Table 3-3
Estimated Units – Current and Build-Out[a]

District Meter Category	Current Units[b]	Total Units at Build-out	
		Unconstrained	Constrained
Residential, services	1,781	5,500	4,500
Multi-family Residential, services	330	2,400 [c]	500 [d]
Commercial, services	87	190 [e]	170 [e]
Industrial, services	1	280 [f]	250 [f]

[a] Represents the potential number of units that could be added through build-out as equivalent dwelling units (EDUs). EDU represents the equivalent of one single family residence. Residential units in build-out projections rounded to the nearest 100. Commercial/industrial units rounded to the nearest 10.
[b] Source: Based on input from District staff and meter data provided by Foresthill PUD.
[c] Based on total potential units from properties with either Commercial or Medium Density land use designation. No reduction is taken for density on commercial units. Units on Commercial parcels already developed have been subtracted out of the increase in residential units (approximately 40 acres vacant @ 21 units per acre=840 multi-family units).
[d] Based on total of potential units from properties with Medium Density land use designation. Assumes no residential development on property with commercial land use designation. Development has been adjusted downward according to the constraints identified on particular parcels. Assumes density no greater than 4 units per acre.
[e] Based on data provided by the Placer County Assessor's Office, total acreage of parcels within the District Boundaries with a Commercial land use designation, but no structure on the property is approximately 50 acres. It is assumed that a commercial use is approved on each 0.5 acres. In the constrained case, development has been adjusted downward according to the constraints identified on particular parcels.
[f] Assumes that approximately 138 acres of undeveloped Industrial property remains within the District service area and that this property will develop as light industrial or commercial type uses. Assumes development of commercial-type use on each remaining 0.5 acre. In the constrained case, development has been adjusted downward according to the constraints identified on particular parcels.

The maximum level of development within the existing District boundary is based on the unconstrained projections. The unconstrained condition, which includes all the land without consideration of constraints, overestimates the level of development, so it is not practicable or realistic. Table 3-3 includes an estimation of the number of potential units (as services) for residential, commercial and industrial service.

The constrained condition represents the best estimate for future development based on current land uses for which the District is obligated to provide treated water service. The water demand factors developed later in this document were used in conjunction with the number of estimated units based on the constrained condition in Table 3-3 to project future water demands.

3.6 HISTORICAL WATER USE AND WATER DEMAND FACTORS

Historical water use is evaluated in this section and used to develop water demand factors for various types of service (e.g. residential, commercial and industrial). Water demand factors represent the historical water use for the various types of development. The water demand factors coupled with land use data developed in Section 3.4 will be used to project future water demands along with appropriate peaking factors. The information developed in this section will be used to assess water supply and treatment, distribution, and storage requirements.

3.6.1 SUMMARY OF WATER PRODUCTION AND PEAKING FACTORS

Water production rates from the District's existing treatment plant were evaluated based on daily operating logs from 2003 through 2005. Production data represents the amount of water produced at the District's water treatment plant (WTP) and delivered to the distribution system as well as water used for operation of the plant including wash down and backwash water. Review of the production data is useful to establish trends, peaking factors, and determine the amount of unaccounted water when coupled with usage and billing records.

3.6.2 ANNUAL PRODUCTION

The annual water production from the WTP is included in Table 3-4. These figures represent total annual water production, which includes backwash water used to clean the filters, which amounts to approximately 20 million gallons annually, but depends on the frequency and duration of backwashes.

Table 3-4
Annual Water Production

Year	Water Production, MG	Annual Rainfall Total[a]
2003	336.3	48.66
2004	386.5	35.17
2005	361.4	72.31

[a] Source: California Department of Water Resources (CDEC), historical accumulated precipitation, Foresthill Ranger Station. Precipitation reported is water year (October 1 through September 30), beginning in October 2002.

Monthly water production patterns from 2003 through 2005 are shown graphically in Figure 3-3. As expected, production rates increase during the spring and summer during the warmer weather months then tail off from September through the winter. The trend seems to be increasing over time with the exception of the 2005 data; however rainfall in water year 2005 was significantly higher than the reported average of 50.82 inches per year and likely reduced the overall water demands during that particular year.

3.6.3 UNACCOUNTED WATER

Unaccounted for water is that which is produced and distributed but is not sold or metered. Sources of unaccounted water include:

- Leaks
- Slow meters
- Theft
- Fire protection
- Un-metered construction water used for flushing pipelines

Table 3-5 includes a summary of historical production and metered water data. The backwash water is not considered to be unaccounted water and was subtracted from the annual totals shown in the table. Unaccounted water has ranged 6 to 12 percent between 2003 through 2005, which is considered excellent. Factors contributing to the District's low unaccounted for water include:

- An aggressive leak detection and repair program that minimizes the amount of water lost due to leaks.
- Construction standards and inspections during construction to ensure new pipelines are designed and installed properly thus reducing future problems in the form of leaks.
- Construction water program to meter construction water.
- Good record keeping monitoring backwash water production and use.
- All services are metered.

