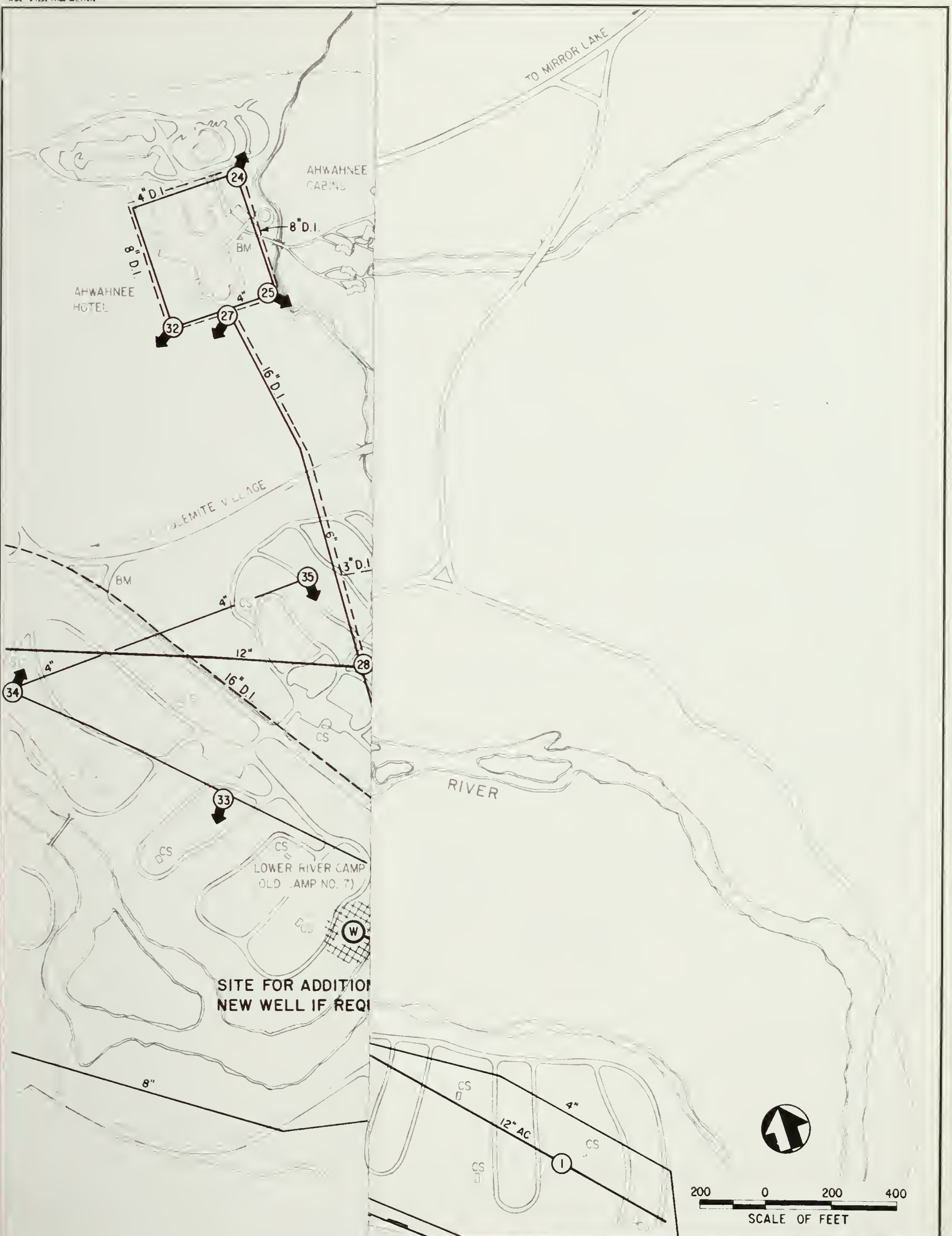


SUNNY SIDE CAMP GROUND
(OLD CAMP NO 4)
CS
SERVICE STATION
8M
TO YOSEMITE FALLS
EMPLOYEE TENT AREA
EW
(ABANDONED)
YOSEMITE LODGE
METER
12" D.I.
10" D.I.
24" D.I.
18" D.I.
NO. 1
NO. 2
YOSEMITE
CREEK
12"
8"
TO VILLAGE
LEIDIG MEADOW
MERCED
RIVER
SWINGING BRIDGE
TO BRIDALVEIL FALL
CHAPEL
90
89
82
83
78
77
76
75
74
73
LEGEND
NUMBER JUNCTION
NODE WITH A FLOW DEMAND
RESERVOIR SITE
PROPOSED WELL SITE
WATER TREATMENT PLANT SITE
NEW WATER LINE
EXISTING WELL
EXISTING SEWER
200 0 200 400
SCALE OF FEET
DESIGNED ESPINOZA
DRAWN
TECH. REVIEW
DATE 4/83
SUB SHEET NO
TITLE OF SHEET
WATER SYSTEM
YOSEMITE LODGE AREA
DRAWING NO 104 41,159
PKG NO 249
SHEET 2 OF 8