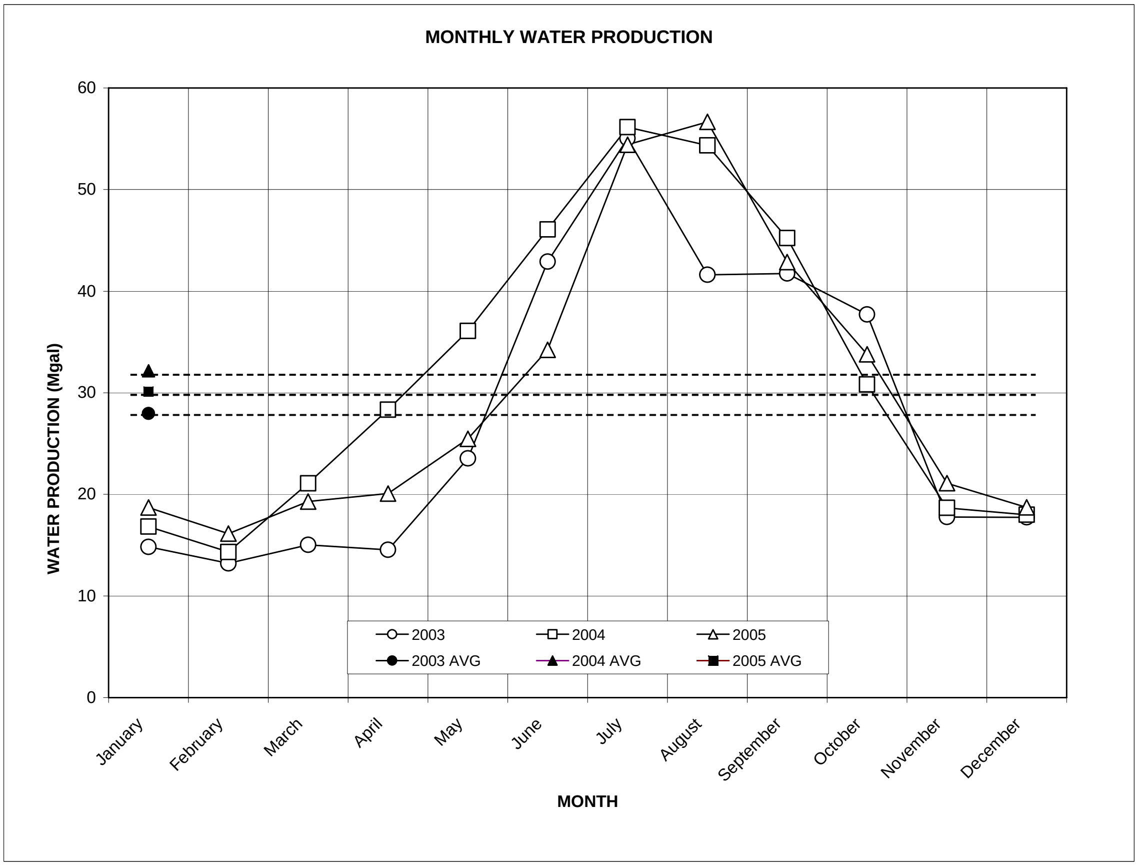


Figure 3-3
Monthly Water Production Data

Table 3-5
Unaccounted Water

Year	Net Annual Production, Mgal[a]	Annual Metered Water, Mgal	Unaccounted Water, %
2003	314.6	295.2	6
2004	364.9	322.7	12
2005[b]	325.4	292.1	10

[a] Annual production data is total production less backwash water.
[b] February 2005 data was thought to be inaccurate and thus not included in the totals. February meter records report approximately 27 MG sold in February 2005; production data reported approximately 16.1 MG produced. Discounting February 2005, the average monthly usage for February during the period reported was approximately 13.3 MG.

The average unaccounted for water based on the 2003-2005 data is 9.3 percent. Unaccounted for water must be included in future water demands projections. For the purpose of estimating supply need to meet future water demands, an unaccounted water factor of 10 percent is used.

3.6.4 PEAKING FACTORS

Peaking factors are necessary to size treatment, storage and distribution system improvements. Key peaking factors expressed as multiples of baseline flows include the maximum day and peak hour demands and are discussed below.

Maximum Day Water Production

Maximum day demand is important and determines the treatment plant capacity and storage requirements. Production data is typically the only daily data available because individual service meters are read on a monthly basis. In the case of the District, the maximum day production would be expected to occur during July or August, as is the case with most systems. Maximum day and month data is summarized in Table 3-6.

Table 3-6
Maximum Day[a]

Month of Max. Day Production	Maximum Day Water Production, Mgal/d	Maximum Monthly Water Production, Mgal/d
2003 – June	2.32	1.8 (July)
2004 – August	2.26	1.8 (July)
2005 - August	2.25	1.8 (August)

[a] Based on 2003-2005 water production data.

Maximum day conditions were determined from plant production data and the ratio of maximum day to average annual ranged from 2.1 to 2.5, which are within the typical range. For planning purposes the maximum day to average annual peaking factor of 2.5 is used.

Peak Hour

Peak hour demands are necessary for sizing distribution and pumping facilities. Peak hour data is not available in most cases, including this one. Therefore typical values must be used which normally range from 1.5 to 1.7 times the maximum day flow. A peak hour peaking factor of 1.7 was used for developing demands within the District.

Summary of Peaking Factors

The peaking factors developed in this section are used for predicting future water demands and are summarized in Table 3-7. The various peaking factors are important for sizing facilities.

Table 3-7
Water Use Peaking Factors

Year	Max Month/Annual Average[a]	Max. Day/Annual Average[b]	Peak Hour/Max. Day[c]
2003	1.775 / 0.921 = 1.9	2.32 / 0.921 = 2.5	-
2004	1.811 / 1.056 = 1.7	2.256 / 1.056 = 2.1	-
2005	1.828 / 0.990 = 1.8	2.246 / 0.990 = 2.3	-
Average	1.8	2.3	1.5 – 1.7
Value Used[d]	N/A	2.5	1.7

[a] Based on Peak Month production, converted into per day units (Mgal/d).
[b] Based on Maximum Daily production, and Annual Average Daily production, with units of Mgal/d.
[c] Peak hour flows are not recorded and typical values from published data are used.
[d] Peaking factor used for projecting future flows in this report.

3.7 WATER DEMAND FACTORS

Improvements to the water supply system necessary to serve future growth depend on the magnitude and location of the water demands throughout the system. For master planning purposes, it is convenient to express demands for each type of development based on a unit demand factor such as gallon per acre per day (gpad), gallon per capita day, or gallon per connection per day. The water demands factors are then applied to land uses throughout the service area to project water demands. Water demand factors are developed in this section.

The District's billing records are very complete and provide excellent information for developing historical water use. Data are collected and maintained from the billing records and include the type of service, meter size, and consumptive use information.

Annual average water demands were developed for each type of customer summarized below, and the resulting demand factors are shown in Table 3-8.

- **Residential**. Represents single-family dwellings on one parcel.
- **Multi-family Residential**. Represents two or more dwelling units on one parcel (served by a single meter).
- **Commercial**. Represents the range of commercial uses including office space, hotels, restaurants, convenience stores, veterinary hospitals, medical offices, dental offices, day care centers, banks, laundry mats, carwashes, warehousing, schools and churches.

- **Industrial**. Represents the range of industrial uses allowed by County land use regulation. However, given the nature of existing uses in the Foresthill area and comments made by CDA and District staff, the Industrial property within the District service area is expected to consist primarily of light industrial or commercial uses in the future.

Water usage data included in Table 3-8 is based on the 2003-2005 billing records and a comparison with the demand factors developed in the 1992 Water Master Plan. The 1992 Water Master Plan adjusted water demands in anticipation of an increase in the pattern of consumption within the District over time (aka consumption creep). The 1992 Master Plan added a factor of 35 percent to the total demand within the District as a means of accounting for consumption creep.

Table 3-8
Water Use Comparison, gpd/unit

Water User	2003 – 2005[a]	1992 Water Master Plan [b]	
		Uncorrected[c]	Corrected[d]
Residential	378	303	430
Multi-family Residential[e]	244	234	330
Commercial	1,389	1004	1,420
Industrial[f]	219	159,000	159,100

[a] Calculated from 2003, 2004, and 2005 meter data.
[b] Based on Water System Master Plan, Giberson & Associates, 1992.
[c] Usage does not include unaccounted water loss of 5%, or the 35% increase factor included in the 1992 plan.
[d] Corrected values include 5% unaccounted water and the 35% increase factor – these values were previously used for projecting water demands within the District in the 1992 Water System Master Plan.
[e] Based on 330 existing Multi-family Residential units (per discussions with Foresthill PUD).
[f] Based on current industrial uses; 1992 industrial usage was much higher as a result of the lumber mill operation, which is no longer in service.

As noted in the table, the lumber mill was in operation and water was supplied from the District. The milling process was water intensive, and skewed the industrial water demand factor upwards to around 159,000 gpd/unit. The mill is no longer in operation; therefore the Industrial water demand numbers derived from the 2003 – 2005 meter data are considerably lower. For future planning purposes it is assumed that industrial development will not include water intensive development such as the lumber mill.

The “uncorrected” values in Table 3-8, represent actual usage for the various services and are directly comparable to recorded water use rates shown between 2003-2005. Water usage within the District has in fact increased as predicted in the 1992 Water Master Plan.

The increase usage rate is likely due to changing demographics within the foothill community as a whole. In 1992, Foresthill was somewhat isolated due to its location and many of the homes were used for vacationing and seasonal use. Recent improvements to Foresthill Road have made access to the area safer and faster. Due to the relatively high cost of land in Placer County and the desire to develop in Placer County, the demographics are changing in the foothills. This change is affecting other foothill communities along the Interstate 80 corridor including Meadow Vista, Weimar, Colfax and Alta.

As a result of the overall trend affecting the demographics of the foothills generally and recent roadway improvements, more people are moving to Foresthill as a primary residence, and new homes being constructed are more typical of neighboring communities such as Auburn. These homes are generally larger with more significant landscaping, which are two of the primary factors affecting residential water use.

Water use within the District was compared with neighboring communities in the 1992 Water Master Plan. At that time, water use within Foresthill was about 30 percent lower than the neighboring communities. Residential water use is still lower in Foresthill than compared to neighboring communities as discussed in Section 3.2.1 below. Factors previously cited that contributed to lower unit demands within the District at the time the 1992 Water Master Plan was developed included type of landscaping (limited), home size, and lifestyle of residents in Foresthill, many of which are no longer valid.

Therefore it is prudent to assume consumptive use will continue to increase. The extent of the increase cannot be known. The best indication is likely other communities in the area. These are considered to be the most appropriate factors to apply in projecting future demand. The recommended water demand factors for estimating future water demands is included in Table 3-9.

Table 3-9
Recommended Water Demand Factors

Water User	Annual Average Water Demand Factor, gpd/unit[a]
Residential	450
Multi-family Residential	330
Commercial	1,420
Industrial	250

[a] Does not include unaccounted water. Residential and multi-family residential factors listed are in units of gpd/EDU. Commercial and industrial factors are in units of gpd/connection.

3.7.1 WATER USE COMPARISON

In an effort to provide context to the foregoing analysis, water demands reported by a number of neighboring water agencies are presented in Table 3-10. The data in Table 3-10 support the usage data presented here for the District. It should be noted that the District, unlike neighboring water purveyors, supplies only treated water for all uses. Some of the other agencies listed provide raw (or recycled) water to users with significant irrigation demand, which is not reflected in the unit consumption rate. The District does not currently provide, nor are they planning to install a dual system to provide irrigation water for customers.

Table 3-10
Neighboring Water Agency Demands (gpd/unit)

Classification	Roseville [a]	Georgetown Divide [b]	El Dorado [c]	PCWA [d]	Foresthill [e]
Residential	403	420	545	621	378
Multi-Residential	4,709	-	232	-	244
Commercial	825	1,654	1,446	1,857	1,389
Industrial	110,166	-	-	2,166	219

[a] Projected 2005 data; Source: 2005 City of Roseville Urban Water Management Plan, Table 2-8 and Table 2-9.
[b] Average from 2003 – 2005 use data. Source: Georgetown Divide PUD
[c] Average from 2003 – 2005 use data. Source: El Dorado Irrigation District (EID) 2006 Water Resource and Service Reliability Report.
[d] PCWA, Zone 1, Upper (Auburn and Newcastle). Source: PCWA Integrated Water Resources Plan, August 2006. Residential (at <1 EDU/acre) units are gpd/EDU. Commercial and Industrial units are gpd/acre.
[e] Average from actual 2003 – 2005 data. Multi-Residential based on 330 units. Source: Foresthill PUD.

3.8 PROJECTED WATER DEMANDS

The land uses and development projections discussed in prior sections have been combined with the water demand and peaking factors to project future water demands within the District. projected water demands are summarized in Table 3-11 based on the constrained build-out projections discussed in Section 3.4.

Table 3-11
Water Demand Estimates

Demands	Current	Build-Out	1992 Water Master Plan
Residential, gpd	673,200	2,025,000	1,662,380
Multi-family Residential, gpd	80,500	165,000	317,460
Commercial, gpd	121,800	238,000	191,700
Industrial, gpd	250	62,500	159,100
Average Day Demand (ADD), gpd [a]	875,750	2,490,500	2,330,640
Production	**Current**	**Build-Out**	
Unaccounted Water (UA), gpd [b]	87,600	249,050	
Total Avg. Day w/UA, gpd [c]	963,350	2,739,550	
Max. Day Demand, gpd [d,e]	2,280,000	6,475,300	
Peak Hour, gpm [f]	2,650	7,525	

[a] Based on demands calculated from land uses and water demand factors.
[b] Unaccounted water calculated at 10-percent of demands.
[c] Based on ADD + UA.
[d] MDD based on historical data from current condition.
[e] MDD for build-out estimated based on (2.5 x ADD) + UA.
[f] Peak hour demand estimated based on (1.7 x MDD) + UA.

The current average daily production demand is just under 1 MGD including unaccounted water. At build-out, the average daily demand is projected to be approximately 2.7 MGD, including unaccounted water.

Unaccounted water is included and based on 10 percent of the demand. Unaccounted water must be included for planning water supply and treatment plant capacity. Unaccounted water is relatively constant and peaking factors do not apply; therefore unaccounted for water was added to the maximum day and peak hour demands values (not multiplied).