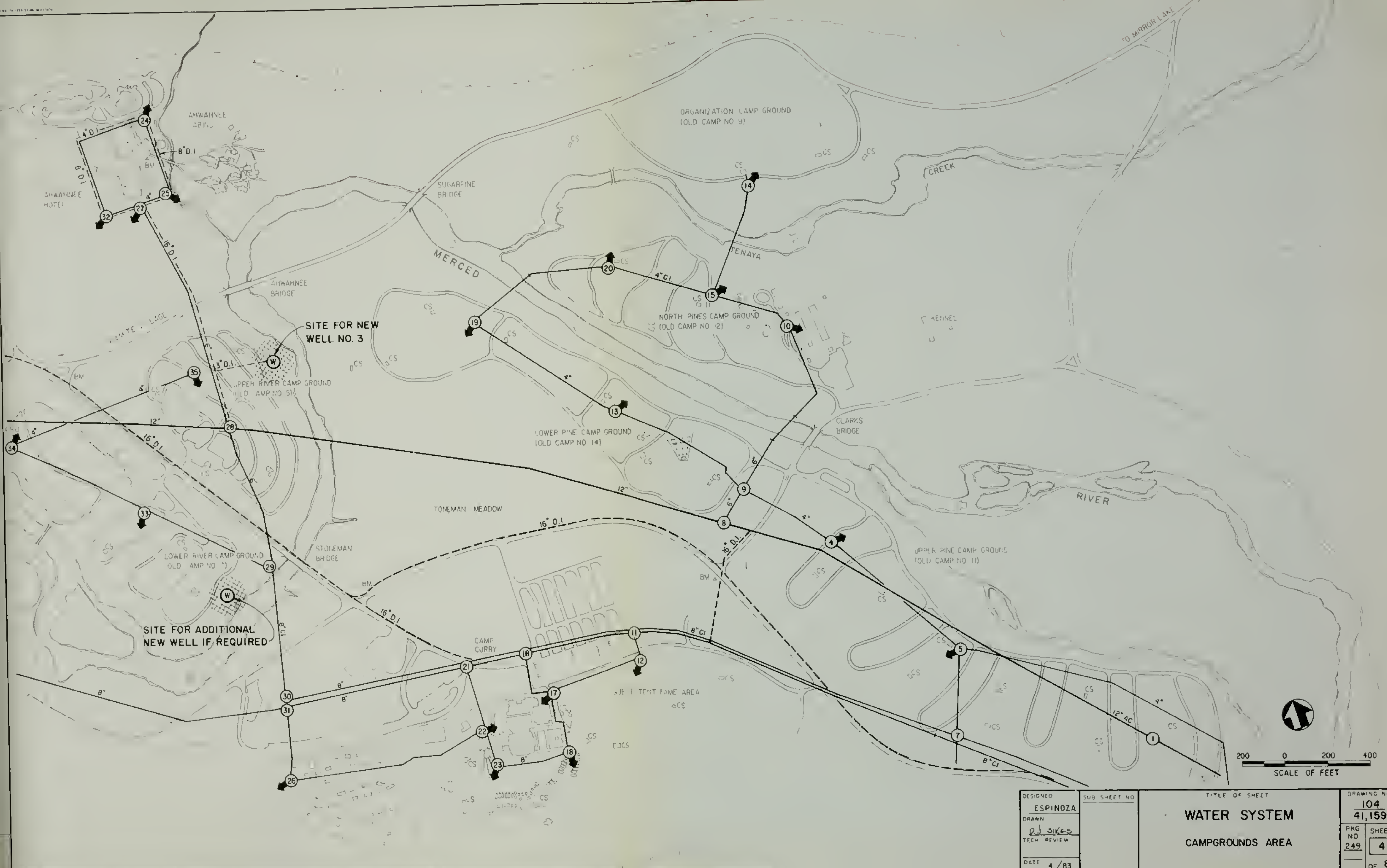


IGNED / . ESPINOZA / AWN / CH. REVIEW / TE 4/83	SUB SHEET NO	TITLE OF SHEET **WATER SYSTEM** YOSEMITE VILLAGE AREA	DRAWING NO 104 41,159 PKG. NO. 249 SHEET 3 OF 8

YOSEMITE FALLS
RESIDENTIAL HOUSING
RESIDENTIAL HOUSING
HOSP AREA
INDIAN CREEK
AHWAHNEE HOTEL
BM
YOSEMITE VILLAGE
CAMP NO. 6
RIVER
MERCED
HOUSEKEEPING CAMP
YOSEMITE CREEK
SENTINEL BRIDGE
TO BRIDAL VEIL FALLS
8" C.I.
6" C.I.
12" A.C.
16" D.I.
12" D.I.
8" G.V.
12"
SCALE 200 0 200 400 IN FEET
DESIGNED H. ESPINOZA
DRAWN
TECH. REVIEW
DATE 4/83
SUB SHEET NO
TITLE OF SHEET
WATER SYSTEM
YOSEMITE VILLAGE AREA
DRAWING NO 104 41,159
PKG NO 249
SHEET 3 OF 8



SIGNED: ESPINOZA DRAWN: D. J. SIKES TECH. REVIEW DATE: 4/83	SUB SHEET NO	TITLE OF SHEET WATER SYSTEM CAMPGROUNDS AREA	DRAWING NO 104 41,159 PKG NO. 249 SHEET 4 OF 8



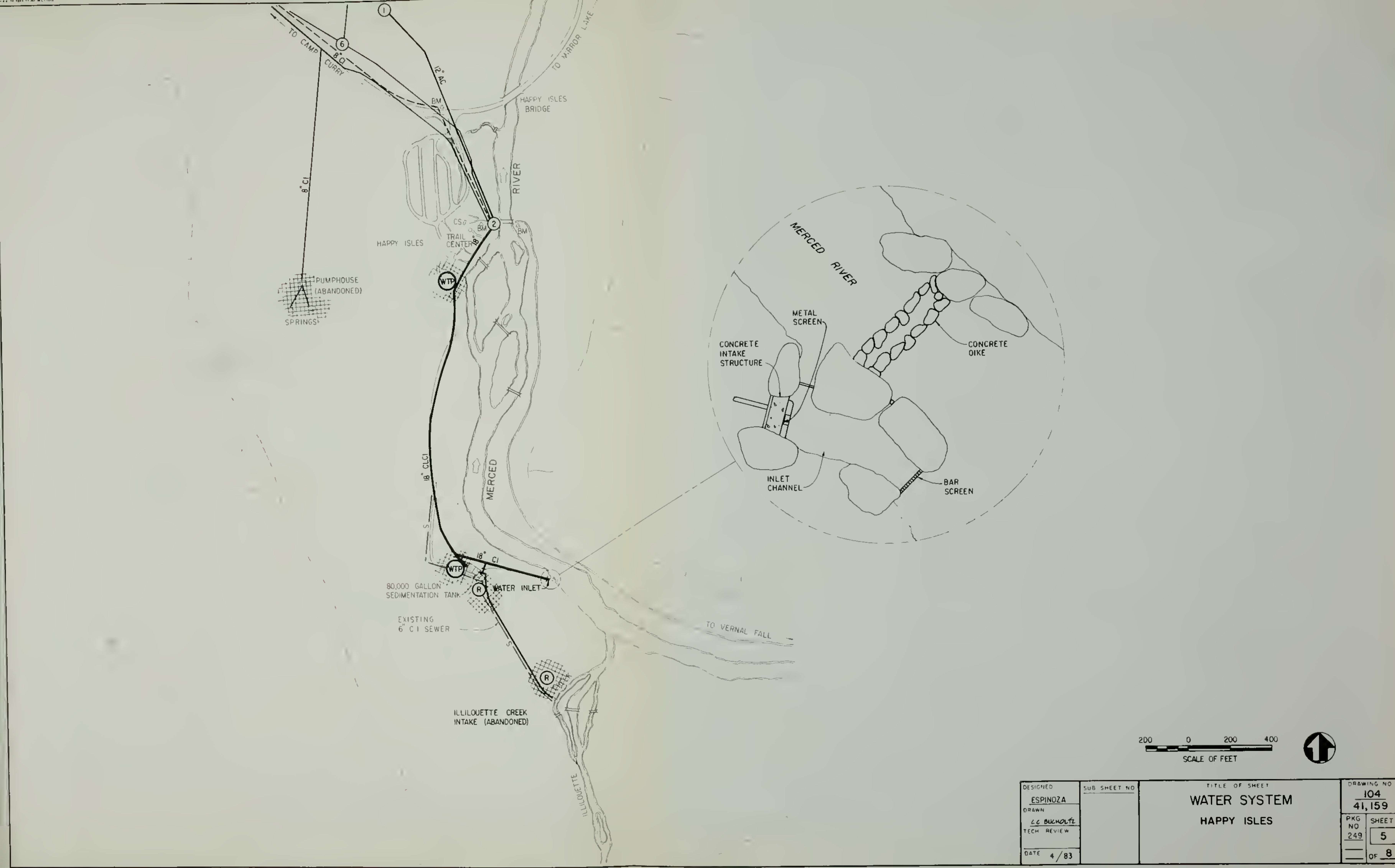
AHWAHNEE HOTEL
AHWAHNEE BRIDGE
SUGARPINE BRIDGE
MERCED
TENAYA
CREEK
TO MIRROR LAKE
ORGANIZATION CAMP GROUND (OLD CAMP NO 9)
NORTH PINES CAMP GROUND (OLD CAMP NO 12)
KENNEL
SITE FOR NEW WELL NO. 3
UPPER RIVER CAMP GROUND (OLD CAMP NO 5)
LOWER PINE CAMP GROUND (OLD CAMP NO 14)
CLARKS BRIDGE
RIVER
STONEMAN MEADOW
STONEMAN BRIDGE
LOWER RIVER CAMP GROUND (OLD CAMP NO 7)
UPPER PINE CAMP GROUND (OLD CAMP NO 11)
SITE FOR ADDITIONAL NEW WELL IF REQUIRED
CAMP CURRY
16" D.I
12"
8" CI
12" AC
SCALE OF FEET
200 0 200 400
DESIGNED ESPINOZA
DRAWN D.J. SIKES
TECH REVIEW
DATE 4/83
SUB SHEET NO
TITLE OF SHEET
WATER SYSTEM
CAMPGROUNDS AREA
DRAWING NO 104 41,159
PKG NO 249
SHEET 4 OF 8