The demand estimates included herein are slightly higher than those predicted in the 1992 Water Master Plan, which was written almost 15 years ago. Although land uses used in the 1992 document were based on the 1981 Community Plan, as was the case herein, the predicted demands are higher. The increased demand is attributed to:

1. Demand to develop in the Foresthill area has increased, and more properties are now primary residences as opposed to seasonal homes which increases water consumption rates;
2. Homes being constructed are more typical of development in neighboring communities such as Auburn and Colfax, and are larger with outside landscaping, both factors that increase water demands; and
3. Residential demand factors used in this analysis are higher. The increase is due to the changing demographics and type of development occurring.

Even using the increased demand factors for residential development, the unit demands are lower than surrounding communities with similar demographics.

To conveniently express development as it relates to water demands within the District the concept of an equivalent dwelling unit (EDU) is introduced. For the purposes of this Master Plan, an EDU represents the demand placed on the system by a single family residential unit, and is not necessarily representative of the number of service connections.

The number of EDUs is calculated by dividing the total water production by the single family residential usage rate, including unaccounted water. The estimated number of EDUs under current and build-out scenarios is summarized below, and calculated based on 450 gpd demand plus 10-percent unaccounted water (495 gpd/EDU). An additional 3,588 EDU are anticipated through build-out.

Current: 1,946

Build-out: 5,534

The annual water demand based on the average daily demand, including unaccounted water, under current and future demand conditions within the District boundary are as follows:

Current: 1,079 acre-ft

Build-out: 3,069 acre-ft

Section 4

Water Supply Yield Study

The estimated yield from the Sugar Pine Reservoir Project is calculated in this section. The currently accepted estimated yield from the project was provided in the Water System Master Plan prepared in 1992 by Giberson & Associates, Inc. (the 1992 Master Plan). The District desired to revisit the estimated yield by updating the historical data available since the 1992 Water System Master Plan was prepared. ECORP Consulting prepared the analysis with input from ECO:LOGIC and District staff. Previous yield estimates utilized a statistical method using a Log Pearson Type III analysis, a drought scenario known as the design event, and data from a period of record from 1956 through 1991.

In this study, two methods are used to calculate the estimated yield of the Sugar Pine Reservoir. The first includes an update of the Log Pearson Type III analysis using the District's adopted Reliability Standard, and extending the period of record using an additional 12 years of stream flow data through 2003. The yield is also calculated using the OASIS model, developed by HydroLogics, Inc. Oasis is a comprehensive water resources systems modeling software which uses multiple input such as reservoir operating data (e.g. spills, releases, elevations, etc.), climatic conditions, and demand patterns and simulates the reservoir responses over time based on the input/outputs.

This section presents the methods used for hydrology development, drought frequency analysis, yield determination and simulation, and presents the results.

4.1 HYDROLOGY DEVELOPMENT

Unimpaired daily flow records for North Shirttail Creek exist from 1956 through 1984. After 1985, flow records are impaired by Sugar Pine Reservoir operations. Prior to the construction of Sugar Pine Dam, the daily USGS flow records were converted into acre-feet, and then accumulated into monthly volumes. After the construction of the Dam, operations records were used to construct the hydrology used in the modeling analyses.

Sugar Pine Reservoir operations reports contain approximately 2 records per week prior to 1991, and one record per week beginning 1991. Reports contain more records during times of high flow or extremely high storage. Chad Odell, Lead Treatment Plant Operator, explained how the data was collected, calculated and recorded. Each record contains an average flow for the period since the last record for fish releases, spills, sleeve valve releases, and flows through Sugar Pine Pipeline. The operation records also contain reservoir elevations and storage. Spills from Sugar Pine Reservoir are calculated using reservoir elevations and the spillway rating curve. Reservoir elevations from hourly operation diaries were acquired during times of high storage when operation records contain no data. These records are accumulated into monthly volumes. Inflow to Sugar Pine Reservoir from North Shirttail Creek can be calculated from those monthly volumes as follows:

Inflow = Δ EOM Storage + Sugar Pine Pipeline + Sugar Pine Fish Release + Sugar Pine Spills + Sugar Pine Sleeve Valve + Evaporation

Inflow for the period of record is built from USGS records for 1 October 1956 through 31 July 1984, and from the operations records for 1 August 1984 through 31 December 2003. Monthly hydrology was used for this analysis.

As a final check, the calculated inflow record was input into an OASIS model of the Foresthill PUD system. For a calibration run, the reservoir releases to North Shirttail Creek and Sugar Pine pipeline were constrained to be equal to the historical releases. Oasis model outputs of Sugar Pine storage were compared to historical storage to ensure that the inflow record and evaporation estimates are accurate. The comparison of these two storage levels is shown in Figure 4-1.

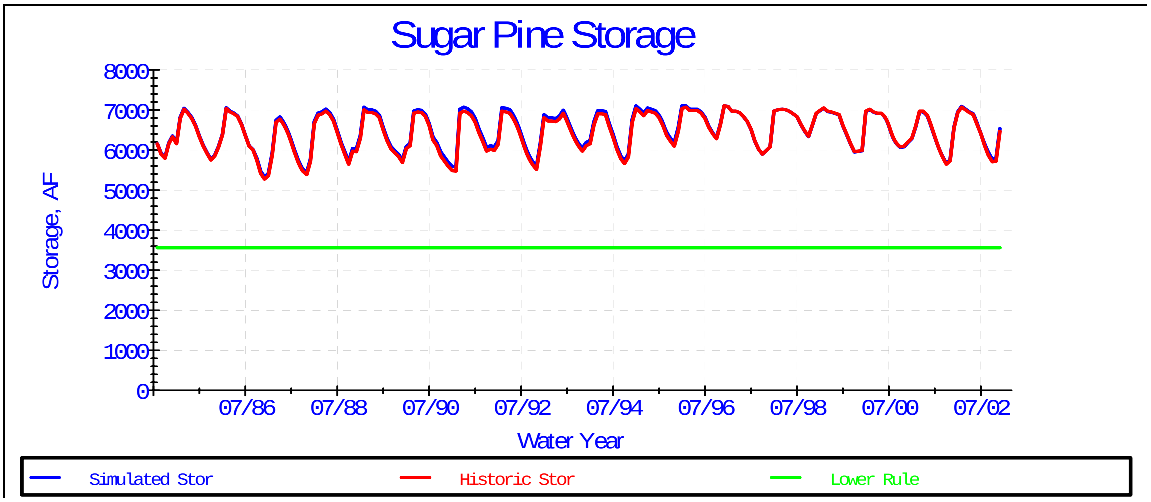


Figure 4-1
Sugar Pine Storage

As shown above, the model results indicate that the simulated storage and recorded storage are very close. This indicates that the calculated inflow and evaporation estimates are reasonable for the 1984 through 2003 period. Combining the USGS gage records prior to the construction of Sugar Pine Dam and the calculated inflow records after construction gives a complete record for the 1958 through 2003 period.

4.2 WATER SUPPLY RELIABILITY STANDARD

Foresthill PUD has adopted a Water Supply Reliability Standard (Reliability Standard) as a method to determine the yield of the project. The 1992 Master Plan defines the Reliability Standard as a 10-year drought followed by a 100-year drought followed by a mean year. To determine these levels, the 1992 Master Plan analyzed 36 water years of annual yield from North Shirttail Creek, 1956 through 1991. A frequency analysis was done to relate the magnitude of the periodic low annual yields from North Shirttail Creek to their frequency of occurrence through the use of Log-Pearson type III probability distributions. From this analysis, annual volumes for a 10-year drought, 100-year drought, and a mean year were determined. The mean used in the 1992 Master Plan was derived by performing a log transform of each of the calculated annual inflows to Sugar Pine, then calculating the mean of those logs. The resulting mean log was then converted back to a flow by taking the anti-log of the mean log.

These annual volumes were distributed to a monthly inflow using a predetermined pattern. The mean year was distributed using a pattern based on the average of all 36 years. The drought years were distributed using a pattern based on the average of the 9-lowest years. A water budget was developed to track system storage through this three-year period. The 1992 Master Plan reports that the District can reliably deliver 2610 acre-feet per year. During the 10-100-mean sequence, the minimum reservoir volume is calculated to go down to 1349 AF.

4.3 DROUGHT FREQUENCY ANALYSIS

The analysis for the 1992 Master Plan used annual flow data from 1956 through 1991. The 1992 Master Plan reports that prior to construction of Sugar Pine Reservoir, the Bureau of Reclamation collected flow data on North Shirttail Creek from 1955 through 1985. Since 1985, the District has been collecting operational data and calculating the inflow to the reservoir. Figure 4-2 illustrates both the data used for the 1992 Master Plan, and the data developed by ECORP.

The period used for computing the annual inflow by the 1992 Master Plan is from 1 June through 31 May. For comparison of the annual inflow, the new data was also totaled from 1 June through 31 May. However, this period reduces the number of years available for comparison. The published USGS gage data for North Shirttail Creek begins in October of 1956. Because the 1992 Master Plan uses a June through May “water year”, the first complete “water year” doesn’t begin until June of 1957. The method used in the 1992 Master Plan includes June 1957 through December 1957 in “water year” 1958. Therefore, the period of record for this updated analysis is from 1958 through 2003. Much of the data during the 1958 through 1991 period is very similar with the exception of 1976, 1989, and 1990. The differences in 1989 and 1990 may be explained by the way the sleeve valve and spill data is interpreted. The reason for the differences in the 1976 annual total is unknown.

Because the 1976-77 period is before the construction of Sugar Pine reservoir, the flow data comes from the USGS gage #11426400 records, not operational records. The differences in 1976 are of particular concern because the 1976-77 drought is the driest two year period for the 1958 through 2003 period of record and it defines the critical period for this system. The 1976 and

1977 critical period is more severe than the design event described in the Reliability Standard and should be used to help define drought operations policy.

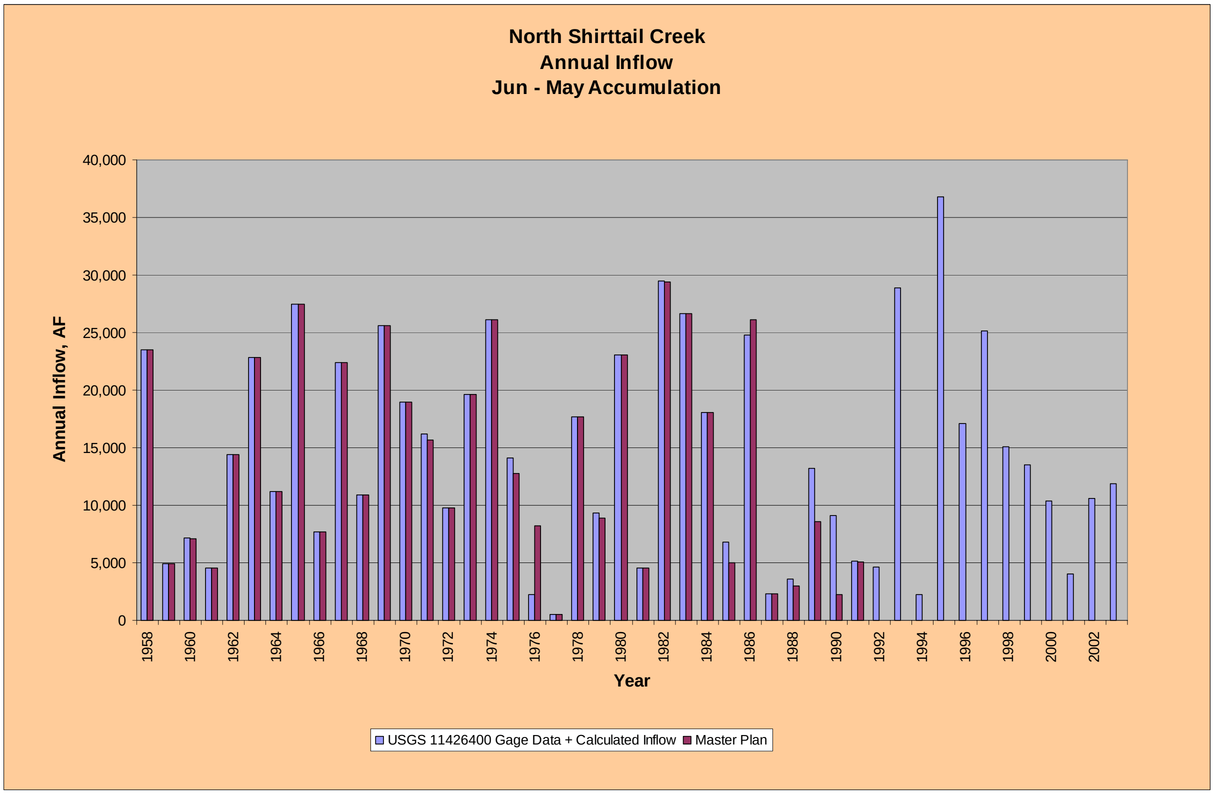


Figure 4-2
Annual Inflow, North Shirttail Creek

4.4 LOG PEARSON TYPE III ANALYSIS OF 1958 – 2003 HYDROLOGY DATA

Using the June through May annual inflow totals, a Log Pearson Type III distribution was performed on the 1958 through 2003 annual inflow data. Table 4-1 is a summary of the analysis. The results of the Log Pearson Type III analysis are located in the Appendix A.