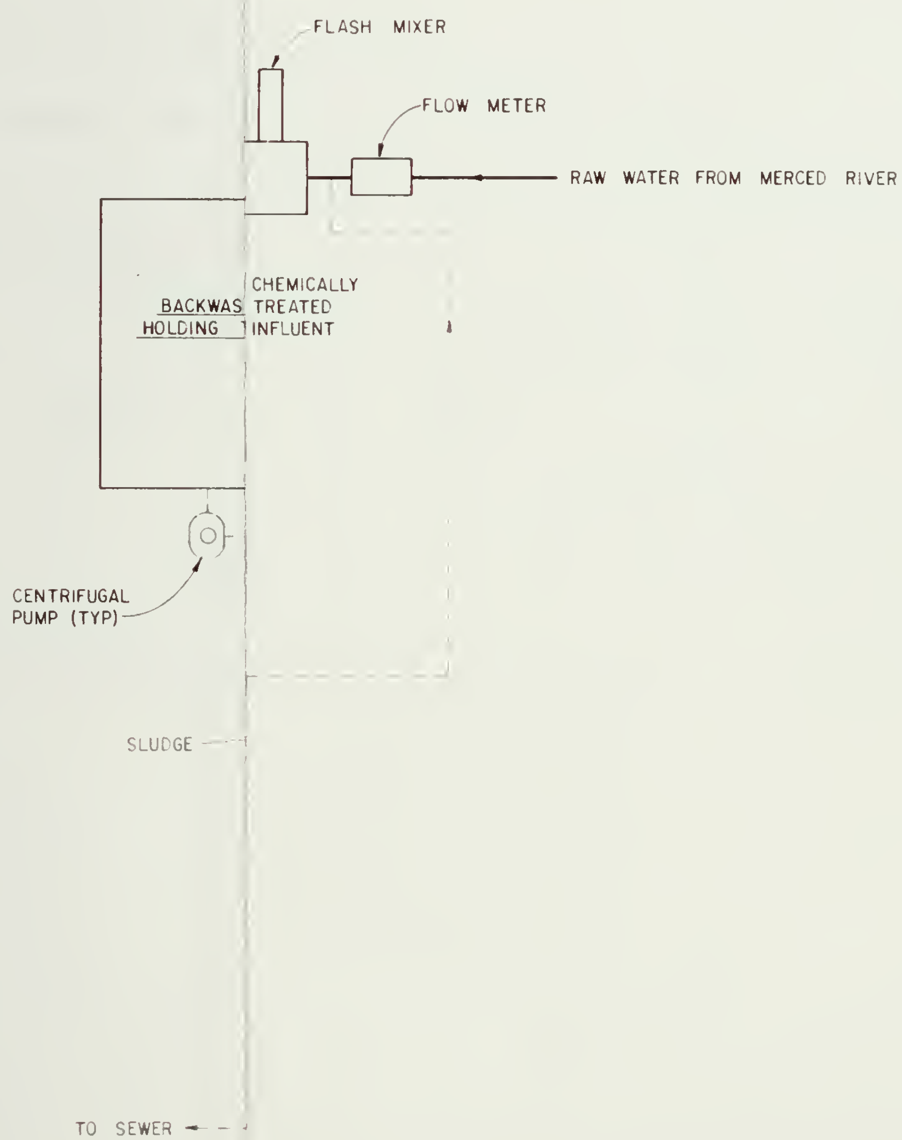
200 0 200 400

SCALE OF FEET

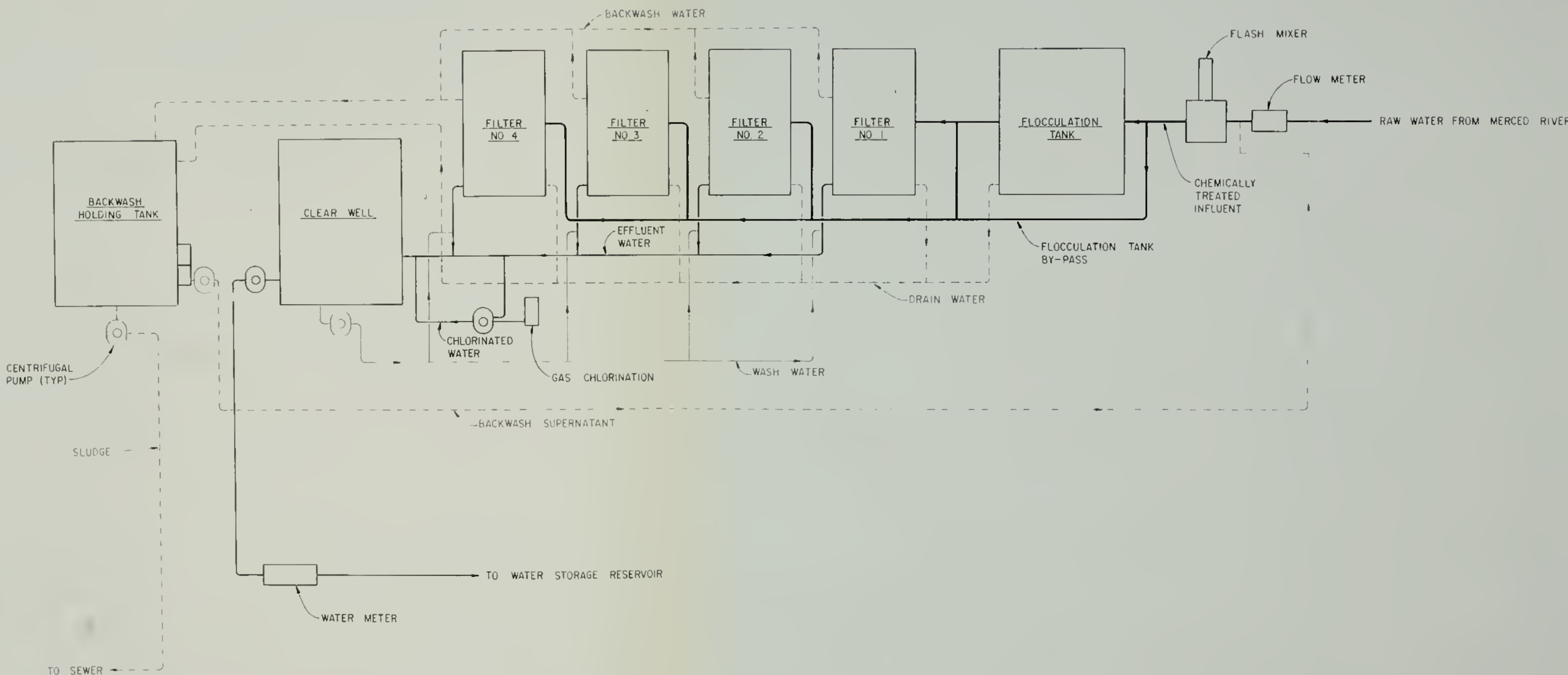
ESIGNED ESPINOZA RAWN C.C BUCHOLTZ ECH. REVIEW ATE 4/83	SUB SHEET NO	TITLE OF SHEET WATER SYSTEM HAPPY ISLES

DRAWING NO 104 41,159	
PKG NO 249	SHEET 5 OF 8

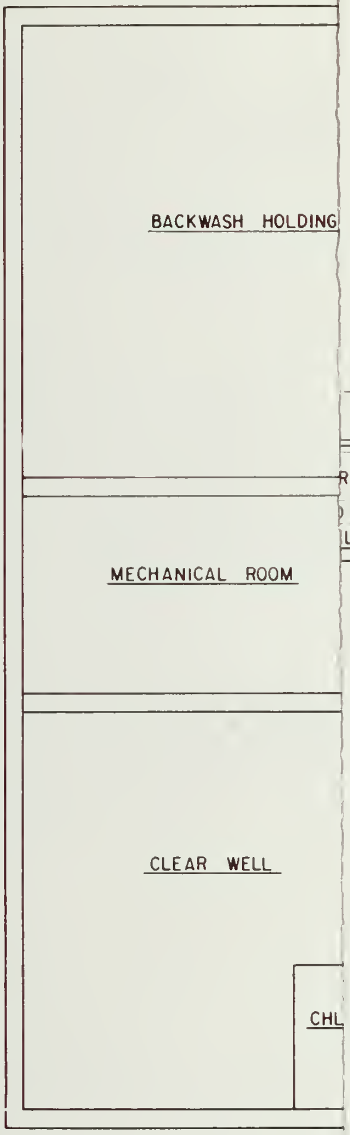

TO CAMP CURRY
8" CI
12" AC
TO MIRROR LAKE
HAPPY ISLES BRIDGE
BM
RIVER
CS
TRAIL CENTER
HAPPY ISLES
18"
WTP
PUMPHOUSE (ABANDONED)
SPRINGS
8" CI
18" CLCI
MERCED
18" CI
80,000 GALLON SEDIMENTATION TANK
WATER INLET
EXISTING 6" C I SEWER
TO VERNAL FALL
ILLILOUETTE CREEK INTAKE (ABANDONED)
ILLILOUETTE
MERCED RIVER
METAL SCREEN
CONCRETE INTAKE STRUCTURE
CONCRETE DIKE
INLET CHANNEL
BAR SCREEN
200 0 200 400
SCALE OF FEET
DESIGNED ESPINOZA
DRAWN L.C. BUCHOLTZ
TECH REVIEW
DATE 4/83
SUB SHEET NO
TITLE OF SHEET
WATER SYSTEM
HAPPY ISLES
DRAWING NO 104 41,159
PKG NO 249
SHEET 5 OF 8

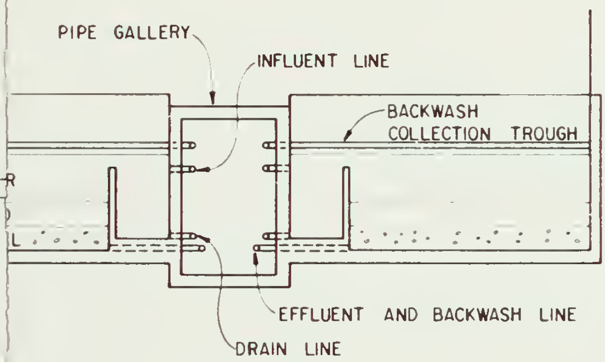


ESIGNED ESPINOZA	SUB SHEET NO	TITLE OF SHEET	DRAWING NO 104 41,159	
RAWN Bucholtz		PROCESS FLOW DIAGRAM	PKG NO. 249	SHEET 6
CH. REVIEW		WATER TREATMENT PLANT		
ATE 4/83				OF 8

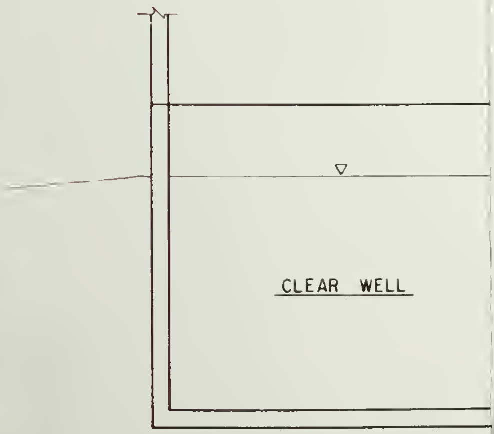


DESIGNED	SUB SHEET NO	TITLE OF SHEET	DRAWING NO
ESPINOZA		PROCESS FLOW DIAGRAM	104 / 41,159
DRAWN		WATER TREATMENT PLANT	PKG NO. 249
Bucholtz			SHEET 6 OF 8
TECH REVIEW			
4/63			