Using the results of the Log Pearson Type III analysis, a simulation study was done using the reliability standard method. The updated analysis confirmed the yield calculated in the 1992 Master Plan. A comparison of the Master Plan and updated annual yield values are shown in Table 4-2. The inclusion of 13 years of updated data hasn't significantly changed the distribution.

Figure 4-3 illustrates the annual inflow to Sugar Pine Reservoir for the 1958 through 2003 period and a plot of the statistical 5, 10, 25 and 100 year droughts and the mean annual flow derived from the drought frequency curve.

Table 4-1
Annual Inflow Summary 1958 - 2003

Water Year of Approximate Magnitude	Annual Yield (ac-ft)	Probability of Recurrence	Approximate Recurrence Interval
1977	700	1%	100 year
N/A	1,100	2%	50 year
1976	1,750	4%	25 year
1988	3,350	10%	10 year
1991	5,650	20%	5 year
N/A	10,900		Anti-log of mean log
N/A	12,800	50%	2 year
1962	14,400	56%	Measured/Calculated Average

Table 4-2
Master Plan and Updated Annual Yield Values Comparison

Master Plan Annual Yield [a] (ac-ft)	Updated Annual Yield [b] (ac-ft)	Approximate Recurrence Interval
600	700	100 year
1,000	1,100	50 year
1,400	1,750	25 year
3,000	3,350	10 year
5,500	5,650	5 year
10,700	10,900	Mean
12,800	12,900	2 year
14,400	14,400	Measured Average

[a] Based on Water System Master Plan, Giberson & Associates, 1992.
[b] Based on results of the current study.

4.5 SIMULATION MODEL DEVELOPMENT

A simulation model of Sugar Pine reservoir was developed to evaluate the period of record operations and the design event as described in the Reliability Standard. Assumptions used in the simulation model include the physical characteristics of Sugar Pine reservoir, storage and diversion rights, downstream water rights, fish water release requirements and recreation requirements based on the Sugar Pine Fish Agreement dated 26 January 1967, and evaporation and rainfall information. With the exception of the physical characteristics of Sugar Pine reservoir, all the assumptions used in the simulation model were taken from the 1992 Master Plan. Below is a summary of the assumptions.

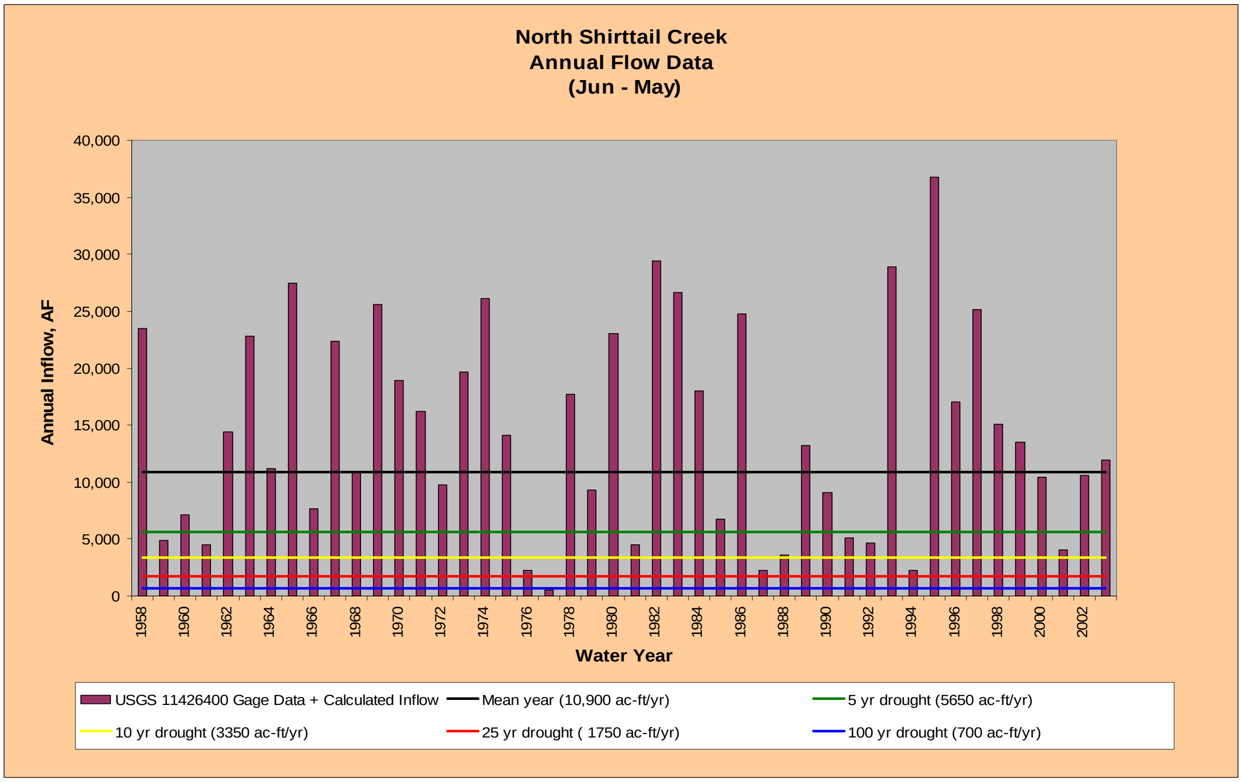


Figure 4-3
Annual Flow Data, North Shirttail Creek

4.5.1 Direct Diversion Rights

Under water right application No. 21945, the District has a direct diversion right of 18 cfs from 1 November to 30 June. This water is diverted directly from North Shirttail Creek.

4.5.2 Diversion from Storage Rights

Under water right application No. 21945, the District is allowed to store up to 15,400 acre-feet annually. This water must be stored from 1 November to 30 June

4.5.3 Fish Flow Requirements

Fish flow requirements are based on the Sugar Pine Fish Agreement, 26 January 1967. The reservoir must release 5 cfs from 1 February to 31 May, and 2 cfs from 1 June through 31 January. These releases are limited to reservoir inflow when inflow is less than the required release. When reservoir inflow is less than 0.5 cfs, fish flow requirement is 0.5 cfs.