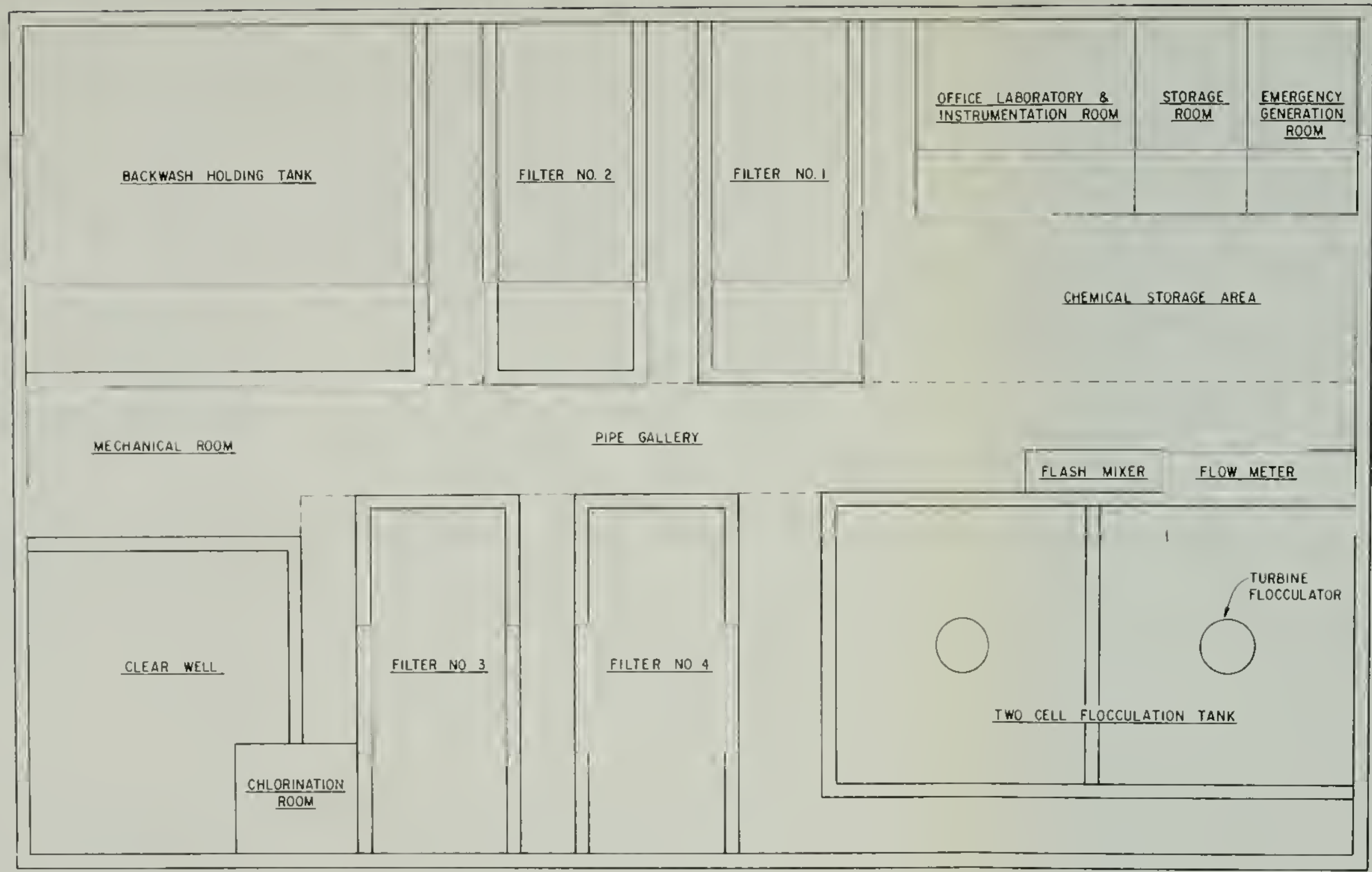




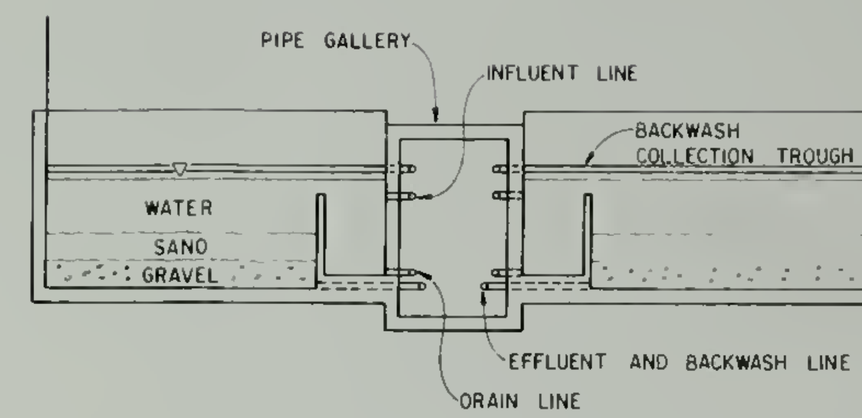
FILTER SECTION



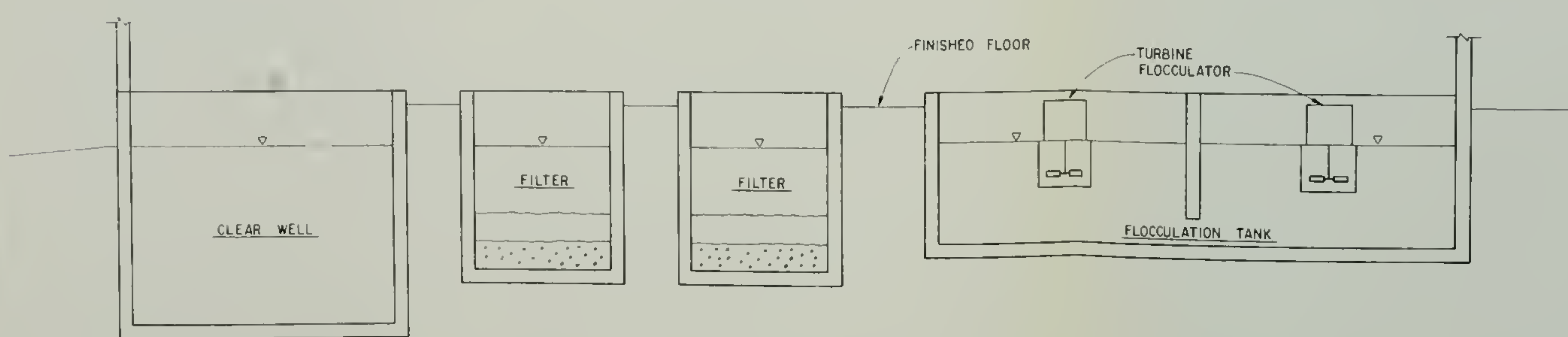
DESIGNED: ESPINOZA DRAWN: Bucholtz TECH. REVIEW: DATE: 4/83	SUB SHEET NO	TITLE OF SHEET WATER TREATMENT PLANT LAYOUT	DRAWING NO 104 41,159 PKG. NO. SHEET 7 OF 8



PLAN



FILTER SECTION



PROFILE

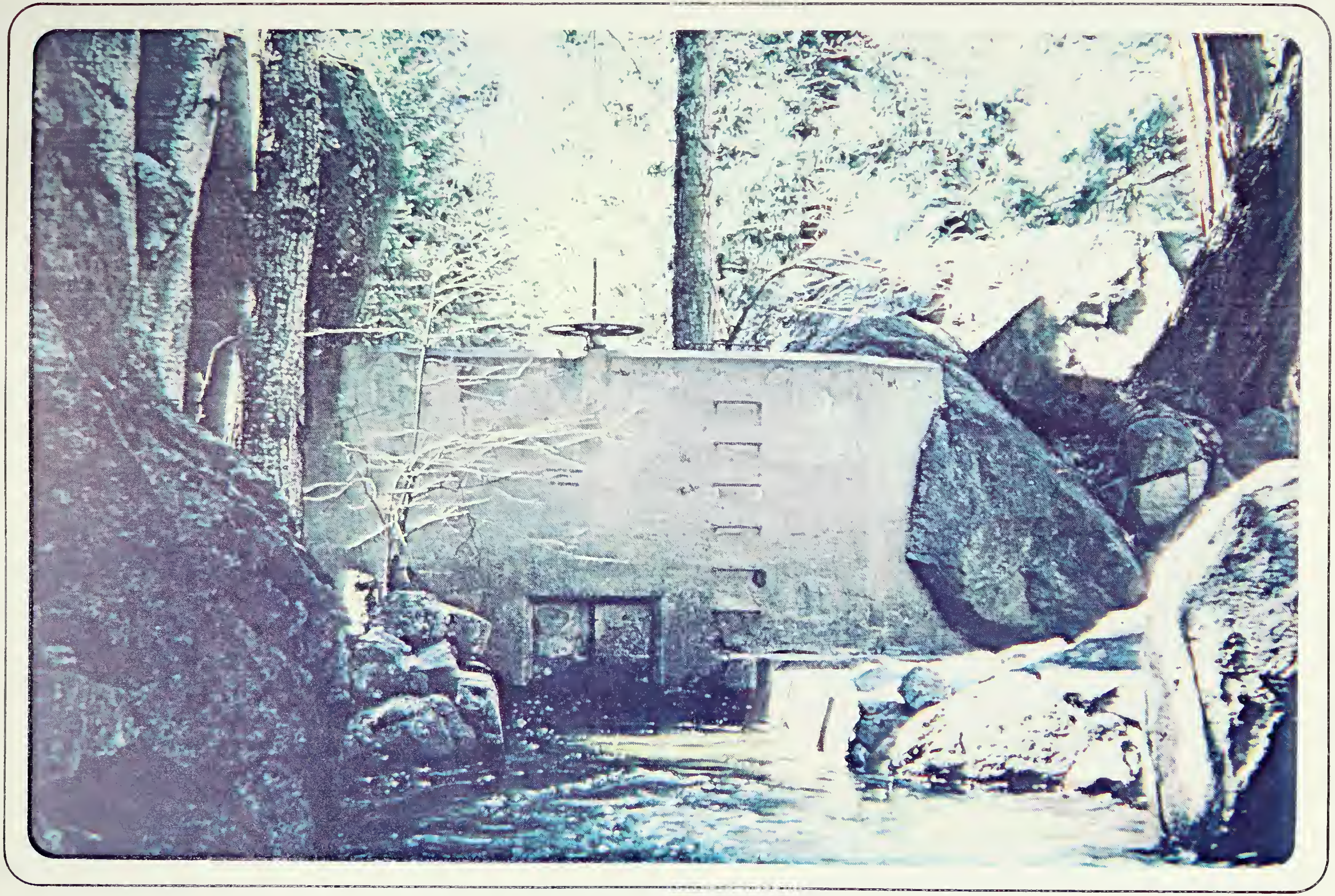
DESIGNED	SUB SHEET NO	TITLE OF SHEET	DRAWING NO
ESPINOZA		WATER TREATMENT PLANT LAYOUT	104 41,159
DRAWN			PKG NO.
TECH. REVIEW			SHEET 7 OF 8
DATE 4/83			

APPENDIX J: PHOTOGRAPHS

Abandoned Springs

Abandoned Spring Pumphouse

Pumphouse No. 1



Water Intake Structure

Concrete Dike Across Merced River

Bar Screen Before Intake

Cast Iron Pipe

Cast Iron Pipe

View from Glacier Point
(Elevation Reservoir Site)

APPENDIX K: WATER QUALITY RECORDS

Chemical and Physical Analysis of Water Samples Collected 8/7/68

	Happy Isles Springs	Merced River Intake
pH	6.2	6.5
Alkalinity as $CaCO_3$	10.0 ppm as HCO_3	5.0 ppm as HCO_3
Turbidity (colorimetric)	0.0	0.0
Color (colorimetric)	0.0	0.0
Hardness as $CaCO_3$	8.0 ppm	6.0 ppm
Total Solids (residue on evaporation)	36.0 ppm	22.0 ppm
Iron as Fe (total - colorimetric)	trace	0.1 ppm
Silica as SiO_2 (colorimetric)	15.0 ppm	7.0 ppm
Sulfate as SO_4 (colorimetric)	5.0 ppm	3.0 ppm
Calcium as $CaCO_3$	7.0 ppm	5.3 ppm
Magnesium as $CaCO_3$	1.0 ppm	0.7 ppm
Manganese as Mn (colorimetric)	0.0	0.0
Chloride as Cl	0.0	2.0 ppm
Sodium as Na (calculated)	3.3 ppm	1.2 ppm