4.5.4 Downstream Water Rights

The District has downstream obligations of 183 acre-feet annually, on the following pattern:

January: 4 acres	July: 32 acres
February: 4 acres	August: 32 acres

March: 6 acres	September: 20 acres
April: 20 acres	October: 15 acres
May: 20 acres	November: 4 acres
June: 2 acres	December: 4 acres

These demands are limited to the reservoir inflow.

4.5.5 Recreation Requirements

The Sugar Pine Fish Agreement, 26 January 1967, also outlined recreation requirements for Sugar Pine Reservoir. A minimum pool of 3,560 acre-feet should be maintained except to meet fish flow requirements or downstream obligations. A minimum pool of 1,100 acre-feet must be maintained regardless of demands.

4.6 STUDY RESULTS

Four studies were completed for this analysis. Studies one and two were developed for the specific purpose of duplicating the Supply Reliability method contained in the 1992 Master Plan. The method was applied to both the current reservoir size and to an enlarged Sugar Pine Reservoir. Studies three and four were developed to identify and evaluate the 1976 and 1977 critical period for the project through a simulation analysis. The following is a list of the studies.

1. Design event analysis for the existing Sugar Pine configuration
2. Design event analysis for the enlarged Sugar Pine configuration
3. Period of record study for the existing Sugar Pine configuration
4. Period of record study for the enlarged Sugar Pine configuration

STUDY 1 – LOG PEARSON ANALYSIS – EXISTING RESERVOIR

Study 1 was included to update the 1992 Master Plan determination of average annual delivery using the design event. As mentioned above the design event is a 10-year drought followed by a 100-year drought followed by a mean year. The results of this study indicate that approximately 2,750 ac-ft per year could be delivered during the design event. This is slightly more than the 2,610 ac-ft reported in the 1992 Master Plan. As in the 1992 Master Plan, a storage buffer was preserved in the reservoir as a safety measure. The minimum pool for this study was 1364 ac-ft. The Study 1 operations table is included in Appendix A.

STUDY 2 - LOG PEARSON ANALYSIS – ENLARGED RESERVOIR

Study 2 also includes the design event described in the 1992 Master Plan. However, rather than using a 7,000 ac-ft reservoir, this study assumed that Sugar Pine reservoir could impound 10,658 ac-ft. Along with the increase in the size of the reservoir, the agreement with the Bureau of Reclamation limiting the maximum diversion of 2,800 ac-ft was removed. All other assumptions remained. The results of this study indicate that approximately 4,150 ac-ft per year could be delivered during the design event. As in study 1, a storage buffer was preserved in the reservoir as a safety measure. The minimum pool for this study was 1355 ac-ft. The mean year was not wet enough to refill the increased reservoir by the end of the design event, however by May of the mean year the reservoir storage reached 8,785 ac-ft. The results of this study reflect current operating criteria. It is likely that any environmental review process necessary for modification of the dam or spillway gates would result in changes to the flow and storage requirements. These potential changes may influence the District's ability to deliver water and a new yield study should be performed if operating criteria change. The Study 2 operations table is included in Appendix A.

STUDY 3 – OASIS SIMULATION – EXISTING RESERVOIR

Study 3 includes the 1958 through 2003 period of record and the current operating assumptions to determine the critical period for the project. The results of this study indicate that May 1975 through January 1978 is the critical period. The historic inflow records indicate that 1976 and 1977 period is approximately equal to a 25 year drought followed by a 100 year drought. During this critical period the annual average delivery is 2,150 ac-ft. Unlike the previous two studies, literally no storage buffer remained in the reservoir. The minimum pool in this study is 1,120 ac-ft. The May 1975 through January 1978 historical sequence is worse than the design event and could be used to determine drought operations policy. As annual demands increase to near 2,000 ac-ft, the District should be prepared to impose deficiencies on customers during drought events such as the critical period. The Study 3 operations table is included in Appendix A.

STUDY 4 - OASIS SIMULATION – ENLARGED RESERVOIR

Study 4 also includes the 1958 through 2003 period of record. As in study 2, Sugar Pine Reservoir storage capacity was increased to 10,658 ac-ft and the agreement with the Bureau of Reclamation limiting the maximum diversion of 2,800 ac-ft was removed. The results of this study indicate that May 1975 through March 1978 is the critical period for this scenario. When compared to the current facility size, two additional months of inflow were needed to refill the increased reservoir capacity. The results of this study indicate that approximately 3,450 ac-ft per year could be delivered during the critical period. The minimum pool for this study was 1,385 ac-ft. As in Study 2, the results of this study reflect current operating criteria. It is likely that any environmental review process necessary for modification of the dam or spillway gates would result in changes to the flow and storage requirements. These potential changes may influence the District's ability to deliver water and a new yield study should be performed if operating criteria change. The Study 4 operations table is included in Appendix A.

4-7 CONCLUSIONS

The analyses contained in this section were used to estimate the yield of the project using a hydrology that began in 1957 and was extended from 1991 through 2003. The hydrology development process was used to not only extend the hydrology, but also verify the hydrology used in the 1992 Master Plan. A verification process was used to identify annual total volumes that were inconsistent with those in the 1992 Master Plan. Although most annual volumes were nearly identical, 1976, 1989 and 1990 were significantly different. Differences in annual volumes for 1989 and 1990 can be explained by differences in interpretation of the operations records, but the difference in the annual volume for 1976 is unknown, which is the critical period for the system.

The Log Pearson Type III analysis was performed on the extended hydrology dataset to identify annual volumes for the 10 year, 100 year and mean year drought scenarios. This sequence is called the Design Event and is used as part of the Reliability Standard to compute the yield for the project. Using this method with the extended hydrology record, the updated yield of the project is approximately 2,750 ac-ft, which is slightly higher than 2,610 ac-ft reported in the 1992 Master Plan. However, the analysis identified the 1975 through 1978 period as the critical period for the project and is more severe than the Design Event. Further analysis using a simulation based on the critical period identified that the annual delivery during the 1975 through 1978 period is approximately 2,150 ac-ft, significantly less than that calculated using the Design Event based on statistical analysis.

Additional studies were done to evaluate the water supply benefits of an enlarged Sugar Pine Dam. Using the Design Event, the yield of the project is 4,150 ac-ft. Using the 1975 through 1978 critical period, the annual delivery is approximately 3,450 ac-ft. Due to the severity of the 1975 through 1978 drought, the District may want to use this period to develop drought operations policy or may want to consider using it to revise the determination of project yield.

As discussed in Section 3, under current development, approximately 1,079 acre-ft of water is needed to meet the current level of development and is well below the estimated reservoir yield during the critical design period. However, under the build-out condition, approximately 3,069 acre-ft of water is needed to meet projected demands. Under the current reservoir configuration conservation during the critical dry period would be required and is discussed in more detail in Section 8 of this report.