...GENERAL MINERAL ANALYSIS

BROWN AND CALDWELL
CONSULTING ENGINEERS

ENVIRONMENTAL SCIENCES DIVISION
1255 POWELL STREET
EMERYVILLE, CA 94608
PHONE (415) 428-2300

Log No. 48J3

Date Sampled 2/28/80
Date Received 3/4/80
Date Reported 3/31/80

Report To:
Mr. Maris Pubulis
National Park Service
Western Region
450 Golden Gate Avenue
Box 36063
San Francisco, CA 94102

plus: INORGANIC CHEMICAL ANALYSIS

Laboratory Director

ion Yosemite NP - Valley System - Merced River

ns	Milligrams per liter	Milliequiv. per liter
(as NO_3) ok	< 0.05	< 0.01
ok	0.95	0.03
ok	< 1.0	< 0.01
HCO_3)	9.9	0.16
$)_3$)	0	0
lents per Liter		0.19

ns	Milligrams per liter	Milliequiv. per liter
ok	1.8	0.08
	0.45	0.01
	1.8	0.09
	0.24	0.02
lents per Liter		0.20

Determination	Milligrams per liter
Hydroxide Alkalinity (as $CaCO_3$)	0
Carbonate Alkalinity (as $CaCO_3$)	0
Bicarbonate Alkalinity (as $CaCO_3$)	8.1
Calcium Hardness (as $CaCO_3$)	4.6
Magnesium Hardness (as $CaCO_3$)	1.0
Total Hardness (as $CaCO_3$)	5.6
Iron ok	0.07
Manganese ok	< 0.01
Copper ok	< 0.001
Zinc ok	< 0.01
Foaming Agents (MBAS) ok	< 0.02
Dissolved Residue, Evaporated @ 180°C ok	28
Specific Conductance, micromhos @ 25°C	22

Determination	Milligra per lit
Fluoride ok	< 0.
Arsenic ok	< 0.00
Barium ok	< 0
Cadmium ok	< 0.0
Chromium ok	< 0.
Lead ok	< 0.0
Mercury ok	< 0.00
Selenium ok	< 0.00
Silver ok	< 0.0
pH	7

22, California Administrative Code
: Water Quality and Monitoring Regulations)

BROWN AND CALDWELL
CONSULTING ENGINEERS
ANALYTICAL SERVICES DIVISION
1255 POWELL STREET
EMERYVILLE, CA 94608
PHONE (415) 428 2300

Log No. 27K4

Date Sampled 3/3/82
Date Received 3/15/82
Date Reported 4/5/82

705-50

Reported To:
Mr. Maris Pubulis
National Park Service
Western Regional Office
P.O. Box 36063
450 Golden Gate Avenue
San Francisco, CA 94102

Laobratory Director

Yosemite National Park

Description Valley System at Dam; Merced River; 10:00 am

Anions	Miligrams per liter	Milliequiv. per liter
Nitrogen (as NO_3)	< 0.04	< 0.01
e	1.1	0.03
(as SO_4)	2.0	0.04
nate (as HCO_3)	8.8	0.14
ate (as CO_3)	0	0
illiequivalents per Liter		0.21
Cations	**Milligrams per liter**	**Milliequiv. per liter**
Na	2.2	0.10
K	0.42	0.01
n	1.9	0.09
ium	0.17	0.01
illiequivalents per Liter		0.21

ns to Title 22, California Administrative Code
i Domestic Water Quality and Monitoring
ons)

Determination	Milligrams per liter
Hydroxide Alkalinity (as $CaCO_3$)	0
Carbonate Alkalinity (as $CaCO_3$)	0
Bicarbonate Alkalinity (as $CaCO_3$)	7.2
Calcium Hardness (as $CaCO_3$)	4.8
Magnesium Hardness (as $CaCO_3$)	0.7
Total Hardness (as $CaCO_3$)	5.5
Iron	< 0.01
Manganese	< 0.01
Copper	< 0.0001
Zinc	0.06
Foaming Agents (MBAS)	< 0.02
Dissolved Residue, Evaporated @ 180°C	29
Specific Conductance, micromhos @ 25°C	22

Determination	Milligrams per liter
Fluoride	< 0.
Arsenic	< 0.0
Barium	< 0
Cadmium	< 0.00
Chromium	< 0.
Lead	< 0.0
[illegible]	[illegible]
Sel[illegible]	< [illegible].0
Silver	< [illegible].00
pH	6

BROWN AND CALDWELL
CONSULTING ENGINEERS

ENVIRONMENTAL SCIENCES DIVISION
1255 POWELL STREET
EMERYVILLE, CA 94608
PHONE (416) 428-2300

GENERAL MINERAL ANALYSIS*

Log No. 60A3

Date Sampled: not given
Date Received: 3/19/79
Date Reported: 4/24/79

plus: INORGANIC CHEMICAL ANALYSIS*
GROSS ALPHA, GROSS BETA ANALYSIS

Report To: Mr. W. Allen Kingsbury
National Park Service
Western Regional Office
Box 36063
450 Golden Gate Ave.
San Francisco, CA 94102

Laboratory Director

tion Yosemite: Valley, Main System, Merced River

ons	Milligrams per liter	Milliequiv. per liter
n (as NO_3)	0.07	< 0.01
	2.7	0.08
)	< 2.0	< 0.01
HCO_3)	6.8	0.11
CO_3)	0	0
alents per Liter		0.19
ons	Milligrams per liter	Milliequiv. per liter
	1.5	0.07
	0.31	0.01
	1.7	0.08
	0.50	0.04
alents per Liter		0.20

Determination	Milligrams per liter
Hydroxide Alkalinity (as $CaCO_3$)	0
Carbonate Alkalinity (as $CaCO_3$)	0
Bicarbonate Alkalinity (as $CaCO_3$)	5.6
Calcium Hardness (as $CaCO_3$)	4.2
Magnesium Hardness (as $CaCO_3$)	2.0
Total Hardness (as $CaCO_3$)	6.2
Iron	0.29 (0.3)
Manganese	< 0.01
Copper	0.010
Zinc	0.04
Foaming Agents (MBAS)	< 0.010
Dissolved Residue, Evaporated @ 180°C	20
Specific Conductance, micromhos @ 25°C	22

Determination	Milligrams per liter
Fluoride	0.05
Arsenic	< 0.0005
Barium	< 0.1
Cadmium	< 0.001
Chromium	< 0.01
Lead	0.017
Mercury	< 0.0001
Selenium	< 0.0005
Silver	< 0.001
[a] Gross Alpha pCi/liter	0.8 ± 0.7
[a] Gross Beta pCi/liter	3.0 ± 1.1
pH	5.7

le 22, California Administrative Code
stic Water Quality and Monitoring Regulations)

a) Analysis completed by: Safety Specialists, Inc.
3284 F Edward Avenue
Santa Clara, CA 95050

ЭK

a.K.