Section 5

Water Treatment Facilities

Water treatment facilities are discussed in this section, including a description of existing facilities currently in operation and improvements to correct existing deficiencies and expand the capacity to serve future growth.

5.1 EXISTING SYSTEM

Existing raw water conveyance, treatment, and storage facilities are discussed in this section. Figure 5-1 includes a schematic of the overall raw water storage/supply, treatment processes and treated water storage facilities. Figure 5-2 includes a site layout with major facilities shown. Descriptions of the facilities are included below.

5.1.1 RAW WATER SUPPLY

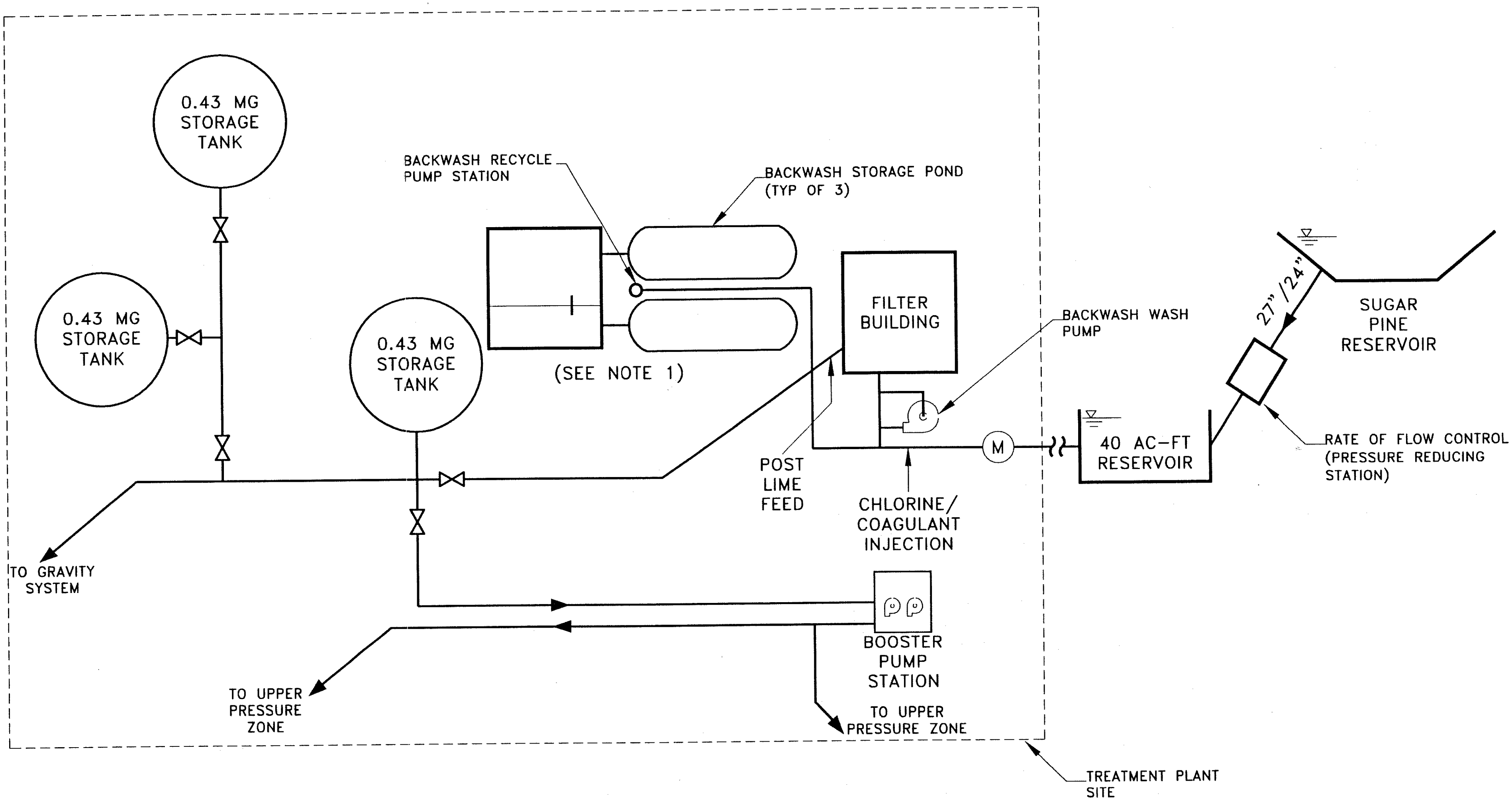
The District's primary water supply is North Shirttail Creek. Sugar Pine Dam was constructed on North Shirttail Creek by the Bureau of Reclamation (the Bureau) in the 1980's. The District purchased the project from the Bureau in 2003. The storage impoundment behind the dam is referred to as the Sugar Pine Reservoir.

Raw water from the Sugar Pine Reservoir is piped to the 40-acre foot storage reservoir. Water is conveyed from Sugar Pine Reservoir through approximately eight miles of ductile iron pipeline ranging in diameters from 27 to 24-inches. The 40-acre foot reservoir can also be filled with water from Mill Creek. Flow from Mill Creek is maximized to preserve the storage capacity in Sugar Pine Reservoir. Flow into the 40-acre foot storage reservoir is controlled through a pressure/flow regulating structure located near the 40-acre foot reservoir. The level in the reservoir is controlled automatically by a float sensor.

Raw water is conveyed to the treatment plant by gravity through a 21-inch diameter pipeline. Raw water entering the treatment plant is metered through a flow tube located in a vault outside of the treatment plant. Plant flow is controlled through a rate of flow control valve located at the filter outlet manifold.

5.1.2 TREATMENT SYSTEM

The treatment plant is considered a direct filtration plant. Two dual media pressure filters provide treatment. Table 5-1 includes the basic design criteria for the treatment plant. Two steel pressure filters provide filtration. Each filter has an area of 364 ft^2 each filter has two cells. The allowable loading rates for dual media pressure filters is 3 gallons per minute per square foot (gpm/ ft^2), resulting in a maximum allowable flow of 1,092 gallons per minute (gpm) per filter. The total flow is 2,184 gpm, or 3 million gallons per day (nominal).



NOTES:

1. BACKWASH WATER IS PERCOLATED AND NOT RECYCLED; NO OFFSITE DISCHARGE OF BACKWASH WATER OCCURS.

FIGURE 5-1 EXISTING WATER TREATMENT PLANT SCHEMATIC