GENERAL MINERAL ANALYSIS*

Log No. 59W1

Date Sampled not given
Date Received 3/19/79
Date Reported 4/18/79

BROWN AND CALDWELL
CONSULTING ENGINEERS
ENVIRONMENTAL SCIENCES DIVISION
1255 POWELL STREET
EMERYVILLE, CA 94608
PHONE (415) 428-2300

plus: INORGANIC CHEMICAL ANALYSIS*
GROSS ALPHA, GROSS BETA ANALYS

Report To:
Mr. W. Allen Kingsbury
National Park Service
Western Regional Office
Box 36063
450 Golden Gate Ave.
San Francisco, CA 94102

[signature]
Laboratory Director

le Description Yosemite: Valley/Main System/Well

Anions	Milligrams per liter	Milliequiv. per liter	Determination	Milligrams per liter	Determination	Milligra per lite
e Nitrogen (as NO_3)	0.18	< 0.01	Hydroxide Alkalinity (as $CaCO_3$)	0	Fluoride	0.0
ide	< 1.0	< 0.01	Carbonate Alkalinity (as $CaCO_3$)	13	Arsenic	0.001
e (as SO_4)	1.7	0.04	Bicarbonate Alkalinity (as $CaCO_3$)	30	Barium	< 0.
onate (as HCO_3)	37	0.61	Calcium Hardness (as $CaCO_3$)	36	Cadmium	< 0.00
nate (as CO_3)	7.8	0.26	Magnesium Hardness (as $CaCO_3$)	2.0	Chromium	< 0.0
Milliequivalents per Liter		0.91	Total Hardness (as $CaCO_3$)	38	Lead 0.008	0.008
Cations	Milligrams per liter	Milliequiv. per liter	Iron 0.3	(0.63)	Mercury	< 0.0001 a
m	2.2	0.10	Manganese	< 0.01	Selenium	< 0.000
sium	2.1	0.05	Copper	0.006	Silver	< 0.00
um	14	0.70	Zinc	0.02	Gross Alpha pCi/liter	≤ 1.
esium	0.5	0.04	Foaming Agents (MBAS)	0.016	Gross Beta pCi/liter	2.6 ± 2.
Milliequivalents per Liter		0.89	Dissolved Residue, Evaporated @ 180°C	72		
			Specific Conductance, micromhos @ 25°C	109	pH	9.7

orms to Title 22, California Administrative Code
rnia Domestic Water Quality and Monitoring Regulations)

a) Results of mercury analysis attached ~~will follow under separate cover.~~

Fe is secondary std. No action needed.

O.K.

BROWN AND CALDWELL
CONSULTING ENGINEERS
ENVIRONMENTAL SCIENCES DIVISION
1255 POWELL STREET
EMERYVILLE, CA 94608
PHONE (415) 428-2300

Log No. 23S ✓

Date Sampled noted belo
Date Received 11/23/79
Date Reported 01/24/80

Report To:
Mr. Maris Pubulis
National Park Service
Western Regional Office
450 Golden Gate Ave., Box 36063
San Francisco, CA 94102

Laboratory Director

Sample Description

SEE BELOW

Results (mg/l unless indicated otherwise)

Sample Log No. / Sample Identification	Date Collected	Gross Alpha pCi/liter	Gross Beta pCi/liter			
El Portal - Moss Creek	11/15/79	1.1 ± 0.8	2.6 ± 2.5			
El Portal - Well 1	11/15/79	≤ 1.4	≤ 4.9			
El Portal - Well 2	11/15/79	1.8 ± 1.0	2.7 ± 2.4			
Hodgdon Meadow	11/15/79	≤ 1.3	≤ 4.3			
Valley - Main System Merced River	11/19/79	≤ 1.2	2.9 ± 1.8			
Valley - Main System Well	11/15/79	1.3 ± 0.9	≤ 5.3			
Wawona	11/15/79	≤ 1.1	≤ 3.4			

Analysis by: Safety Specialists, Inc.
3284 F Edward Avenue
Santa Clara, CA 95050

EMICAL SERVICE LABORATORY, INC.

3408 Industrial Parkway
P.O. Box 220
Jeffersonville, Indiana 4713
812-282-1359

LABORATORY REPORT

FROM: Yosmite
P.O. Box 577
Yosemite, NP, CA 95389

DATE: 9/29/78

SAMPLE DESCRIPTION: Yosemite Vall
Mn System

DATE RECEIVED: 9/11/78

CSL NO: NP 191

Arsenic (As)	<.05	mg/1
Barium (Ba)	<.1	mg/1
Cadmium (Cd)	<.010	mg/1
Chromium - Hexavalent (Cr)	<.05	mg/1
Lead (Pb)	<.05	mg/1
Mercury (Hg)	<.002	mg/1
Nitrate - Nitrogen (NO_3-N)	<.05	mg/1
Selenium (Se)	<.01	mg/1
Silver (Ag)	<.05	mg/1
Fluoride (Fl)	.10	mg/1
Calcium (Ca)	.9	mg/1
Chloride (Cl)	1.5	mg/1
Copper (Cu)	<.01	mg/1
Iron (Fe)	.09	mg/1
Magnesium (Mg)	.08	mg/1
Manganese (Mn)	.04	mg/1
Sodium (Na)	1.1	mg/1
Sulphate (SO_4)	9.5	mg/1
Zinc (Zn)	.07	mg/1
Alkalinity	8	mg/1 as $CuCO_3$
Specific Conductance	49	umhos/cm
Total Hardness	8.8	mg/1
pH	6.4	
Surfactants (MBAS)	<.025	mg/1
Total Dissolved Solids	206	mg/1

OK

REVIEWED BY: QK

APPENDIX K: ABBREVIATIONS

AC	Asbestos Cement
AH	Ahwahnee Hotel
ASPH	Asphalt
AVG	Average
AWWA	American Water Works Association
CF	Cubic Feet
CFS	Cubic Feet Per Second
CI	Cast Iron
COND	Condition
CS	Comfort Station
CV	Curry Village
D	Domestic
DF	Drinking Fountain
DIFF	Difference
EA	Each
EF	Evapotranspiration Factor
ELEV	Elevation
EXIST	Existing
FF	Fire Flow
FIG	Figure
FT	Foot
FV	Fixture Value
GAL	Gallon
GEN	Generator
GPD	Gallons Per Day
GPM	Gallons Per Minute
HP	Horse Power
HQ	Head Quarters
HRS	Hours
I	Irrigation
IN	Inch
KW	Kilowatt
LAV	Lavatory
LBS	Pounds
LF	Lineal Feet
MAX	Maximum
MGD	Million Gallons Per Day
MI	Mile
MIN	Minute
MO	Month
NO	Number
NPS	National Park Service
PPM	Parts Per Million
PSI	Pounds Per Square Inch
UR	Urinal
USGS	United States Geological Survey
RES	Reservoir
RF	Rain Fall
RT	Running Time
SF	Square Feet
VC	Visitor Center
VS	Village Store

WC	Water Closet
WK	Week
YL	Yosemite Lodge
YRS	Years

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As the nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, parks and recreation areas, and to ensure the wise use of all these resources. The department also has major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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